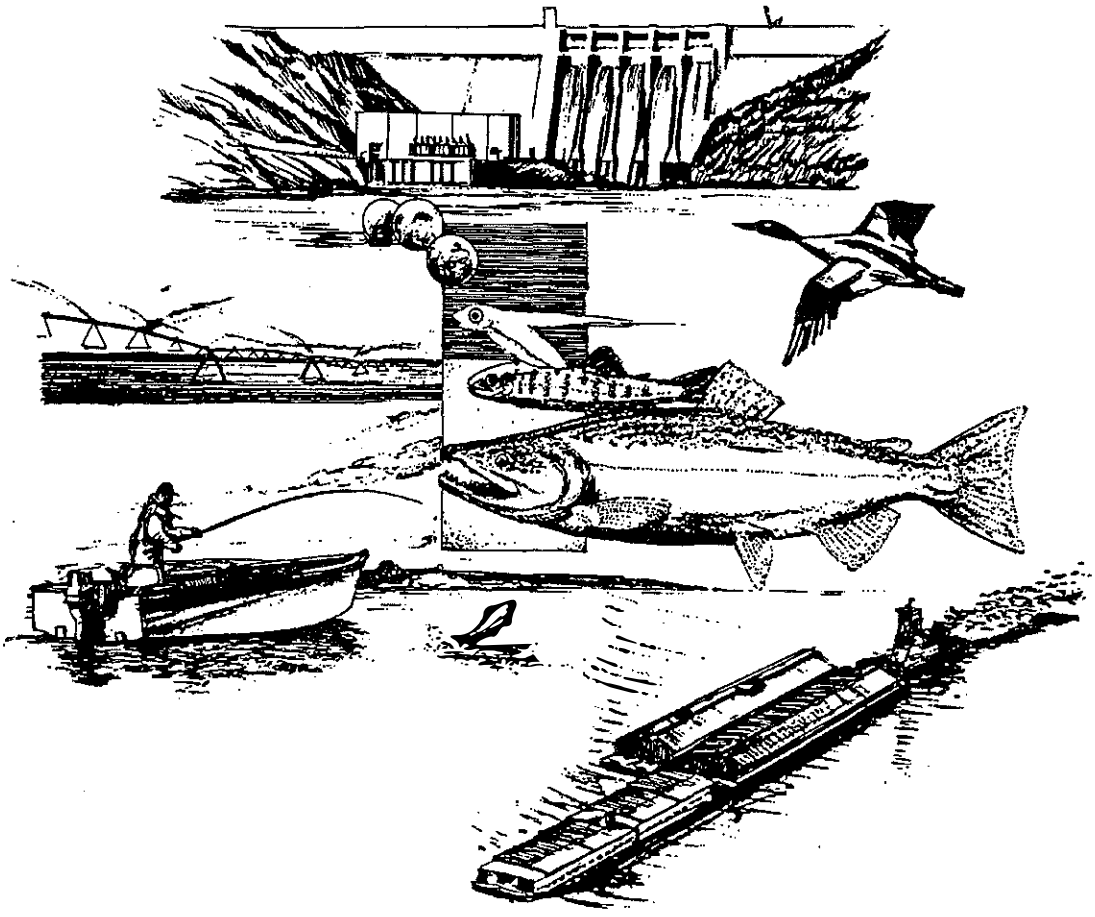
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FINAL

Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon Supplemental Environmental Impact Statement



US Army Corps of Engineers

Bureau of Reclamation

Bonneville Power Administration

March 1993



Printed on Recycled Paper

INTERIM COLUMBIA AND SNAKE RIVER FLOW IMPROVEMENT MEASURES FOR SALMON FINAL SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT (SEIS)

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Comments must be received:

Within 30 days of the publishing of the Notice of Availability of the final SEIS in the Federal Register

Abstract:

Public comments are sought on this final SEIS, which supplements the 1992 Columbia River Salmon Flow Measures Options Analysis (OA)/Environmental Impact Statement (EIS). The Corps of Engineers, in cooperation with the Bonneville Power Administration and the Bureau of Reclamation proposes five alternatives to improve flows of water in the lower Columbia-Snake rivers in 1993 and future years to assist the migration of juvenile and adult anadromous fish past eight hydropower dams. These are: (1) Without Project (no action) Alternative, (2) the 1992 Operation, (3) the 1992 Operation with Libby/Hungry Horse Sensitivity, (4) a Modified 1992 Operation with Improvements to Salmon Flows from Dworshak, and (5) a Modified 1992 Operation with Upper Snake Sensitivity. Alternative 4, Modified 1992 Operations, has been identified as the preferred alternative.

ACOE/2-12-93/03814A

ABSTRACT

This Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon Final Supplemental Environmental Impact Statement (SEIS) evaluates the impacts of several alternatives to operate certain dams and reservoirs in the Columbia-Snake River System during 1993 and future years until a plan of action is developed resulting from ongoing long-term studies. The SEIS has been prepared by the U.S. Army Corps of Engineers (Corps), in cooperation with the Bonneville Power Administration (BPA) and the Bureau of Reclamation (BoR). The proposed action is being considered in response to the listing by National Marine Fisheries Service (NMFS) of the Snake River sockeye salmon as an endangered species under the Endangered Species Act (ESA) on December 20, 1991, and the Snake River fall and spring/summer chinook salmon as threatened species effective May 22, 1992.

The Council on Environmental Quality (CEQ) guidelines direct Federal agencies (such as the Corps) to prepare supplements to final environmental impact statements if: 1) there are substantial changes in the project that are relevant to environmental concerns; 2) there is significant new information relevant to environmental concerns; or 3) the agency determines that the purposes of the National Environmental Policy Act (NEPA) will be furthered by doing so (40 CFR 1502.9). The SEIS examines actions similar to those evaluated in the Columbia River Salmon Flow Measures 1992 Options Analysis/ Environmental Impact Statement (OA/EIS, 1992), but as recurring annual events over a longer time period. Furthermore, it analyzes the impacts of such actions on projects not addressed in the OA/EIS.

To conform to CEQ guidelines (40 CFR 1502.20), this SEIS is tiered to the 1992 OA/EIS. This means that previous discussions and analyses from the OA/EIS, if there has been no change, are generally summarized and incorporated by reference into the SEIS.

The SEIS addresses water management activities to be implemented in 1993 and planned for future years until the plan of action may be changed as a result of long-term studies currently underway. The actions considered in the SEIS involve some combination of measures similar to those selected in the 1992 OA/EIS and identified through consultation with NMFS under Section 7 of the ESA.

Specifically, this SEIS presents five alternatives:

1. Without project conditions, or the no-action alternative, which represent water management actions undertaken from 1985 through 1990.

2. The 1992 operation alternative excluding the March drawdown test of Lower Granite and Little Goose.

3. The 1992 operation alternative (without the March drawdown test) modeled to display potential impacts to Libby and Hungry Horse under different operating assumptions.

4. A modified 1992 operation alternative (without the March test drawdown), including improvements to salmon flows from Dworshak.

5. The modified 1992 operation alternative (without the March test drawdown), modeled to show no water from the upper Snake.

As with the 1992 OA/EIS, the environmental impacts of the proposed actions considered in this SEIS include the effects of altering normal river operations on a number of resource areas. These are water quality, anadromous fish, resident fish, wildlife, soils, air quality, transportation, agriculture, power, recreation, aesthetics, cultural resources, socioeconomics, and project structures.

The fourth alternative, involving modifications to the 1992 operating plan, has been identified as the preferred alternative. It was selected on the basis

of salmon survival effects, cost effectiveness, environmental effects, and the scope of existing authorities.

The following public workshops/hearings were held to obtain oral comments on the draft SEIS:

November 4, 1992 Libby, MT
November 5, 1992 Kalispell, MT
November 9, 1992 Orofino, ID
November 10, 1992 Lewiston, ID
November 12, 1992 Boise, ID
November 16, 1992 Portland, OR
November 17, 1992 Hermiston, OR
November 18, 1992 Pasco, WA
November 19, 1992 Grand Coulee, WA

The public comment period on the draft SEIS was October 23 to December 7, 1992. Written comments on the final SEIS can be sent to:

Department of the Army
Walla Walla District
Corps of Engineers
Building 602
City-County Airport
Walla Walla, WA 99362-6619

INTERIM COLUMBIA AND SNAKE RIVER FLOW IMPROVEMENT MEASURES FOR SALMON FINAL SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT (SEIS)

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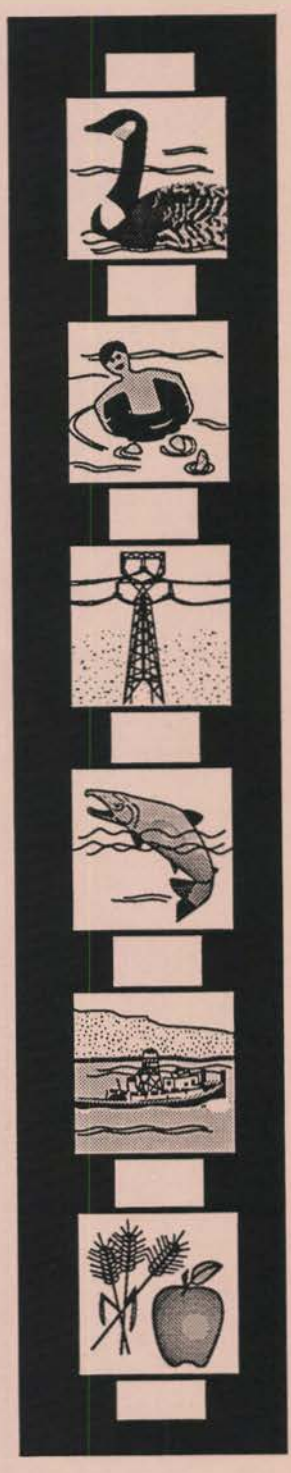
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Executive Summary



EXECUTIVE SUMMARY

1.0 INTRODUCTION

This Supplemental Environmental Impact Statement (SEIS), entitled Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon, evaluates the environmental effects of interim measures to improve flows for salmon during 1993 and future years. The Corps of Engineers (Corps) prepared this document, in cooperation with the Bonneville Power Administration (BPA), and Bureau of Reclamation (BoR). Although the National Marine Fisheries Service (NMFS) was an original cooperating agency for this SEIS, they withdrew from the cooperating agency team as of February 1, 1993, because of concerns about potential or perceived potential conflicts of interest. The SEIS is a supplement to the 1992 Options Analysis/Environmental Impact Statement (1992 OA/EIS), prepared by the Corps, BPA and BoR, and incorporates the original document by reference.

1.1 PURPOSE AND NEED

In November 1991, NMFS declared the Snake River sockeye salmon an endangered species under the Federal Endangered Species Act (ESA) (56 FR 14055) effective December 20, 1991. In April 1992, NMFS listed the Snake River fall and spring/summer chinook salmon as threatened species effective May 22, 1992. NMFS, in its listing, identified hydropower development in the Columbia River Basin as one of the primary factors contributing to the decline of the salmon populations.

Currently, there are several studies underway (see Section 1.5 and Appendix C of SEIS) to address long-term approaches to rebuilding wild salmon runs. However, it is anticipated that actions resulting from these studies will not take place for several years. The function of this SEIS is to evaluate the impacts of several alternatives to the operation of certain dams and reservoirs in the Columbia-Snake River System during 1993 and future years while a long-term plan of action is developed as a result of other studies. The proposed action includes recommendations from the Biological Opinion prepared by NMFS for the 1992 operating plan. The interim operating plan may or may not change in the future as a result of new information or recommendations from other ongoing studies.

The need for these interim actions is well established in the 1992 OA/EIS, the NMFS (1992) Biological Opinion for river system operations, and many other documents addressing Columbia-Snake River salmon stocks. A brief discussion of the life history and current status of the Pacific salmon was provided in Chapter 1 of the 1992 OA/EIS. A more comprehensive discussion can be found in Appendix A of this SEIS. In summary, changes to the previous operation of the Columbia-Snake River System are needed to improve migration conditions, and thereby help to reverse the population decline and contribute to the recovery of these salmon stocks. The proposed actions evaluated in the SEIS are modifications to 1992 system operations that are intended to improve flows to benefit migrating fish. The specific purposes of these actions are to increase river velocities for juvenile fish migrating downstream in spring and summer, and to improve late-summer river temperatures for adult migrants.

The Council on Environmental Quality (CEQ) guidelines direct Federal agencies (such as the Corps) to prepare supplements to final environmental impact statements if: 1) there are substantial changes in the project that are relevant to environmental concerns; 2) there is significant new information relevant to environmental concerns; or 3) the agency determines that the purposes of the National Environmental Policy Act (NEPA) will be furthered by doing so (40 CFR 1502.9). All three of these factors apply to the SEIS. The SEIS examines actions contained in the 1992 OA/EIS and similar to those evaluated in the 1992 OA/EIS, but as recurring annual events over a longer time period, until changes resulting from long-term regional studies are implemented. Furthermore, the SEIS analyzes the impacts of such actions on projects not addressed in the 1992 OA/EIS. Finally, it also updates impact analyses from the 1992 OA/EIS, based on new information that was not available for the original document.

This SEIS avoids repetitive discussion of the same issues and focuses attention on the actual issues under immediate consideration. This means that relevant previous discussions and analyses from the 1992 OA/EIS, if there has been no change, will be summarized and incorporated by reference into the SEIS. Issues and impacts from actions considered in the 1992 OA/EIS that are not incorporated in the current set of alternatives for the interim years are not addressed in the SEIS.

1.2 LOCATION OF STUDY AREA

The geographic scope of this supplement (Figure ES-1) differs slightly from that of the 1992 OA/EIS. The overall area of interest includes the Columbia River Basin from Bonneville Dam in Oregon up to Brownlee Reservoir on the middle Snake River in Idaho, and up to Arrow Lakes on the upper Columbia River in Canada. The potential actions that are being evaluated in the SEIS involve operations at four storage reservoirs (Dworshak, Brownlee, Libby, and Grand Coulee) and five run-of-river reservoirs (Lower Granite, Little Goose, Lower Monumental, Ice Harbor, and John Day). Consequences of the potential actions are evaluated at these nine projects and their downstream tributaries. In addition, potential indirect effects from these system operation changes on Libby and Hungry Horse reservoirs in Montana are analyzed. Operations at the remaining lower Columbia River projects indicated in Figure ES-1 (McNary, The Dalles, and Bonneville) would not be affected by the flow improvement actions addressed in the SEIS.

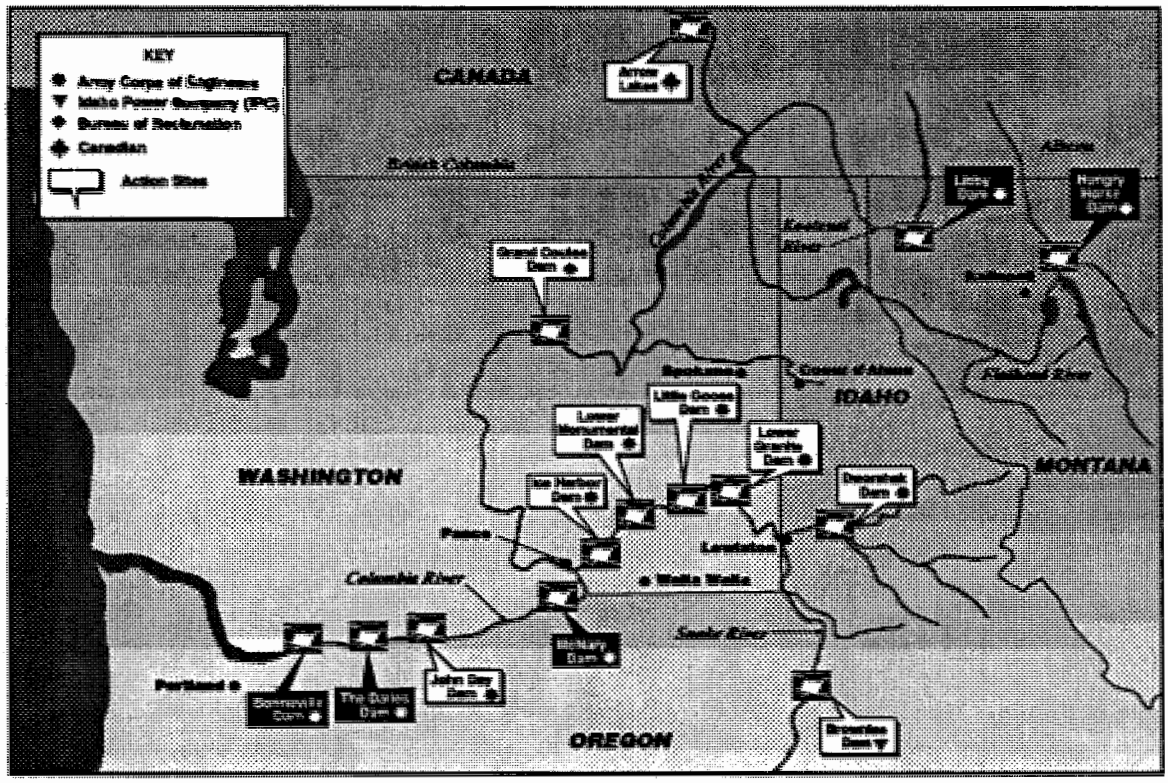


Figure ES-1. Study Area.

1.3 SYSTEM DESCRIPTION

The Federal and non-Federal dams and reservoirs on the Columbia and Snake rivers are operated to meet multiple purposes including but not limited to navigation, flood control, hydropower, recreation, irrigation, and fish and wildlife. Annual plans are established for operating storage and run-of-river projects to meet these needs with consideration of potential snowmelt, rainfall, runoff conditions, and the needs of each purpose and use. Water use and control plans may be adjusted at projects to provide water flows and elevations that might better meet the needs of anadromous fish.

An array of management practices and structures to protect juvenile and adult salmon migrating past the mainstem projects are continually being evaluated and upgraded. Each Corps run-of-river dam was constructed with an adult fish ladder system; some of these have been modified to improve fish use. Prior to 1975, juvenile bypass systems were incorporated in Bonneville, John Day, Lower Monumental, and Little Goose during project construction; however, their effectiveness was limited. Field testing of prototype turbine screens and associated juvenile bypass systems was initiated at Ice Harbor in 1969. A full travelling screen and juvenile bypass system was built into Lower Granite during original construction in 1975, and subsequently added at Little Goose, McNary, John Day, and Bonneville. Similar systems to safely pass juvenile salmon were constructed at Lower Monumental in 1992; others are planned for Ice Harbor in 1996 (although screens may be added by 1993), and The Dalles in 1998. Ice Harbor and The Dalles currently provide effective passage with sluiceways and spill for fish. Spill has also been provided at Bonneville, John Day (in summer only), and Lower Monumental to improve fish passage conditions.

A juvenile fish transportation program speeds downstream migration. The juvenile collection facilities and barge and truck transportation facilities have been developed in coordination with regional fisheries agencies and tribes, and are operated at Lower Granite, Little Goose, and McNary dams. Typically, about 20 million juvenile salmon and steelhead are collected annually at these three projects and transported directly below Bonneville Dam. Construction of additional collection and transportation facilities at Lower Monumental Dam is nearly complete, and will be available for interim operation and testing in 1993.

1.4 SCOPE

One of the most pressing environmental issues facing the Pacific Northwest today is the declining population of salmon that once thrived in the Columbia River Basin. In 1900, an estimated 8 to 16 million wild salmon and steelhead returned to the Columbia and Snake rivers to spawn. Recent records indicate that the runs are about 2.5 million (including known fish harvested in the ocean) of which about 0.5 million are wild fish. In 1990, 1.2 million salmon and steelhead returned to the mouth of the Columbia River. About 0.3 million of these were wild or naturally spawning fish (ODFW and WDF, 1991). The remainder are hatchery-produced fish. Some Columbia River Basin salmon populations have declined to such an extent that their existence is threatened. The listing of three stocks of Snake River salmon (sockeye, spring/summer chinook, and fall chinook) as endangered or threatened under the ESA brought the status of the wild salmon stocks to the forefront of river management considerations in 1991 and 1992.

Many factors have contributed to the declining populations including dams built by the Corps, other Federal agencies, and public and private utilities over many decades; river flow during downstream migration of juvenile salmon; loss of spawning and rearing habitat; reduced streamflows from water withdrawals; harvest levels; pollution in river and ocean environments; and various other stress factors from increased human use of environmental resources.

Before dam construction, juvenile salmon experienced swift water conditions during their outmigration. If one assumes that water velocity, the speed of travel by juvenile salmon, and survival of juvenile salmon during downstream migration are directly related, it is possible that improved flow conditions in the lower Snake and lower Columbia rivers will increase survival of salmon in the Columbia River Basin. Within parameters, it is believed that the quicker the fish pass through the system to the estuary, the less impact existing dams and reservoirs will have on salmon stocks. This is because a shorter travel time may reduce opportunities for predation, residualism, and other physiological stresses. However, it must be stressed that the relationship between travel time and survivability is imprecise and not quantified. At some level, further increases in flow would not provide fish benefits and could even adversely affect survival because of associated dissolved gas supersaturation problems at the mainstem dams. Scientific evidence evaluating such a relationship is needed. Thus, a 25-percent increase in water velocity is unlikely to result in a 25-percent increase in survival because other important factors (e.g., species, age, degree of smoltification, water quality, water temperatures, predation, and availability of food) also affect the survival of migrating juvenile salmonids.

This SEIS presents an evaluation of interim flow measures that may be achieved in the short term to improve migration conditions for anadromous fish. The goal to improve flows would be accomplished by modifying the

manner in which the Corps and BoR projects (dams and reservoirs) are operated during 1993 and future years until a long-term plan of action is developed. Such long-term plans are being formulated in separate study processes. They will address future operation of the system under a variety of scenarios, including significant physical modifications of the dam and reservoir projects.

1.5 RELATED ACTION PROGRAMS

The regional response to the need to aid salmon survival includes many efforts that encompass a broad scope beyond changing the operating regime of Columbia-Snake River dams. Because the scope of this SEIS and by reference the 1992 OA/EIS is limited to analyzing the effects of altering river management operations, studies beyond this scope are not considered in this analysis. However, the purpose of all the studies, short term and long term, operational and structural, is essentially the same—to help improve salmon survival while meeting the needs of other river users. Changes as a result of the long-term studies may require additional NEPA documentation and consultation with NMFS for endangered species protection.

Through the public involvement activities conducted for the 1992 OA/EIS and this SEIS, people have expressed confusion over the scope of the respective studies and the roles of the many participants. Following is a listing of the related programs and studies. A more complete description of these programs is contained in Section 1.5 and Appendix C of the SEIS.

- National Marine Fisheries Service ESA Listing and Recovery Plan
- Northwest Power Planning Council (NPPC) Fish and Wildlife Program
- Columbia River System Operation Review (SOR) being prepared by the Corps, BoR, and BPA
- System Configuration Study (SCS) being prepared by the Corps
- BPA's Annual Implementation Work Plan and ESA-Related Programs
- Bureau of Reclamation Snake River Augmentation Programs

2.0 ACTIONS AND ALTERNATIVES CONSIDERED

The actions addressed in this SEIS are being evaluated in direct response to the listing of three stocks of Snake River salmon as threatened or endangered under the ESA. As part of the regional response to the proposals for listing, in 1991 the Northwest Power Planning Council (NPPC) initiated a four-phase process to amend the regional Fish and Wildlife Program. The first phase, completed in August 1991, addressed immediate fish production (hatchery) and habitat improvement needs. The NPPC ended the second phase in December 1991 by adopting a number of additional amendments involving mainstem survival measures related to river operations, as well as harvest and production measures. The mainstem survival measures overlapped considerably with the scope of the 1992 OA/EIS. Therefore, the Corps and the cooperating agencies on the OA/EIS coordinated with the NPPC to ensure the OA/EIS addressed the flow-related elements of the NPPC plan that the river management agencies would need to consider.

Instream velocity can be increased either by reducing the space through which the same amount of water must flow, or by adding water to normal river flow. Lowering the elevation of mainstem pools increases velocity by passing the same amount of water through a smaller cross-sectional channel area. Alternatively, supplementing river flows during migration periods with additional releases from storage reservoirs (flow augmentation) increases velocity by forcing a greater amount of water through the system.

Consequently, the range of potential actions available for interim flow improvement measures consists of various options for lowering reservoir elevations and augmenting flow, implemented either singly or in

combination. Because the flow improvement measures that are feasible now are limited by the structural configuration of the system and the total amount of storage available, the SEIS evaluates in detail four action alternatives that incorporate a combination of reservoir operation and flow augmentation measures involving multiple projects. The effects of these four alternatives are measured and compared against the no action alternative (the without-project condition), which is defined as the normal operation of the coordinated Columbia River System under the operating rules in effect from about 1985 through 1990.

2.1 ALTERNATIVE 1: WITHOUT-PROJECT CONDITIONS (NO ACTION)

Under this alternative no additional action beyond those actions already adopted by the cooperating agencies would be taken in 1993 and subsequent interim years to alter the normal operation of the reservoirs and dams on the lower Columbia and Snake rivers during salmon migration. Normal operations are the manner in which the projects and fish programs were operated from about 1985 to 1990.

The normal minimum operating pool elevation for each mainstem reservoir is typically 3 to 5 feet below normal full pool. These projects fluctuate according to short-term changes in electric power production from 1 to 2 feet daily to up to 3 to 5 feet weekly. Alternative 1 would continue operation of all four lower Snake River reservoirs and all four lower Columbia River reservoirs in the upper portion of the normal operating range. Storage reservoirs would be operated according to their normal rule curves. Existing flow augmentation provisions known as the Water Budget would continue.

2.2 ALTERNATIVE 2: 1992 OPERATIONS

This alternative includes actions planned for the 1992 operating year. These actions for 1992 were based on consultation with NMFS, Corps, BoR, and BPA Records of Decision, and NMFS' Biological Opinion for 1992 operations. For the interim operating period, Alternative 2 does not include the March drawdown test of Lower Granite and Little Goose pools. The flow augmentation elements of Alternative 2 include additional water from Dworshak, Brownlee, the upper Snake River, and Grand Coulee, Arrow and/or Libby on the Columbia River. Potential use of Libby for flow augmentation is a change from the actions described in the draft SEIS; see Section 3 for a complete discussion. Additional water from the upper Snake River is included in Alternative 2 because it was adopted by the NPPC as a Phase II amendment and was included by NMFS in the Biological Opinion for 1992 operations. The ability to augment flows with this alternative would be enhanced through transfer of some flood control requirements. Flood control transfer involves shifting system flood control storage capacity from one reservoir to another. For example, storage space at Dworshak that would otherwise be held empty for flood control can be used to store water for spring or summer releases. The system response to Alternative 2 was modeled with Libby and Hungry Horse "fixed" in their normal operation, although this provision would not apply to Libby in years when Libby storage was needed for flow augmentation. During periods of the year other than those described where flow augmentation is provided, the projects will be operated in a manner consistent with providing the rates of augmentation described for this alternative.

Components of this alternative are summarized below. Details on these specific components are found in the 1992 OA/EIS.

- Reservoir Operation
  1) Lower Columbia River reservoirs (3) will be operated near full, except that John Day will be lowered to minimum irrigation pool (approximately elevation 262.5 to 263.5) May 1 to August 31. This elevation will be maintained as long as possible without adversely affecting irrigators. The pool will be raised accordingly if irrigation pumping problems occur.
  2) Lower Snake River reservoirs will be operated near MOP, from April 1 to July 31

- Flow Augmentation
  1) Dworshak supplemental releases will be scheduled as follows:
     - 1000 KAF from April 15 to June 15, plus minimum flows of 1.2 kcfs (estimated at 148 KAF), if the runoff forecast is 16 MAF or less; 900 KAF if the runoff forecast is above 16 MAF

- 270 KAF above 1.2 kcfs minimum discharge June 16 to August 30
- To enhance probability of being on flood control curve by April, maintain 1.2 kcfs minimum discharge from October through April unless higher discharges are required to stay on flood control rule curve or for short-term power emergencies
- Up to 200 KAF above minimum 1.2 kcfs discharge in September
- Be at 1,558-feet maximum elevation on December 15 (winter flood draft maximum elevation)

2) Brownlee operation will reflect historical releases plus requests per NPPC amendments, as follows:
   - 110 KAF Water Budget in May
   - 137 KAF in July (replaced with 137 KAF upper Snake contribution in August)
   - 100 KAF in September
3) Upper Snake River
   - 190 KAF April 15 to June 15 (via purchase)
   - 137 KAF released in August to refill Brownlee
   - 100 KAF in September (via purchase)
4) Grand Coulee and upper Columbia River
   - 3.45 MAF Water Budget plus up to 3.0 MAF additional flow augmentation May 1 to June 30. The additional water for flow augmentation, up to 3 MAF, will be obtained, if required, through power purchase and exchange activities.

- Flood Control Transfer
  1) Dworshak system flood control requirements will be shifted to Grand Coulee, if the April forecast predicts runoff to Dworshak of 2.6 MAF or less, and if space is available at Grand Coulee.
  2) System flood control requirements for Brownlee will be transferred to Grand Coulee, subject to the availability of space at Grand Coulee.

2.3 ALTERNATIVE 3: 1992 OPERATIONS WITH LIBBY/HUNGRY HORSE SENSITIVITY

This alternative is being analyzed only as a sensitivity test (a means to gauge comparative effects of the same action under different assumptions) of actions actually planned for the 1992 operating year (less the March drawdown test). It is being modeled to demonstrate whether operations at Libby and Hungry Horse would be indirectly affected in response to flow improvement measures undertaken elsewhere in the system. A basic premise of the 1992 OA/EIS and the 1992 plan was that system operations would be conducted such that Libby and Hungry Horse would not be operated differently to compensate for flow improvement changes in system operations. Additional releases from Libby and Hungry Horse would not be scheduled to augment Columbia River flows, for example, and BPA would not request additional generation from these projects to make up for power losses on the Snake River part of the system. Consequently, the hydroregulation models used to analyze the 1992 OA/EIS alternatives were run with Libby and Hungry Horse "fixed" in their normal operating pattern.

State of Montana officials voiced concern that this constrained operation would not be maintained through the actual day-to-day operation of the system, particularly in light of the low flows and storage reservoir elevations that occurred in 1992. They specifically requested that the Corps include an analysis of potential indirect effects on Libby and Hungry Horse operations in the SEIS. Alternative 3 has been included in response to this request. It contains the same reservoir operation and flow augmentation provisions as did Alternative 2 (in the draft SEIS). The only difference in the original hydroregulation models for this alternative and Alternative 2 is that the constraints on Libby and Hungry Horse operations have been removed. Operation of these projects is allowed to change if needed in response to the additional flow augmentation requirements imposed on other projects by Alternative 2. During periods of the year other than those described where flow augmentation is provided, the projects will be operated in a manner consistent with providing the rate of flow augmentation described in this alternative.

Libby and Hungry Horse did not participate in the flow augmentation measures initiated in 1992. However, because of the fact that water conditions and operational considerations may not always make it possible to provide up to 3 MAF for flow augmentation from Grand Coulee and Arrow alone, evaluation of the potential

use of Libby for helping to provide water for flow augmentation was done. Although it has been found that Libby could be used to help provide water for flow augmentation in many years, there are a number of operational considerations that could be affected by releases for flow augmentation. Some of the current constraints and problems at Libby, for example, are (a) the International Joint Commission rule curve for Kootenai Lake limits releases from Libby during the flow augmentation season, (b) the potential listing of the Kootenai River sturgeon as an endangered species could impose new discharge requirements on Libby, and (c) British Columbia desires to minimize environmental problems at the upper end of Libby Reservoir during the summer by exchanging Duncan releases for Libby releases. These releases may further affect reservoir operation. The more broadly based SOR is considered to be the appropriate vehicle for more detailed examination of these problems, and the potential contribution that Libby and Hungry Horse can make to flow augmentation will be further examined in that process.

2.4 ALTERNATIVE 4: MODIFIED 1992 OPERATIONS

This includes those actions actually planned for the 1992 operating year (less the March drawdown test), flow augmentation from the upper Snake and Brownlee, plus enhancement of summer flow augmentation from Dworshak. The primary differences between Alternative 4 and Alternative 2 are two features of planned flow augmentation from Dworshak. One is that the 200 KAF normally planned for September release in Alternative 2 could be shifted to July and/or August to benefit summer juvenile migrants, and/or adult salmon, when determined to be biologically prudent. The runoff forecast trigger for the flood control transfer from Dworshak to Grand Coulee would also be increased from 2.6 MAF to 3.0 MAF. This would increase the number of years in which a flood control transfer would be possible. During periods of the year other than those described where flow augmentation is provided, the projects will be operated in a manner consistent with providing the rate of flow augmentation described in this alternative.

2.5 ALTERNATIVE 5: MODIFIED 1992 OPERATIONS WITH UPPER SNAKE SENSITIVITY

Alternative 5 includes actions actually planned for the 1992 operating year (less the March drawdown test) plus improvements to salmon flows from Dworshak as in Alternative 4 (see Table 3.2-1), but minus the 427 KAF flow transfer from the upper Snake. This alternative is being run as a sensitivity model to show the difference if no water is available from the upper Snake River. Purchase of uncontracted water from the upper Snake River Basin was an objective of the 1992 operating plan. This objective was only partially met because of low flows in 1992 and the consequent scarcity of water available for purchase. During periods of the year other than those described where flow augmentation is provided, the projects will be operated in a manner consistent with providing the rate of flow augmentation described in this alternative.

3.0 EVALUATION

Section 5 of the 1992 OA/EIS details the process by which the operational plan for 1992 was selected. Since the 1992 operational plan forms the basis for Alternatives 2 through 5 considered in this SEIS, refer to the 1992 OA/EIS for a detailed discussion of the evaluation process for these alternatives. The alternatives selected for evaluation in this SEIS were already determined to be implementable in 1993 and future years, and to be within existing authorities.

Criteria for evaluating the alternatives analyzed in this SEIS are (1) mainstem juvenile salmon survival rate, (2) cost-effectiveness, and (3) environmental effects. Cost-effectiveness is analyzed in terms of relative costs to achieve improved juvenile salmon survival. Environmental effects, including potential benefits to adult migrants, are assessed in detail in Section 4.

Comments by Federal, State, and local entities, and the public on the SEIS will be considered by the cooperating agencies. The public will have 30 days to review this document. From this overall process, an alternative that most closely meets regionally established salmon recovery objectives with acceptable costs and minimal environmental damage will be selected for the interim operational plan.

It should be recognized that the alternative selected for implementation in 1993 and future years might require adjustment on an annual basis depending on hydrologic conditions and new information that may be developed. The Corps, BPA, BoR, and NMFS implemented a process in 1992 to monitor and evaluate the shaping of available water based on real-time flow and fish migration information throughout the fish passage season. This process recognizes that flexibility is needed to optimize the release of available water to maximize the benefit to migrating wild Snake River stocks of sockeye, spring/summer chinook, and fall chinook salmon, and this process should not be constrained by fixing flows on a predetermined schedule.

3.1 JUVENILE FISH SURVIVAL

The proposed SEIS actions are centered around the concept of increasing survival of fish migrating through the Columbia-Snake River system. The 1992 OA/EIS assessed water particle travel time, smolt travel time and smolt survival. The action considered in this SEIS is within the range of those values, but the analysis is based on results of juvenile fish survival models.

Different analytical approaches and interpretation of data have resulted in the regional development of three primary systems of models to estimate the effects of various actions on the fish stocks of the Columbia River system. Each model system has two components, a downstream passage model which estimates downstream juvenile survival and a life-cycle model which estimates adult return escapement. The life-cycle models produce deterministic or probabilistic estimates of adult returns, based on simulation of mortality factors in the respective life-cycle phases. The juvenile passage models account for the complex survival factors affecting downstream migration, and provide key inputs to the life-cycle models.

Because flow measures being evaluated in the SEIS primarily benefit downstream survival, the results of the passage models are used to evaluate alternatives. Passage models include the effects of the proposed flows, as well as other nonflow measures being taken by the cooperating agencies. Such nonflow measures include bypass system improvements, the transportation program, predator control, and other improvements to fish facilities. The results of the life-cycle models are used to estimate the overall effect of all the regional measures being undertaken to improve the survival of the listed Snake River salmon species.

Preliminary model results for Snake River spring/summer and fall chinook salmon are summarized below. The results of the BPA juvenile fish passage model (CRiSP.0) show the proposed operations for 1993 (Alternative 4), relative to a no action return to 1990 baseline operations, would increase the survival of spring, summer, and fall chinook downstream migrants. Substantial additional survival improvements are estimated in the years 1993 and 1998 because of the phasing in of full benefits of measures to be implemented in 1993 and additional ongoing actions currently planned through 1998, such as squawfish management, bypass installations and improvements, and transportation from Lower Monumental Dam.

The results of the BPA life-cycle model (SLCM) also show that the improvements in juvenile survival coupled with additional planned actions by the cooperating agencies through 1998 affecting other life stages of chinook should result in significant gains in spring and fall chinook species populations. Improvements from these actions are more moderate for the summer chinook population. Both the spring and fall chinook show increasing population trends with 1993 and future conditions. Summer chinook show population trends improving from the 1990 baseline conditions. However, the downward baseline trend improves only to a slightly increasing trend if low effectiveness of measures is assumed, and improves to a moderately increasing trend assuming high effectiveness of measures. No CRiSP or SLCM models were run for sockeye because all known stocks are currently in a captive-rearing program.

The results of the NPPC juvenile fish passage model (PAM) also show survival increases for spring chinook associated with the proposed actions in 1993. The NPPC SPM life-cycle model indicated a slight increase in trend in spring chinook adult escapement when all improvements considered were included in their model. Their model included possible actions such as minimal predator control and increased upstream survival, while rearing and spawning habitat improvements resulted in estimates of slight increases in spring chinook

escapement over a 20-year model period. Only slightly increasing trends were apparent in these model runs when lower benefits were assumed for some of the possible future actions.

The NPPC passage analyses and life-cycle analyses only modeled spring chinook and only included actions taking place in 1993, plus rearing and spawning habitat improvements. The increases in juvenile spring chinook survival from the NPPC (PAM) analysis are reasonably similar to the BPA (CRiSP) Model results for the proposed 1993 conditions relative to 1990 baseline conditions. The modeled conditions resulted in relatively comparable increases in spring chinook juvenile relative passage survival of 7 percent (median) for the CRiSP Model and 8 percent (average) for the PAM. Absolute survival increases remained small with both being about 1 to 2 percent. The results from the NPPC (SPM) life-cycle analysis and the BPA analysis (SLCM) for 1993 static conditions both show improvements in population trends relative to baseline conditions. When similar assumptions and actions are included in SLCM and SPM, the models show improvements relative to the baseline. While the relative changes in projected escapements are similar between the two analyses, the estimated adult escapement level for the SPM is greater than the projection for the SLCM for the same period. This is primarily a result of a lower initial baseline escapement projection for the SPM.

Developing a valid comparison of the results of life-cycle models is difficult because the models used different parameter values for some actions, and differed on what future actions should be included in their analysis. A parameter value of an action reflects how effective that action is to increasing survival. Although the coordinated review of the model analysis set some parameter values and critical assumptions common to both SLCM and SPM, other parameter values are different.

Model analyses of actions were also conducted by the State and Tribal Fisheries Agencies (STFA) using their juvenile passage model (FLUSH) and life cycle model (ELCM). The Corps has reviewed the preliminary results of the STFA model. The initial review revealed some concerns that are undergoing further examination and discussion with the STFA. BPA is also in the process of reviewing the STFA analysis, and expects to have additional concerns requiring clarification and discussion. Consequently, the cooperating agencies believe that the preliminary results of the STFA model should not be used in the development of the conclusions of the SEIS. A summary of the STFA model is presented in the SEIS.

The cooperating agencies recognized at the outset that there could be differences in the life-cycle model results because of the models' assumptions. The cooperating agencies support the ongoing processes within the region to facilitate review, understanding, and coordination of the three model systems. The near-term preliminary peer review is expecting to provide information within the next two months, while the long-term model coordination process will be ongoing.

3.2 COST EFFECTIVENESS

The economic evaluation tool used in comparing the SEIS alternatives is cost effectiveness, calculated in terms of relative costs needed to achieve a given percentage change in juvenile survival. The cost-effectiveness analysis was done with the available information, and with full recognition of the uncertainties surrounding the estimates of economic costs and biological effectiveness.

The objective of the actions addressed in this SEIS is to improve the survival rate of juvenile salmon migrating downstream. The juvenile passage models produce results that can be used to estimate the downstream survival rate, in percentage terms, for each stock and for a given set of input parameters. Model results for spring chinook were used as an indicator in the cost-effectiveness analysis. The costs include implementation costs and foregone benefits in terms of reduced output of project benefits from the current conditions.

Total direct costs for each alternative are then divided by the survival improvement to arrive at a measure of the cost per unit (percent) change in survival. This figure is calculated for each alternative, and then the alternatives are ranked according to cost-effectiveness. The direct costs associated with the various options are tabulated in four categories: transportation, irrigation, recreation, and hydropower. Impacts that would occur in other resource areas are not suitably quantifiable in monetary terms.

The total direct costs for the SEIS alternatives range from $52 to $88 million for the operation with Libby/Hungry Horse sensitivity (Alternative 3) to $66 to $93 million for the modified 1992 operations (Alternative 4). The cost of power losses accounts for all of the total direct costs. In cost-effectiveness terms, these two alternatives range from a minimum of about $13.0 to $23.3 million per unit (percent) change in survival. The results represent a comparison of wide ranges of costs and cannot be considered linear (i.e., it cannot be assumed that doubling costs would double survival).

3.3 ENVIRONMENTAL EFFECTS OF THE ALTERNATIVES

The results of the environmental evaluation reflect expected impacts to an extensive and complex water resources system that is managed for a variety of uses, including conservation of fishery resources. Overall, the effects of the proposed action on resources other than anadromous fish can be summarized as follows:

- Minor to insignificant decreases in water temperatures at times in the Clearwater River below Dworshak and in Lower Granite Reservoir
- Some long-term net benefits expected for resident fish in the mainstem reservoirs; adverse effects on resident fish populations in the storage reservoirs
- Some stresses or losses of shallow-water habitat, wetland, riparian habitat, waterfowl, and furbearers at John Day; minimal terrestrial impacts elsewhere in the system
- Insignificant increases in blowing dust during some periods of the year, particularly near the storage reservoirs
- Capacity, firm energy, and nonfirm energy losses to power system, with total estimated power cost ranging from $63 to $90 million for Alternative 2 to $66 to $93 million for Alternative 4
- Limited utility of some recreational facilities at mainstem and storage projects during some months, but minimal or minor projected impacts (some positive, some negative) in recreation usage from Alternatives 2 through 5 in most years. Low probability of significant seasonal decreases in use depending on water conditions, particularly at Dworshak. Initial and long-term adverse effects on fishing and boating on Lake Roosevelt could occur depending upon annual decision for storing flow augmentation water.
- Minor incremental aesthetic effects from increases in reservoir shoreline exposure, primarily at John Day and Dworshak
- Minor increase in potential damage to cultural resources from somewhat deeper drafts and increased exposure
- Minimal or no effects on transportation, utilities, agriculture, socioeconomics, and project structures from Alternatives 2 through 5

From an ecosystem perspective, the environmental analysis illustrates the resource balancing that must be considered in evaluating a plan of action. The proposed actions would generally improve flows in the lower reaches of the river system, and would primarily benefit anadromous fish. Most of the adverse impacts of these actions would occur in the upper reaches of the system, at and near the storage reservoirs, and would primarily affect resident fish, bald eagles, and recreation resources. The tradeoffs involved with actions to benefit one type of resource should be recognized in the decision process.

4.0 PLAN SELECTION AND IMPLEMENTATION

A preferred plan of action for interim flow improvement measures was selected on the basis of the evaluation factors described in 3.0 above. Key considerations in the selection were existing authorities, cost effectiveness, and the comparison of alternatives presented in Section 5 of the SEIS.

4.1 PUBLIC INVOLVEMENT

Several controversial issues are associated with some of the actions evaluated; consequently, public input was sought before an interim plan was selected. The NEPA requires that the views of interested members of the public be sought and considered in selecting the final plan. The process of soliciting the concerns and interests of the public began with the issuance in June 1992 of the Notice of Intent to proceed with the project and to prepare the SEIS. Public information meetings were conducted in July to define the issues to be addressed in the draft SEIS and to discuss the SEIS in relation to other current programs. The draft SEIS was sent to approximately 2,200 people. Following release of the draft SEIS, a 45-day public comment period took place during which written and verbal comments on the alternatives were sought from government agencies and the general public. Nine workshops/public meetings were held to solicit input. Public involvement methods in the decision making process are detailed in Section 6 of the SEIS.

The public participation required in the NEPA process also satisfies the requirements of Section 310(b) and Section 415(b) of the Water Resources Development Act of 1990. Section 310(b) requires public participation in changes to reservoir operation criteria. Section 415(b) requires public notification (hearings) of actions associated with drawdown of Dworshak Reservoir.

4.2 COMPARISON OF ALTERNATIVES

The model analyses indicate no quantifiable difference in juvenile survival results for spring migrants among Alternatives 2 through 5. On a qualitative basis, Alternative 4 might have an advantage by providing potential flow benefits for summer migrants.

The cost-effectiveness analysis indicates there is a great deal of overlap in the ranges of costs per 1 percent increase in survival. The overlaps and wide ranges of results reflect the uncertainty inherent in the fish survival models and power impact analysis. None of the alternatives clearly demonstrate an advantage or disadvantage from this cost-effectiveness analysis.

A key conclusion from comparing environmental effects is there would be little difference in impacts among the alternatives. Because the components of Alternatives 2 through 5 are the same with respect to operation of the lower Columbia and Snake River projects and Columbia River flow augmentation, there is no variation in effects from these actions. Impacts among alternatives would vary somewhat with respect to Snake River flow augmentation. Alternatives 4 and 5 would typically involve slightly deeper drafts at Dworshak than with Alternatives 2 and 3, and therefore would have slightly greater effects on resident fish, recreation, aesthetics, and cultural resources. However, these differences are insignificant when compared to either Alternative 2 or the no action alternative.

4.3 PREFERRED PLAN OF ACTION

The estimates of percent increase in survival and cost effectiveness show that all alternatives achieve similar biological results with similar costs. However, Alternative 4 provides flexibility to shift the timing of flow augmentation to assist either wild juvenile or adult fall chinook migration in late summer and early fall. NMFS indicated in their 1992 Biological Opinion that additional summer flow augmentation should decrease mortality of juvenile wild fall chinook. Based on the best available scientific data, the Corps and the cooperating agencies believe that Alternative 4, with the flexibility to shift the timing of flow augmentation in July through September, will provide the best survival of the four alternatives. Comparison of the environmental impacts of

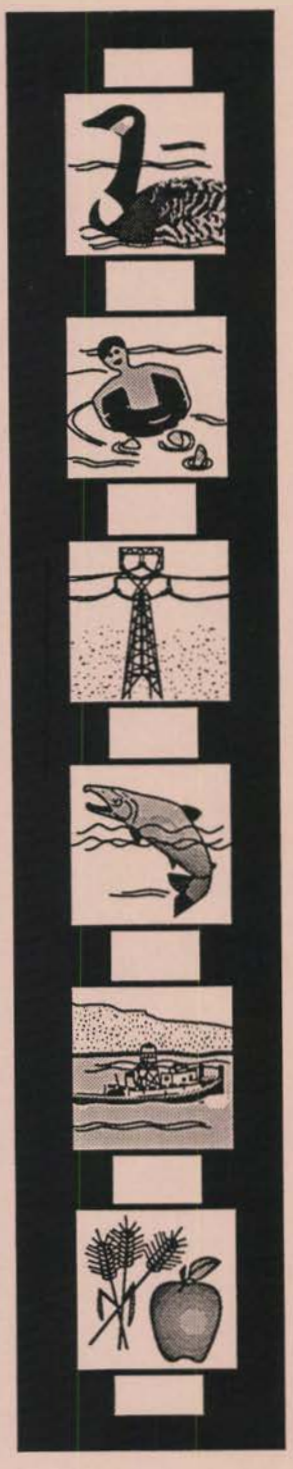
the four alternatives indicates that the impacts at the lower Snake River and John Day projects are identical, and differences at the storage projects are minimal.

Based on an analysis of survival rates, cost-effectiveness, and environmental effects, the Corps and the cooperating agencies have identified Alternative 4 as the preferred alternative for the interim flow measures operational plan.

This plan will be implemented subject to the outcome of consultation with NMFS under Section 7 of the ESA. Alternative 4 would also be implemented in years beyond 1993, although specific elements may need to be modified annually based on new information and year-to-year water conditions. The Corps, BPA, and BoR will consult with NMFS and FWS (where applicable) regarding operating plans on an annual basis. The outcome of ongoing regional processes (such as the NMFS Recovery Plan, the SCS, and the SOR), may modify the proposed actions in the future and require additional NEPA documentation. Operating plans for 1993 and future years that incorporate the actions addressed in this SEIS will be documented in respective Records of Decision by the Corps, BPA, and BoR.

1.0

Introduction



1.0 INTRODUCTION

In January 1992, the Army Corps of Engineers (Corps), in cooperation with the Bonneville Power Administration (BPA) and the Bureau of Reclamation (BoR), issued the final Columbia River Salmon Flow Measures 1992 Options Analysis/Environmental Impact Statement (1992 OA/EIS). The 1992 OA/EIS (Corps et al., 1992) evaluated ways to alter water management operations in 1992 on the lower Columbia and Snake rivers to enhance the survival of wild Snake River salmon.

The 1992 OA/EIS addressed a premise that the longer juvenile salmon remain in the reservoirs on the Columbia-Snake River System, the higher their susceptibility to predators and physiological conditions that increase their mortality. The principal action analyzed in the 1992 OA/EIS was increasing the velocity of the river flow, slowed by the dams, to move the young salmon faster downstream to the ocean. The 1992 OA/EIS recommended a plan of action for 1992 to accomplish this objective.

In November 1991, National Marine Fisheries Service (NMFS) declared the Snake River sockeye salmon an endangered species under the Federal Endangered Species Act (ESA) (56 FR 14055) effective December 20, 1991. In April 1992, it listed the Snake River fall and spring/summer chinook salmon as threatened species effective May 22, 1992. NMFS, in its listing, identified hydropower development in the Columbia River Basin as one of the main factors contributing to the decline of the salmon populations.

The 1992 OA/EIS applied only to actions considered for implementation in 1992. Given the particular circumstances surrounding the salmon listing under the ESA and the initial regional response to the pending listing, the Corps and the cooperating agencies felt that the scope of the OA/EIS should be limited to a 1-year operating period. With the benefit of the information gained through the 1992 OA/EIS process and related programs, it is now appropriate for the agencies to address river system operations to benefit salmon while long-term solutions are being evaluated. The objective of this Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon Supplemental EIS (SEIS) is to build on the 1992 OA/EIS to evaluate the environmental effects of flow improvement measures in 1993 and subsequent years. The proposed action being considered in the SEIS is in response to the listing of the Snake River salmon species as endangered or threatened.

1.1 PURPOSE AND NEED

Currently, there are several studies underway to address long-term approaches to rebuilding wild salmon runs. However, it is anticipated that actions resulting from these studies will not take place for several years into the future. The function of this SEIS is to evaluate the impacts of several alternatives to the operation of certain dams and reservoirs in the Columbia-Snake River System during 1993 and future years. This plan of action may be changed as a result of these long-term studies. The proposed action includes recommendations from the Biological Opinion prepared by NMFS for the 1992 operating plan.

The need for these interim actions is well established in the 1992 OA/EIS, the NMFS (1992) Biological Opinion for river system operations, and many other official documents addressing the decline of Columbia Snake River salmon stocks. A brief discussion of the life history and current status of the Pacific salmon was provided in Chapter 1 of the 1992 OA/EIS. A more comprehensive discussion can be found in Appendix A of this SEIS. In summary, changes to the previous operation of the Columbia-Snake River System are needed to improve migration conditions, and thereby help to avoid the continued decline and contribute to the recovery of these salmon stocks. All of the proposed actions evaluated in the SEIS are intended to improve flows to benefit migrating fish. The specific purposes of these actions are to increase river velocities for juvenile fish migrating downstream in spring and summer, and to improve late summer river temperatures for adult migrants.

The Council on Environmental Quality (CEQ) guidelines direct Federal agencies to prepare supplements to final EISs if: 1) there are substantial changes in the project that are relevant to environmental concerns; 2) there is significant new information relevant to environmental concerns; or

3) the agency determines that the purposes of the National Environmental Policy Act (NEPA) will be furthered by doing so (40 CFR 1502.9). All three of these circumstances apply, to a varying extent, to the SEIS. The SEIS examines actions similar to those evaluated in the 1992 OA/EIS, but as recurring annual events over a longer time. Furthermore, it analyzes the impacts of such actions on projects not addressed in the 1992 OA/EIS. It updates impact analyses from the 1992 OA/EIS, based on new information that was not available for the original document.

The CEQ guidelines (40 CFR 1502.20) encourage agencies to tier EISs to avoid repetitive discussion of the same issues and to focus attention on the actual issues under immediate consideration. This SEIS is tiered to the 1992 OA/EIS. This means if there has been no change, relevant previous discussions and analyses from the 1992 OA/EIS will be summarized and incorporated by reference into the SEIS. Issues and impacts from actions considered in the 1992 OA/EIS that are not included in the current set of alternatives for the interim years are not addressed in the SEIS. Copies of the 1992 OA/EIS are readily available for such reference. Over 900 copies of the final 1992 OA/EIS were distributed; recipients included public libraries in key communities throughout the four-state area (Washington, Oregon, Idaho, and Montana). Additional copies can be supplied by the Corps upon request.

1.2 BACKGROUND

The events leading up to the NMFS listings are detailed in the 1992 OA/EIS. The plan of action identified in the 1992 OA/EIS included a test drawdown of two lower Snake River projects (Lower Granite and Little Goose), operating the four lower Snake River projects near minimum operating pool (MOP), operating John Day Pool on the lower Columbia River at or near elevation 262.5 feet, unless there are impacts to irrigation, and augmenting water for river flows during fish migration periods with additional releases from upstream storage reservoirs. This plan was implemented in 1992, after extensive coordination on details of the plan with NMFS, the Northwest Power Planning Council (NPPC) and other key parties in the region. Results of the drawdown test are summarized in Appendix B. The SEIS uses information gained from the 1992 water management operations, including the test drawdown conducted in March, in its analysis.

Studies examining long-term actions, such as structural modifications to the dams, are continuing. These include the Columbia River System Operation Review (SOR), the System Configuration Study (SCS), the NPPC's process for amending the Columbia River Basin Fish and Wildlife Program, and the salmon recovery plan to be issued by NMFS (see Section 1.5 and Appendix C for more discussion of these studies). Information already gathered for some of these studies, in particular the SOR, is used in the SEIS analysis.

1.3 SCOPE

The geographic scope of this supplement (Figure 1.3-1) is somewhat different from the 1992 OA/EIS. The overall area of interest includes the Columbia River Basin from Bonneville Dam in Oregon up to Brownlee on the middle Snake River in Idaho, and up to Arrow Lakes on the upper Columbia in Canada. The potential water management actions that are evaluated in the SEIS would be implemented at four storage reservoirs (Dworshak and Libby, operated by the Corps; Grand Coulee, operated by the BoR; and Brownlee, operated by Idaho Power Company [IPC]) and five mainstem run-of-river dams operated by the Corps (Lower Granite, Little Goose, Lower Monumental and Ice Harbor on the lower Snake River and John Day on the lower Columbia River). The consequences of the potential actions are evaluated at these eight projects and the associated downstream reaches. There are no new flow improvement measures at Bonneville, The Dalles, and McNary in the SEIS alternatives because of decisions reached in the 1992 OA/EIS. Because of concern over possible indirect effects from these system operation changes, the impact analysis includes two storage reservoirs in Montana—Libby and Hungry Horse—potentially affected by Columbia-Snake River flow alterations but not considered in the 1992 OA/EIS. The potential actions concerning water purchases in the upper Snake River Basin will be addressed in the BoR flow augmentation program as described in Section 1.5 and Appendix C. The alternatives considered in the SEIS do not include any proposed flow

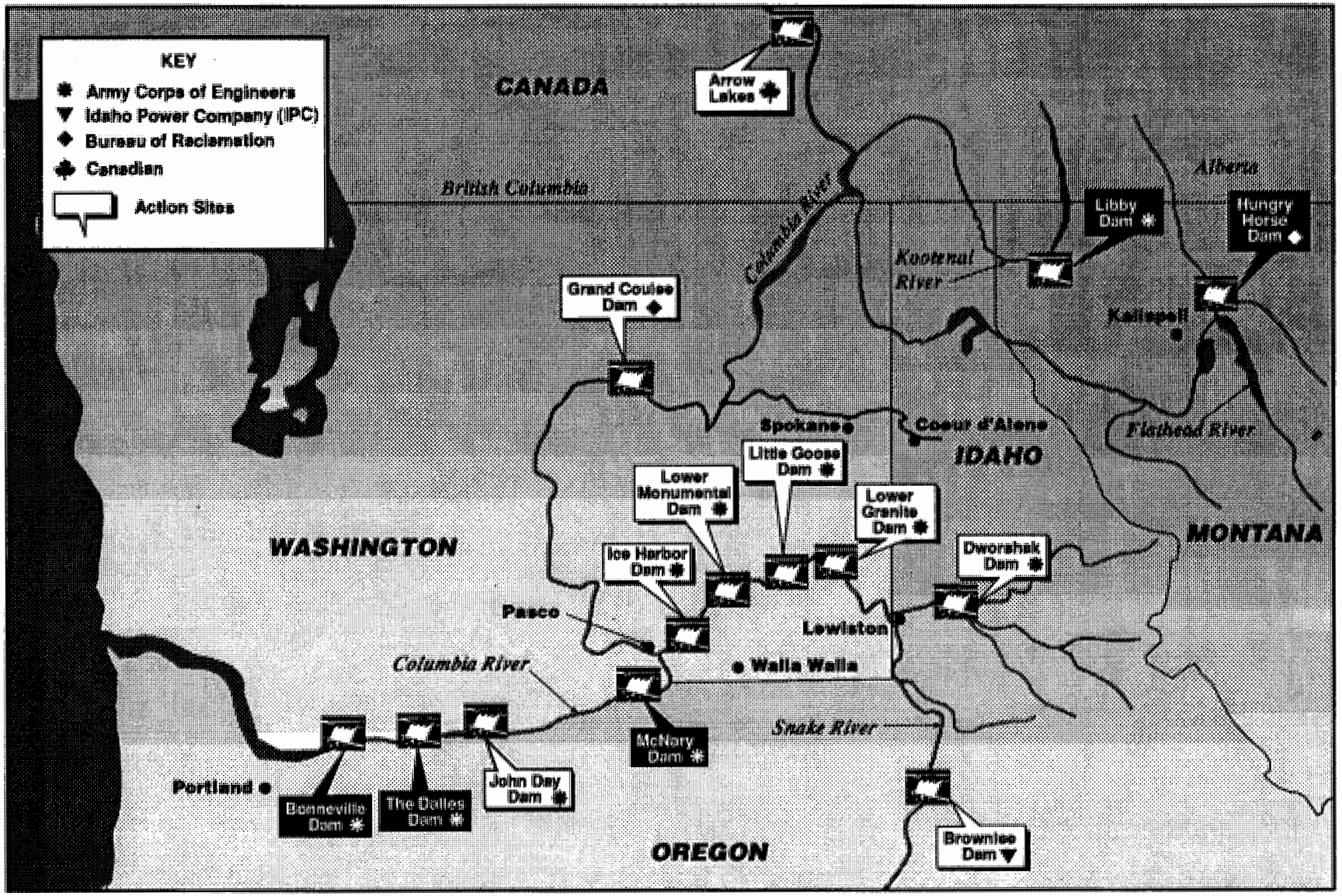


Figure 1.3-1. Interim Flow Improvement Measures SEIS study area map.

improvement measures at Hungry Horse. The SOR is considering alternative operations of Libby and Hungry Horse to improve downstream flows.

The SEIS addresses water management activities for 1993 and future years. These water management activities may change as a result of a long-term plan of action developed from the ongoing studies. The actions considered in the SEIS involve some combination of measures similar to those selected in the 1992 OA/EIS and implemented for 1992 through consultation with NMFS.

Specifically, this SEIS presents four lowered pool operation/augmentation combinations, in addition to the no action alternative.

1. Without-project conditions, or the no action alternative, which would involve continued operation under the water management rules in place from about 1985 through 1990.

2. The 1992 operation alternative, excluding the March drawdown test of Lower Granite and Little Goose.

3. The 1992 operation alternative (without the March drawdown test) modeled to display potential impacts to Libby and Hungry Horse.

4. The 1992 operational alternative (without the March test drawdown), plus adjustments to salmon flows from Dworshak.

5. The 1992 operation alternative (without the March test drawdown), plus adjustments to salmon flows from Dworshak, and modeled to show no water from the upper Snake.

As with the 1992 OA/EIS, the Corps is the lead agency in preparing this document. In addition to BPA and BoR, NMFS was included as a cooperating agency for this SEIS. However, because of its ESA responsibilities to review the proposed actions, NMFS established that it would not participate in development of conclusions relative to the effects of the proposed action on listed Snake River salmon. On February 1, 1993, the Corps formally was notified that NMFS will no longer be a "cooperating agency..." The three agencies will share responsibility for determining and evaluating impacts within their respective areas of jurisdiction as outlined in the 1992 OA/EIS. Each agency will have separate responsibility for reaching and implementing a decision with respect to actions to improve river flows in 1993 and subsequent years.

Scoping with interested parties has been an ongoing process since preparation of the 1992 OA/EIS. The Corps held a series of public information meetings in July 1992 (see Section 6) to discuss the results of the drawdown test of Lower Granite and Little Goose, provide a status report on other related studies (primarily SCS, plus near-term project improvements for fish passage), and present information on the SEIS. Interested individuals attending those meetings offered observations helpful to refining the scope of the SEIS.

1.4 AUTHORITY

Each Federal project in the Columbia River Basin was constructed and is operated and maintained under specific Federal authorization, as well as laws of general compliance. Using these authorities, the Corps and BoR operate multipurpose water resource development projects to balance operation of individual functions with operations for all functions. This operation is coordinated with BPA and other regional interests. In this manner, the Corps and BoR ensure that their responsibility for maximizing sustained public benefits for all desirable purposes, as provided by law, is met.

BPA markets power generated at the Federal hydroelectric projects pursuant to its authorities under the Bonneville Project Act, the Pacific Northwest Electric Power Planning and Conservation Act, and related organic legislation. The Pacific Northwest Electric Power Planning and Conservation Act (PNEPPCA) and the ESA are two authorities that are applicable to the operation of Federal water resource development projects. The PNEPPCA authorizes Federal agencies to recognize the interests of fish and wildlife with other project purposes in the operation of the projects. The ESA requires all Federal agencies to ensure that actions taken by the agency are not likely to jeopardize the continued existence of a species that has been listed as threatened or endangered. In addition, agencies are directed to

use their authorities to carry out programs for the conservation of listed species. With the listing of the Snake River sockeye salmon as an endangered species and the Snake River spring/summer and fall chinook as threatened species, the Corps, BoR, and BPA must comply with the ESA.

In addition, the opportunity for public participation required in the NEPA process satisfies the requirements of Section 310(b) and Section 415(b) of the Water Resources Development Act of 1990. Section 310(b) requires public participation in developing or revising changes to reservoir operation criteria. Section 415(b) requires public notification (hearings) of actions associated with drawdown of Dworshak Reservoir.

1.5 RELATED ACTION PROGRAMS

The regional response to the need to aid salmon survival includes many efforts that encompass a broad scope beyond changing the operating regime of Columbia-Snake River dams. Because the scope of this SEIS and by reference the 1992 OA/EIS is limited to analyzing the effects of altering river management operations, studies beyond this scope are not considered in this analysis. However, the purpose of all the studies, short-term and long-term, operational and structural, is essentially the same—to help improve salmon survival while meeting the needs of other river users. Changes as a result of the long-term studies may require additional NEPA documentation and consultation with NMFS. The objective of this section is to clarify these related studies and other activities that are outside the scope of this SEIS.

1.5.1 Related Regional Studies

Through the public involvement activities conducted for the 1992 OA/EIS and this SEIS, people have expressed confusion over the scope of the respective studies and the roles of all of the many participants. Following is a brief description of the related programs and studies that focus specifically on the coordinated Columbia River System, including a matrix (Table 1.5-1) that attempts to put their respective scopes in perspective. A more comprehensive discussion of these related activities is contained in Appendix C.

- **National Marine Fisheries Service ESA Listing and Recovery Plan**

  While programs to improve the status of Snake River salmon have been ongoing for decades, the filing of formal petitions with NMFS in 1990 for ESA listing of three stocks as threatened or endangered focused regional attention on the need for more aggressive action to address the precarious status of specific wild salmon stocks. Outgrowths of the petition filing included the Salmon Summit, the beginning of the NPPC's amendments to rebuild salmon stocks, and several Corps studies to improve dam operations. The formal listings in December 1991 and May 1992 triggered the initiation of a NMFS recovery plan and Federal agency consultation on the effects of actions, including operation of the coordinated Columbia River System, on listed salmon. Under ESA, the Corps and the cooperating agencies have a responsibility to ensure their actions are not likely to jeopardize the continued existence of the listed species. The cooperating agencies have prepared a Biological Assessment on the action proposed in the SEIS and will enter consultation with NMFS under ESA, Section 7. A Biological Assessment is included in this final SEIS. NMFS will issue a Biological Opinion to determine whether or not the action jeopardizes the continued existence of the subject species.

  Ultimately, a recovery plan will guide all aspects of activities that might affect salmon restoration and recovery. A recovery team has been established and is currently developing a draft recovery plan.

- **NPPC Fish and Wildlife Program**

  The NPPC, made up of representatives of the States of Idaho, Montana, Oregon, and Washington, was entrusted under the Northwest Power Act of 1980 to 1) develop a conservation and electric power plan to ensure an adequate, efficient, economical, and reliable power supply for the Pacific Northwest; 2) prepare a program to protect, mitigate, and enhance fish and wildlife, including related spawning grounds and habitat, affected by the development and operation of any hydroelectric project on the

Table 1.5-1. Scope of related action programs.

Study Process	Hydro System: Transportation	Hydro System: Project Operations and Maintenance	Hydro System: Structural Changes	Habitat	Harvest	Production
NMFS Recovery Plan	X	X	X	X	X	X
NPPC Fish & Wildlife Program						
Phase I				X		X
Phase II	X	X	X	X	X	X
Phase III	X	X	X	X	X	X
Phase IV				X		X
Corps/BPA/BoR 1991 Operations Plan	X	X				
1992 Columbia River Salmon Flow Measures OA/EIS		X				
Interim Columbia and Snake River Flow Improvement Measures for Salmon Supplemental EIS (SEIS)		X				
System Configuration Study (SCS)	X	X	X			
Columbia River System Operation Review (SOR)	X	X	X			
BoR Snake River						
Augmentation Programs						
Uncontracted storage space		X				
New storage appraisal			X			
Water rental group		X				
Water conservation demonstration program		X				
Water acquisition		X				
BPA Annual Implementation Work Plan and ESA Related Programs		X		X		X

Columbia River and its tributaries; and 3) involve the public in these activities.

In 1982, the NPPC issued a comprehensive Fish and Wildlife Program that included salmon and steelhead production, safe passage, and harvest management. In 1991, responding to the potential NMFS listings, the NPPC began a series of amendments to its Fish and Wildlife Program centering on a salmon rebuilding program. The amendment process is being undertaken in four phases that focus on different aspects of salmon survival, including production, habitat improvement, harvest, and fish passage improvements at Federal dams. The role of the NPPC in the salmon issue is in part a natural outgrowth of its Fish and Wildlife Program responsibilities, and in part a response to a direct request from elected representatives within the region. In 1990, the NPPC contracted with the region's tribes and fish agencies to prepare an integrated system plan addressing coordinated management goals for all of the salmon and steelhead rearing subbasins within the Columbia River System. Moreover, following the Salmon Summit in 1990 to 1991, the governors of the Northwest states requested the NPPC to take the lead in developing regionally acceptable recovery actions. The river management agencies have coordinated closely with the NPPC in developing the first three phases of the Fish and Wildlife Program amendments and will continue to do so as the amendments are implemented. While NMFS has the final responsibility for issuing the salmon recovery plans, NMFS has indicated that it favors regionally developed recovery plans and expects to use the Fish and Wildlife Program amendments to help form the foundation for the recovery plans (Harrison, 1992).

- **1992 Columbia River Salmon Flow Measures Options Analysis/Environmental Impact Statement**

  The 1992 OA/EIS, prepared by the Corps, BPA, and BoR in part in response to the Salmon Summit recommendations, was designed to provide NEPA documentation for short-term (1992) river management actions. It examined ways to improve flow conditions during the 1992 juvenile salmon migration period by altering the operation of Federal dams on the lower Columbia and Snake rivers, and to provide test measurements that would be helpful in designing long-term structural actions. The preferred alternative identified in the final 1992 OA/EIS was designed to incorporate the relevant components of the NPPC's Phase II Fish and Wildlife Program amendments of December 1991.

- **1992 Operations Plan**

  As indicated above, the ESA requires that Federal agencies consult with NMFS in taking actions to conserve the listed salmon species. In compliance with this requirement, the Corps and the cooperating agencies consulted with NMFS on the actions that would potentially affect the listed species. The consultation process resulted in a preferred 1992 Operations Plan. NMFS (1992) issued a Biological Opinion concluding that proposed operations "were not likely to jeopardize the continued existence of listed or proposed salmon species." The river management agencies then began implementing the 1992 Operations Plan described in the Records of Decision (ROD), which are consistent with this Biological Opinion.

- **System Configuration Study (SCS)**

  The SCS is a study of structural alternatives in the Columbia River Basin to improve salmon migration conditions. The 1992 OA/EIS referred frequently to the Columbia River Salmon Mitigation Analysis (CRSMA) as the Corps' long-term study to address salmon recovery and potential structural responses. The CRSMA program has been a funding mechanism for a number of Corps actions addressed in the SEIS, including the 1992 OA/EIS, the March 1992 drawdown test, and the SCS. With completion of the initial items, SCS has become the primary focus of CRSMA and efforts to develop long-term plans. A Phase I report on the SCS is scheduled for mid-1993, although a status report was submitted to the NPPC in December 1992. Alternatives being examined include possible additions of upstream storage sites for flow augmentation

and temperature control; annual drawdowns of John Day and the four lower Snake reservoirs; the addition of a new collection facility that would intercept juveniles in the upper reaches of Lower Granite Reservoir; and construction of a migratory canal or conduit that would allow fish to completely bypass the mainstream dams. The SCS will provide information on the feasibility and effectiveness of some of the long-term measures recommended by the NPPC in its Fish and Wildlife Program amendments.

- **Columbia River System Operation Review (SOR)**

  The SOR, undertaken jointly by the Corps, BPA, and BoR, is a comprehensive, long-term study to coordinate operation of Federal water resource projects in the Columbia River Basin. Cooperating agencies include the NMFS, U.S. Fish and Wildlife Service (FWS), National Park Service (NPS), and U.S. Forest Service. One of its key goals is to establish guidelines for the agencies to follow in operating the coordinated Columbia River System, taking into account impacts on all river users, including anadromous fish, power, recreation, resident fish, irrigation, and navigation. It will also provide NEPA documentation to renew the Pacific Northwest Coordination Agreement (PNCA), a contract that sets out the terms for coordinated operation of the river system for power production, and the Canadian Entitlement Allocation Agreements, which provide for U.S. utilities to deliver a certain amount of energy to Canada as a result of the Columbia River Treaty. The SOR and SCS are closely coordinated by Corps participants to minimize duplication of effort and to ensure consistency. The SOR will evaluate potential future operation of the system as it might be reconfigured under SCS alternatives. Study activities of both SOR and SCS are also coordinated with the Corps' current activities to improve existing systems.

- **BPA's Annual Implementation Work Plan and ESA-Related Programs**

  BPA, in cooperation with fishery agencies and tribes, produces an Annual Implementation Work Plan (AIWP) to guide performance of actions called for in the NPPC Fish and Wildlife Program. The AIWP is a product of a process in which projects are identified, scoped, prioritized, and procured. Increasingly, the AIWP includes projects related to the listed Snake River stocks.

  BPA also funds programs and research aimed at restoring runs of listed Snake River salmon. This work includes Snake River sockeye rearing habitat restoration, captive rearing program, and broodstock rearing research; Snake River fall chinook spawning ground distribution, inter-dam losses of adults, genetic structure, population status, factors influencing juvenile migratory behavior, and characteristics of rearing habitat in mainstem reservoirs; and Snake River spring/summer chinook migrational dynamics.

  BPA will work with BoR and States of Idaho and Oregon to secure up to 100,000 acre-feet in the upper Snake River for spring migrants through a program involving financial incentives, water marketing transactions, dry-year leasing, storage buy-backs, and other measures. Providing NMFS and BPA agree that the additional water can be acquired at prices comparable to those in 1991 and that the water can be delivered in a way to significantly benefit anadromous spring migrants, BPA will secure up to 50,000 acre-feet if it should become available. Under the NPPC Phase II amendments, IPC is required to shape 110 KAF from Brownlee under certain conditions. IPC is also required to annually report to the NPPC on their ability to shape all or a portion of an additional 190 KAF that may be made available through the efforts of BoR, BPA, and the States of Idaho and Oregon. BPA will work with IPC to explore means to shape this water for significant benefits to spring migrants. BPA will also continue to work towards providing an additional 1 MAF during the migration seasons (May through September) as requested in the NPPC Phase II amendments.

1.5.2 Bureau of Reclamation Snake River Augmentation Programs

The NPPC's recent amendments to the Columbia River Fish and Wildlife Program identify BoR as having a lead or cooperative role in a number of action items intended to assist in the recovery of

the Snake River salmon runs in addition to BoR's role in the programs discussed in Section 1.5.1. BoR is working to implement the items as components of the regional salmon recovery program, although it has not independently assessed their effectiveness in terms of the overall recovery effort. Among the major tasks, BoR has agreed to seek and facilitate securing flow augmentation water from the upper Snake River Basin to improve conditions for salmon migration. Because some of these activities are ongoing or not necessarily scheduled for completion in the time frame covered by this SEIS, their inclusion here is intended as a status report on BoR's water acquisition efforts.

A general description of BoR's upper Snake River reservoir storage system is provided in Appendix C along with a discussion of factors that affect the procurement and delivery of water for flow augmentation.

- **Uncontracted Storage Space**

  BoR is working to dedicate 95,000 acre-feet of uncontracted and uncommitted space in Cascade and Deadwood reservoirs for protection of threatened and endangered species. A draft Environmental Assessment on the future management of uncontracted space in Cascade and Deadwood was released in March 1992. The preferred alternative included the sale of 380,000 acre-feet to the State of Idaho to be used for continuation of the conservation pools plus dedication of 95,000 acre-feet of uncontracted space to flow augmentation for salmon and/or protection of the Cascade-area bald eagle population. BoR is currently conducting ESA consultations with the FWS and NMFS and analyzing the public comment received on the draft assessment.

- **New Storage Appraisal Study**

  This work was initiated late last fall with the formation of an advisory group of representatives from water user organizations, fish and wildlife experts, and State and Federal agencies. The objective of this study is to identify promising new reservoir projects that could provide storage supplies for flow augmentation. To date, the group has inventoried and mapped 414 potential storage sites above Lower Granite Reservoir. The master site list was evaluated by the advisory group at a meeting in Boise, July 23, 1992, and 12 "storage areas" (some areas have more than one dam site) were selected to receive further appraisal-level evaluations. A work group was established to guide technical study activities so that consistency in the analyses can be attained. The initial work activity will be hydrologic studies to determine water supply availability for the storage areas.

- **Water Rental Group**

  BoR has been participating in the Idaho Water Rental Group, which was formed in 1991 to conduct a 3-year study of the feasibility of renting water from Idaho water banks for lower Snake River flow augmentation. The group consists of representatives from the Idaho Department of Water Resources, Idaho Department of Fish and Game, BPA, Nez Perce and Shoshone-Bannock Tribes, irrigators, IPC, and BoR. This group coordinated the purchase and release of 200,000 acre-feet of flow augmentation water in 1991. Only 90,000 acre-feet of uncontrolled water could be acquired from Cascade and Deadwood reservoirs during the 1992 season because of the lack of water consignments in this period of extreme drought. BoR has notified rental pool managers through letters and meetings that it is interested in securing any water that might become available for flow augmentation.

- **Flow Augmentation Water Conservation Demonstration Project**

  The North Side Canal Company has been selected as the cooperating entity to implement a small-scale water conservation demonstration project in the upper Snake River Basin for flow augmentation purposes. The demonstration project will test the concept of assisting in the funding of conservation measures in return for use of some existing storage space for flow augmentation. Primary techniques to be used in improving efficiency include automating diversion gates, reregulating reservoirs, and lining canals. A change-of-use application may need to be filed with the Idaho Department of Water Resources in conjunction with the use of

any storage space acquired through this demonstration project.

- **Water Acquisition**

  BoR is pursuing the opportunity to acquire water for flow augmentation purposes from willing sellers through such mechanisms as long-term rental pool leases, the permanent purchase of storage space in BoR reservoirs, and leasing water in dry years through "dry-year" option contracts. In August 1992, BoR contacted several entities having contracts for storage space in BoR reservoirs inquiring about their interest in marketing space to BoR. In its inquiry, BoR indicated a desire to discuss the possibility of entering into "option agreements" to purchase storage space contingent upon mutual resolution of such items as the price and securing the necessary approvals, permits, and compliances. A change-of-use application will be filed with the Idaho Department of Water Resources for any permanent purchases of storage space for flow augmentation purposes.

  Significant actions arising out of the above water procurement activities will be subject to appropriate public review, environmental compliance under NEPA, and ESA consultation.

2.0

Description of Existing Environment



2.0 DESCRIPTION OF EXISTING ENVIRONMENT

This section provides information about the existing environment of the portion of the Columbia River Basin System that might be affected by the action alternatives described in Section 3. It includes a description of the basin, the affected projects, and their relationship to the overall system. This is followed by summaries of physical, biological, cultural, economic, and social environments; for additional details, refer to Section 2 of the 1992 OA/EIS, which is incorporated by reference.

The purpose of this section is to provide the resource baseline information against which to measure the anticipated impacts from the river management alternatives considered in this document. As a supplement to the 1992 OA/EIS, the focus of this document is on new information not presented in the original OA/EIS. Accordingly, most of the material in this section of the SEIS addresses geographic areas that were not included in the scope of analysis for the 1992 OA/EIS.

2.1 COLUMBIA RIVER BASIN

The Columbia River and associated tributaries comprise one of the principal economic and environmental resources in the Pacific Northwest. The river originates in the Rocky Mountains of British Columbia, Canada, and flows south to be joined by two major tributaries, the Kootenai and Pend Oreille rivers, near the U.S.-Canadian border. Another important tributary, the Snake River, originates in the region of Yellowstone National Park in Wyoming and joins the Columbia River 330 miles upstream from the mouth. From there the river flows westward past the City of Portland to the Pacific Ocean. The total drainage area of the basin is 259,000 square miles, and the annual runoff is 173 million acre-feet. About 40 percent of the total area lies in the Snake River drainage; however, this relatively arid region contributes only about 18 percent of the total flow during drought years. The greatest contribution of the river's runoff (almost 60 percent in dry years) comes from the Canadian portion of the drainage, which represents only 14 percent of the total drainage area.

The Columbia River Basin is primarily a snow-fed regime with snow accumulating in the mountains during the winter (November through March), then melting to produce runoff during the spring and summer. A broad-crested flood peak usually occurs in early June, and thereafter the river recedes during the late summer and fall. Summary hydrographs of streamflow for the mainstem Columbia River at The Dalles and for the Snake River at Lower Granite Reservoir (Figures 2.1-1 and 2.1-2) show this general hydrologic pattern. Tributaries to the Columbia River that lie near the west coast, such as the Willamette River that flows through Portland, are dominated by winter rains. These result in high streamflow of short duration throughout the winter and lower flow in the summer.

Since the 1930s, the basin has been developed by the construction of dams to capitalize on the hydroelectric potential of the rivers, provide inland navigation on the lower Columbia-Snake River reaches, and achieve improved flood control for areas that have been subject to flooding in the past. Some 77 Federal and non-Federal projects have been constructed, making the basin one of the most highly developed in the world. The total storage capacity of the system is approximately 40 million acre-feet (MAF).

Table 2.1-1 lists the mean annual runoff of the Columbia and Snake rivers in cubic feet per second (cfs), with the equivalent inches of runoff, for selected basin areas during a 40-year period, July 1928 through June 1968. Mean annual runoff for the Columbia River at The Dalles was 129 MAF; at its mouth it was 173 MAF, adjusted for irrigation depletions.

2.2 AFFECTED PROJECTS AND PROGRAMS

Most juvenile salmon originating from the Snake River Basin must make their way past eight dam and reservoir projects on the lower mainstem Snake and Columbia rivers before reaching the Pacific Ocean. The actions considered in this SEIS are operational changes that could be implemented at seven Federal projects and one private project in 1993 and future years, including five of the eight mainstem dams and three upstream storage reservoirs. These eight projects are Lower

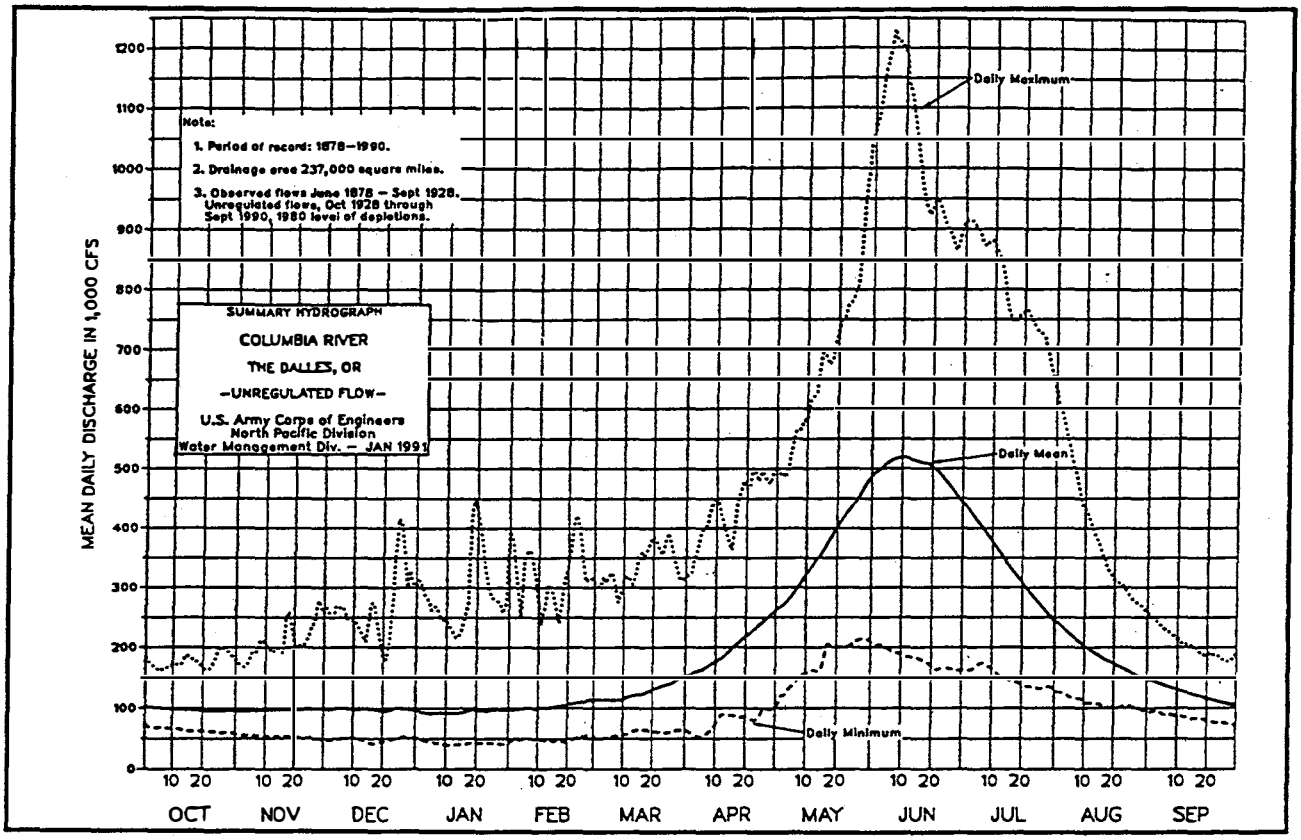


Figure 2.1-1. Summary hydrograph of the Columbia River at The Dalles, Oregon.

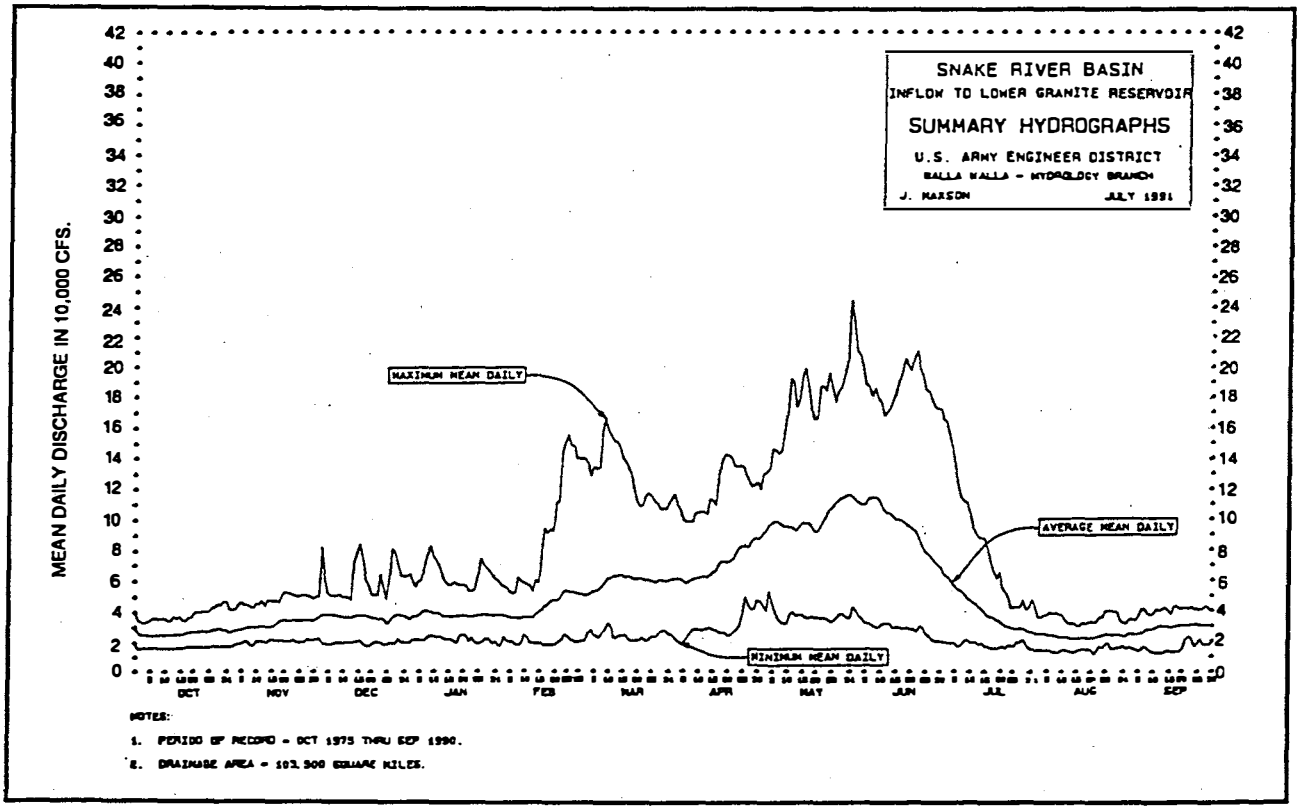


Figure 2.1-2. Summary hydrograph of Snake River inflow to Lower Granite Reservoir.

Table 2.1-1. Columbia-Snake River drainage characteristics.[a/]

Drainage Area Location	Drainage Area (Sq. Mi.)	Mean Annual Runoff		
		Mean Flow (cfs)	Volume Acre-Feet (1,000s)	Equivalent Precipitation (Inches)
Columbia River at Grand Coulee Dam	74,100	107,700	77,970	19.7
Snake River at Brownlee Dam	72,500	16,530	11,970	3.1
Salmon River at Whitebird (Freedom D.S.)	13,320	10,650	7,710	10.9
Clearwater River at Spalding (Lenore D.S.)	8,300	14,110	10,220	23.0
Snake River at Ice Harbor Dam	109,000	47,680	34,520	6.0
Columbia River at The Dalles Dam	237,000	177,900	128,900	10.2
Columbia River at the mouth	259,000	238,800	172,890	12.5

D.S. = Downstream
Source: Corps, North Pacific Division.

a/ Runoff figures based on July 1928 through June 1968.

Granite, Little Goose, Lower Monumental, and Ice Harbor on the lower Snake River; John Day on the lower Columbia River; Dworshak on the North Fork Clearwater River; Grand Coulee on the middle Columbia; and Brownlee on the middle Snake River. In addition, the scope of analysis for the SEIS includes the potential for indirect effects on the operations of the Libby project, on the Kootenai River, and the Hungry Horse project, on the South Fork of the Flathead River. Brownlee is a Federally licensed facility owned and operated by the IPC. The other nine projects are Federal projects, of which Grand Coulee and Hungry Horse are operated by the BoR, and the rest are operated by the Corps (Table 2.2-1).

2.2.1 Characteristics of Affected Projects

The Federal projects on the Snake and Columbia rivers are multi-purpose projects that provide public benefits in many different areas. Project facilities include dams and reservoirs; hydroelectric powerplants and high-voltage transmission lines; navigation channels and locks; irrigation diversions and pumps; juvenile and adult fish passage facilities; parks and recreational facilities; lands dedicated to project operations; and areas set aside as wildlife habitat. The 10 projects fall into two major categories: storage and run-of-river projects. Dworshak, Brownlee, Grand Coulee, Libby, and Hungry Horse are storage facilities, and the remainder are run-of-river facilities.

Table 2.2-1. Characteristics of projects.

Project	Type of Project	Location (State, River, River Mile)	Project Ownership	Reservoir Name	Reservoir Capacity (normal operating range, acre feet)	Reservoir Elevation Normal Operating Range (msl)	Reservoir Length (miles)
Libby	Storage	MT, Kootenai, 221.9	Corps	Lake Koocanusa	4,980,000	2,287-2,459	90
Hungry Horse	Storage	MT, S. Fork Flathead, 5.2	BoR	Hungry Horse	2,980,000	3,336-3,560	34
Grand Coulee	Storage	WA, Columbia, 596.6	BoR	Lake Roosevelt	5,185,000	1,208-1,290	151
Brownlee	Storage	ID, Snake, 285	IPC	Brownlee	980,000	1,976-2,077	60
Dworshak	Storage	ID, N. Fork Clearwater, 1.9	Corps	Dworshak	2,016,000	1,445-1,600	53.6
Lower Granite	Run-of-River	WA, Snake, 107.5	Corps	Lower Granite Lake	49,000	733-738	43.9
Little Goose	Run-of-River	WA, Snake, 70.3	Corps	Lake Bryan	49,000	633-638	37.2
Lower Monumental	Run-of-River	WA, Snake, 41.6	Corps	Lake Herbert G. West	20,000	537-540	28.7
Ice Harbor	Run-of-River	WA, Snake, 9.7	Corps	Lake Sacajawea	25,000	437-440	31.9
McNary[b/]	Run-of-River	WA/OR, Columbia, 292	Corps	Lake Wallula	185,000	335-340	61.6
John Day	Run-of-River[a/]	WA/OR, Columbia, 215.6	Corps	Lake Umatilla	500,000	265-268 (7/1-10/1) 260-265 (11/1-6/1)	76.4
The Dalles[b/]	Run-of-River	WA/OR, Columbia, 191.5	Corps	Lake Celilo	53,000	155-160	24
Bonneville[b/]	Run-of-River	WA/OR, Columbia, 146.1	Corps	Lake Bonneville	100,000	71.5-76.5	45.0

a/ John Day is technically a storage project, because it provides some flood control storage, but is presented as a run-of-river project due to common characteristics with other mainstream projects.

b/ These projects are carried over from the 1992 OA/EIS for reference purposes only.

Sources: BPA et al., 1991; Corps, 1984.

Storage Projects

The main purpose of storage reservoirs is to adjust the natural flow patterns of a river to closely conform to water uses. Storage dams in the Columbia River Basin store the spring and summer runoff water until it is needed. Hydropower operations typically require concentrated releases of stored water from late fall through early spring to generate electricity. Flood control requirements usually require releases in late fall and/or before the spring runoff to make flood storage space available. These two uses of storage are the primary reasons for drawdown, although releases might be made for other uses at individual projects.

These releases of water from storage projects result in a wide range of reservoir elevations during a year's operation. For example, Dworshak can operate over a range of 155 feet; Grand Coulee can operate over a range of 82 feet. Active storage capacity of the five storage projects (shown in Table 2.2-1) ranges from 980,000 acre-feet at Brownlee to 5,185,000 acre-feet at Grand Coulee.

Run-of-River Projects

The eight run-of-river projects on the lower Snake and Columbia rivers were constructed to serve two major purposes: (1) to provide adequate water depth for navigation over rapids and other obstacles, and (2) to provide water for power generation. With the exception of John Day, these projects do not have enough storage to permit seasonal regulation of streamflows. However, each has several feet of daily/weekly storage (pondage), which is used for hourly regulation of powerhouse discharges to follow the daily and weekly load patterns. John Day has, in addition, a limited amount of seasonal flood control storage space.

Table 2.2-1 lists the normal operating ranges and usable storage volumes for each project. While it is physically possible to draft these reservoirs well below the normal minimum pool levels, the projects were not designed to operate in that range. Some of the project facilities, such as the navigation locks, fish ladders, and juvenile bypass facilities, would no longer function, and railroad and highway fills and other embankments would not be protected against wave action on the reservoir.

2.2.2 Project Purposes and Uses

With the exception of Brownlee, which is owned and operated by IPC, each project was constructed under specific Federal authorizing legislation identifying the major intended uses for each project. IPC is responsible for operating Brownlee in a manner that best serves multiple uses. Most of the other projects were specifically authorized for power production, flood control, navigation, and/or irrigation. The abundance of water and the predictability of its use allows a project to support other uses as well, but only after its authorized purposes are met (Table 2.2-2). Generic Congressional authorization allows for such uses as water quality, fish and wildlife, recreation, and municipal and industrial water supply. While the authorizing legislation stipulated intended use, it seldom contained explicit provisions for operating the individual projects or for their coordinated operation within the total system. The Corps and BoR are responsible for deciding how to operate their projects based on principles of multiple-use operation, their agency charters, operating experience, and public concerns. The major uses of the projects are summarized below. Figure 2.2-1 shows the water levels required to accommodate some of these uses. Table 2.2-3 gives specific elevation per project for each item noted in Figure 2.2-1.

Power Generation

Falling water provides the energy to turn power-generating turbines at the dams. Hydropower supplies approximately 75 percent of the electricity in the Pacific Northwest (BPA et al., 1991). When in surplus, it is also an export product for the region. The remainder of the region's electricity comes from thermal resources, mainly nuclear and coal-fired plants.

Power production on the Columbia River System involves three primary objectives that system managers try to meet, within a variety of system constraints:

- Meeting the region's firm energy commitments
- Optimizing future energy production through refill
- Maximizing nonfirm energy production to keep regional power rates as low as possible

Table 2.2-2. Project uses.

Project	Authorized Purpose/Other Uses
Hungry Horse	power generation, flood control, fish and wildlife/recreation, irrigation
Libby	power generation, flood control/recreation, fish
Grand Coulee	power generation, flood control, irrigation/recreation, fish and wildlife
Brownlee[a/]	power generation, navigation, recreation, fish and wildlife, irrigation, and flood control
Dworshak	power generation, flood control, navigation, recreation/fish and wildlife
Lower Granite	power generation, navigation/recreation, fish and wildlife, irrigation, and water quality
Little Goose	power generation, navigation/recreation, fish and wildlife, irrigation, and water quality
Lower Monumental	power generation, navigation/recreation, fish and wildlife, irrigation, and water quality
Ice Harbor	power generation, navigation/recreation, fish and wildlife, irrigation, and water quality
McNary	power generation, navigation/recreation, fish/wildlife, and irrigation
John Day	power generation, navigation, flood control/recreation, fish and wildlife, irrigation, and water quality
The Dalles	power generation, navigation/recreation, fish and wildlife, irrigation, and water quality
Bonneville	power generation, navigation/fishery, recreation, and water quality

Sources: Corps, 1989, 1988a-d, 1986, 1984, 1968, 1962, 1961.

a/ Authorized uses per IPC license from Federal Power Commission (now Federal Energy Regulatory Commission).

Firm Power. Firm power contracts are long-term commitments that carry a guarantee to meet some or all of a customer's load requirements over a defined period. These contracts are based on an estimate of the firm energy load-carrying capability (FELCC) of the system. FELCC can be defined as the energy produced by the hydroelectric system if the 4 critical water years (1928 to 1932, the 4 lowest consecutive years of runoff in the 50-year period used for power planning) were to reoccur. The Northwest's publicly owned utilities have first claim on power produced by the coordinated Columbia River System projects. BPA has long-term firm power sale contracts with over 120 utilities, including municipalities, public utility districts, and rural cooperatives. The agency also sells firm power directly to some of the region's large industries, including aluminum smelters.

Refill. As plans are formulated to draft reservoirs to meet firm power needs, provide flood control, and generate as much nonfirm energy as possible, other continuing needs for reservoir water must be considered. Enough water must be retained in storage to provide flows necessary for spring fish migration, ensure a high likelihood of reservoir refill by summer to fulfill recreational needs, and provide water for next year's power generation.

Nonfirm Power. Nonfirm generation is power in excess of that needed to meet firm power requirements. In most water years, stream flows

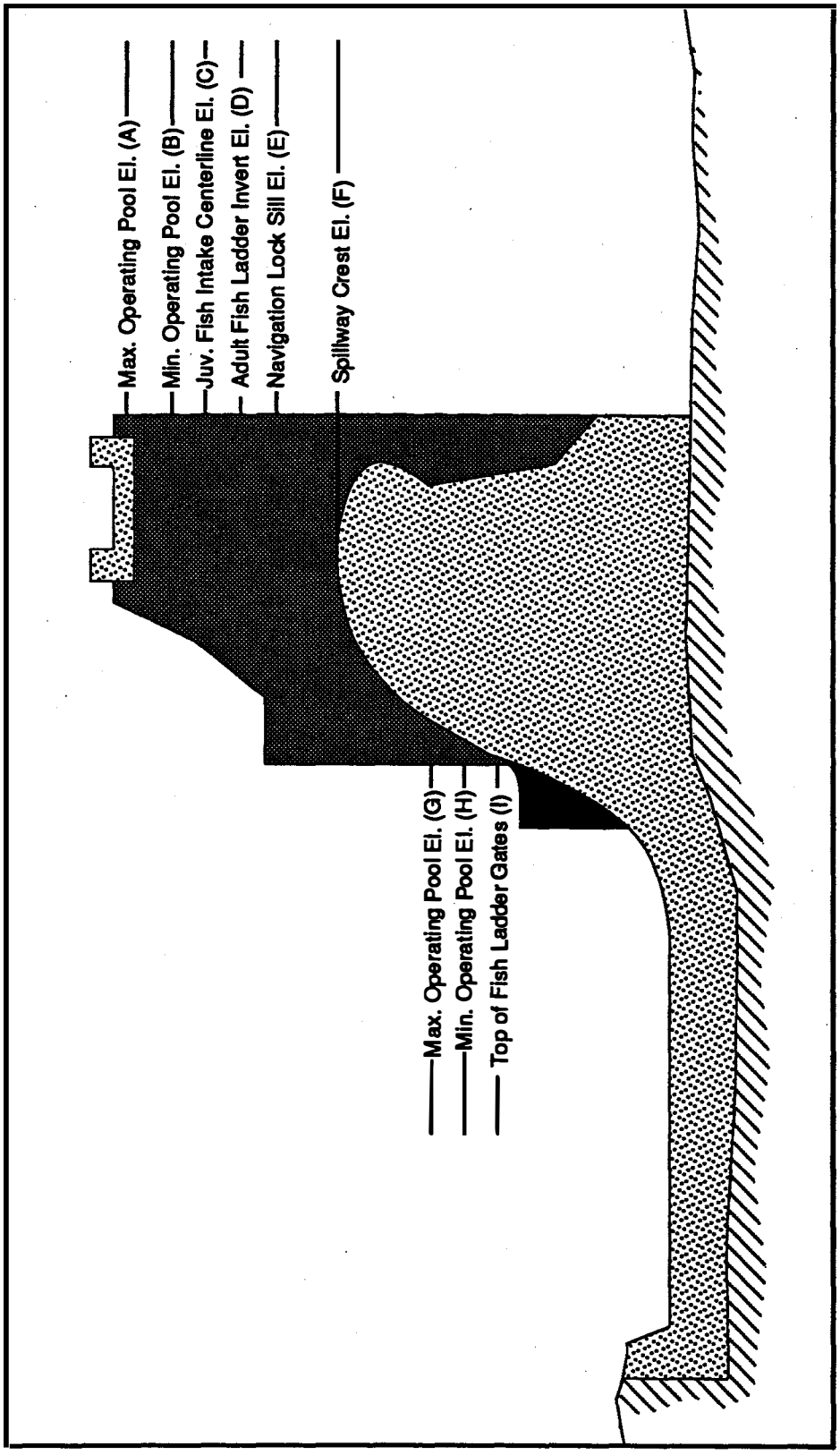


Figure 2.2-1. Summary of pertinent project data and operating limits.

Table 2.2-3. Summary of pertinent project data and operating limits (fmsl).

Project	Upstream						Downstream		
	Maximum Operating Pool Elevation A	Minimum Operating Pool Elevation B	Downstream Juvenile Fish Orifice[a/] Center Line C	Adult Fish Ladder Exit Invert Elevation D	Navigation Lock Sill Upstream Elevation E	Spillway Crest Elevation F	Maximum Operating Pool Elevation G	Minimum Operating Pool Elevation H	Top of Adult Fish Ladder Gates I
Columbia River									
Bonneville	76.5	70.0[b/]	65.5	63.0	40.0	24.0	35.0	7.0	2.0[c/]
The Dalles	160.0	155.0	151.0[d/]	147.0	140.0	121.0	85.0	75.0	67.0
John Day	268.0	257.0	250.4	250.5	242.0	210.0	166.0	157.0	154.0
McNary	340.0	335.0[e/]	330.0	330.0	320.0	291.0	269.0	264.0	252.0
Snake River									
Ice Harbor	440.0	437.0[e/]	431.5[d/]	431.0	422.0	391.0	346.0	340.0	332.0
Lower Monumental	540.0	537.0[e/]	531.5	530.5	521.0	483.0	442.0	439.0	431.0
Little Goose	638.0	633.0[e/]	628.9	627.0	618.0	581.0	541.0	538.0	530.0
Lower Granite	738.0	733.0[e/]	729.0	727.0	718.0	681.0	638.0	633.0	625.0

a/ Orifices allow juvenile fish to pass from the gatewells into the collection channel for bypass past the dam.
b/ 70.0 is the minimum operating pool, but the Corps has an agreement with the Tribes not to operate it below 71.5 without notifying them.
c/ Fish ladder floor elevation; no minimum tailwater requirement for fish ladder operation.
d/ Top of sluiceway.
e/ Minimum forebay elevation used for design of existing fish passage facilities which corresponds to current minimum operating pool (MOP).

are high enough to produce at least some nonfirm generation. This is particularly true after January 1, when initial runoff forecasts make it possible to estimate how much water will be available from snowpack runoff. In an average year, nonfirm generation may add 25 percent or more to the hydro system's generating output. Nonfirm power is generally sold with no guarantee of continuous availability and with the ability to terminate delivery on very short notice. Nonfirm energy is purchased from BPA by Northwest utilities, California utilities, and some large industries that contract directly with BPA for power. Customers in the Northwest have priority to purchase nonfirm power.

Storage reservoirs are the key to matching the region's water resources with electricity use patterns. Energy, in the form of water, is held in reservoirs when natural streamflows exceed power generation requirements. Water is released for generation when it is needed to produce electricity.

Flood Control

The primary flood control season in the Columbia River System is May through July. Rain-induced floods also occur in the winter in the southern and western parts of the drainage. No significant flooding of the Columbia River below Bonneville Dam has occurred since completion of the Federal projects. Because the ability to forecast the source of most flooding (snowmelt) in the study area has improved over time, the amount of flood control storage can be determined several months in advance. Consequently, flood control storage space in Columbia River reservoirs is maintained only during those months with high flood risk, and the amount of space needed can be predicted by the amount of runoff expected. This situation makes it possible to use the reservoir space to store water for other uses (e.g., hydropower, irrigation, recreation, and fish flows), when there is reduced flood risk, and for joint purposes during the flood season.

Navigation

The Columbia-Snake Inland Waterway from the Pacific Ocean to Lewiston, Idaho consists of two segments. The first is the 40-foot-deep, open-river channel for ocean-going vessels that extends 106 miles from the ocean to Portland, Oregon and Vancouver, Washington. The second is the shallow-draft barge channel that extends 359 miles from Vancouver to Lewiston.

Navigation between Bonneville Dam and Lewiston is possible because each dam has a system of locks, and the projects maintain sufficient water at minimum operating pool (MOP) to pass vessels in the authorized 14-foot channel depth. This navigation channel connects the agricultural interior basin with the deep-water ports on the lower Columbia River.

Irrigation

Irrigation is an authorized use at 10 of the projects listed in Table 2.2-2. Grand Coulee, operated by the BoR, is the only one of the affected projects where irrigation diversion facilities are integral to the dam and related structures. Irrigation water is withdrawn from the other projects by pumping stations at the reservoir margins. None of the projects other than Grand Coulee have storage allocated to irrigation. The major irrigation consideration at these projects is to ensure that pool elevations are high enough to permit the pumps to operate. The irrigation season generally extends from about April through September, but can continue into October or November.

Fish

A variety of fish facilities and programs have been developed at the affected projects. Adult fish passage facilities were built into all eight of the mainstem Columbia and Snake River dams. In the early 1950s, the Corps began an intensive program, the Fish Passage Development and Evaluation Program (FPDEP) in cooperation with regional fish agencies and other experts, to improve adult fish passage and develop methods of safe juvenile fish passage at each of the mainstem dams. These research efforts led to the development of submersible traveling screens to divert juvenile fish away from turbine intakes and into special channels for subsequent bypass around the dam or collection for transport downstream by truck and barge. Five of the projects currently have these systems, including Lower Granite, Little Goose, McNary, Bonneville, and John Day, and a juvenile bypass system at Lower Monumental was completed in

1992. Lower Granite, Little Goose, and McNary dams each have fish holding and transportation facilities. The transportation facility at Lower Monumental will be complete in 1993. Ice Harbor and The Dalles currently use sluiceways, and bypass systems are scheduled to be installed by 1996 and 1998, respectively.

In addition to physical facilities, other measures that change the way the river is operated have been implemented to protect fish and wildlife. One such measure is the Water Budget, in which water is discharged from storage projects to increase spring and summer flows for juvenile fish passage in the Snake and Columbia rivers. In another action taken in 1989, NPPC amended their program to incorporate terms of a recently signed regional Fish Spill Memorandum of Agreement (MOA). The amendments called for passing a specific amount of water over the spillways of four Corps projects—Lower Monumental, Ice Harbor, John Day, and The Dalles—in the spring and summer (summer only at John Day), providing nonturbine passage for juvenile fish at these projects pending installation of adequate bypass facilities. This replaced previous Corps spill programs in effect since 1978, which used nightly hydro-acoustic monitoring to initiate spill if fish passage at the projects exceeded threshold numbers.

Rivers and reservoirs are also home to fish that do not migrate to the sea. These fish, such as sculpins and bass, are referred to as resident fish. System operators monitor water levels to protect the shallow spawning habitat of resident fish in the reservoirs as much as possible. State fish and wildlife agencies manage the resident fisheries in these reservoirs for the benefit of the public.

Wildlife

Although the focus of most mitigation and enhancement actions of Federal projects in the Columbia River System has been on fish, wildlife protection is also a consideration. Much of the land within and adjacent to Federal project boundaries is designated and managed as wildlife habitat. Several national wildlife refuges are located on project lands, and a large number of other parcels are operated as habitat management units (HMUs). Wildlife considerations also affect project operations and water management. For example, more than 20,000 acres at Dworshak have been designated for present and future wildlife management. In addition, special operating requirements are put into effect at certain projects in the early spring, when geese are selecting their nesting sites, to keep geese away from areas that may later be inundated with water.

Recreation

Dworshak is the only Corps project within the scope of the SEIS in which recreation is specifically authorized. Recreation use and development is authorized at all of the projects under generic Federal legislation, including the Federal Water Projects Recreation Act of 1964 and the Flood Control Act of 1944. Under these authorities, the Corps is the Federal agency primarily responsible for providing recreation facilities on Corps lakes. The Corps also cooperates with Idaho, Oregon, and Washington State Park departments and a variety of other local entities such as counties, cities, and port districts to build and manage a system of water-related recreation facilities, including boat ramps, swimming beaches, marinas, campgrounds, picnic areas, and interpretive sites. Facilities are provided by the project operators or a variety of Federal, State, local, and tribal agencies. Key activities include fishing, swimming, waterskiing, picnicking, camping, hunting, boating, windsurfing, and sightseeing. Use of the reservoirs occurs mostly from late spring through early fall. Normal operation of the projects for flood control, power generation, and other purposes sometimes conflicts with optimum conditions for recreational use. Where compatible with other project purposes, the projects are operated to maintain recreation benefits.

Water Supply and Water Quality

The projects supply water to some cities and industries by diversion or pumping, but these diversions are small. Water quality in the Columbia River System is generally good, but pesticide runoff in areas of heavy agricultural use negatively affects fish and wildlife populations. Municipal and industrial discharges also degrade water quality in some reaches. In the tributaries, streamflows from reservoir projects must be adequate to maintain water quality requirements for aquatic life,

municipal or industrial use, and water recreation. Minimum outflows are specified for each project based on downstream requirements. With the exception of dissolved gases and water temperature, the projects generally have little effect on water quality.

2.2.3 Project Operation (Prior to 1991)

The Corps, BoR, and BPA each have a role in coordination of the Columbia-Snake River System. The Corps operates 11 of the 14 projects identified in the SEIS (except Grand Coulee, Hungry Horse, and Brownlee). It is responsible for flood control, recreation, fish and wildlife, navigation, power production, and water quality at all major reservoirs in the Columbia River Basin. The Corps also maintains navigation channels to accommodate barges and other river traffic. BoR is responsible for Federally financed water development and irrigation programs. BoR built and operates Grand Coulee and Hungry Horse dams. Brownlee is owned and operated by IPC. BPA markets and distributes the power generated at the Federal projects on the Columbia and Snake rivers. BPA sells power from the dams and other generating plants to public and private utilities and builds and operates transmission lines that deliver the electricity. The Corps and BoR develop operating requirements for their projects and, within these limits, BPA schedules and dispatches power.

The Columbia River Treaty requires the United States and Canada to prepare an Assured Operating Plan and a Detailed Operating Plan each year. The operating plans are prepared by the Columbia River Treaty Operating Committee, made up of representatives of the Corps, BPA, and B.C. Hydro.

The Assured Operating Plan dictates how Treaty storage will operate 6 years in advance. It was developed to meet the flood control and power objectives of the Treaty—the only recognized purposes for the project operation when the Treaty was signed. The Detailed Operating Plan examines the upcoming 4-year critical period and addresses operations over the next 12 months.

The Assured Operating Plan and the Detailed Operating Plan are the basis for the operating rule curves for the Treaty projects in Canada. These two plans are factored into the annual plan developed by parties to the Pacific Northwest Coordination Agreement (PNCA) since releases of water from the Canadian storage reservoirs are crucial for coordinated system planning in the United States.

The PNCA was inspired by the Columbia River Treaty. It is a complex contract for planned operation among the Corps, BoR, BPA, and power generating utilities of the Pacific Northwest. It was signed in 1964 and expires in 2003.

The PNCA calls for annual planning, which must accommodate all the authorized purposes of the Columbia River hydro projects. It also must recognize project and system requirements that are frequently changing to serve multiple river uses. Individual project owners set requirements for using their own reservoirs. All PNCA parties coordinate to meet system requirements. Power generation, which is planned under terms of the PNCA, complies with these requirements. The PNCA planning process establishes day-to-day power operations.

From this process, rule curves are established to guide seasonal reservoir operation. The curves are used to operate individual reservoirs, as well as the total coordinated reservoir system. Rule curves specify reservoir water levels that are desirable for each month and provide guidance in meeting project purposes. Each project operator develops a plan to meet the rule curve at the start of each operating year. Plans are updated as the year progresses and as more information on snowpack and streamflow becomes available.

Once the basic operating guidelines are set, actual operation of the system over the year is based on meeting several related but sometimes conflicting objectives:

- Provide adequate flood storage space for controlling spring runoff;
- Provide for navigation, recreation, and fish and wildlife;

- Maintain an acceptable probability that reservoirs will refill to provide water for next year's operation;
- Provide adequate water supply for irrigation;
- Provide flows to aid downstream migration of anadromous juvenile fish; and
- Maximize power generation, within the requirements imposed by other objectives.

This SEIS represents how nonpower requirements are defined. Parties to the PNCA submit operating requirements into the annual PNCA planning process in February for the following operating year. However, this planning process does not foreclose modified operations, which are identified after the annual planning process is initiated. The cooperating agencies have the flexibility to operate the system to meet the diverse needs of the region, including measures that will conserve and improve conditions for the listed species based on available information throughout the operating year.

Many variables cause short-term operational adjustments. For example, sometimes more rain causes higher flows in the fall. This water can be used to produce nonfirm energy, or the water can be left in storage for future use if storage space is available. In a poor snowpack year, it may be necessary to draft reservoirs to levels jeopardizing their refill to get enough power to meet firm energy demand in the region or to meet other obligations. Runoff can be so low about 25 percent of the time that reservoirs in the system fail to refill. When this occurs, optional power sales cease and power generation is limited to meeting firm power requirements.

General operation of the system can be divided into three seasons:

- **August through December** is the fixed drawdown period, when storage reservoirs are operated according to predetermined rule curves because forecasts of the runoff from the snowpack are not available until January.
- **January through March** represents the variable drawdown period, when operation of the reservoirs is guided by the runoff forecasts. Reservoirs are drafted to provide flood control space and to meet power needs. They are also drafted to make nonfirm energy sales. But enough water must be kept in storage to provide fish flows necessary for spring fish migration and to reasonably ensure reservoir refill by summer.
- From **April through July,** the reservoirs store spring runoff. Also during this time, water is released to help juvenile salmon and steelhead migrate to the ocean. Operations for flood control and power sales continue as needed.

2.2.4 Activities Related to Fish

An extensive array of fishery programs has been developed at the projects. Many of these programs have evolved over time as project operators have sought to meet specific needs. Passage of the Pacific Northwest Electrical Power Planning and Conservation Act of 1980 significantly expanded these programs. The Act created the NPPC and led to its Fish and Wildlife Program to protect, mitigate, and enhance fish and wildlife.

Juvenile Bypass Program

Migrating juvenile salmonids originating above Lower Granite must pass the eight mainstem dams to reach the ocean. Downstream migrants can pass through the spillway juvenile bypass system or the powerhouse at each dam. The majority of water is passed through the powerhouse. Spill occurs when powerhouse capacity is exceeded, demand for electrical power is low, or when specifically requested for passage of juvenile fish.

Mortality of juvenile fish passing through the turbines is estimated to be higher than through the spillway. Rapid changes in pressure and impact from turbine blades are the primary causes of mortality when juveniles pass down through the turbines. The shearing action of water in the turbine can also cause injury and death. In addition, juvenile salmon and steelhead may be stunned and disoriented after passing through the turbines, making them more susceptible to predation (Corps, 1991a).

All eight lower Columbia and Snake River dams have been equipped with some type of system to bypass downstream migrants through the

powerhouse without passing through the turbines. Six of the projects have been equipped with facilities to divert juvenile anadromous fish away from the turbine intakes and through a bypass system to the tailrace, where they are collected for transport or released back into the river (Figure 2.2-2). The systems at Lower Granite, Little Goose, and McNary dams are used to collect fish for the juvenile fish transport program. The bypass systems at Bonneville and John Day dams discharge fish back to the river below the projects. The bypass system at Lower Monumental started operation in 1992. This system will be operational for collection and transportation in 1993. Bypass facilities for Ice Harbor and The Dalles are being designed and are scheduled to be operational in 1996 and 1998, respectively; however, an interim operation of bypass screens at Ice Harbor will begin in 1993.

The bypass systems use submerged traveling screens to deflect juvenile fish out of the turbine intakes into a gatewell slot. At most projects, juvenile fish pass from the gatewell slots through orifices into a collection channel inside the dam. The collection channels run the length of the powerhouses, then change to either pipelines or open flumes that carry juvenile fish to release sites below the projects or to transportation facilities (see description in next section). Ice and trash sluiceways are currently operated for passing fish at The Dalles and Ice Harbor. These sluiceways are concrete channels along the upstream faces of the dams and are separated from the reservoirs by a series of gates. The system was designed so that the gates could be lowered to skim floating ice or debris from the reservoir behind the dam. The sluiceways work in a similar fashion to attract surface-oriented juvenile salmonids. Juvenile fish are attracted into the sluiceways where they pass through the channel to the tailraces below the dams.

Transport

The NMFS and the Corps, in cooperation with the fish agencies and tribes, developed the Juvenile Fish Transportation Program. The program was developed to improve survival of the juvenile fish through the system of dams and reservoirs. Research starting in the late 1960s and continuing in the 1970s indicated survival of transported fish was higher than that of nontransported fish. Mass transport operations were instituted in 1975 and were maintained because results continued to show benefits. In 1981, the NMFS operation of the transport program was taken over by the Corps. The NMFS retained an advisory role for one year, and now continues its involvement, along with the state agencies, through the Fish Transportation Oversight Team.

As described in the Juvenile Fish Bypass Program section above, screens are used to divert fish into bypass systems at six of the dams. At three of these projects—Lower Granite, Little Goose, and McNary—the fish are collected for transportation. (Lower Monumental will have operational collection and transportation facilities in 1993.) The pipe or flume carrying water from the powerhouse passes through a separator where juvenile salmonids are separated from adult salmonids (which have fallen back from the forebay into the turbine intakes), larger resident fish, and debris. Separators are also used to sort the juvenile salmonids by size (some stocks of steelhead are larger than chinook). From the separators, juvenile fish pass through a sampling and distribution system and are routed directly onto a barge for transport or into raceways and held for transport by truck or barge. Barges constantly circulate river water, so the smolts can imprint on the chemical composition of the water to help them locate their home stream when they return as adults. The barges also dissipate high dissolved gas levels of the river water, improving survival. Trucks are used to transport the smaller numbers of smolts collected during the early and final stages of the season. The transport program has generally operated from April through July on the lower Snake River and through mid-September on the lower Columbia River, although beginning in 1991, the program has been extended through October on the lower Snake River and December on the lower Columbia River.

As many as 20 million young salmon and steelhead are transported each year from the Columbia and Snake rivers combined, although this represents only a portion of the outmigrating fish population (the vast majority of which are released from hatcheries) on the Snake River. For example, approximately 12.5 million spring chinook smolts were released from hatcheries in 1990. Of these

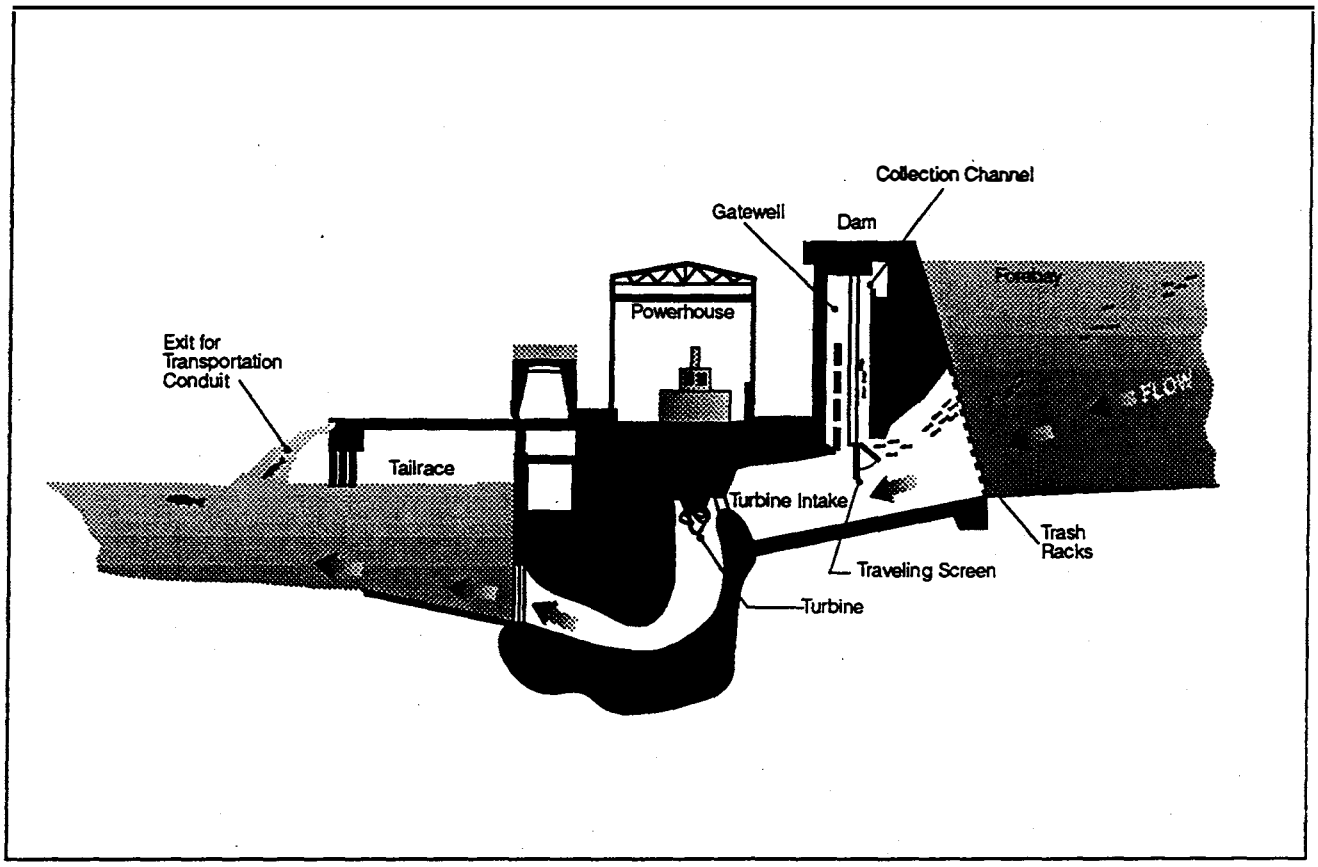


Figure 2.2-2. Juvenile bypass facilities.

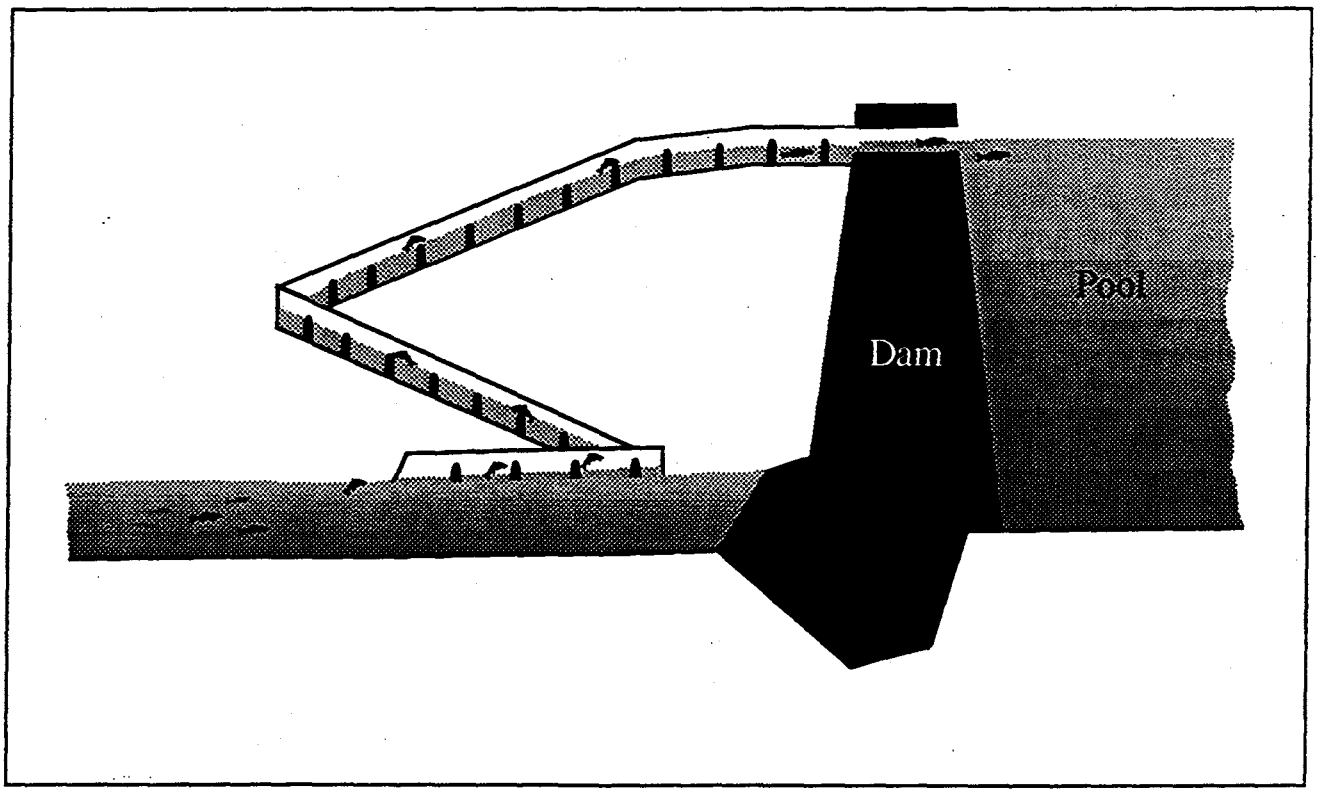


Figure 2.2-3. Adult fish ladder.

fish, plus an estimated 1 million wild fish migrants, only approximately 4.5 million were collected and transported from Lower Granite and Little Goose dams. Less than 50 percent of the estimated population of downstream juvenile migrants was estimated to have arrived at Lower Granite. Large losses of fish occur prior to the upstream end of Lower Granite Reservoir and within the reservoir itself, but the relative losses of each have not been specifically determined.

Tests have been conducted over the course of the transportation activities to determine the relative survival of transported compared to nontransported fish. Separate groups of fish are marked for transport and for inriver passage (research controls) and numbers of adult returns for each group are compared. In the past, these tests have indicated strong positive results for steelhead in all cases, but the results have been mixed for chinook. From 1968 through 1980, 24 studies of chinook transportation were conducted on the Snake River, using both barges and trucks. Significantly more transported than nontransported fish returned in 10 of the 24 tests. In five tests, measurably, but not significantly, more transported fish returned. In nine other tests, very poor returns of both groups (seven tests) or no returns of either group (two tests) produced meaningless results. When results were combined from two of the tests that had very poor returns for both groups, significantly more nontransported than transported fish returned. However, the statistical validity of the conclusion in this instance is questioned (Matthews et al., 1992). Survival of transported yearling chinook and steelhead averaged, respectively, 1.6 and 2.0 times higher than the nontransported control fish for the 1986 test and 2.5 and 2.2 for the 1989 test (Matthews et al., 1992). It should be noted that the control group released below Little Goose Dam traverses only six projects and reservoirs (as opposed to seven), and therefore the benefit of transport based on recent studies is underestimated. Many factors in collection, handling, and transport have been substantially improved since most of the studies were conducted. The latest results indicate transported chinook survive at greater than twice the rate of nontransported chinook (Matthews et al., 1992).

The NMFS has concluded that transport is beneficial to chinook and steelhead under all flow conditions (Matthews et al., 1992) and recommended that transport be maximized for all species at all collection projects. However, in spite of the research results, regional concern remains over the benefits of transporting fish and there is considerable debate about the acceptability of the program, since it is considered relatively "artificial" as compared to inriver migration. A main concern is that survival of transported fish, while most often higher than inriver migrants, may not be as high as expected although project and reservoir mortality factors are avoided. Possible causes for lower survival include stress from transport, stress from crowding with different sized fish, poorer quality hatchery fish (highest benefits have been obtained with wild fish), and increased disease transmission. Typically, more than 98 percent of the transported fish survive from collection at the dams to release below Bonneville Dam. The absolute survival of nontransported fish that pass all eight dams from Lower Granite to Bonneville cannot be predicted accurately at this time, but estimates range from less than 20 percent in low flow years to over 60 percent in good flow years. Based on these estimates of survival, the survival of transport fish would be expected to be anywhere from 1.5 to 5 times greater than that of nontransported fish. Recent studies indicate the benefits to be within the lower end of this range, which is appropriate because the studies were conducted during average to above-average flow years.

The level of effect, if any, of each of the concerns regarding transport has not been accurately determined. Another cause of possible lower-than-expected survival is that many of the fish suffer mortality independent of dam passage, such as from disease, that might not adversely affect fish survival until after they pass Bonneville Dam. The fisheries agencies' policy concerning transport is to "spread the risk." They believe that the transport benefit for spring and summer chinook is less than it should be even though survival of transported fish is higher than for those not transported, and that fish might have an equal or better chance of survival by migrating down the river without being transported during good flow years. The fisheries agencies recognize significant transport benefits in low flow years, during which they direct all fish to be collected and transported, rather than being returned to the river.

Adult Passage

Fish ladders, which are fish passage facilities for adult upstream migrants, were completed during original construction of all eight run-of-river projects (Figure 2.2-3). Each of these projects has one to three ladders that operate continuously, except for winter maintenance outages. Winter maintenance outages occur in January and February and last 1 to 4 weeks.

Bonneville has three ladders; The Dalles, John Day, McNary, Ice Harbor, and Lower Monumental dams have two fish ladders each; and Little Goose and Lower Granite dams each have one fish ladder. Adult fish enter a ladder through collection systems that run along the entire front of the powerhouse, and at other key locations. Specific flow conditions near the ladder and at its entrances are needed to attract the adults into these systems. Once inside a collection system, adult fish swim upstream to the base of the fish ladder where they migrate up the ladder and exit into the reservoir above the dam.

Water for operating the fish ladder comes through the fish ladder exit. At most projects, additional water can be added part way down the ladder to maintain the correct amount of water for fish attraction. More water is added to the fish collection systems through systems that spread the flow over the floors of the ladder entrances and along the collection systems. This additional water provides sufficient flow for attracting adult fish into the fishway entrances. The attraction water is provided by pumps, small turbines, or gravity flow from the reservoirs behind the dam, depending on the design of an individual system. Each fish ladder contains a fish counting station where adult fish pass an underwater viewing window, allowing them to be counted and identified by species through a Corps-funded program.

Additionally, some fish pass upstream through the locks at each of the eight dams in the Columbia and Snake rivers. The proportion using these locks is probably a small portion of the total runs of fish passing up the Columbia and Snake rivers. Losses of adult fish occur between projects as a result of passage mortality, harvest, injury, disease, water quality conditions (most commonly high temperature and dissolved gas), and spawning within reservoirs. These losses are in addition to normal tributary turnoff of healthy fish. Losses for all causes except tributary turnoff are estimated at 3 to 5 percent per project/reservoir.

Spill

In 1989, regional fisheries agencies, Indian tribes, and BPA signed a Fish Spill MOA that modified the existing program for spilling water to protect juvenile salmon and steelhead during their spring and summer migration. The MOA provides that a specific amount of water be passed nightly over the spillways of four projects—Lower Monumental, Ice Harbor, John Day, and The Dalles—in the spring and summer to improve fish passage conditions by reducing the numbers of fish passing through the turbines. The MOA was adopted by the NPPC as a temporary measure for 10 years or until permanent fish bypass facilities could be installed at these dams. The Corps has agreed to consider implementing the spill provisions annually and has done so in 1989, 1990, 1991, and 1992. Spill was also provided at Lower Monumental in 1992 even though its newly installed bypass was operational.

The spill implementation principles adopted by the Corps provide for specific spill rates by season, as long as the spill does not adversely affect non-power uses. In 1992, average seasonal spill rates ranged from 5 percent of total flow at The Dalles in summer to over 60 percent of nighttime flow at Ice Harbor in spring. In 1992, spill for fish passage was also provided at Bonneville Dam. Prior to 1992, restrictions on the operation of the second powerhouse resulted in spill that exceeded the hydraulic capacity of the first powerhouse. In 1992, approximately 53 percent and 41.5 percent of daily average flow was spilled in spring and summer, respectively, to provide a nonturbine fish passage. This spill occurred under all flow conditions.

Water Budget

Spring flows are augmented to levels above those required for authorized project functions when conditions must be improved for the outmigration of juvenile fish. This is accomplished within the Water Budget program, an element of the NPPC Fish and Wildlife Program. Each winter the Corps develops a Coordinated Plan of Operations (CPO) to implement the Water Budget, in cooperation with

BPA, BoR, fisheries agencies, tribes, power interests, and other interested parties. The CPO is submitted to NPPC in late March, with implementation from April 15 to June 15. Releases from storage reservoirs are made after considering requests from the Fish Passage Center in Portland, Oregon, representing the fisheries agencies and tribes. The increased flow is presumed to help flush fish downriver and reduce their exposure to predators and other hazards in reservoirs.

Up to 4.64 MAF of water can be released each spring. The total Water Budget volume includes up to 1.19 MAF on the lower Snake River, and up to 3.45 MAF on the middle and lower Columbia River. The amount and timing of Water Budget releases are determined annually.

The Water Budget is used to achieve flows at specific points along the river. Currently, Priest Rapids Dam on the Columbia River and Lower Granite Dam on the Snake River are the monitoring points. Because neither Priest Rapids nor Lower Granite has significant storage under normal operations, flows for the Water Budget must come from natural flows and releases from upstream storage projects such as Grand Coulee, Dworshak, and Brownlee. On the Snake River, most spring flows depend on natural runoff. As a result, the high flows cannot be achieved in low runoff years, even with large releases from storage reservoirs.

Squawfish Management

Predation may be a significant source of mortality for juvenile salmon migrating downstream through reservoirs on the lower Snake and Columbia rivers. Squawfish are the primary predator of juvenile salmon in the hydrosystem. BPA funds a multi-faceted program to reduce squawfish predation, including removal fisheries, harvest technology research, prey protection measures, and basic biological research. The management program is based on the premise that a sustained, annual squawfish harvest rate of 10 to 20 percent of the total population will reduce juvenile salmonid losses due to predation by 50 percent or more within 10 years (Beamesderfer et al., 1990). Additional reductions in predator-related mortality may be realized through prey protection measures.

Enhanced Law Enforcement

The primary goal of the enhanced law enforcement program is to increase spawning escapement of anadromous salmonid stocks by decreasing illegal fishing. Special focus is on the depleted stocks proposed for protection under the ESA. Other benefits include increased protection of all salmonid stocks and resident fish throughout the basin, increased public awareness, increased prosecution support, and increased protection of juvenile salmon through habitat law enforcement. The program is comprised of four integrated grants from BPA to the Columbia River Inter-Tribal Fish Commission, the Oregon State Police, the Washington Departments of Fisheries and Wildlife, and the Idaho Department of Fish and Game. The scope of this project is system wide, that is, from the mouth of the Columbia River and adjacent nearshore ocean areas, through the mainstem, to the upstream spawning tributaries and nursery lakes. The program is planned as a 3-year demonstration project. It is designed to test the efficacy of this measure; therefore, evaluation is an integral part of the program. The enhanced efforts will be achieved by increasing the number of law enforcement officers (nearly double); increasing effectiveness by use of sophisticated surveillance and patrol equipment; increasing interagency coordination and cooperative task forces; enhancing legal prosecution support; and increasing public awareness. During 1992, the first year of the program, all of the agencies procured necessary equipment, hired additional law enforcement officers, and implemented the enhanced interagency operations. The program is now at full force.

Turbine Operating Guidelines

Operating turbines at peak efficiency may increase survival rates of juvenile fish passing dams through turbines. Accordingly, every effort is made to operate turbines at the eight lower Snake and Columbia River dams within 1 percent of peak efficiency. These guidelines are described in the Corps' annual Fish Passage Plan (Corps, 1992a), NMFS's Biological Opinion (April 1992), and BPA's Draft System Load Shaping Guidelines (March 1992).

Research and Monitoring

Many agencies and organizations are involved in a variety of fishery research and monitoring programs related to Columbia-Snake River salmon and steelhead. These efforts encompass the dams and fish passage facilities, transportation, hatcheries associated with the projects, the reservoirs, and tributary streams. The Corps actively monitors juvenile and adult migration at Corps dams, conducts or sponsors ongoing research on anadromous fish, and participates in the research programs of other organizations. The Corps also operates 23 stations along the river system that monitor dissolved gas levels, which can be harmful to fish. BPA sponsors a wide variety of fish research and enhancement programs related to reservoir mortality, hatcheries, disease, spawning habitat, and numerical modeling of system fish survival. The Fish Passage Center monitors each year's juvenile outmigration, primarily through the Smolt Monitoring Program and by receiving system operations, fish passage, and power generation data from the Corps and BPA. State fish and wildlife agencies from Idaho, Oregon, and Washington and Indian tribes are active participants in research efforts. Most of the funding for research and monitoring comes from either BPA or the Corps.

2.2.5 River Management Actions in 1991

As a result of the Salmon Summit, the governors of Idaho, Montana, Washington, and Oregon agreed to a river management plan in 1991. This plan was used to supplement the Water Budget with additional releases of stored water during the spring juvenile fish migration period. It consisted of the following actions:

- The Corps, with the support of the State of Idaho, released an additional 615 thousand acre-feet (KAF) of outflow from Dworshak during the spring.
- In addition to the 615 KAF from Dworshak, the Corps provided water made available by transferring system flood control requirements at Dworshak to Grand Coulee. This flood control transfer yielded an additional 400 KAF from Dworshak. This water was released between April 24 and May 4.
- IPC released 150 KAF from Brownlee between May 5 and May 15.
- BPA arranged the release of an additional 100 KAF from Brownlee, which was subsequently replaced by releases from reservoirs above Brownlee.
- 200 KAF of uncontracted water from upper Snake Basin water rental pools was committed to salmon flow augmentation.
- BPA, agencies, and tribes expanded a program to harvest northern squawfish, the primary predator on juvenile salmonids. This program was to include all eight lower Columbia-Snake River projects in 1991, as well as the river below Bonneville.
- The BoR and other interested parties initiated water conservation demonstration projects with Idaho, Washington, and Oregon.
- A cooperative effort was initiated between dam operators and fish agencies to improve adult passage by monitoring operations and providing recommendations for improvements.

2.2.6 River Management Actions in 1992

River management actions to improve flows during the 1992 salmon migration were initiated through the 1992 OA/EIS process. The cooperating agencies for the OA/EIS coordinated their proposed actions with the NPPC Fish and Wildlife Program amendment process, so that the December 1991 Phase II amendments addressing flow improvements were generally adopted and incorporated in the preferred plan identified in the final OA/EIS. This plan of operation was modified slightly through consultation with NMFS under Section 7 of the ESA. The final plan that was implemented in 1992 included some additional measures that NMFS determined were needed to make a finding that 1992 operations would constitute no jeopardy to the continued existence of the listed species. The flow improvement elements of the final plan, as actually implemented in 1992, are summarized below.

Flow Augmentation

- Volumes of water were retained in Grand Coulee and Arrow reservoirs to augment flow levels in the lower Columbia River in May and June. Augmentation with 3.45 MAF has been provided in past years, but in 1992 the quantity was increased to 6.45 MAF. Augmentation increased the average flow in the lower Columbia River during May and June by approximately 60 thousand cubic feet per second (kcfs) from 130 kcfs to 190 kcfs.

- Volumes of water were also released from reservoirs in the Snake River Basin to augment flows for fish in the Snake River. Dworshak provided about 1.1 MAF of flow augmentation from April 15 to June 15. This was a significant increase over volumes provided in previous years. Brownlee Reservoir (owned by IPC) provided 110 KAF in May, which was similar to past years, under the terms of a contract with BPA. IPC also released 137 KAF from Brownlee in July, and BoR committed 90 KAF of uncontracted storage from the Water District No. 65 Rental Pool (Payette Basin) to help replace the Brownlee release. BPA also acquired water from upper Snake basin irrigation reservoirs as called for in the NPPC Program, but because of the severe drought conditions in southern Idaho, none was available during the spring period.

Libby and Hungry Horse did not participate in the flow augmentation measures initiated in 1992. The reason was that there are a number of other operational considerations that could be affected by drafts for flow augmentation, some of which are difficult to evaluate at this time. Some of the current constraints and problems at Libby, for example, are (1) the International Joint Commission rule curve for Kootenai Lake limits releases from Libby during the flow augmentation season, (2) the potential listing of the Kootenai River sturgeon as an endangered species could impose new discharge requirements on Libby, and (3) British Columbia desires to minimize environmental problems at the upper end of Libby Reservoir during the summer by exchanging Duncan releases for Libby releases. These releases may affect further reservoir operation. The more broadly based SOR is considered to be the appropriate vehicle to examination these problems, and the potential contribution that Libby and Hungry Horse can make to flow augmentation will be examined in that process.

Temperature Control

The 1992 OA/EIS and the NPPC Program called for volumes of water to be released in August and September from Dworshak and Brownlee to reduce Snake River temperatures and increase flows to benefit adult fall chinook migrants. Water released from Dworshak can be selectively taken from various depths in the reservoir, so cool water down to 45°F can be obtained when needed. NMFS believed that part of this volume would be better used to benefit outmigrating fall chinook juveniles, so in the Biological Opinion NMFS called for the release of 400 KAF from Dworshak and Brownlee (combined) in July instead of August. The releases in July (for juveniles) were provided, and the September releases (for adults) were implemented.

Reservoir Operations

- The four lower Snake River reservoirs (Lower Granite, Little Goose, Lower Monumental, Ice Harbor) were drafted to near MOP from April 1 to October 1992. These projects were operated within 1 foot of MOP during this period.

- John Day Reservoir was to be drafted to near 262.5-foot elevation, allowing upward fluctuation of 1 to 1.5 feet, starting May 1 and ending August 31, 1992, or sooner if irrigation intakes located on the reservoir were adversely affected. As irrigation diversions increase during the season, greater head is required over the pumps to maintain capacity. The reservoir was raised accordingly, after drafting below elevation 263, to ensure that irrigators were not subjected to reduced pumping capability. John Day was subsequently operated near elevation 264 to 265 feet during most of the drawdown period.

Drawdown Test

A test of the physical effects of drawing down two Snake River reservoirs (Lower Granite and Little Goose) was conducted from March 1 to 31, 1992, with refill occurring by April 1, 1992. NMFS

completed an informal consultation/conference on this action and concluded that it was not likely to adversely affect Snake River sockeye or jeopardize Snake River spring/summer and fall chinook salmon. Test objectives, procedures, and results are described in more detail in Appendix B, based on preliminary assessment of the test (Corps, 1992b).

Other Actions

In addition to these flow improvement measures, a variety of other measures directly or indirectly related to river management actions were also implemented. For example, under the terms of the Fish Spill MOA negotiated with the region's fish agencies and tribes in 1989, spill has been provided annually at Lower Monumental, Ice Harbor, John Day, and The Dalles dams. Spill at Bonneville Dam historically has been provided in keeping with the annual Fish Passage Plan established by the Corps. Quantities (expressed as percentages of river flow) and duration of spill were increased at three of the five projects for 1992, either as a result of the NMFS Biological Opinion or the Corps' annual Fish Passage Plan (Corps 1992a).

Spill provisions, nonflow project operations, the fish transportation program, short-term project improvements to benefit fish, and other aspects of river system management in 1992 are discussed in Section 3.2.1.

In summary, the Corps, BPA, and BoR met all operating measures prescribed for fish in the NMFS 1992 Biological Opinion and the NPPC Fish and Wildlife Program over which the agencies had control. The migration conditions for anadromous fish were less than ideal in 1992 because of the poor volume runoff.

BPA sold nonfirm energy during May and June as a direct result of the flow augmentation releases for fish—none would have been expected otherwise because of the low runoff. BPA attempted to mitigate the costs of the fish operations as much as possible by entering into storage and exchange agreements with parties outside the region and marketing the nonfirm energy produced at as high a price as possible.

Both power and nonpower users of the reservoirs and rivers have been adversely affected as a result of low runoff in 1992. The reservoirs may or may not return to normal operating levels by spring 1993 depending on snow pack and runoff conditions.

2.3 WATER QUALITY

Following is a brief summary of relevant water quality data for affected sections of the Columbia River Basin. A more detailed presentation is contained in the 1992 OA/EIS. The water quality for the basin as described in that document remains unchanged. The material presented below primarily consists of new information on subbasins not previously covered, specifically in the vicinity of Libby and Hungry Horse dams.

2.3.1 Water Quality Criteria and Standards

The U.S. Environmental Protection Agency (EPA) and States of Idaho, Montana, Oregon, and Washington have established surface-water criteria or standards applicable to the Columbia River Drainage Basin. The discussion focuses on the State standards because they are the same as or more stringent than the Federal criteria, and they are legally enforceable.

The states have established numerical criteria for a number of quality parameters, including dissolved gas, temperature, and turbidity. In addition, they have developed generic classification systems (each state is different) that correlate with antidegradation policies and beneficial uses. The numeric criteria and classification systems are discussed in detail in the 1992 OA/EIS, and remain unchanged. Key points include an EPA limit on dissolved gas of 110 percent saturation at ambient atmospheric pressure; limited thermal changes (typically less than 2.0°F [1.1°C] with maximum ceilings typically less than 68°F [20°C]); minimal turbidity increases from proposed activities (typically less than 10 percent above ambient conditions); pH restrictions typically between 6.5 and 8.5 pH units; and limited fecal coliforms (typically 100 organisms/100 ml).

Montana water quality regulations are similar to the other Pacific Northwest states; Montana designates water-quality criteria based on beneficial uses. For

the major water bodies of interest (i.e., Kootenai and Flathead rivers), the classification is B-1, with a few minor exceptions. Waters classified as B-1 are suitable for drinking, culinary, and food processing purposes after conventional treatment; bathing, swimming, and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl, and furbearers; and agricultural and industrial water supply.

There are also numerical criteria associated with the B-1 classification. Dissolved oxygen must not be reduced below 7.0 mg/L. Induced pH variation must be less than 0.5 unit between pH 6.5 and 8.5, with no change outside this range, and natural pH above 7.0 must be maintained. The maximum allowable turbidity increase is 5 nephelometric turbidity units (NTUs) above natural background. For temperature, a 1°F maximum increase above naturally occurring water temperature is allowed between 32 to 66°F (0 to 18.9°C). With temperatures between 66°F (18.9°C) and 66.5°F (19.2°C), discharge is not allowed that will increase temperature above 67°F (19.9°C). Where natural water is 66.5°F (19.2°C) or greater, no increase greater than 0.5°F is allowed. A maximum 2°F per hour decrease below naturally occurring water temperature is allowed when water is above 55°F (12.8°C), and a 2°F maximum decrease below naturally occurring water temperature is allowed when the naturally occurring water is between 32 to 55°F (0 to 12.8°C). For bacteria, when the water temperature is above 60°F (15.6°C), fecal coliforms must neither exceed 200 organisms per 100 ml nor comprise 10 percent of the total samples during any 30-day period to exceed 400 organisms per 100 ml. Also, the numerical Federal water quality criteria (EPA 440/5-86-001) and national primary and secondary drinking water criteria are incorporated by reference in State laws. Thus, these criteria are similar to the other Pacific Northwest states.

2.3.2 Lower/Middle Columbia River

Water quality within the lower/middle Columbia River is variable. Dissolved oxygen is near or above saturation with a mean saturation of 105 percent. The pH ranges from 6.4 to 8.5 (Corps, 1977), and fecal coliform bacteria levels are within regulatory limits. In general, stringent water quality standards and regulations have greatly restricted the release of potentially harmful substances into the river, with a few localized exceptions. Except for certain reaches identified in reports for some parameters, most are within the range of sampling variability (Corps, 1977; Corps et al., 1992, Appendix B).

Suspended sediment loads vary within the river as a function of flow velocity, flow volume, and bed slope. Suspended solids in the Columbia River rarely exceed 1,000 parts per million (ppm) and are generally less than 250 ppm in major surface water supply sources. Approximately 98 percent of dredged Columbia River bed sediments below Bonneville Dam are clean, fine sand. The remaining material is composed of organic matter from a variety of sources and does not affect water quality within the river to a great extent.

The extent of gas supersaturation in the lower/middle Columbia River is a function of the amount of spill occurring over dams within the river. Under low spill conditions (September through March), the saturation level is near normal (100 percent). However, dissolved gas levels may increase to as much as 140 percent during the periods of heavy spill that potentially occur from April through August, depending on water flows. Dissolved gas levels are also influenced by higher temperatures and both forebay and tailrace elevations.

Lower Columbia River water temperatures vary seasonally and range from 31°F (-0.5°C) to 75°F (24°C). From December through March, water temperatures range from 32°F (0°C) to 48°F (9°C), and from March through June, water temperatures rise to about 58°F (14°C). By August, the river usually attains its annual maximum average of 68°F (20°C). Thermal stratification within reservoirs on the river is a function of reservoir depth and flow rates, and it rarely exists due to mixing through powerhouses and relatively shallow depths. Deep storage reservoirs are thermally stratified and have complex hydrodynamic thermal mixing characteristics.

Water quality within the lower/middle Columbia River below the Bonneville Dam was recently reviewed through the Bi-State Lower Columbia River Water Quality Program established by Oregon and Washington State legislatures in 1990

(Tetra Tech, 1992). The draft results of the study indicated water column contamination levels exceed some State and Federal water quality criteria, including bacteria levels, dissolved oxygen (low levels), dissolved metals, and adsorbable organic halides (from paper mill bleaching processes). It was noted, however, that most sources of pollutants cannot be determined without further study. The investigators also cautioned that studied areas were densely populated and that additional "more focused" sampling could better define contaminant contributions on both a temporal and spatial basis.

2.3.3 Lower/Middle Snake River

The water quality within the lower/middle Snake River is generally rated as poor primarily because of irrigation and grazing area nonpoint source returns. Water in the middle Snake River is characterized by high loadings of nutrients, suspended sediment, and bacteria. Water temperatures are somewhat elevated and depleted of dissolved oxygen in some areas. In addition, it is likely that organic residuals from pesticides and herbicides are present. Water quality improves in the lower Snake River downstream of the confluence with the Salmon River, and especially downstream of the Clearwater River, because the Snake River mixes with these rivers that have good water quality.

Spill over dams has increased the extent of water supersaturation with gas in the lower/middle Snake River. Supersaturation is caused by spilling water carrying trapped atmospheric air into plunge pool water. In the plunge pool, increased hydrostatic pressure at depth dissolves the air into the water and creates supersaturated conditions. Dissolved gas supersaturation can be very harmful to fish and other aquatic organisms, depending on species, life stage, depth, and length of exposure. Levels of supersaturation in the lower Snake River typically range from 105 to 110 percent of total dissolved gas in the Lower Granite forebay during the spring in high flow years, and successively increase downstream through Little Goose, Lower Monumental, Ice Harbor, and McNary forebays when all projects are spilling. Maximum supersaturation levels of 110 to 140 percent have been observed for extended periods during high flow events.

From 1985 to 1989, large seasonal temperature variations in the lower Snake River ranged from approximately 35°F (1.7°C) in March to over 70°F (21.1°C) in July and August (Vigg and Watkins, 1991). Thermal stratification in the four lower Snake River reservoirs is rare, although vertical temperature gradients of up to 7.0°F (3.9°C) differentiation (from top to bottom) have been observed for short periods during some low flow years. Recent U.S. Geological Survey (USGS) temperature data from the Anatone station on the lower Snake River are available in Appendix B of the 1992 OA/EIS.

2.3.4 Clearwater River/Dworshak

Limited data for the Clearwater River System indicated exceptional water quality characterized by oligotrophic conditions and low dissolved solids. Clearwater River water quality is heavily influenced by water quality in the Dworshak Reservoir. This storage reservoir is deep (600 feet in the forebay) and narrow and is thermally stratified every year. Deep water (below 40 to 50 feet) temperatures remain relatively constant throughout the year at about 39°F (4°C) to 41°F (5°C). Retention time in this oligotrophic reservoir is approximately 1 year. Downstream, the temperature varies with the season, reflecting the temperature of the water released from the reservoir in winter (39.2 to 41°F [4 to 5°C]) but gradually increasing in late spring (44.6 to 50°F [7 to 10°C]) to a typical maximum in late summer of 73.4 to 77°F (23 to 25°C) (Corps et al., 1992, Appendix B).

Some information is available regarding Dworshak Reservoir water quality in 1977 from Falter (1982). In 1977, 68°F (20°C) was attained in surface waters from early June through August. From 1972 to 1974, the mean maximum surface temperature was 79°F (26.2°C). Surface dissolved oxygen was highest during mid-summer with levels from 72 to 90 percent saturation. Dissolved oxygen minima were recorded during spring and fall, with levels as low as 32 percent at 591 feet deep during June 1977. No hydrogen sulfide has been detected. In general, nutrient concentrations were low in 1977, mean epilimnial NO_3 was 0.067 mg/L and deep water orthophosphorus was 7 μg/L. Typical of oligotrophic reservoirs, organic production rates in Dworshak Reservoir were low.

Waters in the North Fork of the Clearwater River Basin are generally soft (low in calcium and magnesium) with low alkalinities and can be slightly acidic. Falter (1982) found generally low nutrient levels that varied seasonally with snowmelt and rain runoff before construction of the dam. Dissolved oxygen concentrations were near saturation levels. Water temperatures are cool from September to June, although water temperatures of 68°F (20°C) are common in July and August.

2.3.5 Grand Coulee/Lake Roosevelt

The Columbia River water quality downstream of the Grand Coulee Dam is influenced by the water quality of Lake Roosevelt. Water quality in the lake was considered to be exceptionally high in 1980 (NPS, 1980), but has since been degraded by high metals contamination thought to result from discharges from a lead-zinc smelter and refinery located approximately 10 miles above the U.S./Canadian border (Johnson et al., 1990). The Spokane River, one of the lake's major tributaries, might also contribute zinc and cadmium from mining activities along the Coeur d'Alene River in Idaho. Cadmium and mercury concentrations in the upper lake have exceeded EPA water quality criteria, and sandy materials from the upper lake contain high concentrations of zinc, copper, and arsenic (Johnson et al., 1990). Water quality data for the Columbia River downstream of the dam are not available to determine the mobility of these metal contaminants.

In general, the lake is quite clear with annual secchi readings averaging over 15 feet in the main part of the lake and its principal arms (NPS, 1980). Elevated turbidity within the lake is local and temporary. Monitoring by the Lincoln County Department of Environmental Health has indicated that the main part of the lake is "essentially free of organics" (NPS, 1980). Air temperatures near the lake range from 5°F (-15°C) in the winter to 95°F (35°C) in the summer.

Gas supersaturation levels below Grand Coulee Dam were as high as 148 percent in June 1973, although fish residing below the dam did not show signs of gas bubble disease (Seattle Marine Labs, 1972, 1974). High dissolved gas levels were due in part to the high nitrogen content of Lake Roosevelt water; nitrogen sources to Lake Roosevelt include the Columbia and Spokane Rivers (Seattle Marine Labs, 1972).

2.3.6 Libby/Kootenai River

The Kootenai River in Montana was impounded by Libby Dam in March 1972 to form Lake Koocanusa. Below Libby Dam, the Kootenai River flows back into Canada to Kootenay Lake, which flows into the Columbia River. Water quality data were collected downstream of Libby Dam by the USGS before and since dam construction. In general, the construction of Libby Dam dampened discharge extremes, increased overall water discharge temperatures, decreased summer discharge temperatures, and decreased nutrient levels in the Kootenai River downstream of the dam (Whitfield and Woods, 1984). Damming of the Kootenai River also increased the pH of the river, although seasonal changes were observed and were proportional to depth of discharge.

Water quality data, collected from October 1984 to September 1985 approximately 0.7 mile downstream from Libby Dam, reported pH values from 7.9 to 8.5; water temperatures from 37 to 61°F (2.5 to 16.0°C); dissolved oxygen from 87 to 113 percent saturation; low nutrient concentration (generally <0.1 mg/L N and <0.01 mg/L P); and low total organic carbon (<2.0 mg/L) (USGS, 1986).

Although highly productive (eutrophic) conditions were predicted for Lake Koocanusa, turbid conditions and physical limnological factors caused low algal productivity (McKim et al., 1976). In addition, Canadian municipal and industrial sources substantially reduced nutrient loading to Lake Koocanusa during the late 1970s. Sediments in Lake Koocanusa are calcareous and low in organic matter, have a silty loam or loam texture, and serve as a phosphorus sink (Iskandar and Shukla, 1981). Combined with the reduced nutrient loading, this may contribute to the low productivity of the lake. During spring snow melt runoff, substantial quantities of suspended sediment are discharged to the Kootenai River downstream of the dam (Ciliberti, 1980).

In 1973, game fish populations were adversely affected by high gas supersaturation levels at least 5

to 6 miles downstream of the Libby Dam (May, 1973). Total gas supersaturation levels of up to 130 percent were observed in some areas of the river (May, 1973). Since Unit 5 began operation in 1984, no spill has been necessary and gas supersaturation levels have generally been below 110 percent.

2.3.7 Hungry Horse/Flathead River

Hungry Horse Reservoir was created in 1953 with the completion of Hungry Horse Dam on the South Fork of the Flathead River, approximately 4 miles from the confluence with the main stem, which subsequently empties into Flathead Lake. Water data collected in 1978 indicated that the reservoir is oligotrophic (i.e., low nutrient input and primary productivity) (May and Weaver, 1987).

Surface water temperatures vary widely in Hungry Horse, ranging from frozen (32°F [0°C]) in winter to over 73.4°F (23°C) in late summer. The reservoir thermally stratifies in summer (typically June through September) but is isothermal (no temperature gradients) in spring and winter. The water volume in the preferred thermal range for cutthroat trout (50 to 60.8°F [10 to 16°C]) is greatest in spring and fall (May and Fraley, 1986). Downstream, hypolimnial discharges from Hungry Horse have lowered the summer water temperature and raised the winter temperature in the Flathead River from historical levels (Beattie et al., 1988). Water temperatures in the South Fork Flathead River 1.7 miles downstream from Hungry Horse Dam varied from 37 to 44°F (3.0 to 6.5°C) from October 1984 to September 1985 (USGS, 1986).

The dissolved oxygen levels in Hungry Horse Reservoir have been consistently above biologically optimal levels of 7 mg/L, typically in the range of 8 to 10 mg/L. The pH (in 1985) ranged from 7.4 to 8.9, with the majority of values between 7.8 to 8.5 units. Specific conductance ranged between 110 to 150 μmhos/cm, on the lower end for productivity (May and Fraley, 1986).

Cross and Waite (1988) characterized the downstream quality in South Bay of Flathead Lake. They noted that this region is quite shallow and is oligomesotrophic (low to medium in terms of algal productivity, water clarity, dominant phytoplankton species, and total dissolved solids). In addition, they reported that eutrophication of the lake has been accelerated in recent years because of increased development and effluent discharges. Cross and Waite (1988) reported the monthly mean ranges for water quality parameters from April through September 1986: temperature = 32 to 72.7°F (0 to 22.6°C), pH = 6.54 to 8.59 units, conductivity = 164 to 192 μmhos/cm, and dissolved oxygen = 8.3 to 12.7 mg/L. These mean values all appear to fall within applicable State and Federal water quality standards and criteria.

2.4 ANADROMOUS FISH

2.4.1 Species Characteristics

Several species and stocks of anadromous fish inhabit the Columbia River and pass over all or some of the mainstem hydroelectric dams during their life (see Figures 2.4-1 and 2.4-2 in the 1992 OA/EIS). These fishes include spring, summer, and fall chinook (*Oncorhynchus tshawytscha*), sockeye (*O. nerka*), coho (*O. kisutch*), chum (*O. keta*), and pink salmon (*O. gorbuscha*); steelhead trout (*O. mykiss*); sea-run cutthroat trout (*O. clarki*); American shad (*Alosa sapidissima*); white sturgeon (*Acipenser transmontanus*); and Pacific lamprey (*Entosphenus tridentatus*).

The following summaries of existing conditions for these species are greatly abbreviated from what was originally presented in the 1992 OA/EIS. However, a comprehensive review of background information on the key salmon stocks is provided in Appendix A.

Spring Chinook Salmon

Adult spring-run chinook begin entering the Columbia River in February. By July, most have passed by the Corps projects on the lower Columbia and Snake rivers. Juvenile spring chinook outmigrate as yearlings from about March through June. The spawning timing and habitat of the Snake River spring stock is typically earlier and higher in the watershed than the summer stock.

The Snake River spring and summer chinook stocks were listed as a threatened species on May 22, 1992.

Summer Chinook Salmon

Adult summer chinook begin entering the Columbia River in May and pass the mainstem dams by September. Summer chinook generally spawn and rear in tributaries upstream of the influence of the projects. Juvenile summer chinook outmigrate from the Snake River as yearlings primarily from March through June, and the upper Columbia River smolts outmigrate from May to September. Like the spring chinook, the spawning regions for the summer chinook are found in the Snake River tributaries.

Fall Chinook Salmon

Adult fall-run chinook begin entering the Columbia River in July and pass the mainstem dams by the end of November. There are two basic races of fall chinook—tules and upriver brights. The tules are an early spawning (September), lower-river variety of fall chinook. Most natural spawning occurs in the tributaries of the Bonneville Pool, although substantial natural spawning also occurs below the Bonneville project. Some of the wild-spawned tule fry rear in the shallow water of the reservoir until they migrate in the spring. Lower river hatchery and wild tules migrate down the Columbia River from June through October. Some hatchery fish are released in late February and early March.

Upriver brights are a late-spawning (October through January) upriver variety comprised of both hatchery and wild fish. Wild fish in the mainstem river spawn primarily below Priest Rapids Dam and rear in the shallow water downstream, including the four lower Columbia River reservoirs. Upriver brights outmigrate during the same approximate period as tules. The current spawning range of the Snake River stock, listed as threatened on May 22, 1992, is limited to approximately 103 miles of the mainstem Snake River—from Hells Canyon Dam to the Lower Granite Pool and the lower reaches of the Imnaha, Grande Ronde, Clearwater, and Tucannon rivers. Some spawning may occur in the tailrace areas such as downstream of Lower Monumental Dam. Fall chinook that rear in the Snake River typically outmigrate before mid-July; the warm temperatures in late summer may not be suitable for chinook, and may influence this migration timing.

Sockeye Salmon

Adult sockeye salmon begin entering the Columbia River in April and continue to pass by the dams through October (Corps, 1991b). Sockeye spawn in September and October and rear in systems with lakes. All sockeye in the Columbia River System are natural stocks because no hatchery operation currently occurs.

The Snake River sockeye population, listed as an endangered species on December 20, 1991 by the NMFS, is currently limited to Redfish Lake in the Stanley Basin in Idaho (Waples et al., 1991). These fish typically arrive from mid-July through August at Redfish Lake to spawn on beaches during October (Chapman et al., 1990). In recent years, the majority have passed Lower Granite Dam by mid-June (Chapman et al., 1990).

Steelhead Trout

Adult steelhead enter the Columbia River as winter and summer stocks year-round. The winter stock is restricted to regions from the Bonneville Pool downstream.

The two groups of summer stocks occur in most areas but are the only steelhead runs in the upriver areas: Group A and Group B. Group A fish are present in all upriver basins while the Group B fish are produced only in the Clearwater and Salmon rivers of the Snake River drainage (CBFWA, 1991a). The summer stock enters the river in February and passage at the mainstem dams continues through December. Group A summer steelhead mainly enter the river from June to early August while Group B fish enter the river from late August into October (CBFWA, 1991a). The upstream migration for the winter stock begins in November and continues through March. Steelhead spawn and rear in tributaries above the influence of the mainstem projects. Juvenile steelhead outmigrate as yearlings primarily from March through June. Many summer steelhead overwinter in the mainstem reservoirs, including tributaries of the Bonneville Pool, and pass the projects in the early spring.

American Shad

Adult American shad enter the Columbia River in April and continue to pass the mainstem dams through August. Shad spawn in the open water of the mainstem reservoirs during July and early August (Wydoski and Whitney, 1979). Extensive rearing takes place in productive shallow-water zones of the reservoir until the juveniles are ready to migrate. When juvenile shad are 4 inches long, they outmigrate as subyearlings from October through December.

White Sturgeon

The white sturgeon is the largest anadromous fish in the Western Pacific, reaching a size up to 1,800 pounds (Wydoski and Whitney, 1979). Few white sturgeon currently migrate above Bonneville Dam (Corps, 1991b), but many subpopulations exist in the individual reservoir pools of the Columbia and Snake rivers, completing their life cycle without migrating to the Pacific Ocean (see Section 2.5.3 for discussion of Kootenai River white sturgeon). The anadromous stocks might be present in the lower river year-round. Spawning typically occurs from May into July (Wydoski and Whitney, 1979). Fertilized eggs settle to the bottom where they develop into larvae. The young-of-year fish are often found in deep-water areas below Bonneville Dam and in the lower Columbia River reservoirs, often in sandy regions (Nigro, 1990). The Upper Granite Pool populations use the confluence area of the Snake River and Lower Granite Pool for rearing those individuals born of spawning stock in the Hells Canyon reach of the Snake River. Sturgeon mature in 9 to 16 years and sometimes live to be over 80 years old (Wydoski and Whitney, 1979).

Pacific Lamprey

The adult Pacific lamprey begin upstream migration in the Columbia River in April and continue through August. Lamprey typically spawn in June and July in the sandy bottoms in the upper ends of pools of small tributary streams. The juveniles (ammocoetes) emerge and drift downstream to burrow in the mud in low-velocity reaches of small tributary streams. After residing in the mud for 5 to 6 years, juvenile lamprey outmigrate to the sea primarily from April through mid-July.

2.4.2 Hatcheries

Nine hatcheries and three satellite stations are located within the project area. These hatcheries include Bonneville Hatchery, rearing upriver bright and tule fall chinook; Cascade Hatchery, rearing primarily coho; Oxbow Hatchery, starting chinook and coho stock for other facilities; Little White Salmon Hatchery, rearing fall and spring chinook; Spring Creek National Fish Hatchery, rearing tule chinook; Irrigon Hatchery, rearing spring and fall chinook and steelhead; Umatilla Hatchery, rearing spring and fall chinook; Lyons Ferry Hatchery, rearing fall and spring chinook salmon and steelhead; and Dworshak National Fish Hatchery, rearing steelhead and spring chinook. The Clearwater Fish Hatchery, across the river from Dworshak NFH, will raise steelhead and spring chinook. Herman Creek and Wahkeena Pond are satellite facilities of Oxbow Hatchery.

2.5 RESIDENT FISH AND AQUATIC ECOLOGY

2.5.1 Lower River Reservoirs

In the lower Snake and Columbia rivers, dominant native species include northern squawfish (*Ptychocheilus oregonensis*), redside shiners (*Richardsonius balteatus*), mountain whitefish (*Prosopium williamsoni*), chiselmouth (*Acrocheilus alutaceus*), bridgelip sucker (*Catostomus columbianus*), and largescale sucker (*C. macrocheilus*). The most common game species include walleye (*Stizostedion vitreum*), bluegill (*Lepomis macrochirus*), smallmouth bass (*Micropterus dolomieu*), largemouth bass (*M. salmoides*), white crappie (*Pomoxis annularis*), black crappie (*P. nigromaculatus*), carp (*Cyprinus carpio*), channel catfish (*Ictalurus punctatus*), and yellow perch (*Perca flavescens*). Cold-water resident species (such as trout and mountain whitefish) that were once common in the Columbia and Snake rivers have declined since the construction of the dams due to the blockage of spawning migrations, modification of habitats (Mullan et al., 1986), and changing prey base. Warm-water species, most of which were introduced, have become common. Most of these species are well adapted to lacustrine environments such as reservoirs.

Backwaters and embayments generally provide slightly warmer habitat, finer substrate, and submergent and emergent vegetation. Backwater areas are used for spawning by bass, crappie, bluegill, pumpkinseed (*Lepomis gibbosus*), yellow perch, and carp (Bennett et al., 1983; Bennett and Shrier, 1986; Hjort et al., 1981; Bennett et al., 1991; Zimmerman and Rasmussen, 1981). Other species such as shad, suckers, walleye, sandroller (*Percopsis transmontana*), white sturgeon (*Acipenser transmontanus*), several cyprinid species, and possibly redside shiner spawn in open water. Prickly sculpin spawn in both open water and backwater, based on the distribution of prolarvae (Hjort et al., 1981). Most of the native species spawn in flowing waters at the headwaters of the reservoirs or in tributary streams. Some species, however, also spawn in the reservoirs.

Juvenile fish are found in abundance in backwater and open-water areas where flowing water is found. Warm-water species are more common in the backwater areas while native cold-water species are most common in the flowing water regions (Hjort et al., 1981; Bennett et al., 1983; Bennett and Shrier, 1986; Mullan et al., 1986).

Adult distribution is generally similar to spawning and juvenile distribution but can change depending upon feeding strategy. Adults may occur throughout the habitats and move seasonally or daily to different areas (Bennett et al., 1983; Bennett and Shrier, 1986; Hjort et al., 1981).

In general, the backwater areas have the greatest abundance of fish in all life stages. Deep habitats support fewer fish. The extensive use of the backwaters may be at least partially due to the abundance of prey normally found in these areas. Zooplankton are generally sparse in the Columbia River except in sloughs and backwaters (Mullan et al., 1986; Stober et al., 1979) where they can maintain growth under decreased susceptibility to drift due to reduced water velocity. High concentrations of zooplankton in the backwater areas attract smaller prey species that feed on these organisms. In turn, high concentrations of prey fishes attract larger populations of predator fish species. Therefore, higher concentrations of zooplankton in backwater areas might affect the habitat selection of several species.

2.5.2 Upriver Storage Reservoirs

Dworshak Reservoir

Dworshak Reservoir is a deep, oligotrophic storage reservoir with a steep-sided shoreline (Falter, 1982). The reservoir stratifies during the summer, providing warm-water habitat in the surface layer and cold-water habitat at depth. The reservoir is normally drawn down approximately 40 feet in the fall and up to 155 feet by late winter or early spring, and is subsequently refilled in spring and early summer (Maiolie, 1988).

Primary sport species in the reservoir include kokanee (*Oncorhynchus nerka*), rainbow trout (*O. mykiss*), smallmouth bass, and bull trout (*Salvelinus confluentus*) (Maiolie, 1988). Kokanee and bull trout spawn in the fall, primarily in the tributaries to the reservoir. Rainbow trout are stocked and little natural reproduction occurs. Because of the steep shorelines, little shallow-water habitat is available to support natural reproduction of smallmouth bass (Corps, undated). Nevertheless, the resident bass population appears to be healthy and has increased in abundance over time (Statler, 1990).

Brownlee Reservoir

Brownlee Reservoir has elevated water temperatures, thermal stratification, high primary productivity, and seasonal nutrient cycling patterns (BPA, 1985). Oxygen content of the waters below the thermocline frequently approaches zero in summer.

The reservoir primarily supports a warm-water fishery. Smallmouth bass, channel catfish, and black crappie populations are the dominant game species (Rohrer, 1984). The reservoir is particularly noted for its smallmouth bass and channel catfish fisheries (BPA, 1985). Carp and sucker, which are typically productive in warm, highly vegetated waters, are also very common. Many of the species in the reservoir spawn near or on the bottom in shallow waters in spring or early summer. Studies have indicated that production of game fish in the reservoir might be limited by the availability of forage species (Bennett and Dunsmoor, 1986; Rohrer, 1984).

Grand Coulee/Lake Roosevelt

Lake Roosevelt, impounded by Grand Coulee Dam, stratifies only weakly, if at all (Crawford et al., 1976). Productivity in the reservoir is moderate to low and is affected by the relatively short water retention time. Average retention time ranges from 15 to 76 days and is shortest in spring and longest in fall and early winter (Beckman et al., 1985). Because of the short retention time, nutrients and plankton are rapidly flushed through the reservoir.

Walleye is the primary sport fish in the reservoir. Walleye normally spawn in April and May during a period of rising water levels in the reservoir (Peone et al., 1990). The young are normally found in littoral areas and the adults are found in embayments and tributary mouths (Peone et al., 1990). It is generally believed that a lack of forage, rather than spawning habitat, limits walleye production in Lake Roosevelt.

The kokanee population in Lake Roosevelt probably is a remnant of a sockeye salmon population that originally spawned in Arrow Lake but became landlocked when Grand Coulee Dam blocked migration to the ocean. The natural kokanee population has been depleted, and two hatcheries have been constructed to replenish the stock.

Yellow perch and smallmouth bass are also abundant in the reservoir. These species spawn primarily from late April through mid-May in shallow-water areas (Peone et al., 1990). Numerous net pens used to raise rainbow trout are also located throughout the reservoir. Trout are raised to catchable size and then released into the reservoir in May and June (Peone et al., 1990). Most of the trout are caught within 14 months of release.

Lake Roosevelt also contains a population of bull trout. Bull trout have been petitioned for listing under ESA (Section 2.5.3). The Washington Department of Wildlife considers the population in Lake Roosevelt to be at high risk of extinction.

Libby/Kootenai River

Lake Koocanusa was formed when the Kootenai River was impounded by Libby Dam in 1972. At full pool, the reservoir has a maximum depth of 350 feet and a mean depth of 126 feet. The reservoir is drafted in fall and winter and refilled during spring and early summer. It refills to maximum pool in July and August. In 1 in 5 years, it does not fully refill due to inadequate runoff (Corps, 1985). The average maximum draft is 120 feet. The reservoir does not always thermally stratify (Chisholm et al., 1989).

The most important game fish in the reservoir include kokanee, westslope cutthroat trout, rainbow trout, bull trout, and burbot (Fraley et al., 1989). Bull trout have been petitioned for listing under ESA (Section 2.5.3). Several warm-water species such as largemouth bass, pumpkinseed, and yellow perch also inhabit the reservoir, but are apparently present in low numbers. In 1985, kokanee accounted for 96 percent of the number of fish harvested from the reservoir (Chisholm and Hamlin, 1987).

An excellent rainbow trout fishery and a sizeable whitefish population are present in the Kootenai River below Libby Dam. The Kootenai River also supports a population of white sturgeon, which was recently petitioned for listing under the ESA (Section 2.5.3). The minimum recommended flow in the Kootenai River below Libby Dam is 4,000 cfs to protect insect production, mountain whitefish spawning, and juvenile salmonid rearing.

Hungry Horse/Flathead River

Hungry Horse Reservoir is an oligotrophic to ultra-oligotrophic system, with low productivity (May et al., 1988). Thermal stratification usually occurs in late spring, summer, and early fall. Dissolved oxygen and pH levels are normally sufficient to support the resident fish populations. The reservoir is typically drafted in December through March and filled to full pool by July. Some drafting occurs in late summer and fall for power production. Under typical water conditions, the annual draft is about 75 feet.

Westslope cutthroat trout (*Oncorhynchus clarki lewisi*) and bull trout are both listed as Species of Special Concern in Montana, and the bull trout has been petitioned for listing under ESA, are the most important game species in the reservoir. Both species spawn in reservoir tributary streams. Late season drawdowns, however, are believed to affect

these populations by 1) reducing the availability of prey, 2) increasing competition in the reduced reservoir volume, and 3) making juveniles more accessible to predation (May et al., 1988).

The South Fork of the Flathead River joins the main Flathead River about 5 miles downstream of Hungry Horse Dam. Before construction of Hungry Horse Dam, the South Fork was a major spawning area for several species from Flathead Lake including westslope cutthroat trout, bull trout, and kokanee (Zubik and Fraley, 1987; Fraley and Graham, 1982). Bull trout and kokanee spawn in the fall (September and October) and cutthroat trout spawn in spring in the river and its tributaries (Fraley et al., 1989; Beattie and Clancy, 1987). Variations in flow releases from Hungry Horse Dam during the spawning and incubation period have negatively affected the production of Flathead Lake populations (Fraley and Decker-Hess, 1987). A minimum stream flow of 3,500 cfs in August through March to has been recommended (Fraley et al., 1989).

2.5.3 Candidate and Sensitive Species

White Sturgeon

Kootenai River white sturgeon (*Acipenser transmontanus*) have been petitioned for listing under the ESA. This population of white sturgeon is believed to have been isolated between Kootenai Falls (approximately 30 miles downstream of Libby Dam) and Bonnington Falls, downstream of Kootenay Lake, for approximately 10,000 years (Apperson and Anders, 1991; Setter and Brannon, 1992). There has apparently been no recruitment to the fishery since before Libby Dam went into operation in the early 1970s, except for some fish from the 1974 year class. Spawning is believed to have been totally unsuccessful since 1977 (Apperson and Anders, 1991). Researchers have hypothesized that the decreased spring river flows below Libby Dam contributed to spawning failures in recent years (Apperson and Anders, 1990). Spawning of sturgeon in the lower Columbia appears to be correlated with increasing flows and increasing water temperatures in the spring (Apperson and Anders, 1991). The only aggregations of white sturgeon in spawning condition observed in the Kootenai River moved to an area of higher flows during a period that both flows and temperatures were increasing in June 1990 and 1991 (Apperson and Anders, 1991). Evidence of successful spawn in 1990 was not found. The fate of any juveniles produced in 1991 is not known. Reproductive problems were also documented in the 1960s which were thought to be caused by pollution. Concern has focused on contaminants as well as spawning and rearing flow conditions since then. The Idaho Department of Fish and Game (IDFG) has been researching this population under BPA funding since the late 1980s and will continue to do so for the time being.

Discussions over the status of this population of white sturgeon began in earnest in May 1992 with a meeting among the Seattle District Engineer, the director of IDFG, the FWS Boise Field Office supervisor, and the executive director of the Kootenai Tribe of Idaho. In addition to various staff members of these organizations, representatives of certain conservation organizations attended. The Corps was asked to provide higher springtime flows from Libby Dam to bring spawning conditions closer to historical values, and to reduce power peaking in the summer. Colonel Cunningham of the Seattle District indicated that the Corps was willing to do what it could within existing authorities. Staff members of the involved organizations (including Montana Department of Fish, Wildlife and Parks [MDFWP] and BPA) formed a technical committee to work on the issue, beginning with a meeting in mid-June at Bonners Ferry.

Meanwhile, on June 11, 1992, conservation groups headed by the Idaho Conservation League petitioned the FWS to list the Kootenai white sturgeon under the ESA. The FWS' 90-day review finding was positive, setting the clock for a decision on whether to propose a rule by June 11, 1993. In the judgment of IDFG and the FWS, the population would be in critical condition in 10 years unless spawning and recruitment begin to succeed.

The committee has met approximately monthly since then and reviewed what is known about the sturgeon, including biological requirements as determined through Columbia River research. Various proposals have been prepared for flow enhancement in spring to encourage spawning.

Corps and BPA have analyzed these proposals to determine the likelihood of having enough water to provide the requested flows while still being able to refill Lake Koocanusa. For the short term (1993), it has been shown statistically that there is a low probability that much, if any, additional water will be available, given that Lake Koocanusa has already been drafted well below the flood control rule curve to meet power requirements. This has been acknowledged by FWS, IDFG, and the Kootenai Tribe. However, FWS has indicated that successful white sturgeon spawning must be demonstrated in 1993 to avoid a proposal to list.

Flow proposals have called for up to 4.7 MAF to be released from Libby in the spring (this amount would provide 35,000 cfs for 6 weeks at Bonners Ferry, plus ramp-up and ramp-down), based on conditions associated with a successful year class in the past (1974). It is suggested that the 6-week period would allow females to spawn up to 3 times each. Lesser discharges for years with lesser runoff volumes also have been proposed, and MDFWP has just finished instream flow sampling in the Bonners Ferry area to determine what discharges are associated with known spawning velocity requirements. However, any flows which are believed to have a chance of succeeding (i.e., above 15,000 cfs for up to 6 weeks) could impact other resources. These include system power generation, flood control, recreation, and reservoir-resident fisheries. Providing the flows without the impacts is believed impossible under current authorities.

Currently, a system operating strategy is being formulated that will attempt to provide sturgeon flows and other fish, wildlife, and recreation needs while neither jeopardizing upper-basin flood control nor unduly impacting power. The instream flow results and the coordination of the sturgeon technical committee are needed to develop the specifications. At the December 16 to 17, 1992 sturgeon technical committee meeting, instream flow results were discussed and used to draft a final set of proposed flows for use in the combined strategy for SOR.

Westslope Cutthroat Trout

Westslope cutthroat trout are a designated Species of Special Concern in Montana and are found in both Libby and Hungry Horse reservoirs. There are three distinct life history patterns of westslope cutthroat in the region of Libby and Hungry Horse Reservoir. An adfluvial population spawns in the tributaries of the reservoir. Eggs hatch in July and August, and juveniles rear in the tributaries for 1 to 3 years before moving into the reservoir. They return to their natal stream in spring to spawn. Fluvial westslope cutthroat trout have a similar life cycle, although they spawn and the juveniles rear in the main stem of the South Fork. The third population, which completes their entire life cycle in the upper tributaries, is also present in the area (Zubik and Fraley, 1987; Shephard and McMullin, 1983; Shepherd et al., 1984).

Westslope cutthroat spawn in streambeds with gravel and small cobble. Egg survival is highest where substrate is composed of less than 20 percent silt and sand. Eggs also appear to survive better if adults hold in cooler water (2 to 4°C) before spawning (Shephard et al., 1984). The fry rear in small streams and backwaters of larger streams where currents are slow. The fish move into faster, deeper water as they grow. In lakes, the trout tend to move to deeper waters in summer as surface waters warm to temperatures greater than 18°C.)

Bull Trout

The FWS has been petitioned to consider bull trout for listing as a threatened or endangered species under the ESA. The 90-day review of the petition is expected to be completed in late January 1993. The species occurs in many of the potentially affected reservoirs including Libby, Hungry Horse, and Dworshak.

Bull trout spawn primarily in tributaries in fall and the eggs hatch in March (Thomas, 1992; Zubik and Fraley, 1987; Fraley and Shepard, 1989). They spawn in loosely compacted gravel and cobble and often at sites with groundwater infiltrations. As is the case for most salmonids, the presence of high quantities (>30 percent) of silt and sand in the gravel negatively affects egg survival (Pratt, 1992). During the incubation period, high flows can scour

redds while excessively low flows can expose redds to freezing temperatures (Thomas, 1992).

For the first 2 years of life, most juveniles remain in streams where they feed primarily on aquatic insects. Cool water temperatures during the early life history states appear to be an important environmental factor. Egg survival and growth rates of fry are higher in cooler temperatures (Shephard et al., 1984). Pratt, 1992 indicated the greatest growth rates in fry at 4°C.

Most young bull trout migrate at the beginning of their third year, at which time they may move into either riverine or lacustrine environments (Pratt, 1992). Those that rear in lakes tend to grow more rapidly. In lakes and reservoirs, bull trout are normally found in waters where temperatures are less than 15°C (Shephard et al., 1984). As thermoclines develop in the summer, the fish will move out of the shoreline areas and into deeper, cooler water (Pratt, 1992). In rivers, adults are normally found where temperatures are less than 15°C and flows are moderate to high (Thomas, 1992; Shephard et al., 1984). Mature adults migrate out of the lakes in May and June, arriving at the spawning grounds in August.

In the Kootenai River drainage, three distinct populations of bull trout exist: one downstream of Kootenai Falls, one between the falls and Libby Dam, and one upstream of Libby Dam. The population downstream of the dam spawns primarily in Quartz and Pipe creeks (Thomas, 1992). Because the trout in this area depend on a small number of streams, they are considered to be at relatively high risk for extinction. The population upstream of the dam spawns in a number of tributaries in Montana and Canada.

The Flathead adfluvial bull trout population is considered to be one of the most viable populations remaining in the United States (Thomas, 1992). Most of the spawning areas for the Hungry Horse population are located in wilderness areas that have not been surveyed. The population is known to use a wide variety of streams. Flathead Lake, downstream of Hungry Horse Dam, contains a healthy population of bull trout which spawns largely in tributaries of the mainstem and north and middle forks of the Flathead River (Thomas, 1992). Recent areal surveys, however, suggest the population is declining. The cause of the decline is unknown and may be part of a natural cycle in species abundance.

Dworshak also contains a small population of bull trout. These fish spawn in tributaries upstream of the reservoir.

Molluscs

The California floater (*Anadonta californiensis*) is a candidate for listing under the ESA. The species is freshwater mussel that is found in the middle Snake River. It most commonly inhabits shallow (<20 feet deep) waters of large rivers but sometimes occurs as deep as 60 feet. The species moves very slowly and is intolerant of desiccation. Mortality of California floaters present in Lower Granite Reservoir was documented during the 1991 reservoir drawdown test (Frest and Johannes, 1992).

The shortface lanx (*Fisherola nuttalli*) is also a candidate for listing under the ESA. This species has been identified in the Snake River, upstream of Lower Granite Reservoir and the upper reaches of the reservoir itself (Frest and Johannes, 1992), and at various locations in the Okanogan, Columbia, Deschutes, and Wenatchee rivers (Neitzel and Frest, 1989). The species is normally found in relatively unpolluted, cold, and well-oxygenated rivers that have permanent flow and a cobble-boulder substrate (Neitzel and Frest, 1990). These conditions are typical of rapids throughout the Columbia River Basin.

The Columbia pebblesnail (*Fluminicola columbiana*) is also a candidate for listing. It has been documented in free-flowing regions of the Columbia, Okanogan, Deschutes, and Wenatchee rivers (Neitzel and Frest, 1989) and might occur in other regions in the Columbia River Basin. Like the shortface lanx, the Columbia pebblesnail normally occupies clean, cold, well-oxygenated rivers with cobble-boulder substrates.

2.6 TERRESTRIAL ECOLOGY

2.6.1 Columbia-Snake Rivers

Vegetation

The Columbia River passes through six major vegetation zones, including the following: (1) Douglas-fir (*Pseudotsuga menziesii*)/western hemlock (*Tsuga heterophylla*); (2) Douglas-fir/ Oregon white oak (*Quercus garryana*); (3) shrub-steppe [with sagebrush (*Artemisia* sp.)], (4) steppe (lacking sagebrush), (5) ponderosa pine (*Pinus ponderosa*), and (6) Douglas-fir and grand fir (*Abies grandis*) (Franklin and Dyrness, 1973; Payne et al., 1975). The Snake River and associated tributaries (including the Clearwater River) pass through the shrub-steppe, ponderosa pine, and Idaho white pine (*Pinus monticola*) series (Franklin and Dyrness, 1973; Daubenmire and Daubenmire, 1984).

The project reservoirs have influenced the extent and distribution of numerous plant and wildlife communities that have existed within the river corridor for many years. Local plant communities have established under normal pool fluctuations and periodic drought. Shallow-water habitat exists primarily along the shoreline of the lower Columbia and Snake rivers and around islands within the various project pools. Shallow-water beds support aquatic plants that provide a valuable food source for waterfowl.

The riparian habitat along the lower Columbia River includes shrub, hardwood, and herbaceous types. Approximately 5,600 acres of riparian vegetation occur mainly in the backwaters along the Columbia. Along the lower Snake River, the project reservoirs are characterized by scrub-shrub, forest scrub, and forest-shrub riparian communities. Several factors have contributed to the lack of extensive riparian areas along the lower Snake River: steep shorelines associated with project reservoirs, the expansion of railroads, and the gradual inundation of the river bottom by reservoirs. A Congressionally authorized mitigation program is ongoing to create additional habitat along the shorelines of these reservoirs.

Lake Roosevelt lacks extensive riparian communities (Payne et al., 1975). The southern portion of Lake Roosevelt is within the shrub-steppe region of eastern Washington (Franklin and Dyrness, 1973) and is therefore subject to periodic drought. Most riparian habitat at the lake is associated with small streams and springs (Payne et al., 1975). Riparian vegetation has established in areas of silt accumulation that are subject to only infrequent flooding. Dworshak Reservoir is bordered by approximately 2,250 acres of riparian vegetation. The primary riparian association along the reservoir includes red alder/maidenhair fern (*Adiantum* sp.) (Asherin and Orme, 1978). Riparian vegetation along Brownlee Reservoir includes communities dominated by willow, creeping wildrye (*Elymus triticoides*) on islands at the upper end of the reservoir, limited distribution of cattail (*Typha* sp.), and cottonwood around shallow bays.

Emergent wetlands are associated with the project reservoirs along the lower Columbia River and the lower Snake River. These wetlands generally occur where drainage from adjoining slopes is interrupted by railroad or highway embankments, or agricultural activities. In general, wetland vegetation consists primarily of rushes, sedges, and cattails. The lower Columbia River is bordered by approximately 1,500 acres of emergent wetlands. Wetlands are most abundant at McNary and John Day and least abundant at Bonneville. Lower Snake River wetlands are limited to approximately 116 acres, and range from 4 acres at Lower Granite to 87 acres at Lower Monumental.

Lake Roosevelt lacks extensive wetland areas. Wetlands dominated by reed canarygrass (*Calamagrostis sp.)* are limited, but occur primarily in the northern portion of the reservoir where moisture is more abundant (Payne et al., 1975). Wetland vegetation in the vicinity of Dworshak Reservoir consists of approximately 72.5 acres of the deciduous scrub-shrub type. Wetland habitat associated with Brownlee Reservoir is limited to shallow bay areas at the upper end of the reservoir and is characterized by sparse amounts of cattails (BPA, 1985). Detailed plant lists are available for each of these reservoirs (Asherin and Orme, 1978; BPA, 1985).

Collectively, the four lower Columbia River projects contain approximately 3,700 acres of embayments and associated habitats. Backwater areas are most abundant at John Day and least

abundant at McNary. The lower Snake River projects collectively contain about 328 acres of backwater habitats.

There are many wildlife management units on the Corps projects. Four designated wildlife management sites occur along John Day, Bonneville, and The Dalles pools and are managed by the Oregon Department of Fish and Wildlife. Five additional areas totaling over 4,500 acres occur on the McNary Pool and are managed by the Corps as HMUs (Sather-Blair et al., 1991). Many additional HMUs are located on the lower Snake River Pools, including 760 acres of irrigated habitat. These areas provide essential habitat for numerous plants and wildlife. These HMUs are irrigated with surface water from the project reservoirs and depend on high pressure irrigation systems to continue vegetative growth. The irrigated HMUs at each of the project dams have been planted extensively with trees, shrubs, herbaceous plants to establish habitat for various wildlife species.

Wildlife

The project reservoirs on the Columbia, Snake, and Clearwater rivers provide essential habitat for 42 reptile and amphibian species, 263 bird species, and 81 mammal species (Payne et al., 1975; Tabor, 1976; Lewke and Buss, 1977; Asherin and Orme, 1978). Wildlife that typically use riparian and wetland areas associated with the project areas can be divided into seven main groups: waterfowl, raptors, upland game birds, aquatic furbearers, big game, other wildlife groups, and threatened and endangered species (Asherin and Claar, 1976; Tabor, 1976; Asherin and Orme, 1978).

Waterfowl. Wintering waterfowl are probably the most abundant wildlife resource on the Columbia and Snake rivers. Resident, breeding waterfowl numbers are generally low except for Canada geese (*Branta canadensis*), which occur throughout the project area, and various duck species. Other common species include mallard (*Anas platyrhynchos*), northern pintail (*A. acuta*), American wigeon (*A. americana*), green-winged teal (*A. crecca*), common merganser (*Mergus merganser*), and scaup (*Aythya sp.*). Fourteen-plus species of ducks with an annual production of 2,000 to 2,500 young occur in John Day Pool (Tabor, 1976; personal communication, J.T. Annear, U.S. Fish and Wildlife Service, Umatilla National Wildlife Refuge, 1983).

Raptors. The osprey (*Pandion haliaetus*), northern harrier (*Circus cyaneus*), and bald eagle (*Haliaeetus leucocephalus*) are directly associated with riparian or wetland areas in the reservoirs. Cliffs and large trees along river banks typically support diverse raptor populations, including the golden eagle (*Aquila chrysaetos*), prairie falcon (*Falco mexicanus*) (Payne et al., 1975; Asherin and Claar, 1976; Tabor, 1976), Swainson's hawk (*Buteo swainsoni*), red-tailed hawk (*B. jamaicensis*), great horned owl (*Bubo virginianus*), northern pygmy owl (*Glaucidium gnoma*) (Payne et al., 1975; Asherin and Orme, 1978), American kestrel (*F. sparverius*), common barn-owl (*Tyto alba*), western screech owl (*Otus kennicottii*), long-eared owl (*Asio otus*), short-eared owl (*A. flammeus*), and northern saw-whet owl (*Aegolius acadicus*).

Upland Gamebirds. Riparian and wetland areas associated with the project reservoirs provide habitat for at least 12 species of upland game birds, including wild turkey (*Meleagris gallopavo*), ruffed grouse (*Bonasa umbellus*), ring-necked pheasant (*Phasianus colchicus*), mourning dove (*Zenaida macroura*), chukars (*Alectoris chukar*), California quail (*Lophortyx californicus*), gray partridge (*Perdix perdix*), and common snipe (*Gallinago gallinago*) (Tabor, 1976; Asherin and Orme, 1978).

Aquatic Furbearers. Aquatic furbearers in the project reservoirs include muskrat (*Ondatra zibethicus*), beaver (*Castor canadensis*), river otter (*Lutra canadensis*), and mink (*Mustela vison*). These species depend on riverine areas, embayments, ponds, tributaries, and riparian forests for den sites and foraging areas.

Big Game. Black-tailed (*Odocoileus hemionus columbianus*) and mule deer (*O. h. hemionus*) are the most common big game species inhabiting the project area (Tabor, 1976). Black-tailed deer occur from The Dalles Pool downstream while mule deer are found upstream throughout most of the remaining project area (McKern, 1976). Columbian white-tailed deer (*O. leucurus*) occur along the lower Columbia River, mostly below Bonneville Dam. Idaho white-tailed deer (*O. v. ochrourus*)

are relatively common in the riparian zones of the upper Columbia River from Grand Coulee Dam upstream and along the Snake and Clearwater rivers. Idaho white-tailed deer are the most common big game species inhabiting the shoreline regions of Dworshak Dam (Asherin and Orme, 1978). Roosevelt elk (*Cervus elaphus roosevelti*) follow a distribution in the project area similar to black-tailed deer, while Rocky Mountain elk (*C. e. canadensis*) occur largely in the Clearwater drainage, the Snake River System upstream from the confluence of the Clearwater River. Elk and white-tailed deer use Dworshak for winter range and some elk use part of the upper reservoir area for calving. An isolated herd of elk occur along the steep slopes upstream of John Day Dam on the Oregon side, and approximately 150 animals were observed wintering along Wanapum Reservoir of the upper Columbia River (McKern, 1976). Elk also occur along Lake Roosevelt (Payne et al., 1975). Bighorn sheep (*Ovis canadensis*) and mountain goats (*Oreamnos americanus*) inhabit the upper slopes of the Snake River below Hell's Canyon Dam.

The major large carnivores in the Columbia/Snake project area are the black bear (*Ursus americanus*) and the mountain lion (*Felis concolor*). Black bears typically occur in the forested regions of the project area, especially the coastal range reaches of the lower Columbia, the Clearwater drainage, the Hell's Canyon portion of the Snake River, along Lake Roosevelt, and the upper Columbia River near the Canadian Border (McKern, 1976; Payne et al., 1975). Mountain lions are found in the upland habitats above Bonneville Reservoir, through Hell's Canyon to Brownlee Reservoir, and along the Clearwater River but are not common (McKern, 1976).

Other Wildlife. The project reservoirs also provide essential habitat for numerous reptiles, amphibians, small mammals, bats, colonial nesting birds, shorebirds, and songbirds (Asherin and Claar, 1976; Tabor, 1976; Asherin and Orme, 1978).

Shallow-water areas, embayments, shorelines, riparian areas, and wetlands associated with the project reservoirs provide important foraging and nesting habitat for shorebirds and colonial birds. These species include great blue herons (*Ardea herodias*), black-crowned night herons (*Nycticorax nycticorax*), California gulls (*Larus atricilla*), ringed-billed gulls (*L. delawarensis*), Forster's terns (*Sterna forsteri*), Caspian terns (*S. caspia*), double-crested cormorants (*Phalacrocorax auritus*), pied-billed grebes (*Podilymbus podiceps*), killdeer (*Charadrius vociferus*), spotted sandpipers (*Actitis macularia*), and white pelicans (*Pelecanus erythrorhynchos*).

A number of insectivorous species of various birds including woodpeckers, warblers, flycatchers, common nighthawks (*Chordeiles minor*), and small mammals, including bats and shrews, inhabit riparian and wetland areas in substantial numbers. Cliff swallows (*Petrochelidon pyrrhonota*), a colonial nesting species, are abundant at various dams where they construct their nests on the structures. Bank swallows (*Riparia riparia*), another colonial nesting species, nest in abundance at Grand Coulee and Chief Joseph projects.

Threatened and Endangered Species. The bald eagle and peregrine falcon (*Falco peregrinus*) are the only species potentially occurring in the Columbia-Snake River System that were identified by the FWS as Federally listed threatened or endangered.

2.6.2 Kootenai and Flathead Rivers

This section presents additional information not included in the 1992 OA/EIS about terrestrial ecology for the Flathead and Kootenai River Systems of Montana, including vegetation and wildlife.

Vegetation

The riparian zones along the free-flowing river systems can be characterized as deciduous shrub and deciduous tree communities with black cottonwood (*Populus trichocarpa*) as the primary tree species (BPA, 1984a,b). The Lake Koocanusa and Hungry Horse reservoirs are largely void of well-established riparian zones and backwater areas because of fluctuating waters levels. The 36 islands (totaling 324 acres) that occur in Hungry Horse Reservoir support conifer and upland shrub habitats. Vegetation communities adjacent to both reservoirs are also dominated by mixed conifer forests composed mostly of Douglas-fir, ponderosa

pine, western larch (*Larix occidentalis*), and spruce (*Picea spp.*).

Wildlife

The Flathead and Kootenai rivers support the variety of wildlife typical of other Columbia River headwater systems. However, because of the river systems' proximity to boreal Canada, Glacier National Park, and the Bob Marshall Wilderness Area, several large mammal species absent in other Columbia River Basin drainages are found here, including gray wolves (*Canis lupus*), grizzly bears (*Ursus arctos horibilus*), and moose (*Alces alces*). These and other dominant wildlife, especially those associated with riparian, riverine, and reservoir systems, are addressed below.

Waterfowl. Key waterfowl inhabiting the Flathead and Kootenai rivers include the Canada goose, mallard, wood duck (*Aix sponsa*), Barrow's goldeneye (*Bucephala islandica*), common goldeneye (*B. clangula*), common merganser, and harlequin duck (*Histrionicus histrionicus*). Approximately 215 Canada goose nest attempts were documented in 1987 in the northern and southern Flathead Valleys, including Flathead Lake (Mackey et al., 1987; Casey and Wood, 1987). An unknown but probably viable population of Canada geese nests along the Kootenai River and adjacent small ponds and lakes. Cavity-nesters, such as the goldeneyes, wood duck, common merganser, and harlequin duck, probably nest in cottonwoods along both river systems. Joslin (1978) noted the presence of harlequin ducks in the vicinity of Kootenai Falls. The common loon (*Gavia immer*) is listed as a sensitive species in the Kootenai and Flathead National Forests, and approximately six loons have been sighted on Lake Koocanusa, although no nests have been documented due to unsuitable habitat (personal communication, Dennis Flath, Montana Department of Fish, Wildlife, and Parks, August 31, 1992; personal communication, Don Skarr, Montana Department of Fish, Wildlife, and Parks, September 2, 1992).

Geese, mallards, goldeneyes, and mergansers probably use Lake Koocanusa and Hungry Horse reservoirs for resting; however, the lack of established aquatic vegetation in the littoral zones limits food availability compared to natural lakes in the region (BPA, 1984a,b). Shoreline habitats along both reservoirs are unsuitable for waterfowl brood rearing because of the fluctuating water levels (BPA, 1984a,b).

Raptors. Of the raptors occurring along the Flathead and Kootenai rivers, osprey, bald eagles, and barred owls *(Strix varia)* are most likely to be affected by lowered reservoir elevations or changes in the riparian zones. In 1983, approximately 15 nesting pairs of osprey used Hungry Horse Reservoir and a "large number" of nests were observed at Lake Koocanusa (BPA 1984a,b). Additionally, 58 active osprey nests were located in the northern Flathead Valley in 1985 (Casey and Wood, 1986). Barred owls are an indicator species for riparian communities dominated by cottonwood trees on the Kootenai and Flathead National Forests. The Cooper's hawk (*Accipiter cooperii*) is also an important raptor of the riparian deciduous tree community. Although not considered riparian obligates, the flammulated (*Otus flammeolus*) and boreal owls (*Aegolius funereus*) are two local species listed as "sensitive species" by the U.S. Forest Service because their viability is of concern in this region. Bald eagles are addressed further in the section on threatened and endangered species.

Upland Gamebirds. The upland gamebird species most likely to be affected by changes in the riparian zone is the ruffed grouse, an inhabitant of deciduous tree and shrub communities. Blue grouse (*Dendragapus obscurus*) and Franklin's grouse (*Canachites canadensis*) also occur in the Flathead and Kootenai drainages but are more restricted to the coniferous forest zones. A remnant population of Columbian sharp-tailed grouse (*Pediocetes phasianellus columbianus*) occurs at Tobacco Plains east of Lake Koocanusa (Bown, 1980) and is currently the focus of a mitigation program for Libby and Hungry Horse dams (Cope, 1992).

Aquatic Furbearers. Aquatic furbearers occur downstream of the Lake Koocanusa and Hungry Horse reservoirs. They include beaver, muskrat, river otter, and mink. Beaver distribution is strongly associated with the presence of cottonwoods in riparian zones, while muskrats, river otters, and mink are particularly abundant in embayments, sloughs, and other backwater areas. The use of Lake Koocanusa and Hungry Horse reservoirs by these species is believed to be low

because the fluctuating water levels hinder establishment of preferred foods for beaver and muskrats and expose denning sites for all species during periods of lowered pool elevation (BPA, 1984a,b).

Big Game. The most common big game species occurring along or near the Flathead and Kootenai River Systems include mule deer, white-tailed deer, and elk. Elk are the principal ungulate species in the vicinity of Hungry Horse Reservoir and white-tailed deer are the most common in the bottomlands of the Kootenai River near Libby Dam. Mountain lions (*Felis concolor*), black bear, and grizzly bear, which is federally listed as threatened, also occur in both river systems. Additionally, moose and bighorn sheep (*Ovis canadensis*) occur along the Kootenai River. The Ural-Tweed bighorn sheep herd, occupying the east face above Lake Koocanusa, was the focus of a major project intended to mitigate for sheep habitat loss created by the construction of Libby Dam (Yde and Olsen, 1984; Yde et al., 1986).

Other Wildlife. Bobcat (*Lynx rufus*), lynx (*L. canadensis*), fisher (*Martes pennanti*), and pine marten (*M. americana*) are key forest carnivores inhabiting the Flathead and Kootenai River drainages. While lynx and fishers are generally found in the upland conifer zones, timbered bottomlands interspersed with fire-caused openings provide suitable habitat for bobcats and pine martens. The western big-eared bat (*Plecotus townsendi*) and northern bog lemming (*Synaptomys borealis*) are also listed by the Kootenai and Flathead National Forests as sensitive wildlife species. North bog lemmings generally occur in wet meadows and sphagnum bogs. North bog lemmings might be affected by fluctuating water levels where these habitats occur within riparian zones.

Threatened and Endangered Species. Four species of wildlife inhabiting the Flathead and Kootenai River drainages are Federally listed as threatened or endangered. These species include the bald eagle, peregrine falcon, grizzly bear, and gray wolf. Appendix D presents the Biological Assessments for the affected species.

Currently, 16 bald eagle nesting territories occur on the Flathead River System from Hungry Horse Reservoir downstream to Flathead Lake, and an additional 10 bald eagle nesting territories are known from the Kootenai River System, including Lake Koocanusa (personal communication, Dennis Flath, Montana Department of Fish, Wildlife, and Parks, August 31, 1992). The reservoirs and riverine systems also support concentrations of wintering bald eagles. Between 50 to 100 transient bald eagles have been observed annually since 1988 along Kikomun Creek (British Columbia), a spring tributary of Lake Koocanusa and spawning grounds for kokanee (*Oncorhynchus nerka kennerlyi*) (personal communication, Don Skarr, Montana Department of Fish, Wildlife, and Parks, September 2, 1992).

The peregrine falcon, an endangered species, subsists primarily on avian prey and might forage in wetland and riparian areas at or near Lake Koocanusa and Hungry Horse reservoirs. However, Flathead Lake is probably more attractive to transient falcons because of its greater abundance of waterfowl. A nest site, last active in 1976, is located approximately 7 miles south of Hungry Horse Reservoir and might still be suitable for future occupancy.

The grizzly bear is listed as a threatened species in Montana and occurs in both the Kootenai and Flathead River drainages. Both drainages lie within the Northern Continental Divide Ecosystem where an estimated 440 to 680 bears live (Dood et al., 1986). Approximately 150 to 180 of these bears inhabit the Flathead River drainage, and the lower South Fork of the Flathead River supports one of the highest densities of grizzly bears in Montana (Jonkel, 1982; U.S. Forest Service, 1983), which is enhanced by its proximity to Glacier National Park and the Bob Marshall Wilderness Area. Fewer bears inhabit the Kootenai River drainage near Lake Koocanusa. Grizzly bears appear to prefer animal prey, but will readily consume plants when animals are not available (Craighead and Mitchell, 1982). Bottomlands and riparian zones are an important seasonal habitat for grizzly bears, especially in the fall when they provide soft mast (berries and cherries) and succulent vegetation as food.

The Rocky Mountain gray wolf is listed as an endangered species and has apparently been re-colonizing northwestern Montana. Researchers recently estimated that 34 wolves in three packs

live in the North Fork of the Flathead River and Wigwam River drainages (Ream et al., 1990). The Wigwam River pack probably ranges to the east shore of Lake Koocanusa. Several individual wolves were sighted in the South Fork at or near Hungry Horse Reservoir in the 1970s (Ream, 1979). In Montana, wolves prey primarily on white-tailed deer, elk, moose, and mule deer (Ream et al., 1989).

2.7 GEOLOGY AND SOILS

2.7.1 Lower Columbia-Snake Rivers

The study area spans five physiographic provinces: the Okanogan-Selkirk Highlands, the Columbia Basalt Plain, the South Cascade Range, the Rocky Mountains, and the Blue Mountains.

The Okanogan-Selkirk Highlands consist primarily of granitic and metamorphic rocks with sedimentary rock. The bedrock geology of the Columbia Basalt Plain consists primarily of thick successions of basaltic lavas. Numerous basaltic formations are distinguished within these lavas, and they are generally known as the Columbia River Basalt Group (CRBG) (Galster and Sager, 1989).

Before entering the Blue Mountains, the Snake River flows through a bedrock sequence of fine-grained lake and marine sediments that are susceptible to landsliding (BPA, 1985). The Clearwater River, in the vicinity of Dworshak Reservoir, flows through metamorphic and igneous rocks within the Rocky Mountain physiographic province (Corps, 1975).

During the Quaternary period, repeated advances of the Lake Pend Oreille lobe of the Cordilleran ice sheet dammed the Clark Fork River and impounded glacial Lake Missoula. This lake released catastrophic floods numerous times during the late Pleistocene, scouring much of the surface of the Columbia Basalt Plain. The floods also overtopped glacial Lake Columbia at the site of the present Lake Roosevelt. Since retreat of the lake, over 700 feet of lake sediments have been exposed along the banks of the reservoir.

These floods eroded the river valleys and produced large deposits of river sediments (Baker et al., 1987). These river deposits occur as scattered terraces along the river valleys. The flood erosion also produced steep slopes that have undergone some retreat, producing steep, coarse-grained talus slopes along bedrock cliffs. All the Pleistocene and contemporary river and alluvial fan deposits consist of gravels and sands with minor amounts of silt and clay.

During the Pleistocene glaciation, sea level was several hundred feet lower than it is today. The lower Columbia River eroded a deep canyon to reach the lower sea level, and this erosion created oversteepened slopes in the lower valley.

Sedimentation within the reservoirs is dominated by river influx and wave-eroded materials, and landslides of various types occur along the reservoir shorelines. These landslides are generally within the surficial sediments, especially those that are somewhat poorly drained because of an admixture of finer-grained sediment. Some landslides involve the CRBG and its interbedded river and lake deposits (Sagar, 1989a, 1989b, 1989c). Some of the larger landslides are currently immobile while others still move at slow rates (Sagar, 1989a).

2.7.2 Upstream Areas

This section discusses conditions in the upriver portion of the study area. This includes primarily the terrain surrounding the Libby, Hungry Horse, Grand Coulee, Dworshak, and Brownlee storage reservoirs.

Libby and Hungry Horse dams are both located in northwestern Montana in the Northern Rocky Mountain Province. They occupy river valleys originating in Canada. The terrain is characterized by high but weathered ranges separated by narrow valleys. Hungry Horse Reservoir is located almost entirely in glacial and alluvial deposits, but the dam is located in Paleozoic limestone (Erdmann, 1944). Libby Dam is located in Precambrian greenschist of the Belt supergroup. Wedge rock slides are present on the left abutment of the dam and undercutting of the rocks during construction of the dam triggered one slide (Voight, 1979). Four potential rockslides are present on the left bank near the dam (Voight, 1979). The slides extend to the current drawdown zone; however, historical movement of a similar

slide appears to have been triggered by extreme precipitation, not water level fluctuation.

Lake Roosevelt, behind Grand Coulee Dam, has 20 major slide areas along its perimeter. These slides areas originate in the lacustrine clay, silt, and sand that are part of ancient landslides. When glacial Lake Columbia drained during the end of the Pliestocene, the associated lake beds became highly subject to slumping. These ancient slides are being mobilized by fluctuating water levels of Lake Roosevelt. Many slides are directly linked to either maximum drawdown events or to spring refilling of the lake (BoR, 1969).

Brownlee Reservoir has significant potential for slope failure under existing flow operations. The main impact is from rapid drawdown decreasing stability of existing landslide area when the buoyant force of the water is removed (BPA, 1985). Numerous slides are present along the perimeter of the reservoir. One large slide exists at the mouth of the Powder River and is capable of damming that drainage.

Dworshak Reservoir is flanked by several potentially unstable areas (Corps, 1975). The areas consist of semi-consolidated shales and deep clay deposits. Some of these areas are active and continue to slowly move, (personal communication, R. Colgan, Project Manager, Dworshak Dam, Orofino, Idaho, August 17, 1992). One currently active area is located at river mile (RM) 32 near Falls Creek. The slide areas are up to 2 acres in size. In addition, much of the lakeshore is in granitic soils, which are highly erodible, especially at steep angles on long slopes. Shoreline sloughing was a common occurrence during the first few years of dam operation and was expected to stabilize with time, assuming no great change in water level fluctuations (Corps, 1975).

2.8 AIR QUALITY

The air quality of the Columbia River System study area varies widely because it is influenced by local air pollution sources, local meteorology, and local topography. In general, the area is relatively arid in the summer and early fall, and disturbance of surface silt and sand can generate high localized particulate matter concentrations.

The air quality in the Columbia and Snake River basins generally continues to meet ambient air quality standards designed to protect public health and welfare. The exceptions to attainment continue to be isolated areas with specific sources of concern to the air pollution agencies. These exceptions include Wallula, Washington at the confluence of the Snake and Columbia rivers, where agricultural activities and paper production generate fine particulate matter concentrations exceeding ambient standards.

Although newly exposed sediments can generate objectionable odors as organic materials decay, the EPA has chosen not to set allowable odor limits because no human health hazard has been identified with ambient concentrations of commonly occurring odorous substances.

The system produces enormous electrical generation, so any potential loss of generation could ultimately be replaced by nuclear plants or by burning additional fuels in thermal powerplants in the region. The existing air quality near the thermal plants is acceptable based on standards to protect human health and welfare. These standards are applicable to power plant emissions for sulfur dioxide, nitrogen dioxide, carbon monoxide, particulate matter, lead, and hydrocarbons, which can lead to ozone formation.

2.9 TRANSPORTATION

The Columbia and Snake rivers directly provide water transportation while the adjacent river valley is used as a land transportation corridor. The Columbia-Snake Inland Waterway is a 465-mile-long water highway formed by the eight mainstem dams on the lower Columbia and Snake rivers and provides navigation access from the Pacific Ocean to Lewiston, Idaho. The transportation system consists of navigation channels and locks, port facilities, and shipping operations. The channels are maintained at authorized dimensions by the Corps, and locks on the mainstem dams provide hydraulic lifts for barge access. Six barge companies operate approximately 40 tow boats and 175 barges. Fifty-four port facilities and shipping operations provide transportation for agricultural and timber products.

Upstream navigation for recreation is common. Many private boaters with several types of motorized and nonmotorized pleasure crafts and commercial tour guides use the mid-Columbia reservoirs, the Snake and Clearwater rivers above Lower Granite and Dworshak reservoirs, and the three reservoirs (Brownlee, Oxbow, and Hells Canyon) of the Hells Canyon Complex.

Another specific commercial use of affected project waters for navigation is transporting logs at Dworshak. Dworshak Reservoir is used to transport approximately 20 million board-feet per year of logs.

The grain-growing areas of Washington, Oregon, Idaho, and Montana are areas potentially affected by the proposed flow measures. These areas are served by the Burlington Northern Railroad, the Union Pacific Railroad, and several shortline operations, such as the Camas Prairie Railroad and the Montana Rail Link.

Rail line abandonment has occurred extensively in the Northwest, particularly in Washington and Idaho. The Palouse region of Washington and Idaho has been most affected by abandonment. Washington lost 1,557 miles of track, and a number of other rail segments are candidates for abandonment. Since 1976, Idaho has also had abandonment of 542 miles of track.

The highway network serving the study area includes interstate and Federal, State, and county highways. Interest primarily centers on routes that could be affected by potential diversion of commodities from barge transportation. See Table 2.9-3 in the 1992 OA/EIS for a breakdown of primary and secondary highways.

2.10 AGRICULTURE

There are about 2.9 million acres of cropland in the 15-county study area, of which approximately 720,900 acres are irrigated (Corps et al., 1992). An estimated 380,000 acres (about 53 percent) of the irrigated cropland is irrigated with water drawn from the eight lower Columbia and Snake River pools and Brownlee Reservoir.

The two primary irrigated crops are hay and wheat, valued at $200 to $550 (in 1991 dollars) per acre per year, respectively. Potatoes and other vegetable row crops grown in the area are valued at $1,500 to $3,800 per acre per year. These and other crops produced through irrigated farming are sold to markets throughout the country and provide substantial revenue to the region. Total value of crops produced from irrigated lands in the study area exceed $263 million. In addition, the farm operations benefit from the relatively inexpensive power provided by the Columbia-Snake River System hydroelectric projects, spending an average $75 per acre per year for electricity to operate irrigation pumps.

2.11 ELECTRIC POWER

The Columbia-Snake River System has been heavily developed for hydroelectric power generation. The coordinated Columbia-Snake River System, the integrated system of 30 Federal hydroelectric projects in the Columbia River Basin operated by the Corps and BoR, has a total installed generating capacity of approximately 21,700 megawatts (MW) (Corps, 1984). Actions to modify flows on the Snake and Columbia rivers would have implications throughout the coordinated Columbia-Snake River System as well as for other hydroelectric facilities owned by public and private utilities.

All 10 dams that might be directly or indirectly affected by the proposed flow measures have hydroelectric facilities and provide a total installed capacity of 14,530 MW. The combined capacity of the 9 Federal projects represents about two-thirds of the overall capacity of the coordinated Columbia-Snake River System. Including Brownlee, the total project capacity is equivalent to about 40 percent of all hydroelectric resources in the Columbia River Basin.

2.12 RECREATION

The rivers, reservoirs, and adjacent land areas included within the scope of the SEIS are regionally important recreational resources that offer a wide variety of activities. A total of about 150 sites offer water-based recreational activities including boating, swimming, fishing, water skiing, and wind surfing. Many sites provide boat ramps, docks, marinas, campgrounds, and day-use areas with

developed swimming, camping, and picnicking facilities. These sites typically have paved launch lanes and parking areas, restrooms with running water, retail and service concessions, landscaping, and irrigated lawn areas.

The projects generally are heavily used for recreational purposes, typically with a total of about 14 million annual recreation visits reported on the 11 study area pools during the period of 1989 to 1990. Visitation levels ranged from a high of about 3 million recreation visits per year at Bonneville to a low of 84,000 annual recreation visits at Lower Monumental.

The following material supplements the information on baseline conditions that was presented in the 1992 OA/EIS. This section presents additional information concerning the Clearwater River and new information about Libby and Hungry Horse reservoirs and their associated downstream reaches.

2.12.1 Clearwater River

The segment of the Clearwater River examined in this SEIS is between the confluence of the main stem of the Clearwater with the North Fork and the confluence of the main stem with the Snake River near Lewiston, Idaho. The North Fork flows from the Dworshak Project, which is located approximately 2 miles upriver from the confluence.

The Clearwater River is an important local and regional recreational resource. The river is well known for steelhead fishing from the fall through early spring (Krumpe, 1987). During the summer, recreationists use the river and its adjacent land for a variety of activities ranging from trout fishing to camping. The Clearwater River is readily accessible from communities in eastern Washington and northern Idaho. U.S. Highway 12 offers access to the southern side of the river and a series of dirt or gravel roads allow access to much of the northern side.

Between Ahsahka and Lewiston, there are a number of existing, day-use-oriented recreational facilities on both banks of the river. All 19 recreation sites on the Clearwater River between Ahsahka and Lewiston identified in the *Clearwater River Recreation Plan's Inventory of Existing Conditions* provide access to the river. Ten of the sites have boat ramps (Krumpe, 1987).

Most of the recreational facilities along the Clearwater have been developed as sports access facilities by the Idaho Department of Fish and Game. In general, these facilities are very basic and only include a gravel parking area, trash receptacles, portable toilets, and a boat ramp. The number of vehicles that can be parked at sports access facilities ranges from approximately 5 to over 70. Other recreational sites along the river have been developed by the National Park Service (as part of the Nez Perce National Historic Park), Idaho Department of Transportation (Lenore Rest Stop), and the Corps. In addition to boat ramps and access trails to the river, other features available at recreational sites located adjacent to the river include picnic areas, undeveloped beaches, and interpretive signs.

The majority (74 percent) of recreational users of the Clearwater River live in Idaho, and 37 percent of those come from local communities (Krumpe, 1987). The remainder of users come from Washington (10 percent), Montana (9 percent), and other states.

Steelhead fishing, the most important recreational activity on the Clearwater River in terms of numbers of participants, is concentrated from the confluence of the North Fork to Lewiston (Krumpe, 1987). Edwin Krumpe of the University of Idaho interviewed Clearwater recreationists during a 12-month period for the Steelhead Impact Committee's "Clearwater Recreation Survey." The survey's findings indicated that usage closely follows the steelhead season, which occurs from October through April. The survey also indicated that the most popular season for recreation was during the fall, between September and November. During those months, there were an estimated 119,600 users, representing 35 percent of the estimated annual usage. Winter, the second most popular season, had an estimated 90,800 recreationists (28 percent of the estimated annual number) using the river from December through February. Spring, between March and May, was the third most popular season with an estimated 82,100 users

(24 percent of estimated annual users). Use dropped off dramatically during the summer, the only time when there is no steelhead season. The summer usage was estimated at 44,300 recreationists (13 percent of annual usage). During the warm months, activities such as swimming, sunbathing, floating, picnicking, fishing for trout and bass, and sightseeing are popular. Fishing activity during the summer is expected to increase if a spring chinook salmon season is established (Krumpe, 1987).

2.12.2 Libby/Kootenai River

Lake Koocanusa is located on the Kootenai River, in the extreme northwest corner of Montana and southeastern corner of British Columbia, Canada. The U.S. portion of the reservoir is entirely contained within the Kootenai National Forest. The project location is fairly remote, but accessible from regional population centers. It is approximately 50 miles west of Kalispell, Montana; 130 miles northwest of Missoula, Montana; and 160 miles east of Spokane, Washington. The upper end of the reservoir is approximately 20 miles southeast of Cranbrook, British Columbia. Lake Koocanusa is an important regional recreational resource on both sides of the U.S.-Canadian border. There are over 15 developed recreational sites on both sides of the border and a number of dispersed sites (Figure 2.12-1). The U.S. Forest Service manages 10 developed and 9 dispersed sites. Features found at the U.S. Forest Service facilities include developed and dispersed campgrounds, picnic areas, fishing access points, boat ramps, and swimming beaches.

Lake Koocanusa Resort and Marina is located approximately 6 miles upstream from Libby Dam. This resort is privately managed and has a special-use permit from the U.S. Forest Service. It has features that include moorage slips, rental cabins, a cafe-bar-convenience store, rental boats, and a service shop. Mariners Haven Marina and Resort Campground, located at Rexford, Montana, is also a full-service campground and marina and provides overnight and day-use facilities.

The Corps manages a visitors center, viewpoints, observation tower, fishing access site, boat moorage, and a day-use area featuring 47 picnic sites.

In the Canadian section of the reservoir, there are two provincial parks located adjacent to the reservoir: Wardner and Kikomun Creek. Kikomun Creek Provincial Park is the more developed of the two and has a boat ramp and campground. Both have picnic areas and swimming beaches. Koocanusa Marina and Campground, the largest private facility on the Canadian side of the lake, has a marina and over 200 campsites.

Recreational activities at Lake Koocanusa are water oriented. Fishing is perhaps the most popular activity, with 45 percent of all visitors reporting it and related activities as their primary recreational activity (Corps, 1985). A factor in the reservoir's popularity is that the U.S. portion is open to fishing year-round. Most anglers fish during the spring and summer from boats; however, ice fishing occurs during the winter. In the Canadian section of the reservoir and near creek mouths and large bays, anglers often fish from shore (Corps, 1985). Popular fish include cutthroat and rainbow trout, kokanee, Rocky Mountain whitefish, and burbot.

Other recreational activities at Lake Koocanusa include picnicking, swimming, sightseeing, power boating, sailing, canoeing, camping and hiking. Swimming and picnicking were the second most popular activities, with 25 percent of recreationists surveyed reporting the two activities to be their primary activity while at the reservoir (Corps, 1985). Swimming is particularly popular with residents from Libby, Eureka, and Rexford.

In 1991, total visitation of U.S. Forest Service facilities at Lake Koocanusa was 2,427,800 visitor days (memorandum from Jeffrey White, U.S. Army Corps of Engineers, Seattle District, to Steve Foster, U.S. Army Corps of Engineers, Seattle District, August 14, 1992). In addition, there were an estimated 188,800 recreation visits at Corps facilities, and 195,000 people drove by the project. Use of Canadian facilities added 466,500 recreation visits for an estimated system total of 3,278,000 recreation visits in 1991. Use in the U.S. portion of the reservoir has been much higher than in the

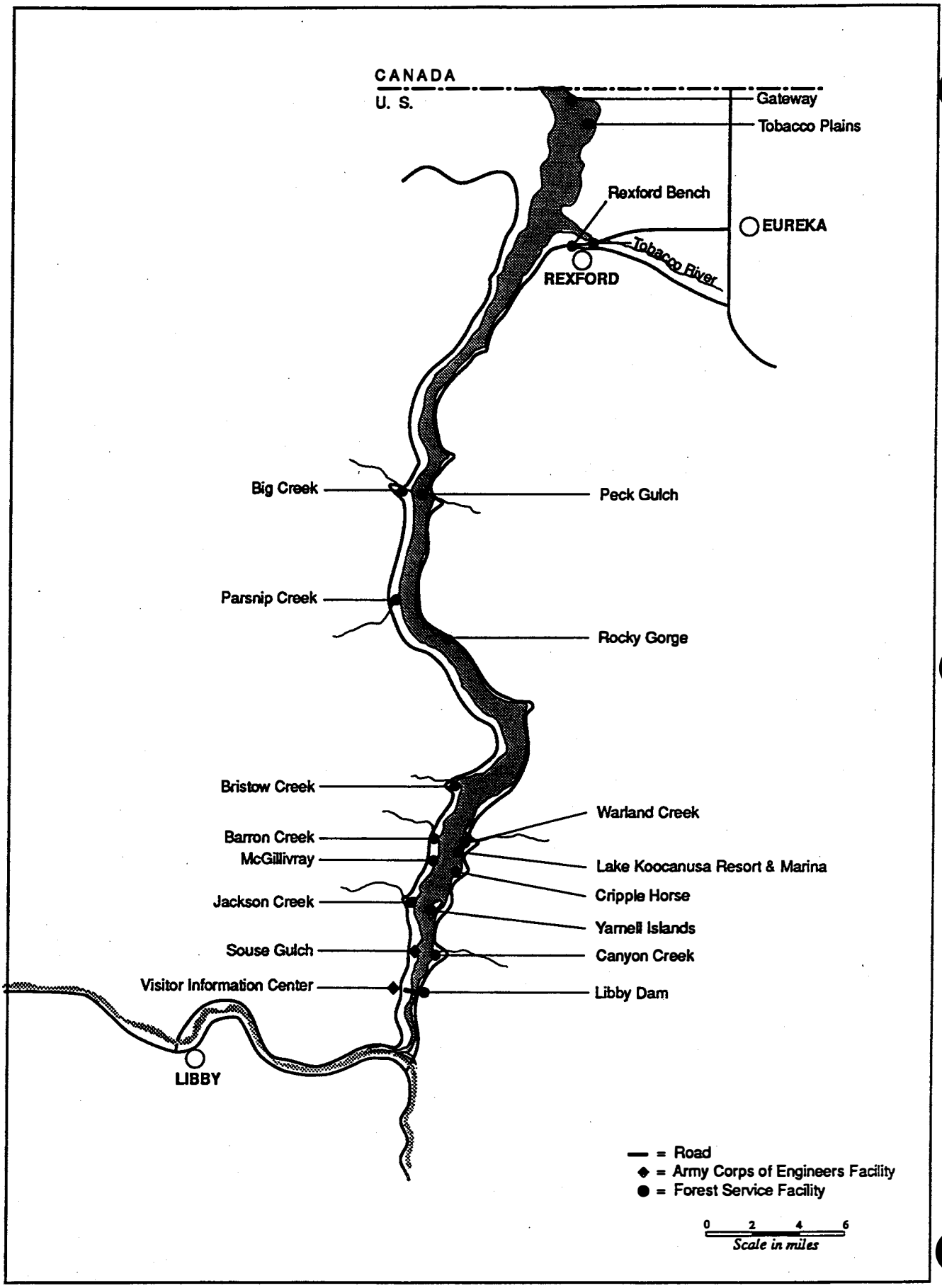


Figure 2.12-1. Lake Koocanusa recreational facilities

Canadian portion, but the percentage of Canadian use is increasing. In 1991, Canadian use represented approximately 15 percent of all use as compared to 5 percent in 1984. Visitation patterns at Lake Koocanusa can be directly tied to the fishing success of the kokanee. In 1985, Lake Koocanusa had an exceptionally good kokanee season and visitation was up significantly. However, the kokanee declined in the late 1980s and so did visitation. Currently, the kokanee population is improving again, as are Corps visitation figures.

Although there are no site visitation numbers available for 1991, 1984 usage data can be used as an indicator of relative use among project facilities. In 1984, the most popular facilities at the reservoir were recreational facilities that had a variety of features allowing water access and that were relatively close to towns. The sites used the most (in terms of recreation visits) were Rexford Beach (200,200 recreation visits), Peck Gulch (133,400 recreation visits), Lake Koocanusa Resort (35,700 recreation visits) and McGillivray (35,000 recreation visits). When use at dispersed sites was added together in 1984, the amount of use was relatively high (125,500 recreation visits).

Recreation at Lake Koocanusa is primarily summer oriented. Approximately 85 percent of the recreational use of the reservoir occurs during July, August, and September (Corps, 1985).

Approximately one-half of the recreational users of Lake Koocanusa are from Montana, 65 percent of which are from Flathead or Lincoln counties (Corps, 1985). Out-of-state visitors tend to come from Idaho, eastern Washington, or British Columbia and Alberta. Recreationists can be categorized into two main groups: nonresident anglers without children who stay in campgrounds between 1 week and 2 months, and local residents who fish, picnic, and swim for the day or camp for the weekend.

The Kootenai River below Libby Dam has developed into an excellent rainbow trout fishery with success rates that are comparable to the best blue-ribbon streams in Montana. Although fishing is frequently restricted by water-level fluctuations caused by hydropower peaking at the dam, it is far superior to that which existed in the free-flowing river prior to the dam. In recent years, a large, but underused, whitefish population has developed in the river, and this population is assumed to be a factor in the somewhat smaller rainbow trout sizes now characterizing the catch.

Downstream of Libby Dam, the Kootenai River follows a free-flowing meandering course, dropping about 5 feet per mile. Nine miles west of the town of Libby, Montana, the river passes over scenic Kootenai Falls, which forms a natural barrier to upstream fish migration.

2.12.3 Hungry Horse/Flathead River

Hungry Horse Reservoir is located within the Flathead National Forest on the South Fork Flathead River, approximately 25 miles northeast of Kalispell, Montana. The dam is approximately 3 miles south of U.S. Highway 2 and 15 miles southwest of the west entrance to Glacier National Park. Glacier National Park receives heavy visitation. In 1991, 2,961,000 visitors were reported at the park. Of those, 368,000 entered through the west park entrance at West Glacier (personal communication, L. Nommensen, Secretary of the Superintendent, Glacier National Park, West Glacier, Montana, September 24, 1992).

With the exception of the visitors center near the dam, which is managed by the BoR, all visitor and recreational facilities at Hungry Horse Reservoir (Figure 2.12-2) are managed by the U.S. Forest Service. This includes 13 developed facilities and 11 dispersed sites that ring the lake and offer picnicking, camping, and water access via swimming beaches and boat ramps. Recreational facilities along the reservoir can be reached by the road that circles almost the entire lake.

Sightseeing is the most popular activity at Hungry Horse; 68 percent of users surveyed reported sightseeing in the area (Ben-Zvi, 1990). Other popular recreational activities and the percentage of users participating in those activities include: picnicking (37 percent), RV camping (34 percent), boating (33 percent), fishing from boats

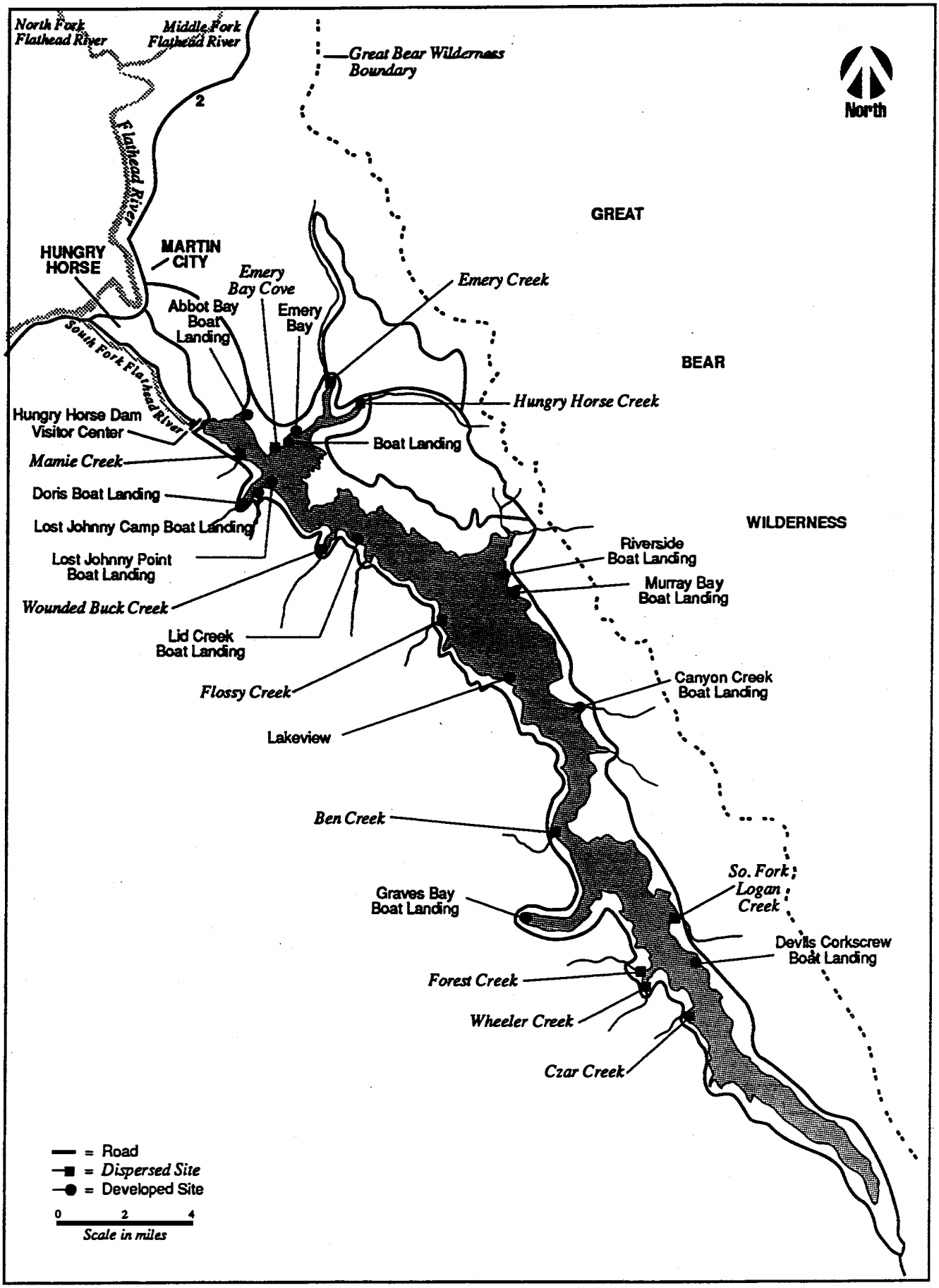


Figure 2.12-2. Hungry Horse Reservoir recreational facilities

(31 percent), swimming (31 percent), bank fishing (26 percent), hiking (24 percent), tent camping (21 percent), forest-products gathering (13 percent), and water skiing (12 percent) (Ben-Zvi, 1990).

As mentioned above, fishing at Hungry Horse and on the Flathead River System is popular. Game species include bulltrout, westslope cutthroat trout, mountain whitefish, brook trout, kokanee, rainbow trout, and lake trout (Ben-Zvi, 1990). In addition to fishing, innertube floating and canoeing are common recreational activities.

Approximately 50 percent of the recreationists at Hungry Horse Reservoir live within a 50-mile radius of the project. One-half of those come from Kalispell and Whitefish and the other half live in smaller, closer communities (Ben-Zvi, 1990). Approximately 63 percent of the recreational visitors come specifically to Hungry Horse as their primary destination. The remaining 37 percent reported that Glacier National Park was their prime destination and that they were visiting Hungry Horse for the day. If they camped at Hungry Horse, it was generally because overnight facilities at Glacier National Park were full (Ben-Zvi, 1990).

Sixty-four percent of visitors to Hungry Horse also engaged in recreational activities downstream on the Flathead River. Downstream recreational users were primarily local (85 percent) and lived within 50 miles of the project (Ben-Zvi, 1990). Local recreationists generally recreated only for the day.

Recreational use of the project between the years of 1981 and 1989 ranged from 64,000 and 78,000 recreation visits per year (with the exception of 1988, when the reservoir level was at a record low) (Ben-Zvi, 1990). Typically, the recreation season at Hungry Horse begins during Memorial Day weekend and ends after Labor Day weekend (Ben-Zvi, 1990).

The South Fork of the Flathead River begins in the Bob Marshall Wilderness Area approximately 70 miles southeast of Hungry Horse Reservoir. The upper reaches of the river have been designated as part of the Federal Wild and Scenic River System. From a regional perspective, recreational use of the South Fork is relatively high. In 1985 there were an estimated 100,500 recreation visits along the river in the section flowing through the wilderness and 50,200 recreation visits on the section outside the wilderness area (Flathead River International Study Board, 1988). Recreational activities along the river include fishing, boating, hiking, and camping.

The mainstem of the Flathead River begins where the Middle and North Forks join. The mainstem continues approximately 10 miles to the junction of the South Fork and then flows through Columbia Falls and Kalispell before entering Flathead Lake. Recreational activities along the mainstem are similar to those along the South Fork. Recreational use is high, but the total number of recreation visits is not known. A 1984 survey reported that there were 104,600 recreation visits at six State-owned fishing access sites along the mainstem (Flathead River International Study Board, 1988). Total usage would be expected to be higher.

2.13 AESTHETICS

The projects addressed in this SEIS are located in arid or semi-arid eastern Washington, eastern Oregon, or western Idaho and mountainous western Montana. In this generally dry region, water features attract much attention and are important aesthetic resources.

2.13.1 Lower Columbia River

The lower Columbia River landscape unit extends from the Columbia Basalt Plain on the eastern end to the South Cascades physiographic province at the western end (Galster et al., 1989). The unit is characterized by the high, steep side walls of the Columbia Gorge. On the Oregon side, these walls have sheer cliffs, tree-covered slopes, and numerous waterfalls in the Bonneville area west of Hood River. East of Hood River, the landscape becomes more arid and passes from the Douglas-fir/Oregon white oak association to steppe (with and without sagebrush) vegetation zones (Franklin and Dyrness, 1973; Payne et al., 1976). Land use along the lower Columbia River is varied and includes agricultural, forestry, recreational, port, industrial, fish and wildlife conservation,

residential, and commercial development. Visual and physical access to the unit is plentiful as a result of major state and interstate highways that follow the Columbia River, towns located adjacent to the river, and a number of recreational access points and parks.

2.13.2 Lower Snake River

The lower Snake River passes adjacent to and through the Blue Mountains and Columbia Basalt Plain physiographic provinces (Galster et al., 1989). Vegetation includes the shrub steppe, Ponderosa pine, and Idaho white pine series (Franklin and Dyrness, 1973; Daubenmire and Daubenmire, 1984). Upstream, the side walls of the river valley become steeper as the river passes through a high canyon that varies from 200 to 2,000 feet deep. The steep, rugged buttes and canyon walls framing the river are the dominant landscape features of the unit. Land use in the unit is varied. Near and adjacent to the river are agricultural uses, port facilities, residential and recreational developments.

2.13.3 Dworshak

Dworshak Reservoir is located in the North Fork of the Clearwater River valley in the foothills of Idaho's Bitterroot Range. The reservoir winds its way through remote, hilly terrain covered with coniferous forests. Land uses adjacent to the reservoir include forestry, recreation, power generation operations, industry, fish and wildlife management, and public port; forestry is the primary use and occurs on private and public land.

2.13.4 Brownlee

Brownlee Reservoir is located upstream from Hells Canyon National Recreation Area between the Blue Mountains in Oregon and the Seven Devils in Idaho. The sides of the narrow v-shaped canyon are extremely steep and high. The slopes are generally covered with grasses and sagebrush, and the steep canyon walls are the dominant landscape feature. Additional adjacent land use includes livestock grazing, ranching, recreation, and scattered rural residential (BPA, 1985).

2.13.5 Grand Coulee/Lake Roosevelt

Lake Roosevelt passes through the Okanogan Highlands and Columbia River Basin physiographic zones as it follows the ancient bed of the Columbia River north to Canada (Galster et al., 1989). The four major vegetation zones that are found along the terrain adjacent to Lake Roosevelt include steppes with and without sagebrush, Ponderosa pine forests, and a mixed zone of Douglas-fir, and grand fir (Franklin and Dyrness, 1973; Payne et al., 1976). Despite the buttes and steep mountainous terrain, the 0.5- to 1-mile-wide lake is Grand Coulee's dominant landscape feature.

2.13.6 Libby/Kootenai River

Libby Dam (Figure 2.13-1) is located on the Kootenai River in the extreme northwest corner of Montana in the Northern Rockies subdivision of the Rocky Mountains (Graf, 1987). Lake Koocanusa is wedged between the Purcell Mountains to the west and the Salish Mountains to the east. The dam is approximately 13 miles east of the town of Libby, Montana. At full pool, Lake Koocanusa is 90 miles long and extends 42 miles into British Columbia. This narrow, winding reservoir varies from approximately 0.5 to 2.5 miles wide. The pool fills the bottom of the Kootenai River valley, which for the most part is very steep and surrounded by peaks and ridges as much as 3,000 to 4,000 feet higher than pool elevations. The rugged side slopes of the river valley are covered primarily with coniferous forests.

State Highway 37 follows the east side of the reservoir for over 20 miles. At Rexford, Montana, it turns east and connects with U.S. Highway 93. U.S. Forest Service roads follow nearly all of the west side of the reservoir.

The Kootenai River flows south from Libby Dam approximately 3 miles, is joined by the Fisher River, and makes a sharp turn to the west. The river then flows in a west-northwest direction through the Purcell Mountains to the Idaho border and eventually into British Columbia. Approximately 9 miles west of Libby, the river drops over Kootenai Falls, which are a regional attraction and have cultural significance for Native Americans.

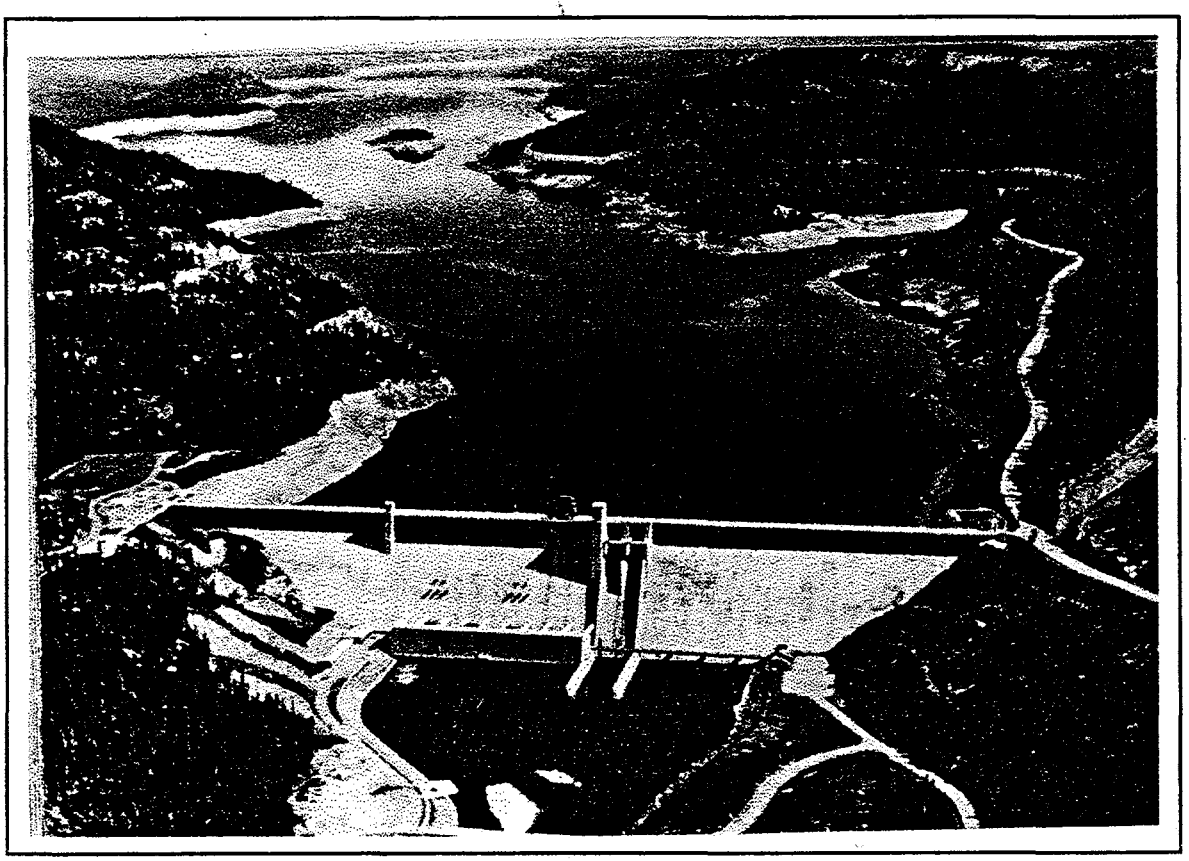


Figure 2.13-1. Libby Dam and Lake Koocanusa.

Between Libby and the river's junction with the Fisher River (approximately 15 miles), the river has cut a relatively narrow canyon. Through the canyon, the river is paralleled by State Highway 37 on the north and the Burlington Northern Railroad tracks on the south. The steep slopes that flank the river rise over 2,000 feet above the river to peaks such as Vermiculite and Swede mountains. The river has a relatively gentle gradient between Libby Dam and Libby, losing approximately 100 feet in elevation in approximately 18 miles. As a result of the relatively gentle gradient, there are several areas of the river that have islands.

Most of the area along the river between the dam and the town of Libby is national forest land and is largely managed for timber production, wildlife management, and recreation. Privately owned land occurs adjacent to the river near the town of Libby.

Vegetation on the hillsides adjacent to the river includes stands of coniferous trees such as ponderosa pine, western larch, and Douglas-fir. Riverside vegetation includes various species of riparian plants, with cottonwood being the most visually dominant.

2.13.7 Hungry Horse/Flathead River

The Hungry Horse Project (Figure 2.13-2) is located on the South Fork Flathead River in northwestern Montana. The river and project lie between the Swan and Flathead Mountain ranges, which are components of the Northern Rockies subdivision of the Rocky Mountains (Graf, 1987). The mountainous terrain surrounding the reservoir includes peaks such as Felix Peak (7,995 feet above sea level), Trinity Mountain (7,535 feet above sea level) and Horseshoe Peak (7,785 feet above sea level). The slopes above the reservoir generally have coniferous forest cover, dominated by



Figure 2.13-2. Hungry Horse Dam and Reservoir.

ponderosa pine at lower elevations, Douglas-fir at mid-elevations, and Englemann spruce and subalpine fir at higher elevations (over 5,000 feet) (Flathead River International Study Board, 1988).

The project is located in the Flathead National Forest near management areas that either emphasize or allow timber production (U.S. Forest Service, 1985). Clearcuts can be observed on the slopes of the hillsides on both sides of the reservoir. The western border of the Great Bear Wilderness is several miles to the east of the reservoir on the top of the crest of the Flathead Range. The Wilderness cannot be observed from the reservoir.

Access to Hungry Horse is limited to two local roads that connect to U.S. Highway 2. A paved road provides access to Hungry Horse Dam and the upper west shore of the reservoir. It continues as a gravel road south past the head of the reservoir, where it joins with a gravel road that parallels the east shore. The project is about 3 miles by road from U.S. Highway 2, 14 miles from the west entrance of Glacier National Park to the northeast, and 26 miles from Kalispell to the southwest. The South Fork of the Flathead River flows approximately 5 miles from Hungry Horse Dam to its junction with the Middle Fork. From the junction, the river flows west and passes through a narrow gap carved by the river between Teakettle Mountain to the north and the Swan Range to the south. Beyond the gap the river enters the relatively level Flathead Valley north of Flathead Lake, changes direction, and flows to the south. Once in the valley, the river's character changes from that of a swift mountain river to that of a meandering, braided river. As the river approaches Flathead Lake and the terrain becomes flatter, the number of islands and oxbow lakes increases.

Land use adjacent to the river between the dam and Flathead Valley is primarily timber production, wildlife habitat, and recreation. After the river leaves the Flathead National Forest and enters Flathead Valley, adjacent land use changes. Development on lands adjacent to the river has been extensive along some sections and includes an aluminum plant at Columbia Falls, timber-related facilities, and extensive agricultural production (primarily cattle grazing and barley production) (Flathead River International Study Board, 1988).

Vegetation on the hillsides adjacent to the South Fork consists largely of stands of ponderosa pine and western larch. Riparian vegetation along the river is dominated by cottonwood, but upland species such as Douglas-fir and spruce are also found. In the Flathead Valley, the river channel enlarges and cottonwoods are the dominant tree lining the river. Cottonwoods and other riparian vegetation are also found on islands and around oxbow lakes.

2.14 CULTURAL RESOURCES

Human occupation of the study area dates back over 10,000 years. The span of human occupation includes several aboriginal tribes who spoke the Sahaptin, Chinookan, and Salish languages; and missionaries and settlers. Identified cultural resources, both prehistoric and historic, are representative of the total span of human use and

occupation of the area. They include villages, fishing sites, trading posts, camp sites, agricultural and industrial communities, railroads, burial sites, homesteads, canneries, mining sites, and military forts.

The following material has been abbreviated from the 1992 OA/EIS. For additional detail, the reader is referred to the original document, with the exception of new information on Libby and Hungry Horse.

2.14.1 Lower Columbia

There are 424 known archaeological sites on the lower Columbia River. Development along the lower Columbia largely parallels that of the lower Snake River during most of the 10,000 years of human occupation although some differences exist, as in the Ethnographic period.

2.14.2 Lower Snake River and Dworshak

A total of 289 known archaeological sites are located in the lower Snake River area, with 210 of these sites within Dworshak Reservoir. These sites span 10,000 years of human occupation and include prehistoric and historic periods.

2.14.3 Grand Coulee

About 300 prehistoric and historic archaeological sites around Lake Roosevelt and an additional 26 sites immediately downstream of Grand Coulee Dam have been recorded. Archaeological investigations indicate the Grand Coulee vicinity has been continuously occupied for at least 7,000 years.

2.14.4 Brownlee

To date, no comprehensive cultural resources survey has been undertaken at Brownlee Reservoir. As a result, only 13 prehistoric sites and 7 historic sites are currently identified within the reservoir area.

2.14.5 Libby

The following information on the Libby Project cultural resources comes from Washington State University, Center for Northwest Anthropology Project Report Number 2 (Thoms, 1984), the Corps Seattle District's cultural resources management plan for Libby Project, and the 1979 LAURD Project report (Roll, 1982).

Currently, 299 archaeological sites and 46 isolated artifact finds have been recorded within the Libby Reservoir area. These sites represent prehistoric and historic human occupation of the project area. Reservoir monitoring is currently being conducted on a continuing basis by the U.S. Forest Service.

It is suggested that the middle Kootenai River region where the Libby project is located was occupied in prehistoric times by small bands of mobile hunters and gatherers who rarely formed villages or long-term habitations before the Historic Period. Earliest human use of the area probably began at least 8,000 to 9,000 years ago. By around 6,000 years ago, small groups of people were regularly using the Montana coniferous environment. Available information indicates that the early Middle Period land-use patterns (5,000 to 4,000 years ago) included winter occupations of the valley, high residential mobility, and reliance on valley wall resources, especially large game animals. During the late Middle Period (3,000 to 1,800 years ago), land-use patterns probably involved some summer occupation, decreased residential mobility, and use of valley bottom and valley wall resources. The Late Period (1,800 to 200 years ago) is best characterized by year-round use of the valley by larger groups of people. During this time, a higher percentage of residential sites were located near major water courses and evidence of fishing and plant processing are better represented than during previous periods.

Ethnographically, the project area was inhabited by the Kootenai Indians who have been recognized as being linguistically distinct from surrounding groups. For material culture, however, the Kootenai resemble both Plains and Plateau groups. The Northern (Upper) Kootenai relied more on hunting, particularly for bison, and therefore

resemble Plains groups as compared to the Southern (Lower) Kootenai, who depended more on fishing and were similar to Plateau groups.

2.14.6 Hungry Horse

To date, cultural resources investigations in the area of Hungry Horse Reservoir have been limited to a cursory inventory of portions of the drawdown area below the high water mark and some site specific areas above the high water mark for proposed U.S. Forest Service undertakings (e.g., timber sales, road construction, and campgrounds).

The cursory inventory of the drawdown area was an attempt to provide some indication of the number of cultural sites inundated by the construction of Hungry Horse Dam. The inventory was conducted when the reservoir level was approximately 80 feet below full pool. It consisted of spot checks along level terraces adjacent to streams flowing into the reservoir. Seven cultural sites were identified, but not thoroughly recorded.

Several U.S. Forest Service project areas have been inventoried for cultural resources on lands adjacent to the reservoir above the high water mark. None of these inventories identified any significant cultural remains near the reservoir.

The Smithsonian River Basin Survey recorded a "small campsite" (24FH0001) near the mouth of Hungry Horse Creek in 1947 prior to the inundation of the reservoir. Artifacts consisted of a "scraper and several chips."

2.15 SOCIOECONOMICS

Any socioeconomic influences of the proposed actions would be felt primarily within the communities along the Columbia-Snake River System in nearby upland areas that draw water supplies from the rivers and in more extensive commodity production areas that rely on the rivers for transportation. These use relationships define a primary influence zone that can extend up to 30 or 40 miles on either side of the river system.

2.15.1 Population

The total population of the study area for the 1992 OA/EIS was 1,215,938 in 1990. Lake, Flathead, and Lincoln counties in Montana add approximately 100,000 to this figure. Multnomah County, Oregon, which contains part of the Portland metropolitan area, accounts for almost one-half of this figure with a population of 583,887. The study area population growth patterns generally mirrored those of the states—high growth rates during the 1970s and slowed growth or actual decline during the 1980s.

During the 1980s, none of the Idaho, Oregon or Washington counties experienced population growth greater than the state-average growth rates. The counties that experienced declined or slowed growth were the smaller, rural areas, while the larger, more urbanized counties were among those that showed consistent growth. Growth rates in all three Montana counties exceeded that of the state during the 1980s.

2.15.2 Employment

The government sector (with an employment share range of 16 to 65 percent) provided the largest share of total nonagricultural employment for all but six counties in the study area. Wholesale and retail and food processing trades are also significant employers. Transportation and public utilities provide a relatively small share of total non-agricultural employment in the study area.

All counties in the study area for which unemployment statistics were available experienced a decline in the unemployment rate from 1986 to 1990 with the exception of Lincoln County, Montana, and Clearwater County, Idaho. However, compared to the statewide unemployment rates for those years, the study area experienced higher unemployment. Unemployment rates for select counties in the study area for the years 1986 to 1990 are presented in Figure 2.15-1.

2.15.3 Income

In 1989, only two counties in Washington exceeded the state per capita personal income (PCPI) of

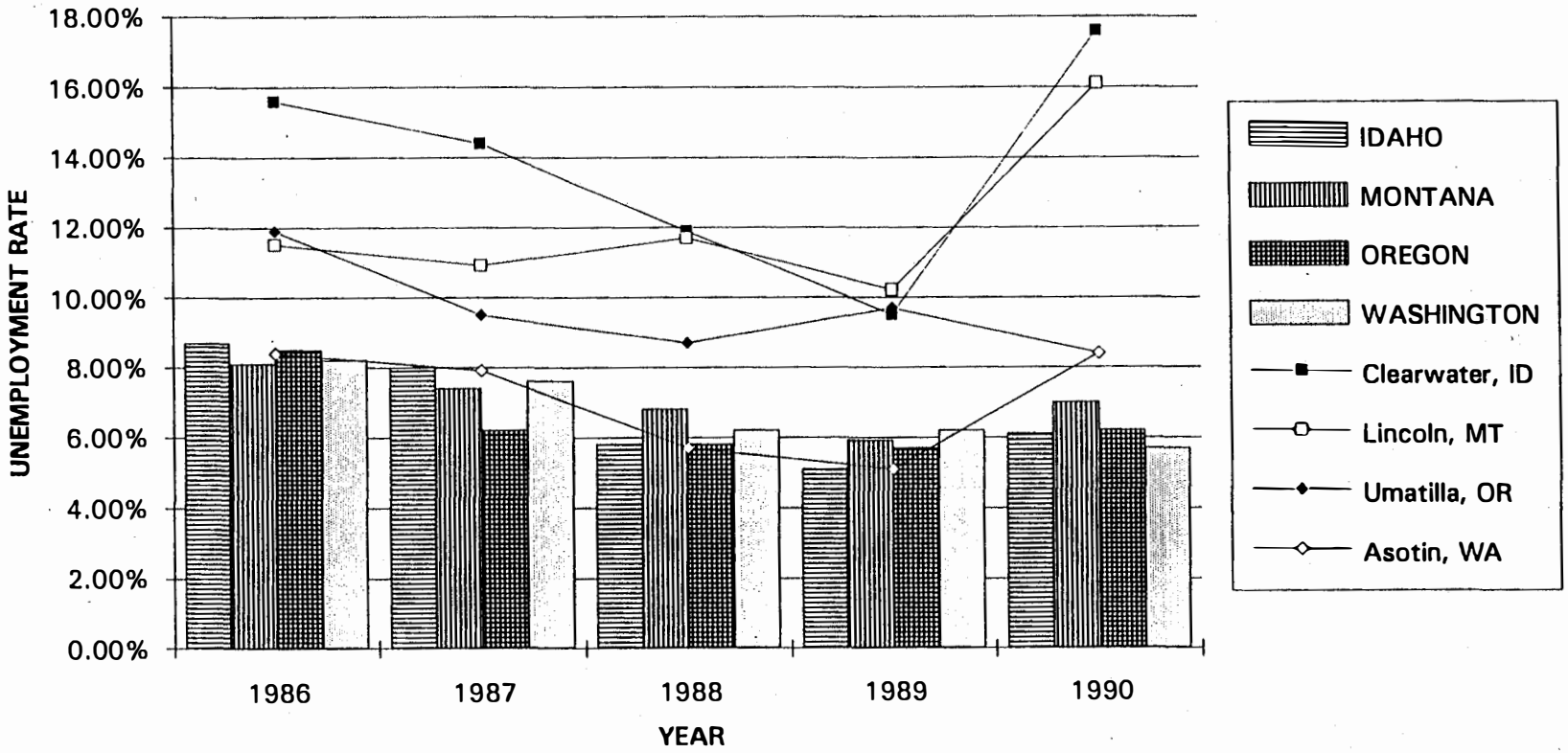


Figure 2.15-1. Selected study area unemployment rates (source: U.S. Bureau of Labor Statistics, 1992).

$17,696: Garfield and Lincoln. Six counties in Oregon exceeded the state average of $16,003: Gilliam, Morrow, Multnomah, Sherman, Wallowa, and Wasco. In Idaho, Adams, Lewis, and Nez Perce counties exceeded the state PCPI of $13,760. In Montana, Flathead County exceeded the state PCPI ($14,520) by $200, while Lincoln County PCPI was approximately $3,000 less.

With regard to median family income in 1989, only one study-area county in each state exceeded the state median: Benton in Washington, Multnomah in Oregon, Nez Perce in Idaho, and Flathead in Montana. Study-area counties with the lowest median family income in 1989 were Grant in Washington, Malheur in Oregon, Washington in Idaho, and Lake in Montana.

2.15.4 River System Users

The Columbia-Snake River System provides a variety of resources for public and private use. Key resource users include transportation, logging, agriculture, electric power, and recreation.

2.15.5 Native American Fishing Rights

Native Americans have fished, camped, and lived on the shores of the Columbia River for centuries. A few thousand years ago, geologic activity caused a 500-foot-high falls on the Columbia River near Bonneville Dam to be filled with slide material, creating rapids that allowed salmon to migrate up the Columbia River. Subsequently, there developed a Native American fall salmon fishery that Lewis and Clark observed on their trek west.

The history of treaty fishing rights on the Columbia River is divided into several historical periods. In the 1840s, after creating Oregon Territory, Congress opened up the territory to homesteading. Both white settlers and Native Americans filed homestead claims along the Columbia River. Then in 1855, a series of nearly identical treaties with Northwest tribes was negotiated with the goal of acquiring much Indian aboriginal-title land for white settlement. These 1855 treaties allowed the Columbia River tribes hunting and fishing rights. The fishing rights included the exclusive right of taking fish on streams on or bordering reservations and at "usual and customary" sites along the Columbia River.

The Northwest Tribes, through these reserved treaty fishing rights, have access to the river banks to fish during the fishing season. This right was affected by the construction of hydroelectric projects on the Columbia River with the construction of Bonneville, Dalles, John Day, and McNary dams. These projects flooded the usual and customary fishing sites, for which Congress provided compensation, both monetary and by provision of five "in-lieu" fishing sites in the Bonneville and Dalles pools.

The Supreme Court decision (Washington v. Washington State Commercial Passenger Fishing Vessel Assn., 443 U S 658 (1979)) held that the "usual and customary fishing sites" language entitled the treaty tribes to 50 percent of the fishery. Currently, the Corps, Bureau of Indian Affairs (BIA), and the tribes are working on a program to provide additional Indian-fishing support-sites to improve the access of the Indians to their Zone 6 commercial fishery (and ceremonial and subsistence fishery).

Under a recent law, Public Law 100-581, signed on November 1, 1988, the Corps is directed to provide a wide range of facility improvements, land transfers, and land acquisitions in support of Columbia River Treaty fishing activity.

Title IV of Public Law 100-581 specifically identified 21 sites (known as Section 401a sites) along the Columbia River in Oregon and Washington to be transferred to the Department of the Interior, BIA for use as treaty fishing access sites by members of the Nez Perce Tribe, the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Warm Springs Reservation of Oregon, and the Confederated Tribes and Bands of the Yakima Nation. The Corps must also identify, acquire, and improve six sites adjacent to Bonneville for treaty fishing access, and conduct facility improvements at five existing in lieu sites.

In August 1989, at public meetings at locations along the Columbia River, the Corps outlined a program to implement the requirements of Public Law 100-581. The first part of the program, the "Interim Management Plan," outlined the strategy by which the Corps would manage the newly designated treaty fishing access sites until they are developed and transferred to the BIA.

The second phase, a multi-year Preconstruction Engineering and Design program, was developed to respond to the P.L. 100-581's diverse requirements. To provide early action to implement the law, the planning activities were divided into two phases. The first planning phase focuses on those sites with potential for expedited development and/or capability to reduce impact to public parks. The second phase focuses on the remaining sites.

(Additional information on the treaty fishing access sites on the lower Columbia River may be found in the revised "Phase One Interim Evaluation Report Public Law 100-581, Title IV Columbia River Treaty Fishing Access Sites," October 1992, released by the U.S. Army Corps of Engineers, Portland District, in December 1992.)

Current fishing techniques include dip-netting from platforms fastened to the steep banks of the river, hook and line fishing, and setting gill nets with one end secured to the shoreline or buoy and the other end projecting into the river. The fishing season, regulated by Federal-State-Indian conservation agreements, may extend 8 to 9 months for some Native American families.

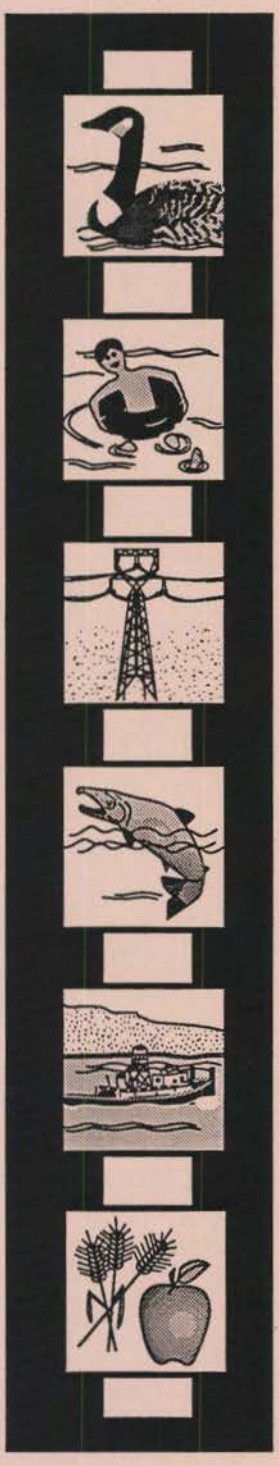
2.16 PROJECT STRUCTURES

Structural features of the projects have been summarized in Sections 2.2 and 2.9.

Dams along the Columbia and Snake rivers consist of navigation locks, spillway dams, powerhouse/intake structures, and earth-filled embankments. These features are founded in bedrock, though excavation through surficial sediment was sometimes necessary. The dam embankments are earth-filled, consisting of a heterogeneous mixture of materials from 6 inches in diameter to silt and clay sized. The dam embankments are protected by riprap only to MOP.

3.0

Proposed Actions and Alternatives



3.0 PROPOSED ACTIONS AND ALTERNATIVES

3.1 BACKGROUND

The actions addressed in this SEIS are being evaluated in direct response to the listing of three stocks of Snake River salmon as threatened or endangered under the ESA. While various programs to conserve salmon populations have been in place for decades, the need for more forceful action to benefit specific wild salmon stocks became readily apparent with the filing of formal petitions for ESA listings in 1990. Concerned parties in the Pacific Northwest initially responded to these petitions through the Salmon Summit, a collective regional effort to voluntarily develop long-term solutions to the decline in wild salmon stocks.

One immediate outgrowth of the Salmon Summit process was the 1992 OA/EIS prepared by the Corps, BPA, and BoR. The 1992 OA/EIS was prepared to provide NEPA documentation for short-term river management actions that the Salmon Summit asked the Corps to consider for implementation in 1992. The OA/EIS addressed a wide variety of measures intended to improve flow conditions during the 1992 juvenile salmon migration period, or to provide test measurements that would be valuable in designing long-term structural actions.

Concurrently, the NPPC initiated a four-phase process to amend the regional Fish and Wildlife Program. The first phase, completed in August 1991, addressed immediate fish production (hatchery) and habitat improvement needs. The NPPC ended the second phase in December 1991 by adopting a number of additional amendments involving mainstem survival measures related to river operations, as well as harvest and production measures. The mainstem survival measures overlapped considerably with the scope of the 1992 OA/EIS. Therefore, the Corps and the cooperating agencies on the OA/EIS coordinated with the NPPC to ensure that the OA/EIS addressed the flow-related elements of the NPPC plan that the cooperating agencies would need to implement.

The analyses and testimony presented through these processes demonstrated that feasible short-term options to improve flows for salmon migration are constrained by the current structural configuration of the river system. A number of viable measures are available, although they are capable of providing relatively modest improvements in flows. Much more substantial improvements might be possible in the long term through major structural modifications of the system, although the feasibility and desirability of such measures remain to be determined through extensive study.

The NPPC and OA/EIS processes also demonstrated that flow improvement measures would be necessary for a period of years until the most effective long-term river management strategy could be identified, designed, and implemented. Because of the specific focus of the 1992 OA/EIS, that document intentionally had a narrowly defined scope that was limited to river operations during 1992. Now that the region has had the benefit of the initial studies and several months of experience with modified river operations, it is appropriate for this SEIS to address flow improvement measures for 1993 and subsequent years until completion of necessary studies and implementation of a long-term strategy.

3.2 ALTERNATIVE ACTIONS

Much migration research indicates that survival of juvenile salmonids, particularly those migrating downstream during the spring freshet (streamflow increase from snowmelt runoff), might be related to water flow or velocity (see Section 4.2.1 of the 1992 OA/EIS for detailed discussion of this issue). According to this research, the longer the juveniles remain in the slow-moving reservoirs, the more susceptible they are to predators and other hazards. If the smolts are delayed too long, they might lose their physiological ability to survive in saltwater (although they might smolt again). Thus, the objective of improving flow conditions is to decrease time spent in the reservoirs, and thereby (theoretically) increase the survival rate during downstream migration. If water velocity is increased, smolts may travel downstream faster than has occurred in past operations.

Instream velocity can be increased either by reducing the cross-sectional area through which the same amount of water must flow, or by adding

water to river flow under normal operation. Lowering the elevation of mainstem pools (reservoir drawdown) increases velocity by passing the same amount of water through a smaller cross-sectional channel area. Reservoir operation options available in the short term generally involve operating mainstem pools near the low end of their normal ranges. The most common perception of the reservoir drawdown concept involves deep drafts well below normal operating ranges. This type of operation is being evaluated under the SCS. Alternatively, supplementing river flows during migration periods with additional releases from upstream storage reservoirs (flow augmentation) increases velocity by forcing a greater amount of water through the system.

Consequently, the range of potential actions available for interim flow improvements consists of various reservoir operation and flow augmentation options, implemented either singly or in combination. Because the flow improvement measures that are feasible now are limited by the structural configuration of the system and the total amount of storage available, the SEIS evaluates in detail four action alternatives that incorporate a combination of reservoir operation at lower pool elevations and flow augmentation measures involving multiple projects. The effects of these four alternatives are measured and compared against the no action alternative (the without-project condition), which is defined as the normal operation of the Columbia River System under the operating rules in effect from about 1985 through 1990.

3.2.1 Future Conditions for All Alternatives

A number of short-term improvements to system facilities and operations are already programmed and will be implemented regardless of whether any interim flow improvement measures are adopted. For modeling purposes only, these improvements were not included in Alternative 1, the no action alternative. For evaluation of impacts to the anadromous stocks, the improvements in system operation and facilities described below are assumed to be in place for Alternatives 2, 3, 4, and 5. This form of analysis is consistent with the manner in which the analysis for a Biological Assessment of the threatened and endangered salmon stocks is being conducted.

Nonflow Project Operations

Project operations elements not related to flow improvements encompass operation and maintenance of the fish bypass facilities, operation of the fish transportation program, provision for spill at selected dams, coordination of fish hatchery release schedules, and monitoring and research on fish passage. Operating directions and criteria for these elements are generally provided in the annual fish passage plan prepared by the Corps, in coordination with BPA, and the fisheries agencies and tribes (through the Columbia Basin Fish and Wildlife Authority [CBFWA]). In addition to providing formal criteria for these operational aspects, the fish passage plan identifies the respective coordination responsibilities of all of the parties involved with the fish passage program.

For this SEIS, the without-project conditions for nonflow operations at the eight mainstem dams are represented by the draft 1993 Fish Passage Plan (FPP) (Corps, 1992d). The draft 1993 FPP incorporates some general guidelines based on the ESA Section 7 consultation with NMFS on 1992 river operations and on the NPPC Phase III amendments. It provides guidelines on system load shaping for BPA to follow that allow the Corps to operate the turbines at the mainstem dams within 1 percent of peak efficiency in most conditions. The draft 1993 FPP also includes additional guidelines and turbine unit priority schedules for project operators that will help to meet the peak efficiency goal. It is believed that these measures will minimize juvenile fish mortality from passage through the turbines. The draft 1993 FPP will continue to use the 70/50 fish passage efficiency (FPE) guideline as a target at projects with bypasses installed, until the region develops either project or system survival goals. The 70/50 FPE guideline seeks to achieve 70 percent passage efficiency for spring juvenile migrants (yearling fish) and 50 percent efficiency for summer migrants (subyearling fish). (FPE in this case means the proportion of the downstream migrants passing the dams through non-turbine passage routes, i.e., fish bypasses, spillways, or sluiceways). This is to be accomplished through a combination of bypassing fish and providing spill. Juvenile fish passage

operations for other dams where spill is to be used are established through other processes, including the Fish Spill MOA, NMFS' Biological Opinion, and the Fish Transportation Oversight Team.

The annual planning process for fish passage was first instituted in the 1960s. The annual plans contained only operating criteria prior to 1977 the spill program was specified. In 1983, measures from the NPPC's Fish and Wildlife Program concerning routine and emergency maintenance were added. A number of disagreements on operations for passage have arisen over the years, most of which the Corps and the fish agencies and tribes have been able to resolve. Year-to-year changes in the fish passage plans have generally reflected agreements among the parties on how to improve operations to attain better fish passage. The draft 1993 FPP includes many changes of this type, adopted in response to the heightened concern over passage conditions.

More specific operating guidelines and changes from the prior plan are summarized below by category of operations activity; the reader is referred to the draft 1993 FPP for specific details on the operating criteria. The Corps and the cooperating agencies are consulting with NMFS on the draft 1993 FPP. The final 1993 FPP is scheduled for publication in March 1993.

Fish Passage Facilities. Juvenile fish passage facilities will operate at all eight mainstem dams during the respective downstream migration period for each facility. Beginning dates for 1993 facility operations are March 4 at Bonneville and April 1 at all other projects. Ending dates range from August 31 at Ice Harbor through December 31 at McNary. The draft 1993 FPP incorporates extended operating seasons for the juvenile facilities at The Dalles, John Day, McNary, Little Goose, and Lower Granite.

The draft 1993 FPP directs project operations personnel to inspect and maintain wires over the tailrace areas at McNary, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite to reduce bird predation on juveniles passing through the powerhouses.

Adult fish passage facilities (ladders) at Bonneville, The Dalles, and John Day will operate continuously, according to specified operating criteria, from March 1 through November 30 (the adult fish passage period). These facilities will also operate continuously and within operating criteria, except when deviations are needed for maintenance or repair, during the winter operating period of December through February.

Adult fish passage facilities at McNary, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite will operate continuously, according to specified operating criteria, from March 1 through December 31. These facilities will be inspected and repaired before March 1 and will receive increased inspection during the operating period. The fish ladder operating criteria for the lower Snake River projects were changed for 1992 in response to the operation of these projects at MOP from April 1 through July 31.

Current restrictions on the operation of the Bonneville second powerhouse will be discontinued in March 1993. Additional fish facilities will be installed fully by the beginning of the fish passage season. These facilities include: 1) full installation of turbine intake extensions in front of alternate intake slots; 2) replacing the top three standard trashracks in each intake slot with streamline trashracks; and 3) lowering the submersible traveling screens (STSs). Operation of the Bonneville project during the 1993 fish passage season will include minimum powerhouse 1 and 2 flows of 60 kcfs and spillway discharge of 50 kcfs with a daytime spill cap of 75 kcfs, when it is necessary for the spillways to operate. During the spring period, the Bonneville second powerhouse will be operated prior to the Bonneville first powerhouse for hydropower production. During the summer period, the Bonneville first powerhouse will be operated prior to the Bonneville second powerhouse for hydropower production. All STSs will be removed during the summer, because fish survival studies indicate better survival of fish when they pass through turbines rather than when they pass through the bypass systems.

Fish Transportation. In general, juvenile fish will be transported by barge and truck as prescribed in the Fish Transportation Oversight Team's (FTOT) Annual Work Plan, developed jointly with the fish agencies and tribes.

The Juvenile Fish Transportation Program will operate from April 1 through October 31, 1993 on the Snake River, with transportation from Lower Monumental, Little Goose, and Lower Granite, and from March 1 through December 31, 1993 (or freezing weather) on the Columbia River, with transportation from McNary.

Spill. Proposed spill operations for 1993 are indicated in Table 3.2-1. Spill at The Dalles and John Day will be in accordance with the Fish Spill MOA. Spill at Bonneville and Ice Harbor for 1993 will be in accordance with the draft 1993 FPP, which is consistent with the Biological Opinion dated April 10, 1992. Monitoring data from 1991 and 1992 show that 60 percent spill at Ice Harbor produced total dissolved gas (TDG) levels downstream of the project between 120 and 129 percent. The Corps, BPA, and BoR believe, based on research results, that these high TDG levels are deleterious to juvenile fish migration survival. Fish agencies and tribes will make spill requests through the Fish Passage Center.

Transportation of fish from Lower Granite, Little Goose, Lower Monumental, and McNary will be in accordance with transportation guidelines. Transportation benefit will be maximized; therefore, spill for fish passage will not be provided at these projects.

Fish Hatchery Releases. Fisheries agencies and tribes are to provide their respective release schedules for juvenile fish in their weekly Fish Passage Center report. Releases are to be coordinated to coincide, insofar as possible, with Water Budget and other coordinated flow augmentations and with the wild/natural fish migration.

Research and Monitoring. The Fish Passage Center will continue the Smolt Monitoring Program, which provides data on smolt numbers and migration characteristics through the mainstem part of the system.

The Corps will continue to operate the Dissolved Gas Monitoring Program, which provides automated measurements of dissolved gas concentrations and selected other parameters from 23 stations along the river system.

The Corps will conduct or coordinate the following specific research tests related to fish passage:

- Fish guidance efficiency (FGE) tests at Bonneville;
- Experimental extended-length screens at The Dalles, McNary, and Little Goose;
- Radio-tagging migration studies of adult fish, using the south shore fish ladder at John Day and Ice Harbor;
- Special tests on juvenile fish passage through the outfall pipe and holding and loading facilities at the new juvenile fish facilities at Lower Monumental;
- Flow variation studies of adult migration at Lower Monumental, Little Goose, and Lower Granite; and
- Additional studies funded in 1993 and future years through FPDEP.

Project Improvements for Endangered Species

The Corps has also developed plans for an extensive program of physical improvements to the fish passage facilities at the mainstem dams. Known as the PIES, this program will improve passage conditions in the future independent of any flow improvement measures adopted through this SEIS. The PIES program was initiated by the Corps in 1991 in response to the proposed ESA listing, and it relies on facility operations and maintenance funding. It consists of multiple individual projects involving the juvenile bypass, adult fishway, or transportation program facilities at each dam. PIES items include unresolved issues from prior fish passage plans and previously unfunded items on Corps nonroutine maintenance lists. There are currently 22 separate projects among the four lower Snake River dams, with a total capital cost estimated at over $5 million. Snake River PIES actions generally include equipment changes to achieve peak turbine efficiencies, replacing fishway mechanical controls, rebuilding turbine fish pumps, and transportation improvements such as shading raceways where smolts are held for transport. The 28 additional

Table 3.2-1. Proposed spill operations for 1993.

	Spill Season	Spill Percentage [a/] --average (range)--
Ice Harbor		
Spring	4/15-5/31	60% (50-70) 30% (20-40)
Summer	6/1-8/22	
John Day		
Spring	None	
Summer	6/7-8/22	20% (15-25)
The Dalles[b/]		
Spring	5/1-6/6	10% (5-15)
Summer	6/7-8/22	5% (0-10)
Bonneville		
Spring	4/15-6/12[c/]	53%
Summer	6/13-8/22	41.5%

a/ Spill for 12 hours/day at Ice Harbor, 10 hours/day at John Day, and up to 24 hours/day at The Dalles and Bonneville. Daytime spill at Bonneville is limited to 75 kcfs.

b/ During both the spring and summer, the daily spill level at The Dalles can be shaped on a seasonal basis by plus or minus 5% of the daily spill percentage indicated in the spill table.

c/ Start of summer spill occurs when subyearling fish predominate daily passage at the project.

PIES projects among the lower Columbia River dams also focus on turbine efficiency improvements, plus items such as spill pattern testing and spillway automation, better means for inspection and maintenance of fish passage facilities, and improved water quality in the adult fishways.

PIES projects will be implemented over a period of years. Some PIES actions have already been completed, but most are currently in the study or plans-and-specifications stage. Existing schedules and budgets for the PIES program indicate that most of these improvements will be implemented by Fiscal Year (FY) 1994, and all will be completed by FY 1996.

3.2.2 Alternative 1: Without-Project Conditions (No Action)

NEPA requires that each EIS include an existing conditions or "no action" alternative against which the effects of all "action" alternatives are measured. Under this alternative for 1993 and subsequent interim years, no additional actions beyond those already adopted by the Corps and the cooperating agencies would be taken to alter the normal operation of the reservoirs and dams on the lower Columbia and Snake rivers during salmon migration. Normal operations are the manner in which the projects and fish programs were operated from about 1985 to 1990. Key components of normal operations that represent future without-project conditions are summarized below. Table 3.2-2 presents a summary of Alternatives 1 through 5.

Reservoir Operation

The mainstem run-of-river reservoirs normally operate within a rather narrow elevation band at the top of pools that are typically about 100 feet deep. The normal minimum operating pool elevation for each reservoir is typically 3 to 5 feet below normal full pool (see Table 3.2-3). These projects follow an operating cycle corresponding to short-term

Table 3.2-2. Summary of alternatives.

Component	Alternative 1. No Action (Without-Project Conditions)	2. 1992 Operation	3. 1992 Operation with Libby/Hungry Horse Sensitivity	4. Modified 1992 Operation	5. Modified 1992 Operation, Upper Snake Sensitivity
Reservoir Operation	• Lower Columbia reservoirs (all 4) normal elevations	• Bonneville, The Dalles, and McNary normal elevations • John Day near 262.5/ minimum irrigation pool May 1-August 31	• Same as Alternative 2, all components.	• Same as Alternative 2, all components.	• Same as Alternative 2, all components.
	• Lower Snake reservoirs (all 4) normal elevations	• Lower Snake near MOP April 1-July 31			
Flow Augmentation					
Snake River					
Dworshak					
Spring	• 600 KAF April 15-May 31	• 900 KAF (600 KAF Water Budget plus 300 KAF), if runoff forecast exceeds 16 MAF. If forecast is 16 MAF or less, release minimum flows of 1.2 kcfs (estimated at 148 KAF over 62 days) plus 1,000 KAF, plus flood control shift water (subject to runoff forecast) April 15-June 15	• Same as Alternative 2	• Same as Alternative 2	• Same as Alternative 2
Summer		• 270 KAF plus min. discharge June 16-August 31	• Same as Alternative 2	• 470 KAF plus min. discharge June 16-August 31	• Same as Alternative 4
Fall		• 200 KAF plus min. discharge in September	• Same as Alternative 2	• Moved to summer	• Same as Alternative 4
Brownlee	• Up to 110 KAF Water Budget in May	• 110 KAF Water Budget in May • 137 KAF in July (replaced with 137 KAF upper Snake contribution in August) and 100 KAF in September	• Same as Alternative 2	• Same as Alternative 2	• Same as Alternative 2
Upper Snake	• Available uncontracted water from upper Snake	• 190 KAF, released through Brownlee April 15-June 15 • 137 KAF released to refill Brownlee in August • 100 KAF released through Brownlee in September	• Same as Alternative 2	• Same as Alternative 2	• No additional upper Snake water

Table 3.2-2. Summary of alternatives.

Component	Alternative				
	1. No Action (Without-Project Conditions)	2. 1992 Operation	3. 1992 Operation with Libby/Hungry Horse Sensitivity	4. Modified 1992 Operation	5. Modified 1992 Operation, Upper Snake Sensitivity
Columbia River	• Up to 3.45 MAF Water Budget April 15-June 15 (normal water)	• Normal Water Budget • Up to 3 MAF additional water from storage at Grand Coulee, Arrow and/or Libby for flow augmentation, based on 80/90 MAF runoff forecast triggers, May 1-June 30; Hungry Horse fixed at no action operation, as is Libby in years when not needed for flow augmentation	• Normal water budget • Up to 3 MAF additional water from storage at Grand Coulee and Arrow, based on 80/90 MAF runoff forecast triggers, May 1-June 30; Libby and Hungry Horse not fixed, allowed to respond to system demands	• Same as Alternative 2	• Same as Alternative 2
Flood Control Operations					
Dworshak	• Draft to 1,558 by December 15 for flood control and maintain rule curve elevations from January 1-July 1	• Attain maximum elevation 1558 by December 15. Operate Dworshak at mandatory flood control rule curves (MCRs) January 1-April 15. Shift system flood control space to Grand Coulee in April, if Dworshak runoff forecast 2.6 MAF or less	• Same as Alternative 2	• Same as Alternative 2, but shift flood control to Grand Coulee if Dworshak runoff forecast 3.0 MAF or less	• Same as Alternative 4
Brownlee	• Draft to flood control target elevation by March 1 for system flood control (varies depending on runoff forecast)	• Shift system flood control space to Grand Coulee, if required	• Same as Alternative 2	• Same as Alternative 2	• Same as Alternative 2
Grand Coulee	• Draft Grand Coulee beginning in January to maintain system flood control	• Above-normal drafts at Grand Coulee, if required, to accommodate flood control shifts from Dworshak and Brownlee	• Same as Alternative 2	• Same as Alternative 2	• Same as Alternative 2

Table 3.2-3. Normal operating elevations of mainstem reservoirs (feet mean sea level [fmsl]).

Project	Normal Operating Range	Minimum Operating Pool
Lower Granite	738-733	733
Little Goose	638-633	633
Lower Monumental	540-537	537
Ice Harbor	440-437	437
McNary	340-337	335
John Day	Varies[a/]	257
The Dalles	160-155	155
Bonneville	76.5-71.5	70

Source: Corps, 1989, 1988a-d, 1968, 1962, 1961.

a/ 265-268 from July 1 to October 1.
260-265 from November 1 to March 1 and May 15 to June 1.
262-265 from March 1 to May 15 (includes cyclical fluctuations for goose nesting).
June and October are transition months.

changes in electric power demands, so the pools of the mainstem projects usually fluctuate 1 to 2 feet on a daily basis and up to 3 to 5 feet on a weekly basis. Alternative 1 for the SEIS would involve continued operation of all four lower Snake River reservoirs and all four lower Columbia River reservoirs in the upper portion of the normal operating range.

Storage reservoir operations are managed according to a series of rule curves, specific to each reservoir, that take into account runoff and refill factors, power demands, and flood control and other nonpower requirements (see Section 2.2 for more details). With no action, these rule curves would not be modified to provide additional flow improvements in 1993 and an indefinite period in the future. Expected elevation characteristics for the relevant storage reservoirs under all alternatives are summarized in Section 3.5.

Flow Augmentation

Since the early 1980s, spring flows on the Columbia-Snake River System have been supplemented with additional storage reservoir releases under the Water Budget, a key part of the NPPC's regional Fish and Wildlife Program.

Alternative 1 would involve normal Water Budget operations, which allow for shaped releases of up to 1.19 MAF on the Snake River between April 15 and June 15, and 3.45 MAF on the Columbia River during the same period. Snake River Water Budget flows include 600 KAF from Dworshak, with the remainder coming from Brownlee and any water available from the upper Snake River Basin. Grand Coulee and upstream reservoirs provide Water Budget flows on the Columbia River.

3.2.3 Alternative 2: 1992 Operations

This alternative includes actions actually planned for the 1992 operating year. They are based on the Corps and BPA Records of Decision. This does not include the March drawdown test of Lower Granite and Little Goose pools. The flow augmentation elements of Alternative 2 include additional water from Dworshak, Brownlee, the upper Snake River, and from Grand Coulee, Arrow and/or Libby on the Columbia River portion of the system. Potential use of Libby for flow augmentation is a change from the actions described in the draft SEIS; see additional discussion below. The 1992 OA/EIS discussed the possible purchase of additional water from the upper Snake River but did not include these flows

in the preferred plan of operations due to uncertain availability. However, this measure was adopted by the NPPC as a Phase II amendment, and was included in the NMFS' Biological Opinion. During periods of the year other than those described where flow augmentation is provided, the projects will be operated in a manner consistent with providing the rates of augmentation described in this alternative.

In 1992, 90 KAF of uncontracted space in Cascade and Deadwood reservoirs in Idaho was rented by the BoR to support salmon flow augmentation. This water was planned for release after November 15, 1992, to replace water released from Brownlee by IPC in July 1992.

Flow augmentation is enhanced under certain flow conditions by transfer of some flood control requirements from Dworshak and Brownlee to Grand Coulee. Flood control transfer involves shifting system flood control storage capacity from one reservoir to another. For example, storage space at Dworshak that would otherwise be held empty for flood control can be used to store water for spring or summer releases. However, the transfer would increase the space that must be held empty at Grand Coulee for flood control.

Components of this alternative are summarized below. Additional details on these specific components can be found in the 1992 OA/EIS and in Section 3.5.

- Reservoir Operation
  1) Lower Columbia River reservoirs (3) will be operated near full; John Day will be lowered to minimum irrigation pool (approximately elevation 262.5 to 263.5) May 1 to August 31; the pool would be held to this level unless impacts to irrigation intakes result, in which case it would be raised accordingly
  2) Lower Snake River reservoirs will be operated near MOP from April 1 to July 31

- Flow Augmentation
  1) Dworshak supplemental releases will be scheduled as follows:
     - 1,000 KAF from April 15 to June 15, plus minimum flows of 1.2 kcfs (estimated 148 KAF), if the runoff forecast is 16 MAF or less
     - 270 KAF, above 1.2 kcfs minimum discharge, June 16 to August 31
     - Up to 200 KAF above minimum discharge of 1.2 kcfs in September
     - To ensure high probability of being on flood control rule curve by April, maintain 1.2 kcfs discharge from October through April unless higher discharges are required to stay on flood control rule curve or for short-term power emergencies
     - Be at 1,558 feet elevation on December 15 (winter flood draft maximum elevation)

     The flow augmentation operation described for Dworshak is slightly different from that described in the draft SEIS with respect to the minimum discharge at Dworshak. The Corps is defining minimum flows at Dworshak to be 1.2 kcfs year round. Previously, minimum flows at Dworshak were 2 kcfs from October through spring and 1.2 kcfs in summer and early fall. This change will not increase or decrease the total volume of water available for flow augmentation between April 15 and June 15. However, it will allow more flexibility by providing more water that can be shaped on a short-term basis.
  2) Brownlee operation will reflect historical releases plus requests per NPPC amendments, as follows:
     - 110 KAF Water Budget in May
     - 137 KAF in July (replaced with 137 KAF upper Snake contribution in August)
     - 100 KAF in September
  3) Upper Snake River
     - 190 KAF April 15 to June 15 (via purchase)
     - 137 KAF released to refill Brownlee in August
     - 100 KAF in September (via purchase)
  4) Grand Coulee and upper Columbia River
     - 3.45 MAF Water Budget plus up to 3.0 MAF additional flow augmentation May 1 to June 30. The additional storage will be obtained if required through power purchase and exchange activities, with associated storage, carried out by BPA.

- Flood control transfer
  1) Dworshak system flood control requirements will be shifted to Grand Coulee, if the April forecast predicts runoff to Dworshak is 2.6 MAF or less.
  2) System flood control requirements for Brownlee will be transferred to Grand Coulee.

  The Columbia River 3 MAF flow augmentation will also differ from the operation described in the draft SEIS and the 1992 OA/EIS, in which water would be stored only at Grand Coulee and Arrow for release in spring. As a result of water conditions and Columbia River Treaty operations in 1992 to 1993, water levels at Arrow are at maximum elevations allowed by flood control rule curves and there is no storage available for additional water to be used for flow augmentation. Therefore, Libby is being considered as an alternative to Arrow for storing the water needed for Columbia River flow augmentation. The operation that would occur at Libby to accomplish this storage would be similar to that used at Arrow.

  It is assumed that all three projects, Grand Coulee, Arrow, and Libby, will be available for storage and flow augmentation in future years, depending upon runoff and operating conditions in any given year. Available storage capacity at any of the projects for flow augmentation would be constrained by flood control requirements.

3.2.4 Alternative 3: 1992 Operations with Libby/Hungry Horse Sensitivity

A basic premise of the 1992 OA/EIS and the 1992 plan was that system operations would be conducted such that Libby and Hungry Horse would not be operated differently to compensate for flow improvement changes in system operations. Additional releases from Libby and Hungry Horse would not be scheduled to augment Columbia River flows, for example, and BPA would not request additional generation from these projects to make up for power losses on the Snake River part of the system. Consequently, the hydroregulation models used to analyze the 1992 OA/EIS alternatives were run with Libby and Hungry Horse "fixed" in their normal operating pattern.

State of Montana officials voiced concern that this constrained operation would not be maintained through the actual day-to-day operation of the system, particularly in light of the low flows and storage reservoir elevations that occurred in 1992. They specifically requested that the Corps include an analysis of potential indirect effects on Libby and Hungry Horse operations in the SEIS.

Alternative 3 has been included in response to this request. It contains the same reservoir operation and flow augmentation requirements as did Alternative 2 (in the draft SEIS), with no additional releases for flow augmentation from Libby or Hungry Horse. The only difference in the original hydroregulation models for this alternative and Alternative 2 is that the Libby and Hungry Horse operations are not "fixed." Operation of these projects is allowed to change if needed in response to the additional flow augmentation requirements imposed on other projects by Alternative 2. As a result of the change in the Columbia River 3 MAF flow augmentation operation for the final SEIS, the results of Alternative 3 remain applicable primarily for Hungry Horse and for Libby in years when Libby would not contribute to flow augmentation. During periods of the year other than those described where flow augmentation is provided, the projects will be operated in a manner consistent with providing the rate of augmentation described in this alternative.

3.2.5 Alternative 4: Modified 1992 Operations

This includes those actions actually planned for the 1992 operating year (less the March drawdown test), plus enhancement of summer flow augmentation from Dworshak. The primary differences between Alternative 2 and Alternative 4 are two features of planned flow augmentation from Dworshak (see Table 3.2-1). One is that the 200 KAF normally planned for September release in Alternative 2 would be shifted to July and/or August to benefit summer juvenile migrants and/or adult migrants. The other is that the criterion for the flood control transfer to Grand Coulee would also be increased from a runoff forecast of 2.6

MAF to 3.0 MAF. This would increase the number of years in which a flood control transfer would be possible. During periods of the year other than those described where flow augmentation is provided, the projects will be operated in a manner consistent with providing the rate of augmentation described in this alternative.

3.2.6 Alternative 5: Modified 1992 Operations with Upper Snake Sensitivity

Alternative 5 includes actions actually planned for the 1992 operating year (less the March drawdown test) plus improvements to salmon flows from Dworshak as in Alternative 4 (see Table 3.2-1), but minus the 427 KAF flow transfer from the upper Snake. This alternative is being run as a sensitivity model to show the difference if no water is available from the upper Snake River. Purchase of uncontracted water from the upper Snake River Basin was an objective of the 1992 operating plan. This objective was only partially met because of low flows in 1992 and the consequent scarcity of water available for purchase. During periods of the year other than those described where flow augmentation is provided, the projects will be operated in a manner consistent with providing the flow augmentation described in this alternative.

3.3 PREFERRED ALTERNATIVE

Alternative 4, the modified 1992 operation, has been selected as the preferred alternative. The basis for this selection is presented in Section 5.

3.4 ALTERNATIVES ADDRESSED THROUGH OTHER PROCESSES

A number of potential actions to improve migration conditions for anadromous fish were not evaluated in detail in this SEIS. Potential actions in this category include other types of flow improvement measures, modifications to the fish transportation program, structural changes to the mainstem projects, and nonproject measures beyond the jurisdiction of the three cooperating agencies. For a variety of reasons, these potential alternatives are beyond the scope of the SEIS. While these alternatives have not been given detailed consideration in this SEIS, they have not been eliminated from study altogether. As described in Section 1.5, alternatives in this category are generally being evaluated in some other study process being led by the Corps, one of the other cooperating agencies, or other responsible parties within the region. Brief summaries of alternatives considered to be beyond the scope of the SEIS are provided below.

3.4.1 Additional Reservoir Operation Alternatives

Reservoir drawdown strategies have been at the forefront of the regional deliberations over how to improve migration conditions for weak salmon stocks. In particular, the concept of drawing the lower Snake River reservoirs down to near spillway crest elevations to more nearly approximate natural flow velocities has received strong support from a number of concerned regional interests. The NPPC Phase II amendments call for implementation of this drawdown strategy by 1995, unless it proves to be biologically imprudent, structurally or economically infeasible, or otherwise inconsistent with the Northwest Power Act (NPPC, 1991).

The 1992 OA/EIS and the subsequent drawdown test established that implementing such drawdowns on the lower Snake would definitely be a lengthy process involving extensive study, planning, design, and construction to accomplish the major structural modifications that would be required for this action. The dams and fish passage facilities would need to be modified substantially to allow safe and efficient operation under these conditions. Irrigation pumping systems and other facilities dependent on the existing pool levels would also need to be reconfigured to avoid serious adverse impacts to water users. Consequently, this drawdown concept is a potential long-term alternative that is beyond the scope of the SEIS and must be covered in a separate study process (see Sections 1.5 and 3.4.4 for additional discussion).

Similarly, the 1992 OA/EIS indicated that without major structural modifications, operation of the lower Columbia River reservoirs to or near MOP levels would entail significant adverse impacts to resources and water users. Through the NPPC amendment process the region identified an interest in further investigating physical changes needed to allow operation of John Day to MOP. The Corps

is leading this investigation through a separate study process that will report results to the NPPC. This study is discussed in more detail in Section 1.5 and Appendix C. This is also a long-term action that is beyond the scope of the SEIS.

As part of the selected plan of operations for 1992, the Corps conducted a test drawdown of Lower Granite and Little Goose dams on the lower Snake River in March 1992. The test was intended to provide information on the physical effects of deep drawdowns on the project structures, the reservoir's physical environment, water velocity, and the level of dissolved gases in the water. The test went well, and provided sufficient information, indicating that another test to provide data on physical factors for Lower Granite will not be needed in 1993 or the near future. Therefore, another physical test has not been included among the SEIS alternatives.

As is evident from the public comments received on the draft SEIS, there is substantial uncertainty surrounding the flow/travel time/juvenile fish survival relationship based on the current biological data. As the region examines options to improve the migration conditions for the listed salmon stocks, there is a recognized need to reduce biological uncertainty.

Many test possibilities are currently being considered by the Corps, other agencies, and advisory groups as means to assist in evaluating reservoir drawdown from a biological perspective. These tests may provide a means to obtain additional information on the relationship between flow, travel time, and juvenile fish survival as well as other pertinent data that may assist in improving salmon survival.

Uncertainties and absence of biological information about the potential benefits and/or risks of the drawdown alternative are of considerable interest to the region and must be satisfactorily addressed before final decisions can be made on the potential use of drawdowns in the salmon recovery process. Consideration for any future reservoir drawdown tests will require NEPA documentation and ESA coordination. To accelerate the completion of a plan for biological testing, NMFS has requested to meet with the Corps to begin developing test protocols.

3.4.2 Upper Snake River Flows

The alternatives described in Section 3.2 include Snake River flow augmentation options that largely depend on additional releases from Dworshak Reservoir on the Clearwater River in Idaho. These would be supplemented with contributions from Brownlee Reservoir (up to 210 KAF) on the Snake River main stem and from unspecified sources in the upper Snake River Basin (0 to 427 KAF). This represents uncontracted water that the cooperating agencies would seek to purchase from water banks, which receive rights to water that is excess to the needs of various irrigation districts and is banked for later withdrawal. When such surplus water exists, it is generally stored in smaller reservoirs upstream from Brownlee.

The preferred plan for the 1992 OA/EIS did not include flow augmentation with uncontracted upper Snake River water, due to the uncertain availability of this water. However, the NPPC Phase II amendments recommended that a total of 190 KAF be acquired from the upper Snake, including uncontracted storage plus water to be obtained through water efficiency improvements and a variety of transactions. Similar provisions were included in the NMFS Biological Opinion and the cooperating agencies' Records of Decision on the 1992 operations plan. The BoR and various Idaho parties were able to obtain 90 KAF of additional water in 1992 to support flow augmentation actions. This provision has been included in most of the alternatives for the SEIS because the cooperating agencies will attempt to purchase water in compliance with the Biological Opinion.

Many parties in the Pacific Northwest have taken a strong interest in acquiring rights to additional Snake River Basin water that is currently allocated to irrigation or other purposes, and using this water to augment in-river flows for fish. The NPPC (1991) requested the BoR, BPA, and the States of Idaho, Oregon, and Washington form a committee to investigate and recommend options for obtaining at least 1 MAF of additional water from the Snake River Basin to aid spring and summer migrants. This would be accomplished through water efficiencies (conservation), market mechanisms, water transactions, and similar measures.

The BoR is cooperating with the States in a coordinated effort in response to this and related requests, such as Phase II amendments concerning the potential for new water storage in the Snake River Basin. This effort is necessarily a complex and lengthy process; completed studies and recommendations are expected by the end of 1993, although several more years would be required to implement recommended measures. In view of this schedule, the potential use of large volumes of upper Snake River water for flow augmentation is clearly a long-term alternative that is beyond the scope of the SEIS. However, this alternative is being pursued through other appropriate forums as discussed in Appendix C.

BPA will work with the BoR and States of Idaho and Oregon to secure up to 100,000 acre-feet in the upper Snake River for spring migrants through a program involving financial incentives, water marketing transactions, dry-year leasing, storage buy-backs, and other measures. Providing NMFS and BPA agree that the additional water can be acquired at prices comparable to those in 1991 and that the water can be delivered in a way to significantly benefit anadromous spring migrants, BPA will secure up to 50,000 acre-feet if it should become available. Under the NPPC Phase II amendments, IPC is required to shape 110 KAF from Brownlee under certain conditions. IPC is also required to annually report to the NPPC on their ability to shape all or a portion of an additional 190 KAF that may be made available through the efforts of BoR, BPA, and the States of Idaho and Oregon. BPA will work with IPC to explore means to shape this water for significant benefits to spring migrants. BPA will also continue to work towards providing an additional 1MAF during the migration season (May through September) as requested in the NPPC Phase II amendments.

3.4.3 Fish Transportation Program Alternatives

The Juvenile Fish Transportation Program operated by the Corps, in conjunction with a number of fisheries agencies, is not uniformly supported within the region. Some parties are skeptical of the benefits to fish that are reported from 20 years of research on the program. They feel that stress, exposure to disease, disorientation, and other aspects of the transportation experience are causing latent or hidden mortality that is contributing to the decline of the weak wild stocks. As a result, the Corps received input at the July 1992 public information meetings that the SEIS should consider major changes to the transportation program and related actions to help fish passage. Similar input has been received over the years from a variety of sources.

Specific alternative actions of this type that have been proposed include the following:

- Stop transporting fish under all conditions, relying on the existing fish bypass systems and spill provisions to provide in-river passage for all juvenile fish.

- Stop transporting fish under all conditions, using 100 percent spill during peak migration periods to bypass downstream migrants around the mainstem powerhouses.

- Bypass all fish back to the river, with no transportation, during peak migration times for wild fish.

- Reduce the flow level that triggers transportation (currently, Snake River fish are transported when flows at Lower Granite are below 100 kcfs, and are bypassed when flows are above that level).

The Corps and the cooperating agencies believe that the SEIS is not the appropriate vehicle for considering these types of actions. As described in Sections 2.2 and 3.2.1, fish passage actions are undertaken through an established annual planning process that is fully coordinated among the Corps, BPA, NMFS, and the State fisheries agencies and tribes. The cooperating agencies for this SEIS see no benefit to opening a duplicative process to cover fish transportation issues. Furthermore, the annual fish passage planning process is better able to adapt to specific river and project operating conditions that vary from year to year. Consequently, consideration of transportation alternatives will remain in that forum. Any future changes in the transportation program would likely reflect results from the extensive ongoing research program on the benefits of transportation.

3.4.4 Major Structural Measures

As indicated in Section 3.4.1, major structural modifications to the mainstem dams and appurtenant facilities are being evaluated through the SCS in response to the NPPC Phase II amendments. These strategies generally include drawing the lower Snake River reservoirs down to near spillway crest or natural river levels, alternatives to reservoir drawdown, and drawing John Day Reservoir (Lake Umatilla) down to MOP (elevation 257 feet) during the spring or spring and summer migrations. The structural measures that are being investigated or have been proposed in the recent past include the following:

- Modifying the juvenile fish bypass systems to allow effective operation over a wider range of reservoir elevations.
- Modifying adult fish ladder entrances and exits to allow effective operation over a wider range of reservoir elevations.
- Constructing an upstream collection facility and an open-channel flume or pipeline for juvenile fish to bypass all of the lower Snake and Columbia River dams.
- Removing turbines and generators to provide safer powerhouse passage for juvenile fish.
- Constructing new sluiceway bypass structures through existing dam embankments.
- Lowering spillway crest elevators to allow the spillways to pass low river flows at desired velocities under free-flow conditions.
- Modifying powerhouses or tailraces to provide acceptable tailwater conditions for operation at reduced reservoir elevations.
- Constructing new low-level outlets at the riverbed level to freely pass a portion of spring flows.
- Developing new facilities and equipment for enhanced operation of the juvenile fish transportation program.
- Relocating or reconstructing irrigation pumps and extending associated pipes to allow pumping from drawn down pools.
- Extending boat ramps and modifying other water-based recreation facilities to allow operation over a wider range of pool levels.
- Reinforcing embankments and other project structures to accommodate physical stresses associated with drawdown.

These structural alternatives are long-term actions that are being addressed through the SCS currently being conducted by the Corps (see Section 1.5 for a more complete discussion of the SCS). Because any major structural measures that prove to be feasible could not be implemented in the short or medium term, they are beyond the scope of the SEIS. However, they are receiving serious consideration from the Corps, the NPPC, and other parties.

3.4.5 Nonproject Measures

Regional deliberations over the status and recovery of salmon stocks have also identified many proposed measures that would not directly involve the Federal projects. Most of these concepts have been under consideration by fisheries managers for a decade or more, and many are in the process of implementation through the NPPC Fish and Wildlife Program amendments. Proposed measures in this category include the following:

- Improving streams and watersheds to restore salmonid spawning and rearing habitat.
- Screening irrigation and other water intake facilities that present migration hazards for salmonids.
- Implementing water conservation programs to reduce the amount of water diverted from streams for consumptive uses.
- Improving hatchery facilities and operations to increase survival of hatchery fish and reduce competition with wild fish.

- Implementing nonpoint source water quality controls to improve the quality of runoff entering streams.

- Restricting ocean and freshwater harvest of salmon to protect threatened stock that are intermingled with more healthy stocks.

- Banning high-seas driftnet fishing for squid, which poses risks to salmonids from incidental capture and provides opportunities for illegal harvest.

All of these measures appear to have some technical merit, and many or all might be required at some time if the region is to make significant progress toward restoring anadromous fish stocks. However, these measures are also outside the scope of this SEIS. BPA is supporting various hatchery and habitat measures through its funding of the Fish and Wildlife Program, while BoR is active in water conservation and screening diversions. The NPPC is addressing harvest, habitat, and hatchery measures in its amendment process, while NMFS is considering all factors affecting salmon in its recovery planning efforts. All of these actions are part of ongoing processes that predate this SEIS and need not be duplicated here. Based on these considerations of scope, authority, and separate programs, these nonproject measures have not been given detailed consideration in this SEIS.

3.5 SUMMARY OF RESERVOIR REGULATION CHANGES

The reservoir operation and flow augmentation actions identified in Section 3.2 are specified in terms of reservoir elevations and volume discharges. Implementing these actions would result in changes to reservoir elevations and outflows compared to existing conditions. While these changes might be considered impacts in the normal sense, in reality they are also characteristics of the proposed actions that provide the basis for the impact analyses presented in Section 4.0 of the SEIS. Consequently, the expected changes in reservoir conditions and river flows with the various alternatives are summarized below.

The various alternatives were modeled to determine potential impacts to reservoir levels, flows, and power generation. The simulation studies were done by the Corps using the Hydro System Seasonal Regulation (HYSSR) Model. This is a monthly hydroregulation model used to simulate the operation of the coordinated regional hydro system over a 50-year period of hydrologic record, spanning 1928 through 1978. Analysis throughout a long period of record reveals what might occur given the fact that the water conditions that will prevail at the initiation of such procedures are as yet unknown. Simulations performed thus reveal what would be expected under high, average, or low streamflow conditions. Similarly, the analysis provides an indication of the range of results that could be expected if a given option were implemented over an extended period.

One key assumption made in these studies was that there would be no degradation in flood protection. In all of the model studies, care was taken to ensure that reservoir levels never exceeded the flood control rule curves. Some of the options included the transfer of system flood control storage space from Dworshak and Brownlee to Grand Coulee. However, this shift was made in such a way that there was no reduction in local flood protection for Lewiston and the lower Clearwater, and sufficient additional space was provided at Grand Coulee to ensure that flood protection for Vancouver, Portland, and adjacent areas would not be diminished.

The Corps, BPA, BoR, and NMFS have implemented a process to monitor and evaluate the shaping of available water based on real time flow and fish migration information throughout the fish passage season. This process recognizes that flexibility is needed to optimize the release of available water to maximize the benefit to migrating wild Snake River stocks of sockeye, spring/summer chinook, and fall chinook salmon and should not be constrained by fixing flows on a predetermined schedule.

3.5.1 Mainstem Reservoir Elevations

Alternatives 2 through 5 all involve modest reductions below normal full pool elevations at the John Day and four lower Snake projects. The specified operating levels for the five reservoirs were previously indicated in Section 3.2. A comparative summary by project of the average normal and proposed reservoir elevations is found

in Table 3.5-1. The expected differences range from about 1 to 3 feet.

3.5.2 Mainstem Flows

The HYSSR simulation studies done for the five alternatives identify expected flows by month (or by a half-month period for April and August), given a set of runoff conditions and operating rules. These flow results are presented in Tables 3.5-2, 3.5-3 and 3.5-4 for Lower Granite, Priest Rapids, and The Dalles, respectively. The data in these tables are the median flows for each period over the 50 years of water record, indicating a 50-percent chance that these flows would be equaled or exceeded in a given year.

For example, the model results indicate that Alternative 2 would increase May flows by about 6 percent at Lower Granite and about 4 percent at The Dalles under typical water conditions. Average flows at Lower Granite would be nearly 25 percent higher during the first part of August. While the monthly average flow does not appear to be large for any given day in the month, augmented flows could be significantly higher than the average for the month. In reality, the water planned for flow augmentation can be shaped on a daily basis to provide the most effective increase to downstream flows coincident with the peaks of fish migration (for typical pattern, see Figure 3.5-1).

Flow augmentation can be particularly valuable in low flow years, if supplemental water is available for release. Table 3.5-5 is included to illustrate the potential effect in low flow conditions that could be expected approximately 1 in every 5 years. Using the 1972 to 1973 water year as an example of these conditions, in this case Alternative 2 would increase flows at Lower Granite by 31 percent in the last half of April, 4 percent in May, 8 percent in June, 7 percent in July, and 41 percent in August. It should be noted that the no action alternative already includes 600 KAF for flow augmentation from Dworshak. Comparison of similar data for the operation before the Water Budget would show an even greater effect of flow augmentation.

3.5.3 Storage Reservoir Elevations and Flows

Accompanying tables summarize the impact of each of the alternatives on drafting and refill at Dworshak, Grand Coulee, Libby, and Hungry Horse (reliable data for Brownlee were not available for the SEIS). Impact on reservoir elevation is described in terms of the median or 50-percent exceedence levels for the spring and summer. The 50-percent exceedance level is the median elevation from the 50-year simulation. For any given year, there is a 50-percent probability that this elevation will be equaled or exceeded at the end of a given month. Impact analyses presented in Section 4 also investigate low-frequency drafts that could occur under adverse water conditions. Impact on reservoir refill is expressed in terms of percent of years in which the reservoir fills to within 5 feet of full pool by the end of July. The results are discussed further, along with summary information on changes in flows, by project below.

Dworshak

Under the no action alternative, Dworshak would usually be at its maximum elevation in July, following the snowmelt runoff (Table 3.5-6). The objective is to maintain the reservoir at this elevation through Labor Day, although some drafting might be required for hydropower or to maintain minimum flows. After Labor Day, drafts are initiated for hydropower, with the additional objective of reaching a maximum elevation of 1558.0 by December 15 to provide required flood control space. On January 1, the first runoff forecasts become available and drafting continues, primarily for power generation, with reservoir elevations being constrained on the high side by the mandatory rule curve (MRC) and on the low side by a rule curve designed to ensure an acceptable refill probability. Drafting below the refill curve would occur only to meet FELCC and to maintain minimum downstream flow requirements. Further adjustments are made to this operation as new runoff forecasts become available. The reservoir reaches its low point in mid-April.

Between mid-April and July, the reservoir is allowed to refill with snowmelt runoff, with a gradually diminishing amount of space being

Table 3.5-1. Summary of mainstem reservoir operating ranges and average elevations.

Project	Normal Operating Range	Proposed Operating Range[a/]	Normal Average Elevation	Alternative 2 Average Elevation	Change in Average Elevation
Lower Columbia					
John Day[b/]	262-268[b/]	262.5 to 264	265.2	263.0	-2.2
Lower Snake					
Ice Harbor	437-440	437-438	438.5	437.5	-1.0
Lower Monumental	537-540	537-538	538.7	537.5	-1.2
Little Goose	633-638	633-634	636.2	633.5	-2.7
Lower Granite	733-738	733-734	735.1	733.5	-1.6

Source: Corps, 1988a-d, 1968

a/ Figures indicated are for respective periods of proposed action, which is May 1 through August 31 at John Day and April 1 through July 31 for the lower Snake River projects. Average elevations are based on historical records for 1980 to 1991.

b/ Normal operating ranges at John Day vary from season to season. They are typically from 262 to 265 feet from March 1 to May 15, 260 to 265 May 15 to June 1, and 265 to 268 from July 1 through September, with June as a transitional month.

Table 3.5-2. Median monthly flows at Lower Granite by alternative.

	Flows (kcfs)[a/]				
Alternative	April 16-30	May	June	July	August 1-15
1. No Action	82.1	94.6	91.9	37.4	22.0
2. 1992 Operations	83.8	100.0	91.3	38.0	27.4
3. 1992 Operations, LIB/HGH Sensitivity	83.8	100.0	91.3	38.0	27.4
4. Modified 1992 Operations	85.3	100.0	91.3	39.7	29.0
5. Modified 1992 Operations, Upper Snake Sensitivity	84.9	99.9	91.3	39.5	24.1

a/ Based on 50 years of operation simulated with HYSSR Model.

Table 3.5-3. Median monthly flows at Priest Rapids by alternative.

Alternative	Flows (kcfs)[a/]				
	April 16-30	May	June	July	August 1-15
1. No Action	140.8	164.8	153.7	153.8	107.3
2. 1992 Operations	147.4	167.5	155.1	153.8	107.3
3. 1992 Operations, LIB/HGH Sensitivity	146.7	167.1	159.9	156.7	107.3
4. Modified 1992 Operations	147.4	167.5	155.1	153.8	107.3
5. Modified 1992 Operations, Upper Snake Sensitivity	147.4	167.5	155.1	153.8	107.3

a/ Based on 50 years of operation simulated with HYSSR Model.

Table 3.5-4. Median monthly flows at The Dalles by alternative.

Alternative	Flows (kcfs)[a/]				
	April 16-30	May	June	July	August 1-15
1. No Action	243.6	264.8	260.4	203.5	144.3
2. 1992 Operations	250.3	275.0	259.3	204.9	147.3
3. 1992 Operations, LIB/HGH Sensitivity	250.8	274.9	262.6	205.4	147.3
4. Modified 1992 Operations	250.3	275.0	259.2	206.5	149.0
5. Modified 1992 Operations, Upper Snake Sensitivity	250.3	275.0	259.2	206.1	144.0

a/ Based on 50 years of operation simulated with HYSSR Model.

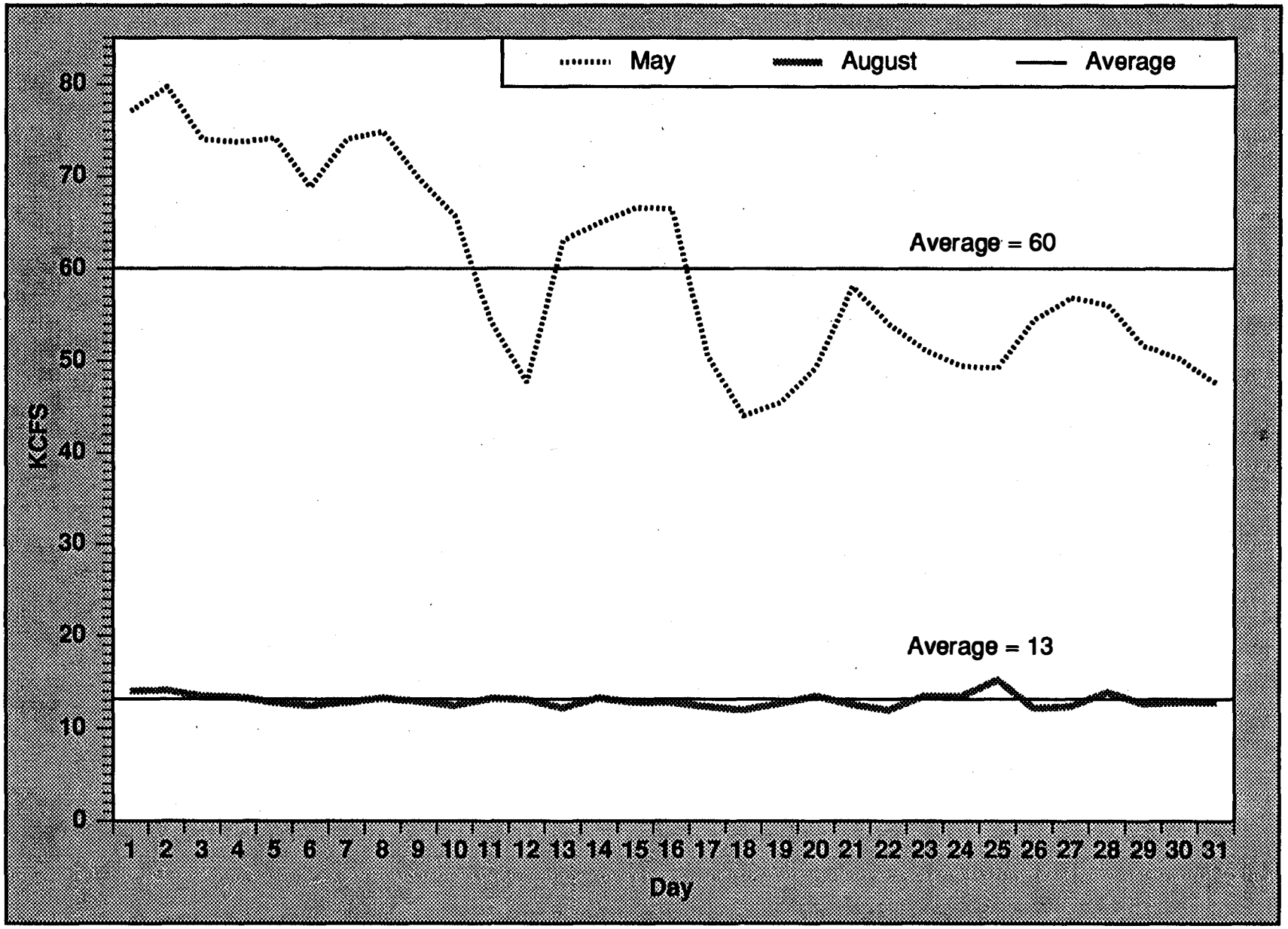


Figure 3.5-1. Daily versus average monthly flows at Lower Granite for May and August 1992 (source: Corps, 1992c).

Table 3.5-5. Monthly flows at Lower Granite in a relatively low flow year by alternative.

Alternative	Flows (kcfs)[a/]				
	April 16-30	May	June	July	August 1-15
1. No Action	37.4	82.8	49.8	24.7	15.5
2. 1992 Operations	49.0	85.8	53.8	26.5	21.9
3. 1992 Operations, LIB/HGH Sensitivity	49.0	85.8	53.8	26.5	21.9
4. Modified 1992 Operations	49.0	85.8	53.8	28.1	23.5
5. Modified 1992 Operations, Upper Snake Sensitivity	47.3	85.0	52.3	27.7	18.5

a/ Based on 50 years of operation simulated with HYSSR Model. Flows indicated are average flows for period in 1972 to 1973 water year, representing low flow conditions with a 20 percent probability of occurring in any given year.

Table 3.5-6. Dworshak Reservoir elevations and refill probabilities by alternative.

Alternative	Median End-of-Month Elevation[a/]							Chance of Refill at End of July[b/] (%)
	April	May	June	July	Aug.	Sept.	Dec.	
1. No Action	1510.9	1565.3	1598.5	1600.0	1600.0	1575.0	1554.4	74
2. 1992 Operations	1511.0	1560.4	1591.0	1596.7	1589.2	1577.7	1558.2	52
3. 1992 Operations, LIB/HGH Sensitivity	1511.0	1560.4	1591.0	1596.7	1589.2	1577.7	1558.2	52
4. Modified 1992 Operations	1516.2	1560.4	1591.2	1591.3	1577.6	1577.9	1558.2	32
5. Modified 1992 Operations, Upper Snake Sensitivity	1516.2	1560.4	1591.2	1591.3	1577.6	1577.9	1558.2	32

a/ Based on 50 years of operation simulated with HYSSR Model.
b/ Maximum pool at elevation 1600, with refill credited at elevation 1595 or above.

provided for flood control and with releases being made for power generation. Storage requirements for local and system flood control combined range from 50 to 2,016 KAF (the total active storage capacity of the reservoir), and average nearly 1,360 KAF over the 50-year period of record. Up to 600 KAF of Water Budget releases are made during May to help meet an 85-kcfs flow target at Lower Granite, to increase river velocity during the peak downstream migration period.

The flow augmentation actions for Alternatives 2 through 5 would be implemented according to specific guidelines that are somewhat more detailed than the presentation in Section 3.2. With the exception of the timing of summer releases and the criteria for flood control shift at Dworshak for Alternatives 4 and 5, these guidelines are the same for all four action alternatives. Based on the Record of Decision for the 1992 operations, these flow augmentation guidelines are as follows:

- Release water from Dworshak to provide flow augmentation in the lower Snake River between April 15 and June 15 based on the following rules: If the Snake River Basin runoff for April to July measured at Lower Granite is forecasted to be 16 MAF or less, Dworshak will provide 1,000 KAF of water budget, plus any flood control shift, plus minimum flow releases (estimated to be 148 KAF). When the Snake River Basin forecast is greater than 16 MAF, a minimum of 900 KAF will be available for flow augmentation subject to the following conditions:

  1) When inflow forecasts and storage conditions at Dworshak result in greater than 70 percent confidence of refill, increase the flow augmentation volume above 900 KAF so that the confidence of refill is equal to 70 percent.

  2) When flows at Lower Granite are greater than 100 kcfs without the Dworshak releases, reduce the flow augmentation volume.

- Shift flood control from Dworshak to Grand Coulee when the forecast for April-to-July inflow to Dworshak is less than 2.6 MAF. The amount of shift in any given year depends on the runoff forecasts, the flood control rule curves, and current storage conditions. With respect to timing, the shift will not extend past April 30.

- Release 400 KAF from Dworshak and the upper Snake River Basin, above a base discharge of 1.2 kcfs from Dworshak, to augment flows from June 16 to August 31.

- Release up to 200 KAF from Dworshak after Labor Day in September above a base discharge of 1.2 kcfs.

- Meet the flow augmentation goals for the lower Snake River, to the extent possible, without drafting Dworshak below a point that would affect available storage necessary for flow augmentation in the following year.

The amount of system flood control space at Dworshak that could potentially be shifted to Grand Coulee under these operating rules ranges from 10 to 681 KAF over the 50-year simulation period, and averages 284 KAF per year. Total April-to-July runoff to Dworshak is less than 2.6 MAF in 18 of the 50 years. Accounting for the availability of space at Grand Coulee, the volume transferred in these 18 years would range from 45 to 374 KAF and would average 161 KAF.

With Alternative 4, the runoff forecast trigger for Dworshak is increased from 2.6 MAF to 3.0 MAF. Total April-to-July runoff is 3.0 MAF or less in 27 of the 50 simulation years. Therefore, Alternative 4 would involve a flood control shift in 9 additional years (out of 50) compared to Alternative 2. The volume transferred with Alternative 4 would average 260 KAF, and would range from 45 to 681 KAF.

Median end-of-month elevations at Dworshak would be similar with Alternatives 2 through 5 (see Table 3.5-6). Elevations would tend to be slightly higher than for Alternative 1 in April and somewhat lower from May through August. The differences in these months range from about 5 feet in May to 11 feet in August for Alternatives 2 and 3. Median conditions for Alternatives 4 and 5 represent larger decreases, compared to

Alternative 1, of 9 feet in July and 22 feet in August. Refill probabilities are significantly lower for the action alternatives, at 52 percent for Alternatives 2 and 3 and 32 percent for Alternatives 4 and 5.

Flow changes at Dworshak with the various alternatives would primarily occur in the April-September period. Average discharges for the second half of April are about 8.8 kcfs currently (Alternative 1) and would increase to 11.8 kcfs with Alternative 2 or 12.2 kcfs with Alternative 4. Alternatives 2 and 4 would result in similar proportional increases in discharge in May and slightly lower releases in June. Average flows for July are about 3.1 kcfs for Alternative 1, 3.6 kcfs for Alternative 2, and 5.0 kcfs for Alternative 4. Respective figures for August are 2.3, 3.4, and 5.0 kcfs. Normal September releases are a relatively high 7.9 kcfs with Alternative 1, dropping to 4.6 kcfs for Alternative 2 and 1.3 kcfs for Alternative 3. Considerable variation around these monthly averages would occur from year to year. (Average flows for Alternatives 3 and 5 would correspond to those for Alternatives 2 and 4, and have been omitted from the above discussion for simplicity).

Brownlee

Operations under the no action alternative call for drafting to elevation 2034 by March 1 of each year to provide 500 KAF for flood control, except in drier years when the flood control requirement is determined by basin conditions. Wet years can result in the requirement to draw down the reservoir for flood control below elevation 2034 and possibly even empty the reservoir to elevation 1976 by April 1. An attempt is made to fill the reservoir by July 1, while meeting a Water Budget requirement of 110 KAF in May. Full pool is reached in about 90 percent of the years.

Under Alternatives 2 through 5, a 137 KAF draft is provided in July to benefit juvenile fall chinook migrants, and an additional 100 KAF flow augmentation draft is made in September for water temperature control per the NPPC amendments. The 137 KAF July release is to be replaced with water acquired from the upper Snake River. In addition, a maximum discharge of 9 kcfs is maintained in November for fall chinook spawning, and stable minimum flows above that level are maintained from December through May to aid in incubation and emergence.

For Alternatives 2, 3, and 4, an additional 190 KAF is discharged in the spring/summer juvenile migration period for flow augmentation, again as requested in the NPPC amendments. This water is available for release from Brownlee during April 15 to June 15 and replaced with upper Snake reservoir releases during the winter. The cumulative effect of these changes for Alternatives 2, 3, and 4 is a somewhat lower probability of refill by July 1 and lower reservoir elevations throughout the summer and fall due to the July and September drafts.

Alternative 5 is similar except that the 427 KAF upper Snake flow augmentation releases during the spring, summer, and fall are deleted.

Grand Coulee

Operations under the no action alternative result in drafting from January through June for flood control purposes and to provide power during the peak seasonal demand period. The greatest drafts usually occurred in April, while the highest reservoir elevations normally occurred from July through December. The spring draft typically reduces the reservoir storage by approximately 55 percent. The SEIS modeling studies included firm requirements that Grand Coulee's pool elevation remain above 1,220.2 feet at all times and reach 1,240 feet by May 31 (Table 3.5-7). Drafts below 1,220.2 feet interrupt crucial ferry service across Lake Roosevelt and adversely affect the ability of the project to meet power emergencies and water supply requirements. The BoR operates Lake Roosevelt to be at or above elevation 1240 by May 31 to meet pumping requirements for irrigation water supplies.

Under Alternatives 2, 4, and 5, water from Grand Coulee, Arrow, and/or Libby would be released to augment lower Columbia River flows from May 1 to June 30, based on the following rules: If the forecasted January through July runoff measured at The Dalles is estimated to be 80 MAF or less, up to 6.45 MAF would be available for release. If the forecasted runoff is between 80 MAF and 90 MAF, the amount of water available for release would vary from 6.45 to 3.45 MAF, respectively. If the

Table 3.5-7. Grand Coulee (Lake Roosevelt) elevations and refill probabilities by alternative.

Alternative	Median End-of-Month Elevation[a/]							Chance of Refill at End of July[b/] (%)
	April	May	June	July	Aug.	Sept.	Dec.	
1. No Action	1234.4	1254.6	1290.0	1290.0	1290.0	1288.1	1287.4	100
2. 1992 Operations	1233.6	1253.7	1288.5	1290.0	1289.9	1288.0	1286.3	96
3. 1992 Operations, LIB/HGH Sensitivity	1233.6	1254.1	1288.5	1289.9	1289.9	1288.0	1286.3	96
4. Modified 1992 Operations	1233.6	1253.7	1288.5	1290.0	1289.9	1288.0	1286.3	96
5. Modified 1992 Operations, Upper Snake Sensitivity	1233.6	1253.7	1288.5	1290.0	1289.9	1288.0	1286.3	96

a/ Based on 50 years of operation simulated with HYSSR Model.

b/ Maximum pool at elevation 1290 with refill credited at elevation 1285 or above.

forecasted runoff is 90 MAF or more, 3.45 MAF is available for release.

All of the alternatives considered in this document affect water surface elevations in Lake Roosevelt similarly in that each is designed to provide higher flows downstream in low-to-moderate water years. During those water conditions, the drawdowns are generally controlled by the need to generate electricity and not by the need to evacuate a large flood control space. In greater-than-moderate water years, the system flood control space shift from the Snake River reservoirs and the 3 MAF lower Columbia flow augmentation are not implemented.

During the low-to-moderate water years, the intent of the alternatives is to shift system flood control from Dworshak and/or Brownlee to Grand Coulee. The effect is to draft Lake Roosevelt more than if it were drafted only for Grand Coulee's share of system flood control. However, this only occurs in low-to-moderate water years (18 of 50 years for Alternative 2) where the maximum draft is controlled by power generation. Seldom does the flood control shift exceed the power draft. The result is that the additional draft for the flood control shift has almost no effect on timing and depth of draft. Alternatives 4 and 5 involve a greater shift and potentially draft Lake Roosevelt during certain moderate water years deeper than the power draft in March and early April. The flood control shift will not extend beyond April 30, so the elevation of Lake Roosevelt will not be affected by any shifting after May 1.

The flood control shift is not the only action that has an effect on water surface elevations. The

storage of up to 3 MAF in Lake Roosevelt from January to April for subsequent flow augmentation tends to increase reservoir elevations during this time frame. However, this water is to be released during the May to June time frame in an attempt to increase flows in the lower Columbia River. The operation of Grand Coulee for lower Columbia flow augmentation would vary depending on the volume of water provided in a particular year as well as the method used to provide it. If water were provided by Grand Coulee alone, it would result in higher elevations than the no action alternative in January to April when water is stored than if it were provided by Grand Coulee in conjunction with Arrow and/or Libby. There could also be larger drafts in May and June on a short-term basis as water is released. Conversely, if Grand Coulee were used with Arrow and/or Libby, it would still result in higher elevations in January to April than the no action alternative, but elevations would tend to be lower than if the project were used alone. If Arrow is used in conjunction with Grand Coulee for flow augmentation, stored water can usually be released into Grand Coulee and passed through the project with no major draft occurring. However, if Libby is used to provide water for flow augmentation, the water released from the project cannot always be passed as readily from Libby into Grand Coulee for release into the lower Columbia River. This is because of restrictions at Kootenai Lake, which is located between the two projects. These restrictions are in the form of an International Joint Commission rule curve which limits lake elevations as well as a natural constriction in a narrow area of the lake which may limit the amount of water that can pass under certain conditions. The effect of these restrictions can be to delay the transfer of water from Libby into Grand Coulee. As a result, in some cases when Grand Coulee and Libby are used for flow augmentation, larger drafts from Grand Coulee may be needed on a short-term basis to provide water needed for flow augmentation in the lower Columbia River. In these situations, drafts would be refilled by water released from Libby as it was passed through Kootenai Lake.

Based on HYSSR Model runs, end-of-month water surface elevations in Lake Roosevelt average virtually the same for Alternatives 2 through 5 as compared to the no action alternative during all months, even May and June, for the 50 water years modeled. Again, runoff, power generation needs, irrigation needs, and fish passage all affect the water surface elevation during the May-to-June time frame. Any particular year might be significantly different from the years modeled for impact analysis for these reasons. In addition, because the record of river flow conditions is very short, historically speaking, impact analysis based on magnitude of flows, timing of runoff, and the chronological sequence of flows from one year to the next is not very precise.

Alternatives 4 and 5 tend to shift system flood control during more of the moderate-range water years. These are generally the water years when little additional water is stored in Lake Roosevelt for flow augmentation and drafts for power generation and flood control are deeper than low-to-moderate years. This operation tends to mimic to some extent the operation that would occur in good water years (i.e., potentially deep drafts for power generation and flood control).

Flow changes at Grand Coulee that would result from the proposed action would primarily occur as somewhat decreased flows in winter and increased flows in May and June. For example, average January flows are about 103.6 kcfs with Alternative 1 and 99.4 kcfs with Alternatives 2 through 5. In June, a key flow augmentation period, discharges would average 138.8 kcfs with Alternatives 2 through 5 versus 129.7 kcfs for Alternative 1. These differences in flows are averaged over all 50 years, whereas the Columbia River flow augmentation would actually occur in about 20 of those years. Consequently, the changes in flows during those 20 years would be higher than the above averages by a factor of about 2.5.

Libby

In the analysis presented in the draft SEIS, the no action alternative would also apply to Alternatives 2, 4, and 5, because Libby would be operated exactly the same. Under Alternative 3, however, the Libby operation was allowed to respond to the additional flow augmentation measures proposed for the Snake and Columbia rivers. Specifically, additional drafts were permitted to help make up the power losses resulting from the flow augmentation measures included in Alternative 2. As described in Section 3.2.3, however, these original provisions for Libby operations would not

apply in all years. Because storage space at Arrow in Canada might not be available for flow augmentation, storage space at Libby would need to be used in some years to help implement the Columbia River 3 MAF flow augmentation action. This could occur in all years in which Grand Coulee alone, or Grand Coulee and Arrow, could not provide the required storage. Depending upon the storage arrangements between Libby, Arrow, and Grand Coulee, Libby could be used for storage in all but one of the 20 years in which augmentation flows are necessary.

This reactive change in the flow augmentation plan occurred shortly before the final SEIS went to print, which did not allow time to revise and reanalyze all of the HYSSR runs for Alternatives 2, 4, and 5. Instead, resulting flows and elevations for Libby were estimated from close inspection of the existing model results for the other projects involved in the flow augmentation operation, and from calculations of the storage space likely to be available at Libby in any given year.

In years falling below the 80/90 MAF runoff forecast trigger, space at Libby would be desired to store water for flow augmentation when adequate space was not available at Grand Coulee and Arrow. This would be possible in approximately 20 of the 50 simulation years, although in some years the space available would be less than needed to meet the flow augmentation target in conjunction with Grand Coulee and/or Arrow. Of the 20 simulation years in which storage for flow augmentation is required at Grand Coulee, Arrow and/or Libby, there are about 16 years in which Libby can provide some storage space. In the remaining 4 years, flood control requirements prevent the use of Libby for storing water for flow augmentation during the January to April period.

The effect of this operation at Libby would be higher reservoir elevations and lower releases during the period from January through April when water is stored, and higher releases during the flow augmentation period from May to June as stored water is released. Because of the restrictions which can occur under certain conditions at Kootenai Lake, releases from Libby for flow augmentation can be delayed before reaching Grand Coulee for release into the lower Columbia River. Releasing water for flow augmentation from Libby as early as April to account for delays which may occur in passing water through Kootenai Lake would have less of an effect on Grand Coulee elevation than if water were released from Libby in late May and June.

It is estimated that end-of-month elevations at Libby would average approximately 20 feet higher, and range up to 90 feet higher, than comparable figures for Alternative 1 in those years when Libby would be needed for flow augmentation. The maximum differences in elevation would generally occur at the end of April, and would exceed 30 feet in 9 years out of 50. Reservoir elevations with Alternatives 2, 4, and 5 would be the same as for Alternative 1 in those years when Libby was not needed or available for flow augmentation (3 years out of 5). In the remaining years, elevation changes would generally be confined to the January-June period of active flow augmentation operations. Winter drafts would be reduced compared to normal operations, and this elevation differential would gradually be eliminated in May and June as the stored water was released. On average, the reservoir elevation would be at the normal level by the end of June.

Monthly releases would also be approximately 5 kcfs lower in some cases through this same period. During May and June when stored water is released for flow augmentation, monthly releases would average approximately 3 kcfs higher and range up to 25 kcfs. Flows currently average about 14 to 18 kcfs in January and February, 7 kcfs in March, and 4 to 6 kcfs from April to June.

The hydroregulation model results for Alternative 3 have been updated for the final SEIS, following correction of some minor problems in the original HYSSR run. The revised elevation results are included in Table 3.5-8. These figures indicate that the median elevations at Libby would be about 10 feet lower (compared to Alternative 1) in April, 4 feet lower in May, 3 feet lower in June, and essentially the same for the remainder of the summer. Differences would be considerably greater than with the median conditions in some months of some water years. July elevations for Alternative 3 are lower than with Alternative 1 in 10 years of the 50 simulated, by from 9 to 33 feet, and are higher (by 18 feet) in one case. The refill probability drops to 78 percent with Alternative 3.

Table 3.5-8. Libby Reservoir elevations and refill probabilities by alternative.

Alternative	Median End-of-Month Elevation[a/]							Chance of Refill at End of July[b/] (%)
	April	May	June	July	Aug.	Sept.	Dec.	
1. No Action	2335.5	2388.5	2452.8	2459.0	2459.0	2450.0	2411.0	
2. 1992 Operations	2335.5	2388.5	2450.8	2459.0	2459.0	2450.0	2411.0	
3. 1992 Operations, LIB/HGH Sensitivity	2332.9	2389.1	2450.1	2459.0	2459.0	2450.3	2411.0	
4. Modified 1992 Operations	2335.5	2388.5	2450.8	2459.0	2459.0	2450.0	2411.0	
5. Modified 1992 Operations, Upper Snake Sensitivity	2335.5	2388.5	2450.8	2459.0	2459.0	2450.0	2411.0	

a/ Based on 50 years of operation simulated with HYSSR Model.
b/ Maximum pool at elevation 3560, with refill credited at elevation 3555 or above.

Differences between Alternatives 1 and 3 in average monthly discharges from Libby are small, generally in the range of 0.2 to 0.4 kcfs. However, there are much more significant simulated changes for some water years. For example, average flows for April 1929 are about 4 kcfs with Alternative 1 and 12 kcfs for Alternative 3. Conversely, July 1939 flows are much higher for Alternative 1 (12.6 kcfs to 4 kcfs). These types of large differences are exceptions.

Hungry Horse

The no action operation would also apply to Alternatives 2, 4, and 5 because Hungry Horse would be operated exactly the same (see Table 3.5-9). Under Alternative 3, however, the Hungry Horse operation is allowed to respond to the additional flow augmentation measures proposed for the Snake and Columbia rivers. Specifically, additional drafts are permitted to help make up the power losses resulting from the flow augmentation measures included in Alternative 2.

In Alternatives 1 and 2, Hungry Horse Reservoir refills (within 5 feet) in 78 percent of the years modeled (i.e., about 4 out of 5 years). Alternative 3 decreases the number of years refilled to 7 out of 10 years, or 70 percent of the time. The median water surface elevations are approximately 13 feet higher in April and May, 8 feet higher in June, the same in July and August, and 1 to 3 feet lower for the remainder of the year. (These results are also derived from a revised HYSSR run, as reported previously for Libby in Alternative 3.)

Elevations would be considerably different from the median conditions in selected years. Hungry Horse refills to elevation 3,560 feet at the end of July in both Alternatives 1 and 3 in 35 of the 50 simulation years. In one year (1932) the reservoir is 3 feet higher with Alternative 3 compared to Alternative 1. In the remaining 14 years Alternative 3 results in lower July elevations, by margins ranging from 8 to 66 feet. On average, July elevations with Alternative 3 are about 29 feet lower in these years. Consequently, the operation represented by Alternative 3 (allowing Hungry Horse to respond to generation changes elsewhere in the system) would result in significantly lower summer reservoir elevations in about 1 out of every 3 to 4 years.

Average monthly flows from Hungry Horse with Alternative 3 vary considerably from Alternative 1 results in some cases. For example, average flows for June are about 2.8 kcfs with Alternative 1 and

Table 3.5-9. Hungry Horse Reservoir elevations and refill probabilities by alternative.

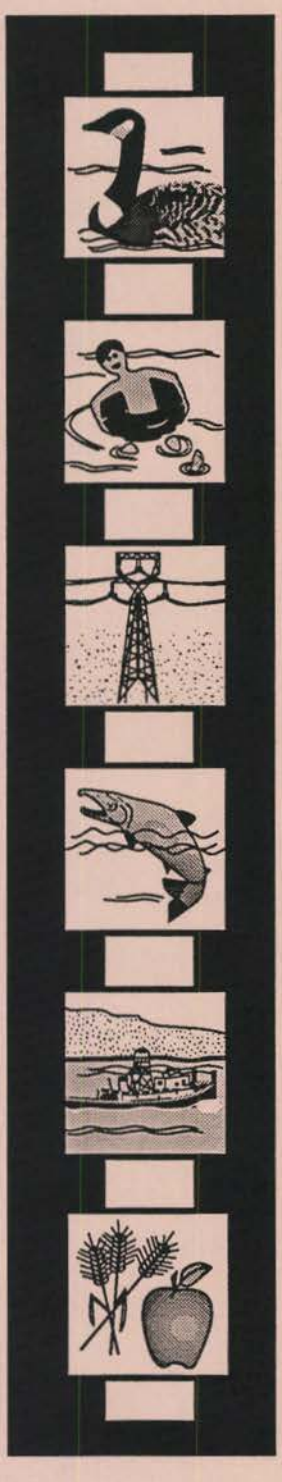
Alternative	Median End-of-Month Elevation[a/]							Chance of Refill at End of July[b/] (%)
	April	May	June	July	Aug.	Sept.	Dec.	
1. No Action	3485.4	3519.7	3552.1	3560.0	3560.0	3541.8	3532.0	78
2. 1992 Operations	3485.4	3519.7	3552.1	3560.0	3560.0	3541.8	3532.0	78
3. 1992 Operations, LIB/HGH Sensitivity	3498.0	3532.9	3560.0	3560.0	3560.0	3538.5	3530.5	70
4. Modified 1992 Operations	3485.4	3519.7	3552.1	3560.0	3560.0	3541.8	3532.0	78
5. Modified 1992 Operations, Upper Snake Sensitivity	3485.4	3519.7	3552.1	3560.0	3560.0	3541.8	3532.0	78

a/ Based on 50 years of operation simulated with HYSSR Model.
b/ Maximum pool at elevation 3560, with refill credited at elevation 3555 or above.

5.8 kcfs with Alternative 3. Hungry Horse average flows with Alternative 3 are also substantially higher for July (3.3 kcfs to 1.7 kcfs), but are lower by about 0.7 to 1.7 kcfs from January through April. Differences are significantly greater in individual water years, such as March 1929 flows of 2.7 kcfs with Alternative 1 and 10.1 kcfs with Alternative 3.

4.0

Environmental Effects of Alternatives



4.0 ENVIRONMENTAL EFFECTS OF ALTERNATIVES

This section presents the anticipated effects on the physical, biological, social, and economic environments associated with the implementation of the alternatives outlined in Section 3. It provides the scientific and analytic basis for the comparison of alternatives presented in Section 5.

Section 4 details the effects of the alternatives by the same resource areas used in Section 2 (i.e., water quality, anadromous fish, resident fish, etc.). As previously noted, actions considered in the SEIS involve some combination of measures similar to those analyzed in 1992 OA/EIS. Because this SEIS is tiered to the 1992 OA/EIS, only the effects of actions not previously analyzed and new information bearing on the previous analysis are discussed in detail in this section. Effects discussed in the earlier document that are relevant to this analysis are summarized.

Impacts in most of the resource areas discussed are directly or indirectly based on an analysis of computer models that simulate conditions depicted in the alternatives:

- The HYSSR Model was used to simulate operation of the coordinated Columbia River System over 50 years of water records, using current operating plans and the proposed alternative plans, and
- Juvenile fish passage and salmon life-cycle models were used to estimate the effects of the five alternatives and ongoing and future actions on Snake River Basin salmon stocks.

With regard to juvenile salmon, the 1992 OA/EIS analyzed alternatives on the basis of their effect on water particle travel time. This turned out to be a complex analysis requiring translation of water particle travel time to smolt travel time and ultimately to smolt survival. To avoid this complexity, the cooperating agencies agreed at the outset of the SEIS to present the effects on salmon on the basis of model analysis of fish survival. Models were used that consider many aspects of the hydropower system that affect anadromous fish, including the life-cycle models that estimate benefits ranging from downstream smolts survival to returning adults.

As with the 1992 OA/EIS, summary tables are provided at the beginning of each resource area identifying the significant impacts of each alternative. This provides a ready tool for quick comparison of alternatives.

4 Environmental Effects of Alternatives

4.1 Water Quality

Alternative	Potential Impacts (Positive/Adverse)
1. Without-Project Conditions (No Action)	• Continued high total dissolved gas levels during spring and summer fish spill periods. • Insignificant changes in temperatures, turbidity, and other parameters.
2. 1992 Operations	
Lower Snake/Columbia, Grand Coulee, Libby	• Insignificant changes in gas saturation levels (continued high total dissolved gas during spring spills), temperatures, turbidity, and other parameters. • No cumulative impacts because of daily and seasonal variations.
Dworshak	• Water temperatures expected to decrease below Dworshak Dam, particularly in Clearwater and lower Snake rivers above Lower Granite, with larger reductions occurring from greater flow releases. • Slight potential elevation of gas levels in mainstem Snake River below dams. • Greater difference in thermal profiles, at least at Lower Granite, with significant Dworshak releases.
Brownlee	• Chemical water quality and temperature of lower Snake potentially degraded by flow augmentation from Brownlee.
3. 1992 Operations with Libby/ Hungry Horse Sensitivity	• Same as Alternative 2. • Potentially lower temperatures in reaches of the Kootenai and Flathead rivers in low-water years.
4. Modified 1992 Operations	• Same as Alternative 2.
5. Modified 1992 Operations with Upper Snake Sensitivity	• Same as Alternative 2.

4.1.1 Gas Saturation

Supersaturation of dissolved atmospheric gases is an important water quality issue in the vicinity of the stilling basins and downstream when water is discharged over the spillways of the dams. Levels in excess of 135 percent have been reported previously for several locations along the Columbia River (Table 4.1-1 in the 1992 OA/EIS), which are above the States' standard of 110 percent maximum saturation. Water passed through the turbines does not increase dissolved gas saturation to an appreciable degree.

In the no action alternative, gas saturation levels would be consistent with background levels. During 1984, 1985, and 1986, the maximum concentration of total dissolved gases ranged from 113 to 139 percent for 12 stations on the Columbia River, all of which exceed the standard of 110 percent (CRWMG, 1986). In 1990, typical background levels ranged from 100 to 123 percent in the lower Columbia (Corps et al., 1992). As indicated in the 1992 OA/EIS and the March 1992 Lower Granite/Little Goose physical test drawdown, it appears that supersaturation levels are strongly and directly correlated with the amount of the spill (i.e., the flow over the spillway) (Wik et al., 1992). Also, variations associated with the elevation changes of the reservoir and stilling basin appear to be of secondary importance.

The HYSSR Model was used to simulate operation of the Columbia River System over 50 years of water records, using current operating plans and the proposed alternative plans. Based on model results currently available, average spills from Alternatives 2, 3, 4, and 5 were not significantly larger than spills in Alternative 1 (Table 4.1-1). Slightly higher spills were predicted at Dworshak, which could result in higher gas saturation levels. The magnitude of this effect is difficult to predict. Thus, based on the model hydroregulation results for spill, it is not expected that the SEIS alternatives would raise the gas saturation levels significantly over background supersaturation levels already observed. In addition, the months of maximum spill volumes, generally April through June, were not significantly different among the alternatives.

Flow augmentation from Grand Coulee is not expected to change gas saturation effects from those existing under a present peak flow discharge, perhaps as high as 120 percent saturation (Corps et al., 1992). The model results indicate no spill at Grand Coulee under all alternatives. Flow augmentation support from Libby under Alternative 3 is not anticipated to impact gas saturation because virtually all releases would be through the turbines, rather than the spillway.

4.1.2 Temperature

River operation changes associated with lower reservoir elevation or flow augmentation could increase or decrease water temperature downstream. Increased temperatures could result in a thermal blockage of salmonid migration at the Snake/Columbia confluence. Significant cold water releases from Dworshak through the Clearwater River might reduce the existing problem in some years (Corps et al., 1992). Thus, not all thermal effects are perceived as adverse to the aquatic biota. Thermal impacts were extensively discussed in the 1992 OA/EIS, and are expected to be the same for the corresponding proposed alternatives. Because of the diurnal and seasonal cycling of temperature, thermal changes would generally not be cumulative.

Flow augmentation from upstream storage or drawdown at John Day was projected to have minor effects on daily mean temperature values, but daily temperature ranges were expected to be wider, approaching the recorded extremes. Results from the 1992 operations monitoring in part confirmed this projection. Some of the temperature extremes are greater than the previous maxima and minima shown in Figure 4.1-6 in the 1992 OA/EIS. However, data are insufficient to determine if the larger extremes are attributable solely to the lower pool levels or other factors such as the low flow drought conditions.

Significant changes in operations at Hungry Horse or Libby dams under Alternative 3 have the potential to alter the downstream temperature regimes. Cold-water releases could slightly drop temperatures in the Kootenai and Flathead River Systems, depending on discharge volumes. Based on the analysis of the historical flow record, this could occur on average once every 5 years in May

Table 4.1-1. HYSSR modeling output for highest monthly and average yearly spill (MW) under Alternatives 1, 2, 3, 4, and 5.

Location	Highest and Average Spill, MW (Alt. 1)[a/]	Highest and Average Spill, MW (Alt. 2)[a/]	Highest and Average Spill, MW (Alt. 3)	Highest and Average Spill, MW (Alt. 4)	Highest and Average Spill, MW (Alt. 5)	Month(s) of highest spill
Libby	12,2	12,2	12,2	12,2	12,2	January (May-June for Alternative 3)
Grand Coulee	0,0	0,0	0,0	0,0	0,0	No Spill
Hungry Horse	41,2	41,2	39,3	41,2	41,2	April 15-30 (May-June for Alternative 3)
Priest Rapids	177,31	177,31	178,31	177,31	177,31	May
Brownlee	39,7	39,6	39,6	39,6	39,7	April 15-30 (April 1-30 for Alt. 5)
Dworshak	86,15	99,21	99,21	182,23	182,23	April 1-15 for Alt. 1 and April 15-30 for Alts. 2-5
Lower Granite	30,5	21,4	21,4	21,4	21,4	June
Little Goose	27,5	21,4	21,4	21,4	21,4	June
Lower Monumental	132,29	128,28	128,28	128,28	128,28	May
Ice Harbor	79,16	66,14	66,14	66,14	66,14	June (and May for Alts. 2-5)
McNary	235,57	232,58	242.59	232,59	232,59	June
John Day	125,23	121,23	124,23	121,23	121,23	June
The Dalles	92,15	87,15	92,15	87,15	87,15	June
Bonneville	429,63	427,63	427,63	427,62	427,63	May

a/ The HYSSR spill output is denominated in equivalent megawatts of power. For convenience, these results have been used directly rather than converted to water volume measures as they still provide a relative measure of spill frequency and volume.

and June for Libby, and once every 7 years for Hungry Horse. Based on the HYSSR results for Alternatives 2 through 5 presented in Tables 3.5-8 and 3.5-9, however, it does not appear that significant changes in flows or elevations would occur at Libby or Hungry Horse in typical flow years. Elevations at Libby would be increased as much as 90 feet (average 21 feet) during a low flow year under Alternative 3 from January to mid-April. This could potentially alter the thermal pattern in the reservoir in late winter and early spring. However, Libby Reservoir is equipped with a selective withdrawal structure, which can control water temperatures. Therefore, it should be possible to operate the selective withdrawal structure to avoid adverse temperature impacts. The NPPC recently approved a measure proposing installation of a selective withdrawal structure at Hungry Horse, but construction would not be completed for several years. No data are readily available to directly project the magnitude and extent of any flow-related impacts, although temperature modeling is under study at this time.

Flow augmentation from Brownlee might result in a small temperature increase in the lower Snake because of higher temperatures in the upper Snake from warm, agricultural return water. Although releases from Dworshak might mitigate this effect to some extent, extreme drafting from Dworshak during late spring and summer could change the thermal structure of the reservoir. Rapid lowering of the reservoir could increase the depth of warm water during summer stratification and potentially increase the temperature of discharge. If the discharge temperature is significantly increased, the use of Dworshak flow to cool the lower Snake River as a mitigation measure would not be as effective. Thermal effects would not be cumulative, as the reservoir reestablishes isothermal conditions, 39°F (4°C), during the fall/winter turnover.

Water temperature model studies are ongoing at this time. Preliminary results indicate that flow augmentation in the form of substantial cold-water (45°F) releases from Dworshak in August can produce approximately only a 1°F change in temperature at Lower Granite in most years. Temperature differences in the North Fork and mainstem Clearwater because of releases from Dworshak would probably be more significant.

4.1.3 Turbidity

Increased flows and sediments newly exposed by lowered pool levels can increase turbidity. As noted in the 1992 OA/EIS, turbidity effects of drafting the four Snake River projects to MOP were expected to be minimal. Results from the 1992 physical tests support this conclusion in general (i.e., no long-term impacts were noted for a more drastic drawdown), but suggest the possibility of some temporary localized impacts.

Increased turbidity and sedimentation under the SEIS alternatives are expected to be minor and temporary. Drafting for flow augmentation could cause a temporal shift of sediment depositional zones, and subsequently a temporal elevation of turbidity downstream. In addition, deposition of lightweight particulates and floatable solids on receding shorelines has been associated with air quality degradation by some local residents. These effects are related, in part, to the flow rate and pool elevation, and thus might not be significant under MOP conditions proposed in the alternatives. As stated in the 1992 OA/EIS, riprap protection down to MOP has been put in place for protection from wave action and wind. However, potential exists for short-term exceedances of the various State standards, typically less than a 10 percent increase. The impacts are not expected to be cumulative or as significant after several years of operation after new depositional zones are established.

4.1.4 Contaminants and Other Water Quality Parameters

The key issues associated with contaminants include exposure from contaminated sediments, existing waste dumps, and exposed sewer outfalls. These impacts have been previously evaluated in detail in the 1992 OA/EIS. Under the proposed alternatives, any impacts would not be as significant because water surface elevations would not be substantially different from normal operations, and the area of exposed sediments would be smaller.

The 1992 drawdown test (Corps, 1992b) exposed some sewer lines in Lower Granite at approximately elevation 705 feet, contrary to invert elevations on line specifications that indicated

exposure would not occur. As a result, some discharge water was observed to pond on exposed bed sediments. Because the majority of alternatives call for lowering the reservoir to MOP only (elevation 733 feet at Lower Granite), this problem would not occur. It does call attention, however, to the uncertainties in some as-built drawings and the need to verify actual discharge and withdrawal line depths for pipes of concern. Currently, there is limited information on potentially affected outfalls, although that information does not indicate there would be any exposure with the proposed action. Discharge systems should be designed to adequately function under MOP conditions, which do occur under existing normal operations. The City of Umatilla has indicated that the Oregon Department of Environmental Quality may require modifications to their outfall if John Day Pool elevations fall below 264 feet because of inadequate mixing of effluent and surface waters, even though the outfall would not necessarily be exposed. It should be noted that the normal operating range at John Day is from elevation 260 to 265 from November 1 to March 1 and May 15 to June 1.

The 1992 OA/EIS identified an issue associated with potential contaminant leaching from encapsulated fill on the north bank of the Snake River at the mouth of the Clearwater River. However, the fill has a liner to prevent seepage through the levee. Therefore, any contact with the river would have to be through groundwater flow beneath the levee cross section, which is about 30 feet below the river surface. Lowering the pool to MOP would be unlikely to affect this deeper groundwater flow.

A recent reconnaissance report prepared for the Lower Columbia River Bi-State Water Quality Program (Tetra Tech, 1992) identified a number of toxics in the water column through sampling conducted below Bonneville Dam (Section 2.3.2). Sources of these toxics, however, have not been identified. Comparable studies within upstream areas addressed by this SEIS have not been conducted, so it is unknown to what extent waters on the lower Snake River, for example, would parallel the characteristics found in the lower Columbia. Lowering the reservoirs to MOP or flow augmentation should not significantly affect the toxics in the water column. A possible exception involves increased aeration and mixing as a result of higher flows, which could increase water column concentrations through resuspension of sediments. Lack of data precludes a judgment as to whether these processes constitute a significant or even measurable transport and fate mechanism. It is likely that conditions would differ little from conditions currently experienced during years of high runoff and flow conditions in the system.

Lowering the Snake reservoirs to MOP could expose small areas of additional sediment beds in localized regions of adjacent population centers or industrial activity, and there might be increased health risks if direct dermal contact is allowed to occur for prolonged periods (Section 4.1.4.1, 1992 OA/EIS). Data on contaminants in sediment are generally lacking, so the significance of this potential exposure is unknown. However, since contaminated sediments would most likely occur directly adjacent to industrial sites, recreational access would be limited and prolonged physical contact would be expected to be minimal. In addition, the areas exposed are currently subject to frequent short-term exposure due to fluctuation of the pools within the normal range. Therefore, the proposed action should have a minimal effect in terms of increased exposure. Sediment sampling that was performed prior to the 1992 drawdown test did not indicate significant human health or aquatic hazards.

Other relevant water quality parameters include dissolved oxygen, conductivity, and nutrients. Except for dissolved oxygen levels, which will increase proportionally to the increase in total dissolved gas, impacts to the other parameters under the SEIS alternatives should be relatively minor. However, flow augmentation from Brownlee might have a minor adverse impact on the lower Snake River water quality because of the generally poorer existing quality conditions of the middle and upper Snake River water.

4.1.5 Mitigation

The primary water quality impact is dissolved gas supersaturation caused by spilling. No single measure has yet been identified that would be completely effective in mitigating supersaturation if significant spilling occurs. This impact can be reduced by monitoring and reducing flows as problems develop. Modifying or adding flip lips to spill bays to minimize deep plunging has generally

proven effective, although these devices are only effective over limited flow and elevation ranges.

Potential for mitigation of thermal impacts is somewhat restricted. Again, monitoring and control of releases as problems develop can reduce impacts. Discharge amounts and timing required by the alternatives might preclude such control, however.

4.2 ANADROMOUS FISH

Alternative	Potential Impacts (Positive/Adverse)
1. Without-Project Conditions (No Action)	• The range of increase in juvenile downstream passage survival for Snake River stocks, relative to conditions occurring in 1990 to 1998, depends on the model used. • CRiSP Results - Relative survival would increase prior to 1998 improvements by 3, 4, and 31 percent for spring, summer, and fall chinook, respectively, because of actions such as predator control, harvest management, and additional screens at Lower Monumental. - Additional increases after 1998 from other actions (increased transport, improved screens, increased predator control). • SLCM Results - No action conditions not modeled for adult escapement • PAM Results - NPPC modeled 1990 conditions as Alternative 1 without incorporating any nonflow actions. Therefore, the PAM results do not reflect any future without-project improvement in juvenile survival rates. • SPM Results - No action condition not modeled for adult escapement.
2. 1992 Operations	• CRiSP Results - Downstream survival resulting from operations changes only will increase relative survival slightly for most stocks prior to 1998 with median relative survival increases of 4, 4, and -2 percent over without-project conditions, respectively, for spring, summer, and fall chinook. - Total relative median survival from the 1990 base case for 1993 conditions is estimated at 7, 8, and 28 percent for the same stocks. - By 1998, the total median increase in relative passage survival (including the increase of all activities, not just operational changes) is 12, 15, and 77 percent for spring, summer, and fall chinook, respectively. - Changes in percent survival would be higher during low flow years. - Sockeye were not modeled, but downstream survival changes should be similar to spring chinook.

Alternative	Potential Impacts (Positive/Adverse)
2. 1992 Operations (continued)	• PAM Results (spring chinook) - For 1993 operational and nonoperational conditions, relative increased survival over 1990 conditions without estimated benefits of predator control are 6% (50 year average) and 9% (8 lowest-flow-year average); with predator control included, benefits are 9% (50 year average) and 13% (8-lowest-flow year average). - For operational and nonoperational conditions beyond 1993, relative increased survival over 1990 conditions without estimated "low" benefits of predator control and other factors are 12% (50 year average) and 19% (8 lowest-flow-year average); with estimated "high" benefits of predator control and other factors, they are 20% (50 year average) and 30% (8 lowest-flow-year average). • FLUSH Results - Spring chinook average relative increased survival over baseline (1977-1988 conditions) from 18 to 32% depending on which of 4 transport models, 3 predation reduction level assumptions, and implemented or planned conditions were assumed. - Fall chinook average relative increased survival over baseline (1981-1989 conditions) from -11 to 64% (TRR 0.5:1), 3 to 71% (TRR 1:1), and 29 to 92% (TRR 2:1) each with 3 levels of predator control reduction—0, 15% and 25%. • SCLM Results (estimated median adult escapement change in 40 years, based on moderate effectiveness of all improvements over 1990 base case condition) - Spring, summer and fall chinook increase 3,000 to 14,000, 1,200 to 6,000, and 300 to 5,200, respectively. - The estimated probability, over a 40-year period, of escapement falling below 1,000 for spring, 500 for summer, and 250 for fall chinook, depending on expected level of effectiveness of actions (low to high) is 16 to 3%, 15% to <1%, and <1% to <1%, respectively. - The estimated projection of significant decreasing future escapement trends is less than 12%, with most less than 4%, for spring, summer and fall chinook over the range of assumed effectiveness of future actions. • SPM Results (spring chinook) - Median escapement based on conditions beyond 1993 show slight increase from about 8,500 to 12,000 (without estimated benefits of predator control, adult passage, and habitat improvements); 8,500 to 19,000 (with these benefits included) over a modeled 20-year period

Alternative	Potential Impacts (Positive/Adverse)
2. 1992 Operations (continued)	• ELCM Results - Estimated Marsh Creek spring chinook escapement through year 2020 estimated to remain relatively flat with any of the proposed actions and assumed conditions (considering 10% reduction in predation, planned and implemented actions, and 4 different transport benefit models), with average escapement remaining from about 20 to 40% of the agency-defined maximum sustainable production goals. Increased escapement over continued baseline conditions for 8 different alternative analysis averaged 27 to 67% higher escapement by the 2016 to 2020 period. - Estimated fall chinook escapement through 2010 decreased or slightly increased from the 1989 to 1991 escapement depending on estimated predation reduction (0,15 or 25%) and TRR ratio (0.5:1, 1:1, or 2:1). Four of 9 combinations slightly increase from 150 (1989 to 1991 average escapement) up to 264 to 489 by the years 2007 to 2010. Three of the 4 increased values assumed a 25% reduction in predation; the other, 15% predation reduction with TRR of 2:1. The 5 decreasing trend estimates had lower assumed predation reduction effectiveness and TRR ratios. Future escapement decreased for an assumed combination middle TRR (1:1), and predation reduction (15%) with NPPC recommended fall chinook harvest rate schedule changes. • Water particle travel time reduction could be as high as 7 days or a 20 percent reduction at low flow or 2 days at high flow. Most often, even in low flow years, reduction would be less than half this amount. • Estimated smolt travel time reduction could be as great as 10 days for short periods of low flow. However, under the lowest (10%) seasonal flow conditions, average reduction in smolt travel time would be about 1 to 2 days from Lower Granite Dam to Bonneville Dam. • Benefits would also occur for other stocks in both the middle and upper Columbia. • Minor loss of subyearling shallow water rearing habitat in Snake River and John Day pools. • Benefits to resident fish may lead to increased predation on anadromous fish.
3. 1992 Operations with Libby/Hungry Horse Sensitivity	• Similar to Alternative 2.
4. Modified 1992 Operations	• Similar to Alternative 2.
5. Modified 1992 Operations with Upper Snake Sensitivity	• Similar to Alternative 2.

The proposed SEIS actions are centered around the concept of increasing survival of fish migrating through the Columbia-Snake River System. The actions being considered are similar to the actions considered in the 1992 OA/EIS, except major drawdowns (below MOP) in the Snake River reservoirs are not being considered.

This section includes effects to anadromous fish and presents model results on survival. The initial material is a review of anadromous fish impact issues addressed in detail in the 1992 OA/EIS. This is followed by a discussion of methods and results for three separate model-based analyses conducted by BPA, STFA and the NPPC. The models used in these analyses include a full life-cycle component, where feasible, to estimate the effects of the proposed actions and ongoing and future actions on the endangered and threatened salmon stocks of the Snake River Basin. This section concludes with a summary of the comparative model results and other pertinent factors.

4.2.1 Review of Impact Issues

The 1992 OA/EIS addressed in detail a considerable number of specific impact issues relative to anadromous fish. For complete discussion of the relationships between flow, water particle travel time, species, river reach, and survival, refer to Section 4.2 of the 1992 OA/EIS. The following discussion is a brief summary of those issues as they pertain to the SEIS alternatives. These issues can generally be characterized as flow and other effects on juvenile salmonids and effects on adult salmonids, other anadromous stocks, and hatcheries.

Flow Effects on Juvenile Salmonids

Past studies indicated that quantity of flow has various levels of correlation with travel time and smolt survival. However, there is some uncertainty about which stocks respond to increased flows, the importance and level of the increased flow and the effects on travel time, and the optimum range of flows. Flow and travel time relationships have sometimes been found to be significant for yearling chinook at low flows in the Snake and Columbia rivers. This relationship is not clear at higher flows (Giorgi, 1991; Kindley, 1991).

Recent analysis indicates that the flow-travel time relationship is weak. Analysis by Stevenson and Olsen (1991) of yearling chinook in John Day Pool found no significant relationship between flow and travel time in 1989 and 1990. Recently, Marsh and Achord (1992) reviewed migration information from PIT-tagged fish through Lower Granite Pool and concluded that the dynamics of outmigration of hatchery and wild spring/summer chinook salmon appeared to be independent of flow. The analysis indicated that many variables in addition to flow are involved in daily fish passage at a dam. McNeil (1992) found that for five "species" (brood runs) of juvenile salmonids in the Columbia and Snake rivers, only 5 of 117 tests of linear correlation of migration timing to flow quantity had a significant positive relationship. Three of those relationships were found for yearling chinook and the other two for subyearling chinook. McNeil (1992) does not contradict or modify any significance or uncertainty associated with existing flow/survival or flow/travel time relationships.

The relationship of subyearling chinook travel time and flow levels is unclear; sometimes they correlate weakly (Berggren and Filardo, 1991) and other times not at all (Sims and Miller, 1982). This relationship is confounded by the level of smolt development (Kindley, 1991) or size of the fish (memorandum from Michele DeHart, FPC, to Merritt Tuttle, NMFS, October 16, 1991). The relationship between flow and survival was developed primarily from early studies on the Snake River by Sims and Ossiander (1981). Sims and Ossiander (1981) found survival of yearling chinook increased with increasing flow. Later analysis of this and additional data developed relationships that were considered to peak at certain flow levels in the range of 85 to 140 kcfs in the Snake River (Sims et al., 1983). (These study results were confounded by effects from dissolved gas supersaturation, which were not measured, but resulted in modification of certain dams by installation of flip lips). No recent studies have been conducted to evaluate further the relationship between flow and downstream juvenile fish survival.

The 1992 OA/EIS assessed water travel time, yearling chinook smolt travel time, and smolt survival. The alternatives considered in this SEIS would yield results within the range of the 1992

OA/SEIS values. The SEIS analyses are based on the results of models designed to predict fish survival. All of these models incorporate water travel time based from the Corps' backwater curves and provide a comprehensive evaluation of the many different factors affecting survival. However, for consistency a brief summary of the general changes in water travel time and smolt travel time/survival based on the 1992 OA/EIS analysis methods and the alternatives considered in the SEIS is presented below.

Based on operation near MOP at the Snake River projects and elevation 262.5 at John Day (exclusive of any flow changes), the reduction in water travel time would be slightly more than 1 day or less than 5 percent total water travel time reduction even at low flows (Corps et al., 1992). (The 1992 OA/EIS reported slightly higher corresponding figures because it assumed greater changes in elevations at the mainstem reservoirs.) The 1992 OA/EIS assumed an additional flow of 20 kcfs through augmentation, plus lower mainstem reservoir elevations. The resulting reduction in total water travel time for the Columbia and Snake rivers was estimated at up to about 7 days at low flow and about 2 days at high flow. In relative terms, this would reduce water travel time by about 20 percent at low flows and less at higher flows.

This level of reduction in water travel time would be rare with the action alternatives considered in the SEIS. HYSSR runs indicate that changes in flow simulated for Alternative 2, which is characteristic of the other alternatives, show an average flow increase of about 3 kcfs in the Snake and 6 kcfs in the Columbia River during the spring passage months (mid-April through May in the Snake, and May through mid-June in the Columbia). Even for the 5 lowest flow years, the average increase during these periods is only 5 kcfs and 18 kcfs in the Snake and Columbia rivers, respectively. Therefore, the relative reduction in water travel time would nearly always be less than half of the 1992 OA/EIS estimate of 20 percent indicated for a 20 kcfs flow augmentation for both the Snake and Columbia rivers at low flow.

Smolt travel time reductions would be similarly reduced when compared to current operations. The 1992 OA/EIS estimated that Snake River flow augmentation of 20 kcfs could reduce yearling smolt travel time up to an estimated 4 to 7 days during low flow, about 1 day at intermediate flows, and less than 1 day at higher flows (Corps et al., 1992). In the Columbia River, the reductions would be less than 3 days even with flow augmentation to above 160 kcfs. Overall, reduced travel time of yearling chinook smolts from Lower Granite Pool to Bonneville Dam with flow augmentation and mainstem reservoir elevations near MOP could be as much as 10 days during low flows, although in most cases it would be much less than indicated above.

Reductions in smolt travel time for the SEIS alternatives usually would be less than 10 days. Based on the average of the lowest 5 of the 50 HYSSR flow years simulated for Alternative 2, and the methods described in the 1992 OA/EIS (Corps et al., 1992), the predicted reduction in smolt travel time would be only about 1 to 2 days in total yearling smolt travel time from Lower Granite Pool to Bonneville Dam. This is based on an average change over the 5 lowest flow years of about 5 kcfs (from 61 to 66 kcfs) in Snake River spring flows and 18 kcfs (from about 196 to 214 kcfs) in Columbia River spring flows.

The Corps HEC-2 model runs using the backwater curves for full pool versus MOP indicated that a reduction in water travel time from the head of Lower Granite Reservoir to the dam would be 1.3 days for low flow years (<60 kcfs), 0.8 days for higher flow years (60 to 100 kcfs), and 0.4 to 0.5 days for flows greater than 120 kcfs.

While information is unavailable to predict the effects of the proposed actions on Snake River sockeye in the future, it is likely effects on downstream passage survival will be similar to that of yearling chinook from the Snake River System. Considering the similarity of size and downstream migration period, likely benefits based on models for yearling spring chinook will be closely representative of what will happen to sockeye juveniles beginning in about 1995. However, the precise relationship between these actions and sockeye survival is unknown.

While it is expected that spring/summer chinook and sockeye juvenile migration rates would benefit from reduced water travel time attributable to the proposed actions, the benefits are not certain and could be less than indicated above. The proposed early and later summer flow enhancements could

also benefit fall chinook migration, although the benefits of flow enhancement for this stock are not well defined because of the uncertainties related to size or degree of smoltification of the fish and feeding behavior. Ongoing and planned research will attempt to further refine current relationships for subyearling flow/survival.

Other Effects on Juvenile Salmonids

Because only minor changes in pool levels would occur at some of the facilities under Alternatives 2, 3, 4, and 5, it is expected that no significant effects on the ability to bypass, collect, and transport juvenile fish would occur under any of these alternatives (refer to 1992 OA/EIS, Section 2, for details of how bypass and collection facilities operate).

No additional adverse effects of turbine passage would occur with Alternatives 2 through 5 compared to existing conditions, because factors affecting survival (e.g., efficiency and depth of turbine) would not change significantly with any alternative.

Increased spill might occur with increased flow in some cases, which could increase dissolved gas saturation levels. Levels above 110 percent can adversely affect fish survival (EPA, 1976). Levels in excess of 120 percent occur commonly during periods of spill. Direct mortality effects on fish have rarely been observed with current fish monitoring programs but actual effects on fish remain uncertain (Corps et al., 1992).

The overall effect of the action alternatives on juvenile salmonid predation is unclear. There are many potential impact mechanisms associated with predation. Some of the physical changes resulting from the proposed actions would work to reduce predation on juvenile salmon, while others would tend to increase it. Faster travel times through the mainstem reservoirs could reduce susceptibility to predation. However, predation is affected by several factors, with temperature probably one of the most important for squawfish activity (Beamesderfer et al., 1990). More stable pool conditions may also favor increased resident fish numbers, with potential impacts to salmonids. However, during higher flow conditions squawfish, the major salmonid predator, remain in more sheltered shallow water away from high velocity regions (Faller et al., 1988) where certain stocks of the anadromous smolts are most often located during migration. If the SEIS actions result in cooler water temperature while maintaining similar migration rates, predator activity should be reduced. However, it is likely that the actions would contribute to very little change in temperature, and possibly even warmer temperatures, which could increase predation. It is uncertain that the reduced pool area could increase the density of predators, which could result in increasing encounters. Sub-yearlings may be subject to higher predation if forced out of shallow-water rearing areas by lower pools.

Because the proposed alternatives would cause only slight changes in area or volume from existing conditions, rearing habitats for migrating fish would experience only minor effects. The more stable pool levels at the run-of-river projects on the Snake River could increase benthic shallow-water production (due to lack of daily dewatering), possibly increasing the seasonally available food supply. Some shallow-water habitat could be lost, primarily in the John Day Pool. However, the overall loss of these areas should be small because the proposed lower pool elevations are within the range of elevations that typically occur during the late winter and early spring, when some of the earliest use of these areas occurs. The importance of these limited regions of shallow-water habitat is not clear at this time, but they could be significant in the Snake River reservoirs and John Day Pool.

Adult Anadromous Fish

Adult migration is unlikely to be affected by the proposed actions, except possibly at higher flows where increased spill may occur. The CBFWA (1991b) suggested that flow increases might benefit upstream migrants. However, Gibson et al. (1979) found that high flows have a detrimental effect on upstream migration. Heavy spill has been found to increase adult spring chinook travel time (i.e., delay fish) in the Snake River (Turner et al., 1983, 1984). However, the SEIS actions are unlikely to increase flows to the high range where most detrimental effects have been observed.

In the past, elevated temperatures raise mortality of adult salmon migrating through the Columbia

River. Temperatures in excess of 70°F (21°C) that occur frequently in the Snake River during fall chinook migration may impede upstream salmon and steelhead migration (EPA and NMFS, 1971). Whether or not reduced temperature would improve measurably late summer migrating adult survival has yet to be demonstrated, but susceptibility to disease might be reduced, resulting in increased survival. Snake River temperatures higher than 70°F (21°C) were recorded in pre-dam times when fall chinook runs were much higher, suggesting fish migration might not be appreciably improved with reduced temperatures (1992 OA/EIS). Cool-water releases from Brownlee or Dworshak scheduled for August or September (Alternatives 2, 3, 4, and 5) could lower mainstem river temperatures. Water temperature model studies are ongoing. Preliminary modeling results indicate that flow augmentation in the form of substantial cold water releases from Dworshak in August could produce approximately only a 1°F change in temperature at Ice Harbor.

Other Anadromous Stocks

Adverse effects from lower reservoir elevations and flow augmentation (Alternatives 2, 3, 4, and 5) on other anadromous species would be minimal, and there also could be beneficial effects (Corps et al., 1992). Lowered reservoir elevation in the John Day Pool could reduce some rearing areas for such stocks as American shad and Pacific lamprey. Pacific lamprey are native species that spawn in free-flowing reaches and tributaries.

Changes of velocity should not affect shad spawning because shad adapt to and spawn in a wide range of flows due to a broadcast spawning strategy. Some lamprey might rear in areas dewatered by lowered-pool operations because they use shallow-water regions. The majority of this habitat would remain, and the stabilized water levels would prevent ammocoetes (juvenile lamprey) buried in the sediment from establishing in regions that might be dewatered at other times of the year.

Stabilizing water levels could increase benthic production in the remaining shallow water areas by increasing food supply. Sturgeon might benefit slightly with increased velocities because they typically spawn in the tailraces below the dams or above the reservoirs in free-flow reaches. Spawning success is limited in low-flow years. Increased velocity could therefore be one factor that could increase spawning success. However, the level of increase over current conditions is unknown and could be insignificant, because increased flows and velocity would be relatively slight compared to normal yearly variability. Sturgeon prefer deeper water regions for rearing. Nigro (1991) found that nearly all young-of-the-year and juvenile sturgeon captured in the lower Columbia River pools were in water deeper than 30 feet, although the Lower Granite population can be found in a variety of depth-related habitats (Bennett, 1991, 1993). The associated velocities of those depths are a dominant factor affecting sturgeon distribution. The overall change in habitat, particularly the deep-water areas, would be negligible because the decrease in pool elevations would be less than 4 feet. This is not expected to adversely affect rearing success.

Hatcheries

Operation of John Day Pool near 262.5 feet could adversely affect water supply at the Umatilla Hatchery, potentially reducing fish production at this facility. In 1992, the Umatilla Hatchery was unable to withdraw more than 9,000 gallons per minute (gpm) when it was designed to withdraw 15,000 gpm. During this period, the water level in the John Day Pool was never down to elevation 262.5 and usually ranged from elevation 263.5 to 265. The Umatilla Hatchery is operating below its design capacity due to existing problems with water quantity supplied by Ranney and shallow wells, so the availability of water as a result of lower pool elevation has not been tested and may be affected.

If river temperatures below John Day increase, the Bonneville Hatchery could be adversely affected. Proposed flow augmentation from Dworshak Reservoir would reduce the temperature of the water supplied to Dworshak National Fish Hatchery in summer. This would result in reduced productivity for a portion of the hatchery's capacity, due to slower growth at lower temperatures. No other hatchery facilities would be affected under any of the alternatives.

4.2.2 Modeling of Flow Improvement Effects

The analysis of the alternatives for effects on anadromous fish resources differs between the SEIS and the 1992 OA/EIS. These differences result from using biological models developed for the Columbia Basin that consider the interactions between more aspects of the hydrosystem that affect overall survival, using life-cycle models that estimate benefits ranging from downstream smolts survival to returning adults. These models can be used to estimate the benefits of the proposed actions.

Different analytical approaches and interpretation of data have resulted in the regional development of three systems of models to estimate the effects of various actions on the fish stocks of the Columbia River System.

Three regional systems of models are presented in the SEIS to estimate changes in downstream survival and total adult escapement. Each model system has two components: a downstream passage model that estimates downstream juvenile survival, and a life-cycle model that estimates adult return escapement. The model system run by the BPA includes the Columbia River Salmon Passage Model (CRiSP.0), estimating downstream juvenile passage survival, and the Stochastic Life-Cycle Model (SLCM), estimating adult escapement. The BPA models are used to analyze spring, summer, and fall chinook. Two different models were developed and run by the NPPC: the Passage Analysis Model (PAM) that estimates downstream survival, and the System Planning Model (SPM), that estimates adult escapement. The NPPC analysis models only spring chinook. Also, two different models were developed and run by a cooperating group of State and Tribal Fisheries Agencies (STFA) called the T.E.C.H. Committee. Their downstream passage model is called Fish Leaving Under Several Hypotheses (FLUSH) and the model that estimates adult returns is the Empirical Life Cycle Model (ELCM). The analyses of these models used headwater indicator stocks for the spring/summer chinook and fall chinook of the Snake River. The results from each of these systems of models is presented separately. A brief description of the models' assumptions and their results is presented in the text. A more complete documentation of the model inputs and their assumptions can be found in Appendices E, F, and G.

Sockeye are not modeled for environmental impacts because of the current low numbers of adults and the near-term emphasis on the captive rearing program that will dominate the future management of this species. Snake River sockeye are not addressed in any of the model analyses discussed later in the text because adequate models have not been defined and because no known sockeye are likely to be in the system for at least 2 years. It is assumed that all juvenile sockeye are part of the captive breeding program managed by NMFS and IDF&G. Currently, no adult sockeye are expected to return to the Snake River System in the timeframe covered by this SEIS. The total escapement to Redfish Lake was 4 adults in 1991 and 1 adult in 1992. These adults were captured for the breeding program. Therefore, in recent history no anadromous adult sockeye remained to escape to the lake, to produce wild smolts from Redfish Lake. However, Idaho's captive breeding program for Snake River sockeye could release smolts into the Salmon River to travel to the ocean within 3 years. Because of the lack of identified juvenile sockeye that are direct offspring from anadromous parents in the system, proposed actions in the SEIS will have no effect on this stock in 1993. But when the smolts are released in the future, possibly by 1995, insystem action will affect this endangered stock.

While models are useful to compare trends between alternatives, it must be emphasized that their primary purpose is not to predict actual numbers of fish returning in the future. The joint Federal agencies are primarily using these models for the purpose of comparing the results of different alternatives with the intention of determining how the actions affect the continued existence of endangered and threatened stocks of salmon. The absolute numbers estimated have wide confidence bounds for the future estimates.

The analysis of the alternatives for effects on anadromous fish resources differs between the SEIS and the 1992 OA/EIS. These differences result from using biological models that consider more aspects of the Snake and Columbia River System affecting overall survival, in particular, life-cycle

models that estimate benefits ranging from smolts to returning adults. These models can be used to estimate the benefits of the proposed actions.

The primary propose of the models is to project and compare trends between alternatives and to evaluate how the proposed actions affect the continued existence of threatened stocks of salmon. The models are not intended to predict an actual number of fish returning at a specific point in time.

Two regional systems of models were used in developing the conclusions in this SEIS to estimate changes in survival and total adult escapement. Each model system has two components: a downstream passage model that estimates downstream juvenile survival, and a life-cycle model that estimates adult return escapement. The model system run by the BPA includes the Columbia River Salmon Passage (CRiSP.0) Model, estimating downstream juvenile passage survival, and the Stochastic Life Cycle Model (SLCM), estimating adult escapement. The BPA models are used to analyze spring, summer, and fall chinook. The models that were developed and run by the NPPC include: the Passage Analysis Model (PAM) that estimates downstream survival, and the System Passage Model (SPM), that estimates adult escapement. The NPPC analysis models only spring chinook.

The results from the two systems of models are presented separately. A brief description of the models' assumptions and their results is presented in the text. A more complete documentation of the model inputs and their assumptions can be found in Appendices E and F. Because of differences in various assumptions, the results of the models are not directly comparable.

At the outset of the SEIS process, the Corps and the cooperating agencies agreed that the anadromous fish impact analysis would also include results from a group of State and Tribal Fisheries Agencies (STFA). This group, called the T.E.C.H. Committee, developed and used a downstream passage model called Fish Leaving Under Several Hypotheses (FLUSH) and a model that estimates adult returns, the Empirical Life Cycle Model (ELCM). Results from the STFA were not available for the draft SEIS due to time constraints. The Corps has reviewed the preliminary results of the STFA model. The initial review revealed some concerns that are undergoing further examination and discussion with the STFA. BPA is also in the process of reviewing the STFA analysis, and expects to have additional concerns requiring clarification and discussions. Consequently, the cooperating agencies believe that the preliminary results of the STFA model should not be used in the development of the conclusions of the SEIS.

The cooperating agencies support the ongoing processes within the region to facilitate review, understanding, and coordination of the three model systems. The near term preliminary peer review is expecting to provide information within the next two months, while the long-term model coordination process will be ongoing.

CRiSP.0, PAM, and FLUSH do not have a dissolved gas module that generates percent of supersaturation as a function of water volume spilled. The effects of supersaturation on fish mortality is an area of contention within the region due to associated uncertainty and the complexity of designing an adequate experiment. Studies in the late 1960s and early 1970s indicated that supersaturated levels as low as 108 percent affect fish condition leading to mortality. These studies led to the design and construction of flip lips on most Snake River dams.

4.2.3 BPA Model Analysis

Analytical Methods

The SEIS analysis conducted by BPA uses advanced technical models based on the best currently available scientific information to evaluate the biological effect of the proposed SEIS actions and other nonflow measures on Snake River chinook salmon stocks listed under the ESA as threatened. Professional judgment has been used in those areas where studies are still in progress, and where data are limited or not available. CRiSP.0 provides information on juvenile passage survival, and SLCM provides information on multigeneration spawning escapement trends. They are an essential analytical tool for a quantitative, comprehensive evaluation of the many factors that combine to affect juvenile system survival to below Bonneville Dam and estimating the long-term population viability of the ESA salmon stocks. A cumulative

analysis (relative to a narrower focus on individual actions or life stages) is critical to evaluate the effects of proposed river operations that would occur in combination with other ongoing nonflow project improvement measures.

To evaluate the effects of system operations for 1993 and future years, it is necessary to analyze available information and data in two ways. First, CRiSP.0 is used to analyze juvenile passage conditions. The model analyzes the alternate flow measures (Alternatives 2, 3, 4, and 5) relative to no action (Alternative 1), with other 1993 nonflow measures in place to determine if the changes in flow and pool elevations will decrease, effect no change, or increase survival of juveniles. In addition, juvenile passage survival for the proposed flow measures in combination with 1993 and 1998 levels of nonflow measures have been compared to 1990 baseline survival conditions. Second, the SLCM is used to project the expected spawning escapement trend of each population over the next 40 years if the system operations were continued into the future. Also included in the SLCM life-cycle analyses are actions that are currently scheduled to be implemented, or that have a high probability of occurring in the near term. These include actions such as installation of additional bypass improvements, improved predator control, extended transportation periods, reductions in harvest, adult upstream passage improvements, and subbasin habitat improvements. The uncertainty regarding effects of these actions is addressed for by analyzing low, moderate, and high effectiveness levels.

The employment of analytical models is important in estimating the possible eventual fate of a population of anadromous fish because of the temporal and spatial distribution of both the population and the actions that affect fish survival. In any given year, fish from 4 or more brood years are distributed throughout the species' range as rearing juveniles, outmigrants, subadults, or adults. The population trend will be affected by nonflow and modified operational actions started in 1991 and escalating through 1998 and beyond. While it may be possible to estimate the effects of 1993 proposed actions on the survival of one or more life stages, it is necessary to combine these effects with other recent and proposed future nonflow actions to assess the overall effect on the population trend.

There is substantial uncertainty and variability inherent in biological systems. In addition, for several of the nonflow measures there are limited data to evaluate project-specific effectiveness. The analyses attempt to capture much of this uncertainty by the use of a statistically based model and application of ranges for several critical assumptions. The results of the models estimate the range of expected future states of the populations and the relative changes in the passage survival levels or the population trends between the 1990 baseline operations and alternative future conditions. It should be noted that the production relationships in the models become more uncertain at critically low population levels where genetics and spatial distributions of the species may become a dominant factor. The significant level of uncertainty in the biological data used in the analysis requires that a strong monitoring and evaluation program closely follow the dynamics of the population and provide for corrections in both the management actions and the models.

Columbia River Salmon Passage Model

Juvenile migration survival levels for Snake River spring, summer, and fall chinook are analyzed with CRiSP.0 developed by the Center for Quantitative Science, University of Washington. CRiSP.0 is used to estimate the juvenile survival rate for passage above Lower Granite Dam, through the operational system, to below Bonneville Dam (system survival). Input parameters describing fish behavior, survival relationships, system configurations, and hydropower operations are specified for the different years and alternatives under analysis. Flow data used in CRiSP.0 are generated from the HYSSR hydroregulation model using the 50 continuous water year record of 1929 through 1978. The survival estimates of CRiSP are used in SLCM to estimate long-term population trends. For more specific information on the CRiSP Model and input parameters, see "Input Parameters for the Modeling of Snake River Salmon with the CRiSP.0 Model" in Appendix E and Hinrichsen et al. (1992).

Stochastic Life-Cycle Model

Changes in spawning escapement trends for spring/summer and fall chinook are analyzed with the SLCM developed by Dr. Danny C. Lee (Inter-

mountain Research Station, Forestry Sciences Laboratory, Boise, Idaho), and Dr. Jeffery B. Hyman (Quality of the Environment Division, Resources for the Future, Washington, DC). The SLCM is used to project spawning escapement trends over a 40-year simulation period (1991 through 2030). This model was designed for population viability assessments combining advanced modeling techniques with concepts from the field of conservation biology. SLCM is designed to mimic the basic mechanisms regulating populations of Pacific salmon, while capturing some of the intra-annual and inter-annual variation inherent in these populations. The model incorporates uncertainty in projecting the state of salmon populations resulting from: 1) temporal variation in populations and environmental conditions; 2) intrapopulation variation among individuals; and 3) uncertainty in parameter values. Variation in population numbers is simulated by incorporating stochastic processes at each step in the life cycle. The stochasticity incorporated in the SLCM allows a more realistic presentation of the possible future states of these populations than would be shown by a deterministic model (one that is based on averages and does not incorporate variability that could simulate uncertainties). Estimated spawning escapement trends are developed by simulating 500 separate populations over the 40-year period for each alternative. Probability distributions for future estimated escapement levels are produced for each of the 40 years.

The SLCM is calibrated and initialized using estimated adult harvest and wild fish return data from 1977 to 1991. SLCM input data were developed separately for Snake River fall chinook salmon and the spring and summer components of the spring/summer chinook, as these three groups of fish have different life history traits. Because the summer component is harvested at different rates and migrate earlier as smolts, it was modeled separately from the spring component even though they are considered within the same evolutionary species unit under the current ESA listings. Output from CRiSP.0 is used to generate a probability distribution of survival for juvenile passage in the SLCM. The analysis of harvest changes for fall chinook use output from a harvest model developed by the Oregon Department of Fish and Wildlife (ODFW). For more specific information on the SLCM and input parameters see "Input Parameters for the Modeling of Upper Snake River Wild Chinook Salmon with the SLCM," Appendix E, and Lee and Hyman (1992).

Critical Assumptions

In addition to the uncertainty modeled through stochastic processes, the SLCM trend analyses assume three separate levels of effectiveness for nonflow measures where significant uncertainty exists. Low, moderate, and high levels of effectiveness are assumed for these measures. The range of effectiveness assumed for these measures in 1993 and 1998 are identified in Table 4.2-1 and discussed briefly below along with critical assumptions for flow augmentation benefits and harvest reductions.

Adult Passage Improvements

- Bypass Screens for Adult Fallback—The extended period of operating juvenile passage facilities through December at McNary, through September at Little Goose and Lower Granite, is assumed to reduce adult fall chinook turbine mortality by collecting additional adults that are falling back downstream during passage. Adult passage counts at McNary for 1991 during the extended period of operating juvenile passage screens showed that 14 percent of the adult run of chinook were guided into the juvenile bypass system after falling back through turbine intakes (Wagner and Hillson, 1992). No data were identified for adult chinook turbine mortality rates; however, data for adult steelhead turbine mortality have been reported ranging from 22 to 44 percent (Wagner and Ingram, 1973). Based on these limited data, the effect of bypass screens is calculated to range from 0.6 to 1.1 percent increase in Columbia River reach total survival when applied to McNary Dam. Similar data collected during 1991 at Lower Granite Dam also showed 14 percent of the adult fall chinook being guided during the extended screening period (ongoing study results, T. Bjornn, University of Idaho, Moscow, Idaho, 1992), which would result in a 6.1 to 12.2 percent increase in Snake River reach total survival when applied at Lower Granite and Little Goose.

  It is assumed that for the mainstem Columbia River dams other than McNary the extended

Table 4.2-1. The ranges of effectiveness applied to measures having significant levels of uncertainty or data limitations for 1993 through 1997 and for 1998 and later years.

Parameter	Stock	1993 Low (%)	1993 Mod. (%)	1993 High (%)	1998 Low (%)	1998 Mod. (%)	1998 High (%)
Juvenile Passage Measures							
Squawfish							
% decrease in reservoir mortality due to implementation of squawfish removal program, based on predation modeling which projects a sustained 10-20% annual squawfish harvest may result in >50% reduction in predation mortality (Rieman and Beamesderfer, 1990).	All	3.8	7.5	11.3	12.5	25	37.5
Pre-smolt Measures							
Habitat							
% increase in production of pre-smolts over existing conditions due to increases in habitat quality (estimate - Robert Austin's review of other biological opinions, Fishery Biologist, BPA)							
	Spring/ Summer	0	0	0	1	5.5	10
Hells Canyon Flow							
% increase in no. of productive redds due to changes in operation of Hells Canyon Dam, which will reduce no. of spawning redds dewatered (Conner 1992; estimate - Dan Daley, Fishery Biologist, BPA)	Fall	0	5	10	0	5	10
Irrigation Diversion Screens							
% increase in pre-smolt to smolt survival rate due to installation of screens (Schill, 1984; estimate - Dan Daley and Robert Austin, Fishery Biologists, BPA)							
	Spring	0	0	0	2	3.5	5
	Summer	0	0	0	1.0	1.8	2.5
Adult Passage Improvements							
Bypass Screens for Adult Fallback							
% decrease in mortality due to extended screening period (Wagner and Hillson, 1992; Wagner and Ingram, 1973; personal communication, T. Bjornn, Consulting Scientist, University of Idaho, Moscow, Idaho, 1992)							
Columbia projects	Fall	0.1	0.1	0.2	0.6	0.8	1.1
Snake projects	Fall	5.0	7.4	9.9	5.0	7.4	9.9

Table 4.2-1. The ranges of effectiveness applied to measures having significant levels of uncertainty or data limitations for 1993 through 1997 and for 1998 and later years.

		1993			1998		
Parameter	Stock	Low (%)	Mod. (%)	High (%)	Low (%)	Mod. (%)	High (%)
Law Enforcement							
% increase in upstream survival due to increased law enforcement (estimate - Steve Vigg, Fisheries Biologist, BPA, 1992)							
Snake	All	0.25	2.63	5.0	0.25	2.63	5.0
Columbia	All	0.25	2.63	5.0	0.25	2.63	5.0
Adult Ladder Improvements							
% decrease in mortality due to improvements in ladder temperature at the four Snake projects under low water conditions (based on mortality estimated from ongoing study of T. Bjornn, Consulting Scientist, University of Idaho, Moscow, Idaho, 1992 and an estimated occurrence of low water/high temp.)							
	Fall	0	0	0	0.08	0.25	0.42
	Summer	0	0	0	0.08	0.25	0.42
	Spring	no effect	no effect	no effect	no effect	no effect	no effect
Combined Effects of Adult Passage Improvements							
% increase in survival calculated through spreadsheet applying combined effects with calibrated adult survivals							
	Fall						
Snake		6.34	11.76	17.18	6.4	11.96	17.53
Columbia		0.33	2.75	5.16	0.81	3.46	6.12
Total		6.69	14.83	23.23	7.26	15.84	24.72
	Spring						
Snake		0.25	2.63	5.0	0.25	2.63	5.0
Columbia		0.25	2.63	5.0	0.25	2.63	5.0
Total		0.50	5.32	10.25	0.5	5.32	10.25
	Summer						
Snake		0.25	2.63	5.0	0.27	2.68	5.09
Columbia		0.25	2.63	5.0	0.25	2.63	5.0
Total		0.50	5.32	10.25	0.52	5.37	10.35

period of screening will not affect a significant number of adults; therefore, no effect is modeled. For the Snake River dams, the extended screening is assumed to affect the entire run of fall chinook only for Little Goose and Lower Granite dams starting in 1993.

- Fish Ladder Temperature Improvements—It is assumed that currently there is a 1 to 5 percent increase in the summer and fall chinook mortality through the four Snake River dams resulting from high temperatures in adult fish ladders during low water conditions (ongoing study analysis, T. Bjornn, University of Idaho, Moscow, Idaho, 1992). Assuming these low water conditions occur approximately one-third of the time, the range of ladder temperature improvement effects for these species is a 0.3 to 1.7 percent decrease in total Snake River passage mortality. Improvements in ladder temperatures as a result of ladder improvements are projected to start in 1998 for adult summer and fall chinook. No effect is assumed on earlier migrating spring chinook.

Harvest Reductions

- Harvest Regulations—Reductions in harvest are modeled only for fall chinook based on a projection of future harvest rates as modeled by ODFW. Harvest rates start in 1991 as a 22 percent decrease in U.S. ocean and a 35 percent decrease in Columbia River fisheries from 1990 rates, decrease an additional 5 percent in the ocean and 24 percent in the river for 1992 to 1995 harvest rates, and then return to 1984 to 1990 rates for 1996 and beyond (Schaller et al., 1992).

- Law Enforcement—Increased law enforcement is assumed to increase the total upstream survival through the entire lower Columbia River reach by 0.25 to 5 percent, and through the entire Snake River reach by 0.25 to 5 percent for spring, summer, and fall chinook by the year 1993 (estimate by Steve Vigg, Fisheries Biologist, BPA).

Habitat Improvements

- Habitat Quality Improvements—It is assumed that increases in habitat quality will increase the production of pre-smolts by a range of 1 to 10 percent over existing conditions starting in 1998 for spring and summer chinook (not fall chinook) (estimate by Robert Austin, BPA).

- Irrigation Diversion Screens—It is assumed that screening of irrigation diversions will increase the pre-smolt-to-smolt survival rate by a range of 2 to 5 percent for spring chinook, and 1 to 2.5 percent for summer chinook based on limited research in the Salmon River. These changes are modeled to take effect in the year 1998 (Schill, 1984; estimate by Dan Daley and Robert Austin, BPA).

- Hells Canyon Dewatering—It is assumed that changes in the operation of the Hells Canyon Dam by Idaho Power Company will reduce the number of downstream spawning redds dewatered and increase the number of productive redds by a range of 0 to 10 percent by the year 1993 (Conner, 1992; estimate by Dan Daley, BPA).

Juvenile Passage Improvements

- Flow Augmentation—Changes in Snake and Columbia River flows are based on Corps HYSSR Model analyses of base case and alternative operations using 1929 through 1978 water conditions. The effects of changes in flow conditions for spring and summer chinook are based on river reach survival data for yearling chinook from 1970 and 1972-80 (Sims and Ossiander, 1981). There is much uncertainty regarding these data and their application to reservoir survival due to the construction and start-up of Little Goose and Lower Granite dams and the changing levels of dissolved gas concentrations before and after years when flip lips became effective. Flow-travel time and flow-survival data are confounded by other factors that affect travel time and survival (see Section 4.2.1).

  The effects of flow augmentation on fall chinook are based on a combination of travel time relationships and an estimate of mortality per day of travel time. The travel time relationship for Lower Granite Pool incorporates fish length and flow rate based on 1991 data (memorandum from Michele Dehart, FPC, to Merritt Tuttle,

NMFS, October 16, 1991). The travel time for all other pools is based on data from John Day Pool (Berggren and Filardo, 1991). It should be noted that these relationships are based on limited data and weak correlations of travel time and flow. Therefore, another option (Flow Travel Time Option 2) was modeled as part of a sensitivity analysis which assumes no relationship between flow and travel time for fall chinook smolts. Other researchers have questioned the existence of a direct relationship between travel time and flow for subyearlings (Giorgi, 1991; Kindley, 1991). The mortality rate per day of travel time is estimated to be 2.26 percent based on output from the Columbia River Ecosystem Model using data for John Day Pool (modeling by Sam Bledsoe, Consulting Scientist, University of California-Davis, 1991 to 1992). A high degree of uncertainty can be attributed to this approach due to using John Day Pool data relationships as representative of Columbia River reservoirs, and especially Snake River reservoirs. In addition, uncertainty might increase when this per day mortality is assumed to be constant across different flow years. Realistically changing period flows would have some effect on travel time and survival.

- Squawfish Management—Changes in reservoir mortality due to the squawfish management program are based on predation modeling which projects that a sustained 10 to 20 percent annual harvest rate of adult squawfish may result in a 50 percent reduction in predation mortality within the planning period (Rieman and Beamesderfer, 1990). Because of the uncertainty in the effectiveness of this program, the ability of the program to sustain these rates of reduction, and the unknown proportion of total reservoir mortality caused by squawfish predation, the analysis assumes a reservoir mortality reduction of 7.5 percent in 1993 and 25 percent by the year 1998. For this analysis, a factor of plus and minus 50 percent is applied to these assumed values to arrive at an uncertainty range for squawfish effectiveness of 3.75 to 11.25 percent reduction in reservoir mortality for 1993 through 1997 and 12.5 to 37.5 percent for 1998 and beyond.

- Transportation—The analysis models the extension of transportation operations for fall chinook from mid-August in the base case to the end of September starting in 1993. Transportation was modeled to start at Lower Monumental in 1993 as scheduled. Like the 1998 fish guidance efficiency (FGE) estimates, FGE for Lower Monumental was assumed based on studies of dams with similar configurations. Additional number of fish that are transported occurs in the 1998 model runs at the transport projects as collection efficiency improves with bypass system improvements. The analysis models transported fish with a direct mortality of 1 percent due to stress of the transportation process. A review of transport benefit data comparing the adult return rate of transported juveniles to nontransported (inriver) juveniles suggests either: 1) there is a higher latent mortality rate for transported fish than for nontransported fish after release below Bonneville, which is to be expected because many of the fish that are transported are hatchery fish in poor condition and are unlikely to survive whether transported or passed inriver; 2) inriver migration mortality estimates are too high; or 3) an unknown combination of 1 and 2. This model analysis assumed an additional post-Bonneville mortality occurs with transported fish (number 1). Based on an analysis of transportation experiments from 1968 to 1989 and life-cycle models, a post-Bonneville mortality rate of 32 to 76 percent is applied to transported fish, depending on the species and point of collection. Another option (Transport Option 2) also was modeled and used only data from 1986 to 1989 transport experiments reflecting more recent transportation program conditions; the post-Bonneville mortality was set at 34 to 57 percent (See Appendix E for further discussion of post-Bonneville mortality for transported fish).

- Lowered Pool Levels—Decreases in operating pool levels to MOP at the Snake River reservoirs and minimum irrigation pool at John Day Pool are modeled by converting the flows for lower reservoir elevations to velocity equivalent flow rates at normal pool elevations (see CRiSP.0 documentation).

- Spill—This analysis assumes that 1992 spill rates continue through 1997 at all projects, except for Lower Monumental where the 1992 spill rates terminate in 1993. Spill terminates at Ice

Harbor, The Dalles, John Day, and Bonneville for 1998 future conditions.

- Fish Bypass Systems—The Lower Monumental bypass system, the Little Goose and Lower Granite gate raises, Ice Harbor screens, and improvements at Bonneville Powerhouse II are modeled starting in 1993. Bypass systems at The Dalles, a gate raise at Lower Monumental, long screens at Lower Granite and Little Goose, and long screens and a gate raise at McNary are modeled starting in 1998. No improvements in bypass systems are modeled at John Day. The fish guidance efficiencies modeled in the analyses are based on information from the Corps Research Reports and consultation with NMFS researchers and documented in Appendix E, "Input Parameters in CRiSP.0."

Benefits Not Considered in the Analysis

The following potential fish survival benefits were not included in the analysis because of such high uncertainty in either the effects, implementation timing, or the complexity to model appropriately.

- Temperature Control—The analysis assumes no adult survival benefits from use of flow augmentation for water temperature control.

- Fish Ladder Flow Improvements—No improvement in adult passage survival is assumed for improved ladder flows, modification of spill patterns, and ladder entrance gate modifications intended to reduce migration delays at dams, although some researchers (personal communication, T. Bjornn, University of Idaho, Moscow, Idaho, 1992) believe that the benefits of modifying ladder entrances and spill patterns are tangible.

- Bypass Screens for Fallback at Lower Monumental—There is no benefit assumed for spring, summer, or fall adults for reduced turbine mortality from bypass screens added at Lower Monumental.

- Peak Turbine Efficiency—No reduction in mortality for juveniles passing through turbines or adults falling back through turbines is assumed for operating turbines within 1 percent of peak efficiency.

- License Buy-Back and Lease Back—No reduction in fall chinook harvest rates resulting from the NPPC's proposed program to buy back or lease back in-river non-tribal gillnet fishing licenses are modeled. The timing and effectiveness of these actions are uncertain.

- Supplementation—This analysis does not model the effects of existing or future hatchery supplementation programs, nor does it model potential effects of future changes in the management of existing supplementation programs.

- Hatchery Production and Management—This analysis does not model future changes in hatchery production quantity or hatchery fish quality that could potentially affect wild fish stocks.

- Transportation Survival—There is no decrease in the direct or post-Bonneville transportation mortality rates modeled for special-care transportation measures or improved fish condition from reduced incidence of disease or stress.

- Future Flow Augmentation—There are no additional future flow augmentation improvements modeled for the Snake River from additional water rental, irrigation curtailments, or water conservation programs.

- Flow Operations—There are no improvements in survival modeled for increased nighttime flows, increased use of flow block pulsing to stimulate fish movement, and increased priority of flow augmentation for wild-run timing versus hatchery run timing, although coordination with the Fish Passage Center currently includes these measures.

CRiSP and SLCM Model Results

CRiSP.0 is used to model the following conditions for spring, summer, and fall juvenile chinook:

1) 1990 Baseline—The 1990 level of river operating rules with 1990 level of nonflow

measures. This alternative is a benchmark of conditions just prior to the ESA listing of Snake River chinook.

2) Alternative 1 - 1993—SEIS Alternative 1 with 1993 levels of nonflow improvement measures. This alternative is equivalent to a no action alternative (can be referred to as Static 1993 Option for comparison).

3) Alternatives 2 through 5 - 1993—SEIS Alternatives 2 through 5 with 1993 levels of nonflow improvement measures.

4) Alternative 4 - 1998—The SEIS Alternative 4 with 1998 levels of nonflow improvement measures.

Alternative 4 was found not to be significantly different from Alternatives 2, 3, and 5. Hence, only Alternative 4 is the preferred alternative and was run with low, moderate, and high levels of effectiveness for the impacts of squawfish management. Alternatives 1, 2, 3, and 5 were only run at the moderate level of squawfish management effectiveness.

CRiSP.0 results for the 1990 baseline, and Alternatives 1 and 4 at the moderate level of squawfish management effectiveness are shown in Table 4.2-2. The table shows the 10th percentile, median, and 90th percentile estimated system survival rates for Snake River juvenile spring, summer, and fall chinook based on the 50 continuous water years of analysis (1929 through 1978). Changes in estimated survival for Alternative 4 relative to Alternative 1 (no action) conditions in 1993 and for Alternative 4 in 1993 and 1998 relative to 1990 baseline conditions are also shown in Table 4.2-2. The estimated juvenile survival values represent the survival of juveniles from Lower Granite through the system to the tailrace of Bonneville Dam, assuming an additional post-Bonneville equivalent mortality rate of 32 to 74 percent applied to transported fish. The median survival values and relative changes from 1990 baseline conditions at the low, moderate, and high levels of squawfish management for 1993 and 1998 future conditions are provided in Table 4.2-3. A change in survival relative to the 1990 baseline is equal to:

$$\text{Relative \% change in Survival from 1990 Base} = \frac{\text{Alternative} - \text{1990 Baseline}}{\text{1990 Baseline}} \times 100$$

Figure 4.2-1 shows the 10th percentile, median, and 90th percentile estimated juvenile survival levels for Alternatives 1 through 5 for spring, summer, and fall chinook, respectively. These survival levels are at the moderate level of squawfish management effectiveness.

The SLCM was run for the following conditions for spring, summer, and fall chinook:

- 1990 Baseline—This is the estimated escapement trend under future conditions with 1990 level of river operating rules and 1990 level of nonflow improvement measures. This is a baseline from which to measure the effects of improvement measures implemented and planned for implementation since 1991.

- 1993 and Future—This is the estimated escapement trend under future conditions with 1993 proposed river operations (Alternative 4) with 1993 level of nonflow improvement measures in effect through 1997, and 1998 level of nonflow improvement measures in effect starting in 1998.

The SLCM results are shown in Figures 4.2-2 through 4.2-4 for the projected spawning escapement trends for spring, summer, and fall chinook for both the baseline conditions and the proposed 1993 and future conditions. The 1993 and future action analysis includes three different levels of effectiveness for the measures taken for squawfish management, adult fallback screening, ladder temperature improvements, increased law enforcement, habitat quality improvements, irrigation diversion screening, and reductions in Hells Canyon redd dewatering. These levels are identified as low, moderate, and high effectiveness and correspond to analyses with these measures all set to the low, mid-point, and high levels of the assumed ranges of effectiveness.

The projected median escapement level shown on each figure is based on 500 stochastic simulations. The 10th and 90th percentile lines on the graphs are the boundaries surrounding 80 percent of the 500 simulated populations for each of the 40 years. The 10th percentile lines (lowest lines on each figure) show the escapement level above which

Table 4.2-2. Smolt hydrosystem estimated survival percentages and relative percent change from the baseline conditions at the moderate level of squawfish management effectiveness.

Condition	CRiSP.0 Survival	Species		
		Spring	Summer	Fall
		Passage Survival (Percent)		
1990 Baseline	10th Percentile	16.8	15.7	6.6
	Median	20.8	19.9	12.4
	90th Percentile	22.6	22.5	17.2
Alt. 1 - 1993 (Static 1992 Option)	10th Percentile	18.2	17.1	9.3
	Median	21.4	20.7	16.2
	90th Percentile	22.9	22.9	21.1
Alt. 4 - 1993	10th Percentile	19.2	17.8	10.0
	Median	22.2	21.5	15.9
	90th Percentile	23.1	23.2	20.6
Alt. 4 - 1998	10th Percentile	21.0	19.8	15.9
	Median	23.3	22.8	22.0
	90th Percentile	24.1	24.3	26.2
		Relative Increase in Passage Survival (Percent)		
Increase Alt. 1 - 1993 to Alt. 4 - 1993	10th Percentile	5.2	4.1	7.5
	Median	3.7	3.9	-1.9
	90th Percentile	0.9	1.3	-2.4
Increase 1990 Baseline to Alt. 4 - 1993	10th Percentile	14.3	13.4	51.5
	Median	6.7	8.0	28.2
	90th Percentile	2.2	3.1	19.8
Increase 1990 Baseline to Alt. 4 - 1998	10th Percentile	25.0	26.1	140.9
	Median	12.0	14.6	77.4
	90th Percentile	6.6	8.0	52.3

Note: Numbers are rounded to the nearest 0.1%. The relative increases were calculated prior to rounding, so some slight differences may appear.

90 percent of the estimated spawning escapements were projected to occur for each year.

The results of the SLCM shown in Figure 4.2-5 indicate the percent of the 500 population projections falling below a specified low level of spawning fish in each year. This level was set by the modelers at 1,000 spawners for spring chinook, 500 spawners for summer chinook, and 250 spawners for fall chinook. These levels were set to show changes in population trends based on the

Table 4.2-3. CRiSP.0 median estimated survival and relative changes in survival from the 1990 baseline conditions for all levels of effectiveness of squawfish management.

Condition	Spring	Summer	Fall
	Passage Survival (Percent)		
1990 Baseline	20.8	19.9	12.4
1993 Low	22.0	21.2	15.4
1993 Moderate	22.2	21.5	15.9
1993 High	22.5	21.8	16.4
1998 and Future Low	22.5	21.9	20.1
1998 and Future Moderate	23.3	22.8	22.0
1998 and Future High	24.0	23.5	24.1
	Relative Increase in Survival from 1990 Baseline (Percent)		
1993 Low	5.8	6.5	24.2
1993 Moderate	6.7	8.0	28.2
1993 High	8.2	9.5	32.3
1998 and Future Low	8.2	10.0	62.1
1998 and Future Moderate	12.0	14.6	77.4
1998 and Future High	15.4	18.1	94.4

Note: Numbers are rounded to the nearest 0.1%. The relative increases were calculated prior to rounding, so some slight differences may appear.

magnitude of current run sizes and are not intended to represent a critical population number.

The probability of the estimated population escapement levels decreasing or increasing over time were analyzed by regressing each of the 500 projected 40-year spawning escapement trends. Each regression trend line was tested with T-tests for statistically significant increasing or decreasing slopes at the 95 percent confidence level. Table 4.2-4 shows the percent of the escapement projections having a statistically significant negative or positive slope and those having no statistically significant slope.

In addition to the low, moderate, and high effectiveness levels of uncertainty modeled and reported in the analysis, the three levels were combined assuming equal probability of occurrence and reported as "All" levels of effectiveness (Table 4.2-4). The figures and tables sharing "All Effectiveness" are based on 1,500 simulations (three effectiveness levels with 500 simulations per level).

Spring and Summer Chinook

In general, CRiSP.0 results (Table 4.2-2) show that estimated spring and summer chinook juvenile survival increases slightly with the SEIS flow measures (difference between Alternatives 1 and 4), and that significant additional survival improvements result from the addition of nonflow improvement measures such as increased transportation, squawfish management, and bypass system additions/improvements (1990 baseline compared to Alternative 4 1993 and 1998). Improvement measures provide more significant benefits in low survival years. Approximately one-half of the median estimated survival increases projected for spring and summer chinook in 1993 are a result of flow augmentation and reduced elevation operational measures. By 1998, approximately one-quarter of the median estimated survival increases are due to flow measures. The

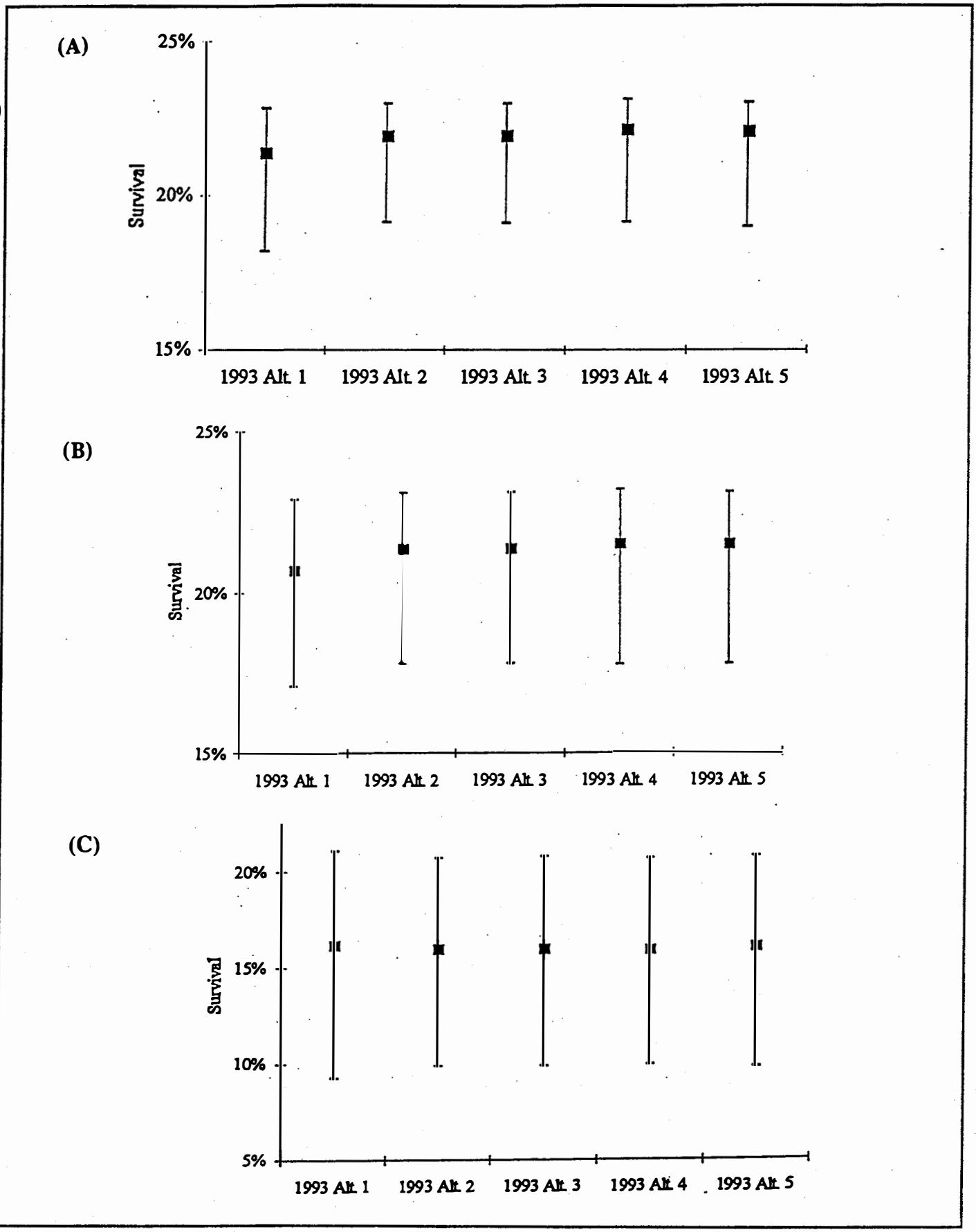
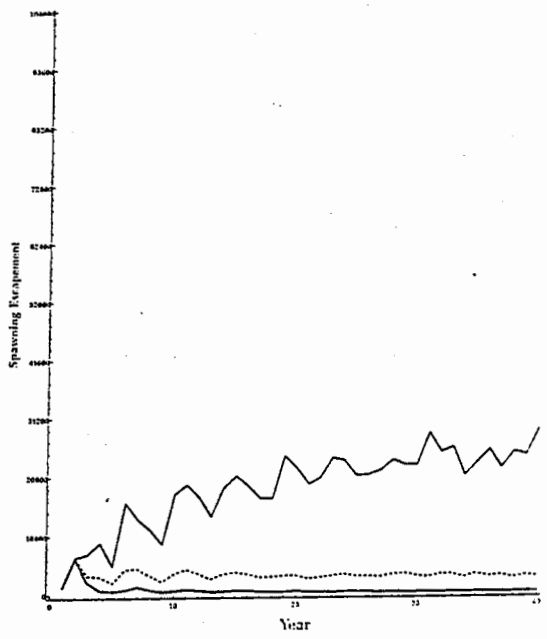
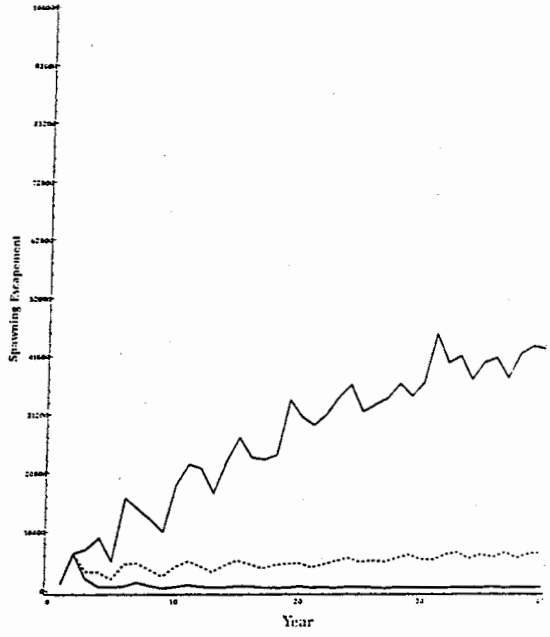


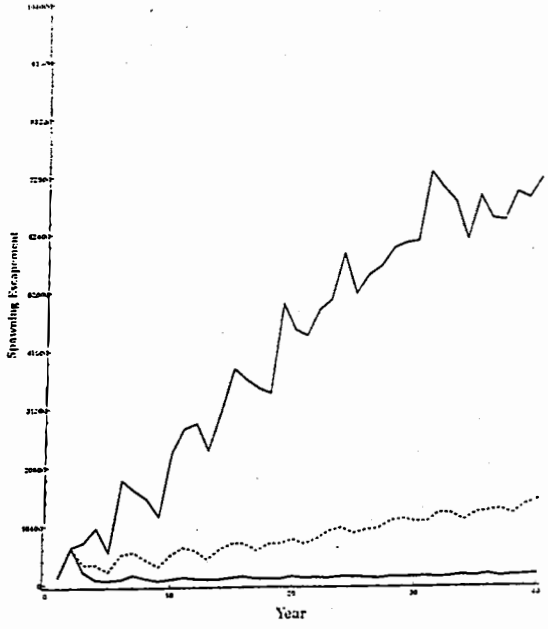
Figure 4.2-1. Spring (A), summer (B), and fall (C) chinook smolt hydrosystem survival percentages (10th percentile, median, and 90th percentile) for the SEIS flow alternatives under moderate effectiveness of squawfish management.



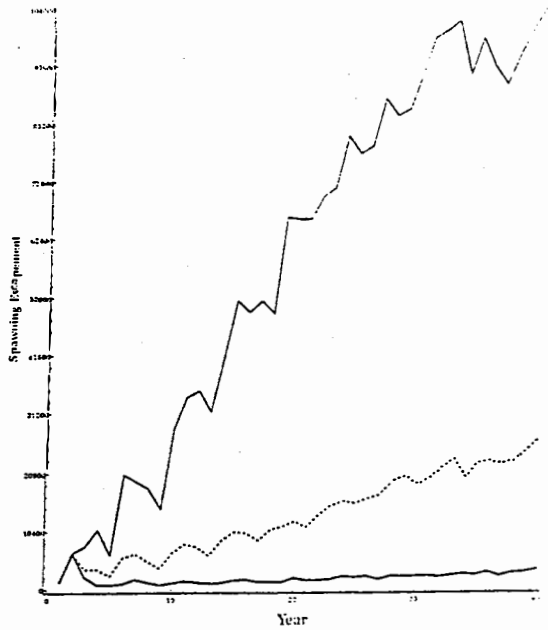
1990 Baseline Conditions



1993 and Future Conditions – Low Effectiveness

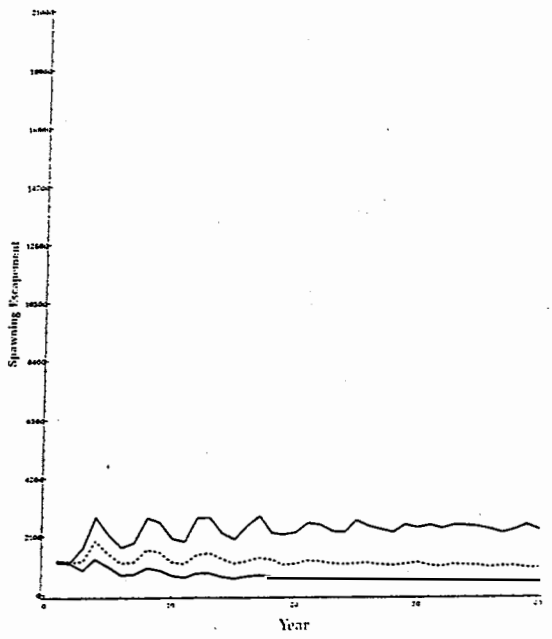


1993 and Future Conditions – Moderate Effectiveness

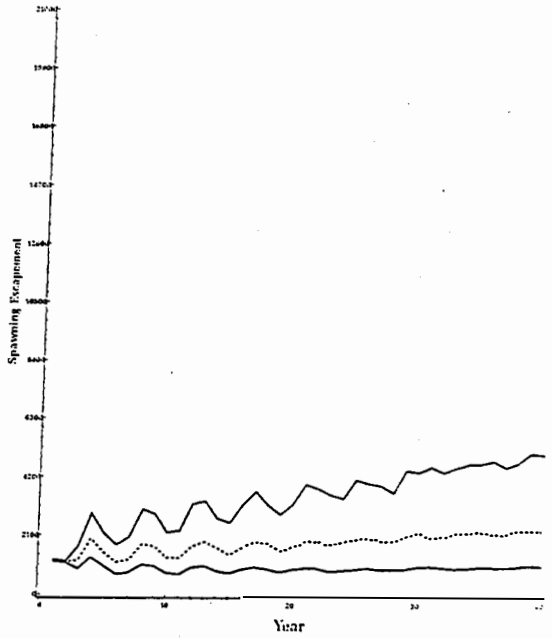


1993 and Future Conditions – High Effectiveness

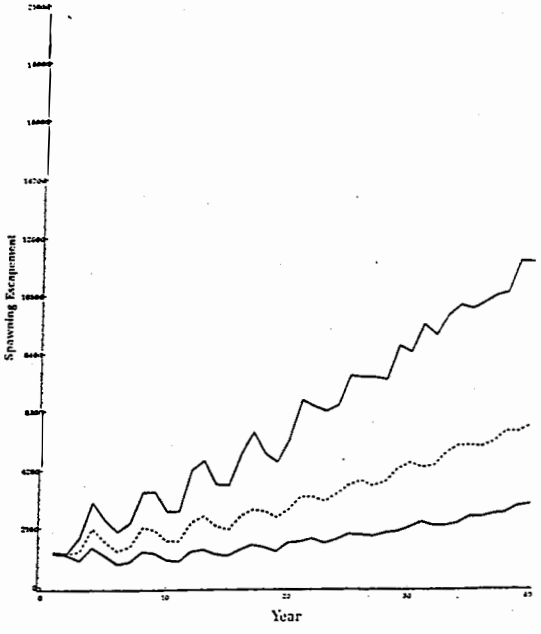
Figure 4.2-2. Snake River spring chinook salmon escapement based on SLCM 500 game and 40-year simulation for baseline and modified system alternatives. Lines denote 90th percentile (upper), median, and 10th percentile (lower) values.



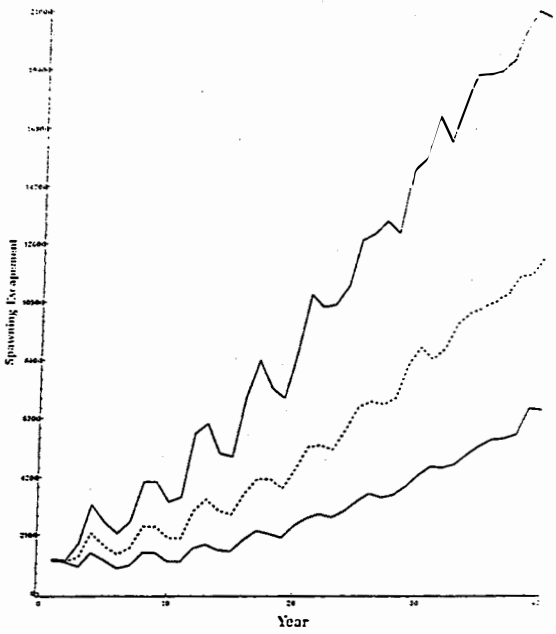
1990 Baseline Conditions



1993 and Future Conditions – Low Effectiveness

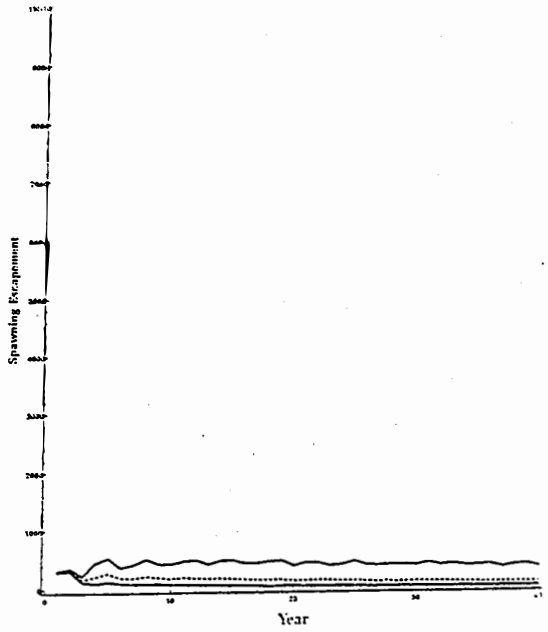


1993 and Future Conditions – Moderate Effectiveness

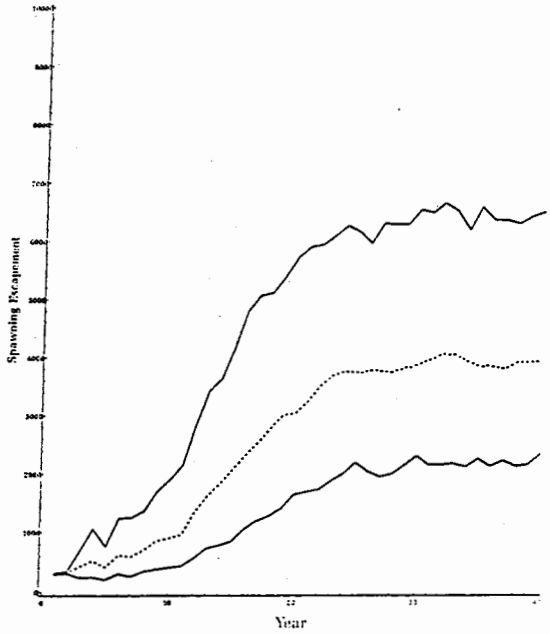


1993 and Future Conditions – High Effectiveness

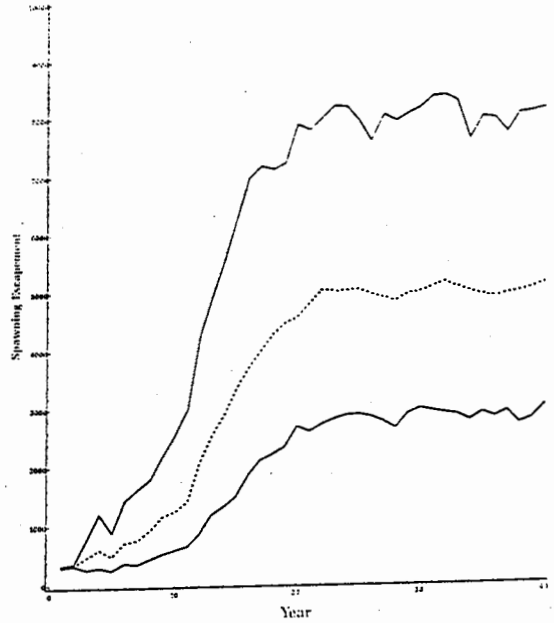
Figure 4.2-3. Snake River summer chinook salmon escapement based on SLCM 500 game and 40-year simulation for baseline and modified system alternatives. Lines denote 90th percentile (upper), median, and 10th percentile (lower) values.



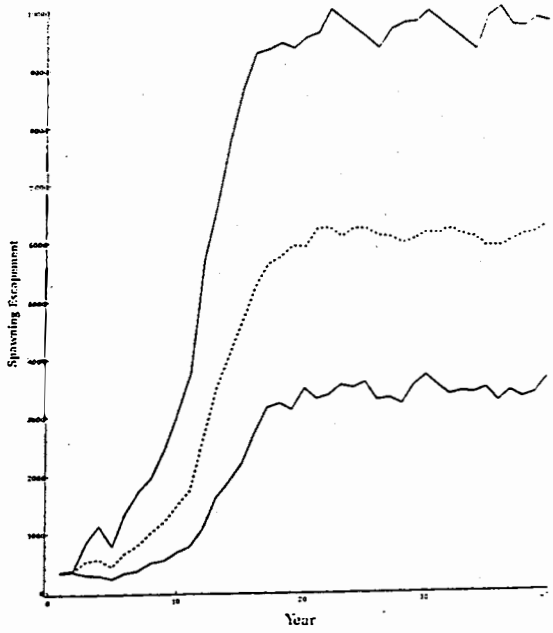
1990 Baseline Conditions



1993 and Future Conditions – Low Effectiveness

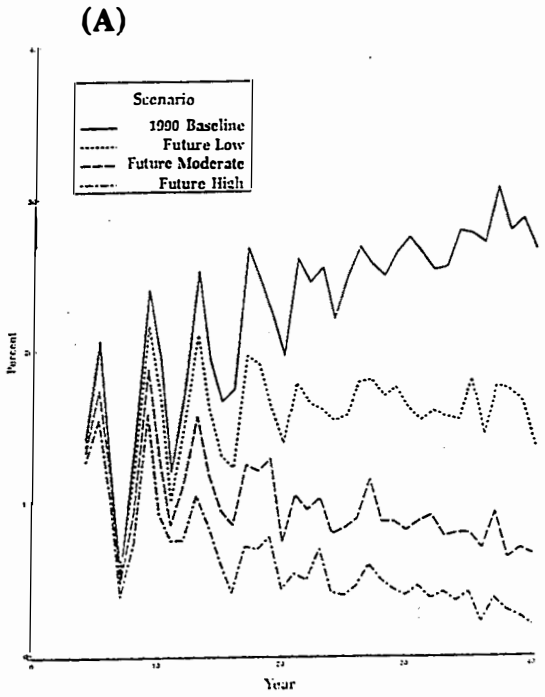


1993 and Future Conditions – Moderate Effectiveness

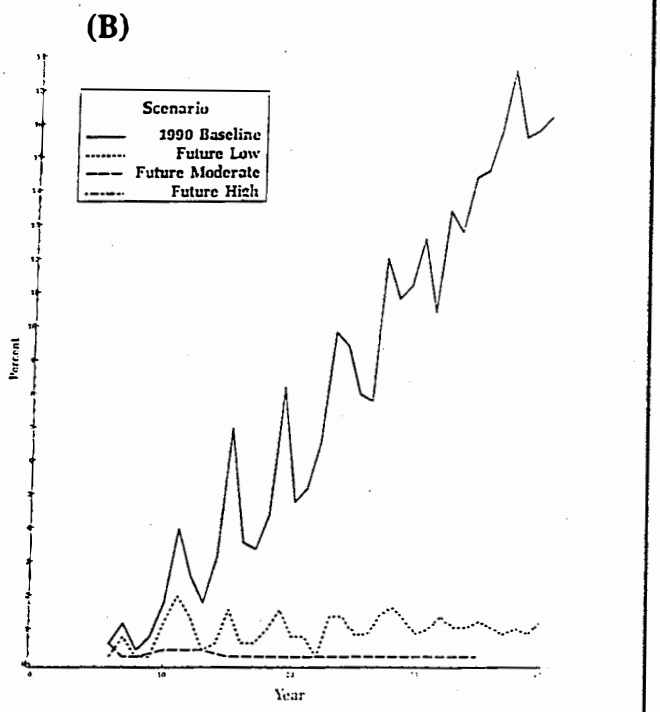


1993 and Future Conditions – High Effectiveness

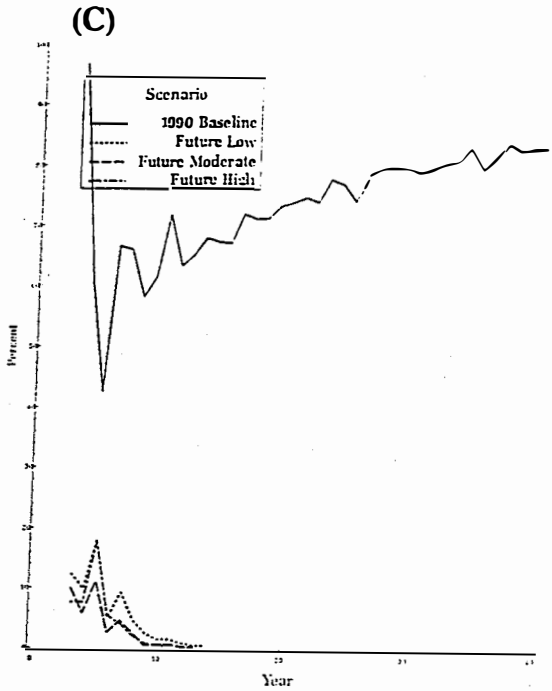
Figure 4.2-4. Snake River fall chinook salmon escapement based on SLCM 500 game and 40-year simulation for baseline and modified system alternatives. Lines denote 90th percentile (upper), median, and 10th percentile (lower) values.



Percent of Simulations Below 1000 spawners



Percent of Simulations Below 500 spawners



Percent of Simulations Below 250 spawners

Figure 4.2-5. Percent of simulation for spring (A), summer (B), and fall (C) chinook escapement below specified values based on SLCM 500 game and 40-year simulation.

Table 4.2-4. Percent of estimated escapement projections with a significantly negative, no change, and positive slope (two-tailed Student's T test; $\alpha = 0.05$).[1/]

Species	Scenario	Trend in Slope of spawners		
		Negative (%)	No Change (%)	Positive (%)
Spring Chinook	Baseline	24	47	29
	Low Future	12	43	45
	Moderate Future	4	33	63
	High Future	1	24	76
	All Future	6	33	61
Summer Chinook	Baseline	49	38	13
	Low Future	4	28	68
	Moderate Future	0	1	99
	High Future	0	0	100
	All Future	1	10	89
Fall chinook	Baseline	71	21	9
	Low Future	0	0	100
	Moderate Future	0	0	100
	High Future	0	0	100
	All Future	0	0	100

[1/] Future runs are 1993 flow with 1993 nonflow actions until 1997, and 1998 nonflow actions beyond 1998.

model results shown in Figure 4.2-1 show that Alternatives 2 through 5 provide minor improvements relative to Alternative 1 (no action), and that there is no significant differences between Alternatives 2 through 5.

More specifically, CRiSP.0 results show that for 1993 the Alternative 4 flow measures compared to Alternative 1 provide a relative increase in the 10th percentile, median, and 90th percentile estimated survivals of Snake River spring/summer juvenile migrants of 5.2, 3.5, and 1.0 percent for the spring component and 3.8, 3.9, and 1.1 percent for the summer component. In addition, the results show that, relative to 1990 baseline conditions, the Alternative 4 1993 flow and nonflow actions increase the 10th percentile, median, and 90th percentile estimated survivals by 14.3, 6.5, and 2.4 percent for the spring component and 13.4, 8.3, and 3.1 percent for the summer component. The results also show that by 1998 the Alternative 4 flow and nonflow actions provide a relative increase in the 10th percentile, median, and 90th percentile estimated survivals of 25.1, 11.8, and 6.9 percent for the spring component and 26.2, 14.6, and 8.2 percent for the summer component.

In general, the SLCM results for the spring and summer chinook components show that at all levels of effectiveness considered for Alternative 4, the projected median estimated escapement levels increase over time relative to 1990 baseline conditions. The probability of escapement projections falling below 1,000 spawners for the spring component and 500 spawners for the summer component is increasing with time under 1990 baseline conditions and stable or decreasing with time under each of the effectiveness levels for

Alternative 4. Relative to the 1990 baseline conditions, the percent of decreasing estimated escapement projections are significantly reduced under each of the effectiveness levels.

More specifically, the SLCM results for the spring chinook component show that under 1990 baseline conditions the median estimated spawning escapement is expected to remain steady over the 40 years at approximately 3,000 adults, with 10th and 90th percentiles at 40 years of approximately 0 and 30,000 (Figure 4.2-2). The considered actions increase the 40-year median projections for low, moderate, high, and all levels of effectiveness of measures from approximately 3,000 adults to approximately 7,000, 14,000, and 27,000, adults, respectively (Figure 4.2-2). The 10th and 90th percentiles estimated for the proposed actions range from less than 1,000 adults (low effectiveness 10th percentile) to over 100,000 adults (high effectiveness 90th percentile). All effectiveness results were similar for moderate effectiveness.

Under the 1990 baseline conditions for the spring chinook component, the probability of estimated escapement levels falling below 1,000 spawning adults increases over time to approximately 28 percent by the 40th year (Figure 4.2-5). The probability of estimates being below 1,000 adults is stable under the low-effectiveness level at approximately 16 percent and decreases under moderate, high, and combined levels of effectiveness to 7, 3, and 8 percent by the 40th year (Figure 4.2-5). The percent of simulations with a decreasing escapement trend changes from 24 percent under baseline conditions to 12, 4, and 1 percent respectively under low, moderate, high, and combined levels of effectiveness (Table 4.2-4).

The specific SLCM results for the summer chinook component show that under baseline conditions the median estimated spawning escapement starts in the range of approximately 1,200 adults and decreases slightly to a 40-year median projected run size of approximately 1,000 adults, with 10th and 90th percentiles of approximately 300 and 2,100 adults (Figure 4.2-3). The alternative actions increase the 40-year median projections for low, moderate, and high levels of effectiveness of 1993 measures from approximately 1,200 adults to approximately 2,200, 6,000, and 12,000, respectively, with "All" adults similar to moderate adults (Figure 4.2-3). The 10th and 90th percentiles for the proposed actions range from an estimated 1,000 adults (low effectiveness 10th percentile) to over 21,000 adults (high effectiveness 90th percentile).

Under the baseline conditions for the summer chinook component, the probability of estimated escapement levels falling below 500 spawning adults increases over time to approximately 16 percent by the 40th year (Figure 4.2-5). The probability of estimates being below 500 adults is stable under the low-effectiveness level at approximately 1 percent and decreases under moderate high, and combined levels to less than 1 percent with "All" adults similar to moderate by the 40th year (Figure 4.2-5). The percent of simulations with a decreasing estimated escapement trend changes from 49 percent under baseline conditions to 4, 0, 0, and 1, respectively, under low, moderate, high, and combined levels of effectiveness (Table 4.2-4).

Fall Chinook

In general, CRiSP.0 results (Table 4.2-2) show that estimated fall chinook juvenile survival is relatively insensitive to the SEIS flow measures (difference between Alternatives 1 and 4) compared to the more significant survival improvements shown with the addition of nonflow measures such as improved transportation, squawfish management, and bypass system additions/improvements (differences between the 1990 baseline and Alternative 4 - 1993 and 1998). The results shown in Table 4.2-2 and Figure 4.2-1 show that Alternatives 2 through 5 decrease the median estimated survival level slightly, around 2 percent, and provide minor improvements in low survival years relative to Alternative 1. These results also show no significant differences between Alternatives 2 through 5.

More specifically, CRiSP.0 results show that compared with Alternative 1 conditions, the Alternative 4 - 1993 conditions provide a relative change in the 10th percentile, median, and 90th percentile estimated survivals of Snake River fall chinook juvenile migrants of 7.6, -1.9, and -2.1 percent. In addition, the results show that, relative to 1990 baseline conditions, the Alternative 4 - 1993 conditions increase the 10th percentile, median, and 90th percentile estimated survivals by

50.8, 28.7, and 20.1 percent, respectively. The results also show that by 1998 the Alternative 4 and other nonflow actions provide a relative increase in the 10th percentile, median, and 90th percentile estimated survivals of 140.9, 78.1, and 52.8 percent, respectively.

The estimated increase in downstream passage survival of fall chinook remains small until the 1998 conditions are in place. Estimated median downstream passage survival ranges from about 12 percent during baseline conditions to 22 percent for Alternative 4 - 1998 conditions. Essentially no estimated difference occurs between Alternatives 1 and 4 - 1993 median conditions. However Alternative 4 - 1993 and 1998 median conditions improve estimated survival by about 4 and 10 percent over 1990 baseline conditions, respectively.

In general, the SLCM results for fall chinook show that at all levels of effectiveness considered the projected median escapement levels increase over time relative to 1990 baseline conditions. The probability of escapement projections falling below 250 spawners is increasing with time under baseline conditions and decreasing with time under each of the effectiveness levels for Alternative 4. Relative to the baseline conditions, the percent of decreasing escapement projections are significantly reduced under each of the effectiveness levels.

More specifically, the SLCM results for fall chinook show that under baseline conditions the estimated spawning escapement starts in the range of approximately 300 adults and decreases to a 40-year median projected run size of less than 200 adults, with 10th and 90th percentiles of approximately 0 and 300 adults (Figure 4.2-4). The considered actions increase the 40-year median projections for low, moderate, and high effectiveness of measures from approximately 300 adults to approximately 4,000, 5,200, and 6,400 adults, respectively, with "All" similar to moderate (Figure 4.2-4). The 10th and 90th percentiles for the proposed actions range from an estimated approximately 2,400 adults (low effectiveness 10th percentile) to approximately 9,800 adults (high effectiveness 90th percentile).

Under the baseline conditions for fall chinook, the probability of estimated escapement levels falling below 250 spawning adults increases over time to approximately 84 percent by the 40th year (Figure 4.2-5). There are no projections below 250 adults under any level of effectiveness by the 40th year (Figure 4.2-5). The probability of a decreasing escapement trend changes from 71 percent under baseline conditions to 0 percent under each level of effectiveness (Table 4.2-4).

Sensitivity Analyses

In an attempt to evaluate uncertainties, sensitivity analyses were performed for post-transportation survival, flow survival relationship for fall chinook only, and a zero level of squawfish management control. Alternative assumptions regarding post-transportation survival and the subyearling flow-travel time relationship were used to evaluate the effects of the proposed actions.

Sensitivity to Post-transportation Survival

Two options regarding post-transportation survival were modeled for spring, summer, and fall chinook. Transport Option 1, used in the main SEIS, assumes that post-transportation survival is calculated using all available data from the NMFS transportation experiments (see Appendix E). Transport Option 2 assumes that post-transportation survival is calculated using only data from the NMFS transportation experiments conducted since 1986 (see Appendix E). Transport Option 2 results in higher post-transportation survival for all chinook, except for fall chinook transported from McNary (see Appendix E). Both options were modeled under the 1990 Baseline Conditions and 1993 Proposed Actions (Alternative 4; moderate effectiveness) cases. Table 4.2-5 and Figure 4.2-6 show the results of the sensitivity analysis for spring, summer, and fall chinook. The absolute smolt survival for all species was higher for Transport Option 2 (higher post-transport survival) than for Transport Option 1. However, the relative increase in smolt survival from the 1990 Baseline Conditions to the 1993 Proposed Actions case showed little change for spring, summer, and fall chinook.

Sensitivity to Fall Chinook Flow-Travel Time

Two options were modeled for the relationship between flow and travel time for subyearling (fall) chinook smolts. Flow-Travel Time Option 1,

Table 4.2-5. Percent change in estimated median survival between baseline conditions and the 1993 actions - moderate effectiveness case for the two options for post-transportation survival and fall chinook flow-travel time.

Sensitivity	Species		
	Spring	Summer	Fall
Transport option 1	6.49%	8.31%	28.74%
Transport option 2	6.60%	7.72%	27.12%
Fall flow-travel time option 1	--	--	28.74%
Fall flow-travel time option 2	--	--	32.81%

Note: The fall chinook flow-travel time options have no differential effect on spring and summer smolt survival.

which was used in the main SEIS analyses, assumes that flow and travel time are related. That is, higher flows result in faster travel times (see Appendix E). Flow-Travel Time Option 2, assumes that travel time is constant and thus independent of flow (see Appendix E). Both options were modeled under the 1990 Baseline Conditions and 1993 Proposed Actions (Alternative 4; moderate effectiveness) cases. Table 4.2-5 and Figure 4.2-7 show the results of the sensitivity analysis. The smolt survival for fall chinook was higher for Flow-Travel Time Option 2 than for Flow-Travel Time Option 1. The relative increase in smolt survival from the 1990 Baseline Conditions to the 1993 Proposed Actions case was slightly greater under Flow-Travel Time Option 2 (Table 4.2-5). Thus, the survival improvements predicted by CRiSP.0 would be slightly higher if travel time was assumed to be independent of flow for fall chinook.

Sensitivity to No-Squawfish Control

A no-squawfish-control case was modeled under 1993 Proposed Actions conditions (Alternative 4). Figure 4.2-8 compares the resulting passage survival for no-squawfish-control effect and all levels of squawfish management under 1993 Proposed Actions conditions to the 1990 Baseline conditions. Table 4.2-3 also shows the median survival levels for low, moderate, and high effectiveness levels in 1993 and 1998 (future) and their effects on the increase in survival relative to the 1990 baseline. This analysis shows that the majority of survival improvements for 1993 are from measures other than squawfish management. In general, for spring and summer chinook approximately one third of the 1993 increase in median survival is the result of squawfish management under the moderate level of effectiveness. The low and the high ranges of effectiveness change the 1993 median survival increase for spring and summer chinook by plus or minus approximately 15 to 20 percent. For fall chinook approximately one-quarter of the 1993 increase in median survival is the result of squawfish management under the moderate level of effectiveness. The low and high ranges of effectiveness change the 1993 median survival increase by plus or minus approximately 15 percent.

4.2.4 NPPC Model Analysis

Model analyses of actions considered in the SEIS using PAM and SPM were conducted by NPPC staff at the request of the cooperating agencies. The actual model results and analysis developed by the NPPC are presented in detail in Appendix F (Anderson and McConnaha, 1992) and are summarized below.

This assessment by NPPC was confined to spring/summer chinook defined by the ESA listing. Three primary scenarios were modeled: 1990 baseline conditions, 1993 static conditions (approximating

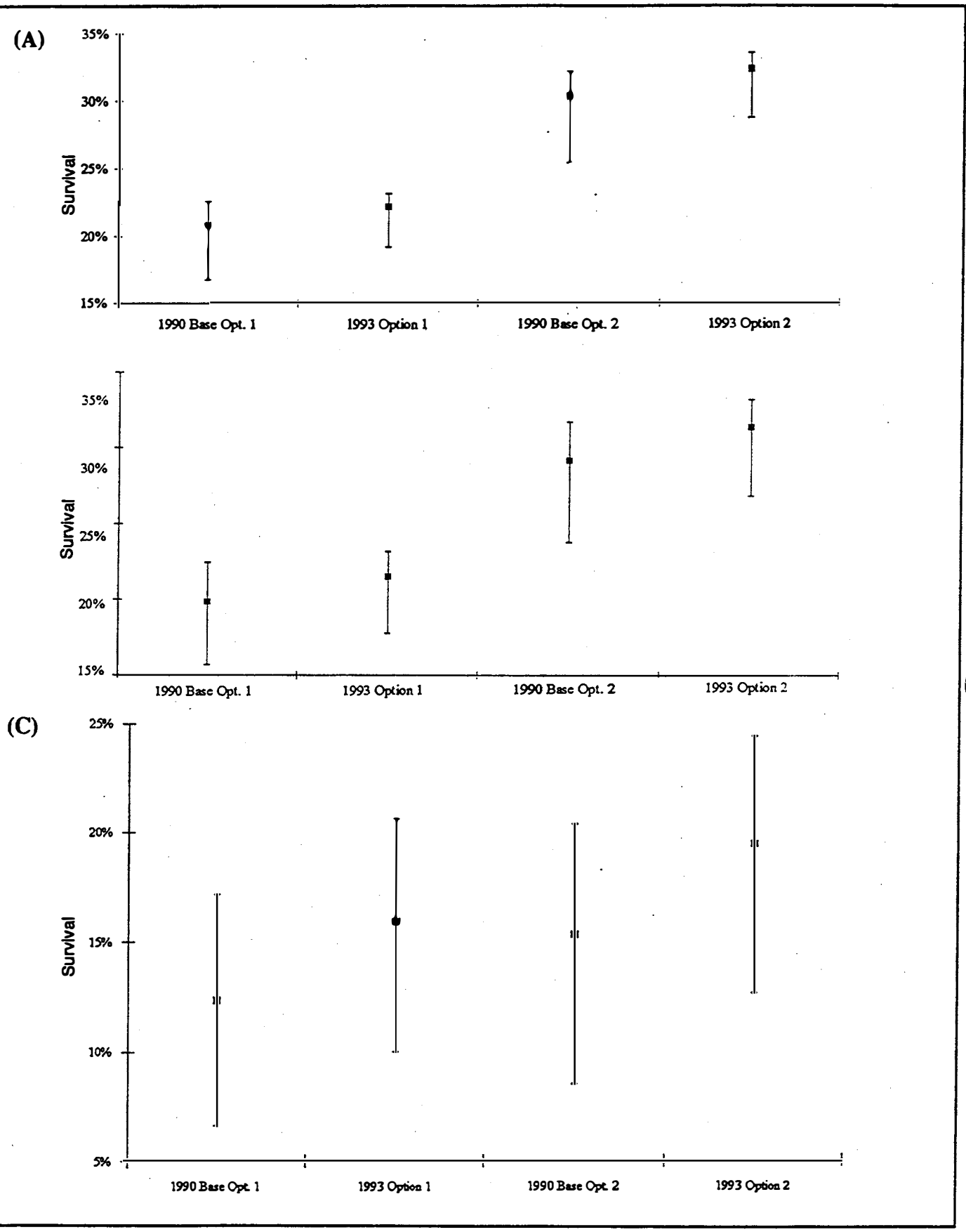


Figure 4.2-6. Spring (A), summer (B), and fall (C) chinook smolt hydrosystem survival percentages (10th percentile, median, and 90th percentile) for Transportation Options 1 and 2 under the Baseline Conditions and moderate squawfish management effectiveness and 1993 Alternative 4.

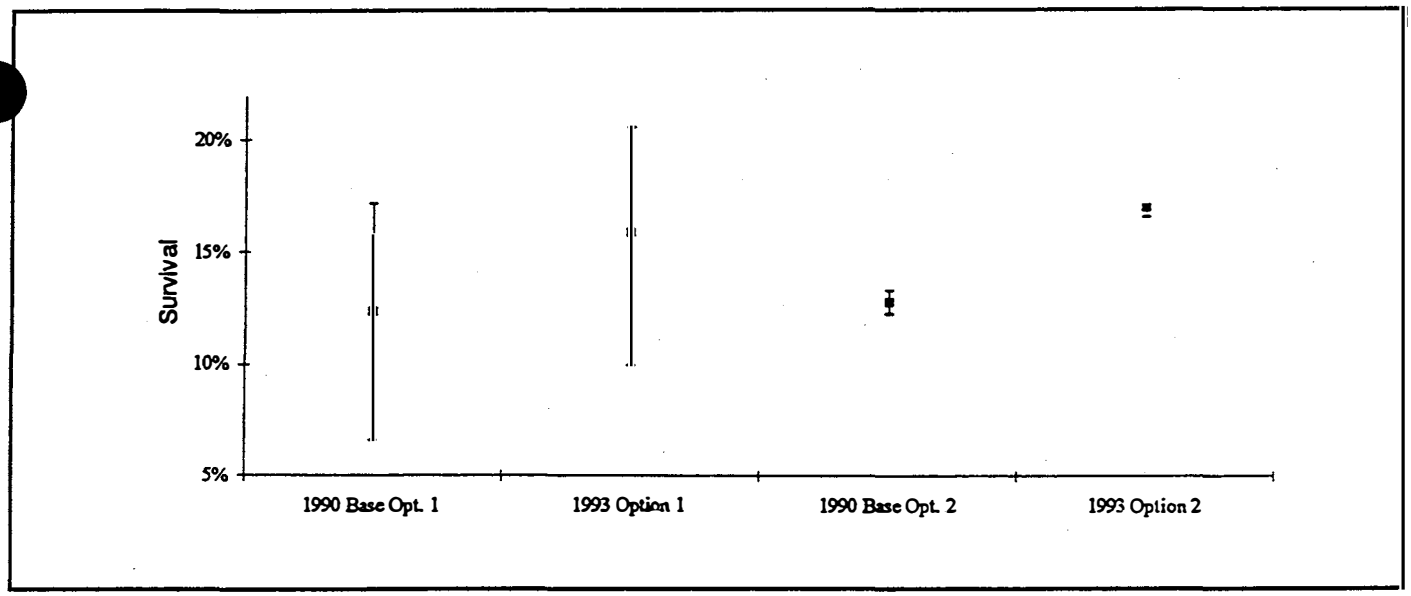


Figure 4.2-7. Fall chinook smolt hydrosystem estimated survival percentages (10th percentile, median, and 90th percentile) for Flow-Travel Time Options 1 and 2 under the Baseline Conditions and moderate squawfish management effectiveness and Alternative 4.

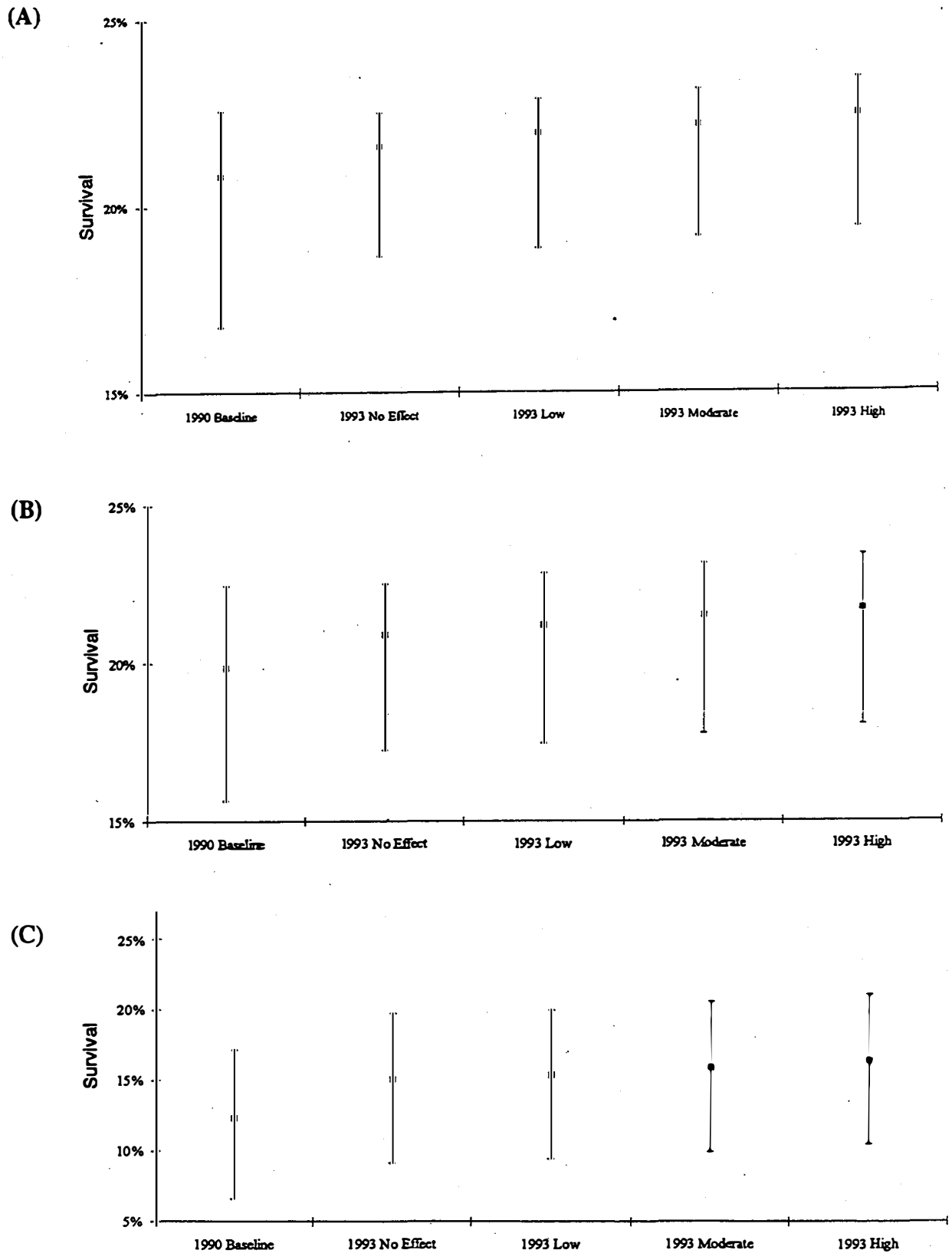


Figure 4.2-8. Spring (A), summer (B), and fall (C) chinook smolt hydrosystem estimated survival percentages (10th percentile, median, and 90th percentile) for the levels of effectiveness of squawfish management under Alternative 4.

Alternative 4 during 1993), and 1993 and future operations, which is similar to Alternative 4 conditions by 1998.

Analytical Methods

Four main areas of concern are targeted in this analysis including flows, production factors in the spawning and rearing areas, downstream passage survival, and upstream passage survival. Ocean survival and harvest were not manipulated in this analysis.

The analysis was confined to Snake River spring chinook. A baseline condition (pre-1992), was compared to the effects of the 1992 to 1993 operation of the hydroelectric system and estimates through and beyond 1998 (referred to as the 1993 static conditions) and to the potential effects of a set of future assumptions and estimates through 1998 and beyond (referred to as 1993 and future conditions). These options were examined at two levels of effectiveness (low and high). Parameter values for these levels are comparable to the low and moderate levels of effectiveness in the BPA analysis as coordinated between the agencies. This analysis did not examine the effect that other future actions, such as additional flow or pool drawdown below MOP, for example, might have on rebuilding. This analysis was designed to mimic the operating conditions postulated by the Corps, BoR, and BPA.

An important aspect of forecasting the biological impacts of the 1993 operations is the effect of scientific and environmental uncertainties. It is important to understand that it is not possible to forecast the biological impacts with certainty. For example, not only is it impossible at this time to forecast runoff and flow for 1993 and future years but also significant scientific uncertainties exist regarding smolt transportation, the effect of water velocity on fish survival, the underlying biological productivity of important fish populations, and other factors. What is possible is to examine a range of outcomes under plausible assumptions over a range of environmental conditions. The effects of these uncertainties on the ability to forecast biological outcomes are important considerations that should affect judgements regarding the potential biological impacts of the 1993 operations.

An effort was made to treat these uncertainties by providing forecasts under two levels of effectiveness of proposed actions. Because of the uncertainty regarding the runoff and flow conditions for the 1993 and future years, the effect of 1993 actions on estimated passage survival was treated as a probability function based on the 50-year record of runoff from 1929 to 1978.

Results of the 1993 static and 1993 and future conditions were compared to the baseline condition using a low/high range of assumptions for three areas of biological uncertainty:

1) The effectiveness of predator control to reduce reservoir mortality,
2) The effectiveness of actions to reduce adult passage mortality, and
3) The effectiveness of habitat restoration projects to increase sub-basin productivity (egg-to-smolt, and smolt-to-smolt survival rate).

Five options with different assumptions were modeled and are shown in Table 4.2-6. Each option was run 500 times with the System Planning Model for a 20-year period (5 life cycles). Estimated downstream passage survival rates were picked randomly (year to year) by the model from the mainstem passage file used in the particular option. For each option, actions that are taken to rebuild Snake River spring chinook remained constant for the duration of the run as opposed to being phased in at the schedule; that is, all assumed changes are in the input files at the start of each run. Estimated escapement to sub-basin by run and year was output (a total of 10,000 output records per option). These results were read into SAS, a statistical software package, that calculated the median as well as 10-percent and 90-percent confidence limits for the estimated escapement by year. These values were plotted by scenario in the results section. The analysis and the resulting combinations of actions are outlined in Table 4.2-6.

Two flow files (one for the 1990 planned operation condition and one for the 1992 to 1993 planned operations) were used. These flow records were provided by the Corps from their HYSSR Model.

Table 4.2-6. Option layout for Snake River spring chinook analysis.[a/]

Parameter	Baseline	1993 Static		1993 and Future	
		Low	High	Low	High
Production					
Egg-Smolt	0.1375	0.1375	0.1375	0.1375	0.1512 (+10%)
Smolt-Smolt	0.95	0.95	0.95	0.95	0.98 (+3.5%)
Downstream Passage					
Predator Control	0%	0%	+7.5%	0%	+25%
FGEs	Pre-92	1993 Values	1993 Values	1996 Values	1996 Values
Transportation	Pre-92	LoMo Online	LoMo Online	LoMo Online	LoMo Online
Upstream Passage					
Total Adult Survival	0.468	0.468	0.489 (+5%)	0.468	0.489 (+5%)

(Source: Anderson and McConnaha, 1992)

a/ Transportation model 1 was used for this analysis, calibration was to wild adult counts at Lower Granite Dam from 1979 to 1991 (average=6879, coefficient of variation=0.55), and a smolt-to-adult survival rate of 0.44 percent (to Lower Granite Dam). High scenarios are set to match moderate effectiveness parameters from discussions with BPA on their modeling parameters.

Baseline Conditions

Because the primary focus of this analysis is to explore the implications of the proposed 1993 flow operations on the stocks involved, all of the mainstem operation and flow assumptions were made by the Corps using their HYSSR Model. For the 1990 baseline condition, the analysis attempted to describe the system operation prior to any of the operational modifications generated by the Salmon Summit and successors. It incorporated the current Water Budget and assumed normal pool elevation for all reservoirs. Standard length screens were present at all projects except Ice Harbor, Lower Monumental, and The Dalles.

1993 Static Conditions

This analysis attempted to model as closely as possible the operating strategy reflected in 1992 operations (Alternative 2). The results for Alternatives 3, 4, and 5 would be similar, based on an examination of HYSSR runs. PAM is not sensitive to the source of the flows, but incorporates the flow at the top of Lower Granite Reservoir. Therefore, results from Alternative 2 can be applied to Alternatives 3, 4, and 5. Alternative 2 is similar to the NPPC's Phase II program (adopted in December 1991) except that this plan ensured a minimum of 900 KAF in the intermediate runoff range and allocated more water to refill in high runoff years. Lower Snake projects were operated to 1 foot over MOP for the spring outmigration, and John Day Pool was operated at an elevation of 263.5 feet during this same period. Standard length screens were assumed to be functional at Lower Monumental Dam, transportation was operational, and voluntary spill was discontinued. At Ice Harbor Dam, standard length screens were assumed to be functional.

1993 and Future Operations

The 1993 and future operations were distinguished from the 1993 static conditions with the addition of extended screens at Lower Granite, Little Goose, and McNary, plus the addition of standard length

screens at The Dalles and a gate raise at Lower Monumental. These conditions more closely approximate BPA-modeled 1998 conditions.

Passage Analysis Model

The estimated downstream passage survival rates for this study were calculated using PAM, a Quattro Pro spreadsheet model written at NPPC.

Input parameters and calibration methods used in PAM are shown in Appendix F. The parameters used include survival, bypass routes, pool elevation, and fish guidance efficiency for each of the 5 options modeled.

The effects of values from the PAM analysis varied among the 5 options, such as the effects of changes in flow, reservoir level, addition of screens, screen lengthening, and added transport from Lower Monumental (Table 4.2-6).

System Planning Model

The SPM is a life-cycle model that uses the survival estimates from PAM and additional factors to estimate returning numbers of adults to the basin. This model requires estimates of a variety of life-cycle characteristics independent of estimated downstream passage survival. A detailed description of the values used for the SPM is presented in Appendix F. Factors in the model that were varied in this analysis were assumed egg-to-smolt survival, smolt-to-smolt survival, and upstream passage survival.

The transport model (Model 1, Appendix F) used in the analysis is based on the results of Matthews (1992) and assumes that survival of transported fish is held constant and does not vary with flow while in-river conditions change. A discussion of this model and other transport models is presented in Appendix F. In 1986, NMFS was able to mark both transported and nontransported groups of fish. Their work indicated that under 1986 passage conditions, the transport benefit ratio (TBR) for spring chinook was 1.6:1 (95 percent confidence interval = C1.01-2.47:1) (Matthews, 1992).

More recent (1989) transport study data indicate an average TBR ratio of 2.1:1 for fish returning to Lower Granite Dam (Matthews, 1992). The 1986 TBR of 1.6:1 was used to calibrate transport survival in PAM. A standardized transport survival rate was derived and run as input into PAM with 1992 flow, spill, and FGE values for 1989 to predict a TBR of 2.44:1, which is very close to the NMFS 2.5:1 estimate.

Because the predator control program is unproven, its effectiveness in increasing the reservoir survival rate was modeled at two levels for the 1993 static condition and the 1993 and future condition. For the 1993 static condition, a low value of 0-percent change and an upper value of 7.5-percent change were assumed. The future options used values of 0 percent and 25 percent.

Upstream passage survival rates (through the whole system) were modeled at two levels for the 1993 static and 1993 and future conditions, either the baseline value of 46.8 percent or an improved value (approximately a 5-percent overall improvement) of 48.9 percent. No data are currently available on the effectiveness of measures affecting adult upstream passage survival. However, a 5-percent overall increase was considered a plausible, if optimistic, estimate for 1993.

Two production levels were explored in the 1993 and future condition to examine the sensitivity of the model to uncertainty in stock productivity and to simulate the effect of improvements in habitat condition. Two parameters were manipulated: the egg-to-smolt survival rate (increased by 10 percent from 13.75 percent to 15.12 percent), and the smolt-to-smolt survival rate (increased by 3.5 percent from 95 percent to 98 percent).

PAM and SPM Results

Passage Analysis Model

Because the flow in 1993 and near future years is currently unknown, estimated survival can only be characterized as a probability function based on the 50-year flow estimates from HYSSR. Therefore, PAM generated 50 estimates of survival for each condition that were run 500 times each to capture uncertainties attributable to flow, and then summarized the cumulative probability curves (Figure 4.2-9).

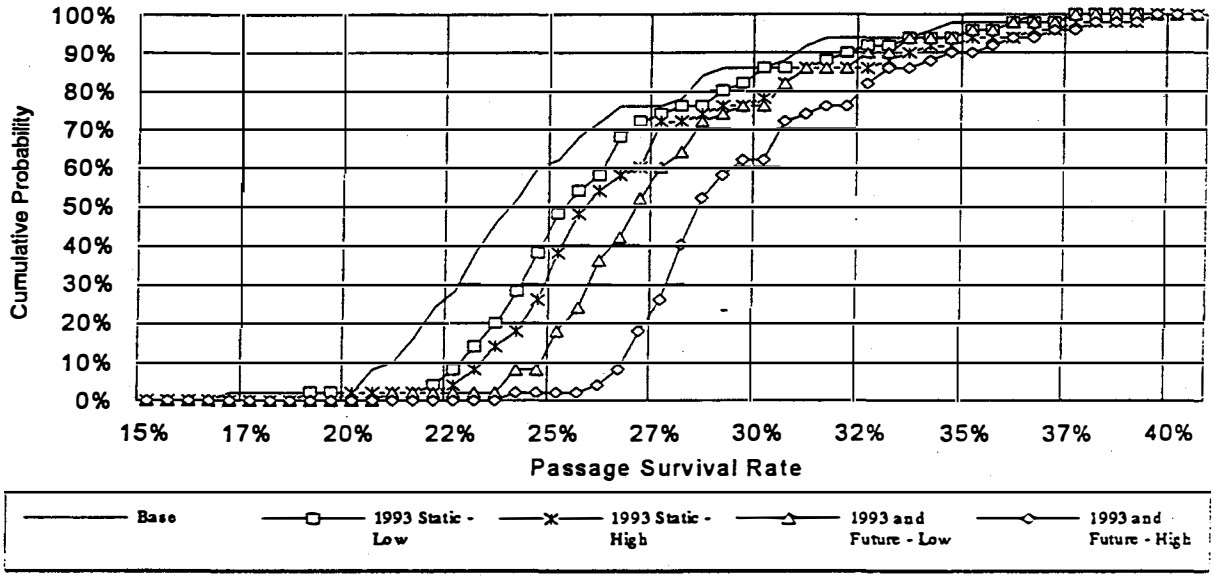


Figure 4.2-9. Juvenile passage survival rates, Snake River spring chinook (Source: NPPC, 1992; Anderson and McConnaha, 1992).

Appreciable relative increases in estimated juvenile passage survival are observed throughout the range of options modeled. The average estimated relative survival rate improvement compared to the baseline condition (for the 50 flow years modeled) ranged from 5.8 percent (1993 static low condition) to 19.8 percent (1993 and future high condition) (Table 4.2-7 and Appendix F, Table 2). The greatest change occurred in the lower flow conditions when estimated survival was the least. The estimated relative survival rate improvement for low flow years compared to the baseline condition ranged from 9.1 percent (1993 static low condition) to 29.8 percent (1993 and future high condition) (Table 4.2-7). This reflects a fairly broad range of assumptions about the effectiveness of predator control on reservoir mortality (0-percent to 25-percent reduction), and substantial increases in fish guidance efficiency at several projects. Flow augmentation was a significant contributor to the improved estimated passage survival while transportation at Lower Monumental Dam provided only a very small relative increase in average survival. The small relative increase in average survival attributable to transportation from Lower Monumental Dam could be expected due to the piggyback operation used to transport those smolts not collected at Lower Granite or Little Goose. Maximized collection at the two upper projects would result in relatively few smolts available to be transported at Lower Monumental compared to total smolts in the river above Lower Granite.

Improvements in estimated passage survival rate compared to the base condition were highest in these years (Table 4.2-7), consistent with NPPC's priority to implement flow augmentation during predicted low runoff years.

Although estimated passage survival increases in the lower flow years are relatively great, it is important to note that absolute passage survival rate changes little under all scenarios. In 1977 flow, for example, estimated passage survival through the entire system with transportation ranged from 16.3 percent to 23.1 percent.

Estimated average survival rate predictions from PAM for the various options are shown in Table 4.2-7.

Table 4.2-7. Survival rate and relative change in survival rate of spring chinook for an average of 50 years and eight lowest flow years from PAM analysis.

	Survival Rate		Relative Change From Base	
Scenario[a/]	Avg Flow (%)	Low Flow (%) 1977	Avg Flow (%)	Low Flow (%)
Base	24.3	19.8		
1993 Low	25.7	21.6	5.8	9.1
1993 High	26.4	22.3	8.6	12.6
Futures Low	27.2	23.5	11.9	18.7
Futures High	29.1	25.7	19.8	29.8

Source: Anderson and McConnaha, 1992.

a/ Low and high refer to assumed effectiveness of the measures.

System Planning Model

The results from the life-cycle modeling for the five major options were expressed as the median estimated escapement values for the 500 runs (Figure 4.2-10), and 1990 base with confidence limits (Figure 4.2-11). The confidence interval ranges follow a similar trend for the other four alternatives modeled (see Appendix F). The impacts of the alternatives were also expressed in terms of estimated smolt-to-adult return rates (SAR) (Figure 4.2-12). Confidence ranges for SAR estimates are shown in Appendix F. While the estimated relative difference in rebuilding under the various options is instructive, it is important to note that the slope of the lines in Figure 4.2-10 is very sensitive to the starting conditions and calibration associated with the Beaverton-Holt production function. Appreciable variation in the estimated rate of rebuilding will occur within a plausible range of assumptions (Future alternative). For this reason, these results are best used to compare relative effectiveness of the different options.

Base Case

The baseline condition (pre-1992 operations, Figures 4.2-10 and 4.2-11) displayed a steadily declining return. The median SAR hovered around 0.30 percent (the average was 0.35 percent, see Figure 4.2-12). This trend appears to be consistent with recent returns of naturally spawning spring chinook to Lower Granite Dam and the threatened status of this population.

1993 Static Operations

The low effectiveness of the 1993 static operations (e.g., flow, screens and transportation at Lower Monumental, reduced pool elevations, no change in reservoir mortality or upstream passage mortality) leveled the downward escapement trend seen in the baseline condition (Figure 4.2-10). The actions were enough to increase the run sizes compared to the baseline, but these actions were not enough to begin any significant rebuilding. SAR median values were around 0.32 percent (average of 0.37 percent) (Figure 4.2-12).

The high effectiveness of the 1993 static operations combined with modest improvements in downstream and upstream passage survival rates changed overall survival enough to produce a slightly increasing trend (Figure 4.2-10). Median SAR values hovered around 0.34 percent (Figure 4.2-12) while the average SAR was near 0.40 percent.

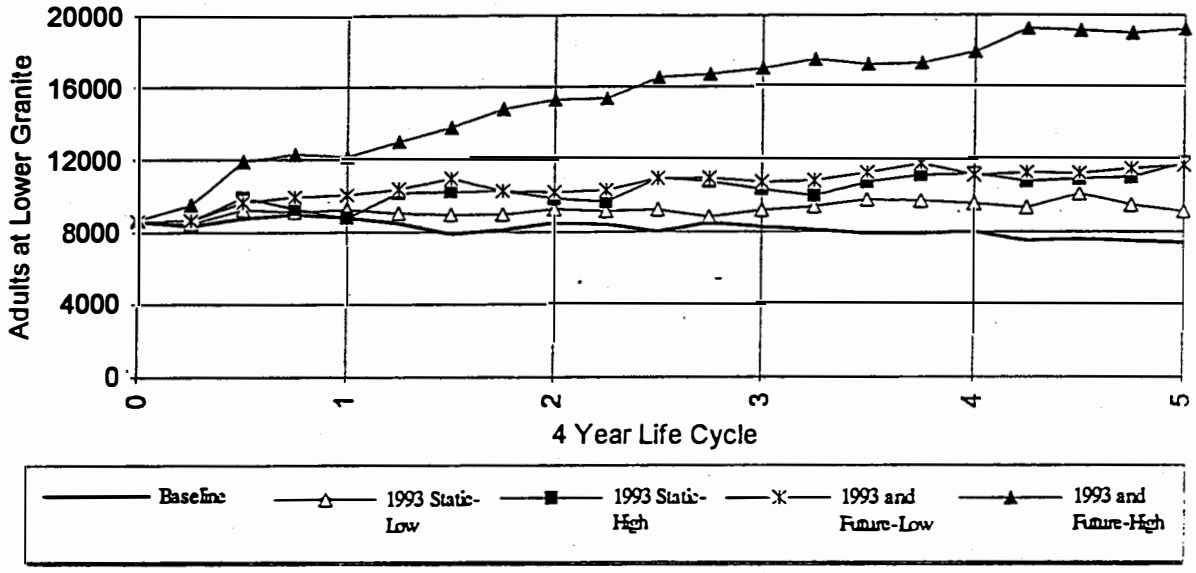


Figure 4.2-10. Snake River spring chinook adult escapement to Lower Granite Dam, 500 run medians (Source: Anderson and McConnaha, 1992).

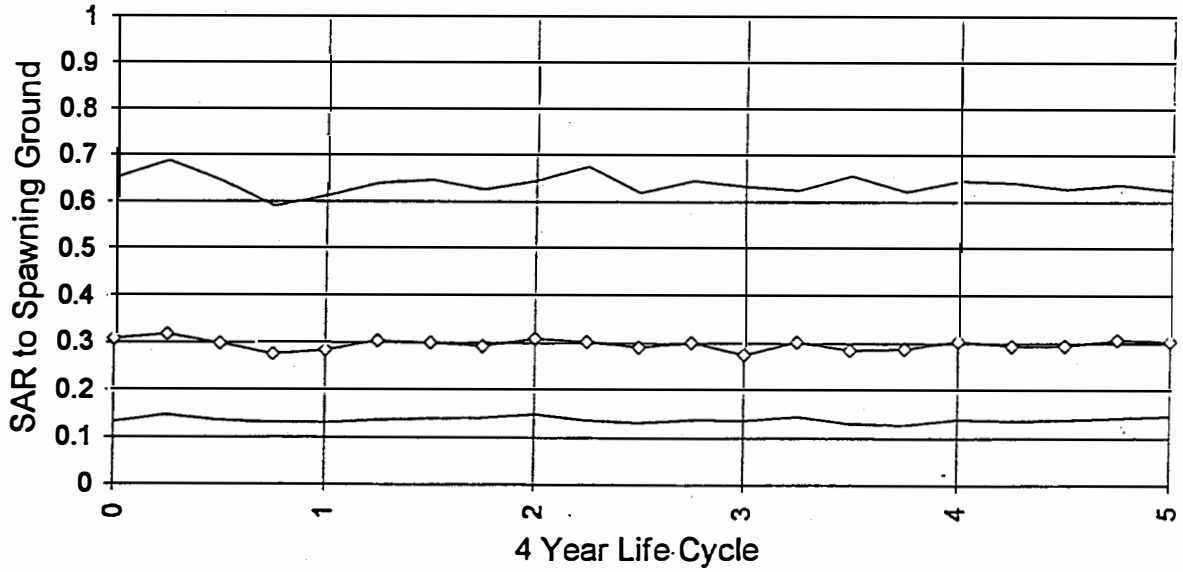


Figure 4.2-11. Snake River spring chinook salmon escapement based on SPM 500 game and 20-year (5 life cycle) simulations for the 1990-92 baseline condition. Lines denote 90th percentile (upper), median, and 10th percentile (lower) values (Source: Anderson and McConnaha, 1992).

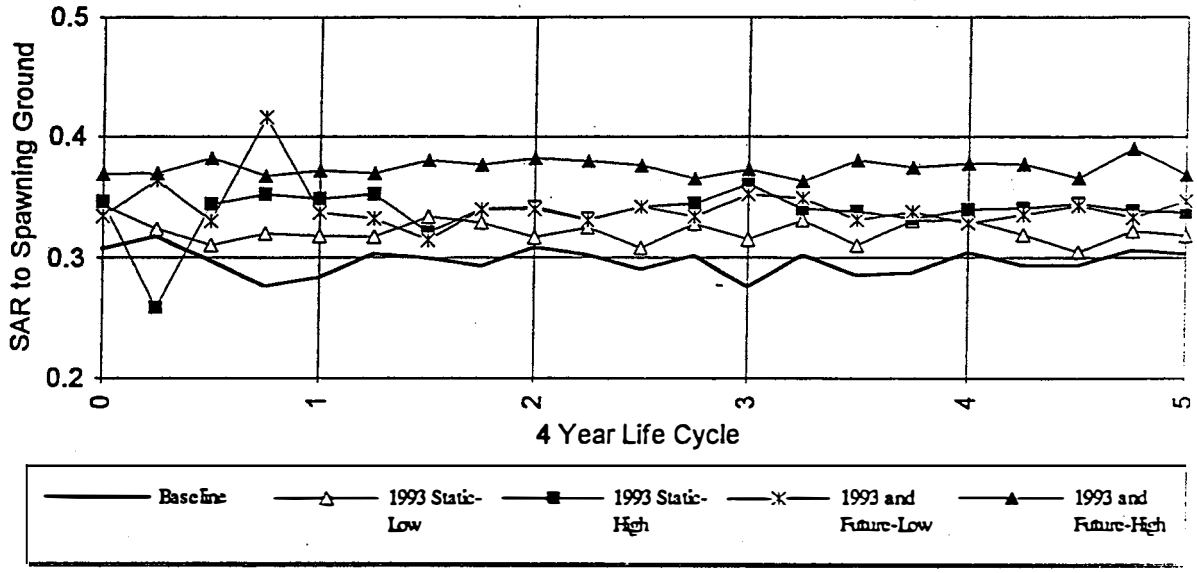


Figure 4.2-12. Snake River spring chinook smolt to adult survival rate (SAR) 500 run medians and 20-year (5 life cycles) simulated (Source: Anderson and McConnaha, 1992).

1993 and Future Operations

The low effectiveness of the 1993 and future operations (e.g., flow; screens and transportation at Lower Monumental; improved screens at Lower Granite, Little Goose, McNary, and The Dalles, reduced pool elevations; no change in reservoir mortality or upstream passage mortality) produced results very similar to the 1993 static operations high effectiveness scenario. The option changed survival enough to produce a slightly increasing trend (Figure 4.2-10). Median SAR values remained around 0.33 percent (Figure 4.2-12) while the average SAR was near 0.39 percent.

The high effectiveness of the 1993 and future operations combined with significant improvements in reservoir, upstream passage, egg-to-smolt and smolt-to-smolt survival rates, was the only condition modeled which showed potential for significantly rebuilding Snake River spring chinook (Figure 4.2-10). The median run size increased over 100 percent in the five life cycles simulated. Median SAR values remained around 0.38 percent (Figure 4.2-12) while the average SAR was near 0.44 percent.

4.2.5 STFA Model Analysis

Model analyses of actions considered in the SEIS using FLUSH and ELCM were conducted by STFA staff. The actual model results and analysis developed by the STFA are presented in detail in Appendix G.

The following summary is excerpted directly from the STFA submittal, although some editing for format has occurred. See Appendix G for more information regarding the STFA models and assumptions. As explained in 4.2.2, the results of the STFA models are not being used in the development of conclusions in the SEIS.

Analytical Methods

The scenarios addressed in this STFA analysis incorporated only those actions initiated or in place in 1992. Direct comparisons between the modeled effects of actions initiated in 1992 and planned for continuation in 1993 are contrasted with a baseline run that assumes continued in-river operation without the action implemented in 1992 on spring/summer and fall chinook. Additionally, STFA ran a sensitivity check of the model to determine changes in flow conditions that reflect improved in-river flow conditions and the termination of the

juvenile fish transportation after 1992 on spring/summer chinook. These conditions do not correspond to any of the interim flow improvement alternatives evaluated in this SEIS. However, this approach by STFA provides the only analysis of in-river migration of juvenile salmon in this SEIS for comparison to transportation operations scheduled for 1993 that are analyzed in the CRiSP/SLCM and PAM/SPM. Additional measures, such as sub-basin habitat improvements or supplementation, that are not currently implemented were not incorporated.

Similar to the BPA and NPPC analyses, the STFA model analysis consists of a downstream passage survival model, FLUSH, and a life-cycle model, ELCM. For spring/summer chinook, FLUSH Version 4.0 was used, and for fall chinook, FLUSH Version 3.0 was used. Documentation of this analysis is presented in Appendix G (STFA, 1992a,b). The following summary was excerpted directly from the STFA submittal, with editing for clarification and presentation.

Fish Leaving Under Several Hypotheses Model

FLUSH models estimate downstream passage survival of juvenile salmon. A variation of the Sims and Ossiander (1981) passage survival relationship is used as the basis for Version 4.0 for spring chinook. Details of this version are presented in Weber et al. (1992). The fall chinook Version 3.0 differs by using flow-travel time relationships developed in John Day and Lower Granite pools (Weber and Petrosky, 1992). Using temperature information driving predation modules (e.g., RESPRED) plus the respective travel time relationship, survival is estimated for fish traveling down the river. Mortality rates specific to the route of passage through each dam are constant estimated values that are independent of flow and fish behavior. The values are consistent with average estimates used in the other passage models. Both models use a variety of assumptions about transport return rates (TRR) in this specific analysis.

Selected brood years were used to develop the database for future analysis with the models. The FLUSH model Version 3.0 was used to estimate mainstem passage survival for fall chinook for the outmigration years of 1981 to 1989. The FLUSH Version 4.0 was used to estimate mainstem passage survival of spring chinook from Marsh Creek and spring/summer chinook from the Imnaha River for the outmigration years of 1977 to 1988. For simulation runs projecting into the future, the base period flows were repeated with proposed management actions (volume of augmented flows in acre feet converted to kcfs) superimposed on the base survivals. The relative changes due to management actions (output from the FLUSH models) were used to adjust ELCM recruitment scalars.

The operation scenarios considered by STFA in the FLUSH model analyses are summarized as follows:

Augmented Flow (Spring/Summer Chinook). The amount of additional flow assumed for the Snake River was defined by the NPPC's Phase II Amendment stipulation. The increment ranges from 1.2 to 1.4 MAF as a function of the base flow level. An additional flow increment of 6.45 MAF was added to the base flow in the mainstem Columbia River. The actual increment added in 1992 differed from the planned volume. For comparison, future years were simulated with both the planned and actual volumes observed in 1992. The additional flow increment is distributed evenly among the 40 days (April 20 to May 30) when 80 percent of the fish are in the river. Actual dates of fish passage vary with timing and volume of runoff, temperature, and photoperiod for any given year. FLUSH does not compensate for this source of uncertainty.

Augmented Flow (Fall Chinook). The additional volumes of water proposed in the NPPC Phase III Amendments were added to the base flows for the years and periods modeled to estimate reduced fish travel time through the mainstem system, based on travel time relationships from Berggren and Filardo (1991) and memorandum from Michele DeHart, Fish Passage Center, Portland, Oregon, October 16, 1991. The actual amounts of water that would be added via scheduled augmentation during monthly or bimonthly periods for 1981 through 1989 were estimated.

Operation at MOP Elevation. The simulation of the 1992 action incorporated minor reductions in reservoir elevations during juvenile outmigration. This action consists of lowering the four Snake River reservoirs to 1 foot above MOP and John

Day to minimum irrigation pool. Travel time estimates were adjusted for the reduction in the water surface elevation from the full pool elevation.

Spill. The 1992 action scenario included spill rates as provided by NMFS and the Corps. The comparative sensitivity analysis scenario included a higher spill rate. This scenario approximated no spill at the collector dams (Lower Granite, Little Goose, and McNary) or John Day and daily averages of 18 percent at Lower Monumental, 40 percent at Ice Harbor, 10 percent at The Dalles, and 53 percent at Bonneville. No effect was modeled for nighttime versus daytime spill.

Bypass. The NMFS requested that only mainstem measures that are in place as of 1992 be used in the analysis. The historical FGEs used in the baseline assessment are taken from Fisher et al. (1992), whereas the 1992 FGE data were taken from a review by NMFS and modified for two dams by the State agencies and tribes (personal communication, R. Heinith, CRITFC, 1992).

Transport Survival (Spring/Summer Chinook). Four alternative transport survival models were used to encompass the range of survival benefits resulting from different interpretations of spring and summer chinook transportation study results. The first two variations correspond to the models used in the NPPC assessment effort. Models 3 and 4 are similar to Model 2 but reflect additional interpretations of the study results (personal communication, F. Olney, FWS, CBFWA Ad. Hoc Committee Report 1992).

- Model 1 was equivalent to the NPPC's Model I, with transport survival estimated to be 1.6 times the estimated 1986 in-river smolt survival from Little Goose Dam (Matthews, 1992). Model 1 transport survival was a constant 42 percent at all water travel times with a transport return rate (TRR, which equals Transport Benefit Ratio used in SLCM and SPM) equivalent to 1.6:1.

- Transport Model 2 was equivalent to NPPC's Model II, with transport survival decreasing from 42 percent at 1986 velocities (15.7 days) to 5 percent at 1977 velocities (37.1 days). TRR equivalent to 1.6:1.

- Transport Model 3 was equivalent to NPPC's Model II with the exception that transport survival decreased from 28 percent at 1986 velocities (15.7 days) to 5 percent at 1977 velocities (37.0 days) with a calculated TRR equivalent to 0.4:1.

- Transport Model 4 was equivalent to NPPC's Model II with the exception that transport survival decreased from 15 percent at 1986 velocities (15.7 days) to 5 percent at 1977 velocities (37.0 days) with a calculated TRR equivalent of 0.4:1.

Transportation Models 3 and 4 were constructed based on reanalysis of NMFS' transport study information of adults returning back to hatchery racks and spawning ground traps. The Corps and cooperating agencies have concerns that uncertainty associated with Models 2 through 4 may be greater than uncertainty associated with Model 1, although much uncertainty exists in the ability to characterize the benefits of transport because of indirect mortalities, condition of fish prior to collection, and changing in-river condition to some degree on flow year, all of which result in low numbers of returning adults from both transported and in-river smolts.

The documentation for the Version 4.0 (Weber et al., 1992) describes the latter two options in greater detail.

Transport Survival (Fall Chinook). A transport return rate of 1:1 was bracketed on the low end by a ratio of 0.5:1 and at the high end by a ratio of 2:1. The range of values reflect uncertainty associated with transportation survival estimates for Snake River spring/summer chinook and the application of these values to Snake River fall chinook. This analysis assumes no further improvements or additions to existing fish collection facilities.

Predator Removal (Spring/Summer Chinook). The effects of squawfish removal were simulated by assuming a mean value of 10 percent reduction in mortality in each reservoir, based on population studies in the John Day Dam. Because of the uncertainty associated with this action, the mean value was bracketed with a low value of 5 percent

and a high value of 15 percent reduction in mortality per reservoir.

Predator Removal (Fall Chinook). The effects of predator removal on subyearlings were assessed by reducing reservoir mortality by zero, 15 percent phased in over 8 years, and 25 percent phased in over 7 years, beginning in 1991. A range of values was modeled because of the uncertainty associated with the predator removal program, which began recently and for which complete results are not yet available. This estimated range is consistent with the CRiSP.0 and PAM analysis.

In-river Option (Spring/Summer Chinook). Finally, to demonstrate sensitivity of results to flow regimes, a combination of management actions was modeled. These actions included drawdown to MOP, moderate predator removal (10 percent), high proportions of spill at Snake River dams, and additional flow augmentation beyond the volumes available in this SEIS of 2.0 MAF in the Snake River and 8.0 MAF in the Columbia River. This scenario was run with no transportation of juveniles to specifically provide for an analysis of the sensitivity of the model system to a combination of potential mainstem passage measures. While the measures incorporated are theoretically possible, but difficult to acquire or schedule at this point in time, the scenario does not represent a specific proposal by the tribal and state fishery agencies involved in this assessment, or one that has been considered by the Corps and the cooperating agencies.

Empirical Life-Cycle Model

The ELCM uses empirical recruitment data to estimate stock productivity. It is a cohort-based approach that provides an index of year-class strength. This model, combined with selected FLUSH models and other information, was used to develop long-term estimates of runs based on selected actions. This approach evaluated Snake River fall chinook brood years 1980 through 1988 (i.e., outmigration years 1981 through 1989) and spring or summer chinook stock for 1977 to 1988 water years. As stated above, the appropriate Versions 3.0 and 4.0 were used to simulate estimated passage survival for the appropriate years.

During simulations into the future, the representative base-period flows were repeated with proposed management actions superimposed on the base survivals. The relative changes due to management actions were used to adjust the ELCM scalars. With this combination of models, it is possible to simulate the effects of changes due to management actions throughout all stages of the spring/summer and fall chinook life cycle (Schaller and Cooney, 1992).

Selected stocks of spring and summer chinook were used. Information from two Snake River chinook stocks, Marsh Creek spring chinook and Imnaha River spring/summer chinook, were used in the evaluation of the effects of 1993 management actions. The Marsh Creek information is representative of Snake River spring chinook runs with average productivity, while the Imnaha run better reflects spring/summer populations of moderate-to-lesser productivity. Information on additional populations is under development.

The operation scenarios considered by the STFA in the ELCM analyses are shown below.

Transportation (Spring/Summer Chinook). The STFA compared the estimated smolt survival from the four transport models with observed-to-expected recruit/spawner ratios for four indicator stocks (Imnaha River and Marsh, Bear Valley, and Elk creeks) for brood years 1975 to 1986. STFA also compared model output to Raymond's (1988) estimated smolt-to-adult return rates for wild spring/summer chinook, brood years 1975 to 1982 (Weber et al., 1992).

Adult Actions (Spring/Summer Chinook). Actions to increase the survival of adult spring/summer chinook are limited to harvest restrictions adopted by U.S. v. Oregon.

Harvest Reduction (Fall Chinook). The level of harvest reduction introduced into all simulations is that adopted by the NPPC in Phase III. Southern U.S. ocean harvest rates were reduced 22 percent from the 1990 level for 1991. The southern U.S. ocean fisheries were reduced an additional 5 percent from the 1991 level for 1992 to 1995. The NPPC recommended reducing inriver harvest rates 35 percent from the 1990 level for 1991. In addition, the in-river harvest levels were to be reduced an additional 24 percent from the 1991

level for 1992 to 1995. Both southern U.S. ocean fisheries and in-river fisheries return to the average 1984 to 1990 harvest rate for the remainder of the simulation years. These estimates are consistent with that used in SLCM.

In addition to the SEIS alternative runs, the sensitivity of the model to changes in harvest rates was assessed by bracketing the above harvest rate scenario. The higher harvest rate consisted of keeping harvest at the 1984 to 1990 level in all out years. The lower harvest rate was simulated by using the NPPC proposal described above, but with the additional restriction of imposing the 1991 harvest rate for 1996 through 1999.

Enhancement (Fall Chinook). The run above Lower Granite Dam consists of returns from spawning above the dam, strays of Snake River origin fall chinook from the Lyons Ferry Hatchery program, and strays of outside stock origin. The assessments include the assumption that strays of Lyons Ferry Hatchery origin have been contributing to natural spawning through the current run year (1993).

Two future supplementation scenarios were assessed. The intent of this specific set of analyses was to assess the potential effect of a standardized set of actions initiated in 1992. The standardized set of actions included the assumption that all known hatchery strays above Lower Granite Dam would be removed (including Lyons Ferry Hatchery and outside stocks). To illustrate the potential effect of supplementation, a run was made incorporating the assumption that supplementation by Snake River origin Lyons Ferry Hatchery stocks would continue under an accelerated program with an effective contribution in the middle range of the scenarios described previously (Schaller and Cooney, 1992).

FLUSH and ELCM Results

Spring/Summer Chinook

The FLUSH model was used to estimate passage survival of juvenile Snake River spring/summer chinook. The results were arranged by four levels of transport assumptions for planned and implemented actions at a level of predator reduction of 10 percent (Table 4.2-8) and by levels of predator reduction of 5, 10, and 15 percent (Table 4.2-9). Tables 4.2-8 and 4.2-9 contain minimum, maximum, and estimated average values for 1992 through 2010. This approach allows for monitoring of planned versus implemented actions by its use of actual flow data for the years analyzed; however, the same degree of statistic uncertainty exists for future projections.

Estimated base survivals were computed for each of the transport models. The average estimated survivals for Transport Models 1 through 4 were 21, 19, 14, and 8 percent, respectively (Table 4.2-8). To compute relative estimated future changes in recruitment due to management actions, the base system survival is subtracted from the estimated action; then, this value is divided by the base system survival using the same transport model, then multiplied by 100 to get a percent (Table 4.2-8). The change in estimated system survival from base conditions to planned action for Transport Model 1 averaged 27.5 percent; the change from maximum survival value was 19.9 percent; and the change from minimum survival value was 19.9 percent, and the change from minimum survival was 311.3 percent. The change in estimated system survival from base conditions to planned action for Transport Model 2 averaged 28.8 percent; the change from maximum survival was 19.9 percent, and the change from minimal survival was 1,335.5 percent. The change in estimated system survival from base conditions to action for Transport Model 3 averaged 27.8 percent; the change from maximum survival value was 23.2 percent; and the change from minimum survival value was 932.3 percent. The change in estimated system survival from base conditions to action for transport Model 4 averaged 26.5 percent; the change from maximum survival values was 28.5 percent; and the change from the minimum survival value was 467.7 percent. Although the estimated relative increases are large in poor survival years, the actual gains in projected recruitment are small due to the actual survival values on which the analysis is based. The bounds around the average exhibit a very large range, especially from the average to the minimum trend line. This uncertain variability would contribute greatly to increasing the slope of the decreasing trend in passage survival.

Table 4.2-8. Juvenile system Snake River spring/summer chinook survival estimated in percent from FLUSH Version 4.0 for base conditions and planned versus implemented actions in 1992 for the four transportation models evaluated.

		In-river Survival	System Survival (%)			
			Trans 1	Trans 2	Trans 3	Trans 4
Base:						
1977-1988	Min.	0.07	2.40	0.31	0.31	0.31
	Max.	23.30	27.70	27.70	22.00	15.80
	Avg.	10.99	20.69	18.72	13.65	7.85
Planned Action:						
1992-2010	Min.	1.49	9.87	4.45	3.20	1.76
	Max.	32.40	33.20	33.20	27.10	20.30
	Avg.	18.37	26.37	24.11	17.45	9.93
Implemented Action:						
1992-2010	Min.	0.66	7.88	2.59	1.96	1.25
	Max.	30.60	32.10	32.10	26.10	19.40
	Avg.	16.47	24.70	22.66	16.39	9.31
Relative percent change in relative survival for 18 years:						
Base condition (1977-1988) to planned action (1992-2010).	Min.	2028.6	311.3	1335.6	932.3	467.7
	Max.	39.1	19.9	19.9	23.3	28.5
	Avg.	67.2	27.5	28.8	27.8	26.5
Base condition (1977-1988) to implemented action (1992-2010).	Min.	842.9	228.3	735.5	532.3	303.2
	Max.	31.3	15.9	15.9	18.6	22.8
	Avg.	49.9	19.4	21.0	20.1	18.6
Planned action (1992-2010) to implemented action (1992-2010).	Min.	-557.0	-20.2	-41.8	-38.8	-29.0
	Max.	-5.6	-3.3	-3.3	-3.7	-4.4
	Avg.	-10.3	-6.3	-6.0	-6.2	-6.2

Source: STFA, 1992a.

Table 4.2-9. Juvenile Snake River spring/summer chinook system survival estimated in percent from FLUSH Version 4.0 for base and planned actions in 1992 for the four transportation models evaluated at three levels of predation mortality reduction.

		In-river Survival	System Survival (%)			
			Trans 1	Trans 2	Trans 3	Trans 4
Base:						
1977-1988	Min.	0.07	2.40	0.31	0.31	0.31
	Max.	23.30	27.70	27.70	22.00	15.80
	Avg.	10.99	20.69	18.72	13.65	7.85
Predator Mortality Reduction at 5 percent:						
1992-2010	Min.	01.41	9.64	03.45	3.13	1.72
	Max.	31.20	32.50	32.50	26.40	19.70
	Avg.	17.25	24.99	23.41	16.94	9.57
Predator Mortality Reduction at 10 percent:						
1992-2010	Min.	1.49	9.87	4.45	3.20	1.76
	Max.	32.40	33.20	33.20	27.10	20.30
	Avg.	18.37	26.37	24.11	17.45	9.93
Predator Mortality Reduction at 15 percent:						
1992-2010	Min.	1.57	10.10	4.56	3.28	1.81
	Max.	33.70	34.00	34.00	27.80	20.90
	Avg.	19.41	25.46	24.63	17.87	10.23
Relative Percent Change in Relative Survival for 18 years:						
Base condition (1977-1988 (to 5% predator reduction (1992-2010).	Min.	191.4	301.7	101.3	909.7	454.8
	Max.	33.9	17.3	17.3	20.0	24.7
	Avg.	57.0	20.8	25.1	24.1	21.9
Baseline condition (1977-1988) to 10% predator reduction (1992-2010)[a/]	Min.	2028.6	311.3	1335.5	932.3	467.7
	Max.	39.1	19.9	19.9	23.2	28.5
	Avg.	67.2	27.5	28.8	27.8	26.5
Base condition (1977-1988) to 15% predator reduction (1992-2010).	Min.	2142.9	320.8	1371.0	958.1	483.9
	Max.	44.6	22.7	22.7	26.4	32.3
	Avg.	76.6	27.9	31.6	30.9	30.3

Source: STFA, 1992a.

[a/] All calculations same as above in base condition to planned action.

FLUSH is a deterministic model and, therefore, FLUSH does not incorporate multiple run analysis techniques to calculate a median survival estimate, but relies on a single run. Multiple runs would act to reduce the variability around the median.

STFA believes that the most likely simulations are predator reduction of 10 percent and TRR of 1.03:1 (Transport Model 3); the average estimated system survival for 1992 implemented management actions was 16.4 percent, improving from an estimated base survival of 13.7 percent, a 20.1-percent increase in relative survival. The minimum survival for these simulation years, of implemented actions, was 1.96 percent and the maximum was 26.1 percent. Using the same set of assumptions, the average estimated system survival for 1992 planned management actions was 1.75 percent, improving from a base survival of 13.7 percent, a 27.8-percent relative survival increase. The minimum estimated survival for these simulation years of planned actions was 3.0 percent and the maximum was 27.1 percent.

Estimated survival increased as the level of predator reduction and assumed transport survival increased. At the lowest level of predator reduction (5.0 percent), the average simulated survival increased from a base value of 20.7 percent to 25.0 percent (20.8 percent relative increase) under Model 1 (the most optimistic transportation assumption), but it only increased from a base of 7.8 percent to 9.6 percent (21.9 percent relative increase) under Model 4 (the least optimistic). At the highest level of assumed predator mortality reduction (15 percent), average simulated juvenile system survival increased from a base of 20.7 percent to 26.5 percent (28.0 percent relative increase) for Model 1 and from a base of 8 to 10 percent (30.0-percent increase) for Model 4.

STFA used the ELCM to estimate adult escapement trends reflecting changes in estimated juvenile passage survival and harvest restrictions. Results of the simulations comparing planned versus implemented flows and their effects on Marsh Creek spring chinook escapements appear in Table 4.2-10. (Because of the similarity of all results for the two stocks, all Imnaha River results are confined to Appendix G.) Table 4.2-10 also summarizes results under the same four assumptions of transportation. While both stocks realize some level of response to management actions, neither show dramatic responses to any individual, or combination of, management actions.

The results of the baseline analysis are depicted in Figure 4.2-13. Projections of return levels through 2020 are combined with estimates of historical escapements returns. Differences in projected escapement levels for planned versus actual flow augmentation (i.e., levels observed in 1992) are shown in Figure 4.2-14 for Marsh Creek and in Appendix G. In years of high flow, the differences between resulting estimated escapements from planned versus implemented simulations are greater. In years of low flow, neither set of actions increase escapement estimates significantly from the base, escapements being less than 12 percent of the maximum sustainable product (MSP) goal.

Assumptions regarding transportation survival have an effect on escapement estimates in Transport Models 3 and 4 (Figure 4.2-14). As exhibited in Transport Models 3 and 4 simulations, as transport survival is assumed to increase, projected escapement levels also increase. In low flow years, none of the assumptions for Transport Models 3 and 4 result in escapement estimates increasing much above base levels (escapements being less than 12 percent of MSP goal).

The STFA scenario, illustrating the sensitivity to in-river flow improvements with no transportation (Appendix G), shows estimated survival levels far above any that are projected for simulations involving 1992 actions including transportation. Under this projection, the estimated escapement trends include very large and variable responses because no harvest response is simulated (that is, no increased harvest was assumed when in-river escapement was high), causing production from the resulting large over-escapement to be subjected to significant density-dependent mortality.

Management actions addressed in this analysis focus on increasing the survival of juvenile spring chinook during mainstem passage. Within the framework of the requested action scenario, STFA looked at the sensitivity of the results to alternative assumptions regarding the effectiveness of predator removal and transport survival.

Predator removal appears to improve mainstem survival to some extent. STFA believes the most likely level is a 10-percent reduction in reservoir

Table 4.2-10. Empirical life-cycle model results of 1993 planned versus 1992 implemented actions being simulated for future years for predominantly wild Marsh Creek spring chinook indicator stock (assuming predation mortality reduction at 10-percent level).

		Spawning Escapement Expressed as Percent of Goal								
			Trans Model 1		Trans Model 2		Trans Model 3		Trans Model 4	
Return Years		Baseline Conditions (%)	Planned (%)	Implemented (%)	Planned (%)	Implemented (%)	Planned (%)	Implemented (%)	Planned (%)	Implemented (%)
1957-1969	Ave.	91.5								
	Min.	49.7								
	Max.	150.0								
1970-1979	Ave.	44.1								
	Min.	10.0								
	Max.	109.6								
1980-1990	Ave.	17.0								
	Min.	1.9								
	Max.	45.9								
1991-1995	Ave.	22.4	22.8	22.7	23.8	23.2	23.4	23.0	23.0	22.8
	Min.	4.2	5.9	5.5	9.4	7.3	8.1	6.7	6.7	5.9
	Max.	46.0	46.0	46.0	46.0	46.0	46.0	46.0	46.0	46.0
1996-2000	Ave.	18.4	23.3	21.3	26.7	22.7	25.2	23.8	23.4	22.6
	Min.	6.9	8.7	8.3	9.8	9.0	9.5	8.8	9.4	8.7
	Max.	31.0	45.8	39.4	50.0	39.5	45.9	46.6	41.5	44.1
2001-2005	Ave.	25.2	33.5	30.6	35.7	33.1	37.9	33.1	35.9	32.9
	Min.	16.0	22.1	19.5	23.3	21.0	26.3	22.1	23.7	21.6
	Max.	34.7	43.8	40.9	49.5	44.2	50.3	43.7	48.9	42.9
2006-2010	Ave.	10.9	15.8	14.2	19.0	17.0	18.8	16.7	17.8	15.7
	Min.	5.8	9.2	8.4	10.6	9.5	11.2	9.3	10.0	8.9
	Max.	24.4	29.5	27.5	31.5	31.2	34.5	30.5	33.9	30.1
2011-2015	Ave.	27.8	43.2	37.1	48.3	45.3	45.9	45.6	44.1	43.1
	Min.	21.1	31.7	27.9	35.4	33.3	32.8	33.4	30.8	32.7
	Max.	35.9	58.0	50.2	73.8	64.4	68.0	66.3	65.5	60.6
2016-2020	Ave.	15.6	22.9	19.8	26.1	23.2	24.5	23.0	23.7	22.8
	Min.	5.5	12.2	10.6	18.6	14.9	15.3	15.3	13.4	12.9
	Max.	24.1	32.2	28.5	34.8	33.4	33.7	32.7	32.8	32.2

Source: STFA, 1992a.
Note: Baseline values are actual from 1957 to 1985 model results from 1985 to 2010.

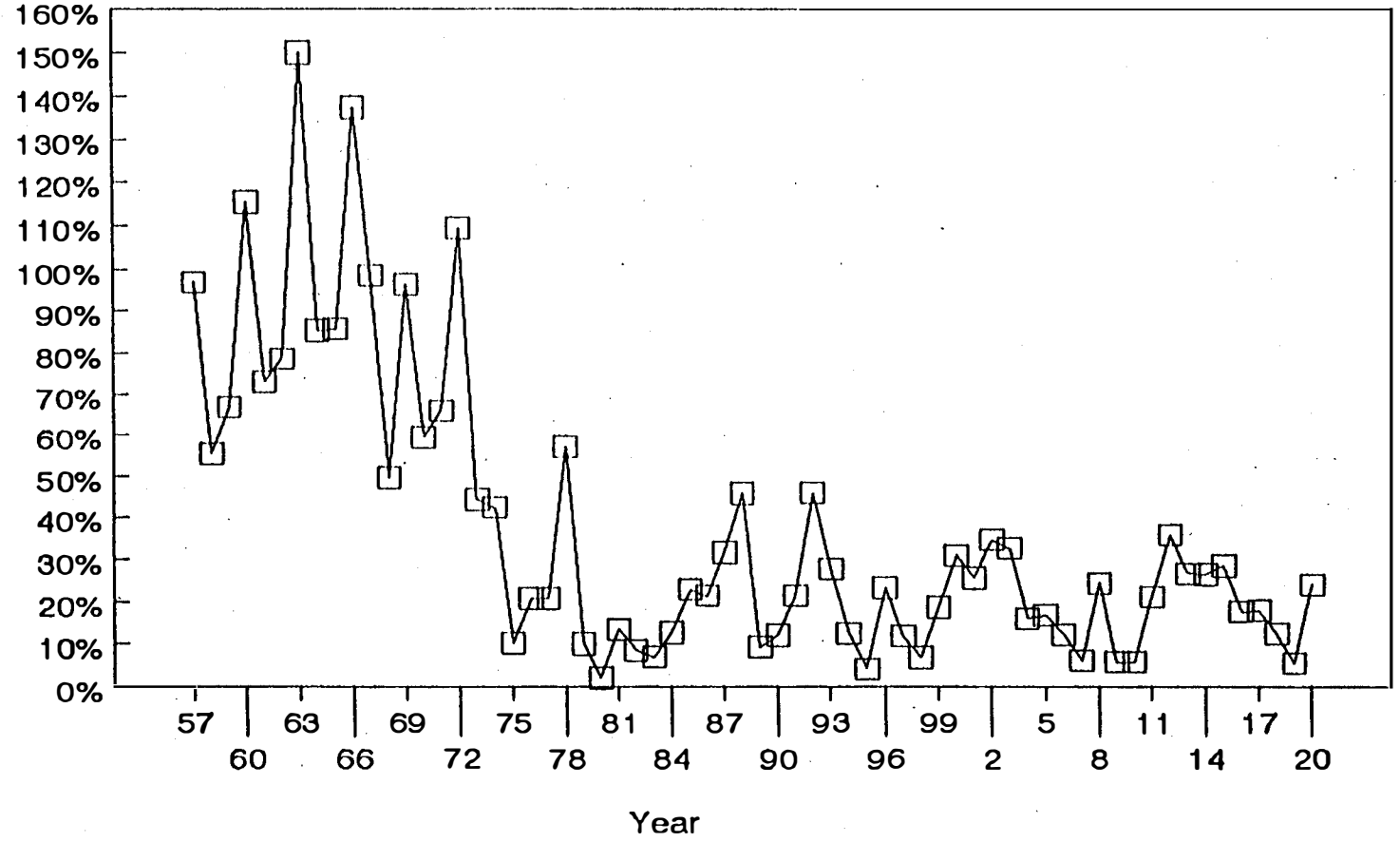


Figure 4.2-13. Snake River spring chinook (Marsh Creek indicator stock) analysis results from ELCM for baseline conditions (source: STFA, 1992a).

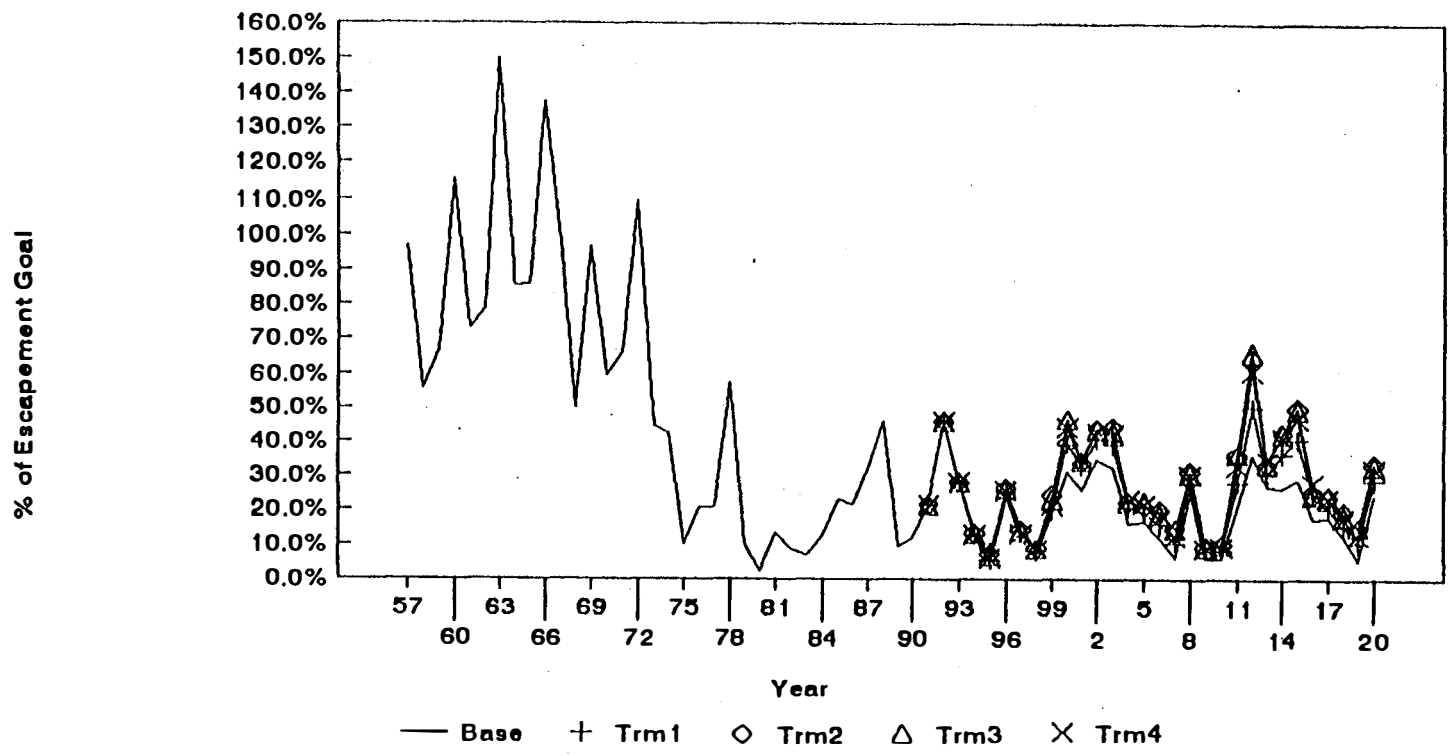


Figure 4.2-14. Snake River spring chinook (Marsh Creek indicator stock) analysis results from ELCM for baseline conditions vs. assuming implemented 1992 operations in the future for the four transport models (assume predator mortality reduction of 10 percent) (Source: STFA, 1992a).

mortality; it does not increase estimated mainstem survival or escapement levels dramatically (particularly in low flow years there is little change from the base).

Assumptions regarding transport survival rates have substantial effects on mainstem survival estimates in this analysis. However, in this analysis whatever assumptions about transportation are made apply both to the base period and future simulated management actions. Therefore, the simulations of adult escapements are less sensitive to the four transport model assumptions than are the individual system survival estimates. The less optimistic transport models and in-river survival most accurately reproduced trends exhibited by Raymond (1988) for smolt-to-adult return and recruit per spawner (R/S) adult indices (Weber et al., 1992; Petrosky and Schaller, 1992).

The relationship between mainstem flow (fish travel time) and estimated mainstem survival was demonstrated by a single simulation that mixed drawdown to MOP, a moderate assumption regarding predator removal, ambitious spill, and additional flow augmentation. Substantial increases in estimated survival were projected for juveniles migrating in the river in the improved flow scenario analyzed for comparative purposes. Estimated cumulative survival under this scenario was projected to exceed that under the most optimistic transport assumption.

The general pattern of all combinations of assumptions in assessing the 1992 actions show the estimated escapements are not exhibiting significant increasing trends. An important finding is that, when poor water years cycle through the simulations, all of the combination of model assumptions for 1992 actions show little improvement in estimated escapement over base conditions.

Fall Chinook

FLUSH was used for nine simulations (three levels of predator reduction by three levels of transport return rate), which were conducted for Snake River fall chinook using Version 3.0. It should be noted that the FLUSH treatment and most assumptions for fall chinook, like those in CRiSP.0, are more theoretically based, with higher levels of uncertainty than those for spring/summer chinook. Therefore, the TRR assumptions are estimates based largely upon research either from the mid-Columbia River or from spring/summer chinook studies that have some amount of fall chinook mixed in. At the TRR of 0.5:1, estimated system survival results from Version 3.0 yielded the lowest levels and exhibited the least relative positive change as predation mortality was varied (relative increase of -15.8 percent to -3.8 percent relative change for the three levels of predator control) (Table 4.2-11). The system survival rates were 3.0 percent, 3.5 percent, and 3.9 percent for predation mortality reductions of 0, 15 percent, and 25 percent, respectively, at a TRR of 0.5:1.

For the TRR of 2:1 at the high range, estimated system survival results from Version 3.0 yielded the highest levels and exhibited the most relative positive change as predation mortality decreased (Table 4.2-11). However, the estimated system survival results were as low as 8.1, 8.8, and 9.4 percent for predation mortality reductions of 0, 15, and 25 percent, respectively, at a TRR of 2.0:1. The base average estimated system survival of 6.5 percent is low. While the relative gains for the most optimistic set of assumptions modeled are substantial (from 3.5 to 26.1 percent relative increase), the estimated absolute survival increases are modest.

ELCM was used in combination with the nine simulations described above and three other simulations to examine the sensitivity of the model to enhancement (supplementation) and different harvest rates. At a TRR of 0.5:1, results generally indicate a continued decreasing trend in estimated escapement levels over four brood cycles under three assumed predator reduction levels: 0, 15.0, and 25 percent (Figure 1 in Appendix G). When the TRR is assumed to be 1:1 (Figure 4.2-15) or 2:1 (Figure 3 in Appendix G), the trend lines rise to slightly higher levels. For example, at a TRR of 2:1 and the highest assumed predator reduction level (25 percent), the escapement projections increase from an estimated 150 in 1989 to 1990 to 489 by 2010.

Figure 4.2-16 shows the sensitivity of escapement projections to the three TRR levels when predator reduction is fixed at 15 percent. Higher escapements are projected with higher assumed TRRs. However, all three simulations exhibit declining or flat trends in escapements. The

Table 4.2-11. Estimates of juvenile fall chinook mainstem migration survival from FLUSH Version 3.0 for three levels of predation mortality reduction.

	Survival Rate Estimates				Relative Change from Base		
		Predation Reduction			Predation Reduction		
	Base	0%	15%	25%	0%	15%	25%
A: TRR of 0.5:1							
Ave.	3.20	2.98	3.47	3.88	-6.9	8.4	2.1
Min.	0.14	0.11	0.21	0.39	21.4	50.0	178.6
Max.	10.10	8.50	9.23	9.72	-15.8	-8.6	-3.8
B: TRR of 1:1							
Ave.	4.49	4.69	5.25	5.70	4.5	76.0	26.9
Min.	0.17	0.16	0.28	0.48	-5.9	64.7	182.4
Max.	13.30	13.50	14.30	14.80	1.5	7.5	11.3
C: TRR of 2:1							
Ave.	6.46	8.10	8.82	9.37	25.4	36.5	45.0
Min.	0.21	0.27	0.42	0.66	28.6	100.0	214.3
Max.	19.90	23.40	24.40	25.10	3.5	18.4	26.1

Source: STFA, 1992b.

simulation that projects the effects of enhancement (supplementation) is shown in Figure 5 in Appendix G. The results indicate a slight increasing trend may be possible with this type of management action, given the assumptions for survival of supplemented offspring compared to natural offspring. The sensitivity of the model to different harvest rates is shown in Figure 6 in Appendix G. The analysis indicated that projected trends in escapements are insensitive to significant changes in harvest management actions.

The management actions of primary interest (transportation, water augmentation, lowering of some reservoirs to MOP, and predator reduction) are aimed at reducing mainstem smolt mortality resulting from development of the hydropower system. The water augmentation and limited reservoir drawdown actions in the 1992 management actions had a minimal impact on reducing estimated fish residence time and mortality. (See TRR of 1:1 and predator mortality reduction of 0 in Table 4.2-11.) Therefore, changes in estimated mainstem smolt survival rely primarily on assumptions about transportation survival and predator reduction. The stock did exhibit more of a response for assumptions on the high end for transport survival and predator mortality reduction, but absolute increase in estimated escapement numbers remained small. The fall chinook stock exhibited an estimated decreasing trend from recent levels for a majority of the simulations. The results of this analysis are consistent with the model simulations performed to evaluate NPPC Phase II Amendments last fall.

It is too early for a complete assessment to determine the effects of the predator control program initiated 2 years ago. Therefore, the range of values used in the simulations (as stated

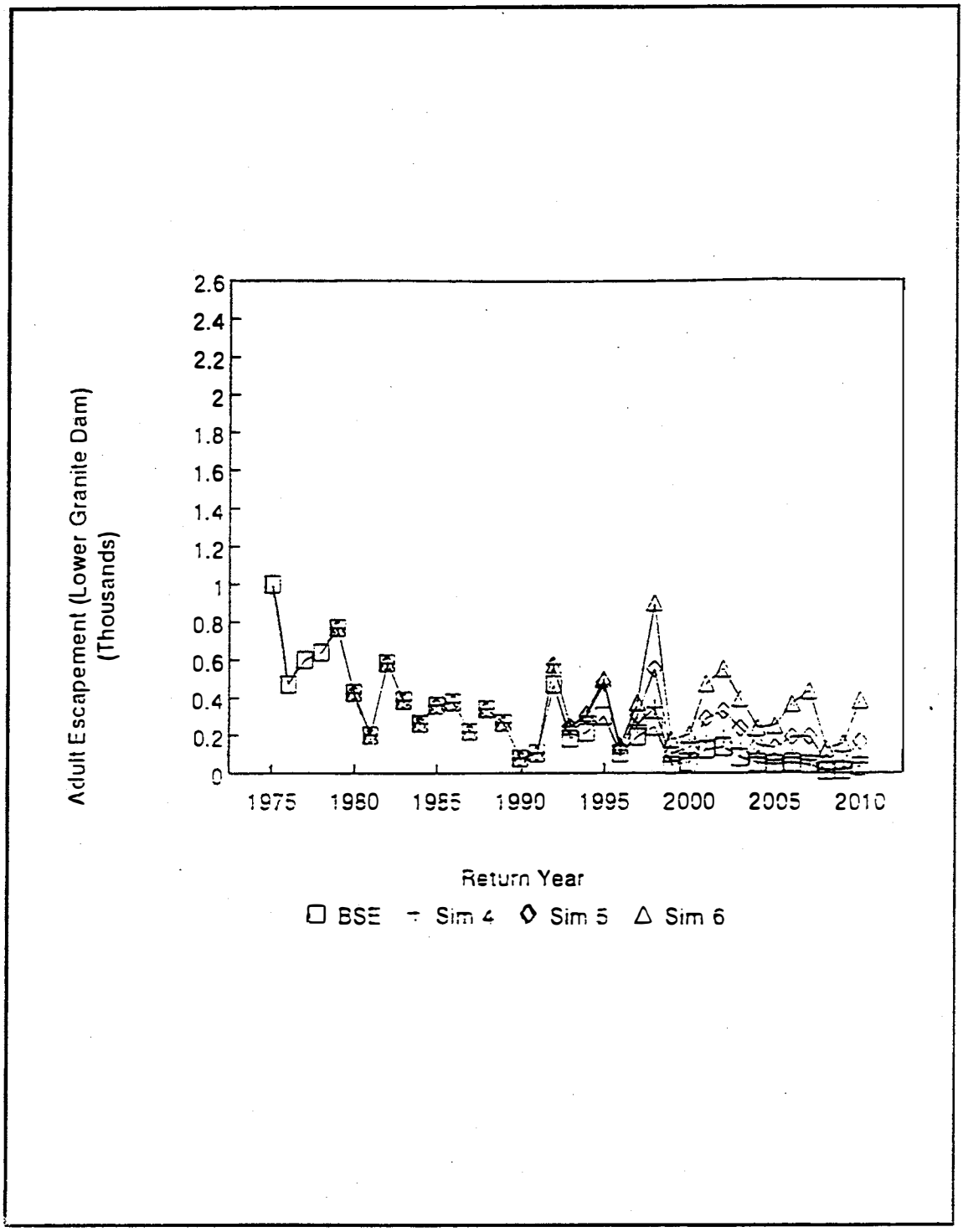


Figure 4.2-15. Empirical life-cycle model results for baseline conditions vs. 1993 operation simulations, escapement measured as naturally spawning fall chinook crossing Lower Granite Dam (Predation mortality reduction assumed over length of program: Sim4 = 0; Sim5 = .15; Sim6 = .25) (Transport return ratio assumed: 1:1) (Source: STFA, 1992b).

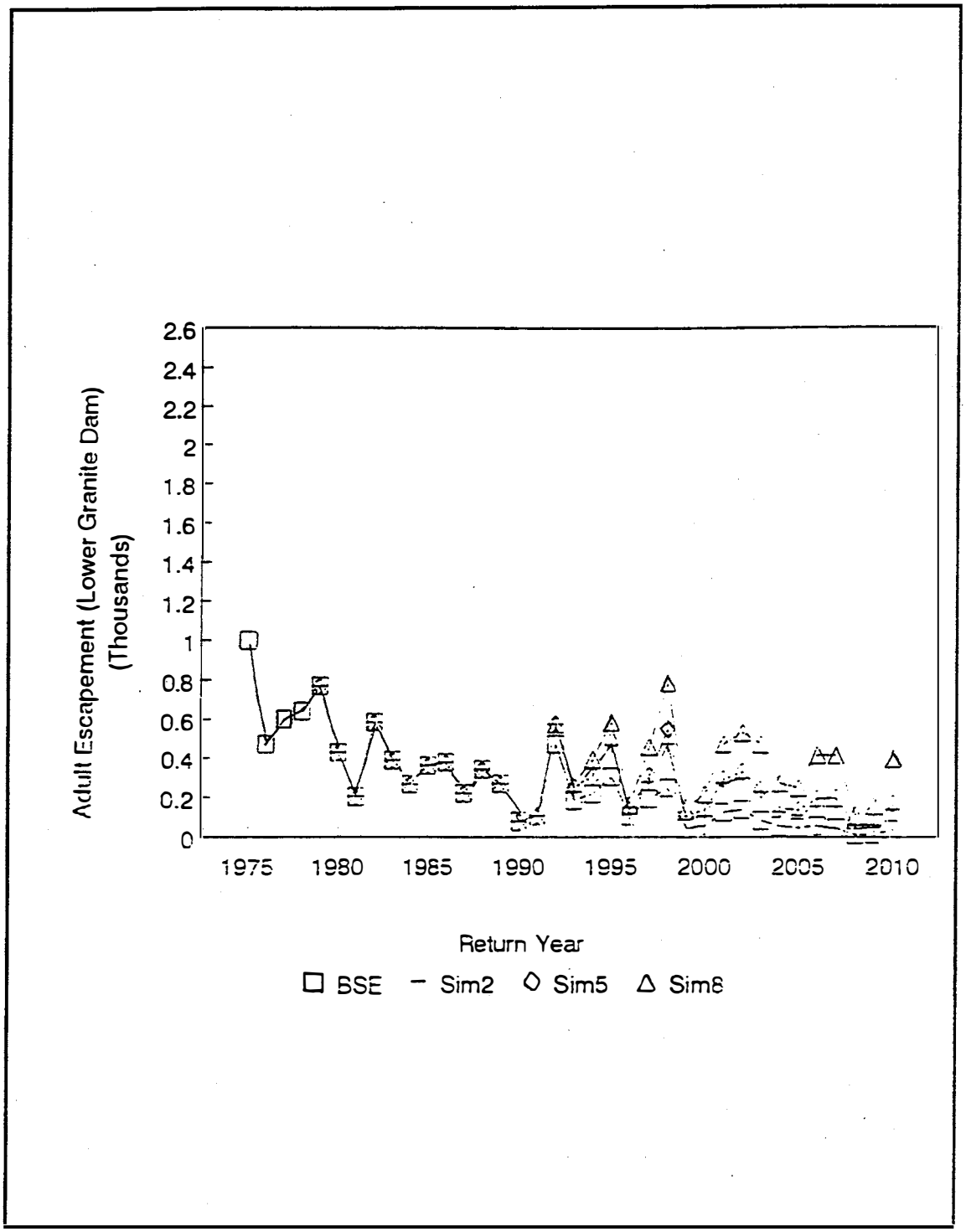


Figure 4.2-16. Empirical life-cycle model results for baseline conditions vs. 1993 operation simulations, escapement measured as naturally spawning fall chinook crossing Lower Granite Dam (Predation mortality reduction assumed over length of program: Sim2 = .15; Sim5 = .15; Sim8 = .15) (Transport return ratio assumed: Sim2 = 0.50:1; Sim5 = 1:1, Sim8 = 2:1) (Source: STFA, 1992b).

above) reflect consideration for uncertainties. Given the range of predator mortality reductions examined, two of three simulations at TRR of 1:1 exhibited declining trends in estimated escapement from recent years.

As exhibited by the sensitivity analysis, harvest restrictions examined had little apparent effect on estimated escapement levels or trends. Although the harvest management actions that were simulated in the sensitivity analysis differed substantially, there was little effect on the model results.

4.2.6 SUMMARY

Preliminary conclusions on the effect of each SEIS alternative on juvenile survival rates are discussed below.

The results of the BPA juvenile fish passage model (CRiSP) show the proposed operations for 1993 (Alternative 4), relative to 1990 baseline operations, will increase the survival of spring and summer chinook downstream migrants (Table 4.2-2). Proposed operations increase survival of fall chinook in low survival conditions, but slightly decrease survival in median and high survival conditions. Substantial additional survival improvements are estimated from nonflow measures to be implemented in 1993 and additional ongoing actions currently planned through 1998, such as squawfish management, bypass installations and improvements, transportation from Lower Monumental Dam, and habitat improvements.

The results of the BPA life-cycle model (SLCM) show that the improvements in juvenile survival coupled with additional planned actions through 1998 affecting other life stages of chinook should result in gains in spring and fall chinook species populations (Figures 4.2-2 and 4.2-4). Improvements from these actions are more moderate for the summer chinook population (Figure 4.2-3). Both the spring and fall chinook show increasing population trends with 1993 and future conditions. Summer chinook show population trends improving from the 1990 baseline conditions. However, the downward baseline trend improves only to a flat trend if low effectiveness of measures is assumed, and improves to a slightly increasing trend assuming moderate and high effectiveness of measures.

The BPA analysis also estimated probability of low future escapement trends for spring, summer, and fall chinook. With all moderate or high conditions, less than 4 percent of the slope lines have significantly decreasing trends. This is compared to 24, 49, and 71 percent of spring, summer, and fall chinook, respectively, predicted to have decreasing trends for modeled baseline conditions. The BPA analysis also examined the probability of low escapement occurring for the three stocks 40 years into the future. For spring chinook, base conditions indicated that estimated escapement of less than 1,000 fish would occur 28 percent of the time. Future low, moderate, and high conditions of less than 1,000 spring chinook would occur 16, 7, and 3 percent of the time, respectively. Summer chinook base conditions were predicted to have escapement less than 500 fish 16 percent of the time over the next 40 years, with low conditions being 1 percent, and moderate and high being less than 1 percent. Fall chinook base conditions for escapement less than 250 fish was estimated to occur 84 percent of the time with all other conditions resulting in low escapement less than 1 percent of the time.

The NPPC passage analyses and life-cycle analyses only modeled spring chinook. Results of the NPPC juvenile fish passage model (PAM) also show survival increases for spring chinook associated with the proposed and other additional actions in 1993. The NPPC SPM life-cycle model indicated a slight increase in the median trend in spring chinook adult escapement for all alternatives except for the 1990 baseline conditions. The only combination of actions that produced a marked increase in future escapement was the one that considered improvements in nearly all areas of the spring chinook life cycle. This included all 1993 proposed flow and reservoir level modifications (as represented by Alternative 4), increased number and length of screens at the dams (most are in future plans for the system), reduced upstream passage mortality (by 5 percent), and increased quality of rearing and migratory habitat (included as a 10-percent increase in egg-to-smolt survival, 3.5-percent increase in smolt-to-smolt survival, and 25 percent reduction in predation loss).

The increases in juvenile spring chinook survival from the NPPC (PAM) analysis are reasonably similar to the BPA (CRiSP.0) results for the proposed 1993 conditions, but higher for 1998

conditions compared to 1990 baseline conditions. The model analysis that assumed the most similar conditions for 1993 showed relatively comparable increases in spring chinook juvenile passage survival of 7 percent (median) for the moderate effectiveness in CRiSP.0 and 8 percent (average) for the high PAM. The similar conditions modeled for BPA 1998 moderate effectiveness, however, increased by 12 percent (median) over 1990 base conditions, while the NPPC comparable model high effectiveness increased 20 percent (average).

Because of the many differences between the level of future actions, treatment of parameters, and sensitivity analyses used for the calculations of the STFA's, FLUSH and ELCM models (STFA, 1992a,b) and those used in the BPA and NPPC models, direct paired comparisons cannot be made for downstream survival and adult escapement. However, some limited comparisons can be made. For spring chinook, assuming Transport Model 1 and 1993 planned actions, average increase in downstream passage survival was higher with the STFA models, having a relative increase of 27.5 percent over their baseline (which was different than the baseline used by the other models). This may be reflective of the deterministic model structure of FLUSH compared to the multiple run analysis of CRiSP.0 and PAM. The BPA and NPPC models relative increases were 20 percent or less. For fall chinook, the STFA estimated TBR of 1:1 and the relative increase ranged from 4.5 percent (no predator reduction) to 26.9 percent (25-percent predator reduction). This range was lower than the BPA model which ranged from 25 percent (3.8-percent predator reduction) to 95 percent (37.5-percent predator reduction).

The Corps and cooperating agencies recognized at the outset that there could be differences in the life-cycle model (SLCM, SPM, and ELCM) results because of the models' assumptions. The Corps and cooperating agencies are continuing to evaluate the life-cycle models, along with a Regional Interagency model comparison group. Developing a valid comparison of the results of life-cycle models is difficult because the models used different parameter values for some actions, and differed on what future actions should be included in their analysis. A parameter value of an action reflects how effective that action is to increasing survival. Although the coordinated effort to set estimates and ranges for the model analysis agreed upon some parameter and assumption values common to SLCM, SPM, and ELCM, other parameter values are different because of more recent data and agency interpretations of the validity of certain available data.

For the life-cycle models of spring chinook, general trends differed among the three models when the same transport model was used. The ELCM indicated little or no increase over a 30-year period while the other two models showed either minor or higher increases depending on which assumptions were used. One difference with the ELCM is that it did not assume any habitat improvement effects as did the other two models. However, for the same 20-year period, SLCM relative increase in run size was 5-fold greater than estimates produced by ELCM. For ELCM, predicted adult fall chinook escapement increased with a lower TBR when predation reduction was assumed to be high (25 percent).

Snake River sockeye salmon were not modeled by BPA because no known anadromous juvenile fish will be in the river in the next 2 to 4 years. NPPC and STFA did not model for sockeye because of insufficient data required to parameterize their models. Currently, there are captive breeding programs in Idaho and western Washington for the remaining known wild stock of Snake River sockeye. Some of the offspring of these fish will be released in the future to migrate downstream from Redfish Lake, Idaho. Information on their behavior and response to flow and survival have not been well documented, but because of their similar size and migration period, sockeye that might be migrating from Redfish Lake are likely to be affected in a similar manner to that of spring chinook. The model results for downstream migration of spring chinook indicate improvements over baseline conditions and should also benefit sockeye in the future when they again migrate downstream. However, because the exact relationship of flow to Snake River sockeye is not well known, assumed benefits of these inriver actions for this stock have greater uncertainty than for the other Snake River stocks.

Other factors are also considered in evaluating proposed flow improvements. For example, travel time changes can provide another perspective on flow improvements. Travel time reductions for nontransported yearling smolts originating in the

Snake River are typically less than 1 to 2 days, which would be less than a 10 percent reduction in total in-river travel time.

Later summer releases of water from the upper storage reservoirs could enhance upstream migration success of some fall chinook in the system, but the level of beneficial effects at this time is unknown.

Some loss of shallow water habitat for rearing, used primarily by fall chinook, could occur with operation of the Snake River Pools and John Day Pool at lower elevations. The areas lost should be a small part of the total available shallow water habitat.

The lowering of the water level has the potential to reduce water supply at the Umatilla Hatchery, possibly reducing full production potential or resulting in early release of some fish.

4.3 RESIDENT FISH AND AQUATIC ECOLOGY

Alternative	Potential Impacts (Positive/Adverse)
1. Without-Project Conditions (No Action)	• Stabilized conditions relative to 1992 conditions at Lower Granite and Little Goose reservoirs will enhance recovery of impacted resident fish populations. • Return to normal operations would have modest effect on Dworshak Reservoir fish populations which benefited from 1992 conditions. • Insignificant change in resident fish populations at other reservoirs.
2. 1992 Operations	
John Day	• Reduction of resident fish populations in culverted backwaters with culverts above elevation 262.5 (not all culverted backwaters). The extent of this reduction is not known, but is not expected to be substantial since this is similar to 1992 operations. • Reduced viable spawning habitat, possible long-term changes in species composition. • Possible, but unlikely long-term benefits to resident fish.
Lower Snake	• Probable enhanced egg survival offsetting reduced spawning area • Possible reduced benthic production in Little Goose Reservoir.
Dworshak	• Effects highly dependent on basin runoff patterns, could be very positive or could cause significant reductions in fish populations.
Brownlee	• Some reduction in spawning and feeding success and reduced fish production.
Grand Coulee	• Increased entrainment of fish, delayed zooplankton production, reduced reproductive success at Lake Roosevelt, particularly under certain runoff and operating conditions.
Libby	• Increased early summer productivity at Lake Koocanusa.
3. 1992 Operations with Libby/ Hungry Horse Sensitivity	• Same as Alternative 2 except as follows:
Libby	• Decreased growth and productivity of fish in reservoir during low-water years.

Alternative	Potential Impacts (Positive/Adverse)
3. 1992 Operations with Libby/ Hungry Horse Sensitivity (continued)	
Hungry Horse	• Potential for decreased growth and productivity of fish in Flathead River in some years. • Potential for decreased productivity of fish in reservoir during low-water years. • Possible minor benefit to spawning bull trout.
4. Modified 1992 Operations	• Same as Alternative 2 except as follows:
Grand Coulee	• Potential for increased entrainment of fish during certain moderate-water years. • Reduced plankton production and feeding success in low-to-moderate water years.
5. Modified 1992 Operations with Upper Snake Sensitivity	• Similar to Alternative 4.

4.3.1 Potential Mechanisms for Population Effects

Resident fish populations of the Columbia-Snake River System might be affected by the alternatives through numerous mechanisms. Most of the potential impacts are related to spawning success, early survival of juveniles, and availability of prey. The changes could be both positive and negative and there could be offsetting effects on some resources. Mechanisms for effects on aquatic organisms of the reservoirs identified in the 1992 OA/EIS included:

- Reduced total area of available shallow-water habitat associated with reduced reservoir surface area;
- Lower shallow-water habitat quality as a result of loss of existing macrophytic vegetation and probable increased sediment content of substrate at lower reservoir elevations;
- Reduced primary productivity associated with increased flushing rates and subsequent decreased residence time of nutrients and increased loss of plankton past the dams;
- Changes in zooplankton productivity because of changes in phytoplankton abundance;
- Loss of benthic production in the zone exposed by lowered reservoir operations;
- Decreased abundance of terrestrial insects because of increased distance between upland vegetation and water's edge;
- Decreased fish feeding success because of reductions in prey availability;
- Reduced fish growth rates associated with reduced feeding success;

- Increased mortality of young fish arising from competition and increased vulnerability to predation in the reduced reservoir volume;
- Increased entrainment of young fish associated with increased discharge from the reservoirs;
- Increased growth of plankton and warm-water fish species associated with increased water temperatures during the spring;
- Decreased plankton production associated with increased turbidity levels and subsequent reductions in light penetration;
- Increased mortality of cold-water fish species in reservoirs where existing temperatures approach upper tolerable limits;
- Shifts in species composition of the plankton community in response to shifts in temperature and/or turbidity;
- Reduced access to tributary spawning grounds;
- Reduced fish production because of dewatering of eggs present along the shoreline during the incubation period;
- Mortality from stranding on dewatered shores; and
- Changes in habitat characteristics associated with changes in sedimentation patterns.

Riverine resources can also be affected through numerous mechanisms including:

- Water temperatures below growth optimums;
- Reduced access to tributary streams for spawning;
- Positive effects on riverine spawning, if flows are increased during the spawning period;
- Negative effects on riverine spawning, if flows decrease during the spawning and incubation period; and
- Mortality due to exposure to supersaturated gas levels downstream of dams.

The potential that these mechanisms have to change the overall reservoir and riverine populations depends on the duration and extent that populations are exposed to the mechanisms and whether the populations are limited by that mechanism. For instance, if spawning habitat is amply available and underused under normal circumstances, reductions in the available habitat might not have a negative impact on the population as a whole. Likewise, reductions in food availability might not affect populations if food levels normally present in the reservoir far exceed levels required to maintain the populations. Because limiting factors and potential impact mechanisms vary from reservoir to reservoir, the following impact assessment is organized on a geographic basis.

4.3.2 John Day

Alternatives 2 through 5 all include operation of John Day at minimum irrigation pool from May 1 through August 31. Under these alternatives, water levels in John Day Pool would be held through the summer at levels similar to or slightly above normal winter levels and at approximately the normal March to May 15 water elevation. This elevation could be attained by holding the winter elevations throughout the summer or by filling the reservoir before May 1 and then drafting the reservoir to increase downstream flow. The impacts of Alternatives 2 through 5 would therefore depend upon operations prior to the drafting period.

The period from May 1 to August 31 corresponds with the spawning and incubation period of most warm-water species. Assuming the reservoir would be filled and then lowered, the reproductive success of species spawning while water levels are declining would be significantly reduced. However, the reproductive success of later spawning fish, such as largemouth bass, smallmouth bass, and crappies, might be enhanced since fluctuations in water levels, and, correspondingly, the potential for dewatering eggs is expected to be reduced. The overall availability of spawning and rearing habitat would, however, be reduced (see Figure 4.3-1). Fish residing in culverted backwaters might suffer mortality as the temperature increases and dissolved oxygen decreases in shallower-water areas. Stranding of fish in backwaters might be significant when the reservoir is being lowered.

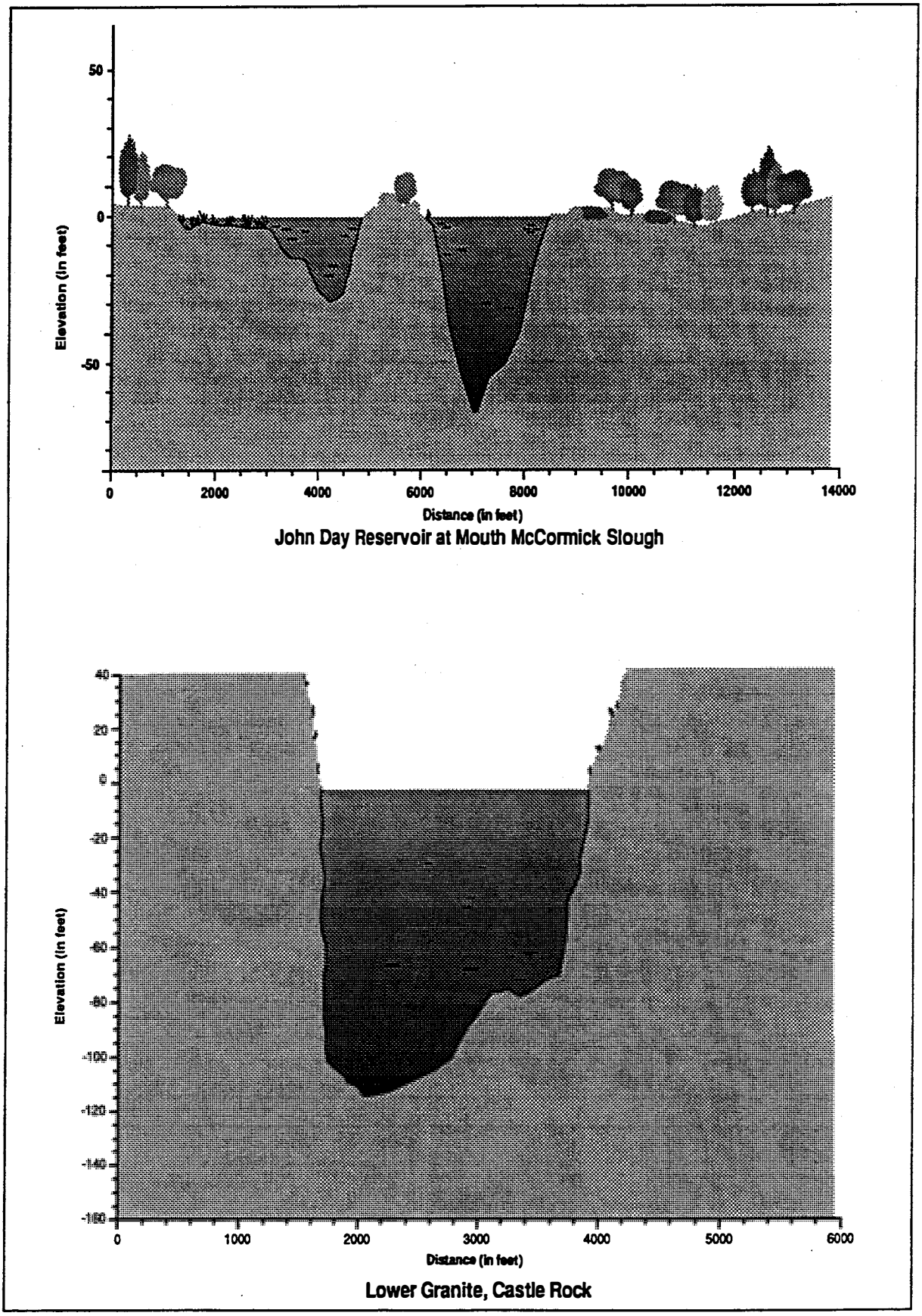


Figure 4.3-1. Representative John Day and Lower Granite reservoir profiles.

Benthic organisms in the littoral zone exposed during the winter drawdown would not survive into spring. Hence, no net loss of benthic organisms would occur during the transition from winter operations to those proposed under Alternatives 2 through 5. Benthic production would be less than normal during the summer with the loss of normally productive backwater habitats. Reductions in water retention times, increased turbidity, and decreased surface area could reduce plankton production which, in turn, could affect the feeding success of planktivores.

If water levels are held stable from winter into summer, many of the potential impacts to resident fish might be avoided. The overall area of shallow-water habitat would be reduced compared to normal levels resulting in reduced availability of spawning and rearing habitat; however, eggs deposited in shallow areas in spring and early summer would not be subjected to desiccation when the reservoir is drafted, which would reduce the impacts of Alternatives 2 through 5. Constant water levels would also avoid the potential for stranding of fish in backwaters; however, fish present in those areas would still be subjected to the effects of deteriorating water quality over the summer. Effects on benthic and planktonic production would be similar to those expected if water levels were first raised and then lowered in spring.

Under either scenario (maintaining winter elevations or filling to elevation 265 in April before lowering the pool again), reductions in abundance of resident fish can be expected. Filling and then lowering the reservoir elevation during late spring and summer for one season would result in short-term reductions in fish abundance. Exercising this scenario for several consecutive years, however, would tend to favor species that spawn later in the summer and might result not only in reduced abundance of resident fish but also result in a long-term change in species composition in the reservoir.

If the option of holding the reservoir at winter levels is exercised for only 1 year, those impacts would be short term. If, however, the option is repeated for several consecutive years, longer term changes in the fish populations in John Day Pool could be expected. If repeated for several years, the net effects might be beneficial. Over time, a more constant pool elevation would permit the growth of shoreline vegetation. The reduced magnitude of annual disturbance of the shallow-water areas would also allow the development of macrophytic and benthic populations at levels greater than currently exist in the reservoir. Fish populations could be expected to respond favorably to these more stable conditions and enhanced shoreline productivity.

No specific estimates of population change under either scenario can be made at this time because there are no current population estimates (except for squawfish) and sufficient information regarding factors controlling productivity in the reservoir is not available.

4.3.3 Lower Snake River

Alternative 1 calls for normal (pre-1992) operations at the four lower Snake River dams (Ice Harbor, Lower Monumental, Little Goose, Lower Granite). Resident aquatic species would, therefore, be unaffected by Alternative 1.

Under Alternatives 2 through 5, the reservoirs would be drafted to MOP from April 1 to July 31. With all four reservoirs at MOP in spring and early summer, water surface elevations would be held near the lower elevation of the normal April-to-August operating range at most of the reservoirs. MOP elevations at Little Goose are approximately 2 feet lower than the normal summer operation range. Average water levels at all four reservoirs would be reduced by up to 3 feet during the affected period; however, water levels would be held fairly constant compared to normal operations.

Most of the resident fish in the Snake River reservoirs spawn from April 1 to July 31. All pool elevations normally fluctuate a fair amount during spring. Eggs laid in shallow water areas when the reservoir is at its highest level are subject to desiccation when water levels drop. Therefore, truly viable spawning habitat available under normal conditions at most of the reservoirs is the shallow-water area not normally exposed by normal reservoir water level fluctuations. The viable spawning habitat available at MOP is probably similar to or slightly less than that available under

normal operating conditions. Stabilized water surface elevations would tend to ensure that most spawning activity occurs in areas that would be inundated throughout incubation; therefore, operations at MOP should have a small positive effect on successful egg incubation. The reduced total shallow-water habitat, however, would tend to negatively affect overall reproductive success of the resident fish populations. The net effect of lowering reservoir elevations to MOP on spawning and incubation is uncertain.

Water retention times in the reservoirs would be adequate to enable zooplankton populations to increase to densities high enough to provide food for larval fishes. Turbidity might increase temporarily when water levels are first reduced but turbidity should return to ambient levels and should, therefore, have little overall effect on plankton productivity (Bennett, 1991).

Benthic community production should not be greatly affected under operation at MOP at any of the reservoirs, except Little Goose. Current operation at all dams but Little Goose includes water level fluctuations to levels near MOP, which has probably reduced the benthic community within the original full pool fluctuation range. Therefore, the benthic community should not be greatly affected. At Little Goose, MOP water levels are 2 feet below the normal range of operations. Benthic organisms in this 2-foot range would be negatively affected.

Since benthic and planktonic prey sources are not expected to be greatly affected, feeding success of resident fish populations should also be relatively unaffected. Flows in the river and spill levels would not change significantly. Therefore, river populations should also be unaffected by operations at MOP.

Two candidate mollusk species for listing under the ESA are known to be present in or near Lower Granite Reservoir. The shortfaced lanx (*Fisherola nuttalli*) is a cold-water snail species that thrives in rapids and similar habitats. No individuals were seen exposed during the March 1992 drawdown test (personal communication, T. Frest, Diexis Consultants, Seattle, Washington, August 1992) but that is not to say the whole population might not have been negatively affected. Several freshwater mussels (*Anodonta californiensis*) were found in the drawdown zone of Lower Granite Reservoir. These animals cannot move very quickly and many were found dead. Water elevation during the 1992 drawdown test was reduced to unusually low levels. Alternatives 2 through 5 do not include reductions in water levels below normal operations. Few mussels are expected to be present within the fluctuating range of MOP operations; therefore, few, if any, animals should be affected by operations at MOP.

In summary, operation of all four lower Snake River reservoirs at MOP is not likely to activate any of the mechanisms that would substantially affect resident fish populations. Therefore, operations at MOP are anticipated to have minimal effects on resident fish populations.

Spawning might be positively affected by stabilized water levels, but the reduced spawning area may offset those positive effects. However, any impacts at Little Goose or Lower Granite pools would be cumulative with impacts sustained during the 1992 test drawdown to near spillway crest. Preliminary tests suggest that the benthic and resident fisheries populations in Lower Granite Pool might have sustained significant impacts in 1992. It can be assumed that the impacts to the aquatic resources in Little Goose Pool were similar, but to a lesser degree because the duration and depth of the Little Goose drawdown were substantially less than Lower Granite. Any additional impacts to those resources would delay the eventual recovery of the reservoirs' resources.

4.3.4 Dworshak

Without-Project Conditions

Under normal conditions, Dworshak Reservoir is drafted about 100 feet and as much as 155 feet in fall and winter and refilled in spring and early summer. Because of the extensive variation in water surface elevation and continued wave actions, aquatic macrophytes are virtually nonexistent along the shorelines and benthic production is low (Corps, undated; Statler, 1990).

Spawning of kokanee is unaffected by the deep drafts of the reservoir because the resident population spawns in the tributaries in September and October (Horton, 1980). However, mortality

of young is very high; it has been estimated at over 80 percent (personal communication, Melo Maiolie, Idaho Department of Fish and Game [IDFG], Coeur d'Alene, Idaho, August 23, 1991). Preliminary results of studies conducted in the reservoir suggest that entrainment (fish being pulled through the dam by flows), which is correlated to discharge, is the primary cause of mortality.

Effects of Proposed Flow Augmentation

The proposed flow augmentation from Dworshak Reservoir would generally include filling the reservoir to the winter flood draft maximum elevation followed by 900 KAF (or more) releases April 15 through June 15, 270 KAF releases June 16 through August 30, with an additional 200 KAF under Alternatives 4 and 5, and 200 KAF release in September (possibly August) under Alternatives 2 and 3. HYSSR Model runs indicate that Alternatives 2 through 5 have a very similar effect on expected water surface elevations in the reservoir. On average, these alternatives result in water elevations that are 4 to 9 feet higher in spring and up to 22 feet lower in summer than generally occurs under Alternative 1.

This pattern of higher elevations in spring followed by summer drawdown roughly follows the fill-and-release pattern implemented in 1992. In 1992, however, the reservoir was not drafted as low as would be expected on average under the alternatives. The elevated water levels in spring of 1992 were high enough to inundate terrestrial vegetation along the periphery of the reservoir. Subsequent releases resulted in a draft of only 80 feet by mid-April, compared to the normal 100- to 150-foot drafting.

Preliminary results of investigations conducted to assess the effects of the 1992 operations on the aquatic resources of the reservoir suggest that the operations had a significant positive effect (personal communication, M. Maiolie, IDFG, August 20, 1992; personal communication, D. Statler, Nez Perce Tribe, September 3, 1992). Unusually large numbers of young kokanee have been intercepted in the reservoir. It has been hypothesized that the higher reservoir elevation, together with the late winter low flows, has significantly reduced juvenile mortality through entrainment into the dam. In addition, the inundated vegetation has provided an excellent substrate for benthic production and also provides cover from predation. Benthic production was further benefitted from the higher reservoir elevation. Preliminary studies also suggested that the inundated vegetation and higher reservoir elevation might have benefitted spawning and feeding success of other reservoir species as well. These observations follow the general pattern in reservoir productivity normally observed during the first years that a reservoir is filled or following a long period of lower reservoir elevation. The inundated vegetation provides nutrients and structure that are used by a wide variety of aquatic organisms.

While the results of the 1992 operation are encouraging, they may not be repeated in future years. Assuming that discharge patterns return to normal in 1993, flow rates through the reservoir would be increased and the reservoir might be drafted farther than it was in 1992. Flood protection concerns during a year of normal discharge patterns might prevent the filling of the reservoir to the level seen in 1992.

Increased flow and drafting of the reservoir is expected to increase the number of young kokanee entrained through the dam. If the reservoir were not filled to levels reached in 1992, the benefit of increased benthic production and terrestrial insect input would be lost. Historically, benthic production has been nearly absent in the reservoir because of the normal wide fluctuations in elevation. The steep slope of the bank is likely another factor in the limited benthic production. Under normal conditions, resident populations rely largely on terrestrial insects and plankton as food sources. Additional drafting of the reservoir would likely increase the flushing rate of the reservoir, reducing overall plankton production and decreasing feeding success in late summer. Under either normal operations or flow augmentation operations, the reservoir has a low probability (52 to 68 percent) of refilling by July of any year. Failure to refill would further increase kokanee entrainment and reduce benthic production.

The potential effects of the proposed actions in Dworshak Reservoir are highly dependent on the discharge patterns in the watershed, which would affect the maximum water elevation reached in the

reservoir and the extent of drafting during the summer. Overall effects could range from a significant positive increase in reservoir production to a significant loss of net production. These effects would vary with inflow conditions from year to year, so both positive and negative effects would likely be experienced over a 5- to 10-year period of interim operations.

The effects of the alternatives on bull trout rearing in the reservoir would be the same as for other species in the reservoir, varying with actual fill/refill patterns. Resident species present in the Clearwater River downstream of Dworshak Dam would encounter increased flows in spring and summer (varying by alternative as described above). The modification in flow patterns is expected to benefit spring spawners in the river below. Reduced flows in fall, however, might be detrimental to fall spawning species such as bull trout.

The increased releases of water from Dworshak Dam in August with Alternative 4 would tend to cool the river downstream of the dam. The river typically reaches temperatures in the range of 70 to 75°F in August which approaches lethal temperatures for several native species. Reductions in river temperature in August could benefit native species by reducing heat stress. However, growth of salmonids decreases in water temperatures below 64°F. Excessive releases could therefore diminish fish growth during a critical part of the growing season. The overall effect of changes in water temperature therefore depends upon the temperature of the river, the temperature of the release water, and the quantity of water released.

4.3.5 Brownlee

Alternatives 2 through 5 incorporate flow augmentation releases in May, July, and September. Due to drafting constraints and replacement of the July release with upstream water, the average annual fluctuation in water elevation would be similar to existing conditions.

The shorelines of the reservoir are steep, providing little shallow-water spawning area. Poor or no smallmouth bass reproduction has been reported in years when water surface elevations are low (BPA, 1985). Other species that depend on shallow water for reproduction might also be affected by low-water levels and subsequent lack of available spawning habitat. Any additional drafts that might occur to provide flow augmentation are likely to affect the reproduction of these shallow-water spawning species. The impacts of a single year of additional drafts would result in short-term minor changes in fish abundance in the reservoir. Additional drawdowns continued over several years, however, could potentially have serious effects on the species composition and abundance of the reservoir's fish populations. If low water-surface elevations result in failed spawning for a number of years, the abundance of shallow-water spawning fish could be reduced substantially and might require many years to recover.

It is anticipated that benthic and primary productivity at Brownlee would be unaffected by changes in reservoir elevations from April through June. Likewise, significant changes in water quality are not anticipated. The proposed releases are not likely to significantly affect entrainment because drafting rates and resulting water surface elevations would not be substantially different from existing conditions.

4.3.6 Grand Coulee/Lake Roosevelt

Lake Roosevelt is an upstream storage reservoir that stores a relatively small quantity of water relative to the water that passes through, resulting in relatively short water retention times compared to most other storage reservoirs. The water retention time varies between 15 to 76 days and controls much of the aquatic primary production upon which the fishery is based in this reservoir. Water retention times of 30 to 35 days or greater are suspected to be of critical importance to provide sufficient forage for resident fish populations in this reservoir (Peone et al., 1990). More information collected from 1990 to 1992 supports this need (personal communication, A. Scholz, UCUTS, February 4, 1993).

In addition, past studies indicate that the kokanee population in Lake Roosevelt is affected by the annual drafting of the reservoir for flood control and power generation. Kokanee are maintained in the reservoir to mitigate for lost salmon production. In Lake Roosevelt, kokanee spawn in the fall and early winter during a time when water surface

elevations are still relatively high. Subsequent desiccation of eggs during the early spring as the water surface elevation is lowered to provide for flood control and power generation reduces the reproductive success of the population. Spring drafting also impacts incubation of walleye and yellow perch eggs.

The HYSSR Model runs for Alternatives 2 through 5 indicate that during low-to-moderate water years a significant portion of the May to June runoff, which is normally captured in Lake Roosevelt, will be released to augment flows downstream. With this release is potentially a large portion of the nutrient load in the runoff. That nutrient load is normally trapped in the reservoir, providing the base for primary productivity. Whether annual nutrient loading is limiting to resident fish in Lake Roosevelt is unknown; however, shortened water retention times reduce phytoplankton/zooplankton production during the late spring/summer period.

In any one year, the release of nutrients would probably not be significant. However, the cumulative effects of drastically reduced primary and secondary production could severely limit the growth of almost all juvenile fish. Increased competition between juveniles for food could limit the population size of kokanee, yellow perch, rainbow trout, and the non-game species. Because yellow perch are preyed upon heavily by adult walleye, reductions in yellow perch abundance or growth will also affect the walleye population. White sturgeon might also be affected but to a lesser degree since the majority of the population is believed to reside in the upstream end of the reservoir.

In addition to affecting primary productivity, decreased water retention times and/or drafting during the spring-summer timeframe also affect entrainment of fish through Grand Coulee Dam. During high flow periods, as much as 30 percent of the annual rainbow and kokanee production may be passed downstream (personal communication, A. Scholz, UCUTS, February 4, 1993). Rainbow trout and kokanee tagged and released in Lake Roosevelt have been captured at sites as far downstream as Rock Island Dam. This entrainment at Grand Coulee and subsequent entrainment through downstream projects may partially account for the spread of walleye through the lower Columbia River. Drafting and water level fluctuations also adversely affect trout net pen operations.

Drafting of Lake Roosevelt during the May time frame might eliminate the yellow perch spawn. The yellow perch is the prey base of walleye and potentially the prey base of the petitioned bull trout. In Lake Roosevelt, yellow perch spawn on woody debris in shallow water. They also spawn on aquatic vegetation; however, this habitat is limited in Lake Roosevelt. Spawning of walleye may also be affected, although the majority of walleye spawn in the Spokane River and some in the San Poil River.

One of the potential flow augmentation operations proposed is based on the premise of storing water in Lake Roosevelt first and, if any additional water is required, storing it either in Arrow or Libby. In some water years, most of the flow augmentation storage would occur in Lake Roosevelt. If this operation occurs, water retention times might be decreased, drafts might be deeper during May to June and full pool elevations might not be reached until later in the summer. Depending upon how much water is stored and the timing of the runoff, several years of this operation could devastate resident fisheries in Lake Roosevelt.

If the additional water is stored in Arrow, it may be possible to limit the drafts and increase the water retention times by providing sufficient inflow from Arrow. If Libby is used for additional storage, the effect of providing inflow is not as beneficial as if it were provided from Arrow, but is better for resident fish than using Lake Roosevelt only for the majority of the flow augmentation.

Although this NEPA document accounts for interim operations, both the flood control shift and the 3 MAF flow augmentation are operational features of the Northwest Power Planning Council's Fish and Wildlife Amendments and may be proposed for the future. With this in mind, regardless of how the 3 MAF flow augmentation is accommodated, resident fish in Lake Roosevelt probably face a continual decline that is not easily mitigated. Depending upon the sequence of water years and the flow augmentation operation, this decline might be cyclic with some mediocre years and some severe years.

4.3.7 Libby/Kootenai River

Under current conditions, Lake Koocanusa is drafted up to 120 feet. These large annual drafts negatively affect the density of benthic invertebrates which in turn might affect feeding success and growth of reservoir fish populations (Chisholm et al., 1989).

Biological rule curves intended to protect reservoir fish resources are being developed by the Montana Department of Fish, Wildlife and Parks for proposed operation of Libby Dam. These rule curves would provide project operators with more information on the needs of resident fish during each season of the year. They have not been adopted but have been used informally in some applications to assess departures from favored conditions that are caused by existing operations. Generally, the rule curves call for maintenance of Libby Reservoir at full pool July through mid-September, with drafting and subsequent refilling of the reservoir occurring during the balance of the year. These curves have not yet been adopted.

The HYSSR Model simulations for Alternatives 2, 4, and 5 indicate that the reservoir would not be drafted as deep in winter and would have higher water elevations in spring and early summer in low-runoff years. The increased elevations would tend to (1) increase the area of the reservoir bottom within the photic zone, (2) increase benthic and planktonic production, (3) increase recruitment of terrestrial insects into the reservoir by providing more habitat for juvenile lifeforms and through input of adults from surrounding terrestrial vegetation, and (4) increase growth and feeding success of reservoir fish populations. The increased water levels in spring should also benefit spring spawning of warm water fish.

Under these alternatives, flow in the river below the dam would also not change significantly in April and May compared to existing conditions. Based on current theories regarding flow requirements for white sturgeon spawning, flows below the dam would be insufficient to trigger spawning of white sturgeon or provide for egg incubation in most years.

Under Alternative 3, model runs indicate that on average, spring drawdowns of Libby Reservoir would be 10 feet greater than occurs under normal operations. The probability of refill is not predicted to be substantially changed. Assuming the model predictions are correct, benthic and pelagic production would be reduced. This, in turn, might affect feeding success and growth of all species in the reservoir, including bull trout.

Spring (May to June) median flow releases from the dam would be slightly reduced under Alternative 3. The reduced spring flows would be detrimental to spawning of Kootenai River white sturgeon, which are resident below the dam and believed to be dependent upon high spring flows for successful spawning. The exact flows required to trigger spawning of white sturgeon are unknown at this time; however, biologists feel that at least 20 to 25 kcfs at Bonner's Ferry may be necessary. Future studies and observations will provide more information regarding flow requirements. Assuming a 20-kcfs threshold, spawning would be triggered in 4 to 8 years out of 40. In years that spawning occurs, all alternatives provide sufficient flow to support egg incubation at Bonner's Ferry. The white sturgeon population is the subject of intense interest because of a petition and positive 90-day review finding for possible listing under the ESA. Studies are planned to monitor sturgeon activity and document any spawning. Fall flows would also be reduced slightly, but should not affect spawning movements of bull trout.

4.3.8 Hungry Horse/Flathead River

Under current operations, Hungry Horse Reservoir is drafted in winter, early spring, and summer. Biological rule curves are being developed by Montana Department of Fish, Wildlife and Parks to define recommended reservoir operations for certain fish species. These rule curves would provide project operators with more information regarding the needs of resident fish during each season of the year. Generally, the rule curves call for maintenance of Hungry Horse Reservoir at full pool July through December and allows for drafting and subsequent refilling of the reservoir during the balance of the year. These curves have not yet been adopted.

Reservoir productivity, as well as spawning and rearing, might be affected by operational changes (letter from L. Peterman, Montana Department of

Fish, Wildlife and Parks to James Goller, Chairman, Northwest Power Planning Council, October 25, 1992). The depth of reservoir drawdown is likely less important than the timing (May et al., 1988). Deeper drafts during the late summer and fall appear to have more of an impact on the fishery than the deep winter drafts. This is because late summer drafts increase the mortality of reservoir populations by increasing competition and making the juveniles more susceptible to predation.

Lower water surface elevations during drier years decrease the volume and extent of water available for benthic insect production and decrease the surface area available for terrestrial insect capture and drift. Terrestrial insect drift is especially important in the late summer and fall when a substantial proportion of the annual fish growth occurs.

In Alternatives 2, 4, and 5, water level patterns would be unchanged. Under Alternative 3, the median water surface elevations during the summer are predicted to be approximately the same as found under normal operations. Median elevations in the fall would be slightly lower than normal. On the other hand, average elevations would generally be slightly higher. Model predictions indicate water levels would generally be higher during dry years.

A slight reduction in the depth of the drafting in fall in dry years under Alternative 3 is expected to have a slight beneficial effect on resident fish. The normal depth of the draft, however, is great enough that the slight difference under Alternative 3 would probably be immeasurable.

In the Flathead River, effects on fisheries under Alternative 3 could occur through large increases in early summer flows and median decreases in early fall flows. Although the overall median fall flows are projected to decrease in most years, fall flows are expected to increase slightly in most years. Occasional larger decreases in flows reduce the overall median value. Because the outflow from Hungry Horse in late summer and early fall comes from the deeper, colder waters of the reservoir, years with decreased fall flows would tend to increase temperature in the river and may slightly increase growth of fish resident downstream of the dam. In most years, the difference in flow is slight and the benefit is likely to be minimal. Years that fall flows are increased would tend to decrease temperatures. Higher flows and cooler water temperatures should benefit spawning of bull trout in the fall. In spring, water released from the reservoir is similar in temperature to that of the river. Increased spring releases would not likely have a significant effect on river fish populations. Increased releases in June, however, might depress river temperatures and reduce fish growth in early summer.

4.4 TERRESTRIAL ECOLOGY

Alternative	Potential Impacts (Positive/Adverse)
1. Without-Project Conditions (No Action)	• Minimal impacts expected overall. Some loss of shorebird nesting habitat which developed at John Day during 1992 pool lowering, but stabilization of goose nesting habitat impacted by 1992 drawdown test at Lower Granite and Little Goose.
2. 1992 Operations	
Lower Columbia	• Impacts at John Day to shallow-water habitat, riparian communities, wetland development, waterfowl nesting, and furbearers. • Cumulative impacts to terrestrial resources mainly in habitat loss for most plant and wildlife species in project area.
Lower Snake	• Minimal and potentially beneficial, immediate impacts to aquatic plants and invertebrates, riparian communities, wetlands, and wildlife. • Cumulative impacts to terrestrial resources mainly in habitat loss for some plant and wildlife species in project area and increased livestock damage to riparian areas.
Dworshak	• Minimal impacts expected for most resources; potential for elk losses in winter under certain ice and snow conditions.
Brownlee	• Minimal impacts expected for most resources; potential reduction in fish prey availability for bald eagles.
Grand Coulee	• Minimal impacts expected for most resources; potential reduction in fish prey availability for bald eagles.
3. 1992 Operations with Libby/ Hungry Horse Sensitivity	• Similar to Alternative 2; minimal incremental effects for most resources at Libby and Hungry Horse; potential reduction in fish prey availability for bald eagles.
4. Modified 1992 Operations	• Similar to Alternative 2.
5. Modified 1992 Operations with Upper Snake Sensitivity	• Same as Alternative 4.

This section largely focuses on new information vrelative to the lowering of John Day Pool to near elevation 262.5 (as proposed for Alternatives 2 through 5), the results from the investigation of the

1992 spring/summer operation of John Day Pool, and potential direct and indirect effects from potential operational responses at the storage reservoirs, particularly at Libby Dam (Lake Koocanusa) and Hungry Horse reservoirs. Issues concerning effects on terrestrial resources from operation of the lower Snake River reservoirs at MOP, and from flow augmentation actions involving Dworshak, Brownlee, and Grand Coulee, were fully addressed in the 1992 OA/EIS and are summarized or referenced here. Changes in the 3 MAF flow augmentation operation at Grand Coulee, Libby, and/or Arrow has been discussed in other sections.

Effects to aquatic and riparian vegetation from lowered reservoir elevations would depend on a number of factors including project length; reservoir topography; duration, timing, and the extent of the area exposed by lowered elevations compared to normal operating conditions; water permeability of associated soil groups and concomitant effect of pool levels and soil permeability on subsurface water table depth; and severity of summer droughts. In general, effects would be most significant, although probably minimal, for the John Day Project when operated at elevation 262.5 and least significant at the storage reservoirs, which already experience deep drafting. Furthermore, pool lowering to MOP is not likely to differ from existing conditions for projects where the proposed lowering is within the lower limits of normal operating conditions.

4.4.1 Shallow Water Habitat

The detailed composition, nature, and extent of aquatic and invertebrate communities associated with shallow-water habitat throughout the project area are poorly documented. Thus, impacts of lowered pools to resources cannot be assessed quantitatively. However, these resources are expected to be adversely affected to some degree by lowered pools. Aquatic plant and invertebrate communities are expected to be most affected by lowering of the John Day Pool to elevation 262.5 because of the extensive shallow-water habitat occurring there (see Figure 4.3-1). A net loss is expected to occur in those aquatic plant and invertebrate communities that have become established over long periods under existing reservoir conditions. Densities of aquatic plants and invertebrates might temporarily increase in newly established shallow-water areas as a result of pools being lowered. Aquatic plants might also shift downward along an elevation gradient. However, eventual return to normal pool level near full would likely prevent establishment of plants in lower elevation zones.

Potential increased drafting of Brownlee, Dworshak, and Lake Roosevelt pools and operational changes at Libby and Hungry Horse, would have minimal effects. Shallow-water habitat is extremely limited at these pools (see Figure 4.3-1) and the associated aquatic plant and invertebrate communities have developed under widely fluctuating pool levels since the dams were built.

4.4.2 Riparian Communities

Detailed information on the distribution and composition of riparian communities along the project reservoirs is limited. Thus, the assessment of impacts to riparian communities from the proposed lowered reservoir elevations is qualitative. The primary impacts to riparian communities would depend largely on the extent, duration, and location of the reservoirs operated at lowered elevations and water permeability of associated soil groups, and the concomitant effect of lowered pool elevations and soil permeability on subsurface water table depth. Although riparian vegetation associated with the project reservoirs is accustomed to 3 to 5-foot water fluctuations, negative effects may occur because the proposed lowered reservoir elevations would occur during the growing season when plant water requirements are highest. Significant mortality of riparian trees has been associated with lower water tables attributed to drought (Albertson and Weaver, 1945) and water diversion/ groundwater pumping (McNatt et al., 1980). Effects on riparian vegetation from keeping projects in eastern Oregon and Washington at lowered pool levels would likely be exacerbated by the desert climate; moisture recharge is especially important during the growing season for riparian plants. Species in the riparian zones that would be particularly sensitive to lowered pool elevations include shallow rooting plants such as willows (*Salix* spp.), white alder (*Alnus rhombifolia*), and mulberry (*Morus alba*). Cottonwoods (*Populus* spp.) are also very sensitive to lowered pool

elevations based on observed response to drought and lowering of groundwater levels (Albertson and Weaver, 1945; McNatt et al., 1980). A 3-year drought resulted in 49 to 82 percent mortality of cottonwoods along an intermittent stream in Kansas (Albertson and Weaver, 1945). Water diversion and lowering of groundwater via pumping resulted in cottonwood mortality ranging from 17 to 84 percent along the Verde River in Arizona (McNatt et al., 1980).

Among the lower Snake and lower Columbia reservoirs, effects on riparian communities would be most significant at John Day Pool near elevation 262.5. This project has extensive backwater areas, and riparian vegetation is considerably more abundant than at any of the other project reservoirs. However, no readily discernible impacts to riparian habitat were observed on the Umatilla National Wildlife Refuge (NWR) from operation of the John Day Project at elevation 263 (approximate) from May 3 to May 20, 1992. One grove of cottonwoods just upstream of Plymouth, Washington exhibited signs of stress; limb mortality, loss and/or yellowing of leaves, and a general poor condition of cottonwoods at this site were observed. These are symptomatic of water stress but could be attributed to other factors. No detailed investigation to determine the causal factor was conducted.

Pool lowering to elevation 262.5 would probably not produce any noticeable effects to established riparian vegetation with the possible exception of the cottonwood stand near Plymouth. Recruitment of seedlings might be compromised by lower pool levels. Desiccation of seedlings might occur at upland sites during the pool lowering where subsurface water levels are below seedling root penetration. Seedlings that establish on exposed land within the pool boundaries would be inundated when the pool is raised. Loss of these seedlings to wave action, erosion, or occasional ice lift during winter is possible. Loss of seedlings above elevation 268 and in the narrow riparian zone would be the most important. Continued annual loss of these seedlings would eventually jeopardize the presence of riparian cottonwood stands.

Effects of operating the lower Snake projects at MOP and any modified drafting and refill patterns at the storage reservoirs on riparian communities should be relatively minimal and potentially beneficial. For example, the recruitment of willow and alder seedlings in the drawdown zone at MOP has been very successful with excellent survival, especially in the vicinity of a seed source. Continued seedling establishment is expected to add 2 to 3 acres per year to riparian areas, with potentially increased yearly acreage establishment through implementation of an active seeding program. Furthermore, these riparian communities have developed under the widely fluctuating range of water levels associated with the normal operation of these pools. However, development of riparian communities is extremely limited along the shorelines of these reservoirs (especially at the storage reservoirs) and is basically restricted to the relatively limited backwater areas.

4.4.3 Wetlands

Detailed information on wetland communities is limited for the project area, precluding any quantitative assessment of effects on wetlands at this time. In general, effects of the proposed lowered pool elevations on wetland communities in the project area would likely resemble those already discussed for riparian habitat (see Section 4.4.2).

Among the lower Snake and lower Columbia River reservoirs, effects are expected to be most severe at the John Day Pool near elevation 262.5. Extensive wetland areas have developed in associated backwater areas at this pool, particularly in the Paterson and McCormack Slough Units of Umatilla NWR. Impacts observed (by Corps staff) to wetland plant communities by operation of John Day Pool to elevation 263 for 18 days in 1992 were loss of standing water in the emergent zone, apparent loss of turgor pressure in dry emergent stands, and sunscald of leaf tips (cattail [*Typha latifolia*] and bulrush [*Scirpus* spp.]). Encroachment of emergent plants outward from existing stands onto exposed mudflats was also observed. These plants included cattails, bulrush, smartweed, annual grasses, seedling willows (*Salix* spp.), and cocklebur (*Xanthium* spp.). These species are opportunistic and require unvegetated, moist soil conditions for germination. It is expected that a flush of these species would occur with each lowered pool elevation that exposes mudflats. The longer the pool is held at elevation 262.5, the greater the opportunity for these plants to complete their life-cycle and produce the

seedbase for future generations, although these parent plants should not survive reservoir refill. The survival of emergent plants (i.e., cattails encroaching into the open-water zone after pool lowering is expected, although not ensured. A loss of open-water habitat would result if these emergents survive.

Flow augmentation actions directly or indirectly affecting elevations at Lake Koocanusa, Hungry Horse, Brownlee, Dworshak, and Lake Roosevelt would have minimal impacts on wetlands. Wetland development at the storage reservoirs is extremely limited, and reservoir levels would generally vary within the range of elevations occurring under existing conditions.

4.4.4 Embayments, Ponds, and Associated Tributaries

The primary effects to embayments, ponds, and associated tributaries caused by the proposed lowered pool elevations on the Columbia and Snake rivers would also be largely dependent on the extent and duration of lowered pool elevations. As the reservoirs are lowered, embayments and associated habitats would lose their hydraulic connection to the main channel and begin to dry. Associated plant communities would also experience moisture stress as discussed above. Some of these effects might be offset by the development of new backwater areas within the zone exposed by lowered reservoir operations. However, the lack of adjacent, established shoreline vegetation coupled with greater exposure to wind would lessen their value to most wildlife currently inhabiting embayment areas.

Effects of pool lowering are expected to be most significant at John Day because of the extensive development of embayments at this project. Lowering John Day Pool to elevation 262.5 would result in substantial exposure of mudflats. Acreage of open-water habitat would decrease substantially, particularly at Willow Creek embayment, Paterson Slough, and McCormack Slough. Emergent marsh habitat occurring in embayments and ponds would be dewatered. Ponds in the Irrigon Wildlife Management Area would be dewatered or reduced in acreage. However, a more detailed evaluation, probably in the way of a field study of regeneration and soil moisture availability is required before impacts on riparian vegetation can be quantified.

Flow augmentation actions that would influence elevations at the 5 storage reservoirs would have minimal impacts to embayments because reservoir levels would generally vary within the range of elevations under existing conditions, and limited embayment development has occurred at the storage reservoirs.

4.4.5 Waterfowl

The most significant impacts on terrestrial wildlife as a result of the proposed lowered reservoir elevations and operational changes would likely be to island-nesting waterfowl occurring in the John Day Reservoir. Potential negative impacts of frequent lowered reservoir elevations of John Day Pool might include the following:

- A decrease in the quantity of aquatic plant beds and benthic invertebrates as food sources for waterfowl in shallow-water areas;
- A decrease in the number of embayments and protected shallow-water areas for waterfowl nesting, roosting, loafing, feeding, and brood rearing;
- Land-bridging of some islands used for goose nesting and increased access to these nest sites by mammalian predators;
- An increase in escape distance between shoreline foraging resources and the water; and
- A decrease in marsh vegetation used for nesting cover by ducks.

In addition, a number of positive effects to waterfowl populations could result from the proposed lowered reservoir operations:

- The density and accessibility of invertebrate populations for waterfowl foraging might temporarily increase in certain shallow-water areas; and
- The accessibility of aquatic vegetation for waterfowl foraging may temporarily increase.

The degree of these effects to waterfowl populations would be site specific and depend largely on the timing, duration, and level of lowered reservoir elevations. Effects of pool lowering on nesting waterfowl would result from dewatering of emergent marsh vegetation. Species that nest over water in emergent marsh vegetation, particularly diving ducks and coots, would lack habitat during much of the nesting season. If the period of lowered pool elevations is short term, as observed in spring 1992, some waterfowl nests established by typically upland nesting ducks in the post-drawdown emergent zone would be flooded and lost. Operation of the John Day Pool near elevation 262.5 would expose mudflats between the emergent marsh community and open-water habitat. Duck broods use emergent marsh habitat for escape cover. The inability of broods to swim to emergent marsh cover would be expected to lead to an increased predation loss of ducklings. The dewatering of ponds and associated marsh habitat at Irrigon Wildlife Management Area would reduce available habitat for waterfowl.

Observations of the effects of lowering John Day to approximately elevation 263 in spring 1992 indicated that at least 530 ducklings were present on McCormack Slough in early July; fledging of an unknown number of ducks would have occurred by this date. The number observed was significantly higher than usual. The high number of ducks was attributed to carp control measures and subsequent reestablishment of submerged aquatic plant beds (personal communication, J. Annear, U.S. Fish and Wildlife Service, Umatilla NWR, undated, 1992). Few ducks or ducklings were present on Paterson Slough, where large numbers of carp were present and submerged aquatic vegetation was virtually absent. Use of moist soil plants by waterfowl and their broods at Willow Creek was observed.

Overall, a reduction in the number of waterfowl nesting and rearing at McCormack Slough would be expected with lowering the pool to near elevation 262.5. However, other factors such as continued carp control could lead to improved water quality and, therefore, to increased coverage and production of submerged aquatic plants thereby potentially influencing the level and intensity of use by waterfowl. An increase in the number of upland nesting ducks attracted to the area by the improved aquatic beds may be accompanied by a decrease in nesting for diving ducks precluded by loss of standing water in emergent marsh habitat. The development of moist soil plant communities on exposed mudflats would also provide foraging resources for waterfowl and their broods. Consequently, the net effect of lowered pool elevations on waterfowl is difficult to predict.

Effects to waterfowl from direct or indirect flow augmentation changes at Lake Koocanusa, Lake Roosevelt, and Dworshak, Brownlee and Hungry Horse reservoirs, where nesting waterfowl are less numerous, should be minimal. However, the net effect of the proposed lowered pool elevations cannot be precisely determined without more detailed, site-specific information regarding quantitative impacts on aquatic vegetation and invertebrate prey populations and the extent to which embayments and backwater areas would become desiccated.

On the lower Snake River, 6 nest islands at Lower Granite and 2 islands each at Ice Harbor, Little Goose, and Lower Monumental are considered vulnerable to land-bridging at MOP. However, the Chief Timothy Islands on Lower Granite and New York Island on Little Goose, the primary goose production sites on the lower Snake River, are not expected to become land-bridged because of lowering to MOP, although Chief Timothy Islands may be vulnerable to land-bridging due to siltation at MOP. New York Island did not land-bridge during a test drawdown of Little Goose 12 feet below MOP during March 1992. Also, lowering John Day Pool to near elevation 262.5 would not result in a loss of Canada goose nests because no land-bridging of islands is expected. However, updated and detailed water-depth information in the vicinity of the nest islands is necessary to accurately determine the potential for land-bridging (or increased predator access) of individual nest islands as a result of pool lowering.

Effects of lowered pool elevations to brood-rearing areas for Canada geese in the project areas are less clear. In areas where waterfowl and their broods depend on shoreline forage resources, escape distance from these feeding sites to the water would increase and might result in greater mammalian predation. On the lower Snake River, effects on distances between shoreline vegetation and water caused by lowering to MOP would be significant; these distances are expected to increase by up to 20 feet. However, in the last 2 years these emergent

zones have naturally revegetated, indicating there should not be a significant impact to waterfowl.

Abundance and distribution of aquatic plant and benthic invertebrate communities near the shore and in embayments are expected to shift in response to the proposed lowered pool elevations. These communities would become desiccated in some areas; however, in other areas, these resources might become more concentrated and closer to the surface, resulting in a temporary increase in availability to waterfowl. Consequently, concentrations of foraging waterfowl that use these resources might also shift. Both short- and long-term quantitative effects on the aquatic plant and benthic invertebrates communities, however, cannot be determined without site-specific information describing their distribution and abundance in the project area.

Effects to wintering Canada geese in the project area are expected to be negligible because winter wheat crops, which are not irrigated, should still be capable of supporting geese after lowered pool elevations, especially in the John Day area. Similarly, impacts to wintering ducks are expected to be minimal, provided that irrigated crops are not significantly affected by the proposed lowered pool elevations. Loss of irrigated crops would increase the severity of impacts, particularly to over-wintering ducks.

4.4.6 Raptors

Negative effects to raptors caused by the proposed lowered pool elevations on the Columbia and Snake rivers would depend primarily on loss of riparian habitat, embayments, and wetland habitat along affected reservoirs, and reductions in prey densities associated with these habitat losses. In addition, some benefits to raptors might occur including: (1) an increase in distance prey species would have to travel from water to cover; (2) higher concentrations of prey (primarily fish) within remaining shallow-water areas; and (3) increased number of snags for perching within the riparian zone at John Day and (possibly) Lower Granite pools. Although some inferences can be made based on anticipated changes in habitat, the net effect of these changes cannot be determined without more detailed information regarding abundance, distribution, and dependencies of various prey and raptor species on riparian and wetland communities, and impacts of lowered reservoir elevations on riparian, wetland, and embayment areas in the dewatered zone.

Riparian, wetland, and embayment areas that become desiccated because of lowered reservoir elevations would influence local distribution and abundance of prey, particularly small mammals, fish (see Sections 4.2 and 4.3), and songbirds. Raptors dependent on these prey species might show concomitant shifts in population numbers and distribution. However, this effect might be partially offset by increases in distance between the water's edge and escape cover expected from reservoir elevations, which could increase raptor prey captures as well. In addition, fish might become concentrated in portions of the remaining channel following lowered reservoir elevation, providing piscivorous (fish eating) raptors (bald eagles and ospreys) with additional foraging opportunities. However, the benefit to fish-eating raptors might be temporary because of overall reductions anticipated in resident fish populations because of lowered reservoir elevations (see Section 4.3).

Impacts to raptors from flow augmentation from Lake Roosevelt, Dworshak, Brownlee, Lake Koocanusa, and Hungry Horse Reservoir are expected to be minimal since impacts to their nesting habitat and prey species are expected to be minimal. The exception involved bald eagles, especially at Lake Roosevelt, as discussed in detail in Section 4.4.11.

4.4.7 Upland Game Birds

Effects of the proposed lowered pool elevations on upland gamebird populations would be largely dictated by changes in riparian vegetation along the affected reservoirs and increased distance between vegetated shorelines and the pool edge. The expected loss of riparian habitat caused by the proposed lowered reservoir elevations would negatively affect those upland gamebird populations that are either partially or totally dependent on these riparian areas for their existence. Some expansion of habitat available to ring-necked pheasants (*Phasianus colchicus*) might result from dewatering of emergent marsh habitat, especially at John Day near elevation 262.5, provided subsurface water is sufficient to maintain the emergent marsh

and riparian for communities currently present. Riparian for communities form dense cover in a band adjacent to emergent marsh/riparian forest communities, providing habitat for upland gamebirds. The riparian for community is perceived as good nesting and escape cover for upland gamebirds. An expansion of habitat by dewatering emergent marsh is not considered a significant benefit for this species. Habitat for mourning doves, nesting in riparian forest habitat, could decrease if trees or foliar cover is lost from the John Day Pool being lowered to near elevation 262.5. This is not anticipated, although deterioration in stand condition for cottonwoods near Plymouth, Washington might be related to the lowered reservoir elevation.

4.4.8 Furbearers

Negative impacts of the proposed lowered pool elevations on furbearers, especially at John Day, would primarily include the following: (1) exposure of muskrat and beaver dens during the spring and summer when kits are present; (2) reduction in riparian areas used by foraging beavers; (3) reduction in emergent wetlands used by muskrats; and (4) exposure of riprap used by river otters as den sites. In addition, dens established during low-water periods could be flooded when the pools are raised. Access to foraging areas for beaver and muskrat would be over land in many instances, because lowered reservoir elevations would dewater emergent marsh communities and isolate riparian areas farther from the water's edge. This could result in increased predation on these species during foraging bouts. Predator access to den sites would also be increased because bank dens and muskrat houses in emergent marsh habitat would be dewatered and be more readily accessible to predators. Dewatering ponds at Irrigon Wildlife Management Area would eliminate habitat for muskrat. Mink and river otter might also lose habitat if embayments and associated tributaries and ponds become desiccated. Mink would also be affected by a reduction in the muskrat population, a primary prey species.

Flow augmentation from Lake Roosevelt, Brownlee, and/or Dworshak, and drawdown to MOP at the lower Snake pools would not likely affect aquatic furbearers because pool levels would generally vary within the range of elevations under existing conditions. Impacts of potential direct or indirect operational changes at Lake Koocanusa and Hungry Horse Reservoir are also probably minimal because there are few aquatic furbearers dependent on these reservoirs, and elevations would still remain within the range of current experience.

4.4.9 Big Game

The proposed lowered pool elevations would be expected to minimally affect big game, with the exception of deer and possibly elk in some locations. Primary effects to deer would likely include the following: (1) a reduction in riparian habitat and embayments that provide foraging and wintering areas, (2) an increase in distance from the water's edge to cover, (3) an increase in land bridges to islands used for fawning, and (4) an increase in road kills. An increase in the distance to cover might decrease deer productivity because of higher predation. Land-bridging to fawning islands and desiccation of watering areas during the summer could also be particularly damaging to deer productivity because of potentially high fawn losses. Lowered pool elevations that result in loss of embayments or other water sources might increase road kills as deer cross the highways in search of other watering areas. This effect is most likely to occur on the Oregon side of Interstate 84 where the highway is closest to the river along John Day Pool, although the effect would be minor due to limited use of this area.

Impacts to deer are expected to be minimal from lowering the John Day Pool to near elevation 262.5 since few deer occur in riparian habitats adjacent to the river. The highways and railroads abutting the river serve as barriers to big game and also fragment the existing habitat. Losses to riparian areas would, therefore, probably be minor since habitat fragmentation probably limits deer use in this area. The possible exception is Umatilla NWR, which supports a relatively sizeable deer population, especially near McCormack Slough.

Deer losses are not anticipated from flow augmentation at Lake Roosevelt and Brownlee reservoirs, and drawdown to MOP at the lower Snake Pools, because they would continue to operate within normal range. Potential elevation changes at Lake Koocanusa and Hungry Horse Reservoir would also not affect deer significantly

because of an existing lack of established riparian communities.

Dworshak would also operate within the normal elevation range and would generally experience reduced pool fluctuation over the year, but the proposed operating changes for flow augmentation could possibly affect elk. During the winter of 1992-1993, there were an increased number of incidences of elk mortality in the reservoir, when ice gave out from under the animal. Elk falling through the ice is not a new phenomenon to Dworshak Reservoir; however, the last time the number of incidences was this high was when the reservoir was first being filled, and there was an abundance of vegetation still along the shoreline in the water. This encouraged deer to go out and browse the vegetation, subsequently falling through the ice. Factors perhaps responsible for this noted increase in elk mortality include operations of the reservoir for 1992 flow augmentation actions for the lower Snake River. This reduced winter discharges from the Dworshak, resulting in an uncharacteristically stable pool elevation as compared to past years' operation. The static pool elevation prohibited the typical collapse and distortion of the ice around the edge of the reservoir, which has occurred in past years due to winter drafting of the reservoir. In addition, early and heavy snows in the region compelled the elk herds to move to winter range adjacent to the upper end of the reservoir earlier than usual. As ice formed on the reservoir, large volumes of snow covered the frozen shoreline and the lake surface. Compounded by uncommonly warm temperatures for the area and the insulation provided by the heavy snow, the formation of a thick ice surface on the pool was prevented.

The heavy snow layer and the unbroken lake surface may have deceived elk that an open field was in the pathway of their migratory route. It is believed that this illusion and the thin ice may have caused some increased elk mortality. IDFG has observed higher than expected elk mortality for a typical winter in the Little North Fork, North Fork Clearwater, Gold Creek, and Grandad Bridge areas of the reservoir. IDFG staff have surveyed evidence of this elk mortality during the winter period and will continue to monitor the incident.

As a special note, a deer mortality problem has existed at a Corps of Engineers operated project known as Luck Peak, outside of Boise, Idaho. When the lake level fluctuated beneath the ice, it caused the ice to buckle, leaving a very distorted shoreline and making it impossible for deer to climb up the shoreline of the lake after they had ventured out onto the ice. At the recommendation of the IDFG, the lake level has been maintained at a constant level during the winter months, thereby reducing annual deer losses from as many a 100 to approximately 10 deer per year (Corps, 1998e). Based on this information, and the various other factors involved with the 1992-1993 winter, it is difficult to determine at this point the true impact of reservoir operation on the current year elk mortality.

4.4.10 Other Wildlife

Information on site-specific impacts to the large number of wildlife species occurring in the project area is currently unavailable. However, some general inferences can be made based on predicted changes in habitat.

Concomitant changes in wildlife communities associated with the project reservoirs are likely to occur in response to habitat changes induced by lowered reservoir elevations. Species directly dependent on riparian and wetland communities and shallow-water areas for food, water, and cover would likely experience local population declines. This could potentially affect up to 65 vertebrate species that depend on riparian habitat (Lewke and Buss, 1977) including numerous reptiles, amphibians, small mammals, bats, colonial nesting birds, and songbirds. Colonial nesting birds might be affected if islands used for nesting become land-bridged or if trees and shrubs used for nesting die. Mudflats exposed by lowering of John Day to near elevation 263 in spring 1992 resulted in the occurrence and nesting of black-necked stilts (*Himantopus mexicanus*), American avocets (*Recurvirostra americana*), and killdeer (*Charadrius vociferus*). The exposed mudflats provided nesting habitat for these species while adjacent shallow waters provided foraging opportunities. Other species, such as rails (*Rallus* spp.), which forage and nest in emergent marsh communities standing in shallow water, were probably adversely affected by this pool level.

Nest predation probably increased with dewatering of emergent marsh stands. Moreover, if fish are concentrated in the remaining channel within the lowered pool elevations, several piscivorous species might benefit. These species include belted kingfisher (*Ceryle alcyon*), herons, mergansers, mink, and river otter.

The degree to which these wildlife communities would be affected is site specific and depends largely on the timing, duration, and level of the lowered reservoir elevations. Operation near elevation 262.5 on John Day would have the greatest effect on wildlife associated with riparian and wetland communities. Impacts to non-endangered wildlife from potential elevations at changes Lake Koocanusa and Hungry Horse, and flow augmentation at Dworshak, Lake Roosevelt, and Brownlee are expected to be minimal.

4.4.11 Threatened and Endangered Species

Four threatened or endangered species, the peregrine falcon, bald eagle, grizzly bear, and gray wolf inhabit portions of the project area and could potentially be affected by associated operations. These species were identified by the FWS as requiring Section 7 Consultation under ESA and, therefore, are further addressed in the Biological Assessment, Appendix D. Impacts vary with each species and are dependent on the relative importance of each site as a source of food, water, and cover.

Peregrine Falcon

Non-nesting peregrine falcons along the lower Columbia River would likely not be affected by the proposed pool lowerings; use of regions of the project area outside of Bonneville and The Dalles by peregrines appears to be low. Lowering the lower Snake River reservoirs to MOP or John Day to 262.5 is not likely to significantly alter wetlands or riparian areas on which associated prey species depend (see Sections 4.4.2 and 4.4.3). Thus, based on existing information, none of the proposed flow options is likely to affect peregrine falcon use of the project reservoirs.

Bald Eagle

Bald eagles inhabiting the project area might be affected by the proposed interim flow improvements if one or more of the following occurs:

- Nesting food sources (primarily fish and waterfowl) are significantly affected on Lake Roosevelt, Lake Koocanusa, or Hungry Horse Reservoir during the nesting season (mid-February through August);
- Wintering food sources (primarily waterfowl and upland gamebirds, and fish in Montana) are significantly affected in the project area between November and April; and
- Occurrence of potential perching, roosting, or nesting trees in the project area (primarily cottonwoods and ponderosa pines) is significantly affected (potentially at John Day Pool).

Temporarily lowering water levels at any of the project pools during spring and summer has the potential to both positively and negatively affect bald eagles using the Columbia, Snake, Clearwater, Flathead, and Kootenai rivers. Bald eagles could benefit from lowered pool elevations in the following ways:

- More adult fish might eventually return to the project area for spawning, providing more potential food for bald eagles foraging along the Columbia, Snake, and Clearwater rivers (but not the Flathead and Kootenai rivers) in the future (see Section 4.2);
- More fish might become stranded or concentrated in the resulting shallow-water areas, thus temporarily increasing their availability to bald eagles (see Section 4.3);
- More nesting waterfowl might become vulnerable to predation as a result of loss of nesting and escape cover due to temporary drought and/or an increase in distance between shoreline escape cover and the water's edge (see Section 4.4.5); and

- More large snags might become available for bald eagle perching and roosting as a result of project-related desiccation.

Likewise, the proposed operations could negatively affect bald eagles using the Columbia, Snake, Clearwater, Flathead, and Kootenai rivers in the following ways:

- Overall numbers of resident fish might decline because of reductions in shallow-water spawning habitat and entrainment, resulting in decreased productivity (see Section 4.3);

- A decrease in waterfowl production might occur (see Section 4.4.5), reducing bald eagle foraging opportunities;

- A decrease in waterfowl wintering in the project area might occur (see Section 4.4.5), reducing winter food sources for bald eagles;

- A decrease in upland gamebirds might occur (see Section 4.4.7), reducing bald eagle foraging opportunities; and

- A decrease in the recruitment of potential perching, roosting, or nesting trees might occur because of project-related desiccation.

The extent to which these potential impacts might affect bald eagles would depend largely on the location, time of year, duration, and degree of lowered pool elevations. Potential effects on bald eagles would be greatest where they are most concentrated and the change in pool elevations is relatively high, and least significant where eagles are uncommon and the change in pool elevations is minimal. Because of their opportunistic diet habits, however, bald eagles appear to be more dependent on availability of prey biomass and diversity, particularly fish, than on any one species. For example, despite a decline in the preferred kokanee prey species in the Flathead Lake area in recent years, the number of nesting bald eagles has increased overall, and these birds now subsist primarily on the largescale sucker and squawfish (personal communication, D. Flath, Montana Department of Fish, Wildlife, and Parks [MDFWP], Bozeman, Montana, August 31, 1992). However, if lowered pool elevations result in reduced availability of suitable prey biomass, fewer eagles might be supported by the aquatic environment.

Nesting bald eagles occur at Lake Roosevelt, Lake Koocanusa, and Hungry Horse Reservoir. While diet information on breeding bald eagles at Lake Roosevelt is presently unavailable, fish are presumably an important component of their diet as with breeding birds elsewhere along the Columbia River system. Should the flow augmentation measures result in significant declines in resident fish, which is indicated as a possible outcome in Section 4.3.6, these impacts could conceivably affect bald eagles and result in a decline in nesting success. However, the extent to which these potential impacts may affect breeding pairs cannot be accurately assessed until detailed information on diets and foraging locations becomes available. Verification of nesting bald eagles at Lake Roosevelt is a relatively recent occurrence. In the 1970s and early 1980s, there were not verified bald eagle nest sites on Lake Roosevelt, although at least one pair was suspected to be nesting in the early 1980s. In recent years, the numbers of nesting pairs of wintering bald eagles have increased on Lake Roosevelt. Whether this increase is part of the general nationwide bald eagle recovery in general resulting from declining DDT usage or is in response to increased resident fish populations resulting from several favorable water years, stocking of kokanee, and increased net-pen operations is not known.

Impacts to the 10 eagle pairs nesting at Lake Koocanusa and in the surrounding Kootenai Valley and to the one pair nesting at Hungry Horse Reservoir are expected to be insignificant based on Alternatives 2, 4, and 5, which are not anticipated to result in any changes to the aquatic environment. Effects on these nesting eagles from Alterative 3 would be related to the overall availability of kokanee, mountain whitefish, and largescale suckers, their predominant prey species. If Alternative 3 results in a long-term reduction in this prey biomass, then the aquatic environment may support fewer nesting eagles. Although waterfowl are relatively abundant at Hungry Horse Reservoir, they comprised only 7 percent of 30 samples of prey remnants collected at the known nest site (personal communication, D. Flath, MDFWP, August 31, 1992); thus, a reduction in waterfowl would probably have minimal effects on the nesting

pair. No adverse impacts are expected on prey fish used by bald eagles in the Flathead Lake area, and the availability of largescale sucker and squawfish prey might be augmented by increased river flow in spawning areas.

Wintering eagles are concentrated on Lake Roosevelt, Brownlee and Dworshak reservoirs, and Umatilla NWR on John Day Pool, where food sources should be adequate. The flow augmentation plan for the Columbia and Snake rivers would cause minimal change during the bald eagle wintering season (November to April) because flow augmentation releases would occur from the last part of April through June. The drafting of John Day Reservoir would be within the authorized operation of the project; therefore, increased impacts to waterfowl would not take place. Furthermore, waterfowl potentially overwintering at John Day Pool are largely birds produced elsewhere (farther north); therefore, long-term impacts on waterfowl production at John Day Pool should not affect wintering bald eagles. Waterfowl do not appear to compose a substantial portion of the bald eagle diet in the Montana project areas, particularly at Lake Koocanusa, since suitable wintering waterfowl feeding habitat is limited. Since the effect on gamebird populations is also expected to be negligible for Alternatives 2 through 5, there would be no impacts to wintering bald eagles that rely on upland game species as prey.

No anticipated impacts are expected to occur to bald eagle perching, roosting, or nesting trees with the possible exception of John Day. Long-term operation of John Day Pool at elevation 262.5 each spring/summer may result in the gradual loss of riparian trees and future snag recruitment. This could impact wintering use of the area by bald eagles. The time frame for riparian tree loss, is unknown, therefore impacts are speculative until observations are recorded. On the lower Snake River any sizeable trees used by bald eagles adjacent to the reservoir are snags or are located in the side draws and canyons, which would not be affected by lowered reservoir elevations to MOP. Conifer trees used predominantly by bald eagles in the Montana project areas occur beyond the affected area and should not experience any adverse effects.

The operation of John Day Pool during May to August near the 262.5-foot elevation and the operation of the four lower Snake River reservoirs at MOP from April 1 to July 31 would not affect the food sources used by bald eagles. The long-term production of offspring from waterfowl and fish is not expected to be diminished within the normal operating scheme of these five reservoirs. The operational changes at the Lake Roosevelt, Hungry Horse, Lake Koocanusa reservoirs may have minimal to major effects on long-term fish and waterfowl recruitment rates, resulting in a potential reduction in availability of eagle prey, especially at Lake Roosevelt.

Although a more detailed assessment of the effects on bald eagles is not possible at this time, based on existing information, the implementation of Alternative 3 at Lake Koocanusa and Hungry Horse Reservoir in Montana may result in a significant reduction in the availability of the three predominant species of fish prey in these areas which could affect the number and viability of eagle nesting sites and the number of wintering eagles. The flow augmentation actions may also reduce the fishery resource at Lake Roosevelt potentially resulting in an eventual loss in the number of breeding bald eagle pairs using the reservoir.

Grizzly Bear

It is unlikely that the Montana grizzly bear population would be affected by any direct or indirect operational changes at Libby and Hungry Horse because they: (1) do not depend on the fish or waterfowl potentially affected by the lower elevations, (2) rarely occur at Lake Koocanusa or downstream of Hungry Horse Reservoir, and (3) tend to inhabit the higher elevation alpine and subalpine zones during the period when reservoir elevations might be reduced.

Gray Wolf

Impacts to Rocky Mountain gray wolves associated with potential elevation changes at Lake Koocanusa and Hungry Horse Reservoir are expected to be inconsequential. Wolves in this region primarily subsist on white-tailed deer, elk, moose, and mule deer, and these prey species are not anticipated to experience any significant decline from lower

elevations. In addition, gray wolves occur infrequently in the project areas. They were last sighted at or near Hungry Horse Reservoir in the 1970s, while Lake Koocanusa appears to lie on the periphery of an established wolf range (Ream, 1979; Ream et al., 1990).

Unconfirmed sighting of gray wolves have recently been reported in the vicinity of Dworshak Reservoir (telephone conversation, B. Zoellich, FWS, Boise, Idaho, September 30, 1992) and Lake Roosevelt (telephone conversation, K. Taylor-Goodrich, Coulee Dam National Recreation Area, Coulee Dam, Washington, October 1, 1992). However, these sightings have been so infrequent that they probably represent individual wanderers that would not likely be affected by the proposed flow options.

4.4.12 State-Listed and Candidate Species

Site-specific impacts to the large number of State-listed and candidate species potentially occurring in the project area cannot be determined without further study of local abundances, specific habitat associations, and species-specific responses to lowered reservoir elevations and MOP operations. However, some general inferences can be made based on predicted changes in habitat caused by lowered reservoir elevations under the different options.

Each of the listed plant species in the project area typically occurs in moist areas that have established under moisture recharge from existing reservoir conditions. Continuous operation of reservoirs at MOP could eliminate many of these plants along the lower Snake River. It is also possible that some of the more vulnerable listed plants could be replaced by colonizing species (e.g., purple loosestrife [*Lythrum salicaria*]) that are typical of disturbed areas. This may be especially important on the lower Snake River where grazing impacts have resulted in plant communities dominated by weedy species (Tabor, 1976; Lewke and Buss, 1977). Lowering the reservoirs to MOP on the lower Snake River and flow augmentation from the storage reservoirs, however, would likely have only minor impacts to listed plants since both actions would deviate only slightly from existing reservoir conditions. Listed plant species might show signs of moisture stress, particularly if lowered pool elevations occur from May 1 to August 31 as proposed for the John Day Pool. This might be especially important at the John Day Pool where riparian and wetland areas that potentially support listed plants are most extensive. However, lowering to near elevation 262.5 is not expected to cause widespread shifts in vegetation communities that support listed plant species.

Response of listed wildlife to pool elevation changes would likely depend on site-specific changes in essential habitat components associated with the project reservoirs. Species with limited dispersal capabilities (e.g., many reptiles, amphibians, and insects) would be especially vulnerable to lowered reservoir elevations and would, therefore, at least temporarily experience local population declines from potential reductions in breeding success and loss of habitat. Other wildlife could potentially experience impacts through loss of habitat or prey species associated with wetlands and riparian areas. This might be especially important for insectivorous species and species dependent on the narrow fringe of riparian vegetation associated with the project reservoirs such as amphibians and herons. Listed species associated with backwater areas, including herons, turtles, frogs, and ducks, would also likely experience local population declines if backwater areas become desiccated. In contrast, some listed wildlife might temporarily benefit from changes in habitat that increase vulnerability of prey species (e.g., see Section 4.4.6) or from greater exposure of mudflats along shoreline areas (e.g., shorebirds).

As with other wildlife species in the project area, the severity of the impacts from the lowered reservoir elevations to listed wildlife would depend on duration, timing, and extent of lowered pool elevations. Since the lowering of John Day Pool to near elevation 262.5 alternative would likely have the most significant impacts to wetlands, riparian areas, embayments, and shallow-water habitats, listed wildlife species associated with these areas would probably at least temporarily experience local population declines. Lowering the reservoirs to MOP on the lower Snake River and flow augmentation from the storage reservoirs would likely have only minor impacts to listed wildlife because reservoir conditions would deviate only slightly from existing conditions.

4.4.13 Cumulative Impacts

Lowering pool elevations at reservoirs would likely contribute directly or indirectly to cumulative impacts on terrestrial resources of the lower Columbia, lower Snake, Clearwater, Flathead, and Kootenai rivers. Since the projects were built, riparian and wetland habitats have declined on regional and local levels primarily because of agriculture and urban expansion, hydroelectric development, and timber harvest (Lewke and Buss, 1977). Habitat loss is the primary cumulative impact for most plant and wildlife species in the project area.

Lowered reservoir elevations would also likely increase livestock damage to riparian habitat, which has already been extensive throughout the Columbia River Basin (Lewke and Buss, 1977). Exposed shorelines would allow livestock access to HMUs that are currently fenced to prevent livestock damage under existing reservoir conditions.

Commutative impacts to resident fish as a result of flow augmentation, especially at Lake Roosevelt and Lake Koocanusa, could result in adverse impacts to nesting and wintering bald eagles by reducing prey availability.

4.4.14 Summary

Impacts to aquatic and riparian vegetation and associated wildlife groups from lowered reservoir elevations would be most pronounced with drawdown of John Day Pool to near elevation 262.5 because of the extensive shallow-water habitats and riparian vegetation that have developed. Flow augmentation from the storage reservoirs is not expected to significantly affect vegetation and wildlife communities because the resulting reservoir elevations would deviate only slightly from normal operating conditions.

Losses to wildlife habitat under the various options would include temporary reductions in shallow-water habitats, wetland habitats, riparian areas, embayments, and designated habitat management areas, including several wildlife refuges and HMUs that depend on moisture received from the project reservoirs. Numerous associated plants and wildlife, including state and Federally listed species, have established in these areas over prolonged periods of reservoir operation. The bald eagle is the only endangered species anticipated to be potentially affected by lower elevations, specifically at Lake Koocanusa or Hungry Horse Reservoir as a result of the implementation of Alternative 3 and at Lake Roosevelt under the flow augmentation actions where lowering reservoir elevations during May to June could affect productivity of prey species. The proposed flow modifications would likely contribute to cumulative impacts on terrestrial resources of the lower Columbia, lower Snake, Clearwater, Flathead, and Kootenai rivers. Since the projects were built, riparian and wetland habitats have declined primarily because of agriculture and urban expansion, hydroelectric development, and timber harvest. The proposed flow modifications would add to these impacts as stated above, primarily along the lower Snake and Columbia rivers.

Beneficial impacts are also anticipated from the proposed flow measures. These include temporary increases in foraging areas for shorebirds, temporary concentrations of raptor prey and waterfowl food sources into remaining shallow-water areas, localized increases in snag densities along shoreline areas, and localized willow and alder seedling recruitment.

4.4.15 Mitigation

Extensive documentation, research, and monitoring have been conducted to determine the original habitat losses from construction of the project reservoirs. It is anticipated that additional monitoring and further research of both of the lowered reservoir elevations actions would be required to fully assess impacts and determine appropriate mitigation requirements for losses to shallow-water habitat, wetlands, embayments, riparian areas, and HMUs.

Several mitigation measures were reviewed initially for their feasibility and costs for John Day Pool drawdown mitigation. These measures include construction of dikes, installation of pumps, and provision of water distribution systems to maintain backwater habitats, emergent marshes and riparian habitat on the Umatilla NWR and Irrigon and Willow Creek Wildlife Management Areas. The high soil permeability ratings that were documented made water supply and control measures extremely

expensive, with success questionable. Other prohibitive issues were construction damage to the existing habitats, operation and maintenance costs, and lack of a water right for water supply.

Loss of goose nesting areas because of lowered reservoir elevations might require additional study to document the extent of impacts and need for appropriate mitigation. Planting the exposed mud flats with annual food plants might be an appropriate action for waterfowl, elk, and deer, and could provide some aesthetic benefits. Potential effects of reservoir elevation changes on bald eagles nesting at and near Lake Koocanusa, Lake Roosevelt, and Hungry Horse Reservoir might also require further study.

Mitigation might include operation of the 3 MAF flow augmentation to limit drafting of Lake Roosevelt after May 1 each year.

4.5 GEOLOGY AND SOILS

Alternative	Potential Impacts (Positive/Adverse)
1. Without-Project Conditions (No Action)	• Minimal impacts on mainstem reservoirs. • Continued moderate shoreline erosion and moderate landslide activity on storage reservoirs.
2. 1992 Operations	
Lower Snake/Columbia	• Minimal increase in landslide activity. • Minimal shoreline erosion of beaches, recreation facilities, roads, and railroad grades.
Dworshak, Brownlee, Grand Coulee	• Moderate increase in erosion and sedimentation.
Libby	• Minor increase in landside activity; minor increase in erosion and sedimentation.
3. 1992 Operations with Libby/ Hungry Horse Sensitivity	• Minor increases in shoreline erosion, slope instability, streambank erosion, and sedimentation at Hungry Horse; moderate increase at Libby. • Slight increase in erosion downstream from Libby and Hungry Horse dams in low-water years.
4. Modified 1992 Operations	• Same as Alternative 2 except minor increase in erosion and sedimentation at Dworshak. • Minor increase in erosion and landslide activity along Brownlee Reservoir.
5. Modified 1992 Operations with Upper Snake Sensitivity	• Similar to Alternative 4.

The flow improvement alternatives on the Columbia-Snake River System would result in fluctuating reservoir levels and increased flow velocities. Fluctuating water levels prevent wave action from creating an "equilibrium" shoreline, where unconsolidated materials reach a slope at which little or no net erosion occurs. Annually fluctuating water levels increase shoreline erosion and slope instability and accelerate lake sedimentation. Flow augmentation increases water velocities, which increase stream bank erosion.

The impacts of the proposed 1992 selected alternative were discussed in the 1992 OA/EIS. This section discusses the effects of the proposed modifications for the SEIS.

4.5.1 Slope Stability

Fluctuating lake levels tend to decrease stability of shoreline materials for three reasons. First, the material's strength is decreased as the buoyant force of water is removed. Second, exposure of lower parts of the shoreline promotes undercutting of the materials from wave erosion. Third,

groundwater in the shoreline materials begins to drain, increasing pore pressure and decreasing internal material strength. Rapid and prolonged lowered reservoir elevations are associated with increased shoreline instability (Lawson, 1985).

As stated in the 1992 OA/EIS, the potential for impacts on the slope stability of projects on the Columbia and Snake rivers would be minimal, with two exceptions. An active slide has been reported near Alderdale along Lake Umatilla where lowering of the pool could accelerate its movement (Gufstafson, 1992). Brownlee could also experience significant slope stability problems if the draft rate were greater than 1.5 feet per day, because Brownlee has numerous unstable areas along the reservoir shoreline (BPA, 1985). However, the proposed flow augmentation options involve relatively minor contributions from Brownlee and are spread out over a minimum of 1 month, making the draft rate less than 1.5 feet per day.

At Libby Dam, the average draft at the end of April is about 124 feet. Hungry Horse Reservoir experiences an average April draft of 74 feet. Operation under Alternatives 2 through 5 would alter the spring refill curve of these two reservoirs in various ways.

Under Alternatives 2, 4, and 5, use of Libby for flow augmentation would decrease the average annual draft at Libby in 16 out of 50 years by an average of 20 feet, with a range of up to 90 feet. During these years, unconsolidated sediments and soil would become saturated in the late winter and early spring. The slope stability would be affected only in these years. During extreme years (6 out of 50), the decreased draft would be greater than 50 feet above base conditions. Stability problems would likely develop during April, May, and June, when the water is the highest and as it is rapidly released. The increase in instability under these alternatives would be less than under Alternative 3.

The HYSSR results for Libby indicate that, compared to no action, Alternative 3 would result in lower April elevations (greater drafts) in 18 of the 50 simulation years and the same April elevations in the remaining 32 years. The differences in elevation among these years ranges from 2 to 75 feet; the incremental draft by the end of April would be 30 feet or more in 11 years. Overall, Alternative 3 would increase the average April draft to 131 feet.

The additional annual drafting at Libby in some years would likely cause an incremental decrease in slope stability. Additionally, the average annual elevation would be about 7 feet lower than the base case. The sediments in the zone between the former high water shoreline and the new shoreline would experience slumping and sloughing for a short period, gradually diminishing as the new shoreline approaches equilibrium. The rapid loss of elevation during May and June, when the water stored for flow augmentation is released, would further contribute to instability.

The April elevations for Hungry Horse with Alternative 3 follow a distinctly different pattern compared to Libby. In 32 of the 50 years, Alternative 3 would result in higher reservoir elevations, by differences ranging from 7 to 37 feet. Alternative 3 would produce lower elevations, by margins of 6 to 112 feet, in 16 of the 50 years. Alternative 3 would therefore result in moderate decreases in drafting and reservoir fluctuations in most years, but significantly deeper drafting in about one-third of the years. The average annual draft with Alternative 3 would be 62 feet, about 13 feet less than the base case. The impact would be a slight reduction in shoreline instability because less shoreline would be exposed during any given year. Seasonal drafting patterns and reservoir elevations with Alternatives 2, 4, and 5 would be the same as with Alternative 1.

The additional draft of Lake Roosevelt in the winter and early spring to accommodate transferred flood storage space from Dworshak and Brownlee could expose slopes not usually exposed during the annual draft. However, the additional draft averages only 1.5 feet. This could lead to a slight increase in slope movement. However, this effect would occur only in years in which a flood control transfer were possible, based upon the specified runoff forecast constraints. Impacts to shoreline stability are expected to be minimal.

4.5.2 Shoreline Erosion

Shoreline erosion is expected to be one of the more significant impacts on the reservoirs, primarily

because of the extended range at which wave erosion will affect the shore. Shoreline erosion occurs as a result of the complex interaction of pool elevation, shoreline geology, shoreline orientation, recreational use, and local climate. Processes of shoreline erosion include wave and current action; freeze-thaw cycles; mass wasting (including landslides); groundwater sapping; and surface erosion (sheet wash, rilling, and gullying). In reservoirs, pool elevation is a limiting factor; pool elevation and fluctuation determine what processes occur on the shoreline, and their extent.

The lower Snake and lower Columbia dams are run-of-river operations (except for John Day), and as such the pool elevations don't fluctuate greatly. The more stable the pool elevations, the more likely shorelines will reach an "equilibrium profile," one in which relatively little net erosion takes place. Under the no action alternative, all lower Snake and lower Columbia dams will operate at the usual level. Minimal shoreline erosion would occur due to operations.

At John Day, which experiences erosion and active slides under existing conditions, lowering the pool to elevation 262.5 would expose more shoreline materials to erosion. However, given the existing pool elevation range of 265 to 268 feet, the erosion would be slightly higher than normal at first and then should stabilize to approximately existing conditions.

Storage reservoirs have the greatest potential for shoreline erosion under all five alternatives. At Brownlee, significant fluctuation in pool elevation currently causes some erosion and instability. Sediment deposited from slides and alluvial fans and deltas is likely to be remobilized by drafting, which would vary year to year as dictated by runoff calculations. Under Alternatives 2 through 5, shoreline erosion should be slightly less, as annual elevation fluctuation could be less in some years due to flood control shifting. Brownlee would have relatively small releases in July and September. Impacts of flow augmentation drafts of this size would be negligible, especially compared to existing operations.

The same scenario applies for all reservoirs affected by drafts; the magnitude of the initial pulse of erosion and the fraction of sediment influx remobilized will vary with the magnitude of draft. Since Libby and Hungry Horse are storage projects, they already experience large drafts. Alternatives 2, 4, and 5 would decrease the annual winter-spring draft at Libby in 16 out of 50 years. Alternative 3 would increase the annual draft in 18 out of 50 years. Therefore, Alternative 3 would increase the surface area of shoreline exposed during these years, while exposure to erosion would be less with Alternatives 2, 4, and 5.

The operation of Hungry Horse would be unaffected by Columbia River flow augmentation in Alternatives 2, 4, and 5; thus, only Alternative 3 would produce a change over the base case. The average elevation would be 6 feet lower than the base case; therefore, sediments above 3,518 feet previously covered by water would be exposed. These unconsolidated sediments would probably erode rapidly during the first year of exposure. After several years of exposure, vegetation would re-establish on the former lakebeds. Revegetation could be accelerated by seeding the sediments the first year. There would be a pulse of sediment associated with these exposed lakebeds. This sediment would diminish as vegetation becomes established. When effects over several years are considered, the amount of erosion prevented as a result of decreasing the draft would be greater than the erosion caused by lowering the average elevation. Therefore, the net effect of Alternative 3 would most likely be a slight decrease in shoreline erosion.

The winter-spring drafts at Dworshak associated with Alternatives 2, 4, and 5 would be less than existing drafts during typical water years reducing the potential for shoreline erosion during this portion of the year. Erosion would be slightly increased later in the year by lower elevations resulting from Snake River flow augmentation because shorelines would be exposed in the summer, when recreation use is high. Direct shoreline impacts and wave-generated impacts are generally higher in the summer.

Lake Roosevelt could be drafted more in the winter and early spring to take up the flood storage space transferred from Dworshak and Brownlee. This draft would be in addition to the normal flood control draft. The expected result would be exposure of slopes and embayments not typically exposed during a normal year. However, as noted above, this draft is only slightly more than current

drafts, and would not occur annually. In addition, it might be offset to at least some extent by winter flow/purchase activities to store water in Lake Roosevelt for Columbia River flow augmentation in the spring. Impacts on shoreline erosion could be erratic. Since the increased draft would occur in early spring, when recreation-related erosion would be lower than during the summer, when recreational use is heavy. However, rain and wind impacts would be more significant. A minor increase in shoreline erosion is expected.

4.5.3 Soil and Streambank Erosion

As reservoir levels decrease, sediment deposits in side channels and embayments would be incised, as the tributary streams adjust to the new base level. Raindrop impact and sheetwash on exposed shorelines would also contribute to erosion.

Erosion potential for most of the scenarios presented was analyzed in the 1992 OA/EIS. Soil and streambank erosion on the mainstem projects would not be increased notably over the existing flow regime under Alternatives 2 through 5.

Under the no action alternative, minor streambank erosion may occur due to increased velocities associated with the spring Water Budget on the Columbia and Snake rivers. Higher velocity allows mobilization of more and/or larger sediment. While difficult to quantify, additional spring flow augmentation can increase lateral streambank erosion through entrainment and undercutting. The expected erosion, though, from most alternatives, is relatively low. Alternatives 2 to 5 would have the same spring flow augmentation. Based on the magnitude of flow changes indicated in Section 3.5, they would in general cause slightly higher, but still low, streambank erosion rates.

However, under Alternatives 2, 4, and 5 streambank erosion on the Kootenai River would increase. If water stored for flow augmentation is released in May and June, discharges from Libby would increase by an average of 3,000 cfs, and could range up to 25,000 cfs. This represents a minimum increase of about 50 percent of the base flow during those months. Correspondingly, releases in January through April would average 5,000 cfs less than under the base case. More streambank erosion could be expected in May and June; however, this erosion would be offset somewhat by the decreased amount of erosion that would occur between January and April. In addition, the increased erosion would occur only in 16 out of 50 years.

Minor effects directly or indirectly associated with flow augmentation might be seen on the tributaries. Downstream from Libby Dam, for example, tributaries to the Kootenai River have been depositing alluvial fans across the floodplain. Fans are accumulating because of the lack of high spring flows in the Kootenai, which is due to the flood storage behind the dam (Ciliberti, 1980). Lateral erosion of the streambank across from the fans has occurred as the Kootenai flows around these fans. If the proposed actions indirectly led to higher spring releases from Libby, this would in turn slightly increase the erosion of the Kootenai into the fans, meaning a very small shift back toward pre-dam flow conditions. This would be a positive impact. A similar scenario could be seen downstream of Hungry Horse Dam on the Flathead River.

Tributaries to the Columbia River on Lake Roosevelt slightly erode deltas during annual drafts related to flood control. According to the HYSSR Model runs, spring pool elevations would be higher than under current operation. The deltas would therefore generally experience equivalent or less erosion.

4.5.4 Sedimentation

Increased sedimentation would occur in all of the proposed alternatives. The increase in sedimentation would be a direct result of increased exposure of shoreline materials and increased incision of tributary streams into fan/delta deposits. With the no action alternative, sedimentation is limited to river sediment influx on the mainstem rivers. As with erosion, the storage reservoirs currently experience significant sedimentation. In general, Alternatives 2 through 5 would all result in moderate incremental increases in sedimentation in years when flow augmentation would change normal operating patterns. The frequency of these changes would range from about 1 in 5 years at Libby with Alternative 3 to 1 in 2 or 3 years at Dworshak with all action alternatives.

Under current operations, pool elevations on mainstem reservoirs fluctuate daily so impacts from Alternatives 2, 4, and 5 on sedimentation would be almost negligible.

4.5.5 Conclusions

Generally, soils and geology impacts would be minor to moderate for all alternatives. Shoreline erosion, slope instability, streambank erosion, and sedimentation would all experience some minor increases. Effects would be small compared to the impacts of current operations. Effects of the proposed actions differ from the 1992 OA/EIS impacts primarily in that different areas are affected. Sediments already deposited in the reservoirs would be redistributed, with the coarser sediments falling out in the downstream parts of the reservoirs. Fine particles, showing up as increased turbidity, would likely be attenuated downstream.

4.5.6 Mitigation

Because the effects of the alternatives fall within the existing range of conditions, mitigation would be limited to continued practice of each agency's existing erosion control and slope stabilization measures, including monitoring. For each alternative, drafting impacts related to flow augmentation could be minimized by lowering water levels as slowly as possible. Increased monitoring of potential and active slide areas could be conducted.

4.6 AIR QUALITY

Alternative	Potential Impacts (Positive/Adverse)
1. Without-Project Conditions (No Action)	• Least amount of exposed sediments that are subject to wind erosion. Lowest air quality impact. Resident complaints over existing blowing dust incidence, particularly at Libby and Grand Coulee.
2. 1992 Operations	
John Day, Lower Snake	• Increased exposure (in area and duration) of sediments likely to result in insignificant increase in fugitive dust and potential odors during summer.
Dworshak, Brownlee, Grand Coulee, Libby	• Apparent insignificant increase in exposed sediments in summer, little change in dust generation. • Decreased sediment exposure and potential for windblown dust in late winter to early spring in flow augmentation years. • No additional dust generation at Brownlee, Grand Coulee, and Hungry Horse. Minor decrease in dust generation at Libby in low-runoff years.
Hungry Horse	• No change from Alternative 1.
3. 1992 Operations with Libby/Hungry Horse Sensitivity	
John Day, Lower Snake, Dworshak, Brownlee, Grand Coulee	• Same as Alternative 2.
Libby	• Same as Alternative 2 in most years. Increased sediment exposure and dust generation in late winter-early spring and more frequent moderate exposure in summer in low-runoff years.
Hungry Horse	• Decreased winter-spring exposure and dust in 2 of 3 years, increase in remaining years.
4. Modified 1992 Operations	• Same as Alternative 2, except at Dworshak. • Minor increase in sediment exposure and dust generation in flow augmentation years.
5. Modified 1992 Operations with Upper Snake Sensitivity	• Same as Alternative 2.

The 1992 OA/EIS identified three air quality concerns related to operation of the reservoirs. The first was fugitive dust generated by strong winds blowing across exposed sediments during dry conditions. These conditions can result in high dust loadings and nuisance conditions for nearby residents and recreational users of the reservoirs. The second concern was odors that can arise from decaying organic matter in sediments exposed to the air. The third concern was chemical emissions from the power plants in the western U.S. that might be used to make up any generating capacity loss during reservoir drawdown or flow augmentation.

Based on the experience gained during the 1992 operations, the fugitive dust issue is the most significant. Local residents and recreationists felt that the impacts of odors are not as significant as the fugitive dust impacts. The chemical emissions of the power plants are not regarded as significant because the plants are permitted to operate at maximum capacity and ambient air quality is still protected. Impacts of this nature were discussed in more detail in the 1992 OA/EIS, and are covered thoroughly in NEPA documentation for BPA resource acquisitions.

Consequently, this discussion is limited to the effects that the exposure of sediments have on fugitive dust concentrations. In simplest terms, the alternatives that result in the lowest elevations of reservoirs would expose the most sediment. This sediment is normally barren of vegetation, and therefore likely to erode significantly during periods of dryness and high winds. The summer months are the driest in the Pacific Northwest.

Under current (without-project) conditions, normal operation of the storage reservoirs can create localized fugitive dust problems. Blowing dust is usually most noticeable in late winter and early spring, when storage reservoirs are typically at their lowest elevations. Seasonal drafting of 50 to 100 feet or more, which is common, can expose extensive areas of reservoir bottom to drying and wind transport. At the mainstem projects, however, drafting and sediment exposure are much less. In addition, frequent pool fluctuations tend to keep the exposed areas wet and thereby reduce the potential for blowing dust.

The Corps received public comment and Congressional inquiry about the levels of fugitive dust generated during recent annual drawdown periods at Libby Dam. In response to these comments, the Corps is conducting a geotechnical survey to identify dust sources around the rim of the reservoir and to better understand the origins of the dust problem. The Corps is installing air and meteorological monitoring instruments to evaluate these local dust conditions.

The experience of the residents and recreationists confirms the prediction of the earlier analyses that fugitive dust concentrations are likely to be significant and detrimental to local users of the reservoirs during drawdown periods. However, a means to mitigate wind blown dust has not yet been identified. The Corps is assessing the problem, and will report on the findings in 1994, after data have been obtained near Libby Dam for a full year. The results of the study will be generally applicable to identifying the factors that cause the dust and any means to mitigate impacts. It is likely that the other storage reservoirs such as Hungry Horse, Grand Coulee, and Dworshak would experience similar dust impacts.

Generally, the action alternatives call for operation near MOP on the lower Snake from about April 1 to July 31 of each year, and operation at minimum irrigation pool at John Day from May 1 through August 31. This is the driest time of the year in the region, so the sediments exposed by the change in operations would likely be subject to drying and wind transport. Thus, there would be more fugitive dust generated than was experienced in years before the change in operations. The physical characteristics of the pools of the lower Columbia-Snake River dams indicate that 50 to 100 acres are generally exposed for each foot of drafting below the normal pool level. BPA (1985) estimated that winds generate roughly 0.35 pounds of fugitive dust per day per acre of exposed land. These emissions are significant only very near to large expanses of exposed, dry sediments, which would not occur with the proposed reservoir operation actions for the mainstem projects. Operation near MOP would represent a decrease in elevation of about 1 to 3 feet compared to normal operations. This would indicate that the proposed action would typically expose only 50 to 300 acres per project. Further, much of the exposed area

would consist of riprap rather than bottom sediments.

Flow augmentation actions in lower-runoff years would have varying effects. Particularly at Grand Coulee and Libby, storage for spring releases in Alternatives 2, 4, and 5 would reduce the normal late winter-early spring drafts. This would decrease the area of exposed shoreline, and therefore the potential for blowing dust. Depending on runoff and forecast conditions, in some cases the flow augmentation operation could result in lower elevations in late spring and early summer. However, these drafts would be considerably less than the late winter drafts that typically occur. Therefore, the potential for dust generation during the summer could be less than during the period of peak shoreline exposure.

Alternative 3 would result in deeper winter drafts at Libby, with end-of-April differences ranging from 2 to 75 feet. These drafts would add to the area normally exposed and increase the potential for blowing dust generation. July elevations would remain lower than with Alternative 1 in 10 out of 50 years, indicating potential for blowing dust in summer. The HYSSR results for Hungry Horse with Alternative 3 indicate a similar pattern to Libby in about one-third of the water years, with somewhat deeper drafts. However, in the remaining years, the reservoir would be higher in April, resulting in a decrease in dust generation.

The flow augmentation components of Alternatives 2 through 5 would result in somewhat lower elevations at storage reservoirs, particularly Dworshak, during late spring and early summer. This would slightly increase the potential for blowing dust at this time of year, compared to the base condition. Up to two-thirds ton per day of additional fugitive dust could be expected per foot of drawdown for pool elevations between 2,036 feet and 2,077 feet at Brownlee Reservoir on the Snake River, for example (BPA, 1985). Comparable emission estimates can be expected for all of the reservoirs in the system. This loading of fugitive dust could be a nuisance for persons using or residing on the shorelines of the reservoirs. However, the size of the particles is likely to prevent long-range transport of the dust and would not significantly affect regional air quality.

The significance of the impacts would be influenced by settlement and recreational use patterns. Public sensitivity to dust problems is likely to be greater at the Libby Project because the town of Rexford is adjacent to the reservoir. There are also several small communities located along Lake Roosevelt. In comparison, human presence at Dworshak and Hungry Horse is generally limited to temporary use at recreation facilities.

The level of dust impacts would also depend on the magnitude and timing of elevation differences relative to no action. In general, the reservoir regulation data presented in Section 3.5 indicate there would be minor decreases in median elevations at Dworshak in July and August with Alternatives 2 and 3, and slightly greater decreases with Alternatives 4 and 5. In all such cases, the reservoir would be within 25 feet of full, however, indicating that areal exposure would be much less than what typically occurs in early spring. Further, these adverse changes would be offset by operating Dworshak near the mandatory flood control rule curve, which would result in higher than normal elevations in late winter and early spring when drafting is greatest.

Hydroregulation model results for Alternatives 2 through 5 indicate there would be minimal changes in elevations at Grand Coulee, Libby, and Hungry Horse with typical water conditions. Therefore, in most years there would be no or minimal incremental impacts from blowing dust associated with project operations.

4.7 TRANSPORTATION AND UTILITIES

Alternative	Potential Impacts (Positive/Adverse)
1. Without-Project Conditions (No Action)	• Normal operation of Columbia-Snake River Inland Waterway, Dworshak log transportation, and river corridor railroads and highways.
2. 1992 Operations	• No interruption of barge traffic. Possible continued depth problems at Almota terminals with operation at MOP. Potential for temporary navigation difficulties in Ice Harbor cut due to higher spring flows. • Minimal potential for curtailment of operating season for Dworshak log dumps in normal or dry years. • No adverse impacts to railroads or highway network. • Potential for poor mixing at sewer outfall of Umatilla. • Potential increase in water treatment for Boardman, OR.
3. 1992 Operations with Libby/ Hungry Horse Sensitivity	• Same as Alternative 2.
4. Modified 1992 Operations	• Essentially the same as Alternative 2.
5. Modified 1992 Operations with Upper Snake Sensitivity	• Essentially the same as Alternative 2.

4.7.1 Navigation

Columbia-Snake River Inland Waterway

The 1992 OA/EIS evaluated the effects to navigation of proposed drawdowns to spillway crest in specific pools of the Snake River System. Drawdowns below MOP were expected to substantially affect navigation in the Snake River System because barges would not be able to operate (see Section 4.7.1 of the 1992 OA/EIS for greater detail). However, drawdowns of this type are not under consideration in this SEIS; under all scenarios, the minimum water depth in the navigation channels of the Snake and Columbia shallow draft system would not fall to less than MOP. Day-to-day and seasonal water fluctuations would occur within 1 foot above MOP. Under these scenarios, barge traffic on the Columbia-

Snake River System would continue to be able to transit the navigation locks and cross channels at full load. However, barge operations could be adversely affected through insufficient water depth at port facilities and increased flow velocity in the channel.

Port Facilities. Wheat and barley produced in eastern Washington, Idaho, Montana, and northeastern Oregon rely on barge transportation on the Columbia and Snake rivers to move grain to export facilities. These barges and grain elevators are generally designed to operate around MOP, the water level behind the dams at which there is a minimum 14-foot water depth. However, some terminals do not have a 14-foot depth with pools at MOP. In preparation for operation of projects at MOP in 1992, the Corps completed extensive dredging of port facilities to alleviate these draft limitations. However, some terminal facilities still experience access difficulties at MOP.

Specifically, grain elevators at Almota (i.e., S&R and Almota Grain Company) on the Little Goose Pool have experienced water depth problems after the dredging. Dredging has improved access to these facilities but this area continues to be a concern. Jumbo grain barges have hit bottom during loading operations at Almota. As a consequence, barges have been light loaded. At full capacity, a jumbo grain barge can carry 3,600 tons of grain. Under light loading (at the above facilities), approximately 3,300 to 3,400 tons can be carried. Below 3,400 tons, which is considered a minimum load, penalties on shippers can be imposed by the barge companies.

Increased Flow Velocity. Increased river velocity can make navigation more difficult in physically constrained areas and could impede navigation by altering sediment deposition patterns. In general, the proposed flow improvements are not expected to have a serious impact on navigation practices or costs, as they would not produce large increases in velocity. However, one section of the channel that has been mentioned by barge operators as a potential constraint is the Ice Harbor cut, an excavated channel section in the upper end of McNary Pool just downstream of the Ice Harbor lock. The Ice Harbor cut is very narrow (approximately 240 feet) and is a particularly difficult stretch of channel to negotiate. Higher velocities as a result of the proposed action could increase difficulty of navigation through this stretch during the late spring and early summer. The most likely effect would be a slight increase in barge travel time in this reach.

In the future, increased velocity from flow improvements might increase sediment deposition in certain sections of the channel or at specific port facilities (i.e., those located in accretion zones). Deposition patterns can be monitored over time, and actions to maintain navigation clearance can be taken in the future, if necessary.

Dworshak Log Transportation

Potlatch has used four log dumps in the past including Smith Ridge, Benton Creek, Milk Creek, and Little Meadow Creek. Log rafting occurs between mid-May and lasts until early September (Labor Day) as water levels permit. However, in the recent past, Smith Ridge has accounted for approximately two thirds of log rafting with the remaining one third occurring at Benton Creek. The next 5 years will continue to see heavy use of Smith Ridge and Benton Creek as well as a smaller volume from Milk Creek.

According to Potlatch, Milk Creek is operational at 1,585 feet, and Benton and Meadow Creek are operational at 1,580 feet (personal communication, Norm Linton, Potlatch Corporation Northern Units, St. Maries, Idaho, December 18, 1992). Smith Ridge has recently been extended. Previously, it was operational at 1,580 feet but, with the improvements, it is operational for most logs at 1,570 feet. Most of the logs are green logs which can use the facility to 1,570. However, some of the logs are dry (i.e., pulpwood logs such as dead white pine or dead larch) which may hang up on the ramp at 1,570 and, thus, may need more water.

Approximately 90 percent (or more) of the log rafting occurs in June, July, and August. The impact to log rafting operations from flow augmentation at Dworshak would depend upon whether the year is a normal water year or a low water year. Both cases are evaluated below.

Normal Year. Under the no action alternative and in a normal water year, the elevation at Dworshak is above 1,580 feet for June, July, and August,

then drops to 1,575 feet by the end of September (see Table 4.7-1). Hence, the log dumps can generally operate without constraint during their normal summer operating season. In May, the rafting facilities are typically beyond the limit of the usable elevation (i.e., below 1,565). Under Alternative 2 or 3, the median reservoir elevation would exceed the key elevation of 1,570 feet (based on Smith Ridge) for most of June and all of July, August, and September. At the end of September, the elevation would be 1,570 feet, which only restricts use of Milk Creek, Benton, and Meadow Creek. During May, the elevation is expected to be less than 1,560 feet, which is slightly lower than under the no action alternative. In a normal year, there would be only minimal impact to log rafting operations from flow augmentation at Dworshak. The impact would consist of curtailed operations at Milk Creek during part of September.

Alternative 4 (or 5) would result in elevations comparable to Alternative 1 in May, June, and September, and up to 23 feet lower in August. However, the end-of-August elevation in this case would be 1,577 feet, which is still high enough to allow operation at Smith Ridge, except for dry logs. Some restrictions to Benton and Meadow Creek will occur in late August and September, but the number of logs affected is small. Therefore, only minimal constraints on log rafting would be expected with Alternative 4.

Dry Year. The 1932 to 1933 water year is representative of a dry (relatively low elevation) year with a one-in-five probability of occurring in any given year. Under such conditions, log dump operations are not significantly different than under the normal year. Under the no action alternative, the elevation would exceed 1,570 feet for most of June, and all of July, August, and September. With Alternative 2, the reservoir elevation would actually be higher in June, the same in July, 8 feet lower in August, and 5 feet lower in September. With Alternative 4, dry year elevations would be lower than the no action alternative by 5 feet in July and 20 feet in August, but would still allow log rafting operations at Smith Ridge throughout the summer. Therefore, even in a dry year, there would also be minimal or no impact to log rafting operations from flow augmentation at Dworshak with Alternatives 2 through 5.

In summary, there would be minimal impact to log rafting operations in Dworshak from flow augmentation during normal or dry years.

4.7.2 Railroads

The 1992 OA/EIS addressed two primary impact issues related to railroads. One concern was that rail lines adjacent to the affected reservoirs could suffer physical damage from erosion and failure of the railway embankments. This issue only applied to actions such as drafting the lower Snake River reservoirs to near spillway crest, which is not included in any of the SEIS alternatives. Operating the lower Snake River projects at MOP and John Day at near minimum irrigation pool, as proposed in Alternatives 2 through 5, would involve reservoir levels within the normal range of operations. This would not pose a risk to the stability of railway embankments.

The second concern over railroads in the 1992 OA/EIS was the potential for indirect effects through diversion of cargo now carried by barge. Again, this would only occur if barge transportation on the lower Snake or Columbia River were interrupted, which would require lowering reservoir elevations below MOP. None of the alternatives addressed in this SEIS would draft any mainstem reservoir below MOP, so there would be no indirect effects on railroads from these actions.

4.7.3 Highways

The impact issues and projected consequences for highways parallel those described above for railroads. The 1992 OA/EIS focused on the potential for physical damage to highways from drawdown or from diversion of barge traffic to trucks, both of which were associated with drawdowns well below MOP. Operating the lower Snake River reservoirs at MOP and John Day at minimum irrigation pool, as proposed in Alternatives 2 through 5, would not result in these direct or indirect impacts to highways.

4.7.4 Utilities

Water supply intakes and waste water effluent outfalls on the lower Snake River reservoirs are designed to function over the normal range of project operations. Therefore, use of these

Table 4.7-1. Dworshak water elevations, normal (median) and dry years, Alternatives 1, 2, and 4.[a/]

(Feet elevation at end of month)

	Normal (Median) Elevation			Dry Year Elevation		
Month	No Action	Alternative 2	Alternative 4	No Action	Alternative 2	Alternative 4
April	1,510.9	1,511.0	1,516.2	1,445.2	1,445.2	1,445.2
May	1,565.3	1,560.4	1,560.4	1,490.7	1,498.6	1,498.7
June	1,598.5	1,591.0	1,591.2	1,585.1	1,590.1	1,590.1
July	1,600.0	1,596.7	1,591.3	1,593.8	1,593.8	1,588.4
August	1,600.0	1.589.2	1,577.2	1,595.9	1,587.9	1,576.2
September	1,575.0	1,577.7	1,577.9	1,582.3	1,577.0	1,577.2

a/ The dry year elevations are for the 1932-33 water year, which is the 10th lowest year on record, based on the average annual base case elevation for the period 1928 to 1978.

facilities would not be impaired with operation of the reservoir at MOP, as proposed for Alternatives 2 through 5. The Potlatch outfall at Lewiston and the City of Clarkston sewer outfall were exposed during the March 1992 drawdown test, but these exposures did not occur until Lower Granite Reservoir was drafted to approximately elevation 705 feet.

On the John Day Pool, exposure of the City of Umatilla sewer outfall begins at elevations below 262.5 feet. No damage around the outfall has been observed to date during the 1992 operation. However, as noted in Section 4.1.4, poor mixing of the effluent occurs with the pool at elevation 264 or below.

The City of Boardman noted a significant increase in hardness and alkalinity for the municipal water supply when the John Day Pool was operated below elevation 263 feet in 1992. Operation at 263 feet or below in the future may again require treatment. The existing water supply is adequate for the City's needs, although the ability to serve future needs if growth occurs might be constrained with recurrent operation at lower pool levels.

4.8 AGRICULTURE

Alternative	Potential Impacts (Positive/Adverse)
1. Without-Project Conditions (No Action)	• Continued pumping from reservoirs to serve major agricultural developments from Ice Harbor and John Day. • Minor irrigation withdrawals from selected storage reservoirs, primarily Brownlee.
2. 1992 Operations	• No loss of pumping capability for irrigators at John Day or lower Snake, due to operation within normal range for irrigation. Minor increase in pumping costs due to additional head, higher electrical rates. • No adverse effects on withdrawals from storage reservoirs, due to relatively minor changes to normal drafting patterns.
3. 1992 Operations with Libby/ Hungry Horse Sensitivity	• Same as Alternative 2.
4. Modified 1992 Operations	• Same as Alternative 2.
5. Modified 1992 Operations with Upper Snake Sensitivity	• Same as Alternative 2.

The 1992 OA/EIS anticipated that serious economic consequences could occur for irrigators drawing water from lowered pools. These consequences were estimated to include the following:

- Substantial direct economic losses due to curtailment of production. Possible bankruptcy for some land owners and farm operators if production and resulting income were lost.
- Secondary impacts could occur due to the loss of production that might affect other private businesses and governmental agencies indirectly dependent upon farm income and/or taxes.

In this SEIS, with Alternatives 2 through 5, the Snake River pools would be maintained at or slightly above MOP. This would not affect the ability of irrigators to withdraw water from any of the pools, including Ice Harbor where virtually all irrigation pumping in this reach is concentrated.

John Day would operate at or above minimum irrigation pool to avoid any impact to irrigators. During the 1992 operation, the Corps identified six pump stations that incurred problems at elevations of approximately 262 to 263 in the John Day Pool. Four pump stations served Circle C (Cook Farms), Strebin Farms, C&B Livestock, and Perkins Farm, which are all located between RM 270.6 and 289 on the Oregon side of the river in the John Day Pool. Two additional pump stations, Sullivan and J. Trafton, are located on the Willow Creek tributary near RM 252.

Because of the drought conditions in 1992, irrigation demand began in mid-May in 1992. The Corps maintained the John Day Pool at minimum irrigation pool, which was flexible to meet irrigators' requirements. As soon as the Corps was notified of an impact to irrigators, the pool was raised to alleviate the impact. Thus, the pool was generally maintained at elevation 264 to 265.

As a result of this operation method, the impact to irrigators during the lowered pool elevation was negligible in terms of ability to continue pumping. The same operating procedures would be used in 1993 and future years, so this type of irrigation impact would again be avoided.

Public comments on the draft SEIS indicated irrigators' concerns that the lowered pool levels, particularly at John Day, would slightly increase the head for the pumping plants. This would increase power consumption and therefore production costs. Indirectly, the proposed actions could contribute to higher electric rates, which would also increase production costs.

Impact studies of the proposal to operate John Day Pool at MOP (257 feet; this is being addressed in the SCS process) indicate that this operation would indeed have a measurable effect on pumping costs, increasing them by a few percent. In view of the small change projected at elevation 257 feet, it was concluded that the effect of the proposed interim operation (near elevation 262.5) feet on pumping head and costs would be negligible.

Flow augmentation proposed for Alternatives 2 through 5 would not affect irrigation in any of the reservoirs.

4.9 ELECTRIC POWER

Alternative	Potential Impacts (Positive/Adverse)
1. Without-Project Conditions (No Action)	• Normal power system operation according to operating rules in place from 1985 to 1990.
2. 1992 Operations	• Capacity losses of 100 to 1,500 MW, depending on month (cost of $11 million). • Firm energy loss of 80 aMW (cost of $25 million). • Non-firm energy loss ranging from 200 to 1,300 MW-months (cost of $2 to $14 million). • Columbia 3.0 MAF (cost of $25 to $40 million). • Total estimated power cost increase of $63 to $90 million.
3. 1992 Operations with Libby/ Hungry Horse Sensitivity	• Capacity losses of 100 to 1,500 MW depending on month (cost of $11 million). • Firm energy losses of 40 to 60 aMW (cost of $12 to $19 million). • Nonfirm energy losses of 400 to 1,700 MW-months (cost of $4 to $18 million). • Columbia 3.0 MAF (cost of $25 to $40 million). • Total estimated power cost increase of $52 to $88 million.
4. Modified 1992 Operations	• Capacity losses of 100 to 1,500 MW, depending on month (cost of $11 million). • Firm energy losses of 90 aMW (cost of $28 million). • Nonfirm energy losses of 200 to 1,300 MW-months (cost of $2 to $14 million; only slight changes in nonfirm value due to seasonal shifting). • Columbia 3.0 MAF (cost of $25 to $40 million). • Total estimated power cost increase of $66 to $93 million.
5. Modified 1992 Operations with Upper Snake Sensitivity	• Capacity losses of 100 to 1,500 MW, depending on month (cost of $11 million). • Firm energy losses of 55 aMW (cost of $17 million). • Nonfirm energy losses of 400 to 1,500 MW-months (cost of $4 to $16 million). • Columbia 3.0 MAF (cost of $25 to $40 million). • Total estimated power cost increase of $57 to $84 million.

The proposed actions could have a variety of consequences for the power production operations at the affected projects and for the regional power system as a whole. Both the lowered pool elevations and flow augmentation actions would result in lost power generation and operating flexibility. This could require production of replacement power by other sources either within or outside of the region. Lost hydroelectric generation would represent an economic cost to the region, which could translate into increased power rates. It could also result in an economic cost to the Pacific Southwest, because lost nonfirm power normally exported to the Southwest would require replacement, likely by oil- and gas-fired generation.

The 1992 OA/EIS identified and assessed power losses associated with several different elements of power production. These elements include changes to the overall generating capability of the system as a result of plant shutdown, loss of peaking capacity from operating specified reservoirs at static elevations and transfer of this peaking operation to other projects, efficiency losses from reduced operating head, and reshaping of storage releases. In addition to capacity effects, generation levels and values would be affected by changes in the distribution of firm and nonfirm energy generation. The actions addressed in this SEIS would generally involve the same types of impact issues. The following material summarizes the discussion of impact mechanisms from the OA/EIS, and presents power impact estimates specific to the proposed actions currently under review.

The costs of estimated changes in capacity, firm, and nonfirm energy production due to the proposed actions are also shown in the summary table at the beginning of this section. These numbers are only approximations; they should not be regarded as precise quantitative expressions, but rather as a means of making rough comparisons among the proposed actions.

4.9.1 Capacity

The lower Snake and Columbia mainstem dams fluctuate regularly within their normal operating ranges as a result of system peaking operations. Reservoir levels at these projects can vary 2 to 5 feet on a daily or weekly basis as generation from these plants is shaped to follow load patterns. If the reservoirs were held relatively constant at minimum pool levels the ability to cycle the plants to meet peak loads would be eliminated. This would result in a significant loss of peaking capacity on the system. In addition, part or all of the load-shaping operation might be transferred to other projects, which would in turn experience greater pool and tailwater fluctuations.

Capacity loss estimates for this SEIS are based on 50-hour sustained peaking values. This assumes that the generation available during a week is shaped to meet a 10-hour peak load each weekday, while still meeting minimum outflow and forebay restrictions. Operating with a relatively stable pool limits how much the generation can be shaped and thus results in a reduced ability to generate sustained peaking capacity. The lost capacity is the difference between the maximum 50-hour peak load that can be met and the 50-hour peak load that can be met with the proposed action. The critical period monthly average flow was calculated and used in a spreadsheet model to determine the amount of generation that could be shaped each month.

Estimated monthly capacity losses are indicated in Table 4.9-1. For Alternatives 2, 3, 4, and 5, drafting all four lower Snake River projects to MOP from April 1 to July 31 would result in capacity losses ranging from 200 MW in May to 1,200 MW in the first half of April. Capacity losses at John Day would range from 100 MW in July and August to 1,000 MW in May.

Estimating the costs of capacity losses is rather difficult. If the regional power system were in capacity load/resource balance, the cost of capacity losses could be based on the cost of a new resource purchased to replace these losses (for example, a combustion turbine). However, it is generally assumed that the regional power system has a capacity surplus. Under most conditions, there is enough capacity to satisfy Northwest needs. Therefore, the projected capacity losses may not currently affect the system's ability to serve Northwest peak loads, but may affect its ability to market capacity. A number of assumptions, therefore, were necessary to estimate the cost of spring and summer capacity losses. The first 1,000 MW of lost capacity in May and June (high nonfirm months) was assumed to be useful only for

Table 4.9-1. Estimated 50-hour sustained capacity losses in megawatts (MW) for Alternatives 2, 3, 4, and 5.[a/b/]

Period	Lower Snake Projects to MOP Apr 1 - Jul 31	John Day 262.5 Apr 1 - Aug 31
April 1-15	1,200	--
April 16-30	1,100	--
May	200	1,000
June	1,100	400
July	600	100
August		100
September		--

a/ Based on critical water conditions.
b/ Figures are for mainstem plants affected by drawdown only. Capacity losses at storage projects are minor and are not quantified.

shaping nonfirm from light load hours into heavy load hours, and was therefore given a value of zero. For losses of 1,000 to 3,000 MW in May and June, and for the first 3,000 MW in all other months, the lost capacity was valued at $4/kilowatts [kW]/month, the rate that BPA charges for capacity sales. Based on these cost factors, the costs of the estimated capacity losses would be $9 million for the lower Snake River projects and $2 million for John Day.

Capacity losses resulting from the proposed flow augmentation changes tend to be minor. The Northwest Power Planning Council's Phase II Amendments include the ability to use Dworshak to meet peaking emergencies. If this were not the case, the requirements to operate Dworshak as close as possible to its upper rule curve by April 15 of each year could result in large losses of peaking capability in the winter months. The revised operation at Dworshak would result in some capacity losses in the winter, but there also would be some gains in summer capacity due to summer water releases. Because of the uncertainty in determining the losses and gains, the two effects were assumed to balance.

4.9.2 Firm Energy

A key aspect of any evaluation of hydropower operational changes in the Northwest is the impact on the FELCC of the regional system. FELCC is the level of energy that could be produced by the existing regional hydro-thermal system if the region's worst historical water conditions (the 42 months from September 1928 through February 1932) were to reoccur. Energy produced within the FELCC limit is firm energy that can be guaranteed at all times and therefore sold at higher rates, while generation in excess of FELCC due to better streamflows is surplus or nonfirm power that is usually sold at lower rates because its availability cannot be guaranteed.

Operating all four lower Snake River plants at MOP from April 16 through July 31 would result in minor FELCC losses that are not large enough to be quantified for this analysis. Similar circumstances apply to FELCC losses at John Day.

Increasing the spring water budget on the Snake River under Alternative 2 would reduce the FELCC of the system by about 80 average megawatts (aMW). This FELCC would be lost throughout the year. However, in this case there would be

additional nonfirm energy produced in the spring, which would have some value. The additional summer water budget, which is released in July, August, and September, is assumed to be usable for meeting firm loads. However, when the September water is released in July and August, Dworshak would start the annual drafting period lower than usual resulting in an FELCC loss of about 10 aMW.

A loss of FELCC would mean a reduced ability to meet regional energy loads under the worst, or critical, water conditions. Therefore, the projected loss of FELCC would need to be replaced by whichever regional party suffers the loss. In most cases, the loss would be borne by the Federal portion of the hydro system, which would give BPA responsibility for securing replacement power. It is likely that loss of FELCC on the Federal system would be made up by resources acquired through BPA's various acquisition processes. It is clear that these resources would be more expensive than the hydro resources that they would replace. However, it is difficult to predict the exact cost of acquiring replacement power since it is not known which resources or types of resources would be acquired to cover FELCC losses. However, a good ballpark number may be used. Most firm resources that BPA can be expected to acquire in the near future to replace FELCC losses are likely to cost around 35 mills/kWh, in levelized real-dollar terms. Real levelization is a technique for comparing resources with different cost streams. In this context, it means a resource will cost 35 mills the first year of operation, with costs rising by the rate of inflation over time. Hence, this number may be used to estimate the cost of FELCC losses under Alternative 2. Valued at this rate, the cost of estimated FELCC losses from flow augmentation on the Snake River amount to about $25 million.

The types of resources that BPA might acquire to replace hydro system losses could have environmental consequences of their own. This is difficult to assess for the purposes of this document. However, BPA has prepared a draft Resource Programs Environmental Impact Statement that discusses the environmental consequences of acquisition of various resource types.

4.9.3 Nonfirm Energy

In addition to capacity and FELCC losses discussed above, there would be significant nonfirm energy losses with some options because of water being spilled rather than used to generate energy. This lost energy would translate into reduction in revenues from nonfirm sales.

Projects operating at or below MOP would be unable to generate energy in excess of streamflow in the daytime, and might well spill water at night due to lack of a market for energy or lack of sufficient forebay space to store nighttime inflows. In the case of MOP operations, nonfirm energy would be lost due to spill during light load hours. Hence, all amounts shown for the lowered reservoir elevations options are total losses from spilled water. These nonfirm losses range from 400 to 700 MW-months annually for operating the lower Snake River projects at MOP, and 200 to 500 MW-months annually for operating John Day at minimum irrigation pool. There are also minor nonfirm losses due to reduced head, but these appeared to be less than 100 MW-months and were not included.

For the flow augmentation options, it was assumed that FELCC losses would be converted to nonfirm energy, and that a portion of this nonfirm energy would be sold as nonfirm; some of it, however, would be spilled. Also with the larger water budget at Dworshak, it is expected that at least some of the releases from Dworshak will be in the form of spill, since turbine capacity is only 10 kcfs and maximum outflow is 25 kcfs. In all alternatives the energy from FELCC being converted to nonfirm was not large enough to balance the nonfirm losses from the MOP operations and the spill at Dworshak.

Reduction in the ability to produce nonfirm energy would represent a loss in revenues because there would be less nonfirm energy to sell to regional utilities to displace thermal resources, or to export to the Pacific Southwest. The price received from nonfirm energy sales generally depends on the quantity sold and the season in which the sale is made. This can range from roughly 10 to 20 mills/kWh. A value of 15 mills/kWh was used here.

The 3 MAF on the Columbia would cost about 330 MW of FELCC if it were included in firm planning. However, it is clear that in the 1992 - 1993 water season, the Columbia River flow augmentation will not be included in firm planning, but rather be done operationally, which may require purchasing energy and/or foregoing nonfirm sales. This will produce changes in nonfirm energy availability, and also shift nonfirm production from winter to spring, changing its value. These uncertainties make a MW determination of the nonfirm changes very difficult. Instead a dollar cost of $25 to $40 million was determined by assuming different costs of energy purchases and different nonfirm sales values, and then determining the average cost over the 50-year historical water record using a spreadsheet model. This large range indicates the uncertainty in these values. It should be noted that because of the uncertainties in timing and availability of water, actual costs in any given year may be higher or lower than the estimated average annual cost.

In 1992, the Columbia 3 MAF was met at a significantly lower expense than expected. This was due to an oversupply of gas resulting in low prices in California and ample energy supplies from B.C. Hydro during the time that the 3 MAF was being stored. The purchase prices averaged only 20 mills/kWh, rather than the 40 mills assumed for a long-term average. Because of poor water conditions and the timing of the release (June and July, rather than May) much of the energy was usable by BPA, resulting in a net salvage value of about 17 mills/kWh. This resulted in a net cost to BPA of about $7 million.

Operating generators within 1 percent of best efficiency can limit the maximum generation and result in spill. This effect would probably be small in most years, but could result in large losses of nonfirm energy in some years. Because of a number of unknowns, no MW or dollar value for these losses is available.

4.9.4 Effect on Rates

At this time, BPA has set its rates for fiscal years 1992 and 1993. Consequently, the costs associated with implementation of any of these options during FY 1993 would not be recovered through increased rates in FY 1993. Rather, it is likely that BPA's operating reserves would be reduced. To the extent that the reduced cash reserves need to be recovered to meet BPA's financial goal of maintaining a high probability of making U.S. Treasury payments, there could be some upward pressure on rates in the FY 1994 to 1995 rate period; however, this is difficult to predict. As discussed above, the costs shown here are best used to compare options rather than to predict the actual increases in cost that the power system might face. Hence, no future rate impacts were estimated.

4.9.5 Mitigation

Losses in the ability of the system to generate firm energy resulting from implementation of any of the alternatives would need to be replaced. As discussed previously, it would likely come from acquisition of new resources, or possibly from increasing generating capacity at existing projects or by purchasing firm energy from outside the region. Losses in the ability of the system to generate capacity might need to be replaced with new resources in some situations; in others, it would reduce the system's ability to market capacity. Nonfirm losses result primarily in revenue losses and would not need to be replaced.

4.10 RECREATION

Alternative	Potential Impacts (Positive/Adverse)
1. Without-Project Conditions (No Action)	
John Day, Snake River	• Minor impacts to recreation facilities when elevations at lower end of normal operating range.
Dworshak	• Impacts to recreational facilities from large reservoir fluctuations. Attempts made to keep reservoir above elevation 1590 from end of June through Labor Day so recreation facilities remain usable. • All 7 boat ramps usable on average from May through October.
Brownlee	• Three boat ramps on average open during spring fishing season. • Most recreation facilities functional during summer.
Grand Coulee	• Most recreation facilities typically functional from July through the end of September.
Libby	• All recreational facilities generally functional in July and August, 16 of 20 through the end of September, on average.
Hungry Horse	• Reservoir near full pool, recreational facilities usable from July through Labor Day in most years.
2. 1992 Operations	
John Day (to elevation 262.5)	• 6 of 14 boat ramps usable, 5 marginally usable, 3 unusable. • 6 of 9 moorage facilities fully functional, 2 marginally, 1 unusable. • 10 of 11 swimming areas fully functional, 1 marginally. • No displaced visitation expected.
John Day (to elevation 264.0)	• 12 of 14 boat ramps fully functional, 2 marginally usable. • 8 of 9 moorage facilities fully functional, 1 marginally. • 11 swimming beaches fully functional. • No displaced visitation expected.
Snake River	• 14 of 28 boat ramps functional, 14 marginally usable. • 1 of 5 moorage facilities functional, 4 marginally usable. • 2 of 11 swimming areas functional, 5 marginally usable, and 4 unusable. • Insignificant displaced visitation expected.

Alternative	Potential Impacts (Positive/Adverse)
Dworshak	• Swimming beaches usable, on average, from the end of June to late August. • Restricted access to some minicamps in early and late summer. • Use of moorage facilities marginally affected. • All 7 boat ramps usable mid-June to the end of September, on average. • No expected decrease in visitation, representative of median water conditions; measurable decrease possible in low-runoff years. • All river access facilities on Clearwater River functional; no effect on steelhead fishing or summer recreation.
Grand Coulee	• Minimal effects in most years. • Uncertain probability and magnitude of significant impacts to fishing and houseboating, if May-June drafts required for flow augmentation.
Libby	• Higher winter-spring pool elevations in flow augmentation years, earlier access to some facilities.
Hungry Horse	• No effects on access or visitation.
3. 1992 Operations with Libby/ Hungry Horse Sensitivity	• Same as Alternative 2, except as follows:
Libby	• Possible access limitations from lower pool in spring 1 year in 3; insignificant to moderate facility impacts from lower summer elevations 1 year in 5. • Expected visitation decrease of 3 to 4 percent at Libby, representative of median water conditions.
Hungry Horse	• Insignificant increases to access limitations in low-runoff years.
4. Modified 1992 Operations	• Same as Alternative 2, except as follows:
Dworshak	• Impacts similar to Alternative 2, but greater magnitude; somewhat higher probability of lower elevations and adverse impacts in any given year. • Expected visitation decrease of 3 percent, representative of median water conditions. Larger decrease in low-runoff years.
5. Modified 1992 Operations with Upper Snake Sensitivity	• Same as Alternative 4.

The 1992 OA/EIS identified and analyzed the impact issues that would be associated with reservoir drawdown and flow augmentation. In both cases, the primary impact mechanism would be lower reservoir elevations during the recreation season. The 1992 OA/EIS discussed how elevation changes could impair or preclude the use of various types of recreation facilities and how these physical impacts could translate into changes in visitation patterns. Based on detailed inventory of affected facilities and their operating ranges, the 1992 OA/EIS included a project-specific analysis of physical and visitation impacts relevant to the proposed 1992 actions.

Given this base of information, it is not necessary for the SEIS to repeat the generic assessment of impact mechanisms or much of the project-specific input to the analysis. The following material updates and summarizes the 1992 OA/EIS analysis with respect to John Day, the lower Snake River projects, Dworshak, Brownlee, and Grand Coulee. Facility and visitation impacts for the latter three projects are estimated based on 1992 OA/EIS data and HYSSR Model results for the current set of flow augmentation alternatives. New material providing a comparable analysis of effects on resources at Libby, Hungry Horse, and their downstream river reaches for Alternative 3 (a sensitivity test) has been added.

4.10.1 John Day/Lower Columbia

The 1992 OA/EIS identified a target pool elevation of 262.5 at John Day between May 1 and August 31 to be maintained unless irrigation problems were to occur. During initial implementation of this plan in 1992, pumping problems arose as the pool was drafted below elevation 263. John Day Pool was raised in response, and was subsequently operated at approximately elevation 264 to 265 for the remainder of the season. During the initial implementation, few effects to recreational facilities were observed, and no problems were observed at Corps recreation sites. Since the pool elevation was achieved prior to the summer recreation season and the pool level remained fairly constant, recreational activities adapted to the pool levels. Recreational use levels were observed to be typical for a hot dry summer.

Under more normal water conditions than existed in 1992, it is estimated that the minimum irrigation pool level would be between 262.5 and 265 feet. Consequently, reservoir operation for irrigation affects recreational facilities at elevations 262.5, 263.5, and above 264.0, as displayed in Table 4.10-1.

To help determine the effects of lower pool elevations, recreational facilities were classified as being fully usable, marginally usable, or unusable at various elevations.

Boat ramps are generally fully usable when there is a minimum of 3 to 4 feet of water at the toe of the ramp. With this depth, most of the larger trailered boats common on the Columbia River can be safely and efficiently launched. At reduced depths, boat launching becomes more unsafe and the length of time required to launch increases. Larger craft may have to go to alternative ramps. A ramp is considered unusable when there is no water at the base of the ramp or when small trailered craft cannot be launched.

Boat marinas and moorages are considered fully usable when all docks, moorages, and other associated facilities are accessible to all sizes of boats for which they were designed. Boat moorages become marginally usable when the water depth becomes too shallow under some of those facilities to accommodate the type of craft that they normally can accommodate. An important consideration in the usability of moorages and marinas is the depth of channel between the boat basin and the main navigation channel of the river.

The number of facilities that would be unusable or marginally usable would be reduced if the elevation at John Day were 263.5 rather than 262.5. The extra 1-foot of pool elevation would allow 6 more boat ramps to be fully functional, so that 12 of the 14 ramps would be fully or marginally usable. Two additional moorage facilities would also be fully functional at elevation 263.5 as opposed to elevation 262.5, which would result in 8 of the 10 facilities being fully functional at the higher elevation, and all swimming facilities being functional. At pool elevations above 264.0, all facilities would be fully or marginally usable.

Table 4.10-1. Utility of John Day/Lake Umatilla Recreational Facilities at Elevations 262.5, 263.5, and above 264.

	Boat Ramps			Moorage Facilities			Swimming Areas	
Elevation	Fully Functional	Marginally Functional	Unusable	Fully Functional	Marginally Functional	Unusable	Functional	Unusable
262.5	6	5	3	6	2	1	10	1
263.5	9	3	2	8	0	1	11	0
above 264.0	12	2	0	8	1	0	11	0

Operating John Day near elevation 263.5 would not have significant effects on most project recreational facilities. Primary effects would involve shallow water and shoaling near some facilities, which could impair boat access to embayment lakes, dispersed campsites, and some boat ramps.

There would most likely not be any significant short-term or long-term effects on recreational use as a result of operating John Day at elevation 262.5 or 263.5 from May through the end of August. Short-term effects on visitation as a result of operating at a pool elevation of 262.5 were discussed in the 1992 OA/EIS. They included the possibility of shifting use from facilities affected by the drawdown to unimpaired facilities at John Day or to facilities at other projects. However, because there would still be an adequate supply of facilities available and functional at John Day at a pool elevation of 262.5, the number of recreation days lost at the project as a result of the seasonal pool lowering would not be expected to be significant. The potential for visitation losses at an elevation of 263.5 feet is even smaller. However, some crowding at other recreation sites could occur in either case.

4.10.2 Lower Snake River

Operating the lower Snake River projects at MOP from April through July would have some impact on facilities at the four projects, but as discussed in the 1992 OA/EIS, most facilities would remain at least marginally usable. All 28 boat ramps would be usable, although 14 would be marginally usable and would be difficult to access because of shallow water and shoaling. Likewise, most (4 or 5) of the moorage facilities would be marginally usable, but all 5 could be used to various extents. Four of the 11 swimming beaches would not be usable and an additional 4 would be marginally usable. Long-term effects on recreational facilities at the Snake River projects would primarily involve shoaling and shallow waters that could make access to docks and moorage areas difficult. Some damage to boat ramps could result from wave-cut erosion.

As illustrated in Table 4.10-2, visitation to the four lower Snake River projects through July 1992 actually increased slightly compared to the previous 2 years. The number of visits to Lower Granite through July 1992 increased 25 percent in comparison to the same time the year before. Increased visitation to the other 3 projects for the same time compared to the previous year were as follows: Little Goose = 33 percent, Lower Monumental = 11 percent, Ice Harbor = 16 percent. Some of the increased visitation can be attributed to the public curiosity over the impacts of the March 1992 Little Goose and Lower Granite drawdown test. Media coverage of the drawdown test sparked widespread interest, and people visited the 2 projects earlier in the year than they normally would have. In view of the significant but smaller increases at Ice Harbor and Lower Monumental, it is likely that annual differences in weather conditions or other factors not related to project operations were also partially responsible for increased use.

The 1992 OA/EIS concluded that no significant decrease in visitation at the lower Snake River projects would be anticipated as a result of operating near MOP from April through July. Actual counts and anecdotal field reports to date during the 1992 operation do not indicate any reason to change this Conclusion.

Table 4.10-2. 1990-1992 Visits to Lower Snake River Projects.

Project Visitation	1990 through July	1991 through July	1992 through July	Fiscal Year 1990	Fiscal Year 1991
Lower Granite	1,330,700	1,204,300	1,503,800	1,654,000	1,654,100
Little Goose	137,200	138,800	184,400	191,000	197,370
Lower Monumental	86,200	90,300	100,000	120,100	131,200
Ice Harbor	333,000	343,200	398,300	447,100	449,200
Total	1,887,100	1,776,600	2,186,500	2,412,200	2,431,870

Source: Memorandum from the Army Corps of Engineers, Walla Walla District, Walla Walla, Washington, 1992.

4.10.3 Dworshak

Most recreational facilities at Dworshak cannot operate over the full range of reservoir elevations and are only usable during part of the year. Developed swimming beaches operate over a narrow range of pool elevations, generally above elevation 1,595 feet. The boat ramps on the reservoir are functional over a much wider range of elevations; at the extremes, one ramp becomes unusable below elevation 1,577 feet, while the Big Eddy ramp is usable at the maximum project drawdown elevation of 1,445 feet. Summer pool elevations have generally been kept above elevation 1,590 between the end of June and the end of August to accommodate recreational use. Historically, annual visitation has been greatest during the summer, with 77 percent occurring between June and September.

The proposed flow augmentation actions would result in pool elevations that would be lower to varying degrees than existing conditions during the summer. Compared to the without-project condition (Alternative 1), Alternatives 2 and 3 would generally result in lower elevations from May through August (see Table 3.5-6). The median end-of-month elevations for Alternatives 2 and 3 are 8 feet lower in June, about 3 feet lower in July and 11 feet lower in August. Therefore, in a typical water year, the reservoir would be below the designed operating range of the swimming beaches during most of June, part of August, and all of September. Access to the minicamps would be more difficult than during existing conditions, particularly in August, although the camps would remain usable. Most other recreational facilities would not be significantly affected and water access to the reservoir would be available. All 7 boat ramps would be fully functional from about mid-June through the end of September in a typical year, while 4 to 6 of the 7 ramps would be usable from the beginning of May through nearly the end of October.

To determine what effects the alternatives would have on recreational facilities during relatively low water years, the 10th lowest average annual pool elevation in a 50-year period (1928 through 1978) was selected for analysis. Twenty percent of the time, or 1 in 5 years, pool elevations would be at or below the elevations for this year. Conversely, in 80 percent of the years pool elevations would be higher. At Dworshak, the 10th lowest annual average pool elevation occurred in the water year 1932 to 1933; these elevations were indicated previously in Table 4.7-1.

Based on the HYSSR Model runs, elevations with Alternatives 2 and 3 during low water years would generally be higher during May and June than pool elevations for the base case. (This can be attributed to the specification in Alternative 2 that Dworshak be maintained near the mandatory flood control rule curve in the winter, which would reduce the extent of winter drafting, and storage for

flow augmentation.) The Alternative 2 (and 3) elevation for the 1932 to 1933 water year is the same as Alternative 1 in July, 6 feet lower in August, and 5 feet lower in September. The primary difference among these alternatives would involve July, when swimming beaches and minicamp access would be constrained.

Alternatives 4 and 5 would have greater negative effects on recreational facilities at Dworshak during moderate water years than Alternatives 2 and 3. The median end of June pool elevation for Alternatives 4 and 5 would be approximately 8 feet lower than the base case and all recreational facilities except swimming beaches would be fully usable. By the end of July, the pool elevation would be approximately 9 feet lower than the base condition. Negative effects to recreational facilities would include the elimination of use of developed swimming facilities, difficult access to some mini-camps, and some difficulty in using moorage facilities. All boat ramps would be fully functional. The pool elevation at the end of August would be approximately 23 feet lower than normal.

Additional negative effects to recreational facilities would include difficulty in accessing mini-camps and increased difficulty in using moorage facilities. All boat ramps would remain fully functional through the end of November. By the end of September, the pool elevation would be at least as high or higher than Alternative 1 pool elevations and there would be no negative effects to recreational facilities.

During low-water years, Alternatives 4 and 5 would result in lower late-summer elevations compared with the base case. By the end of July the pool elevation would be 6 feet lower than the base case. Developed swimming beaches would be unusable and minicamp access would be constrained. By the end of August, the pool elevation would be approximately 20 feet below the base case pool elevation. No developed swimming beaches would be usable in this case, moorage facilities would be slightly affected, and some minicamps would be difficult or impractical to access. All boat ramps would be fully functional.

See Section 4.10.10 for a discussion concerning visitation effects of the alternatives.

With Alternatives 2 and 3, early spring releases from Dworshak into the North Fork Clearwater River would be very similar in timing and extent to historical releases. As a result, there would not be any anticipated effects to steelhead fishing on the North Fork or mainstem Clearwater River. Proposed flow augmentation would produce higher-than-normal flows (ranging from about 11,900 cfs in late April to 3,400 cfs in July and August) which do not overlap with the primary steelhead season of October through April. The higher than normal flows in the Clearwater River during July and August could slightly affect warm weather recreationists. Activities such as informal swimming, fishing, and picnicking along the North Fork could be affected by higher flows that could inundate some beaches and make swimming conditions less safe. No significant effects would be expected on the mainstem.

With Alternatives 4 and 5, releases into the Clearwater would be very similar to the releases with Alternatives 2 and 3 except during August and September. With Alternatives 4 and 5 late-August flows (5,020 cfs) would be approximately 1,500 cfs greater than with Alternatives 2 and 3 (3,400 cfs) and 3,000 greater than median base case flows (2,000 cfs). The increase in flow and possible decrease in water temperature could affect North Fork Clearwater River recreationists participating in activities such as innertubing, swimming, and picnicking. No effects to recreationists on the main stem would be expected. Releases at the end of September (1,200 cfs), on the other hand, would be significantly lower than Alternatives 2 and 3 (4,600 cfs) or the base case (8,286 cfs) releases. The lower September flows of Alternatives 4 and 5 might be preferred by users engaged in activities such as innertubing, swimming, and picnicking, compared to conditions under Alternatives 2 and 3.

Median releases during September (4,600 cfs) would be substantially less than the base case (8,286 cfs), as would releases in November (3,373 cfs versus 5,204 cfs) and December (2,000 cfs versus 4,493 cfs). Steelhead fishing in the late fall and winter would not likely be negatively affected by the reduction in flow. The lower flows would be relatively stable, which is more conducive to fishing success than significantly changing flows, and appear to be within the range of acceptable flow conditions for fishing.

4.10.4 Brownlee

Historically, Brownlee Reservoir has reached its lowest median pool elevation at the end of April (elevation 2,044.6) and has been refilled to full pool (elevation 2,077) by the end of June. As discussed in the 1992 OA/EIS, the most popular time of the year for anglers was between April 1 and May 31, during refill. After refill, the pool has been lowered gradually in elevation to a summer low of 2,068.4 in August. Water-oriented and related recreational activities such as boating, water skiing, swimming, and camping have been most popular during July and August. In September, recreational use historically remained low until spring.

Alternatives 2 through 5 involve releases from Brownlee in July and September. The July release has a 96 percent chance of refill by the end of August. The July release would lower the pool elevation approximately 8 feet, or to a minimum pool elevation of 2,069, whichever is higher. Based on 50 years of historical pool elevations, an elevation of 2,069 occurs in July 27 of 50 years, or 54 percent of the time. The primary potential effect that a pool elevation of 2,069 would have on recreation in July would be on water access for boat anglers dependent on ramps. Three of the 5 recreation sites with boat ramps at Brownlee would still be usable at a pool elevation of 2,069.

The September release would on average lower Brownlee Reservoir approximately 8 feet to an elevation of approximately 2,060 feet. At elevation 2,060, three of the boat ramps would still be usable. See Section 4.10.10 for a discussion concerning visitation effects of the alternatives.

4.10.5 Grand Coulee/Lake Roosevelt

Many of the recreational facilities at Lake Roosevelt are designed to function near the full pool elevation of 1,290 feet. With the existing condition, most of the facilities are functional during the busy summer season in most years because pool elevations usually fluctuate between approximately 1,285 feet and full pool.

Alternatives 2, 3, 4, and 5 involve average pool elevations between May and September that would be very similar to base conditions. Pool elevations would be within 2 feet of full pool in most years from the end of June through the end of September, so there would be minimal effects on recreational facilities at Lake Roosevelt.

Recreation at Lake Roosevelt is a function of the quality of fishing, accessibility, water levels, and water fluctuation. Fishing alone is a $12-million industry on Lake Roosevelt. Boating and houseboating have increased dramatically in the last decade. The recreation industry centered on and around Lake Roosevelt figures heavily in the local economic future and the economic futures of both the Colville Confederated Tribes and the Spokane Tribe. Because of the resident fish impacts described elsewhere and the potential drafting and fluctuations of Lake Roosevelt in May and June during low flow years, the fishing and houseboating industry might be affected significantly. Recreation impacts are difficult to quantify under stable conditions; therefore, they would be very difficult to predict when they are based on operations that are dependent on runoff and numerous other conditions. See Section 4.10.10 for a discussion concerning modeling of visitation effects.

4.10.6 Libby/Lake Koocanusa

Recreational facilities at Libby are affected by existing reservoir fluctuations that typically range between 100 and 140 feet below full pool (elevation 2,459). Most recreational facilities were designed to operate near full pool. Among the facilities most affected by normal drafting are dispersed recreation sites and swimming beaches. Most of the dispersed sites require a full pool elevation to launch boats. Swimming beaches, likewise, function best at higher pool elevations. A 5-foot draft would affect the beach at McGillivary and the swimming lagoons at Kikomun Creek Provincial Park. A draft of 15 feet would extend beyond the operating range of developed beaches at 4 of the 5 project recreation sites. A draft of 20 feet would eliminate usage of all developed beaches.

Boat ramps and moorage facilities function over a wider range of elevations than swimming beaches. All but 2 of the project's 11 boat launching and mooring facilities are operable down to elevation 2,444. The old Kootenai River Cruises dock and the mooring lagoons at Rexford Bench are usable at

this elevation. Six of the 7 facilities with ramps are operable down to elevation 2,424. At elevation 2,409, 3 of the 7 facilities remain operable. The ramps at Souse Gulch and Peck Gulch extend to elevation 2,310, which is 149 feet below full pool. The annual drafting leaves silt and gravel deposits on the boat ramps in the spring, which requires maintenance effort and expense prior to use.

Pool elevations at Libby have typically been full by the end of July and remained so through the end of August. By the end of September, the pool elevation has historically been lowered to an elevation of 2,450 feet (which is approximately the same elevation as at the end of June), which, as discussed above, still allows usage of all of the projects boat ramps and most of the other recreational facilities.

The action alternatives would have little or no great effect on pool elevations or recreational facilities during years when flow augmentation would not be necessary. The HYSSR Model runs indicate that median pool elevations with Alternatives 2, 4, and 5 would be very similar to Alternative 1 elevations during the spring and summer. Flow augmentation from Libby would occur approximately 1 in 5 years or less. The primary effects to recreation at Libby would be that pool elevations generally would be higher throughout the winter and spring than with historical or Alternative 1 elevations. The HYSSR Model runs indicate that in years when flow augmentation from Libby would be expected, pool elevations would average 4 feet higher in January, 12 feet in February, 20 feet in March, and from 27 to 31 feet in April. The higher pool elevations would occur during a time of the year when recreational use of Libby is not great, in part due to the fact that access to the lake is limited. During normal years, access to the lake between January and June is possible only from the ramps at Souse Gulch and Peck Gulch. Access to most of the other ramps (6 of 7), is not possible until the pool reaches elevation 2424, which usually occurs in June. During years when augmentation storage would be required, elevation 2424 would typically be reached in April; thus, there would be increased access to the reservoir during mid-spring.

Augmentation releases from Libby would occur in the late spring. Although HYSSR runs for summer pool elevations were not made, it is assumed that by July the reservoir elevation would return to the Alternative 1 pattern. Summer pool elevations and recreational use of the pool would be expected to continue as usual. Errors in runoff forecasts could affect reservoir refill, but would only be expected to result in decreases or increases in pool elevations (relative to Alternative 1) of several feet. Therefore, significant impacts to recreation would not be expected.

The operating scenario represented by Alternative 3 would result in pool elevations lower than Alternative 1 in low-runoff years, with potential negative effects to water-oriented recreation. Alternative 3 pool elevations would be from 1 to 75 feet lower during April in 18 of the 50 water years, and from 9 to 33 feet lower during July in 10 of 50 years.

The effects of Alternative 3 pool elevations on recreation in low-runoff years can be illustrated by year-to-year comparisons of elevations. For example, the third driest water year (1977 to 1978) would result in a July elevation of 2,402 feet, 16 feet lower than the Alternative 1 elevation of 2,418 feet. With these types of annual runoff conditions, facilities such as swimming beaches that are operable near full pool would not be usable under either Alternative 1 or Alternative 3 operations. Four of the 7 boat ramps on the reservoir would be inoperable with the Alternative 1 conditions, while 5 of 7 would be inoperable with Alternative 3. In this particular case, the incremental decrease in summer pool elevation with Alternative 3 would have an insignificant effect on facility accessibility and recreation use, which would already be limited by low water in the base condition. This type of effect, in which Alternative 1 elevations would already be significantly below full in July, would occur in 7 of 50 years.

In other years the elevation differential associated with Alternative 3 could have somewhat more effect. Simulated Lake Koocanusa elevations for July 1939 are 2,459 feet (full) with Alternative 1 and 2,440 feet with Alternative 3. In this case, the 19-foot difference in elevation would indicate that the swimming beaches and 1 boat ramp would be usable with Alternative 1 but not with Alternative 3. Overall, 3 of the 50 simulation years indicate a full pool in July with Alternative 1 but elevations 14 to 19 feet below full with Alternative 3. Recreation impacts in these situations can be

characterized as significant, but limited to selected types of activities.

See Section 4.10.10 for a discussion concerning visitation effects.

4.10.7 Kootenai River

The section of the Kootenai River below Libby Dam is an excellent rainbow trout stream. Fishing and other forms of river recreation on the Kootenai River are affected by operations at the Libby Project. Normal minimum discharge from the project into the Kootenai is 4,000 cfs, although the flow is sometimes reduced to 3,000 cfs. Discharges on weekends and holidays and on weekdays from 3 hours before sunrise to 1 hour after sunset are kept below 8,000 cfs when possible between May 1 and September 15 to benefit anglers (although boaters and canoeists prefer flows of between 8,000 and 12,000 cfs) by maintaining more stable flows to improve fishing in the river. However, local users have indicated to Corps personnel that large drops in flow from Friday evening to Saturday morning (reflecting the normal cycling of electric loads) will put fish off the bite for 24 hours or more. This often disrupts users' weekend fishing activity.

Small daily fluctuations in pool elevation occur at the Libby Project depending upon daily cycling of electric loads. The fluctuations result in small changes in flow into the Kootenai River, and are so slight that most recreationists would not notice them.

The Corps has identified a future objective of maintaining stable flows of between 8,000 and 12,000 cfs between May 31 and September 31 to benefit anglers, drift boaters, and other recreational boaters and canoeists. There is currently discussion between various agencies concerning the possibility of managing flows in the Kootenai River to assist the white sturgeon (see Section 4.3), but potential flows and their effects on recreation are not known at this time.

Significant releases from Libby to augment flows (Alternatives 2, 4, and 5) could occur in about 1 out of 5 years, and would occur during the spring. It is assumed that a typical scenario would be a release of approximately 16 kcfs into the Kootenai River. The 16 kcfs would be in addition to the normal minimum discharge of 4 kcfs, and would result in flows of 20 kcfs. The high flows would be greater than anglers, boaters, and canoeists prefer. By maintaining a relatively stable discharge level, the impacts to fishing associated with fluctuations could be avoided or diminished. However, high flows could still negatively affect angler success.

In addition to possible impacts to angler success, high flows could increase safety risks for river recreationists. However, the most significant safety concern is large, sudden fluctuations in discharge. Maintaining relatively stable flows would help minimize potential safety risks.

With Alternative 3, Libby would respond to the effects of flow improvement measures on the hydro system by shifting operating patterns in low-runoff years. In general, this would involve more generation and higher discharges in the spring, resulting in higher than normal Kootenai River flow. The effects of these shifts on river recreation would be very similar to those described above for flow augmentation from Libby.

4.10.8 Hungry Horse

Hungry Horse Reservoir has generally reached full pool elevation (3,560 feet) by early July and remained close to 3,560 feet through Labor Day. The pool is typically kept high enough during the summer so that all of the 11 boat ramps on the reservoir are usable through the majority of the recreation season. Use of recreational facilities is affected as the pool is lowered in the fall. At pool elevation 3540, 6 of the 11 ramps are not usable, and by elevation 3483 all ramps with the exception of the ramp at Abbot Bay are unusable (Ben-Zvi, 1990). As the pool elevation is lowered, the distance from campgrounds, picnic areas, and parking lots to the edge of the water increases.

The base condition refill pattern at Hungry Horse has involved refilling the pool through the spring to a median elevation of 3,552 feet by the end of June. By the end of July, the pool is usually full and remains so through the end of August. After Labor Day the pool is lowered to a median elevation of approximately 3,551.5 feet by the end of September.

Alternatives 2, 4, and 5 would result in the same pool elevations as Alternative 1 because the operation of Hungry Horse would be "fixed" in its normal pattern.

Alternative 3 would result in pool elevations lower than with Alternative 1 in 14 of 50 years, with potential negative effects to water-oriented recreation. Pool elevations would be as much as from 6 to 112 feet lower during the spring (April), and from 8 to 66 feet lower during the summer (July). In 4 of these 14 years, the reservoir would be full or nearly full in July with Alternative 1 and from 8 to 33 feet lower with Alternative 3. In these cases, the low summer pool elevations would eliminate activities such as swimming at developed beaches that require pool elevations near full pool. Access to the lake via several of the boat ramps would be restricted in two cases. In the 10 remaining low-runoff years, Alternative 3 would result in further elevation- decreases when Hungry Horse Reservoir would already be significantly below full. Alternative 3 would generally result in insignificant increases to seasonal limitations on recreational access and use caused by low runoff.

In contrast to the pattern in low-runoff years, the simulations indicate Alternative 3 would result in higher April elevations at Hungry Horse in 32 of the 50 years. Positive effects on recreation would likely occur in these cases, primarily in the form of earlier access to elevation-dependent recreation facilities.

See Section 4.10.10 for a discussion concerning visitation effects.

4.10.9 Flathead River

The mainstem of the Flathead River is fed by the Middle, North, and South Forks of the Flathead. Of the annual 7.1 MAF flow at Columbia Falls, approximately 2.6 MAF comes from South Fork runoff and Hungry Horse releases (Ben-Zvi, 1990). As a result, reservoir releases have a significant effect all year on water level, water temperature, and recreation on the mainstem of the Flathead. Current project operations reflect a minimum release of 145 cfs from Hungry Horse into the South Fork. Discharge objectives also include a minimum of 3,500 cfs in the section of the mainstem below its confluence with the South Fork.

Current operational practices restrict the maximum discharge from Hungry Horse between October 15 and December 15 to 4,500 cfs. Base condition median discharges from Hungry Horse have ranged from a high of 9,020 cfs in April to a low of 1,314 in August. Ben-Zvi determined that the majority (approximately 75 percent) of Flathead River recreational users surveyed considered strong flow rates to be unacceptable for recreation and preferred slower rates (Ben-Zvi, 1990). Most of the users who preferred slower rates were involved in fishing, boating, and swimming. Those who preferred somewhat stronger flows tended to be rafters. Ben-Zvi included that reservoir releases from Hungry Horse that increase flows above the 10,000 cfs range have an adverse effect on recreation on the river.

July (1,986 cfs) and August (1,314 cfs) are the months of lowest base condition releases from Hungry Horse, which has been beneficial to downstream summer recreational users and reservoir users alike. Because Alternatives 2, 4, and 5 would essentially replicate existing operations at Hungry Horse, releases from Hungry Horse into the Flathead in terms of timing and water quantity would not be expected to change. The HYSSR results for Alternative 3 indicate that Hungry Horse discharges to the South Fork Flathead River could vary considerably compared to Alternative 1. Average flows would generally be lower from January through April, corresponding to the pattern of higher reservoir elevations in 32 of the 50 years described in Section 4.10.7. These differences would likely have little or no effect on river recreation, which primarily occurs in the warmer months. During low-runoff years, however, Alternative 3 outflows would generally be higher in late spring, and into the summer in some cases. These flow increases would likely be considered adverse by anglers, swimmers and most boaters, but would likely be preferred by rafters.

4.10.10 Visitation Changes

Modeling Results for Storage Reservoirs

The SOR Recreation Pilot Models were executed to provide a preliminary estimate of the quantitative effect of SEIS alternatives on recreation visitation at the four major storage reservoirs—Grand

Coulee, Dworshak, Libby, and Hungry Horse. The models were developed by the SOR Recreation Work Group for the recently completed SOR screening analysis. Although these models are preliminary in nature, they serve as an adequate proxy for the recreation impacts that may be expected to occur under alternative Columbia River System operating policies. The detailed analytical framework of the models is presented in the Columbia River SOR Screening Analysis—Description and Conclusions (BPA et al., 1992).

In summary, the models estimate how changes in reservoir elevations affect four major recreational activities—boating, fishing, swimming, and camping/picnicking. Impacts are computed in terms of visitor-hours for each activity. The models were derived by specifying a simple mathematical relationship between reservoir drawdown and expected reductions in visitation from historical levels for each activity. These relationships are based on the degree to which physical access and visual values may be impaired. For example, lowering lake levels exposes mud flats, renders boat ramps unusable, limits shore access, and reduces overall lake aesthetics. Since the models are not true recreation demand functions, they are limited in that the effect of qualitative changes in site attributes (e.g., fishing success rates) or the availability of substitute recreation sites are not captured. Consequently, the visitor-hour estimates should be treated as approximate indicators of expected changes, rather than as an absolute measure of recreationists' behavioral or contingent valuation responses to changes in hydrologic conditions.

The models were varied around a range of high and low values to reflect the degree to which reductions in visitation at various pool elevations may be uncertain. Five representative water years ranging from low to high hydrologic conditions (1930 to 1931: dry (6 percent historical probability), 1939 to 1940: semi-dry (18 percent probability), 1937 to 1938: normal (50 percent probability), 1956 to 1957: semi-wet (18 percent probability), and 1955 to 1956: wet (8 percent probability) were used to execute the models. Table 4.10-3 presents the recreation model results for each SEIS alternative. The expected, 10 percent, and 90 percent probability values are reported for each storage reservoir in visitor-hours aggregated across all 4 activities.

When compared to the no-action alternative, the expected (median or 50 percent probability) values indicate that none of the alternatives would appear to adversely affect visitation at the major storage reservoirs. The effects at Grand Coulee and Hungry Horse reservoirs are negligible, with expected visitation estimated to be just slightly lower or similar to the base case under each alternative. At Dworshak Reservoir, aggregate expected visitation is estimated to increase slightly over the base case under Alternatives 2 and 3, while declining only approximately 3 percent under Alternatives 4 and 5. Negative effects at Libby are most pronounced under Alternative 3; however, visitation is estimated to decline only 3.5 percent in this instance. Given the construction of the recreation models, these results are essentially impacts that are averaged over the range of water conditions. Significant changes in reservoir elevations would be required to trigger significant increases or decreases in recreation use. These types of elevation differences are confined to the low-runoff years when flow augmentation would be required. Summer reservoir elevations at Libby with Alternative 3, for example, would only be affected in 10 years out of 50. Decreases in visitation during a low-runoff year would be greater, but the magnitude of these effects are masked in the overall model results by their low frequency.

As stated, the SOR recreation model results reflect the inherent variability in historical water conditions and the uncertainty in parameter values and visitation impact equations. The probabilistic values presented in Table 4.10-3 reflect this uncertainty. Therefore, the expected values and probability ranges provide only an estimate of the range in visitation effects (averaged over the 5 representative water years analyzed) as compared to the no-action alternative and should not be considered specific predictions of visitation. If extremely low runoff conditions, such as what occurred in 1992, were to persist or recur in a future year, the effects on visitation could be expected to be greater than what was calculated for the preferred plan of operation (Alternative 4).

Table 4.10-3. Recreation model results (visitor-hours).

Alternative	Probability Range	Dworshak	Grand Coulee	Libby	Hungry Horse
Alternative 1 No-Action	90%	677,994	5,710,280	626,735	1,063,699
	Expected value	523,419	5,373,419	542,985	814,911
	10%	402,537	4,955,396	488,570	641,157
Alternative 2	90%	644,799	5,690,709	626,735	Same as
	Expected value	530,945	5,364,585	542,985	Alternative 1
	10%	453,373	4,943,389	488,570	
Alternative 3	90%	644,799	5,683,739	624,163	1,083,349
	Expected value	528,226	5,360,719	524,048	820,627
	10%	447,685	4,943,389	470,683	641,157
Alternative 4	90%	622,322	5,690,709	626,735	1,063,699
	Expected value	507,018	5,364,585	541,293	814,918
	10%	431,194	4,943,389	470,174	641,157
Alternative 5	90%	622,067	5,690,709	626,735	1,063,699
	Expected value	506,960	5,365,782	542,980	815,814
	10%	431,168	4,943,389	488,570	641,157

The SOR recreation models also understate potential visitation changes due to the activity mix represented in the models. The models incorporate water-based activities for which relatively simple elevation relationships can be specified. Sightseeing is a water-oriented activity that is not easily amenable to this type of treatment, and therefore is not included in the models. Sightseeing is usually a significant activity at the affected projects; for example, it accounted for 17 percent of all use at Dworshak in 1990. In comparison, the four activities included in the model accounted for a collective 62 percent of all use at Dworshak in 1990. A hypothetical decrease of 30 percent in annual sightseeing use would therefore translate into a 5 percent decrease in total annual use.

Comparison with 1992 Conditions

Many reviewers of the draft SEIS took issue with the model-based analysis of potential visitation impacts, particularly with respect to Dworshak. They compared the draft SEIS "prediction" of a 3 percent loss for Alternative 4 with the much larger decrease in visitation actually experienced in 1992, and concluded that the model analysis was unrealistic and inaccurate. In view of these concerns, some clarification and further explanation of the original impact analysis and results is in order. This will be accomplished by reviewing conditions experienced in 1992 and prior recent years, and assessing the degree to which 1992 conditions may be indicative of expected future conditions.

Total recreation use reported for Dworshak for 1992, through September, was about 1,042,000 visitor hours. This was a 19 percent decrease from total visitation during the first nine months of 1991. Lowered pool levels at Dworshak undoubtedly had a significant impact in the form of decreased use. The reservoir reached a peak elevation for the year of 1,599 feet on May 13, then declined to 1,576 feet (24 feet below full) on June 15, 1,571 feet on July 15, and 1,561 feet (39 feet below full) at the end of August. Access to some of the Dworshak recreation facilities was therefore eliminated or restricted for all or most of the peak recreation season, and visitors experienced reduced aesthetic conditions due to exposed shoreline. For several reasons, however, visitation patterns during 1992 may not be representative of future conditions.

The inflow volume to Dworshak during the 1992 runoff season was the third lowest among 65 years of water record, representing approximately a 5 percent probability of occurrence in any given year. If the interim flow improvements are in place for 5 years, the likelihood that water conditions like those of 1992 will be repeated is quite low. Moreover, the effect of low runoff on Dworshak elevations in 1992 was exacerbated by error in the runoff forecast; 1992 flow improvements were initiated based on a runoff volume forecast for the April to July period of 1.6 MAF, but the actual volume was 1.3 MAF. While forecast error is common and unavoidable, it can as easily occur as underestimation as overestimation. A lower (underestimated) forecast in the spring of 1992 might have resulted in somewhat higher reservoir elevations through the spring and summer.

Visitation at Dworshak during much of 1992 was also reduced by facility damage at the Big Eddy marina, the largest boating facility at the reservoir. A windstorm in late June severely damaged moorage facilities at the marina, causing the concessionaire to remove the docks and close down the operation for the season. This event eliminated one of the most popular recreation facilities on the reservoir at a time when reservoir elevations, although significantly lower than normal, would otherwise have permitted use of the Big Eddy marina. Some use that would have occurred at Big Eddy was probably shifted to other sites at the project (boaters who would normally moor at Big Eddy could still trailer their boats to ramps on the reservoir), and still recorded in the visitation totals for the year. Overall, however, disruption of the Big Eddy operation represents a major confounding factor that prevents a clear assessment of the net contribution of lower reservoir levels to the decrease in recreation use in 1992.

Recreation use patterns are also affected by several other kinds of external factors, such as prevailing economic conditions and variability in weather conditions. For example, the national and regional economic recession that extended well into 1992 may well have dampened demand for recreation in 1992 at Dworshak and elsewhere around the region. It is not possible to identify all of the factors that may have affected Dworshak visitation in 1992 or the magnitude of their respective contributions. Again, reservoir levels may well have been the most significant factor. Nevertheless, the existence of other known and probable determining factors clearly indicates that it is an oversimplification to attribute the entire 1992 decrease in use to flow augmentation and lowered pool levels.

Additional perspective on this issue can be obtained by reviewing monthly visitation data over a period of years. Figure 4.10-1 is a graphical presentation of total visits to Dworshak by month for 1988 through October 1992. The graphed data clearly show a sharp decrease from 1991 to 1992 for July and August. July visits dropped from 50,500 in 1991 to 34,600 in 1992, a decrease of 31 percent. August visits declined from 46,500 in 1991 to 29,600 in 1992, a loss of 36 percent. September visits also decreased significantly.

However, the graph also indicates that May and June 1992 visits were significantly higher than the same period in 1991. This suggests that some Dworshak visitors may have shifted activity earlier in the season, either in anticipation of lower pool levels later in summer or because high pool levels in April and May made early-season fishing particularly good (see Section 4.3). Due to the reversed pattern for May and June, total January to October visits in 1992 were only 14 percent lower than in the corresponding period of 1991. (As reported previously, total visitor hours decreased by 19 percent.) The disproportionate decrease in visitor hours indicates that the average time spent per visit decreased in 1992. This could be

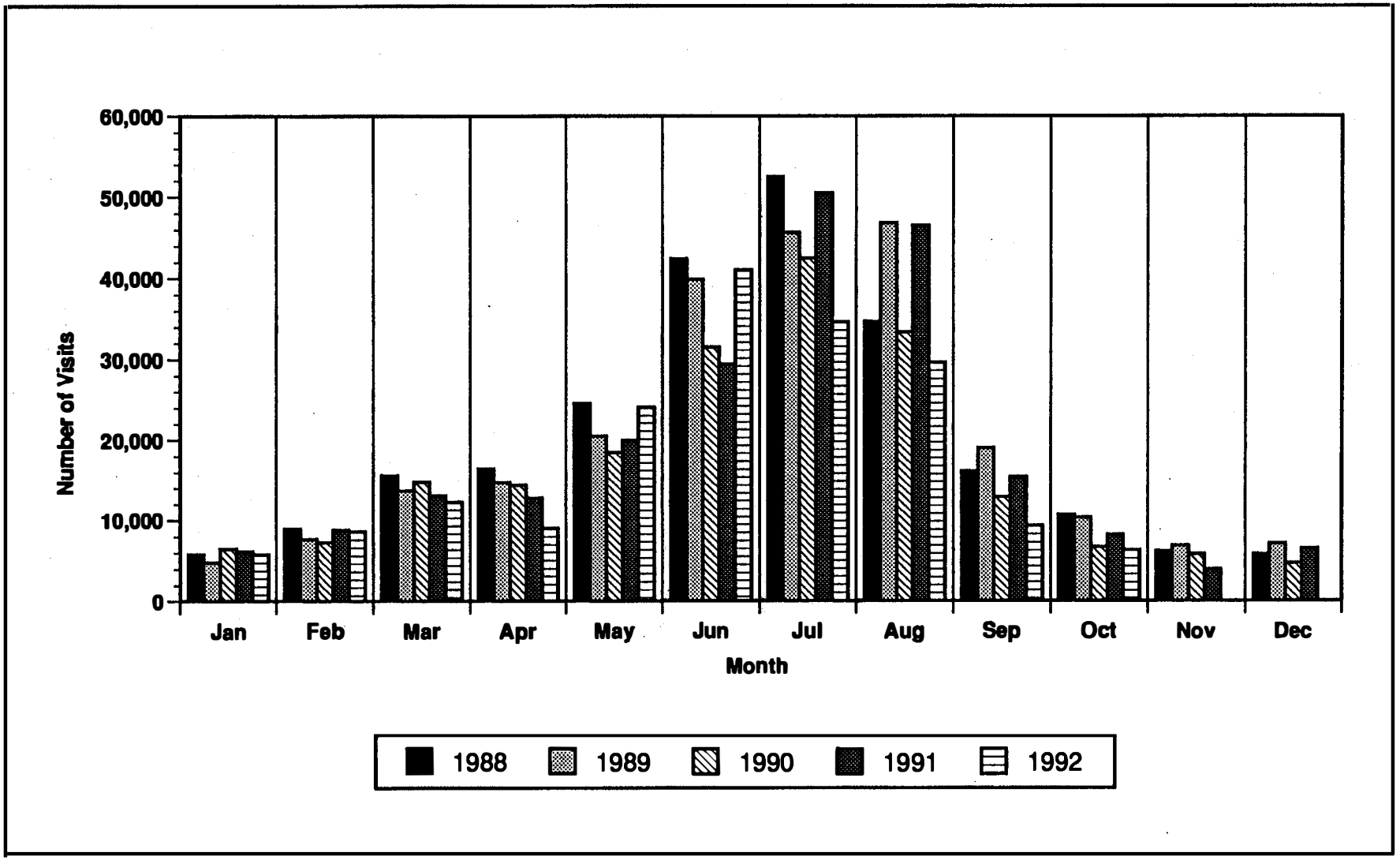


Figure 4.10-1. Dworshak recreation visits by month, 1988 to 1992.

explained by a shift in the activity mix, with relatively fewer overnight visits compared to day use.

A second key aspect of Figure 4.10-1 is that it illustrates that there is normally significant year-to-year variability in monthly visits, particularly in the summer. August visits fluctuated by about 25 to 40 percent from the prior year in each case, and the 1992 figure was only slightly less than August 1988 or 1990 visits. Large year-to-year changes prior to 1992 also occurred with June and July visits. This observation is not intended to explain away or obscure the obvious contribution of lower pool levels to lower visitation in 1992. However, it is indicative of causal factors other than pool levels that affect visitation, and supports the position that all of the decrease for 1992 should not be attributed to the flow augmentation operation.

4.10.11 Mitigation

Recreational facilities at the John Day Project would be somewhat affected at a pool elevation of 262.5, and less so at an elevation of 263.5. Boat ramps would be potentially damaged (or would be further damaged) by wind-driven waves. To protect sites from wake action and to make the ramps fully usable, the ramps at Crow Butte State Park, Quesnel Park, Roosevelt Park, and Sundale Park could be extended to provide a minimum of 3 feet of water depth at the toe of the ramp. Additional protection of banks adjacent to the ramps might also be desirable. However, it is not standard practice to implement long-term construction measures to mitigate for interim actions. Therefore, construction items such as extension of boat ramps are being addressed through the appropriate long-term studies (i.e., SOR and SCS).

Most of the negative effects to recreational facilities at the lower Snake River reservoirs could be mitigated. Approximately half of the 26 boat ramps would need to be lengthened or dredged to remain fully functional and 4 swimming beaches would require some modifications to be operable near MOP. Dredging might also be required to keep several marinas functional. Again, the need and feasibility of these measures will be addressed in the long-term studies.

The recreational facilities at Dworshak that would be most affected by potential lower pool levels in summer would be the swimming beaches and mini-camps; simulated reservoir elevations for the alternative actions indicate that boat ramps would remain usable in late summer. The swimming beaches are operable over a narrow range of elevations, generally within 5 feet of the full pool. Extending the range of these facilities to be operable with potential conditions under Alternative 4, which could be about 8 to 23 feet lower than normal during the summer would not be very practical or cost-effective. It is possible that a reasonable degree of mini-camp accessibility could be maintained by constructing hardened access paths to some of the sites, but the feasibility of this measure has not been determined. Aside from potential physical actions, public comments on the draft SEIS from the Dworshak area suggested that improved public information would help to alleviate some adverse recreation impacts.

No significant impacts to recreational facilities or use are projected at Brownlee or Grand Coulee. Therefore, no potential mitigation measures for those projects are identified.

While consideration of structural modifications to recreational facilities is being deferred to long-term studies, some effective shorter-term measures could be incorporated into project operations and maintenance. For example, warning signs could be temporarily installed at boat ramps where low pool levels would make launching difficult or impractical. Public information efforts specific to the flow augmentation actions would help to give the public up-to-date, accurate information on reservoir elevations relative to recreation. Education measures would be particularly helpful where public perception might tend to exaggerate adverse effects on recreation.

In general, the temporary nature of the interim operations will be an obstacle to the development of mitigation measures. Given the realities of the Federal budgeting process, it would be difficult to secure funding to mitigate for actions that would be in effect for an uncertain, and likely relatively short period.

4.11 AESTHETICS

Alternative	Potential Impacts (Positive/Adverse)
1. Without-Project Conditions (No Action)	
John Day	• Minimal impacts from pool elevations within normal operating range.
Snake River	• Minimal impacts from pool elevations within normal operating range.
Storage Reservoirs	• Significant reservoir fluctuation with greatest impacts in late winter, early spring. Low pool elevations expose tree stumps, rocks, shoreline, and lake bottom. Negative impacts increased as pool lowered and contrast with hillsides is greater.
	• Typical annual drafts at each project are:
	Dworshak 100 feet Brownlee 40 feet Grand Coulee 30 - 80 feet Libby 120 feet Hungry Horse 70 - 90 feet
1992 Operations	
John Day	• Exposed reservoir bottom in shallow areas in some places. • Indirect aesthetic impacts through effects of low pool elevation on project wetlands.
Snake River	• Increased duration of exposure of shoreline area, within normal limits. • Limited adverse effects on wetlands.
Dworshak	• Median summer elevations 1 to 8 feet below base condition, insignificant incremental aesthetic effects, primarily from exposing additional shoreline and lake bottom. • No effects on Clearwater River.
Brownlee	• Drafts up to 8 feet in July and September would refill quickly, aesthetic effects insignificant.
Grand Coulee	• Minimal change in median elevations. Incremental increase in seasonal drafts in some years with minor additional shoreline exposure.

Alternative	Potential Impacts (Positive/Adverse)
1992 Operations (continued)	
Libby	• Minor positive impacts from reduced winter-spring drafts in flow augmentation years.
Hungry Horse	• Same as Alternative 1.
3. 1992 Operations with Libby/ Hungry Horse Sensitivity	
John Day, Snake River	• Same as Alternative 2.
Dworshak, Brownlee, Grand Coulee	• Same as Alternative 2.
Libby, Hungry Horse	• Increased drafts and impacts in winter-spring in flow augmentation years. Lower pool levels, adverse effects, in summer season 1 in 4 to 5 years.
4. Modified 1992 Operations	
John Day, Snake River	• Same as Alternative 2.
Dworshak	• Median pool elevations 9 feet lower in July and 20 feet lower in August, compared to base case, with additional aesthetic impacts from increased shoreline exposure.
Brownlee, Grand Coulee, Libby, Hungry Horse	• Same as Alternative 2.
5. Modified 1992 Operations with Upper Snake Sensitivity	• Sames as Alternative 4.

4.11.1 Factors of Visual Change

Shoreline Contrast

As explained in the 1992 OA/EIS, changes in drawdown patterns associated with flow augmentation have the greatest aesthetic impacts in areas where: (1) the greatest amount of shoreline is exposed; (2) the greatest color and textural contrast (from mud, sand, rocks, exposed stumps, logs, etc.) between shoreline and adjacent uplands occurs; and (3) significant numbers of people can view the affected shoreline. The potential for these changes is greatest at storage reservoirs, due to the significant drafting that occurs with the normal operating pattern. The greater the vertical and horizontal distances are between the high-water level and the current reservoir level, the greater the shoreline contrast tends to be.

By maintaining reservoirs at lower elevations for longer than they are currently maintained, the chances increase that erosion and slumping could occur. These types of scars often create additional shoreline contrast. Bottom debris such as rocks, tree stumps, and logs that might normally be

hidden by early seasonal filling of the reservoirs could remain visible to viewers for a longer period of time if the refilling of pools were delayed or the elevation of refill reduced. Grasses and emergent plants could encroach onto the exposed shorelines of some areas if pool levels remained low for sufficient amounts of time (see Section 4.4.3).

Seep Lakes

Seep lakes and embayments most frequently occur along mainstem Columbia-Snake River projects. Seep lakes are physically separated from the reservoirs by railroad and highway embankments. Embayments are connected to the reservoirs by open channels. Because both are connected to reservoirs hydrologically, without water replenishment they could be reduced in size. Operation at lower pool levels could have several long-term effects. Wetlands associated with seep lakes and embayments, frequently viewed from adjacent highways and railroads, could be affected by lower water levels. In addition to possible wetland deterioration, lowering the water level of seep lakes could expose bottom material and debris on the bottom of the seep lakes and embayments that might normally be hidden by water. Lowered pool levels could reduce water quality.

Facility Impacts

Changes in elevation patterns can have significant aesthetic effects on waterside facilities such as marinas, docks, boat ramps, beaches, and swimming areas. Viewers might find that facilities such as picnic areas and campgrounds are less aesthetically appealing if they are adjacent to dewatered reservoir areas. As a result of normal drafting at storage reservoirs, picnic and camping facilities might be located as far as several hundred feet away from the water and over a hundred feet above it. Low pool elevations can also affect the ability to irrigate vegetation, particularly lawn areas found at recreation facilities, and in the long-term could result in the alteration or abandonment of the waterside facilities mentioned above. The degree of aesthetic impacts resulting from the alteration of facilities would vary from site to site. At sites that would not be able to sufficiently meet the water requirements of the vegetation, the long-term effects on the vegetation would be aesthetically negative if plants died or declined.

Water Characteristics

As discussed in the 1992 OA/EIS, there are several changes in water characteristics that result from changes in system operations. The most obvious change would be the reduced water area as a reservoir is lowered and reduced in size. If reservoirs are lowered for longer periods and at different times than they have been traditionally, viewers at the reservoirs would experience less water than in the past. Most of the normal water area would be replaced by exposed lake bottom. In the upper reaches of the reservoirs, the reduced pools would result in reduced or eliminated slackwater and the reestablishment of rivers and streams that had been inundated by the pool. A reduction in pool elevation would be accompanied by an increase in water turbidity, which would cause a decrease in clarity and a change in color.

Dust and Odors

Fine reservoir bottom sediments exposed by drafting could result in an increase in wind-blown dust. The increase in dust could affect recreationists and nearby residents depending on wind direction, intensity, and dust particle composition (see Section 4.6). Actions that would draft reservoirs for the longest periods and expose the greatest amount of shoreline and lake bottom would have the greatest potential for increasing dust. Odors could potentially be detected in areas where organic materials were exposed. Odor impacts would depend on amount and type of organic material exposed, wind direction, proximity to areas frequented by people, and sensitivity of people to odors.

4.11.2 Aesthetic Effects by Project Area

John Day/Lower Columbia

The aesthetic effects of operating the John Day Project at elevation 262.5 or 263.5 during late spring and summer would not be great in terms of impacts to waterside facilities. The primary aesthetic issue at John Day would be the potential impacts to wetlands at the Umatilla National Wildlife refuge, some riparian habitats, and local HMUs as a result of an extended period of low pool elevation during the spring and summer (see

Section 4.4.2). If exposed embayments and dewatered wetlands were visible from the pool, adjacent towns, residences, and Interstate Highway 84 or State Highway 14, the aesthetic quality of the project area would be diminished for some viewers. The lowering pool levels would have the greatest aesthetic effects on embayments and wetlands at the Willow Creek, Paterson Slough, and McCormak Slough that would have open water habitat reduced in area, and possibly a change in wetland plant communities.

Most of the Lake Umatilla recreational facilities would be fully functional, so the negative aesthetic effect of unused facilities would not be great. Irrigation of the vegetation at all recreation facilities would be possible, so there would be little if any negative impacts associated with vegetation impacts. Shallow areas might be exposed from the lowered pool elevation, but the aesthetic impacts would not be expected to be great.

Lower Snake River

The current operating ranges for the Snake River projects are not great and the aesthetic effects as a result of operations are not significant. Shallow areas may be exposed at lower pool elevations, but pool elevations do not usually remain low for long.

In general, the aesthetic effects resulting from operating the four Snake River projects at MOP would not be significant. Shallow areas on some pools might be exposed from lowering reservoirs to MOP, but the aesthetic impacts are not expected to be great due to the small change in elevation compared to normal conditions. Moreover, areas that would be exposed are currently visible on a periodic basis. Consequently, travellers, recreationists, and residents living near these reservoirs would not be viewing unusual conditions or features with sharp visual contrast.

Dworshak

The current annual reservoir fluctuation at Dworshak averages about 100 feet, creating a significant visual effect that typically occurs in late winter and early spring. Pool elevations with Alternatives 2 and 3 would be from approximately 1 to 8 feet below average from June through August, and would occur primarily during the summer, when the number of potential viewers would be highest. August would be the summer month that would have the greatest (8 feet lower) difference between median pool elevation in the without project condition and median elevations with Alternatives 2 and 3. The difference in elevation would expose some of the reservoir bottom and some constructed facilities, such as swimming beaches. This physical effect would be minor compared to the deep winter-spring drafts that normally occur, and should not constitute a significant adverse change in relative terms. However, it would be noticeable to summer recreationists, and may detract slightly from their experience.

Alternatives 4 and 5 would have greater negative aesthetic effects than Alternatives 2 and 3. The normal end of June Pool elevation for Alternatives 4 and 5 would be approximately 1 foot lower than existing conditions. By the end of July, the pool elevation would be approximately 9 feet lower than the normal condition and by the end of August, the pool elevation would be approximately 20 feet lower. The primary negative aesthetic effects from Alternatives 4 and 5, particularly at the end of August, would include less slackwater lake surface area, a greater amount of shoreline and lake bottom exposed, and recreational facilities located farther from the water's edge than in Alternatives 2 and 3. Other negative effects would include the dewatering and stranding of some recreational facilities and nonusability of others. These physical effects would be considerably more noticeable than conditions with Alternative 2, and would detract from the summer recreation experience.

Dry years would increase the negative effects for all alternatives, particularly for Alternatives 4 and 5.

Brownlee

Alternatives 2 through 5 involve July and September drafts of up to approximately 8 feet, as described in the NPPC Phase II Amendments, as long as the pool elevations remain at 2,067 feet in July. There are no elevation constraints in September. The July release would occur during the primary recreation season but recreational facilities would not be greatly affected and refill would be rapid. The alternative actions would have

a moderately negative aesthetic effect because pool elevations could be lowered 8 to 10 feet at a time of the year when the pool elevations have historically been high, usually within 8 feet of full pool. The July draft would be observed by more people because it would occur during the middle of summer. The 8-foot draft in September would be viewed by less people because visitation at Brownlee historically decreases significantly by the end of September.

Grand Coulee/Lake Roosevelt

Drafts at Grand Coulee have historically ranged from 30 to 82 feet. By the end of July the pool is frequently full (elevation 1290) and typically remains within 2 feet of full pool through the end of September. The aesthetic effects of lowered pools are not great during the busy summer season of most years. Because most of the actions for most years would be within 2 feet of historical pool elevations, most of the actions would not create additional aesthetic effects at the project and most viewers would not notice a change in pool level or aesthetic quality. Increased drafts due to the proposed actions would occur in some years, but aesthetic effects would be limited because these would occur primarily in winter or spring.

Libby/Kootenai River

Flow augmentation at significant volumes would occur at Libby approximately 1 in 5 years. During those years, winter-spring pool elevations would be higher than normal. As a result, visual effects resulting from typical deep drafts would be less than normal in the spring (although snow covers many of the visual effects associated with low pool elevations). Summer pool elevations would be expected to be near normal during augmentation years, so no additional visual impacts would be expected. Spring releases into the Kootenai River would typically be increased from a normal 4 kcfs to about 20 kcfs. The increase would result in a more active and powerful river, which would likely enhance viewer interest.

Libby operations as modeled for Alternative 3 would result in deeper winter-spring drafts in 18 out of 50 years, with summer elevations remaining below normal in 10 years. In both cases, the effect of Alternative 3 would typically be to add incrementally to the adverse appearance of an already lowered pool. In 3 of 50 years, however, Alternative 3 would result in July elevation decreases of 14 to 19 feet when the reservoir would otherwise be full. These conditions would be noticeable to summer visitors, but would not cause the degree of shoreline exposure that would be considered a major visual impact.

Hungry Horse/Flathead River

Hungry Horse reservoir elevation patterns varied considerably from existing conditions in the sensitivity analysis modeled as Alternative 3. Compared to Alternative 1, April elevations would be up to 37 feet higher in 32 of the 50 water years. Adverse effects of the typical annual drafts would be reduced under those water conditions. However, April elevations would be lower in 16 of 50 years, by margins of 6 to 112 feet. The adverse visual impacts of the typical drafts would be amplified in these cases. Moreover, lower elevations would persist through July in 10 of these years, creating moderate to significant visual impacts during the summer recreation season.

Releases into the Flathead River would generally remain within historical ranges, so there would be little or no change in overall aesthetic qualities based on flows expected.

4.12 CULTURAL RESOURCES

Alternative	Potential Impacts (Positive/Adverse)
1. **Without-Project Conditions (No Action)**	• Adverse impacts from erosion, scouring, wet/dry cycles, slumping, vandalism, recreation, vehicular traffic, unchanged from present conditions.
2. **1992 Operations**	• Little change from no action alternative except for John Day, where holding the pool at lower elevation would expose a larger area to adverse impacts for a longer period of time.
3. **1992 Operations with Libby/ Hungry Horse Sensitivity**	• Same as Alternative 2 for lower Snake and John Day projects. • Minor incremental impacts to Libby and Hungry Horse from somewhat deeper drafts in dry years; minimal change in most years.
4. **Modified 1992 Operations**	• Similar to Alternative 2.
5. **Modified 1992 Operations with Upper Snake Sensitivity**	• Similar to Alternative 2.

4.12.1 Lower Columbia River

Under the no action alternative, sites at all of the study area projects would continue to be adversely affected, as they were during the baseline years of 1985 to 1990, by both natural and human activities. Natural activities include erosion, scouring, wet/dry cycles, and slumping. Human activities include vandalism, recreation, and vehicular traffic, etc.

There would be little change from the baseline level of impact under Alternative 2 and variations on that alternative except for John Day. Holding the John Day Pool at a lower elevation would result in a larger total site area being exposed to adverse impacts for a longer period.

4.12.2 Lower Snake River

Under the no action alternative, sites at all of the study area projects would continue to be adversely affected, as they were during the baseline years of 1985 to 1990, by both natural and human activities. Natural activities include erosion, scouring, wet/dry cycles, slumping, etc. Human activities include vandalism, recreation, vehicular traffic, etc.

Holding reservoirs to lower pool elevations under the 1992 operations and its variations would result in a larger total site area being exposed to adverse impacts for a longer period. Pulsing would increase erosional impacts to sites.

4.12.3 Dworshak and Brownlee

Under the no action alternative, sites at all of the study area projects would continue to be adversely

affected, as they were during the baseline years of 1985 to 1990, by both natural and human activities. Natural activities include erosion, scouring, wet/dry cycles, slumping, etc. Human activities include vandalism, recreation, vehicular traffic, etc.

Holding reservoirs to lower pool elevations under Alternative 2 and its variations would result in a larger total site area being exposed to adverse impacts for a longer period of time.

4.12.4 Grand Coulee

The components of Alternatives 2 through 5 could involve Grand Coulee Dam in some years to accommodate the flood shift or to augment flows. However, since the operation associated with the flow augmentation would never draft below 1,220.2 feet (12.2 feet above the historic springtime minimum operational elevation for Grand Coulee), it is anticipated that little or no additional effect would occur to cultural resources as a result of these modified operations. Existing impacts associated with the normal spring drawdown for flood and power operations (erosion, vandalism, recreational use, and off-road vehicle operation) would continue, but are not attributable to the proposed actions. The impacts from these normal operations are being addressed by BoR and BPA under other programs. These programs, to be implemented under a Memorandum of Agreement signed on October 27, 1991, will result in a reservoir-wide site inventory followed by site evaluation, excavation, or stabilization in accordance with a site management plan that will be approved by the Colville Confederated Tribes, the Spokane Tribe of Indians, the Washington State Historic Preservation Office (SHPO), and the Advisory Council on Historic Preservation. BoR will also continue the annual spring monitoring of sites that contain human burials. The only anticipated potential impact upon cultural resources at Lake Roosevelt from the modified operations to augment flows would occur when the reservoir was drafted earlier than normal to ensure room for the Dworshak flood control shift. Then, an incremental increase in ongoing effects could occur because of prolonged access to the sites by vandals or recreators, or from prolonged exposure to wind erosion.

4.12.5 Libby

Alternative 3 would result in additional draft in low flow years during most months. Increased drafts especially during the late spring, summer, and early fall would expose cultural resources to human access resulting in increased vandalism.

Other impacts, though probably not significant, would accrue from increased erosion of the exposed shorelines.

4.12.6 Hungry Horse

Alternative 3 would result in additional draft in low-flow years during most months. Increased drafts especially during the late spring, summer, and early fall would expose cultural resources to human access resulting in increased vandalism. Other impacts, though probably not significant, would accrue from increased erosion of the exposed shorelines.

4.12.7 Cultural Resources Evaluation

Proposed cultural resources actions will be coordinated with the State Historic Preservation Offices of Washington, Oregon, Idaho, and Montana, if necessary, along with the Advisory Council on Historic Preservation, appropriate Native American tribes, and other interested agencies and parties. Key components of the evaluation process will be the preparation of a comprehensive overview of all identified cultural resource sites located within the project area and development of a monitoring program for assessing project impacts to sites. This information will be used, in turn, to develop long-range management plans and strategies for project sites.

4.12.8 Mitigation

Mitigation requirements for project impacts to cultural resources may range from archival of field documentation to detailed data recovery and site stabilization preservation plans. Potential vandalism of sites might be prevented by use of additional enforcement. There would be no constraint on when these actions could begin.

4.13 SOCIOECONOMICS

Alternative	Potential Impacts (Positive/Adverse)
1. Without-Project Conditions (No Action)	• Normal use of project reservoirs for navigation, irrigation pumping, log transport (Dworshak only), power generation, recreation, and municipal and industrial water supply, among other uses.
2. 1992 Operations	• No increase in operating costs for navigation, irrigation, log transport, and water supply. • No identifiable employment and income effects from lost power generation. • Minimal change in expected recreation visits and associated employment and income effects, based on median conditions. Potential for larger visitation and economic effects in low-runoff years.
3. 1992 Operations with Libby/ Hungry Horse Sensitivity	• Same as Alternative 2 for John Day, lower Snake, Dworshak, Grand Coulee, and Brownlee. • Potential for minor recreation-related economic effects at Libby and Hungry Horse. Net value of displaced recreation expected at about $6,000, based on median conditions. Potential for larger visitation and economic effects in low-runoff years.
4. Modified 1992 Operations	• Nearly the same as Alternative 2, with potential displaced recreation valued at about $8,000, based on median conditions. Potential for larger visitation and economic effects in low-runoff years. • Uncertain, but greater potential for revenue decreases for recreation-related businesses
5. Modified 1992 Operations with Upper Snake Sensitivity	• Essentially the same as Alternative 4.

The potential socioeconomic impacts of the proposed actions were evaluated to determine whether the various river interests within the study area would be affected. Those interests of particular concern include transportation (navigation and log rafting), agriculture, recreation, water supply, and Native American fishing rights. The potential lowering of pools and flow augmentation measures would affect certain communities within the study area by somewhat reducing recreation activity; however, adverse impacts to navigation, log rafting, and irrigation would be minimal. The expected impacts and the related effects on employment are discussed in the following paragraphs.

4.13.1 Employment and Related Effects

Potential employment and related economic effects are presented below for each resource. These assessments are based on results derived in the corresponding resource sections of the SEIS. The total impacts presented in the following paragraphs include both direct and indirect impacts. Direct impacts include employment, income, and production impacts associated with the affected industries in the study area. Indirect impacts occur as the direct impacts filter throughout related industries and the rest of the regional economy.

Transportation

Navigation. No significant quantifiable impacts to navigation within the study area would occur as a result of any of the alternatives under consideration. Because water levels would be maintained at MOP or higher throughout the system under each alternative, barge transportation would not be impeded. There are a few port facilities, however, that are experiencing loading restriction at MOP. Dredging activities at these facilities, which include two grain elevators at Almota, would apparently be required for operations to continue without loss at MOP.

In addition, navigation interests are concerned about the possibility of future annual dredging that may be required as a result of the increased velocity of the flow augmentation program. There is also concern about the safety of tug and barge navigation in faster waters, particularly in the vicinity of Ice Harbor.

Log Rafting. Potential impacts to the logging industry would be localized primarily in the region surrounding the Dworshak Project. Significant drawdowns at this site have the potential to restrict log rafting, which would require timber companies to convert to truck or rail to continue transporting timber. Log rafting, which occurs from mid-May through early September, is significantly less expensive than transportation by truck—according to Potlatch, rafting costs approximately $17.98 per thousand board feet less than trucking (see Section 4.7).

Under Alternatives 2 and 4 (which include flow augmentation at Dworshak), month-end reservoir levels during June, July, and August would be greater than 1,589 and 1,577 in normal years and 1,590 and 1,578 in dry years, respectively. Because the 2 main rafting dumps used by Potlatch have been extended to operate to elevation 1565, the impacts to log rafting would be insignificant during both normal and dry years. Because the alternative reservoir levels during June, July, and August are higher than the log dump elevation, no significant impacts to timber transport are anticipated. During May and September, however, log dump usage is generally constrained even under normal conditions. Potential impacts under Alternative 2 during these 2 months would not be significantly different from the no action alternative. Since virtually all of the rafting occurs in July, July, and August (approximately 90 percent), no adverse impacts to log rafting are expected.

Agriculture

Irrigation would not be directly affected under any of the alternatives under consideration. The John Day Pool, which experiences problems with irrigation intakes near MOP, would be operated at minimum irrigation pool or higher. Other pools do not experience a problem with water intakes at MOP. However, production costs might be increased slightly because of higher head and increased electricity costs. No significant adverse impacts to agriculture are expected.

Recreation

Recreational visitors using reservoirs engage in a number of activities including boating, fishing, swimming, sightseeing, camping and other uses, with most visitors participating in multiple activities. An unknown but presumably significant number of recreation-related jobs in the retail and services industries within the study area are supported by recreation activity occurring at project reservoirs. Reduced or discontinued use of facilities because of changed water levels could directly and indirectly affect employment. Direct employment impacts would occur at concessions and marinas located on the pools, campsites, and other private businesses directly adjacent to the pools. Indirect employment effects could occur at

lodging, restaurants, and other service establishments that depend partially on recreational users for business.

The proposed flow augmentation alternatives could affect recreation use by decreasing the pool elevation, therefore decreasing the quality of the recreation experience. Users could respond to these changes in one of three ways: by discontinuing their recreation participation altogether, by shifting to another recreational activity at the same site that is less affected by elevation changes, or by shifting their recreation use to another site. The first option would result in a net loss of recreation value to the region, while the second and third options contain some substitution effect that would offset direct pool level-related losses. Without an accurate assessment of how users would respond to pool elevation changes, a complete assessment of net economic impacts cannot be determined. As part of the SOR study, the Recreation and Economics Work Groups are studying these substitution effects. The SOR effort will include a survey of recreation users from throughout the region to estimate the impact of alternative reservoir operation strategies on recreation participation along the Columbia River and tributaries and to determine the economic values of those changes.

As shown in Section 4.10, the change in recreation use over the range of representative water conditions is expected to be small for all alternatives at all the reservoirs. Dworshak is the only reservoir expected to be adversely affected by Alternative 4. Modeling results indicate that there would be no adverse net economic impacts to recreation at any other project-related recreation sites within the study area.

Given the construction of the recreation models, these results are essentially impacts that are averaged over the range of water conditions. Decreases in visitation during a low-runoff year would likely be greater than the percentages indicated in Section 4.10.

Net Economic Impacts

To estimate potential lost recreation benefits, the economic value of a recreation day was assumed to be $7 per activity day. This value is based on the Water Resource Council's "Principles and Guidelines" (as price level adjusted as reflected in the Corps' Economic Guidance Memo 93-1) determination of general recreation unit-day value of $2.30 to $6.92 in 1993. The maximum figure of $6.92 has been rounded to $7 for convenience.

Estimated losses in recreation visitation and benefits for Alternatives 2 through 5 are presented in Table 4.13-1. Under Alternative 2, there would be an expected loss of 55 visitor-days and $385 in recreation value. (See Section 4.10.10 for interpretation of the 10 percent, 90 percent, and expected value results.) Under Alternative 3, the expected loss would be 880 visitor-days and $6,160 in recreation value. Alternative 4 could result in a loss of 1,122 visitor-days and $7,854 in recreation value. Expected Alternative 5 losses would be 967 visitor-days and $6,769 in value.

Review comments on the draft SEIS indicated widespread skepticism over the derivation and application of these recreation value figures. The original $5 per activity day was considered by some commentors to be an inadequately low unit day value. There was more widespread objection to the estimates of aggregate recreation losses (on the order of $5,000 or less) that resulted from multiplying the visitation changes by the unit day value.

The Water Resource Council's unit day values are intended as measures of marginal changes in recreational value attributable to a project area, and not as measures of the total value of a day of recreation use. That is why the unit day value used in the SEIS is considerably less than many daily willingness-to-pay values reported in numerous sources, including the 1992 OA/EIS. While the Water Resource Council figure is considered to be the most appropriate value for the marginal changes at issue, the maximum value in the range has been applied in the final SEIS and a higher figure has been used in the sensitivity portion of the cost-effectiveness analysis (see Section 5.2.2).

The aggregate value losses are based on simple multiplication of the unit-day values and the estimated visitation losses. The unit-day value applied in the SEIS is consistent with policy direction to Federal agencies for net economic impact analysis. The visitation losses are the

Table 4.13-1. Dworshak visitation and net value impacts based on recreation model results.

Alternatives	Probability Range	Total Visitor Hours	Total Visitor Days	Change from Alternative 1 (Visitor Days)	Net Value of Visitation Change[a/]
1	90%	8,078,708	336,613	0	$0
	Expected Value	7,254,734	302,281	0	$0
	10%	6,487,660	270,319	0	$0
2	90%	8,025,942	334,414	-2,199	
	Expected Value	7,253,426	302,226	-55	-$15,393
	10%	6,526,489	271,937	1,618	-$385
					$11,326
3	90%	8,036,050	334,835	-1,777	
	Expected Value	7,233,620	301,401	-880	-$12,439
	10%	6,502,914	270,955	636	-$6,160
					$4,452
4	90%	8,003,465	333,478	-3,135	
	Expected Value	7,227,814	301,159	-1,122	-$21,946
	10%	6,485,914	270,246	-73	-$7,854
					$511
5	90%	8,003,210	333,467	-3,146	-
	Expected Value	7,231,536	301,314	-967	-$22,022
	10%	6,504,284	271,012	693	-$6,769
					$4,851

a/ Calculated by multiplying change in visitor days by marginal unit day value of $7. See text for derivation and definition of unit value.

expected value figures derived from the recreation models. As indicated previously, the visitation model results are averaged over the five representative water conditions. Aggregate value losses would be considerably larger, in relative terms, in low-runoff years.

Regional Economic Impacts

The estimates of aggregate recreation losses shown in Table 4.13-1 represent marginal changes in value summed over all recreationists who would reduce their participation, and apply only to their individual losses of value. However, these figures were commonly misinterpreted as estimates of projected revenue losses to recreation-dependent businesses. Such revenue losses are determined by the magnitude of shifts in visitation and recreationists' gross expenditure levels. This subject was discussed in detail in the 1992 OA/EIS, which assumed an average gross expenditure of $27 per person per day. Applying this rate to the visitation changes shown in Table 4.13-1 results in a maximum loss of about $30,000 in recreation-related expenditures, which applies to Alternative 4. Again, this calculation is based on the expected (median) visitation values from the recreation models, which are averaged over the five representative water conditions. Expenditure or revenue losses would be considerably larger in low-runoff years, by an indeterminate amount. Revenue losses under these conditions might approach what business interests in the Dworshak area experienced during 1992, and reported

thoroughly in their comments on the draft SEIS (see Letter A21 in Appendix H.)

Potential revenue and employment losses that local businesses might experience as a result of changes in recreation use are difficult to estimate. As discussed in Section 4.10, the visitation and business activity losses experienced around Dworshak in 1992 are not indicative of typical conditions with the proposed actions. Nevertheless, a review of this information provides some perspective on the types of local socioeconomic impacts that might occur.

In the summer of 1992, recreation facilities at or near Dworshak had fewer visitors. The Orofino Chamber of Commerce stated that Dworshak State Park saw its 1992 revenues fall by 20 percent and camping usage reduced by 25 percent from 1992 levels. At the same time, other Idaho state parks in the vicinity experienced a 10 percent growth in usage and revenues. Tourist inquiries at nearby Clearwater fell by a similar 26 percent. Revenues or sales in 1992 were down from 1991 levels in businesses such as charters, marine supply and repair, sporting goods, grocery stores, restaurants; other retail outlets fell from between 10 to 25 percent. Monthly sales reductions between 1992 and 1991 reported by the Glenwood IGA were $22,655 in July and $25,109 in August. Other businesses reported declines in activity but could place no dollar value or percent reduction on the loss.

Traffic counts taken by the Idaho Transportation Department on US 95 east of US 12 east near Lewiston (west of the Dworshak Dam) and on US 12 at the junction of State Road 64 near Kamiah (east of the Dam) confirm that traffic decreased during summer 1992 (Idaho Transportation Department, Division of Highways, "Automatic Counter Volumes by Month," November 24, 1992). These counters track a very large share of the traffic entering the Dworshak area. The traffic station east of the dam near Kamiah reported annual daily traffic (ADT) reductions in August, September, and October of 1992 over previous year's levels. ADT in these months had been steadily increasing until this year. This was the first time that August ADT fell from that of the prior year since 1985. Last year's August ADT grew by 9 percent over 1990 levels. August ADT west of the dam also declined from the previous year for the first time since 1985.

In summary, changes in recreation use at Dworshak clearly had an adverse effect on the level of traffic and business activity in the Orofino area. The reports from local business representatives generally indicated they experienced revenue losses, but did not specifically identify employment effects resulting from the reduced business. Similar types of impacts could be expected in the future with the proposed action, particularly Alternative 4 or 5. However, the magnitude of such future impacts would probably be less in any given year largely because the water conditions in 1992 have a low probability of recurring soon.

Cumulative Socioeconomic Impacts. A number of reviewers of the draft SEIS noted that the socioeconomic impacts described above are more likely to have a cumulative effect in the more rural, less developed portions of the study area in Idaho and Montana. Such comments were particularly frequent among people living near the Dworshak, Libby, and Hungry Horse projects. They pointed out that other recent economic dislocations, primarily in the timber industry, have created weaker local economies that are more vulnerable to further economic losses.

The unemployment data presented in Section 2.15 tend to support this position. Counties such as Lincoln in Montana and Clearwater in Idaho have historically had higher unemployment than their respective states or the nation. Local economies such as these are generally less developed and diversified, and less able to recover from losses in a key economic sector. Recreation-related businesses are important in these local economies, indicating that socioeconomic impacts from the proposed actions may be felt disproportionately in the areas around the key storage projects.

4.13.2 Water Supply

Groundwater wells adjacent to the mainstem reservoirs could be affected by drawdowns during the summer period. For example, RZA-AGRA (1992), in a special study of the more than 2,000 groundwater wells within 3 miles of John Day Reservoir, estimated that up to 100 wells might be affected by a drawdown to MOP (elevation 257)

and the approximate cost to modify 67 wells would be $663,000. This is based upon a study, with no field investigations, of only 600 wells. The 1992 pool elevations of John Day were not held at the 262.5-foot level for a long enough period to confirm whether problems will occur with the wells. Because of impacts to irrigation pumping, pool elevations were generally in the 263.5-foot to 265-foot range. No complaints were received for impacts to wells. Major impacts are not expected under the alternatives, because operation to the 262.5-feet elevation would not regularly occur. As a possible mitigation measure, monitoring groundwater changes in wells in that area should be considered during the lowered pool elevations.

4.13.3 Native American Resource Uses

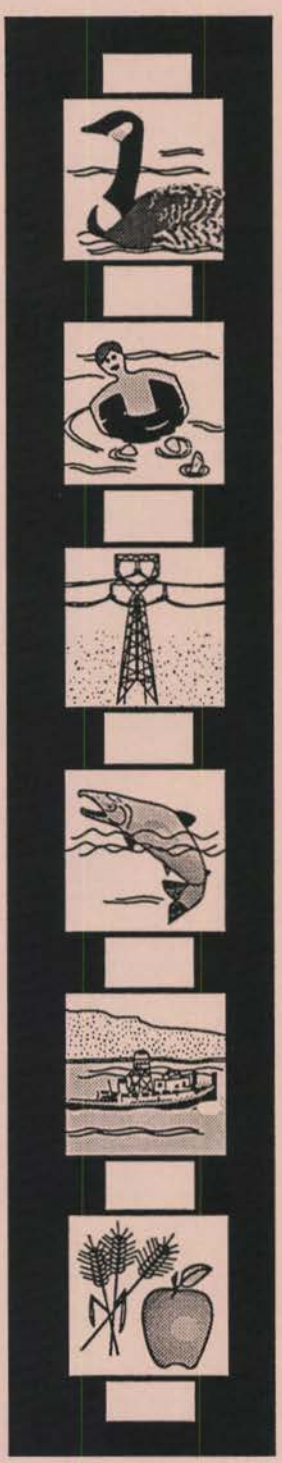
For Native Americans fishing at usual and customary sites at tributary mouths, operation of John Day at 262.5 during fishing season could necessitate the moving of nets or switching to set lines as shallow areas become exposed. Build-up of deltaic bars at tributary mouths could block tributaries sufficiently that anadromous fish could not enter tributaries to spawn. This is most likely at Willow Creek, an Oregon tributary entering Lake Umatilla at RM 252.5. Willow Creek, however, does not currently support an anadromous fishery. Impacts to Native American fishers are expected to be minor at pool elevation of 262.5 as proposed under these alternatives.

4.14 PROJECT STRUCTURES

Potential risks to the integrity of project structures, including dam embankments, stilling basins, navigation locks, levees, and railroad and highway embankments, were a significant concern in the 1992 OA/EIS. This concern applied to the 1992 options for reservoir drawdown to near spillway crest on the lower Snake River. Alternatives 2 through 5 involve future operations that would be within the normal operating ranges for the respective projects. Consequently, there would be no increased risks to project structures.

5.0

Plan Selection and Implementation



5.0 PLAN SELECTION AND IMPLEMENTATION

The objective of this section is to describe the process of developing an operational plan for 1993 and future years that will improve conditions for salmon in the Columbia River Basin. A determination on flow improvements will be based primarily on improved survival rates of juvenile salmon within the river system.

5.1 Evaluation Criteria

Section 5 of the 1992 OA/EIS details the process by which the operational plan for 1992 was selected. Since the 1992 operational plan forms the basis for each of the action alternatives considered in this SEIS, the reader is referred to the 1992 OA/EIS for a detailed discussion of the evaluation process. The alternatives selected for evaluation in this SEIS were determined to be implementable in 1993 and future years, and to be within existing authorities.

Criteria for evaluating the alternatives analyzed in this SEIS are (1) juvenile salmon survival rate, (2) cost-effectiveness, and (3) environmental effects. Cost-effectiveness will be analyzed in terms of relative costs to achieve improved juvenile salmon survival. Environmental effects, including potential benefits to upstream adult migrants, were assessed in detail in Section 4.

Comments by Federal, State and local entities and the public on the draft SEIS have been considered by the cooperating agencies. The public had 45 days to review this draft document and participate in public meetings on its content. From this overall process, an alternative that most closely meets regional salmon recovery objectives with acceptable costs and minimal environmental damage will be selected for the 1993 and beyond operational plan.

It should be recognized that the alternative selected for implementation in 1993 and future years might require adjustment on an annual basis depending on hydrologic conditions and new information that may be developed. The Corps, BPA, BoR, and NMFS implemented a process in 1992 to monitor and evaluate the shaping of available water based on real-time flow and fish migration information throughout the fish passage season. This process recognizes that flexibility is needed to optimize the release of available water to maximize the benefit to migrating wild Snake River stocks of sockeye, spring/summer chinook, and fall chinook salmon, and this process should not be constrained by fixing flows on a predetermined schedule.

5.2 Comparison Of Alternatives

The range of potential actions available for interim flow improvement measures consists of various lower reservoir elevations and flow augmentation options, implemented either singly or in combination. Because the flow improvement measures that are feasible now are limited by the structural configuration of the system and the total amount of storage available, the SEIS evaluates in detail four action alternatives that incorporate a combination of lower reservoir elevations and flow augmentation measures involving multiple projects. The effects of these four alternatives are measured and compared against the no action alternative (the without-project condition), which is defined as the normal operation of the coordinated Columbia-Snake River System under the operating rules in effect from about 1985 through 1990.

The data presented for comparison are a summary of information outlined in Section 4. For a complete description of the individual alternatives, refer to Section 3. The performance of all alternatives against the plan selection criteria is described below.

5.2.1 Performance Against Survival Objectives

The objective of the interim flow measures alternatives with respect to juvenile salmon is to improve downstream survival rates. The actions addressed in the 1992 OA/EIS were evaluated for their performance against the physical objective of increased river velocity, as measured by water particle travel time. This evaluation required a lengthy and complex, stepwise analysis to translate reduced water particle travel time into smolt travel time and subsequently smolt survival. In this SEIS, the effects of flow improvements on fish survival are analyzed through operation of the salmon life-

cycle models. Each life-cycle model has an accompanying juvenile passage model.

The key characteristics, input requirements and results produced by these models are described in more detail in Section 4.2 (and in the Biological Assessment that is included as an appendix to the final SEIS). Briefly, the models produce deterministic or probabilistic estimates of returning (adult) spawners, based on simulation of mortality factors in the respective life-cycle phases.

Preliminary conclusions on the effect of each alternative on juvenile survival rates are discussed below.

The results of the BPA juvenile fish passage model (CRiSP.0) show the proposed operations for 1993 (Alternative 4), relative to a no action return to 1990 baseline operations (Alternative 1), would increase the survival of spring/summer and fall chinook downstream migrants. Substantial additional survival improvements are estimated in the years 1993 and 1998 because of the phasing in of full benefits of measures to be implemented in 1993 and additional ongoing actions currently planned through 1998, such as squawfish management, bypass installations and improvements, and transportation from Lower Monumental Dam.

The results of the BPA life-cycle model (SLCM) also show that the improvements in juvenile survival coupled with additional planned actions through 1998 affecting other life stages of chinook should result in significant gains in spring and fall chinook species populations. Improvements from these actions are more moderate for the summer chinook population. Both the spring and fall chinook show increasing population trends with 1993 and future conditions. Summer chinook show population trends improving from the 1990 baseline conditions. However, the downward baseline trend improves only to a slightly increasing trend if low effectiveness of measures is assumed, and improves to a moderately increasing trend assuming high effectiveness of measures. No CRiSP or SLCM models were run for sockeye because all known stocks are currently in a captive-rearing program.

The results of the NPPC juvenile fish passage model (PAM) also show survival increases for spring chinook associated with the proposed actions in 1993. The NPPC SPM life-cycle model indicated a slight increase in trend in spring chinook adult escapement when all improvements considered were included in their model. Their model included possible actions such as minimal predator control and increased upstream survival, while rearing and spawning habitat improvements resulted in estimates of slight increases in spring chinook escapement over a 20-year model period. Only slightly increasing trends were apparent in these model runs when lower benefits were assumed for some of the possible future actions.

The NPPC passage analyses and life-cycle analyses only modeled spring chinook and only included actions taking place in 1993, plus rearing and spawning habitat improvements. The increases in juvenile spring chinook survival from the NPPC (PAM) analysis are reasonably similar to the BPA (CRiSP) results for the proposed 1993 conditions relative to 1990 baseline conditions. The modeled conditions resulted in the relatively comparable increases in spring chinook juvenile relative passage survival of 7 percent (median) for the CRiSP Model and 8 percent (average) for the PAM. Absolute survival increases remained small, with both being about 1 to 2 percent. The BPA analysis also included a comparison of projected 1993 conditions with the proposed action to no action (Alternative 1) conditions; these results indicated median relative increases of 4 percent for spring chinook, 4 percent for summer chinook, and -2 percent for fall chinook.

The results from the NPPC (SPM) life-cycle analysis and the BPA analysis for 1993 static conditions both show improvements in population trends relative to baseline conditions. When similar assumptions and actions are included in SLCM and SPM, the models show improvements relative to the baseline. While the relative changes in projected escapements are similar between the two analyses, the estimated adult escapement level for the SPM is greater than the projection for the SLCM for the same period. This is primarily a result of a lower initial baseline escapement projection for the SPM.

Generally, the expected average or median downstream passage survival is similar between the two models, with the PAM having slightly higher survival values than CRiSP. The relative increase in survival over base conditions (Alternative 1) was

also similar, with increases in downstream survival ranging from 5 to 12 percent; these included the changes in both the system operation and/or other actions that may be taken in the system. Because the flow measures being evaluated in the SEIS primarily benefit downstream survival, the results of the passage models (CRiSP and PAM) are used to evaluate the alternatives.

Developing a valid comparison of the results of life-cycle models is difficult because the two sets of models used different parameter values for some actions, and differed on what future actions should be included in their analysis. A parameter value of an action reflects how effective that action is to increasing survival. Although the coordinated review of the model analysis set some parameter values and critical assumptions common to both SLCM and SPM, other parameter values are different.

The cooperating agencies recognized at the outset that there could be differences in the life-cycle model results because of the models' assumptions. The cooperating agencies are continuing to evaluate the similarities and differences in life-cycle models.

The NPPC model results, which depict the effects of adding individual actions to the base case one at a time, suggest that some of the greatest enhancement to adult returns would be from improving the spawning and rearing habitat. Not until this component was added did the trend in returns begin to increase instead of decrease. Whether the level of increase in egg-to-smolt survival modeled is reasonable for future actions in the basin is not known at this time.

Other factors are also considered in evaluating proposed flow improvements. For example, travel time changes can provide another perspective on flow improvements. Travel time reductions for nontransported yearling smolts originating in the Snake River are typically less than 1 to 2 days, which is usually less than a 10- percent reduction in total in-river travel time.

Later summer releases of water from the upper storage reservoirs could enhance upstream migration success of some fall chinook in the system, but the level of beneficial effects at this time is unknown.

Some loss of shallow water habitat for rearing, used primarily by fall chinook, could occur with operation of the Snake River pools and John Day Pool at lower elevations. The areas lost should be a small part of the total available shallow water habitat.

The lowering of the water level has the potential to reduce water supply at the Umatilla Hatchery, possibly reducing full production potential or resulting in early release of some fish.

5.2.2 Cost Effectiveness

Typically, the Corps bases plan selection on the Federal objective established in the Water Resource Council's *Economic and Environmental Principles for Water and Related Land Resources* (February 3, 1983). The Federal objective is to select the plan that maximizes contributions to national economic development (NED) consistent with protecting the nation's environment. Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary terms. The evaluation of alternatives under this objective requires thorough assessment of all the costs and benefits associated with each alternative.

The use of strict NED analysis is not considered appropriate when dealing with endangered and threatened species. Any attempt to assign a monetary value to endangered fish, given current techniques, would not account for the full value to society. Furthermore, insufficient biological data are available to establish, with reasonable certainty, the numbers of returning adult fish. To somewhat limit the degree of uncertainty and to reflect the nature of the alternatives investigated in the SEIS, biological effectiveness was measured as the percentage change in juvenile survival. An evaluation tool used is cost effectiveness, calculated in terms of relative costs needed to achieve a given percentage change in juvenile survival. Ideally, the costs should be distributed to all the species that would benefit. The data needed to do this analysis are not available, so, the analysis uses the aggregate costs compared to limited estimates of spring chinook survival increases. The cost-effectiveness approach avoids the issue of assigning monetary values to endangered species by comparing alternatives to identify the least-cost way to increase survival.

Approach and Methods

The objective of the actions addressed in this analysis is the improvement of the survival rate for juvenile salmon migrating downstream. The fish passage models discussed in Section 5.2.1 produce results that can be used to identify the downstream survival rate, in percentage terms, for each stock and for a given set of input parameters. Therefore, the results of the passage models are used to evaluate alternatives. A thorough discussion of the modeling approach and the results achieved by the alternative actions can be found in Section 4.2.

In determining the costs for this analysis, only the NED costs were considered. The costs include implementation costs and foregone benefits in terms of reduced output of project benefits from the current conditions.

Total direct costs by alternative are then divided by the survival improvement to arrive at a measure of the cost per unit (percent) change in survival. This figure is calculated for each alternative, and then the alternatives are ranked according to cost-effectiveness.

The cost-effectiveness analysis has several shortcomings and this was recognized when the process was used for plan selection. Primary obstacles are the uncertainty and level of precision in measuring both survival benefits and costs. The intent of the cost-effectiveness analysis was primarily to rank alternatives from the most cost-effective to the least, and to reject those alternatives that were clearly most costly for the improvement in survival.

Survival Improvements

Survival improvement data for the cost-effectiveness analysis were taken from the downstream passage components of the anadromous fish model analyses using spring chinook as an indicator. These results were summarized in Section 5.2.1 and are indicated in the left-hand column of Table 5.2-1. The BPA analysis yielded a survival increase of 4 percent for spring chinook, relative to Alternative 1. The NPPC analysis did not include the same comparisons to Alternative 1 conditions.

Costs of Alternatives

The direct costs associated with the various options are presented in Table 5.2-1. The costs are tabulated in the four categories of transportation, irrigation, recreation, and hydropower. A discussion of the assumptions made in evaluating these costs is presented in the following paragraphs. Impacts that would occur in other resource areas are not suitably quantifiable in monetary terms.

Transportation. The impact analysis for the SEIS alternatives indicated that effects on navigation and log rafting would be minimal or nonexistent, so no direct costs to transportation have been estimated. A detailed discussion of transportation costs is presented in Section 4.7.

Irrigation. The approach used to estimate costs to irrigation in the 1992 OA/EIS was to determine the loss of net farm income that would be caused by lost access to irrigation water. However, the impact analysis for the SEIS alternatives indicated that effects on irrigation would be minimal or nonexistent, so no direct costs to irrigation have been estimated.

Recreation. Recreation displacement was based on the assumption that if the physical facilities were not usable (e.g., a dry boat ramp), then the activity associated with that facility would be displaced to another reservoir or lost completely. No attempt was made to determine the reduction in quality of the recreation experience if the recreation activity continues, but with fewer attributes. Because of the lack of data or studies, the expected changes in visitation were not allocated to other recreation sites or activities.

For the cost-effectiveness analysis, the economic value of recreation was assumed to be $7 per activity day. This value is taken from the Water Resources Council's "Principles and Guidelines" (price level adjusted, as reflected in the Corps' Economic Guidance Memo 93-1) determination of general recreation unit-day values of $2.30 to $6.92 in 1993. The maximum figure of $6.92 has been rounded to $7.

The Water Resource Council's unit day values are intended as measures of marginal changes in recreational value attributable to a project area, and not as measures of the total value of a day of

Table 5.2-1. Cost effectiveness of alternatives.

Alternative	Percent increase in survival over no action[a/]	Direct Costs ($ millions)								Cost per 1 percent increase ($ millions) in survival[b/]	
				Recreation		Power		Total			
		Transportation	Irrigation	(low)	(high)	(low)	(high)	(low)	(high)	(low)	(high)
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	4	0.00	0.00	0.00	0.001	63.00	90.00	63.00	90.00	15.75	22.5
3	4	0.00	0.00	0.006	0.023	52.01	88.02	52.01	88.02	13.0	22.01
4	4	0.00	0.00	0.008	0.029	66.01	93.03	66.01	93.03	16.5	23.26
5	4	0.00	0.00	0.007	0.025	57.07	84.03	57.07	84.03	14.27	21.01

a/ Percentages indicated here are the median relative increase for spring chinook from the BPA CRiSP Model analysis. Comparing Alternative 1 to Alternative 4 with 1993 conditions, corresponding figures for NPPC analysis would be approximately 6 to 9 percent for spring chinook, the only stock included in the NPPC analysis.

b/ The results represent a comparison of wide ranges of costs and cannot be considered linear. That is, one cannot assume that doubling costs would double survival.

recreation use. That is why the unit day value used in the SEIS is considerably less than many daily willingness-to-pay values reported in numerous sources, including the 1992 OA/EIS. While the Water Resource Council figure is considered to be the most appropriate value for the marginal changes at issue, the maximum value in the range has been applied in the final SEIS and a higher figure has been used in the sensitivity portion of the cost-effectiveness analysis (see Section 5.2.2). A higher unit-day value for recreation was used for sensitivity analysis. Based on information presented in the 1992 OA/EIS, the value of $26 per day was applied in this case.

Hydropower. The impacts to power are summarized in three categories: loss in capacity, loss in firm energy, and loss in non-firm energy. The capacity impacts are often minor because the Northwest power system is considered to have capacity surplus except in certain situations. Significant impacts to capacity would occur with any of the action alternatives; however, major economic costs would occur in 1993 and subsequent years only if the capacity surplus is exceeded. For this reason, the SEIS valued estimated capacity losses for the first 1,000 MW in May and June at zero. Losses of 1,000 to 3,000 MW in May and June, and the first 3,000 MW in all other months, were valued at $4/kW/month.

Firm energy impacts are determined by losses in the FELCC, which is the level of energy the power system can generate in the worst historical water condition. The FELCC is an assured amount of energy and carries a higher value than the nonfirm energy. The SEIS valued losses of FELCC at 35 mills/kWh, which is reflective of what BPA is currently paying for firm energy resources that it will acquire for the long term.

The nonfirm energy is sold over a wide range of values based on market conditions at the time of sales. The availability of nonfirm energy reduces the need for generation of energy with more costly generation resources. The value of this displacement represents the NED value. A range of values were used to account for the variations in purchases at different times of the year and the range of possible nonfirm losses.

Comparative Evaluation of Alternatives.

The last four columns in Table 5.2-1 present the range of total direct costs by alternative and the costs per 1 percent increase in survival. The total direct costs range from $52 to $88 million for the operation with Libby/Hungry Horse sensitivity (Alternative 3) to $66 to $93 million for the modified 1992 operations (Alternative 4). The cost of power losses accounts for virtually all of the total direct costs. In cost-effectiveness terms, these two alternatives range from a minimum of about $13.0 to $23.3 million per one percent change in survival. As can be seen from Table 5.2-1, there is a great deal of overlap in the ranges of costs per unit change in survival. The overlaps and wide ranges of results reflect the uncertainty inherent in the fish survival models and power impact analysis. None of the alternatives clearly demonstrate an advantage or disadvantage from this cost effectiveness analysis.

Generally, a sensitivity analysis is performed to define the range of values that the direct costs may take depending on different possible conditions not related to the proposed alternatives. However, because there were no transportation or irrigation impacts expected, a sensitivity analysis for these resources would be irrelevant. For hydropower and recreation, the range of possible direct costs are included in the cost-effectiveness analysis discussed in the previous section and presented in Table 5.2-1.

5.2.3 Environmental Effects of Alternatives

The results of the environmental evaluation reflect expected impacts to an extensive and complex water resources system that is managed for a variety of uses, including conservation of fishery resources. The following material is an abbreviated summary of those impacts, as presented in detail in Section 4 of the SEIS. The objective of this summary is to aggregate the details of the evaluation with respect to each alternative and present broad conclusions that focus on the most significant environmental impact issues. Table 5.2-2 has been prepared to facilitate comparison of the environmental effects of the alternatives.

A key conclusion of the comparison of environmental effects is that there would be little

difference in impact among the alternatives. Because the components of Alternatives 2 through 5 are the same with respect to operation of the lower Columbia and Snake River projects and Columbia River flow augmentation, there is no variation in effects from these actions. Impacts among alternatives would vary somewhat with respect to Snake River flow augmentation. Alternatives 4 and 5 would typically involve slightly deeper drafts at Dworshak than with Alternatives 2 and 3, and therefore would have somewhat greater effects on resident fish, recreation, aesthetics, and cultural resources.

Overall, the effects of the proposed action on resources other than anadromous fish can be summarized as follows:

- Minor to insignificant decreases in water temperatures at times in the Clearwater River below Dworshak and in Lower Granite Reservoir
- Some long-term net benefits expected for resident fish in the mainstem reservoirs; adverse effects on resident fish populations in the storage reservoirs
- Some stresses or losses of shallow water habitat, wetland, riparian habitat, waterfowl, and furbearers at John Day; minimal terrestrial impacts elsewhere in the system
- Insignificant increases in blowing dust during some periods of the year, particularly near the storage reservoirs
- Capacity, firm energy, and nonfirm energy losses to the power system, with total estimated power costs ranging from $63 to $90 million for Alternative 2 to $66 to $93 million for Alternative 4
- Limited utility of some recreational facilities at mainstem and storage projects during some months, but minimal or minor projected impacts (some positive, some negative) in recreation usage in most years. Low probability of significant seasonal decreases in use depending on water conditions, particularly at Dworshak. Initial and long-term adverse effects on fishing and boating on Lake Roosevelt could occur depending upon annual decision for storing flow augmentation water.
- Minor incremental aesthetic effects from increases in reservoir shoreline exposure, primarily at John Day and Dworshak
- Minor increase in potential damage to cultural resources from somewhat deeper drafts and increased exposure
- Minimal to no effects on transportation, utilities, agriculture, socioeconomics, and project structures.

From an ecosystem perspective, the environmental analysis illustrates the resource balancing that must be considered in evaluating a plan of action. The proposed actions would generally improve flows in the lower reaches of the river system, and would primarily benefit anadromous fish. Most of the adverse impacts of these actions would occur in the upper reaches of the system, at and near the storage reservoirs, and would primarily affect resident fish and recreation resources. The tradeoffs involved with actions to benefit one type of resource should be recognized in the decision process.

5.3 PREFERRED ALTERNATIVE

The estimates of percent increase in survival and cost-effectiveness show that all alternatives achieve similar biological results with similar costs. However, Alternative 4 provides flexibility to shift the timing of flow augmentation to assist either wild juvenile or adult fall chinook migration in late summer and early fall. NMFS indicated in their 1992 Biological Opinion that additional summer flow augmentation should decrease mortality of juvenile wild fall chinook. Based on the best available scientific data, the Corps and the cooperating agencies believe that Alternative 4, with the flexibility to shift the timing of flow augmentation in the period of July through September, is the alternative that will provide the best survival of the four alternatives. Comparison of the environmental impacts of the four action alternatives indicates that the impacts at the lower Snake River and John Day projects are identical, and differences at the storage projects are minimal.

Based on an analysis of survival rates, cost-effectiveness, and environmental effects, the Corps and the cooperating agencies have identified Alternative 4 as the preferred alternative for the interim flow measures operational plan.

5 PLAN SELECTION AND IMPLEMENTATION

This plan will be implemented subject to the outcome of consultation with NMFS under Section 7 of the ESA. Alternative 4 would also be implemented in years beyond 1993, although specific elements may need to be modified annually based on new information and year-to-year water conditions. The Corps, BPA, and BoR expect to consult with NMFS and FWS (where applicable) regarding operating plans on an annual basis. The outcome of ongoing regional processes (such as the NMFS Recovery Plan, the SCS, and the SOR) may modify proposed actions in the future and require additional NEPA coverage. Operating plans for 1993 and future years that incorporate the actions addressed in this SEIS will be documented in respective Records of Decision by the Corps, BPA, and BoR.

Table 5-1. Environmental comparison of alternatives.

Resource/ Issue	Without Project (No Action)	1992 Operations	1992 Operations with Libby/ Hungry Horse Sensitivity	Modified 1992 Operations	Modified 1992 Operations with Upper Snake Sensitivity
WATER QUALITY	• Continued high total dissolved gas levels during spring and summer fish spill periods. • Insignificant changes in temperatures, turbidity, and other parameters.	**Lower Snake/ Columbia, Grand Coulee, Libby** • Insignificant changes in gas saturation levels (continued high total dissolved gas during spring spills), temperatures, turbidity, and other parameters. • No cumulative impacts because of daily and seasonal variations. **Dworshak** • Water temperatures expected to decrease below Dworshak Dam, particularly in Clearwater and lower Snake rivers above Lower Granite, with larger reductions occurring from greater flow releases. • Slight potential elevation of gas levels in mainstem Snake River below dams. • Greater difference in thermal profiles, at least at Lower Granite, with significant Dworshak releases. **Brownlee** • Chemical water quality and temperature of lower Snake potentially degraded by flow augmentation from Brownlee.	• Same as Alternative 2. • Potentially lower temperatures in reaches of the Kootenai and Flathead rivers in low-water years.	• Same as Alternative 2.	• Same as Alternative 2.

Table 5-1 (continued). Environmental comparison of alternatives.

Resource/ Issue	Without Project (No Action)	1992 Operations	1992 Operations with Libby/ Hungry Horse Sensitivity	Modified 1992 Operations	Modified 1992 Operations with Upper Snake Sensitivity
ANADROMOUS FISH	• The range of increase in juvenile downstream passage survival for Snake River stocks, relative to conditions occurring in 1990 to 1998, depends on the model used. • CRiSP Results - Relative survival would increase prior to 1998 improvements by 3, 4, and 31 percent for spring, summer, and fall chinook, respectively, because of actions such as predator control, harvest management, and additional screens at Lower Monumental. - Additional increases after 1998 from other actions (increased transport, improved screens, increased predator control). • SLCM Results - No action conditions not modeled for adult escapement • PAM Results - NPPC modeled 1990 conditions as Alternative 1 without incorporating any nonflow actions. Therefore, the PAM results do not reflect any future without-project improvement in juvenile survival rates. • SPM Results - No action condition not modeled for adult escapement.	• CRiSP Results - Downstream survival resulting from operations changes only will increase relative survival slightly for most stocks prior to 1998 with median relative survival increases of 4, 4, and -2 percent over without-project conditions, respectively, for spring, summer, and fall chinook. - Total relative median survival from the 1990 base case for 1993 conditions is estimated at 7, 8, and 28 percent for the same stocks. - By 1998, the total median increase in relative passage survival (including the increase of all activities, not just operational changes) is 12, 15, and 77 percent for spring, summer, and fall chinook, respectively. - Changes in percent survival would be higher during low flow years. - Sockeye were not modeled, but downstream survival changes should be similar to spring chinook.	• Similar to Alternative 2.	• Similar to Alternative 2.	• Similar to Alternative 2.

Table 5-1 (continued). Environmental comparison of alternatives.

Resource/ Issue	Without Project (No Action)	1992 Operations	1992 Operations with Libby/ Hungry Horse Sensitivity	Modified 1992 Operations	Modified 1992 Operations with Upper Snake Sensitivity
ANADROMOUS FISH (continued)		• PAM Results (spring chinook) - For 1993 operational and nonoperational conditions, relative increased survival over 1990 conditions without estimated benefits of predator control are 6% (50 year average) and 9% (8 lowest-flow-year average); with predator control included, benefits are 9% (50 year average) and 13% (8-lowest-flow year average). - For operational and nonoperational conditions beyond 1993, relative increased survival over 1990 conditions without estimated "low" benefits of predator control and other factors are 12% (50 year average) and 19% (8 lowest-flow-year average); with estimated "high" benefits of predator control and other factors, they are 20% (50 year average) and 30% (8 lowest-flow-year average). • FLUSH Results - Spring chinook average relative increased survival over baseline (1977-1988 conditions) from 18 to 32% depending on which of 4 transport models, 3 predation reduction			

Table 5-1 (continued). Environmental comparison of alternatives.

Resource/ Issue	Without Project (No Action)	1992 Operations	1992 Operations with Libby/ Hungry Horse Sensitivity	Modified 1992 Operations	Modified 1992 Operations with Upper Snake Sensitivity
ANADROMOUS FISH (continued)		level assumptions, and implemented or planned conditions were assumed. - Fall chinook average relative increased survival over baseline (1981-1989 conditions) from -11 to 64% (TRR 0.5:1), 3 to 71% (TRR 1:1), and 29 to 92% (TRR 2:1) each with 3 levels of predator control reduction—0, 15% and 25%. • SCLM Results (estimated median adult escapement change in 40 years, based on moderate effectiveness of all improvements over 1990 base case condition) - Spring, summer and fall chinook increase 3,000 to 14,000, 1,200 to 6,000, and 300 to 5,200, respectively. - The estimated probability, over a 40-year period, of escapement falling below 1,000 for spring, 500 for summer, and 250 for fall chinook, depending on expected level of effectiveness of actions (low to high) is 16 to 3%, 15% to <1%, and <1% to <1%, respectively. - The estimated projection of significant decreasing future escapement trends is less than 12%, with most less than 4%, for			

Table 5-1 (continued). Environmental comparison of alternatives.

Resource/ Issue	Without Project (No Action)	1992 Operations	1992 Operations with Libby/ Hungry Horse Sensitivity	Modified 1992 Operations	Modified 1992 Operations with Upper Snake Sensitivity
ANADROMOUS FISH (continued)		spring, summer and fall chinook over the range of assumed effectiveness of future actions. • SPM Results(spring chinook) - Median escapement based on conditions beyond 1993 show slight increase from about 8,500 to 12,000 (without estimated benefits of predator control, adult passage, and habitat improvements); 8,500 to 19,000 (with these benefits included) over a modeled 20-year period • ELCM Results - Estimated Marsh Creek spring chinook escapement through year 2020 estimated to remain relatively flat with any of the proposed actions and assumed conditions (considering 10% reduction in predation, planned and implemented actions, and 4 different transport benefit models), with average escapement remaining from about 20 to 40% of the agency-defined maximum sustainable production goals. Increased escapement over continued baseline conditions for 8 different alternative analysis averaged 27 to 67% higher escapement by the 2016 to 2020 period.			

Table 5-1 (continued). Environmental comparison of alternatives.

Resource/ Issue	Without Project (No Action)	1992 Operations	1992 Operations with Libby/ Hungry Horse Sensitivity	Modified 1992 Operations	Modified 1992 Operations with Upper Snake Sensitivity
ANADROMOUS FISH (continued)		- Estimated fall chinook escapement through 2010 decreased or slightly increased from the 1989 to 1991 escapement depending on estimated predation reduction (0,15 or 25%) and TRR ratio (0.5:1, 1:1, or 2:1). Four of 9 combinations slightly increase from 150 (1989 to 1991 average escapement) up to 264 to 489 by the years 2007 to 2010. Three of the 4 increased values assumed a 25% reduction in predation; the other, 15% predation reduction with TRR of 2:1. The 5 decreasing trend estimates had lower assumed predation reduction effectiveness and TRR ratios. Future escapement decreased for an assumed combination middle TRR (1:1), and predation reduction (15%) with NPPC recommended fall chinook harvest rate schedule changes. • Water particle travel time reduction could be as high as 7 days or a 20 percent reduction at low flow or 2 days at high flow. Most often, even in low flow years, reduction would be less than half this amount.			

Table 5-1 (continued). Environmental comparison of alternatives.

Resource/ Issue	Without Project (No Action)	1992 Operations	1992 Operations with Libby/ Hungry Horse Sensitivity	Modified 1992 Operations	Modified 1992 Operations with Upper Snake Sensitivity
ANADROMOUS FISH (continued)		• Estimated smolt travel time reduction could be as great as 10 days for short periods of low flow. However, under the lowest (10%) seasonal flow conditions, average reduction in smolt travel time would be about 1 to 2 days from Lower Granite Dam to Bonneville Dam. • Benefits would also occur for other stocks in both the middle and upper Columbia. • Minor loss of subyearling shallow water rearing habitat in Snake River and John Day pools. • Benefits to resident fish may lead to increased predation on anadromous fish.			

Table 5-1 (continued). Environmental comparison of alternatives.

Resource/ Issue	Without Project (No Action)	1992 Operations	1992 Operations with Libby/ Hungry Horse Sensitivity	Modified 1992 Operations	Modified 1992 Operations with Upper Snake Sensitivity
RESIDENT FISH AND AQUATIC ECOLOGY	• Stabilized conditions relative to 1992 conditions at Lower Granite and Little Goose reservoirs will enhance recovery of impacted resident fish populations. • Return to normal operations would have modest effect on Dworshak Reservoir fish populations which benefited from 1992 conditions. • Insignificant change in resident fish populations at other reservoirs.	**John Day** • Reduction of resident fish populations in culverted backwaters with culverts above elevation 262.5 (not all culverted backwaters). The extent of this reduction is not known, but is not expected to be substantial since this is similar to 1992 operations. • Reduced viable spawning habitat, possible long-term changes in species composition. • Possible, but unlikely long-term benefits to resident fish. **Lower Snake** • Probable enhanced egg survival offsetting reduced spawning area • Possible reduced benthic production in Little Goose Reservoir. **Dworshak** • Effects highly dependent on basin runoff patterns, could be very positive or could cause significant reductions in fish populations. **Brownlee** • Some reduction in spawning and feeding success and reduced fish production.	• Same as Alternative 2 except as follows: **Libby** • Decreased growth and productivity of fish in reservoir during low-water years. **Hungry Horse** • Potential for decreased growth and productivity of fish in Flathead River in some years. • Potential for decreased productivity of fish in reservoir during low-water years. • Possible minor benefit to spawning bull trout.	• Same as Alternative 2 except as follows: **Grand Coulee** • Potential for increased entrainment of fish during certain moderate-water years. • Reduced plankton production and feeding success in low-to-moderate water years.	• Similar to Alternative 4.

Table 5-1 (continued). Environmental comparison of alternatives.

Resource/ Issue	Without Project (No Action)	1992 Operations	1992 Operations with Libby/ Hungry Horse Sensitivity	Modified 1992 Operations	Modified 1992 Operations with Upper Snake Sensitivity
RESIDENT FISH AND AQUATIC ECOLOGY (continued)		**Grand Coulee** • Increased entrainment of fish, delayed zooplankton production, reduced reproductive success at Lake Roosevelt, particularly under certain runoff and operating conditions. **Libby** • Increased early summer productivity at Lake Koocanusa.			

Table 5-1 (continued). Environmental comparison of alternatives.

Resource/ Issue	Without Project (No Action)	1992 Operations	1992 Operations with Libby/ Hungry Horse Sensitivity	Modified 1992 Operations	Modified 1992 Operations with Upper Snake Sensitivity
TERRESTRIAL ECOLOGY	• Minimal impacts expected overall. Some loss of shorebird nesting habitat which developed at John Day during 1992 pool lowering, but stabilization of goose nesting habitat impacted by 1992 drawdown test at Lower Granite and Little Goose.	**Lower Columbia** • Impacts at John Day to shallow-water habitat, riparian communities, wetland development, waterfowl nesting, and furbearers. • Cumulative impacts to terrestrial resources mainly in habitat loss for most plant and wildlife species in project area. **Lower Snake** • Minimal and potentially beneficial, immediate impacts to aquatic plants and invertebrates, riparian communities, wetlands, and wildlife. • Cumulative impacts to terrestrial resources mainly in habitat loss for some plant and wildlife species in project area and increased livestock damage to riparian areas. **Dworshak** • Minimal impacts expected for most resources; potential for elk losses in winter under certain ice and snow conditions. **Brownlee** • Minimal impacts expected for most resources; potential reduction in fish prey availability for bald eagles.	• Similar to Alternative 2; minimal incremental effects for most resources at Libby and Hungry Horse; potential reduction in fish prey availability for bald eagles.	• Similar to Alternative 2.	• Same as Alternative 4.

Table 5-1 (continued). Environmental comparison of alternatives.

Resource/ Issue	Without Project (No Action)	1992 Operations	1992 Operations with Libby/ Hungry Horse Sensitivity	Modified 1992 Operations	Modified 1992 Operations with Upper Snake Sensitivity
TERRESTRIAL ECOLOGY (continued)		**Grand Coulee** • Minimal impacts expected for most resources; potential reduction in fish prey availability for bald eagles.			
GEOLOGY AND SOILS	• Minimal impacts on mainstem reservoirs. • Continued moderate shoreline erosion and moderate landslide activity on storage reservoirs.	**Lower Snake/ Columbia** • Minimal increase in landslide activity. • Minimal shoreline erosion of beaches, recreation facilities, roads, and railroad grades. **Dworshak, Brownlee, Grand Coulee** • Moderate increase in erosion and sedimentation. **Libby** • Minor increase in landside activity; minor increase in erosion and sedimentation.	• Minor increases in shoreline erosion, slope instability, streambank erosion, and sedimentation at Hungry Horse; moderate increase at Libby. • Slight increase in erosion downstream from Libby and Hungry Horse dams in low-water years.	• Same as Alternative 2 except minor increase in erosion and sedimentation at Dworshak. • Minor increase in erosion and landslide activity along Brownlee Reservoir.	• Similar to Alternative 4.

Table 5-1 (continued). Environmental comparison of alternatives.

Resource/ Issue	Without Project (No Action)	1992 Operations	1992 Operations with Libby/ Hungry Horse Sensitivity	Modified 1992 Operations	Modified 1992 Operations with Upper Snake Sensitivity
AIR QUALITY	• Least amount of exposed sediments that are subject to wind erosion. Lowest air quality impact. Resident complaints over existing blowing dust incidence, particularly at Libby and Grand Coulee.	**John Day, Lower Snake** • Increased exposure (in area and duration) of sediments likely to result in insignificant increase in fugitive dust and potential odors during summer. **Dworshak, Brownlee, Grand Coulee, Libby** • Apparent insignificant increase in exposed sediments in summer, little change in dust generation. • Decreased sediment exposure and potential for windblown dust in late winter to early spring in flow augmentation years. • No additional dust generation at Brownlee, Grand Coulee, and Hungry Horse. Minor decrease in dust generation at Libby in low-runoff years. **Hungry Horse** • No change from Alternative 1.	**John Day, Lower Snake, Dworshak, Brownlee, Grand Coulee** • Same as Alternative 2. **Libby** • Same as Alternative 2 in most years. Increased sediment exposure and dust generation in late winter-early spring and more frequent moderate exposure in summer in low-runoff years. **Hungry Horse** • Decreased winter-spring exposure and dust in 2 of 3 years, increase in remaining years.	• Same as Alternative 2, except at Dworshak. • Minor increase in sediment exposure and dust generation in flow augmentation years.	• Same as Alternative 2.

Table 5-1 (continued). Environmental comparison of alternatives.

Resource/ Issue	Without Project (No Action)	1992 Operations	1992 Operations with Libby/ Hungry Horse Sensitivity	Modified 1992 Operations	Modified 1992 Operations with Upper Snake Sensitivity
TRANSPORTATION AND UTILITIES	• Normal operation of Columbia-Snake River Inland Waterway, Dworshak log transportation, and river corridor railroads and highways.	• No interruption of barge traffic. Possible continued depth problems at Almota terminals with operation at MOP. Potential for temporary navigation difficulties in Ice Harbor cut due to higher spring flows. • Minimal potential for curtailment of operating season for Dworshak log dumps in normal or dry years. • No adverse impacts to railroads or highway network. • Potential for poor mixing at sewer outfall of Umatilla. • Potential increase in water treatment for Boardman, OR.	• Same as Alternative 2.	• Essentially the same as Alternative 2.	• Essentially the same as Alternative 2.
AGRICULTURE	• Continued pumping from reservoirs to serve major agricultural developments from Ice Harbor and John Day. • Minor irrigation withdrawals from selected storage reservoirs, primarily Brownlee.	• No loss of pumping capability for irrigators at John Day or lower Snake, due to operation within normal range for irrigation. Minor increase in pumping costs due to additional head, higher electrical rates. • No adverse effects on withdrawals from storage reservoirs, due to relatively minor changes to normal drafting patterns.	• Same as Alternative 2.	• Same as Alternative 2.	• Same as Alternative 2.

Table 5-1 (continued). Environmental comparison of alternatives.

Resource/ Issue	Without Project (No Action)	1992 Operations	1992 Operations with Libby/ Hungry Horse Sensitivity	Modified 1992 Operations	Modified 1992 Operations with Upper Snake Sensitivity
POWER	• Normal power system operation according to operating rules in place from 1985 to 1990.	• Capacity losses of 100 to 1,500 MW, depending on month (cost of $11 million). • Firm energy loss of 80 aMW (cost of $25 million). • Non-firm energy loss ranging from 200 to 1,300 MW-months (cost of $2 to $14 million). • Columbia 3.0 MAF (cost of $25 to $40 million). • Total estimated power cost increase of $63 to $90 million.	• Capacity losses of 100 to 1,500 MW depending on month (cost of $11 million). • Firm energy losses of 40 to 60 aMW (cost of $12 to $19 million). • Nonfirm energy losses of 400 to 1,700 MW-months (cost of $4 to $18 million). • Columbia 3.0 MAF (cost of $25 to $40 million). • Total estimated power cost increase of $52 to $88 million.	• Capacity losses of 100 to 1,500 MW, depending on month (cost of $11 million). • Firm energy losses of 90 aMW (cost of $28 million). • Nonfirm energy losses of 200 to 1,300 MW-months (cost of $2 to $14 million; only slight changes in nonfirm value due to seasonal shifting). • Columbia 3.0 MAF (cost of $25 to $40 million). • Total estimated power cost increase of $66 to $93 million.	• Capacity losses of 100 to 1,500 MW, depending on month (cost of $11 million). • Firm energy losses of 55 aMW (cost of $17 million). • Nonfirm energy losses of 400 to 1,500 MW-months (cost of $4 to $16 million). • Columbia 3.0 MAF (cost of $25 to $40 million). • Total estimated power cost increase of $57 to $84 million.

Table 5-1 (continued). Environmental comparison of alternatives.

Resource/ Issue	Without Project (No Action)	1992 Operations	1992 Operations with Libby/ Hungry Horse Sensitivity	Modified 1992 Operations	Modified 1992 Operations with Upper Snake Sensitivity
RECREATION	**John Day, Snake River** • Minor impacts to recreation facilities when elevations at lower end of normal operating range. **Dworshak** • Impacts to recreational facilities from large reservoir fluctuations. Attempts made to keep reservoir above elevation 1590 from end of June through Labor Day so recreation facilities remain usable. • All 7 boat ramps usable on average from May through October. **Brownlee** • Three boat ramps on average open during spring fishing season. • Most recreation facilities functional during summer. **Grand Coulee** • Most recreation facilities typically functional from July through the end of September. **Libby** • All recreational facilities generally functional in July and August, 16 of 20 through the end of September, on average. **Hungry Horse** • Reservoir near full pool, recreational facilities usable from July through Labor Day in most years.	**John Day (to elevation 262.5)** • 6 of 14 boat ramps usable, 5 marginally usable, 3 unusable. • 6 of 9 moorage facilities fully functional, 2 marginally, 1 unusable. • 10 of 11 swimming areas fully functional, 1 marginally. • No displaced visitation expected. **John Day (to elevation 264.0)** • 12 of 14 boat ramps fully functional, 2 marginally usable. • 8 of 9 moorage facilities fully functional, 1 marginally. • 11 swimming beaches fully functional. • No displaced visitation expected. **Snake River** • 14 of 28 boat ramps functional, 14 marginally usable. • 1 of 5 moorage facilities functional, 4 marginally usable. • 2 of 11 swimming areas functional, 5 marginally usable, and 4 unusable. • Insignificant displaced visitation expected.	• Same as Alternative 2, except as follows: **Libby** • Possible access limitations from lower pool in spring 1 year in 3; insignificant to moderate facility impacts from lower summer elevations 1 year in 5. • Expected visitation decrease of 3 to 4 percent at Libby, representative of median water conditions. **Hungry Horse** • Insignificant increases to access limitations in low-runoff years.	• Same as Alternative 2, except as follows: **Dworshak** • Impacts similar to Alternative 2, but greater magnitude; somewhat higher probability of lower elevations and adverse impacts in any given year. • Expected visitation decrease of 3 percent, representative of median water conditions. Larger decrease in low-runoff years.	• Same as Alternative 4.

Table 5-1 (continued). Environmental comparison of alternatives.

Resource/ Issue	Without Project (No Action)	1992 Operations	1992 Operations with Libby/ Hungry Horse Sensitivity	Modified 1992 Operations	Modified 1992 Operations with Upper Snake Sensitivity
RECREATION (continued)		**Dworshak** • Swimming beaches usable, on average, from the end of June to late August. • Restricted access to some minicamps in early and late summer. • Use of moorage facilities marginally affected. • All 7 boat ramps usable mid-June to the end of September, on average. • No expected decrease in visitation, representative of median water conditions; measurable decrease possible in low-runoff years. • All river access facilities on Clearwater River functional; no effect on steelhead fishing or summer recreation. **Grand Coulee** • Minimal effects in most years. • Uncertain probability and magnitude of significant impacts to fishing and houseboating, if May-June drafts required for flow augmentation. **Libby** • Higher winter-spring pool elevations in flow augmentation years, earlier access to some facilities. **Hungry Horse** • No effects on access or visitation.			

Table 5-1 (continued). Environmental comparison of alternatives.

Resource/ Issue	Without Project (No Action)	1992 Operations	1992 Operations with Libby/ Hungry Horse Sensitivity	Modified 1992 Operations	Modified 1992 Operations with Upper Snake Sensitivity
AESTHETICS	**John Day** • Minimal impacts from pool elevations within normal operating range. **Snake River** • Minimal impacts from pool elevations within normal operating range. **Storage Reservoirs** • Significant reservoir fluctuation with greatest impacts in late winter, early spring. Low pool elevations expose tree stumps, rocks, shoreline, and lake bottom. Negative impacts increased as pool lowered and contrast with hillsides is greater. • Typical annual drafts at each project are: Dworshak 100 ft Brownlee 40 ft Grand Coulee 30-80 ft Libby 120 ft Hungry Horse 70-90 ft	**John Day** • Exposed reservoir bottom in shallow areas in some places. • Indirect aesthetic impacts through effects of low pool elevation on project wetlands. **Snake River** • Increased duration of exposure of shoreline area, within normal limits. • Limited adverse effects on wetlands. **Dworshak** • Median summer elevations 1 to 8 feet below base condition, insignificant incremental aesthetic effects, primarily from exposing additional shoreline and lake bottom. • No effects on Clearwater River. **Brownlee** • Drafts up to 8 feet in July and September would refill quickly, aesthetic effects insignificant. **Grand Coulee** • Minimal change in median elevations. Incremental increase in seasonal drafts in some years with minor additional shoreline exposure.	**John Day, Snake River** • Same as Alternative 2. **Dworshak, Brownlee, Grand Coulee** • Same as Alternative 2. **Libby, Hungry Horse** • Increased drafts and impacts in winter-spring in flow augmentation years. Lower pool levels, adverse effects, in summer season 1 in 4 to 5 years.	**John Day, Snake River** • Same as Alternative 2. **Dworshak** • Median pool elevations 9 feet lower in July and 20 feet lower in August, compared to base case, with additional aesthetic impacts from increased shoreline exposure. **Brownlee, Grand Coulee, Libby, Hungry Horse** • Same as Alternative 2.	• Same as Alternative 4.

Table 5-1 (continued). Environmental comparison of alternatives.

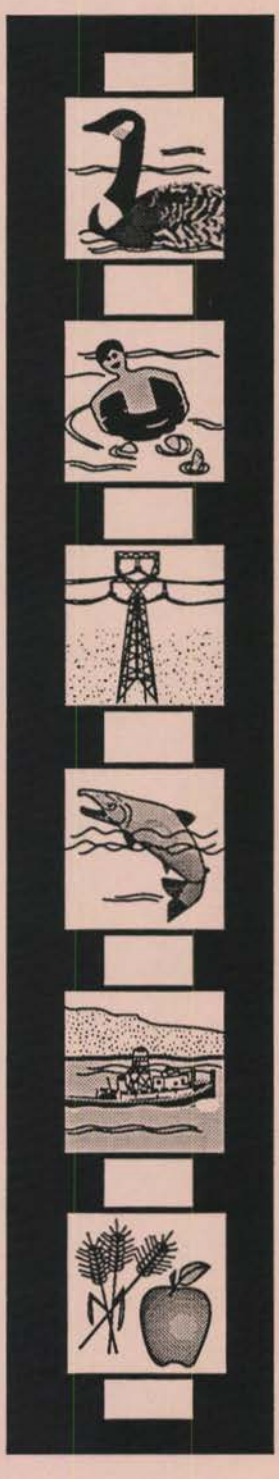
Resource/ Issue	Without Project (No Action)	1992 Operations	1992 Operations with Libby/ Hungry Horse Sensitivity	Modified 1992 Operations	Modified 1992 Operations with Upper Snake Sensitivity
AESTHETICS (continued)		**Libby** • Minor positive impacts from reduced winter-spring drafts in flow augmentation years. **Hungry Horse** • Same as Alternative 1.			
CULTURAL RESOURCES	• Adverse impacts from erosion, scouring, wet/dry cycles, slumping, vandalism, recreation, vehicular traffic, unchanged from present conditions.	• Little change from no action alternative except for John Day, where holding the pool at lower elevation would expose a larger area to adverse impacts for a longer period of time.	• Same as Alternative 2 for lower Snake and John Day projects. • Minor incremental impacts to Libby and Hungry Horse from somewhat deeper drafts in dry years; minimal change in most years.	• Similar to Alternative 2.	• Similar to Alternative 2.

Table 5-1 (continued). Environmental comparison of alternatives.

Resource/ Issue	Without Project (No Action)	1992 Operations	1992 Operations with Libby/ Hungry Horse Sensitivity	Modified 1992 Operations	Modified 1992 Operations with Upper Snake Sensitivity
SOCIO-ECONOMICS	• Normal use of project reservoirs for navigation, irrigation pumping, log transport (Dworshak only), power generation, recreation, and municipal and industrial water supply, among other uses.	• No increase in operating costs for navigation, irrigation, log transport, and water supply. • No identifiable employment and income effects from lost power generation. • Minimal change in expected recreation visits and associated employment and income effects, based on median conditions. Potential for larger visitation and economic effects in low-runoff years.	• Same as Alternative 2 for John Day, lower Snake, Dworshak, Grand Coulee, and Brownlee. • Potential for minor recreation-related economic effects at Libby and Hungry Horse. Net value of displaced recreation expected at about $6,000, based on median conditions. Potential for larger visitation and economic effects in low-runoff years.	• Nearly the same as Alternative 2, with potential displaced recreation valued at about $8,000, based on median conditions. Potential for larger visitation and economic effects in low-runoff years. • Uncertain, but greater potential for revenue decreases for recreation-related businesses	• Essentially the same as Alternative 4.

6.0

Agency Coordination and Public Involvement



6.0 AGENCY COORDINATION AND PUBLIC INVOLVEMENT

Because the operation of the coordinated Columbia and Snake River System affects such a wide range of water users in the region, it is essential that interested agencies, organizations, and the general public be given the opportunity to provide meaningful input into the decision-making process of any proposed changes to that system. Without such input, it would be impossible for the Corps and cooperating agencies to design a plan of action that truly balances the many valuable resources associated with the river system. To facilitate agency and public input into the process, the NEPA requires the cooperating agencies to provide specific opportunities for public participation in the decision-making process. These include opportunities for input to documents during open comment periods and formal testimony through public hearings.

This SEIS addresses water management activities for 1993 and the future. To support the SEIS, the Corps and its cooperating agencies are continuing to pursue programs to maintain and enhance a two-way dialogue with all parties concerned with the operation of the system. This chapter describes activities the Corps has undertaken since the release of the final 1992 OA/EIS to involve other agencies and the public in the decision-making process. It also describes methods the Corps has used during preparation of the draft and final 1993 SEIS. For a detailed description of the scoping process for the 1992 OA/EIS, see Section 6.0 of that document.

6.1 AGENCY COORDINATION

6.1.1 Cooperating Agencies

This final SEIS was prepared by the Walla Walla District of the U.S. Army Corps of Engineers as lead agency. The Corps was supported by the BPA and BoR as cooperating agencies. The Corps and BoR share the primary responsibilities for operation of the Federal projects on the Columbia-Snake River System. The Corps is the lead agency because it designed, built, and operates most of the dams included in the project scope. BPA and BoR are cooperating agencies because the coordinated Columbia River System is operated as a single system. The Corps and BoR manage and operate the hydroelectric facilities while BPA markets the power.

NMFS was a cooperating agency for the draft SEIS because of their special expertise with respect to anadromous species. Because of its ESA responsibilities to review the proposed actions, NMFS established at the beginning of the SEIS process that it would not participate in development of conclusions relative to the effects of these actions on listed Snake River salmon.

On February 1, 1993, the Corps was formally notified that NMFS will no longer be a "cooperating agency" as defined in the CEQ's regulation under NEPA for preparation of this SEIS. NMFS determined "that serving as a cooperating agency would complicate or even appear to compromise our ESA responsibilities" (letter from Rolland A. Smith, Regional Director, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Seattle, Washington, February 1, 1993).

The FWS was not a cooperating agency but did participate in the SEIS. The FWS attended public meetings and commented on the draft SEIS, and prepared a draft Coordination Act Report (CAR) that is appended to the final SEIS. The Corps also consulted with FWS under Section 7 of the ESA with respect to potential effects on listed species under FWS jurisdiction.

The Corps held a series of coordination meetings with the cooperating agencies to define the scope of the SEIS (including issues, time, and geographic coverage), identify alternative actions, resolve analytical approach, and assign agency responsibilities. The cooperating agencies met while the SEIS was being developed, maintained their involvement through the SEIS review process, and also provided input into the final SEIS.

6.1.2 Other Agencies

As with the 1992 OA/EIS, the Corps sought agency participation throughout the development of the draft and final SEIS. Input was sought and considered from all agencies responsible for or

affected by river management practices. These other agencies were encouraged to submit any information that would be helpful for developing the final SEIS by reviewing and commenting on the draft SEIS. A total of 23 agencies provided verbal comment at the scoping meetings or submitted written comments for the 1992 OA/EIS.

The agencies or elected officials that provided written comments in response to the Notice of Intent for the draft SEIS included:

- Montana Office of the Governor
- Northwest Power Planning Council members John Brenden and Stan Grace (Montana)
- Idaho State Senator Marguerite McLaughlin
- Port of Whitman County
- Idaho Office of Attorney General, William S. Whelan

The cooperating agencies also conducted extensive coordination by telephone and through meetings with other agencies around the region. These contacts occurred throughout the SEIS process, and involved both policy-level discussions concerning proposed alternatives and their implementation and requests for specific information needed for the SEIS. Participants in these contacts included the full spectrum of Federal, State, and local government agencies and officials, plus a variety of organizations representing river users and other interested parties.

6.1.3 Coordination Activities

The Corps coordinated with other agencies throughout the SEIS process. The Corps and cooperating agencies evaluated comments on the draft SEIS after it was released for review. Comment letters and responses to comments on the SEIS are provided in Appendix H of this final SEIS. The Corps considered all public comments, written and oral, when choosing the preferred plan of action. Comments on the final SEIS will be considered in drafting the ROD.

Furthermore, consultation with NMFS under Section 7 of the ESA will occur, based on the Biological Assessment that will be submitted to NMFS. The coordination process involving the Corps, NMFS, and other agencies will continue while NMFS conducts its review and will conclude when NMFS issues a Biological Opinion for 1993 actions in March. Until a long-term operating plan is adopted, consultation under ESA is expected to occur for each year's operation.

With the 1992 OA/EIS, the Corps worked with NPPC to ensure that actions suggested for implementation in the EIS were consistent with NPPC's amendments. The Corps will work to maintain this consistency with NPPC with the actions that will be implemented from the final SEIS.

The Corps, cooperating agencies, and other parties in the region will continue to coordinate with the NPPC's four-phased amendment process for the regional Fish and Wildlife Program. This coordination is critical because, while the NPPC adopts amendments for action for the river system, it depends on the river management agencies to implement these actions. In addition, the Corps coordinates with NPPC through the Drawdown Oversight Committee, which is monitoring the long-term drawdown studies in the NPPC Phase II amendments.

The cooperating agencies were also involved in almost continuous coordination with the NPPC, NMFS, and the Fish Passage Center concerning 1992 river operations, and it is expected this will continue in 1993 and subsequent years. After the plan of action for 1992 operations was selected, the cooperating agencies, NPPC, and NMFS continued their coordination to implement the plan in response to actual conditions encountered in 1992. In addition, the Corps and the cooperating agencies coordinate river operations with NPPC through the Fish Operations Executive Committee. This activity also involved the Fish Passage Center, which depends on close daily interaction with the cooperating agencies to request flows and maintain water levels that will help the fish during the downstream migration. The Fish Passage Center, staffed by the member agencies of CBFWA has the responsibility to work very closely with the cooperating agencies to shape the annual Water Budget. After the final SEIS has been issued, a ROD, documenting interim actions, is scheduled to be signed in early April. The Corps expects that these 1992 coordination activities will continue after the ROD is issued as the actions from the SEIS are implemented. BPA will also issue its own ROD to assist in implementing SEIS actions.

6.2 PUBLIC INVOLVEMENT

The Corps and its cooperating agencies have shaped a public involvement program that has two main goals: (1) to inform and educate the general public and interested agencies and parties; and (2) to offer all interested individuals and groups the opportunity to provide meaningful input into the decision-making process. The Corps uses several methods to achieve these two goals, such as structured public meetings, factsheets to targeted mailing lists, public comment periods on draft and final documents, and press releases.

6.2.1 Pre-draft SEIS Public Information Meetings

As part of the process to provide information to the public, the Corps conducted a series of seven meetings in July 1992 to inform the public and interest groups about a number of ongoing Corps programs to benefit salmon in the Columbia and Snake River System. A primary objective of these pre-draft SEIS public meetings was to report on the results of the March 1992 drawdown test of lower Snake River dams and the status of possible system improvements for fish passage. In addition, the Corps discussed two study efforts: (1) the SCS, an extensive study of potential structural changes to enable long-term fish passage actions; and (2) this SEIS to address interim river management actions while long-term solutions are being developed.

The following information meetings were held from 7:00 to 9:00 p.m. About 330 people who were not affiliated with the cooperating agencies attended the seven information meetings. Attendance ranged from about 10 to 15 at Coulee Dam and Kalispell to 70 to 80 at Boise and Lewiston.

- July 6 - Portland, Oregon
- July 7 - Umatilla, Oregon
- July 8 - Pasco, Washington
- July 9 - Coulee Dam, Washington
- July 14 - Boise, Idaho
- July 15 - Lewiston, Idaho
- July 16 - Kalispell, Montana

LTC Robert Volz, U.S. Army Corps of Engineers, Walla Walla District, began each of the meetings by welcoming the audience, discussing the 1992 drawdown test, and explaining the SEIS and the SCS. His presentation was accompanied by a slide show, including graphics illustrating key points; artists' renditions of proposed improvements; pictures of the projects; and narrative discussion of the issues involved and the effects caused by the two-reservoir drawdown test. After his presentation, Colonel Volz introduced the leaders of the four discussion groups (SEIS, drawdown, system improvements, and SCS) and asked the audience to break up into groups, depending on their interest. However, because of a lower attendance level at the Coulee Dam and Kalispell meetings, the Corps opted to conduct these meetings as panel discussions.

The purpose of these discussion groups was to allow the public to voice any concerns, ask questions, or identify issues for consideration by the Corps. The Corps maintained an informal record of comments and concerns, and encouraged the public to submit any written concerns or questions at this time. Individuals or special interest groups who issued scoping-type comments are:

- Direct Service Industries, Inc.
- Northwest Irrigation Utilities
- Umatilla Electric Cooperative Association
- Columbia/Snake River Irrigators Association
- Tom Morse
- Steve and Donna Holberg
- Trout Unlimited

6.2.2 SEIS Public Involvement Program

Because the Corps and cooperating agencies feel that keeping the public informed and involved with ongoing and future issues on the Columbia-Snake River System is important, they provided several opportunities for the public to participate in and obtain information including through comment on the draft SEIS, factsheets, public meetings and hearings, press releases, and public notices.

The SEIS supplements the 1992 OA/EIS; because the impact issues remain essentially the same, there has been no additional formal scoping process specifically for the SEIS. The Notice of Intent to prepare the SEIS was published in the Federal Register on June 9, 1992. This was followed by a series of public meetings conducted (July 1992) by

the Corps to inform the public about a number of ongoing programs affecting the Columbia and Snake River users.

The draft SEIS was officially released to the public on October 23, 1992. Approximately 2,200 copies of the draft SEIS were sent to representatives of Federal, State, local, and tribal agencies; elected officials at Federal, State, and municipal levels; tribal organizations; public libraries; public utility districts; members of the agricultural, forest products, recreation, transportation, and other industry interest groups; environmental conservation organizations; and the general public. Release of the draft SEIS, and publication of the Notice of Availability in the Federal Register, opened a standard 45-day period for public review and comment. All comments postmarked within this period are addressed in the final SEIS. To provide additional opportunities for comment, the Corps held a series of public meetings in November.

Public Meetings/Hearings

After the draft SEIS was released, a series of nine public meetings was held from 7:00 to 10:00 p.m. in the same cities (with the addition of Orofino, Idaho and Libby, Montana) that hosted the July 1992 public information meetings.

- November 4 — Libby, Montana
- November 5 — Kalispell, Montana
- November 9 — Orofino, Idaho
- November 10 — Lewiston, Idaho
- November 12 — Boise, Idaho
- November 16 — Portland, Oregon
- November 17 — Hermiston, Oregon
- November 18 — Pasco, Washington
- November 19 — Grand Coulee, Washington

Each meeting had an introductory presentation consisting of a slide show, graphics, and maps; a narrative discussion of the issues involved and the anticipated effects; and a question and answer session allowing the public to ask questions of the agency staff responsible for preparation of the final SEIS. The meetings concluded with an official hearing to receive the formal public testimony on the draft SEIS. Public testimony from the hearing was transcribed word-for-word to ensure that all comments are documented. These hearings are in compliance with the NEPA requirement to provide a 45-day public comment period for EISs and supplements. In addition to oral testimony, the Corps accepted written comments on the draft SEIS during this comment period.

Approximately 221 people who were not affiliated with the Corps or cooperating agencies attended the nine public meetings. Attendance ranged from about 8 at Libby, Montana to 46 at Pasco, Washington. Of this number, 38 people offered verbal comment on the draft SEIS.

The Corps also received 75 letters regarding the document. Written and verbal comments were received from elected officials; representatives from Federal, State, local, and tribal agencies; members of the agricultural and recreation industries; representatives of local utilities; people from environmental conservation groups; members of local economic development councils; and unaffiliated individuals.

Factsheets

A series of factsheets to keep the public informed of ongoing activities is a part of the public involvement process. Factsheet No. 1 (issued October 14) announced the completion of the draft SEIS and provided information on the upcoming schedule, future opportunities for public involvement, and the public meetings scheduled for November. Factsheet No. 2 (to be issued in conjunction with the final SEIS) will summarize the final SEIS, describe the proposed interim actions, and explore opportunities for public comment. Factsheet No. 3 (issued after the ROD is signed) will summarize the information contained in the ROD. All issues of the factsheet will provide the names, addresses, and phone numbers of cooperating agency personnel to contact for more information.

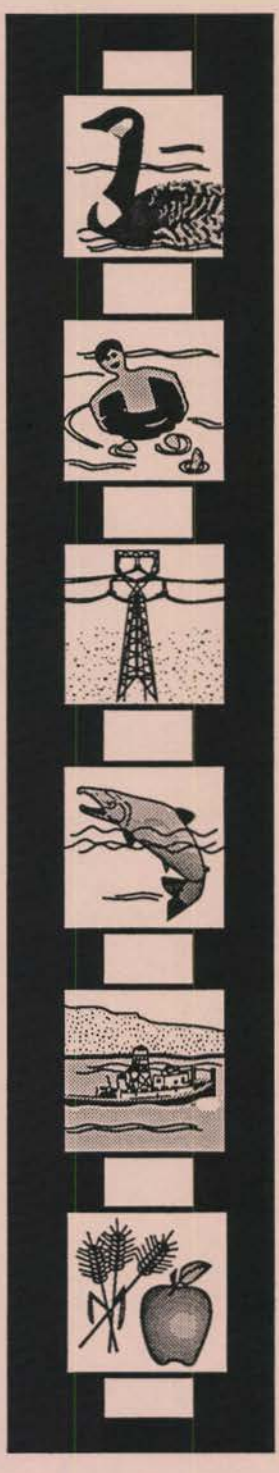
Press Releases and Public Notices

To stimulate interest and local media coverage, six press releases are to be issued over the course of the SEIS: (1) before the draft SEIS was released; (2) before draft SEIS public meetings/hearings; (3) before the final SEIS is released; (4) during the formal consultation with NMFS; (5) after the ROD is signed; and (6) when action is initiated. Press

releases cannot guarantee media coverage, but they can help facilitate media access to information from the Corps.

7.0

Compliance with Environmental Statutes



7.0 COMPLIANCE WITH APPLICABLE FEDERAL ENVIRONMENTAL STATUTES AND REGULATIONS

This section presents and analyzes the Federal statutes, implementing regulations, and orders that are potentially applicable to the proposed interim flow improvement measures.

7.1 ARCHAEOLOGICAL RESOURCES PROTECTION ACT

The Archaeological Resources Protection Act provides for the protection of cultural properties located on public and Indian lands, establishes permit requirements for the excavation or removal of cultural properties from public or Indian lands, and establishes civil and criminal penalties for the unauthorized appropriation, alteration, exchange, or other handling of cultural properties.

Implementation of any drawdown or flow augmentation measure could result in the new or increased exposure of cultural site areas. This in turn could lead to vandalism or an increase in on-going vandalism at cultural sites. Appropriate monitoring/surveillance methods and awareness programs will be developed to prevent or minimize vandalism. The Corps and BoR are prepared to take appropriate action, including prosecution, against individuals caught vandalizing cultural sites.

7.2 NATIONAL HISTORIC PRESERVATION ACT

The National Historic Preservation Act requires that Federal agencies evaluate the effects of Federal undertakings on historical, archeological, and cultural resources and afford the Advisory Council on Historic Preservation the opportunities to comment on the proposed undertaking.

The first step in the process is to identify cultural resources included on (or eligible for inclusion on) the National Register that are located in or near the project area. The second step is to identify the possible effects of proposed actions. The lead agency must examine whether feasible alternatives exist that would avoid such effects. If an effect cannot reasonably be avoided, measures must be taken to minimize or mitigate potential adverse effects.

The Corps and BoR, in coordination with the State Historic Preservation Offices and Native American tribes, are identifying cultural resources and sites in the project areas for inclusion on the National Register. In addition, the Corps is evaluating the effects of the proposed alternatives on these sites and measures that might be implemented to mitigate the potential effects. Implementation of any of the flow improvement alternatives would affect cultural sites to varying degrees. Larger areas of the cultural sites would be exposed at lower pool levels. Sites normally inundated might be exposed and subject to impacts from vehicular traffic, vandalism, and erosion from wind and waves. Repeated cycles of exposure and inundation might accelerate decomposition of organic materials contained within the sites. New reservoir operating conditions might require an accelerated program of site testing to determine National Register eligibility, and increased mitigation efforts.

7.3 NATIVE AMERICAN GRAVES PROTECTION AND REPATRIATION ACT

The Native American Graves Protection and Repatriation Act addresses the recovery, treatment, and repatriation of Native American and Native Hawaiian human remains and cultural items (associated funerary objects, unassociated funerary objects, sacred objects, and objects of cultural patrimony).

The implementation of any drawdown or flow augmentation measure could result in the exposure of Native American human remains and cultural items. In the event this should happen, the appropriate Indian tribe(s) and lineal descendants will be notified and the necessary actions taken to protect the burials as prescribed by law.

7.4 CLEAN AIR ACT

The Clean Air Act (CAA) establishes a comprehensive program for improving and maintaining air quality throughout the United States. The goals of the CAA are achieved through permitting of stationary sources, restricting the

emission of toxic and other pollutants from stationary and mobile sources, and establishing National Ambient Air Quality Standards (NAAQS). The CAA programs are implemented through combined Federal, State, and local efforts.

The proposed alternatives presented in the SEIS would likely increase fugitive dust emissions from the exposed reservoir shorelines and bottom areas. This increased particulate matter might affect the status of attainment areas (places where the NAAQS are met) and nonattainment areas. Depending on the amount of particulate matter released, attainment areas might be redesignated to a status of nonattainment while nonattainment areas, such as Wallula, Washington, might be unable to meet attainment dates set by the CAA.

In addition, reduced generation of hydroelectric power as a result of changes in river operations might indirectly cause additional air emissions from thermal power plants. These facilities, however, will not impair the air quality in the region because they are subject to New Source Performance Standards and permitting requirements that restrict the air emissions from such facilities to ensure that air quality is not degraded.

7.5 CLEAN WATER ACT

The Clean Water Act (CWA) sets national goals and policies to eliminate discharge of water pollutants into navigable waters, to regulate discharge of toxic pollutants, and to prohibit discharge of pollutants from point sources without permits. The CWA also authorizes EPA to establish water quality criteria that are used by States to establish specific water quality standards.

Dissolved gas supersaturation associated with Corps dams in the Columbia-Snake River System has routinely exceeded the EPA criterion and the Oregon and Washington water quality standards of 110 percent saturation. However, the Corps does not consider the release of water from its dams as point sources of discharge, but does everything practicable to meet State water quality standards.

The water quality issues pertaining to the flow improvement alternatives are increased turbidity, gas saturation levels, and higher water temperatures. The alternatives could cause further departure from required water quality levels. A larger volume of water spilled at the dams, over a longer time, could increase gas saturation values to as high as 140 percent. Although operating the lower Snake River projects near MOP would cause minimal turbidity, increased flow during spring and summer might increase turbidity for short periods. Lowered pool operation might also cause local water quality changes due to modifications in mixing zone characteristics. These changes might violate State water quality standards and State and Federal standards and conditions in National Pollutant Discharge Elimination System (NPDES) permits (for point source discharges to water). Changes in water temperatures are expected to be minimal.

7.6 ENDANGERED SPECIES ACT

The ESA, most recently amended in 1988, establishes a national program for the conservation of threatened and endangered species of fish, wildlife, and plants and the preservation of the ecosystems upon which they depend. Section 7(a) of the ESA requires Federal agencies to consult with the FWS and the NMFS, as appropriate, to ensure that the actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their critical habitats. Actions that might jeopardize listed species include direct and indirect effects, and the cumulative effects of other actions.

Section 7(c) of the ESA and the Federal regulations on endangered species coordination (50 CFR § 402.12) also require that Federal agencies prepare biological assessments of the potential effects of major construction actions on listed or proposed endangered species and critical habitat. The Corps is preparing two biological assessments, for submittal to FWS and NMFS, in compliance with this requirement.

The FWS identified four threatened and endangered species expected to occur in the vicinity of one or more of the potentially affected projects. Specifically, resident and migrant peregrine falcons and bald eagles are known to inhabit the area of these projects, and grizzly bears and gray wolves may use some of the affected project areas. Project-related impacts to peregrine falcons are not

expected because there is a substantial and diverse prey base for peregrine falcons. Project-related impacts to nesting and wintering bald eagles can be positive and negative depending on the location, time of year, time of day, and degree of pool lowering. Project-related effects on grizzly bears are not expected because the timing and location of these actions do not overlap with grizzly bear use patterns. Gray wolves, if they use any of the project areas, do not depend on the resources that would be affected by the proposed action.

The Snake River sockeye salmon was listed by the NMFS as an endangered species on November 10, 1991 (56 Federal Register 58619) effective December 10, and the Snake River fall and spring/summer chinook salmon were listed as threatened on April 22, 1992 (51 Federal Register 14653) effective May 22. The analysis presented in this SEIS is the result of concerns regarding these species. The proposed alternatives evaluated in the SEIS focus on potentially increased survival of these threatened and endangered species and other anadromous fish from reduced water particle travel time and flow.

Project-related impacts that might affect salmon survival include operations that decrease rearing habitat quality and quantity due to reservoir drafting, increased gas saturation, effects of turbines at hydroelectric dams, and reduction of water flows. Overall, the proposed action is expected to result in increased survival for migrating juvenile salmon, and thereby contribute to the recovery of the listed stocks.

7.7 FISH AND WILDLIFE COORDINATION ACT

The Fish and Wildlife Coordination Act requires consultation with FWS when any water body is impounded, diverted, controlled, or modified for any purpose. FWS and State agencies charged with administering the wildlife resources in the State will conduct surveys and investigations to determine the potential damage to wildlife and the mitigation measures that should be taken. The FWS incorporates the concerns and findings of the State agencies and other Federal agencies, including the NMFS, into a CAR that addresses fish and wildlife concerns and provides recommendations for mitigating or enhancing impacts to fish and wildlife affected by a Federal project. The Federal project must include justifiable measures that address the FWS recommendations and concerns. Federal agencies that construct or operate water-control projects are authorized to modify or add to the structure and operation of those projects to accommodate the means and measures for conservation of fish and wildlife.

Operation of the Snake River projects at MOP would reduce the amount of shallow-water habitat. Shallow-water habitat is important for spawning and rearing for a number of resident fish species, and their spawning success might be reduced. Spawning success, however, might increase due to stabilized water surface elevations. Additional impacts on vegetation and wildlife are outlined in the SEIS. The Corps is consulting with FWS regarding implementation of the proposed measures. The FWS has completed a draft CAR, which is appended to the final SEIS.

7.8 NATIONAL ENVIRONMENTAL POLICY ACT

NEPA provides a commitment to conduct Federal activities in a manner that protects the environment. It also requires that an EIS be included in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment. The SEIS must provide detailed information regarding the proposed alternatives, the environmental impacts of the proposed action, and any adverse environmental impacts that cannot be avoided if the proposal is implemented. Agencies are required to demonstrate that these factors have been considered by decision makers prior to undertaking actions.

The 1992 OA/EIS was prepared to assess Columbia and Snake rivers flow improvement measures for salmon during 1992. This Interim Flow Measures SEIS evaluates flow improvements for the Columbia and Snake rivers during 1993 and subsequent years to determine the most effective river operations to improve salmon migration conditions in the Columbia and Snake rivers, prior to the development of long-term plans that might involve significant construction actions. As part of the development of this document, public meetings were held after distribution of the draft SEIS.

Public comments received on the draft SEIS are responded to in Appendix H of the final SEIS. The development of this document complies with NEPA's requirements and implementing regulations.

7.9 EXECUTIVE ORDER 11988, FLOODPLAIN MANAGEMENT

If a Federal agency program will affect a floodplain, the agency must consider alternatives to avoid adverse effects in the floodplain or to minimize potential harm. Executive Order 11988 requires Federal agencies to evaluate the potential effects of any actions they might take in a floodplain and to ensure that planning programs and budget requests reflect consideration of flood hazards and floodplain management.

The real and potential impacts of the flow measures under consideration on flood control capability are considered negligible. Flood storage capacity at some upstream reservoirs could be diminished with flow augmentation measures, but this capacity would be shifted elsewhere to maintain overall system flood control capacity. Further, flood storage shifts would only be implemented if projected runoff were relatively low, in which case the risk of flooding would also be reduced. Lowered pool operation would enhance the flood control capacity of the system during the time of drawdown.

7.10 EXECUTIVE ORDER 11990, PROTECTION OF WETLANDS

Executive Order 11990 authorizes Federal agencies to take actions to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands when undertaking Federal activities and programs. Any agency considering a proposal that might affect wetlands must evaluate factors affecting wetland quality and survival. These factors should include the proposal's effects on the public health, safety, and welfare due to modifications in water supply and water quality; maintenance of natural ecosystems and conservation of flora and fauna; and other recreational, scientific, and cultural uses.

Emergent wetlands communities are prevalent in several areas under study. If these wetlands depend on full pool levels for water supply, through subirrigation or shallow inundation, the wetlands might be lost or species composition might be altered. Mudflats may also be exposed, and measures to minimize impacts to wetlands should be considered.

7.11 FEDERAL WATER PROJECT RECREATION ACT

In planning any Federal navigation, flood control, reclamation, or water resource project, the Federal Water Project Recreation Act requires that full consideration be given to the opportunities that the project affords for outdoor recreation and fish and wildlife enhancement. The Act requires planning with respect to the development of recreation potential. Projects must be constructed, maintained, and operated in such a manner if recreational opportunities are consistent with the purpose of the project.

Recreation sites have been developed at all of the Federal projects involved in the proposed action and are operated by a variety of entities. Developed facilities and informal use areas at the mainstem projects should experience minimal impacts from lowered pool operation. Use of recreation facilities at upstream storage reservoirs could be impaired as a result of flow augmentation, which could cause reservoir elevations to be lower than under normal operation. Specific types of impacts could include dewatering boat ramps, docks, marinas, and swimming beaches. Water-oriented campgrounds and day-use areas could become less desirable because of exposed shoreline and increased distance to water.

7.12 PACIFIC NORTHWEST ELECTRIC POWER PLANNING AND CONSERVATION ACT

The Northwest Power Act was passed by Congress on December 5, 1980. This law created the 8-member NPPC (an interstate agency whose members are appointed by Idaho, Montana, Oregon, and Washington governors). NPPC was entrusted with adopting a Fish and Wildlife Program for the Columbia River Basin by

November 1982 and preparing a 20-year Regional Electric Power and Conservation Plan by April 1983. These plans are periodically updated.

NPPC's Fish and Wildlife Program established a number of goals for restoring and protecting fish populations in the basin. These goals have led to changes in the operation of the coordinated Columbia River System. One of the most notable changes is the Water Budget, which provides for the release of specific amounts of water in the upper Columbia and Snake rivers to help juvenile salmon migrate downstream in the spring.

Both lowered pool operation and flow augmentation would temporarily reduce the power generation capability of the affected projects. The cooperating agencies are coordinating with the NPPC regarding the power generation implications of the proposed action.

The Act also directs the NPPC to provide fish and wildlife resources with equitable treatment in the operation of the river system and to prepare a program to manage and protect fish and wildlife resources. Through its Fish and Wildlife Program activities, the NPPC is developing its own proposals to protect the threatened and endangered salmon stocks. The NPPC has completed three phases of its four-phased approach to revise its Columbia River Basin Fish and Wildlife Program. The proposals evaluate mainstem survival, harvest, production, habitat, and flow measures that can be used to increase salmon and steelhead runs. The cooperating agencies have been coordinating with the NPPC to better integrate the proposed flow measures with the NPPC process for priority salmon actions. The SEIS alternatives incorporate the flow improvement measures adopted by the NPPC in December 1991.

7.13 CEQ MEMORANDUM, ANALYSIS OF IMPACTS ON PRIME OR UNIQUE AGRICULTURAL LANDS IN IMPLEMENTING NEPA

The CEQ Memorandum establishes criteria to identify and consider the adverse effects of Federal programs on the preservation of prime and unique farmland; to consider alternative actions, as appropriate, that could lessen adverse effects; and to ensure the programs are consistent with all State and local programs for protection of farmland. The proposed actions were determined not to have a direct impact on prime or unique agricultural lands; direct impacts would be confined to the reservoirs. Proposed reservoir operations have been specified so as not to interrupt the supply of water to irrigated prime farmlands, and they would not displace or diminish the productive capacity of these lands.

7.14 COASTAL ZONE MANAGEMENT ACT

Federal agencies conducting or supporting activities directly affecting the coastal zone must conduct or support those activities in a manner that is consistent with approved State coastal zone management programs. A State coastal zone management program (developed under State law and guided by the Act) sets forth objectives, policies, and standards to guide public and private uses of lands and waters in the coastal zone. The coastal zone as defined in the Act extends inland to the extent necessary to control shorelines.

Washington and Oregon have approved coastal zone management programs, both of which list 7 types of Federal activities directly affecting the coastal zone. The upper boundary of the coastal zone is downstream of Bonneville Dam. The proposed actions would have minimal or no effect on water levels or use downstream of Bonneville Dam.

7.15 ESTUARY PROTECTION ACT

The purpose of the Estuary Protection Act is to establish a program to protect, conserve, and restore estuaries. It includes provisions to Federally manage estuarine areas in coordination with States and requires that all Federal projects consider impacts on estuarine areas. The Act does not affect an Agency's authority for existing programs within an estuary. The impact of the proposed action on the Columbia River estuary would be minimal or nonexistent.

7.16 LAND AND WATER CONSERVATION FUND ACT

The Land and Water Conservation Fund Act (LWCFA) assists in preserving, developing, and ensuring accessibility of outdoor recreation resources. The LWCFA establishes specific Federal funding for acquisition, development, and preservation of lands, water, or other interests authorized under the ESA and National Wildlife Refuge Areas Act and grants to States and localities. Numerous recreation sites and public land parcels along the affected projects have been acquired or developed with LWCFA monies. Although maintenance and use of these resources could be temporarily impaired by the proposed actions, the intended uses would not be precluded or displaced on a long-term basis. Because the uses of these recreational sites and public land would not be precluded, temporary project-related impacts would be consistent with the LWCFA.

7.17 MARINE PROTECTION, RESEARCH, AND SANCTUARIES ACT

The Marine Protection, Research, and Sanctuaries Act regulates dumping of material into the ocean and prevents or strictly limits the dumping of any material that would adversely affect human health, welfare, the marine environment, ecological systems, or economic potentialities. Because the Corps proposed action will not result in the dumping of material into the ocean, the Act does not apply.

7.18 RIVERS AND HARBORS ACT

The Rivers and Harbors Act prohibits constructing bridges, dams, dikes, or causeways over harbors or navigable waters of the United States without approval of the Corps. The Act also prohibits any obstruction to the navigable capacity of any waters of the United States.

Under the alternatives, the impacts to commercial navigation would be minimal or nonexistent. Operation of the projects at MOP elevations would maintain water levels at or above the authorized 14-foot minimum channel required for barge shipping and transfer operations. Log transportation operations at Dworshak would experience minimal elevation limitations. Currently, log dump sites are operable at elevations down to 1,570 feet and are constrained during annual drawdown periods. Under current operations, the reservoir reaches elevation 1570 on about June 15 and remains at that level until late September. The proposed flow augmentation measures would result in drawdown patterns similar to current operations, and would not decrease the period for log dump operations.

7.19 WATERSHED PROTECTION AND FLOOD PROTECTION ACT

The purpose of the Watershed Protection and Flood Protection Act is to protect watersheds from erosion, floodwater, and sediment damages. It provides assistance programs to local organizations to conduct investigations and surveys, prepare plans and estimates, develop soil and water conservation practices, and install improvement works for protection of watersheds. The proposed alternatives do not appear to violate any watershed protection requirements.

7.20 WILD AND SCENIC RIVERS ACT

The Wild and Scenic Rivers Act designates qualifying free-flowing river segments as wild, scenic, or recreational. The Act establishes requirements applicable to water resource projects affecting wild, scenic, or recreational rivers within the National Wild and Scenic Rivers System, as well as rivers designated on the National Rivers Inventory. Under the Act, a Federal agency may not assist the construction of a water resources project that would have a direct and adverse effect on the free-flowing, scenic, and natural values of a wild or scenic river. If the project would affect the free-flowing characteristics of a designated river or unreasonably diminish the scenic, recreational, and fish and wildlife values present in the area, such activities should be undertaken in a manner that would minimize adverse impacts and should be developed in consultation with the NPS.

Several portions of the Snake River have been designated under the Wild and Scenic Rivers System. The Hells Canyon reach of the Snake

River is of primary interest, which is downstream of Brownlee Reservoir. Flow augmentation options involving release of stored water from Brownlee would temporarily elevate flows in Hells Canyon over what would otherwise occur. However, these flow levels would be well within the range of regulated flows normally experienced in Hells Canyon. The Corps is coordinating with the U.S. Forest Service, which administers this reach of the river.

Several tributaries to the Snake and Columbia rivers have also been added to the Wild and Scenic Rivers System. These include portions of the Klickitat and White Salmon rivers in Washington and the Sandy, Deschutes, John Day, Grande Ronde, and Imnaha rivers in Oregon. The proposed actions would not adversely affect these protected resources.

7.21 NATIONAL WILDLIFE REFUGE SYSTEM ADMINISTRATION ACT

The primary purpose of the National Wildlife Refuge System Administration Act is to consolidate various categories of wildlife ranges and refuges for management under one program. The Act provides protection for both wildlife and refuge lands from destruction and injury. The Act also provides authority for the regulation of hunting and fishing within refuge boundaries. Two National Wildlife Refuge (NWR) areas are located within the project areas: Umatilla NWR (located near John Day) and McNary NWR (located at the confluence of the Snake and Columbia rivers). Although the proposed alternatives are expected to have minimal impacts on these wildlife areas, refuge lands might be affected by the proposed flow measures. Wetlands in the Umatilla NWR might be lost or species composition might be altered if the wetlands are dependent on full pool levels for water supply. The Corps will consider means to minimize impacts to refuge lands.

7.22 COLUMBIA RIVER GORGE NATIONAL SCENIC AREA ACT

On November 17, 1986, Congress established the Columbia River Gorge National Scenic Area (Scenic Area) as a Federally recognized and protected area [Public Law (P.L.) 99-663]. The Scenic Area Act also created the bi-state Columbia River Gorge Commission and directed the Commission and the U.S. Forest Service to jointly develop a management plan for the Scenic Area. The management plan will reflect legislatively established purposes, which include a mandate to protect and provide for the enhancement of the scenic, cultural, recreational, and natural resources of the Scenic Area. The Commission adopted a management plan on October 15, 1991. Counties affected by the plan have been encouraged to adopt ordinances consistent with this plan. The plan establishes land use designations for lands within the Scenic Area and specifies broad policies that provide for the protection of resources within the Scenic Area. The proposed project actions would have no effect on visual, recreation, or other conditions on the Columbia River within the Scenic Area, and therefore, are compatible with the plan.

7.23 WATER RESOURCES DEVELOPMENT ACT OF 1990

Congress generally authorizes water resources projects through biennial legislation, such as the Water Resources Development Act (WRDA) of 1990. Section 310(b) of WRDA 1990 requires public participation in changes to reservoir operation criteria. Section 415(b) requires public notification (hearings) of actions associated with drawdown of Dworshak Reservoir. The SEIS process is in compliance with these requirements.

7.24 MIGRATORY WATERFOWL ACT

The Migratory Waterfowl Act, 16 U.S.C. §§ 715 et seq., requires that lands, waters, or interests acquired or reserved for purposes established under the Act be administered under regulations promulgated by the Secretary of the Interior. These regulations must conserve and protect migratory birds in accordance with treaties entered into between the United States and Mexico, Canada, Japan and the Union of Soviet Socialist Republics; must protect other wildlife, including threatened or endangered species; and must restore or develop adequate wildlife habitat. The migratory birds protected under this Act are specified in the respective treaties. In regulating these areas, the Secretary of the Interior is

authorized to manage timber, range, agricultural crops, and other species of animals, and to enter into agreements with public and private entities.

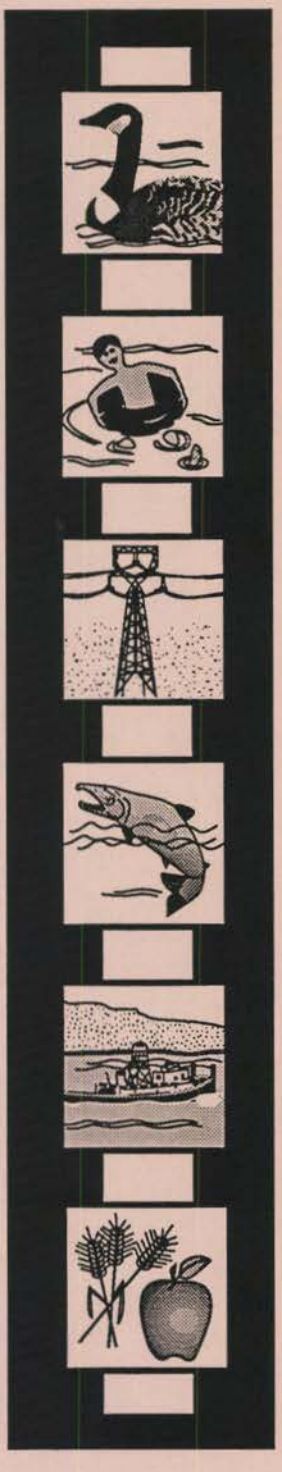
Some Umatilla National Wildlife Refuge lands at Crow Butte on the John Day Pool were acquired as Special Law Lands and transferred to the United States Department of Interior. Any migratory birds, specified in the aforementioned treaties, inhabiting this National Wildlife Refuge are protected under the provisions of this Act and the international treaties. Operating John Day Pool near elevation 262.5 could potentially affect island-nesting waterfowl that are protected under the Migratory Waterfowl Act. These impacts include exposure of mudflats between emergent marsh community and open-water habitat that could result in the predation loss of ducklings that are unable to use emergent marsh habitat for escape. Impacts to Canada goose nests at the John Day Pool are not expected because no landbridging of islands is anticipated. Mitigative measures such as construction of dikes, installation of pumps, and provision of water distribution systems to maintain backwater habitat and emergent marshed areas on the National Wildlife Refuge could be implemented to protect and conserve migratory waterfowl protected under this Act.

7.25 STATE AND LOCAL PLANS AND LAWS

The CEQ regulations (40 CFR § 1506.2) require consideration of the consistency of a proposed action with approved State and local plans and laws. Given the schedule demands for the SEIS and the extremely large number of State and local jurisdictions within the study area, the cooperating agencies have not been able to review all of the individual plans and laws that may be applicable. Based on the orientation and typically limited applicability of State and local authorities to the Federal multi-purpose projects, the cooperating agencies assume the proposed actions would generally be consistent with State and local plans and laws. Because most local planning ordinances establish restrictions for development and growth in areas, local ordinances will generally not be applicable to the proposed flow measure alternatives.

8.0

List of Preparers



8.0 LIST OF PREPARERS

The Interim Flow Measures SEIS was prepared by an interdisciplinary team consisting of the U.S. Army Corps of Engineers, the Bonneville Power Administration, the Bureau of Reclamation, and the National Marine Fisheries Services. Ebasco Environmental, a consulting firm under contract to the Corps, helped the cooperating agency team in developing the SEIS. Ebasco was assisted by BST and Associates, operating as a subcontractor. In addition, information was provided by Don Chapman Consultants, Inc., regarding fisheries issues; Dr. David Bennett of the University of Idaho regarding resident fisheries issues; and Washington State University, Center for Northwest Anthropology, regarding archaeological research. Contributions by individual preparers were subject to revision during the internal review process.

Individuals responsible for preparing this SEIS are listed in Tables 8-1 through 8-9, organized by agency and consultant. Because of the number of people involved in coordinating this study, the information presented in these tables is limited to the names, education and years of experience, experience and expertise, and general roles these individuals had in developing the SEIS.

Table 8-1. List of preparers, U.S. Army Corps of Engineers, Walla Walla District.

Name	Education/Years of Experience	Experience and Expertise	Role in SEIS Preparation
Peter Poolman Environmental Resource Specialist	B.S. Forest Mgmt. 14 years	Environmental resources coordination Natural resource management	Study manager
Teri Barila Fisheries Biologist	M.S. Fisheries Mgmt. 11 years	Fisheries management Fisheries biology	Flow survival Bypass Transportation
Anneli Carlson Environmental Resource Specialist	B.S. Candidate Environmental Policy 1 year	Environmental resources coordination	Environmental coordination Public involvement
Linda Carter	5 years	Outdoor recreation planning	Visitation statistics
Paul Fredericks Economist	M.A. Economist 28 years	Economics	Navigation
Dave Hurson Fisheries Biologist	B.S. Fisheries 15 years	Fisheries biology	Fish bypass
Dan Kenney Fisheries Biologist	B.S. Fisheries Mgmt. 8 years	Fisheries management Fisheries biology	Resident fish
John Leier Archaeologist	M.A. Anthropology/Archaeology 11 years	Archaeology Cultural resources	Cultural resources
Mark Lindgren Hydraulic Engineer	M.S. Civil Engineering 15 years	Hydraulic engineering	Fish passage Spillway characteristics Water quality
John Maxson Hydraulic Engineer	B.S. Civil Engineering 18 years	Hydrology Hydraulic engineering	Travel time and velocities
Lonnie Mettler Wildlife Biologist	M.S. Wildlife Resources 12 years	Wildlife management Wildlife biology Endangered species Wetlands ecology	Fish and wildlife coordination Act compliance ESA compliance
Tom Miller Limnologist	M.S. Biological Sciences B.S. Natural Sciences 4 years	Aquatic ecology Water quality Limnology	Water quality
Chris Pinney Fisheries Biologist	M.S. Aquatic Ecology B.S. Zoology 6 years	Fisheries biology	Lifecycle model coordination

Table 8-1. List of preparers, U.S. Army Corps of Engineers, Walla Walla District (continued).

Name	Education/Years of Experience	Experience and Expertise	Role in SEIS Preparation
Sandy Shelin Wildlife Biologist	B.S. Wildlife Science 13 years	Wildlife biology Environmental resources coordination	Environmental coordination
Gina Trafton Economist	B.A. Economics 5 years	Economics	Irrigation Socioeconomics
Sarah Wik Fisheries Biologist	M.S. Environmental Science B.S. Biology 12 years	Fisheries management Fisheries biology Water quality Limnology	Water quality Fisheries Reservoir drawdown test

Table 8-2. List of preparers, U.S. Army Corps of Engineers, Portland District.

Name	Education/Years of Experience	Experience and Expertise	Role in SEIS Preparation
Richard A. Cassidy Environmental Engineer	B.A. Biology M.S. Zoology M.S. Env. Engineering 22 years	Aquatic biology Hydraulic engineering Environmental engineering	Water quality Reservoir regulation
Geoff Dorsey Wildlife Biologist	M.S. Wildlife Science B.S. Wildlife Science 12 years	Wildlife science Wildlife biology	Wildlife resources
John Ferguson Fisheries Biologist	M.S. Aquatic Ecology B.S. Fish & Wildlife Biology 16 years	Fisheries	Anadromous fish Flow survival Turbine passage
Arthur C. Fong Civil Engineer	M.S. Soil Mechanics B.S. Engineering 16 years	Soils engineering Foundations/embankments Geotechnical engineering	Irrigation mitigation Soils and geology Geotechnical engineering
Jerry Gardenhire Civil Engineer	B.S. Forest Engineering 20 years	Civil engineering	Mitigation Recreation
Philip L. Grubaugh Geotechnical Engineer	B.A. Geology 39 years	Geology Geotechnical engineering	Geology Geotechnical engineering Foundation/materials Groundwater
L.D. Hamilton Environmental Specialist	M.A. Geography/Biology B.A. Geography 18 years	EIS coordination, writing, editing Community planning Outdoor recreation planning	Team leader OA/EIS coordination In-lieu fishing
Joseph Hise Economist	M.A. Economics B.S. Economics 21 years	Regional economics	Socioeconomics
Gary A. Johnson Fisheries Biologist	B.S. Zoology 19 years	Fisheries biology	Adult/juvenile passage Mitigation Propagation
Kim W. Larson Fisheries Biologist	M.S. Fisheries B.S. Zoology 19 years	Fisheries biology	Resident fish Predation Juvenile migration
Ed Magner Hydraulic Engineer	M.S. Civil Engineering B.S. Civil Engineering 18 years	Hydraulic design Hydraulic performance mathematics	Projects design review Analysis of hydraulic impacts

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Table 8-2. List of preparers, U.S. Army Corps of Engineers, Portland District (continued).

Name	Education/Years of Experience	Experience and Expertise	Role in SEIS Preparation
Rock Peters Fisheries Biologist	B.S. Wildlife Science 14 years	Fisheries biology	Anadromous fish Juvenile fish Hatcheries
Brian Pillette Economist	B.S. Economics 1 year	Economics	Economics
Matthew Rea Outdoor Recreation Planner	B.S. Outdoor Recreation Planning 13 years	Recreation planning Master planning	Recreation
Mark R. Smith Fisheries Biologist	B.S. Fish and Wildlife Biology 3 years	Fisheries biology	Resident and anadromous fish
Jay Sturgill Physical Scientist	B.S. Geology 26 years	Geotechnical design Environmental assessment	Geology and soils
Lynda Walker Archaeologist	M.A. Anthropology B.S. Anthropology 17 years	Archaeology Outdoor recreation planning	Cultural resources

Table 8-3. List of preparers, U.S. Army Corps of Engineers, North Pacific Division.

Name	Education/Years of Experience	Experience and Expertise	Role in SEIS Preparation
James Barton Hydraulic Engineer	M.B.A. Management B.S. Civil Engineering 15 years	Hydraulic engineering	Hydroregulation
Celia Kool Civil Engineer	B.S. Civil Engineering 9 years	Civil engineering	Project coordinator
Adele Merchant Project Manager	B.A. Economics 13 years	Economic analysis Program/project management	Background summary
David Ponganis Civil Engineer	M.S. Civil Engineering B.A. Environmental Planning 13 years	Water resource planning Environmental assessments Policy and regulation	Project coordinator
Bolyvong Tanovan Hydraulic Engineer	Ph.D. Hydraulic Engineering M.S. Civil Engineering 29 years	Hydraulic engineering Fish studies/water quality Reservoir regulation Computer modeling	Temperature model studies Water quality review
Nancy Yun Hydraulic Engineer	B.S. Industrial Engineering 11 years	Computer modeling Project management	Temperature model studies

Table 8-4. List of preparers, U.S. Army Corps of Engineers, Seattle District.

Name	Education/Years of Experience	Experience and Expertise	Role in SEIS Preparation
David Rice Archaeologist	Ph.D. Anthropology 27 years	Cultural resources	Cultural resources at Libby
Jeff Laufle Fisheries Biologist	M.S. Fisheries 9 years	Fisheries biology	Fish bypass Resident fish issues
Jeffrey White Outdoor Recreation Planner	M.L.A. Landscape Architecture 14 years	Recreation planning Landscape architecture	Recreation impacts
Glen Singleton Hydraulic Engineer	B.S. Civil Engineering 9 years	Hydraulics Water quality	Water quality
Wayne Wagner Hydraulic Engineer	B.S. Geology B.S. Oceanography 20 years	Hydrology/hydraulics Water management	Reservoir regulation

Table 8-5. List of preparers, Bonneville Power Administration.

Name	Education/Years of Experience	Experience and Expertise	Role in SEIS Preparation
David Askren Environmental Engineer	M.S. Oceanography M.S. Civil Engineering B.S. Geological Oceanography B.S. Geology 18 years	Environmental engineering Modeling	Resource modeling
Tim Fisher Fisheries Biologist	M.S. Fisheries Biology B.S. Ecology 3 years	Fisheries biology Statistical analysis	Fisheries modeling
Jim Geiselman Environmental Engineer	M.S. Env. Engineering B.S. Agric. Engineering 9 years	Anadromous fish modeling	Anadromous fish effects
William Gordon Hydraulic Engineer	B.S. Civil Engineering 30 years	Hydraulic engineering	Power system coordinator
Rich Hinrichsen Center for Quantitative Science (University of Washington) Research Assistant	Post-M.S. Quant. Ecology M.S. Mathematical Sciences B.S. Mathematics 2 years	Anadromous fish modeling	Anadromous fish effects
Kathy Hoffman Hydraulic Engineer	B.S. Mathematics 22 years	Hydraulic engineering	Power effects
Chuck Korson Public Utilities Specialist	M.S. Natural Resource Mgmt. B.A. Biology B.A. Economics 13 years	Fisheries management Environmental analysis	EIS coordination Recreation impacts
Robert Neal Civil Engineer	B.S. Physics 13 years	Civil engineering	Power effects
Audrey Perino Industry Economics	M.A. Economics B.A. Mathematics 13 years	Economics Project management & coordination	Power effects
Terry Thompson Electrical Engineer	B.S. Electrical Engineering 24 years	Electrical engineering	Power effects

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Table 8-6. List of preparers, Bureau of Reclamation.

Name	Education/Years of Experience	Experience and Expertise	Role in SEIS Preparation
Richard Prange Environmental Specialist	B.S. Natural Resource Mgmt. 26 years	NEPA compliance Fisheries management Clean Water Act Section 404 Water resource planning ESA consultation	Upper Snake Reservoir System discussions
Frederick Crase Environmental Specialist	M.S. Biological Conservation 22 years	Ecology Fisheries management Environmental planning	Upper Snake Flow Augmentation Program
Ronald McKown Environmental Compliance	Ph.D. Speciation 23 years	Environmental compliance Biological studies	Grand Coulee Dam effects EIS coordination
Douglas James Environmental Officer	B.A. Sociology 29 years	Urban planning Demography	Agency input

Table 8-7. List of preparers, Northwest Power Planning Council.

Name	Education/Years of Experience	Experience and Expertise	Role in SEIS Preparation
Chip McConnaha Systems Ecologist	M.S. Fisheries 12 years	Fisheries management Modeling Fish passage	Fish passage modeling
Duane Anderson Fisheries Analyst	M.S. Marine Biology 7 years	Fisheries modeling Data management	Fish passage Lifecycle modeling

Table 8-8. List of preparers, Ebasco Environmental (consultant).

Name	Education/Years of Experience	Experience and Expertise	Role in SEIS Preparation
Chris Lawson Resource Planner	M.A. Geography B.S. Geography 14 years	Multidisciplinary environmental studies Hydroelectric operations Environmental assessments Regulations	Project manager
Judith Schneider Communications Specialist	B.A. English/History 23 years	Public involvement Communications Project management	Assistant project manager
Lisa Clark Air Quality Specialist	B.S. Physics/Math 3 years	Air pollution control Solid waste management Air permitting	Air quality
Peter Carr Public Involvement Specialist/ Technical Editor	B.S. Journalism 4 years	Public involvement Technical editing and writing	Agency coordination/ Public involvement
Greg Green Wildlife Biologist	M.S. Wildlife Ecology B.S. Biology 13 years	Marine studies Terrestrial studies Mammal studies	Terrestrial ecology
Karen Raffa Regulatory Analyst	M.PA. Environ. Mgmt. B.A. Political Science 1 year	Regulatory analysis Policy evaluation	Compliance with regulations
Domoni Glass Fisheries Biologist	B.S. Fisheries Biology 12 years	Fisheries management Fisheries biology	Resident fish
Mark Greenig Landscape Resource Planner	M.U.P. Urban Planning B.S. Landscape Arch. 11 years	Visual resources Recreation planning & design Site planning and design	Recreation & aesthetics
Kathy Godtfredsen Water Quality Specialist	Ph.D. Env. Engineering M.A. Env. Engineering B.S. Chemical Oceanography 1 year	Environmental chemistry	Water quality

Table 8-8. List of preparers, Ebasco Environmental (continued).

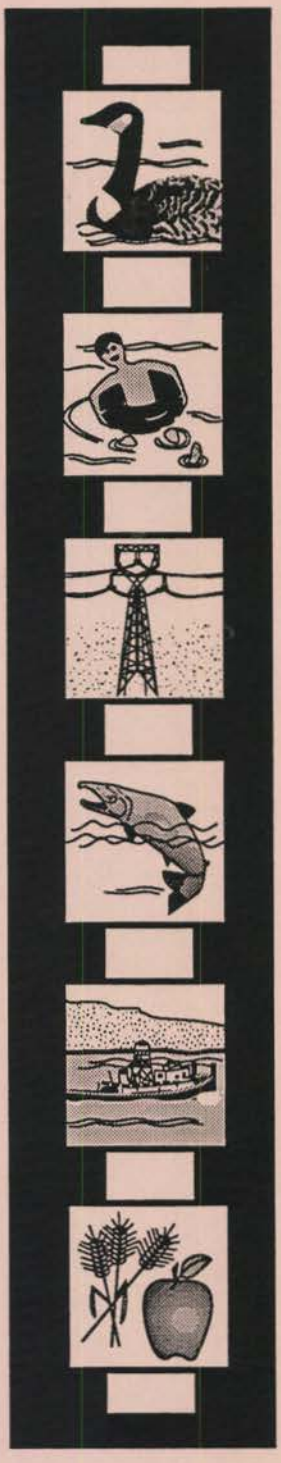
Name	Education/Years of Experience	Experience and Expertise	Role in SEIS Preparation
Garrett Jackson Geomorphologist	M.S. Geosciences B.S. Geosciences 5 years	Geomorphology Soil-vegetation associations Mapping stream channels Geologic hazard evaluation	Geology and soils
Irene Johnson Economist	M.A. Economics B.S. Economics 4 years	Natural resource economics Environmental economics Policy analysis	Economics Socioeconomics
Coreen Johnson-Dean Technical Editor	B.A. English 3 years	Technical writing and editing Document production	Lead editor Document production manager
Roger Kadeg Water Quality Specialist	M.S.E. Env. Engineering M.S. Analytical Chemistry B.S. Physics 15 years	Water quality Environmental chemistry Wastewater engineering Solid and hazardous waste management	Water quality
John Knutzen Aquatic Scientist	M.S. Fisheries B.S. Biology 13 years	Aquatic resources Water quality Fisheries	Anadromous fish
Jack Mowreader, P.E. Consulting Engineer	B.S. Civil Engineering 20 years	Civil engineering Water resource projects Environmental services	Project director Senior review
Tim Richards Graphic Artist	18 years	Graphic design/production Computer-generated graphics Illustration Architectural design	Graphics, illustrations
Lynn Skaves Graphic Artist	A.S. Business 10 years	Graphic design Desktop publishing Computer-generated graphics	Graphics
Bruce Stoker Geomorphologist	M.S.E. Civil Engineering M.S. Remote Sensing/Geology B.S. Geology 14 years	Geology Sediment transport Hydrology Slope stability	Geology and soils
Danene Warnock Graphic Artist	B.A. Anthropology 14 years	Graphic design Computer-generated graphics Desktop publishing	Graphics

Table 8-9. List of preparers, BST Associates (consultant).

Name	Education/Years of Experience	Experience and Expertise	Role in SEIS Preparation
Paul Sorensen Principal	M.A. Economics B.A. Economics	Waterfront planning and development Economic assessment	Transportation
Brian Winningham Economic Research	B.A. Business B.A. Economics	Economic research Economic modeling OA/EIS preparation	Transportation

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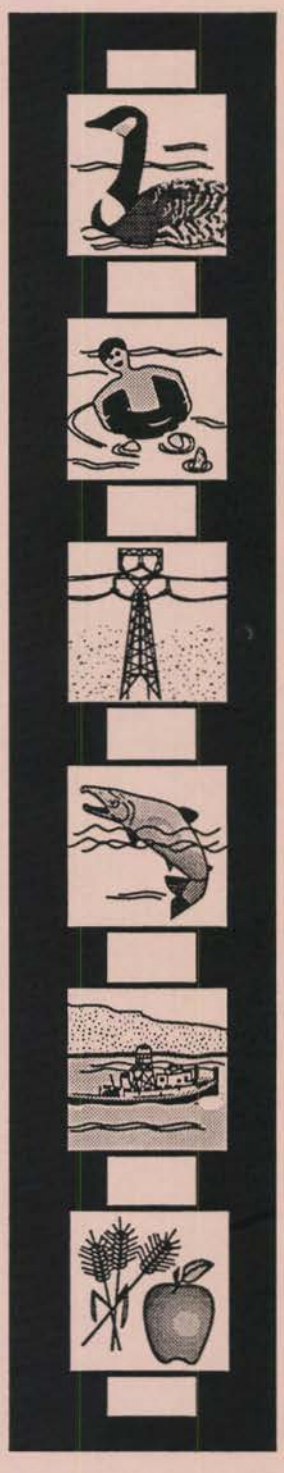
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Lyman Schwartzkopf

10.0

Glossary and Acronyms



10.0 GLOSSARY AND ACRONYMS

ACEC - Areas of Critical Environmental Concern

Acre-foot - The volume of water that will cover 1 acre to a depth of 1 foot.

Adfluvial - Fish that ascend from freshwater lakes to breed in streams.

AIWP - Annual Implementation Work Plan

aMW - Average megawatt; the average amount of energy (number of megawatts) supplied or demanded over a specified period of time.

Anadromous fish - Fish, such as salmon or steelhead trout, that are born in freshwater, migrate, to and mature in the ocean, and return to fresh water as adults to spawn.

Annual operating plan - A yearly plan for operating storage reservoirs on the Columbia River. Such a plan is specifically required by the Columbia River Treaty and by the Pacific Northwest Coordination Agreement.

Assured refill curve - A curve showing minimum elevations which must be maintained at each project to ensure refill, even if the third lowest historical water year occurred; it sets limits on the production of energy.

Augmenting - Increasing; in this application, increasing river flows above levels that would occur under normal operations by releasing water from storage reservoirs.

Baseload - In a demand sense, a load that varies only slightly in level over a specified time period. In a supply sense, a plant that operates most efficiently at a relatively constant level of generation.

BIA - Bureau of Indian Affairs

BKD - Bacterial kidney disease of salmonid fish

BLM - Bureau of Land Management

BNRR - Burlington Northern Railroad

BoR - Bureau of Reclamation

BP - Before the present time

BPA - Bonneville Power Administration

Bypass system - Structure at a dam that provides a route for fish to move through or around the dam without passing through the turbines.

CAA - Clean Air Act

Calibration - Adjustment of model processes to reflect known data.

Capacity - The maximum sustainable amount of power that can be produced by a generator or carried by a transmission facility at any instant.

Capacity/energy exchange - A transaction in which one utility provides another with capacity service in exchange for additional amounts of firm energy (exchange energy) or money, under specified conditions, usually during offpeak hours.

CAR - Coordination Act Report

CBFWA - Columbia Basin Fish and Wildlife Authority; represents regional fish agencies (state and federal) and tribes.

CEQ - Council on Environmental Quality

cfs - cubic feet per second

Corps - U.S. Army Corps of Engineers

CPO - Coordinated Plan of Operations

CRBG - Columbia River Basalt Group

CRGNSA - Columbia River Gorge National Scenic Area

CRiSP - Columbia River Salmon Passage Model

CRITFC - Columbia River Intertribal Fish Commission

Critical period - That portion of the historical 50-year streamflow record that would produce the least amount of energy with all reservoirs drafted from full to empty. For the past several years of planning, the critical period has been from September 1928 through February 1932.

Critical rule curves - A set of curves which define reservoir elevations that must be maintained to ensure that firm system requirements (both power and non-power) can be met under the most adverse historical streamflow conditions. Critical rule curves are derived for all four years in the critical period. They are used to guide reservoir operation for power.

CRM - Columbia river mile

CRSMA - Columbia River Salmon Mitigation Analysis; includes evaluations of short-term (such as the 1992 lower Granite and Little Goose reservoir drawdown) and long-term measures.

Cubic feet per second (cfs) - A unit of measurement pertaining to flow of water. One cfs is equal to 449 gallons per minute.

CWA - Clean Water Act

Demand - The rate at which electric energy is used, whether at a given instant or averaged over any designated period.

Discharge - Volume of water flowing in a given stream at a given time, usually expressed in cubic feet per second.

Displacement - The substitution of less expensive energy for more expensive thermal energy (usually hydroelectric energy transmitted from the Pacific Northwest or Canada to substitute for more expensive coal and oil-fired generation in California). Such displacement means that the thermal plants can reduce or shut down their production, saving money and often reducing air pollution.

Draft - Release of water from a storage reservoir.

Drawdown - The distance that the water surface of a reservoir is lowered from a given elevation as water is released from the reservoir. In the current EIS application, drawdown generally refers to elevational changes below MOP.

DSI - Direct Service Industry

Edaphic - Of or relating to soil, especially as it affects living organisms.

EIS - Environmental Impact Statement

ELCM - Empirical Life Cycle Model

Endemism - Native or limited to a certain region (endemic).

Energy content curves - A set of curves which establish limits on the amount of reservoir draft permitted for non-firm energy production.

EPA - U.S. Environmental Protection Agency

Epilimnion - A fresh water zone of relatively warm water in top layer of reservoir in which mixing occurs as a result of wind action and convection currents.

ESA - Endangered Species Act

Escapement - Number of salmon that actually return to a stream to spawn.

FELCC - Firm Energy Load Carrying Capacity; the amount of energy the region's generating system, or an individual utility or project, can be called on to produce on a firm basis during actual operations. FELCC is made up of both hydro and non-hydro resources, including power purchases. The hydro portion of FELCC is based on the energy that could be produced if critical period water conditions were to reoccur.

FGE - Fish guidance efficiency; the proportion of juvenile fish passing into the turbine intakes that are diverted away from the turbines and into bypass facilities.

Firm energy - Guaranteed or assured energy

Fish hatchery - A facility in which fish eggs are incubated and hatched and juvenile fish are reared for release to lakes or rivers.

Fish ladders - A series of ascending pools constructed to enable salmon or other fish to swim upstream around or over a dam.

Fish passage facilities - Features of a dam that enable fish to move around, through, or over without harm. Generally an upstream fish ladder or a downstream bypass channel.

Flip lips - Also known as spill deflectors; structural modifications made to the spillways of some Columbia-Snake River projects to deflect flows and reduce the deep plunging flows that create high-dissolved gas levels.

Flood control rule curve - A curve, or family of curves, indicating reservoir drawdown required to control flood flows. (also called Mandatory Rule Curve or Upper Rule Curve).

Flow - The volume of water passing a given point per unit of time.

FLUSH - Fish Leaving Under Several Hypotheses

fluvial - Of, pertaining to, or inhabiting a river or stream.

fmsl - feet mean sea level

Forebay - The portion of a reservoir at a hydroelectric project that is immediately upstream of the dam.

FPC - Fish Passage Center; institution that has the responsibility to monitor anadromous fish passage through the Columbia-Snake River System

FPDEP - Fish Passage Development and Evaluation Program

FPE - fish passage efficiency

FPP - Fish Passage Plan

fps - feet per second; a measure of water velocity.

Freshet - A rapid temporary rise in streamflow caused by heavy rains or rapid snowmelt.

FTOT - Fish Transportation Oversight Team

Full pool - The maximum level of a reservoir under its established normal operating range.

FWS - U.S. Fish and Wildlife Service

FY - Fiscal year; the annual period used for budgeting purposes; the Federal fiscal year begins October 1 and ends on September 30.

Gas supersaturation - Concentrations of dissolved gas in water that are above the saturation (100 percent capacity) level of the water. Excess dissolved gas can harm aquatic organisms.

Generation - Act or process of producing electric energy from other forms of energy; also the amount of electric energy so produced.

gpm - gallon per minute

HCNRA - Hells Canyon National Recreation Area

HMU - Habitat Management Unit

Hydraulic head - The vertical distance between the surface of the reservoir and the surface of the river immediately downstream from the turbine and dam.

Hydraulic jump - A transition in water flow when water accelerates over a local steep gradient and enters a lower gradient immediately downstream. The water accelerates, its surface lowers, and accumulates energy. At the lower gradient, the flow decelerates, the water surface rises, and the accumulated energy is dissipated in a region of extremely turbulent flow.

Hydroelectric - The production of electric power through use of the gravitational force of falling water.

Hydrology - The science dealing with the continuous cycle of evapotranspiration, precipitation, and runoff.

Hydrometeorological observations - Rainfall, snowpack, and other climatic measurements used to predict runoff.

Hypolimnion - A lower level of water in a stratified lake, characterized by a uniform temperature that is generally cooler than that of other strata in the lake.

HYSSR - Hydro System Seasonal Regulation

IDFG - Idaho Department of Fish and Game

INHP - Idaho Natural Heritage Program

Intake - The entrance to a turbine at a dam, a diversion works, or a pumping station.

Interchange energy - Electric energy received by one utility system usually in exchange for energy to be delivered to another system at another time or place. Interchange energy is to be distinguished from a direct purchase or sale, although accumulated energy balances are sometimes settled in cash.

Interruptible power - A supply of power, which by agreement, can be shut off on relatively short notice (from minutes to a few days).

IPC - Idaho Power Company

Jack - An early maturing male salmonid fish

Juvenile - The early stage in the life cycle of anadromous fish when they migrate downstream to the ocean.

kWh - kilowatt hour

KAF - thousand acre-feet

kcfs - 1,000 cfs

kV - kilo volt (1,000 volts)

Levee - An embankment constructed to prevent a river from overflowing.

Littoral - on or along the shoreline.

Load - The amount of electric power or energy delivered or required at any specified point or points on a system. Load originates primarily at the energy-consuming equipment of the customers.

Locks - A chambered structure of a waterway closed off with gates for the purpose of raising or lowering the water level within the lock chamber so ships can move along the waterway.

Low pool - At or near the minimum level of a reservoir under its established normal operating range.

LTSA - Long-Term Spill Agreement

LWCFA - Land and Water Conservation Fund Act

MAF - million acre-feet

Mainstem - The principal portion of a river in a river basin, as opposed to the tributary streams and smaller rivers that feed into it.

MDFWP - Montana Department of Fish, Wildlife, and Parks

Megawatts (MW) - A megawatt is one million watts, a measure of electrical power.

mg/l - milligram per liter

Mid-Columbia - The section of the Columbia River from Chief Joseph Dam to its junction with the Snake River.

mills/kwh - one tenth of one cent per kilowatt hour; for example, 35 mills/kwh equals 3.5¢ per kwh.

MOA - Memorandum of Agreement

MOP - minimum operating pool; the minimum elevation of the established normal operating range of a reservoir.

MRCs - mandatory flood control rule curves, refer to flood control rule curves

msl - mean sea level

MSP - maximum sustainable product

MW - megawatt(s)

MWh - megawatt hour(s)

NAAQS - National Ambient Air Quality Standards

NED - national economic development

NEPA - National Environmental Policy Act

NFH - National Fish Hatchery

NMFS - National Marine Fisheries Service

Nonpower operating requirements - Operating requirements at hydroelectric projects that pertain to navigation, flood control, recreation, irrigation, and other non-power uses of the river.

Nonfirm energy - Energy available when water conditions are better than critical; such energy is sold on an interruptible (non-guaranteed) basis. Also called secondary energy.

Northwest Power Pool (NWPP) - Made up of BPA, the Corps, BoR, and public and private utilities in the Northwest, British Columbia, and Alberta. The group's primary functions are administering the Pacific Northwest Coordination Agreement and Northwest Power Pool Committee activities. The NWPP maintains a central staff in Portland known as the NWPP Coordinating Group.

NPDES - National Pollutant Discharge Elimination System

NPPC - Northwest Power Planning Council

NPS - National Park Service

NRHP - National Register of Historic Places

NTU - Nephelometric turbidity units; a measure of the amount of suspended sediment in the water.

NWR - National Wildlife Refuge

OA/EIS - 1992 Options Analysis/Environmental Impact Statement

Offpeak hours - Period of relatively low demand for electrical energy, as specified by the supplier (such as the middle of the night).

ONA - Outstanding Natural Areas

ONHP - Oregon Natural Heritage Program

Operating limits - Limits or requirements that must be factored into the planning process for operating reservoirs and generating projects. (Also see operating requirements, below.)

Operating requirements - Guidelines and limits that must be followed in the operation of a reservoir or generating project. These requirements may originate in authorizing legislation, physical plant limitations or other sources.

Operating rule curve - A curve, or family of curves, indicating how a reservoir is to be operated under specific conditions and for specific purposes.

Operating year - The 12-month period, from August 1 through July 31, that is used for power system planning purposes.

Outages - Periods, both planned and unexpected, during which the transmission of power stops or a particular power-producing facility ceases to function.

PAHs - polyaromatic hydrocarbons

PAM - Passage Analysis Model

PCBs - polychlorinated biphenyls

PCPI - per capita personal income

Peak loads - The maximum electrical demand in a stated period of time. It may be the maximum instantaneous load or the maximum average load within a designated period of time.

PNEPPCA - Pacific Northwest Electric Power Planning and Conservation Act

PIES - Project Improvements for Endangered Species

Piezometer - A small-diameter well or other device for measuring groundwater levels.

PNUCC - Pacific Northwest Utilities Conference Committee

PNCA - Pacific Northwest Coordination Agreement. A binding agreement among BPA, the Corps, BoR, and the major generating utilities in the Pacific Northwest that stemmed from the Columbia River Treaty. The Agreement specifies a multitude of operating rules, criteria, and procedures for coordinating operation of the system for power production. It directs operation of major generating facilities as though they belonged to a single owner.

Pool - Reservoir; a body of water impounded by a dam.

ppm - parts per million

Project outflow - The volume of water per unit of time discharged from a project.

Proportional draft - A condition in which all reservoirs are drafted in the same proportion to meet firm loads.

PSC - Pacific Salmon Commission

PUD - Public Utility District

Pulsing - Use of augmented flow releases from Dworshak to move smolts through the river system. Pulsing is coordinated with the Water Budget and nighttime peaking attraction activities through the Fish Passage Center and NMFS coordination.

Redds - Salmon spawning nests in gravel.

Refill - The point at which the storage reservoirs of the hydro system are considered "full" from the seasonal snowmelt runoff.

Reliability - For a power system, a measure of the degree of certainty that the system will continue to meet load for a specified period of time.

Reservoir draft rate - The rate at which water, released from storage behind a dam, reduces the elevation of the reservoir.

Reservoir elevations - The levels of the water stored behind dams, stated in reference to mean sea level.

Reservoir storage - The volume of water in a reservoir at a given time.

Resident fish - Fish species that reside in fresh water throughout their lives.

Residualism - A condition in which migrating juvenile salmonid smolts lose their urge to migrate, physiologically revert to their freshwater life form, and remain in fresh water rather than migrate to sea.

RM - River mile

RNA - Research Natural Areas

ROD - Record of Decision

Rule curves - Water levels, represented graphically as curves, that guide reservoir operations.

Run-of-river dams - Hydroelectric generating plants that operate based only on available streamflow and some short-term storage (hourly, daily, or weekly).

Run-of-river reservoirs - The pools or impoundments formed behind run-of-river dams.

Salmonids - Of or pertaining to fish of the family Salmonidae, including salmon, trout, and steelhead.

SAM - System Analysis Model, a mathematical model developed and operated by BPA to simulate the operation of the integrated Northwest hydroelectric system.

SAR - smolt-to-adult return rates

SCS - System Configuration Study; long-term evaluations being conducted under the Columbia River Salmon Mitigation analysis.

Secondary energy - Hydroelectric energy in excess of firm energy, often used to displace thermal resources. Also called non-firm energy.

SEIS - Supplemental Environmental Impact Statement

Sensitivity - The degree to which a given outcome is subject to change based on changes in assumptions or input parameters. A sensitivity test is intended to compare the consequences of the same action under differing sets of assumptions.

Shaping - The scheduling and operation of generating resources to meet changing load levels. Load shaping on a hydro system usually involves the adjustment of storage releases so that generation and load are continuously in balance.

SHPO - State Historic Preservation Officer

SLCM - Stochastic Life Cycle Model

Smolt - A juvenile salmon or steelhead migrating to the ocean and undergoing physiological changes to adapt its body from a freshwater to a saltwater environment.

SOR - (Columbia River) System Operation Review

Spawning - The releasing and fertilizing of eggs by fish.

Spill - Water passed over or through a spillway or through regulating outlets without going through turbines to produce electricity. Spill can be forced, when there is no storage capability and flows exceed turbine capacity, or planned, for example, when water is spilled to enhance juvenile fish survival.

Spillway - Overflow structure of a dam.

SPM - System Passage Model

Storage reservoirs - Reservoirs that provide space for retaining water from springtime snowmelts. Retained water is released as necessary for multiple uses—power production, fish passage, irrigation, and navigation.

Streamflow - The rate at which water passes a given point in a stream, usually expressed in cubic feet per second (cfs).

Subyearlings - Juvenile fish less than 1 year old.

Surplus energy - Energy generated that is beyond the immediate needs of the producing system. This energy is frequently sold on an interruptible basis.

Tailrace - The canal or channel that carries water away from a dam.

TBR - transport-benefit ratio

TDG - Total dissolved gas

Thermal power plant - Generating plant which converts heat energy into electrical energy. Coal, oil and gas-fired power plants, and nuclear power plants are common thermal resources.

TPU - Transportation and public utilities

Tules - The name commonly applied to fall chinook salmon originating on the lower Columbia River.

Turbine - Machinery that converts kinetic energy of a moving fluid, such as falling water, to mechanical or electrical power.

ungulate - Hoofed mammals such as horses, cattle, and deer.

Upriver brights - The name commonly applied to fall chinook salmon originating on the middle Columbia River, primarily in the area below Priest Rapids Dam.

UPRR - Union Pacific Railroad

Usable storage - Water occupying active storage capacity of a reservoir.

Usable storage capacity - The portion of the reservoir storage capacity in which water normally is stored or from which water is withdrawn for beneficial uses, in compliance with operating agreements.

USFS - U.S. Forest Service

USGS - U.S. Geological Survey

Variable energy content curve (VECC) - The January through July portion of the energy content curve. The VECC is based on the expected amount of spring runoff.

Velocity - Speed; the time rate of linear motion in a given direction.

Water Budget - A part of the Northwest Power Planning Council's Fish and Wildlife Program calling for a volume of water to be reserved and released during the spring, if needed, to assist in the downstream migration of juvenile salmon and steelhead.

Water particle travel time - The theoretical time that a water particle would take to travel through a given reservoir or river reach. It is calculated by dividing the flow (volume of water per unit time) by the cross-sectional area of the channel.

Water Rights - Priority claims to water. In western states, water rights are based on the principle "first in time, first in right," meaning older claims take precedence over more recent ones.

WDW - Washington Department of Wildlife

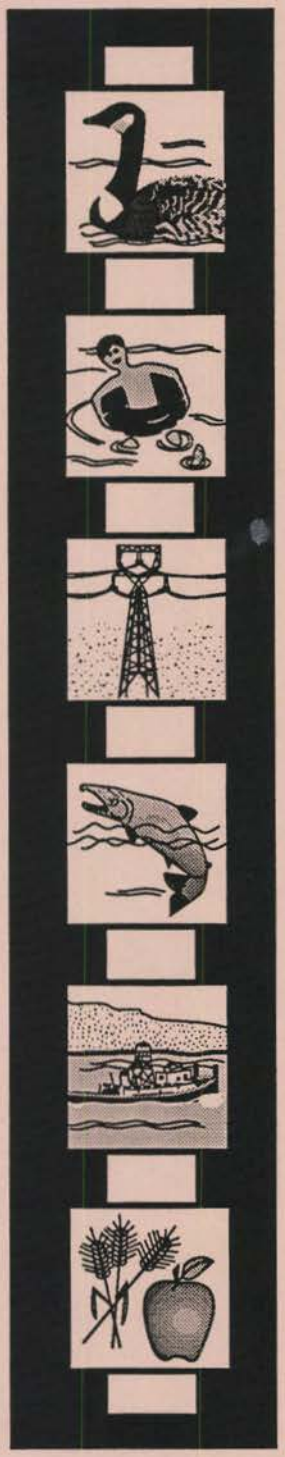
WNHP - Washington Natural Heritage Program

WRDA - Water Resources Development Act

Xerophytic - Plant types that are structurally adapted for life and growth with a limited water supply.

11.0

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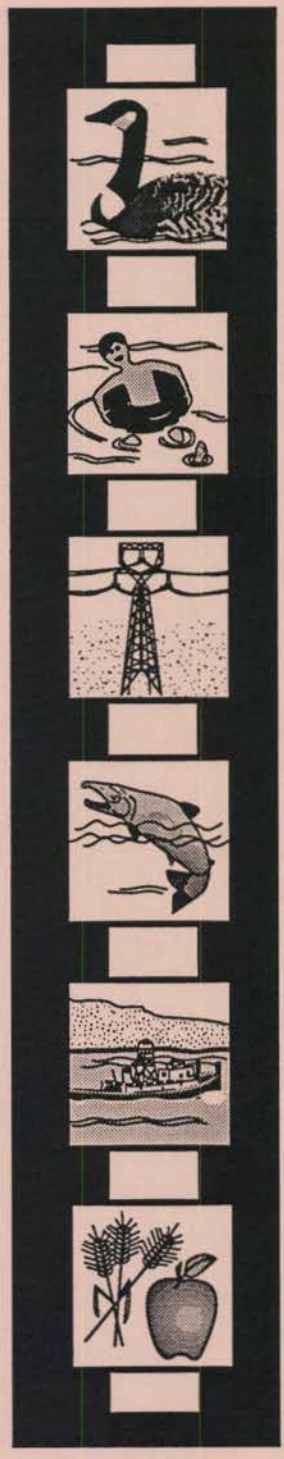
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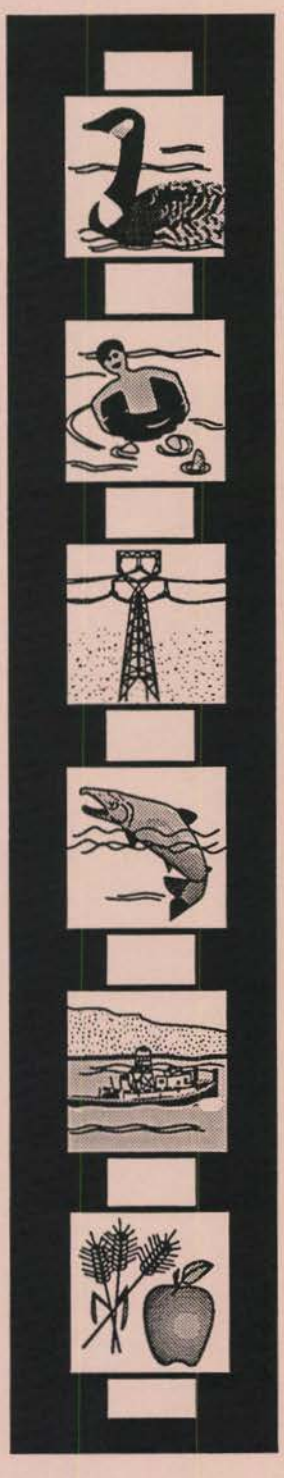
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Appendices



Appendix A

Historical and Current Salmonid Run Status and Effects

APPENDIX A
HISTORICAL AND CURRENT SALMONID RUN STATUS AND EFFECTS

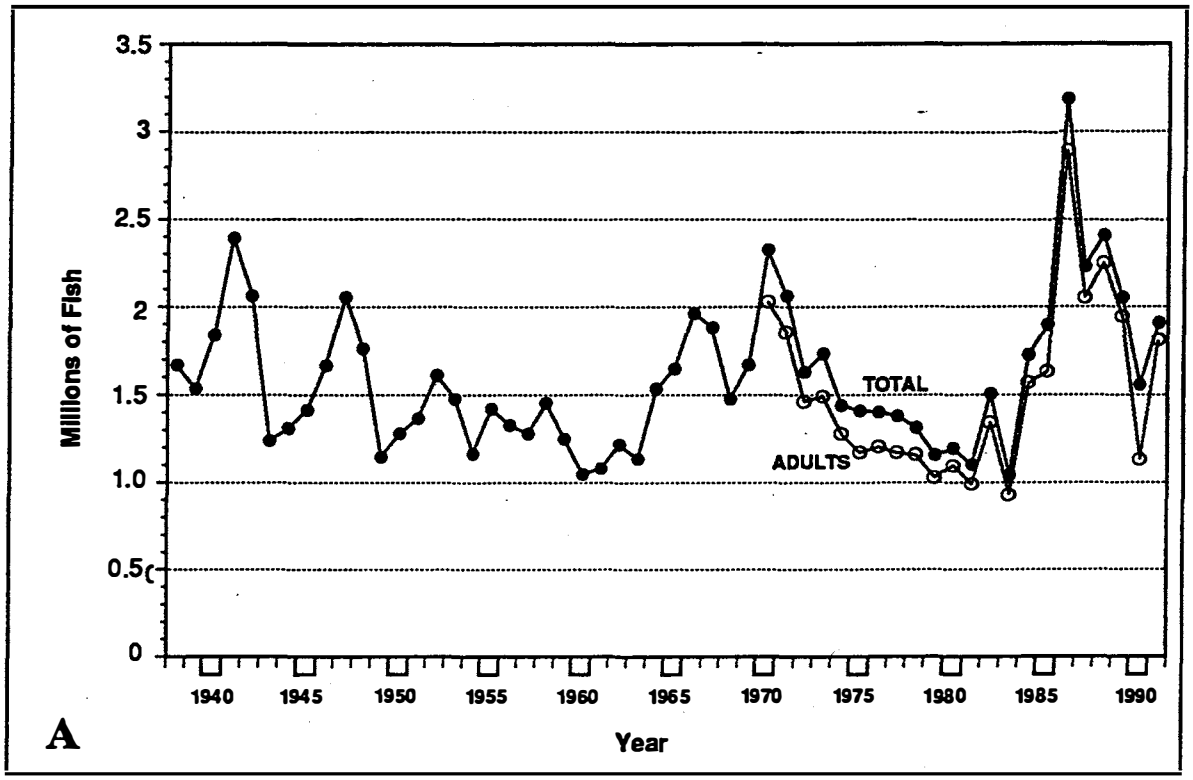
This appendix presents an overview of historical and current population trends for salmon and steelhead stocks in the region with an emphasis on the wild Snake River populations. It also attempts to put into perspective the causes of reductions in stocks over time and what actions, including hydroelectric operation modification, can and should be considered to enhance the current endangered runs.

1.0 RUN STATUS AND TRENDS

While factors affecting all regions and stocks of the Columbia River System are discussed in this appendix, the emphasis is on the endangered and threatened anadromous salmon stocks and their habitat. On December 20, 1991 the Snake River sockeye salmon was listed under the Endangered Species Act (ESA) as an endangered species. This was followed on May 22, 1992 by the ESA listing of the Snake River Basin fall chinook, and summer and spring chinook (considered as one spring/summer stock under the listing) as threatened stocks. The following discussion emphasizes in more detail the factors affecting these stocks and their primary rearing habitat in the Snake River Basin.

Before non-Native Americans developed the region, annual runs of anadromous fish to the Columbia River were estimated to be 8 to 16 million fish. Recent records indicate that the runs are about 2.5 million (including known fish harvested in the ocean), of which about 0.5 million are wild fish. Since 1938, the minimum estimate of total return of salmon and steelhead, not including ocean harvest, has ranged from 0.9 to 3.2 million fish (Figure A-1). In 1991, 1.9 million salmon and steelhead actually entered the Columbia River, excluding ocean harvest. About 0.5 million of these were wild fish (WDF and ODFW, 1992).

Columbia River harvest of chinook and sockeye beginning in 1886 is presented in Figure A-2 to indicate the historical run changes of these stocks. Before about 1940, most of the Columbia River stocks harvested were taken in the river, so the numbers are a good indication of run trends during this period. Significant decreases in these two stocks occurred before 1900; then again, after about 1920, abundance gradually decreased through 1940. Reductions occurred after 1940 in the stocks, but harvest in the Columbia River is not a reliable indicator of total runs because harvest in the ocean and farther upriver may have become significant factors. Runs decreased substantially from historical levels by 1940 for both chinook and sockeye. Greatly reduced harvests tracked this decline (Figure A-2). However, the minimum number of salmonids (hatchery and wild combined) entering the river and migrating over Bonneville Dam has not changed markedly since the dam was built in 1938 (Figure A-1).



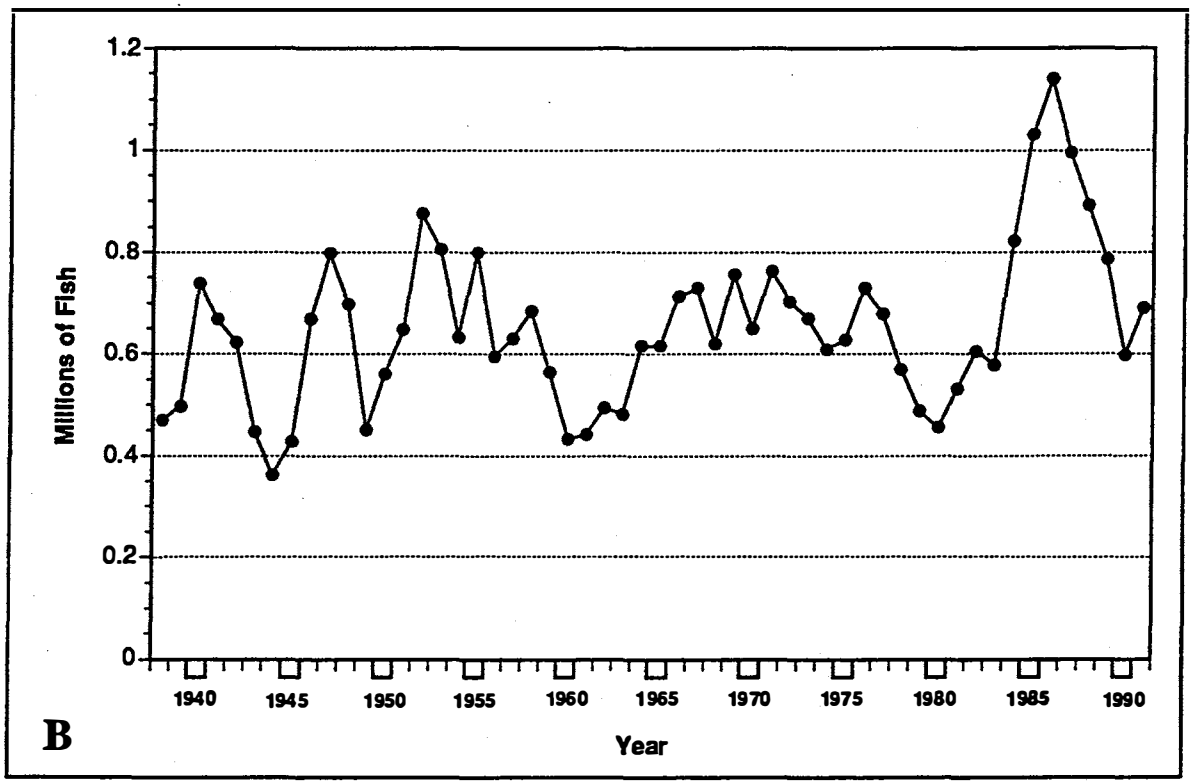
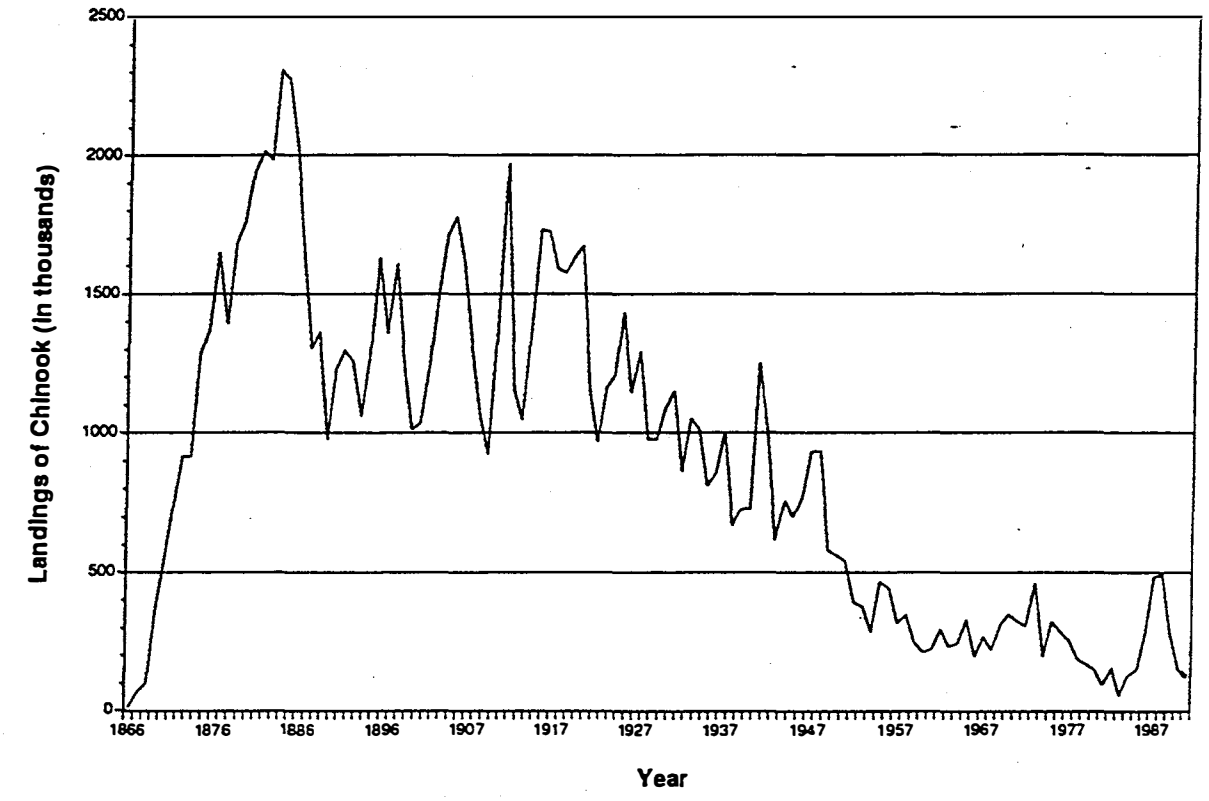


Figure A-1. Minimum numbers of salmon and steelhead entering the Columbia River (A) and migrating over Bonneville Dam (B), 1938 to 1991 (Source: WDF and ODF&W, 1992; Corps, 1991).



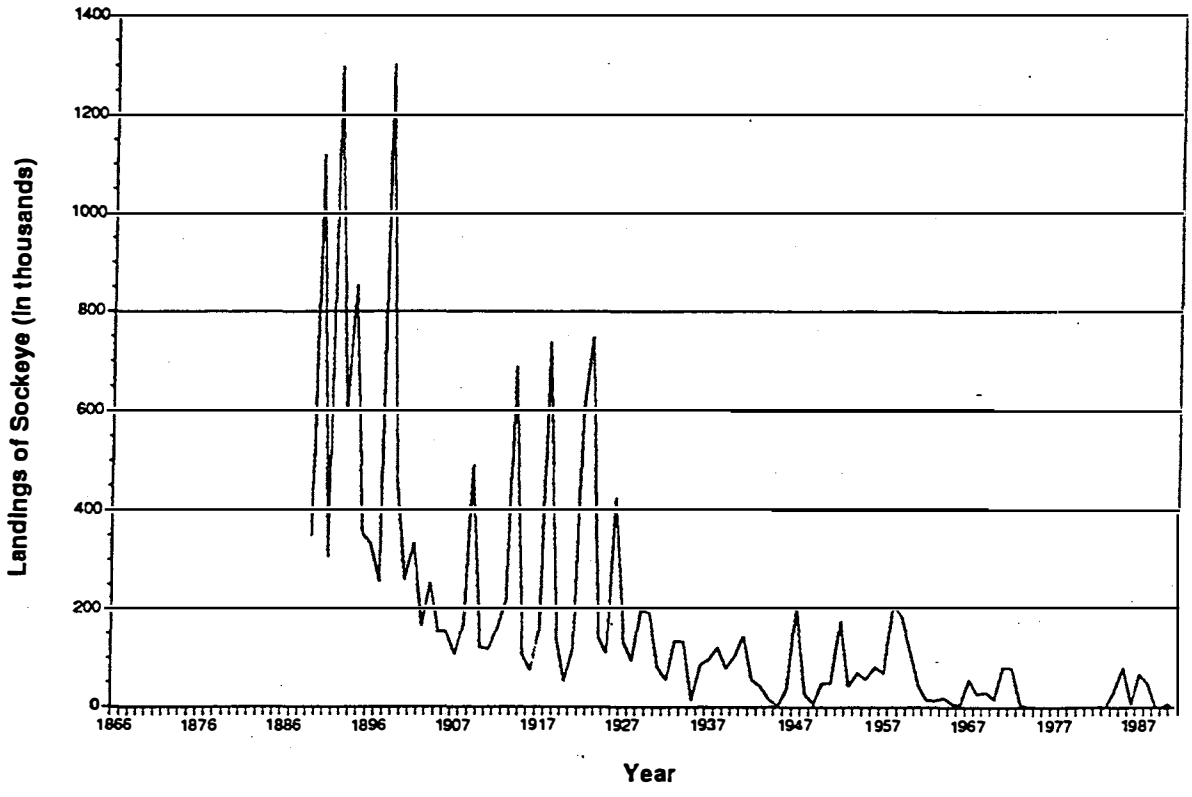


Figure A-2. Total commercial landings (thousands of fish) of chinook and sockeye salmon in the Columbia River, 1866 to 1990 (Sources: modified from NPPC, 1986; WDF and ODF&W, 1992).

1.1 SPRING CHINOOK

Recent regional trends in spring chinook stocks in the Columbia-Snake River System show different patterns. Recent counts at Bonneville and McNary dams indicate that upriver spring chinook stocks (both hatchery and wild) reached lows in the early to mid-1980s, then rebounded (Table A-1) until 1989 when they again declined, followed by a slight increase in 1990 and 1991 (PFMC, 1992a). Total escapement by wild and hatchery spring chinook to the upper basin (above McNary) increased sharply in 1992 to the highest level since 1988 (PFMC, 1992a; FPC, 1992a). Hatchery spring chinook stocks below Bonneville Dam have remained healthy; the largest inriver run since before 1971 occurred in 1990, and the 1991 run remained moderately high (PFMC, 1992a).

The low estimate of total chinook produced annually from the Snake River Basin prior to 1850, based on habitat capability, was 1.4 million fish. Other estimating methods suggest the run could have been twice this size. By the mid-1900s, historical abundance of spring and summer chinook from the Snake River had been reduced by 95 percent. Abundance has been decreased another tenfold in the last 30 to 40 years so that current populations of wild fish are only 0.5 percent of historical levels (Matthews and Waples, 1991).

The Snake River wild chinook population, as indicated by the number of spawning redds for summer and spring chinook combined, declined from 13,000 redds in 1957 to 620 redds in 1980 (Figure A-3). The number of redds increased gradually through 1988 to 3,395 but declined again to 1,008 in 1989 and 1,224 in 1990 (Matthews and Waples, 1991). Recent counts were 1,200 and 1,595 in 1991 and 1992, respectively (published and unpublished WDF, ODFW and IDFG data). Counts of natural spawning spring chinook over Lower Granite Dam (constructed in 1975) averaged 27,200 fish from 1975 to 1979. Since 1979, estimated (wild fish cannot be directly separated from hatchery fish when counted at the dams) runs have averaged 6,900 fish, with a low of 2,400 in 1991 (NPPC, 1992a).

1.2 SUMMER CHINOOK

Bonneville Dam counts indicate that upriver summer chinook populations rebounded somewhat from low numbers in the early 1980s to a slight peak in 1987 and have been declining since that time (PFMC, 1992a). About 65 percent of these fish are wild stock (CBFWA, 1991a), so this trend indicates a decline in wild runs. Snake River stocks showed an increase in escapement in 1990 over record low numbers in 1989, but decreased again in 1991 (PFMC, 1992a). One of the lowest escapements on record occurred in 1992, with only 3,000 hatchery and wild fish passing over Lower Granite Dam (FPC, 1992a). The exact counts of summer chinook are unknown, however, as some are included in the counts of spring chinook during some years. The date of counts at dams is set based on estimates of expected historical timing of arrival at Bonneville Dam, with a constant expected travel time added to each upstream dam passed. During warm flow years, some of the summer run might actually pass up river earlier and be counted as part of the spring chinook run. Natural spawning summer chinook decreased substantially from 1973 to 1979. Average counts over Lower Granite Dam, from 1975 to 1978 averaged 8,500 fish. Since 1979, estimated counts of natural stocks have averaged 3,100 with a low of 2,700 in 1988 (NPPC, 1992a). Matthews and Waples (1991) estimated actual escapement

Table A-1. Recent salmon and steelhead (including jacks) passage at selected Corps projects.

Species	Project		
	Bonneville	McNary	Lower Granite/Ice Harbor[a/]
Spring Chinook			
1971-80	118,801	48,143	32,208
1981-85	67,956	36,611	17,216
1986-90	100,621	53,621	28,664
1990	96,252	44,499	20,730
1991	61,228	22,631	11,288
1992[b/]	90,582	50,504	26,114
Summer Chinook			
1971-80	50,399	34,266	11,369
1981-85	27,076	18,228	4,972
1986-90	33,254	24,346	6,505
1990	28,021	22,248	5,794
1991	21,953	17,588	5,861
1992[b/]	19,245	14,413	4,363
Fall Chinook			
1971-80	209,027	62,838	4,282
1981-85	233,189	95,471	3,959
1986-90	340,026	161,335	6,277
1990	216,717	80,692	5,317
1991	191,441	74,622	6,026
1992[b/]	146,243	70,688	5,531
Steelhead			
1971-80	142,555	109,795	38,057
1981-85	238,979	117,211	83,338
1986-90	286,574	151,917	96,229
1990	183,027	95,061	56,859
1991	274,545	168,962	100,381
1992[b/]	312,955	203,341	113,362
Coho			
1971-80	50,832	12,693	749
1981-85	41,172	3,817	26
1986-90	52,467	1,888	0
1990	24,845	2,059	0
1991	64,057	2,272	0
1992[b/]	17,360	1,804	0
Sockeye			
1971-80	57,818	39,769	299
1981-85	105,136	47,597	127
1986-90	69,259	51,235	14
1990	49,581	46,145	0
1991	76,481	69,365	8
1992[b/]	84,998[c/]	68,732[b/]	14[b/]

Source: Corps, 1991; FPC, 1992b (1992 data only).

a/ For chinook, Ice Harbor counts were used for all years. For all other stocks, Ice Harbor counts were used for 1971 through 1974, and Lower Granite counts were used for all other years.

b/ Through 11/5/92 at Bonneville and 10/31/92 at others.

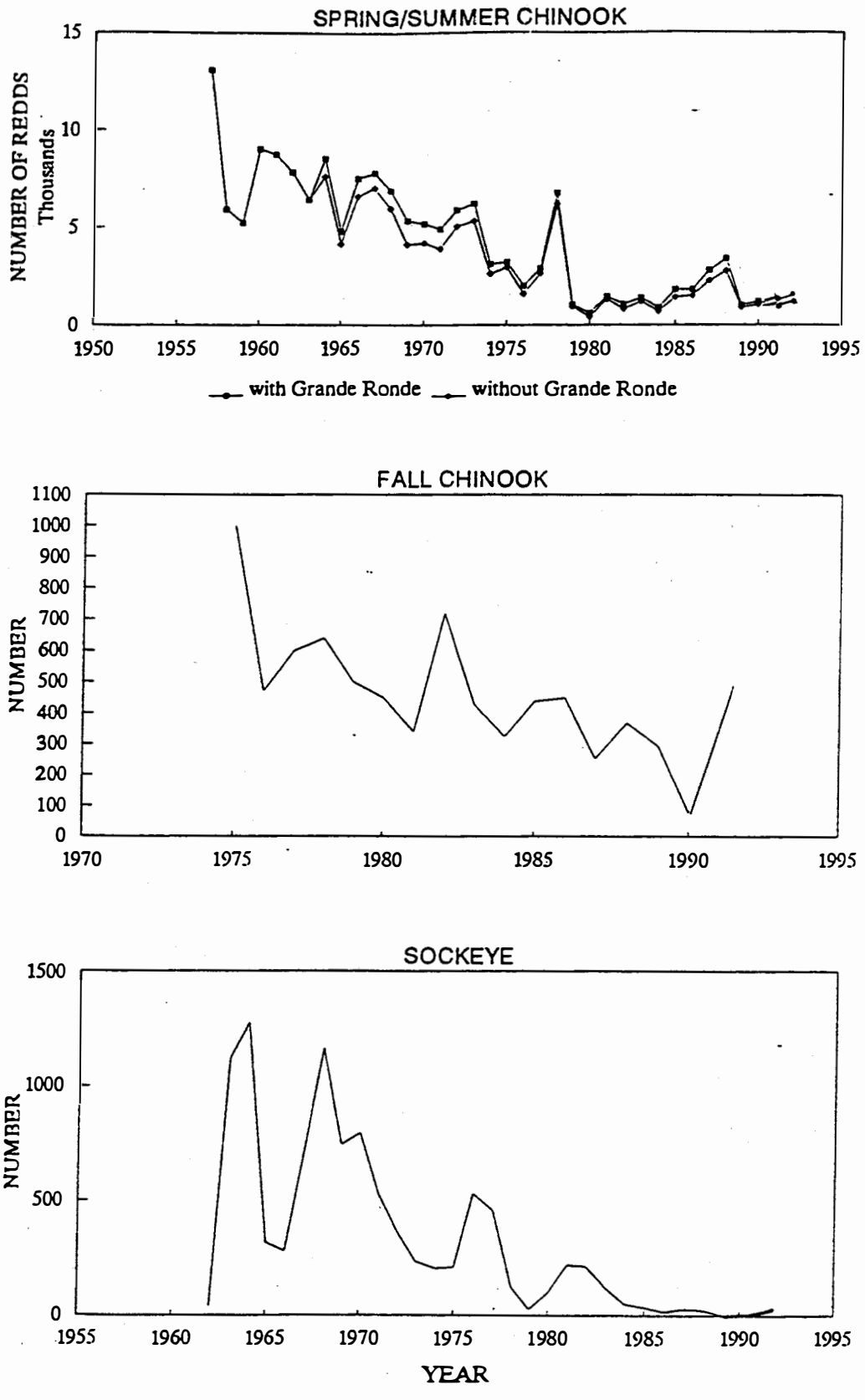


Figure A-3. Number of Snake River wild spawning spring/summer chinook (redds), wild fall chinook above Lower Granite Dam, and sockeye passing Ice Harbor (before 1975) and Lower Granite Dam (after 1974) (Sources: modified from Waples et al., 1991a; Matthews and Waples, 1991; and Corps, 1991).

to the spawning ground of both spring and summer chinook (Figure A-3) (see spring chinook above). Hatchery stocks, although slightly depressed in recent years, increased sharply in 1992.

1.3 Fall Chinook

The upriver bright wild fall chinook stock, the major wild fall stock that spawn above McNary Dam, has declined from record numbers in 1987, but this species remains more abundant than in most years since 1971 (PFMC, 1992a). Hatchery stocks from this region have followed a similar trend. Hatchery stocks (below Bonneville Dam) remain healthy, following a trend similar to upriver fish, except that 1990 showed a sharp decline in total river run (PFMC, 1992a). Hatchery stocks between McNary and Bonneville dams remain healthy in abundance but also had a sharp decline in 1990 (PFMC, 1992a).

The historical runs of fall chinook for the Snake River are unknown but were probably a large part of the total chinook runs. Abundance decreased early in the century after construction of Swan Falls Dam in 1910 blocked 150 miles of spawning habitat. By 1958 another 165 miles of spawning and rearing habitat was lost with the construction of Brownlee Dam. Other dams, including Hells Canyon (completed in 1967), cut off access to prime upstream spawning areas. The four lower Snake River projects also reduced spawning area. Estimated annual escapement went from an average of 72,000 fish in 1938 to 1949 to an average of 29,000 fish during the 1950s (Waples et al., 1991). By 1964 to 1968, average counts over Ice Harbor Dam were 13,000 fish. Through 1980, all fall chinook in the Snake River Basin were of wild origin. The Snake River wild fall chinook gradually declined from these levels to about 1,000 in the mid-1970s. Escapement ranged from 200 to 400 fish from 1983 to 1989, with a sharp decline to an estimated 78 fish in 1990 (Figure A-3) (Waples et al., 1991). However, in the last 2 years, estimated wild escapement has increased to 318 and 533 (preliminary estimation) in 1991 and 1992, respectively over Lower Granite Dam (personal communication, Larry Lavox, Harvest Management Fish Biologist, WDF, Clark County, Washington, February 2, 1993). The trend for Lyons Ferry Hatchery stock, the only active fall chinook hatchery on the Snake River, has been a decreasing return (Waples et al., 1991). Waples et al. (1991) noted that increasing numbers of stray fall chinook from the Umatilla River (up to 30 percent of all fall chinook in the Snake River) could have a negative effect on the genetic integrity and possibly the viability of the wild Snake River fall chinook stock.

1.4 Sockeye

Based on counts from Priest Rapids Dam, upper Columbia River wild stocks of sockeye salmon, excluding the Snake River, have remained healthy but have continued to decline since the large runs of 1984 and 1985 (Chapman et al., 1990). Recent sockeye return to the Columbia River has ranged from about 50,000 to 200,000 fish. Historically about 650,000 sockeye were produced in the system, the majority (about 500,000) in the upper Columbia River (NPPC, 1986). The historical run size of sockeye from the Snake River was estimated to be about 150,000 fish (NPPC, 1986). Much of the original rearing habitat, however, is no longer accessible. Current estimates of potential habitat availability for escapement to the remaining Sawtooth Valley lakes in the upper Salmon River is about 6,000 (CBFWA, 1991a). Much of this habitat, however, is currently inaccessible because of small blockages. Only Redfish Lake of the five lakes in this region currently is

accessible to sockeye. This lake has an estimated potential to produce 1,500 spawning adults (Chapman et al., 1990). The returns of sockeye destined for Redfish Lake have been less than 1,000 fish since 1970, and less than 100 since 1981 (Chapman et al., 1990). Based on counts past Ice Harbor, escapement averaged less than 20 fish from 1985 to 1988. Only two fish returned in 1989, and none in 1990 (Figure A-3). In 1991, eight sockeye passed Lower Granite Dam and four returned to Redfish Lake. In 1992, 14 fish passed Lower Granite Dam, but only one arrived at Redfish Lake. Escapement of kokanee to the lower system from their origin (such as Dworshak) poses concerns in correct quantification of the sockeye stock. Identification between the *O. nerka* forms is based predominantly on size.

1.5 Other Anadromous Stocks

The numbers of other anadromous stocks on the Columbia River show varying trends. Coho on the Columbia River, which are nearly all of hatchery origin (with less than 10 percent wild) have returned in abundance, with 1991 being the second largest return since 1970 (WDF and ODFW, 1992). Coho destined above Bonneville Dam have followed the same trend (PFMC, 1992a). Snake River coho have been extinct since 1987. Lower river winter steelhead runs, both hatchery and wild, have remained low in recent years (WDF and ODFW, 1992). Some up-river (above Bonneville) river summer stocks of wild steelhead have been depressed while others remain near Columbia Basin River Fish Management Plan interim escapement goals. In 1991, the returns of group A wild stocks were at their second lowest level in the 1984 to 1991 period, while the group B wild stock has remained above escapement goals, but has been below the goals in half of the years between 1984 and 1991. Hatchery stocks in 1991 of group A are the second lowest and group B the second highest runs since 1984 (WDF and ODFW, 1992).

Shad populations remained very high in the last decade. The two highest recorded runs occurred in the last 2 years, with nearly 3 million and 2 million shad passing over Bonneville Dam in 1990 and 1991, respectively (Corps, 1991). Counts past Lower Granite Dam increased substantially in 1992.

White sturgeon populations in the lower Columbia, below Bonneville Dam, are considered to be on the rebound after overexploitation in the mid-1980s (WDF and ODFW, 1992). The relatively non-migratory populations in the Columbia River Pools are considered depressed and have suffered relatively low productivity and high mortality from harvest. The stocks above The Dalles are considered to be even more depressed (WDF and ODFW, 1992). In the Hanford reach of the middle Columbia, the population probably is self-sustaining (personal communication, D. Dauble, Battelle Memorial Institute, Richland, Washington). In the Middle Snake River, the Hell's Canyon population may be stabilized with juvenile abundance in Lower Granite Pool rearing areas. These two populations have moderate juvenile recruitment with lower adult abundance, whereas the Kootenai River population is near threatened status due to weak juvenile recruitment and moderate overmature adult abundance because spawning conditions are not optimal. Hence, it is likely that populations with access to free-flowing river reaches available for spawning are more stable in that the juveniles can use the pools of recruits or tailrace habitat for rearing. Of the preferred habitat conditions, velocity is probably the most critical for distribution (personal communication, A.D. Bennett, University of Idaho, Moscow, Idaho).

Pacific lamprey are currently considered to be on the decline in the Columbia-Snake River System (Technical Advisory Committee, 1991). The exact numbers of past runs are unknown but their historical use by Native Americans indicates they were an abundant stock in the system. Historical harvest of this stock at Willamette Falls in the 1940s was 300,000 pounds per year. Current harvest is 3,000 to 11,000 pounds. This change in harvest suggests substantial reductions. Limited count data at Bonneville Dam in the 1960s indicated nearly 400,000 adult lamprey passed over the dam in the highest years. Counts at Bonneville powerhouse number 1 in 1989 and 1990 were only 34,000 and 2,000, respectively. Project biologists at Bonneville Dam have noticed marked reductions of their abundance in ladders in the past 5 to 10 years. The exact reason for the reductions is unknown but it appears to have coincided with development in the basin, including dams. Lamprey require cool, clean streams for spawning, which could have contributed to their reductions because this habitat has been decreasing with development. There does not appear to be an obvious problem in passing ladders at the dams, but effects on downstream migration are unknown. Historically, these stocks ascended the Snake River and as recently as the 1960s, 5,000 to 50,000 passed over Ice Harbor Dam. Currently, the numbers are so low that only very limited harvest by Native Americans occurs at regions above Bonneville Dam.

2.0 FACTORS AFFECTING RUN STATUS

As summarized by NPPC (1986), the decrease in salmon and steelhead populations has been an ongoing trend that began with the arrival of non-Native settlers (in the mid-1800s) to the Pacific Northwest.

> "The earliest identified negative human impact was fishing. Early harvest focused on chinook; when the chinook harvest declined after 1884, emphasis shifted to steelhead and sockeye (1890 to 1900), followed by chum and coho (1920s). By 1945, all species had declined significantly.
>
> Other impacts closely followed fishing. By 1900, mining had become important in areas of Oregon, Washington and Idaho. By 1925, there were major increases in land devoted to agriculture, and there were also major advances in irrigation and logging as well. By 1941, large hydropower projects (Rock Island, Bonneville and Grand Coulee dams) had been built. The period 1940 to 1965 saw major increases in logging and water storage for a variety of purposes including hydropower generation and irrigation."

A brief review of the apparent influence of these and other factors on the sizes of the runs follows.

2.1 HARVEST HISTORY

Methods of capturing fish on the Columbia River have changed dramatically. Historically, the Native Americans captured fish with methods ranging from gaffs to nets. The Native Americans constricted fish migration routes for major harvest; they harvested large numbers of salmon and steelhead at Celilo Falls above The Dalles. They fished from shore or platforms using dip nets (long-handled nets). This region was inundated in 1957 with the construction of The Dalles Dam, so Native American fishing changed from dip nets to set gill nets (anchored nets that catch fish by the gills) (NPPC, 1986). The region of the Columbia River between Bonneville Dam and McNary Dam is still commercially fished exclusively by Natives in this manner. Prior to

1939, Kettle Falls above Grand Coulee Dam was another major Native American fishing area where baskets and spears were used to harvest fish.

Aboriginal harvest of the Columbia River stocks, prior to the arrival of Europeans, (based on early estimates of native populations and reliance on anadromous stocks) was estimated to be about 42 million pounds (NPPC, 1986) or about 2.6 million fish annually (Chapman, 1986). Chapman (1986) estimated that, based on the likely characteristics of the fish stocks during this time, aboriginal harvest would not have decreased the production of the wild runs of fish.

Commercial fishing in the lower Columbia River has relied on various methods to harvest fish over the years. As harvests increased and concern for the runs became more apparent, many types of fishing gear were banned. Banned harvest methods include gaffs and spears, purse seine (a large net used to surround fish, either from boat or shore), whip seine (similar to purse seine), drag seine, set nets (anchored gill nets), traps (contains guides leading fish to trap), and fish wheels (large wheels with scoops placed near shore that turned with the current, scooping up migrating adult fish). Currently, the only commercial gear used on the lower Columbia River is drift gill nets (gill nets that drift with the current).

Commercial fishing was an industry on the Columbia prior to 1861 (NPPC, 1986). Rapid expansion of the industry occurred with catch equalling 2.3 million chinook in 1883, but after this period drastic reductions in chinook harvest occurred; in 1889, less than 1.0 million were taken (Figure A-2). This reduction was already primarily a result of overharvesting chinook stocks. The fishery at the mouth of the Columbia was initially on summer chinook; as catch diminished, the fishery shifted harvest to the less desirable fall and spring stocks. The industry also began to harvest other stocks, adding sockeye and steelhead in 1889, coho in 1892, and chum in 1893. Before European arrival, native harvest of all stocks was higher than current commercial harvest of chinook. Native harvest, however, was distributed among all stocks (not just chinook) and therefore did not cause a decline in overall population.

After an initial sharp decline in catch around 1890, harvest of chinook salmon in the Columbia River remained fairly constant to about 1920, then it gradually decreased from 1920 to 1966 (Fulton, 1968). Much of this decline can be attributed more to other sources of mortality (e.g., dams, logging, mining, and agriculture) and less to overharvest. A decreasing trend of Columbia River commercial harvest is apparent for both chinook and sockeye from the late 1800s to the present (Figure A-2). These figures do not account for all harvest of Columbia River stocks, particularly after the middle of the 19th century, primarily because of the growth of ocean harvest.

Until about 1912, when trolling began off the mouth of the Columbia, virtually all of the fishing was confined to the Columbia River. Beginning in about 1912, fishermen in small boats trolled baited hooks or lures. Later, larger boats were built that permitted harvesting in the salmon feeding areas farther offshore. Currently, this method harvests substantial numbers of Columbia River stocks feeding from Alaska to California. Ocean troll harvest of chinook salmon began to compete with river harvest in 1912 (NPPC, 1986). By 1919, the offshore fishery had expanded, with about 1,500 boats fishing off the mouth of the Columbia. By 1910, offshore fishing was also occurring off the coast of Vancouver Island and Cape Flattery. The number of boats fishing off the

mouth of the Columbia remained about the same until about 1951; however, fishing techniques and equipment had improved, with the offshore and coastal fishery taking a larger share of Columbia River stocks, particularly fall chinook and coho. By 1967, this offshore troll fleet equaled 2,400 vessels (Thompson, 1976). The first year of reporting of total coastal troll landings of chinook indicated that the total catch off Washington and Oregon was 6 million pounds of chinook and 6 million pounds of coho. By 1951, including British Columbia catch, the coastal troll catch was about 21 million pounds of chinook and 28 million pounds of coho (Beiningen, 1976). Many of these fish would have originated from the Columbia River but the proportion is not possible to determine. The peak ocean troll fishery for the west coast occurred in the early 1950s at about 35 million pounds of chinook captured from Washington, Oregon, California, Alaska, and British Columbia, with a following decline resulting partly from overharvest.

Ocean sport harvest of stocks also became a significant factor in later years. Sport fishing became a factor in the harvesting of Columbia River stocks after World War II (NPPC, 1986). Sport harvest has varied by region, basin, and stock, but accurate early records are not available. Beginning in 1960, when the first records were reported, Pacific coastal ocean sport harvest was about 200,000 chinook. This increased to a peak of about 900,000 chinook in 1975 and has since decreased to about 300,000 in the late 1980s. Spring chinook harvest in the lower mainstem Columbia was high in 1961 to 1974 but has decreased considerably since that time. Steelhead harvest in this region was also high in the 1960s but has declined substantially since then. Lower river tributary harvest by sport fishing has been variable, with some sport fisheries showing increases since the 1950s while others have not. In Idaho, Snake River sport harvest of chinook was high in the 1950s but has declined substantially since then with no sport harvest of wild chinook since 1978. Harvests of some stocks have been closed in many years since 1965. Steelhead harvest, decreasing from high levels in 1960 to record low levels in 1976, increased to high levels again by the early 1980s, while wild steelhead stock catch has often been catch and release only.

In the 1970s, including sport and commercial, more than 60 percent of the total chinook salmon run was harvested in the ocean, with the greatest portion of fish harvested off Alaska and British Columbia. Typically, less than 10 percent of the total chinook run was harvested in rivers during this period (NPPC, 1986). The 1985 U.S.-Canada salmon treaty has reduced harvest of U.S. fish in Canadian and Alaskan waters. However, the effect of this treaty on some stocks with Columbia River origin is in question. The U.S.-Canada treaty was mandated on the premise of equal benefit from each country's stocks to the country of origin. The U.S. harvest of Canadian stocks occurs primarily in Alaska on varied stocks and in the northern Puget Sound on sockeye and pink salmon. Currently, Canada's harvest of U.S. stocks occurs primarily off the west coast of Vancouver Island on coho and chinook. The Snake River fall chinook stock is currently harvested in high proportion in this region. NMFS, for example, estimated that in 1992 over 70 percent of all harvest of the Snake River fall chinook occurred off the west coast of Vancouver Island (memorandum from Robert Turner, Acting Director, State of Washington Department of Fisheries, Olympia, Washington, October 23, 1992). Currently, this treaty is under renegotiation, which may influence future harvest of these stocks; however, the direction and magnitude of future alterations in harvest regime is unknown at this time. Recent tag data indicate that ocean harvest of spring and summer Snake River chinook stocks is probably less than 1 percent of the total run (NMFS, 1992). The inriver harvest rate from 1986 to 1991 for the Snake River spring and summer chinook was 7.7 to 13.7 percent (NMFS, 1992). The Snake River fall chinook harvest rate was much higher, averaging

41.4 percent for ocean harvest and an additional 47.6 percent for inriver harvest, respectively (NMFS, 1992). Ocean harvest of sockeye has historically been rare. Although in recent years both Alaska and British Columbia have developed troll fisheries designed to intercept sockeye in the ocean, ocean harvest essentially does not occur for Snake River sockeye. The PFMC (1992b) reported that the total catch of sockeye from troll fisheries off the Washington, Oregon, and California coast was less than 100 fish a year since 1985. The fact that many other large sockeye stocks from the Fraser River, Puget Sound, Washington Coast, and upper Columbia River, numbering over a million fish in total, are present suggests that the chances of Snake River sockeye being among the small number of fish harvested is very low. Also, while British Columbia captures substantial numbers of sockeye in a troll fishery in late July and August, the run timing of Snake River sockeye indicates they would not be susceptible because they are believed to enter the Columbia River in June and July.

Sockeye harvest in the Columbia River before 1950 was up to 86 percent of the total run, declining to less than 60 percent during most years from 1950 to 1969 (Chapman et al., 1990). The inriver harvest rate during the low return years of 1974 and 1982 averaged less than 2 percent. With increased river returns during the 1985-to-1988 period, average harvest rates increased to 37 percent of the run. With low river returns, harvest rates were again low in recent years, at 4 percent in 1989 and less than 1 percent in 1990 and 1991. The proportion of Snake River sockeye in this harvest is unknown but probable similar timing of the runs suggests that harvest rates should be similar.

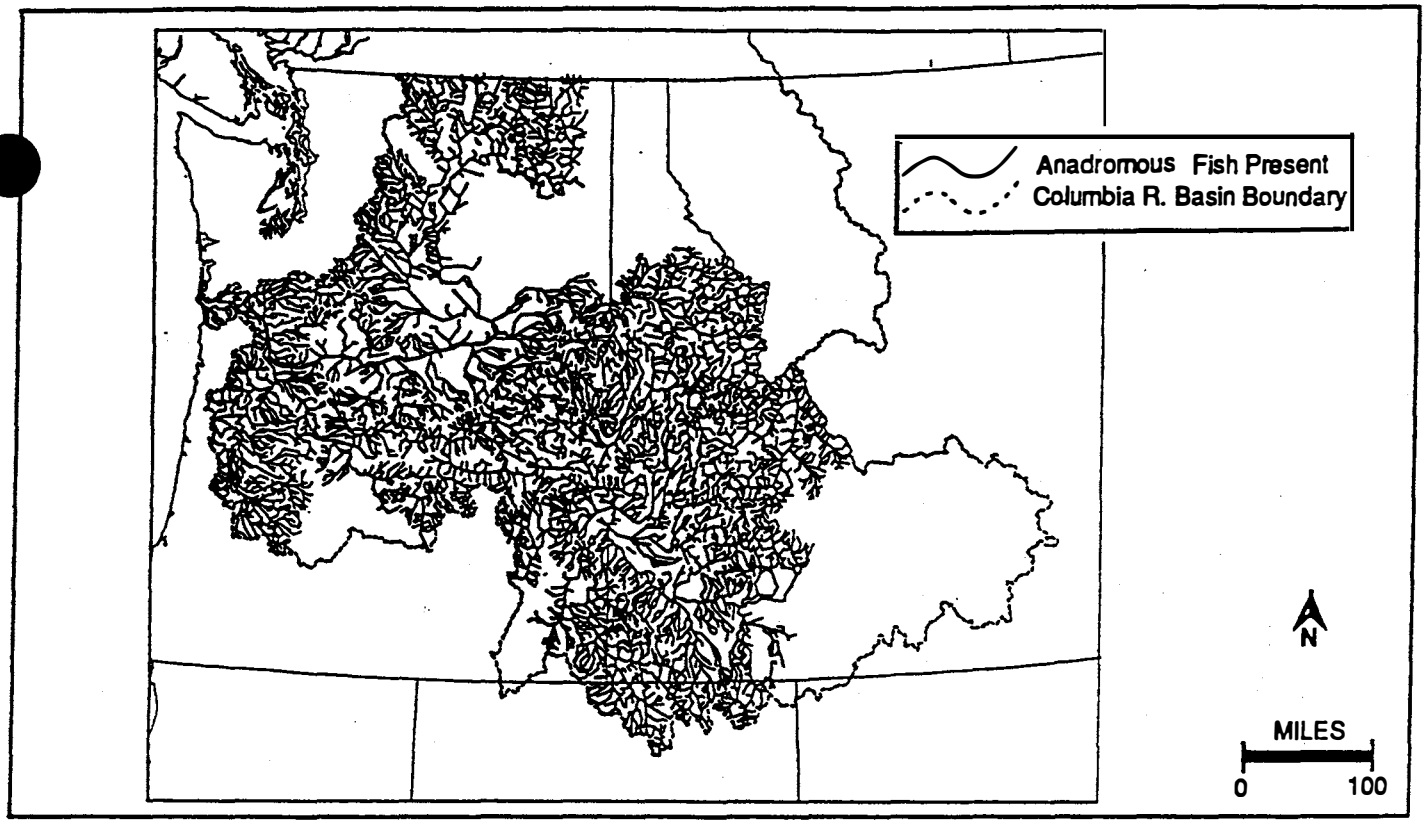
2.2 DAM DEVELOPMENT

Dam development in the Columbia River Basin began in the 1800s. Mainstem dam development began with Rock Island Dam on the Columbia River in 1933 and continued through 1975 with the completion of Lower Granite Dam on the Snake River. Most of the dams were constructed from the 1950s through the 1970s. Fourteen mainstem Columbia River and 13 mainstem Snake River dams were constructed in areas critical to the upstream and downstream migration of anadromous fish stocks. Including tributary areas, 136 dams have been built for hydroelectric and other purposes in the Columbia drainage (NPPC, 1986).

Dam construction has had varied effects on anadromous fish stocks. Dams without upstream fish passage facilities completely block access to spawning and rearing habitat for returning adults. Even where fish ladders or other upstream passage facilities are provided, returning adults may encounter delays and stress from increased water temperatures, water quality degradation, adverse flow conditions, and other factors associated with the dams. Dams and reservoirs also have had a significant effect on juvenile fish through mortality from turbine and spillway passage and by impeding their downstream migration and elevating risk factors, such as predation and disease, in the downstream journey.

2.2.1 Habitat Blockage

About 31 percent of all anadromous fish habitat (stream miles) that existed in the Columbia River Basin before development times has been blocked by dams (Figure A-4) (NPPC, 1986). Major habitat loss from blockage by dams has occurred in nearly all major drainages of the Snake River System (Table A-2). The loss in this system equals 46 percent of the predevelopment habitat. More than two-thirds of this loss occurred in areas



Historic distribution of anadromous fish in the Columbia River Basin (U.S. portion) (Source: BPA).

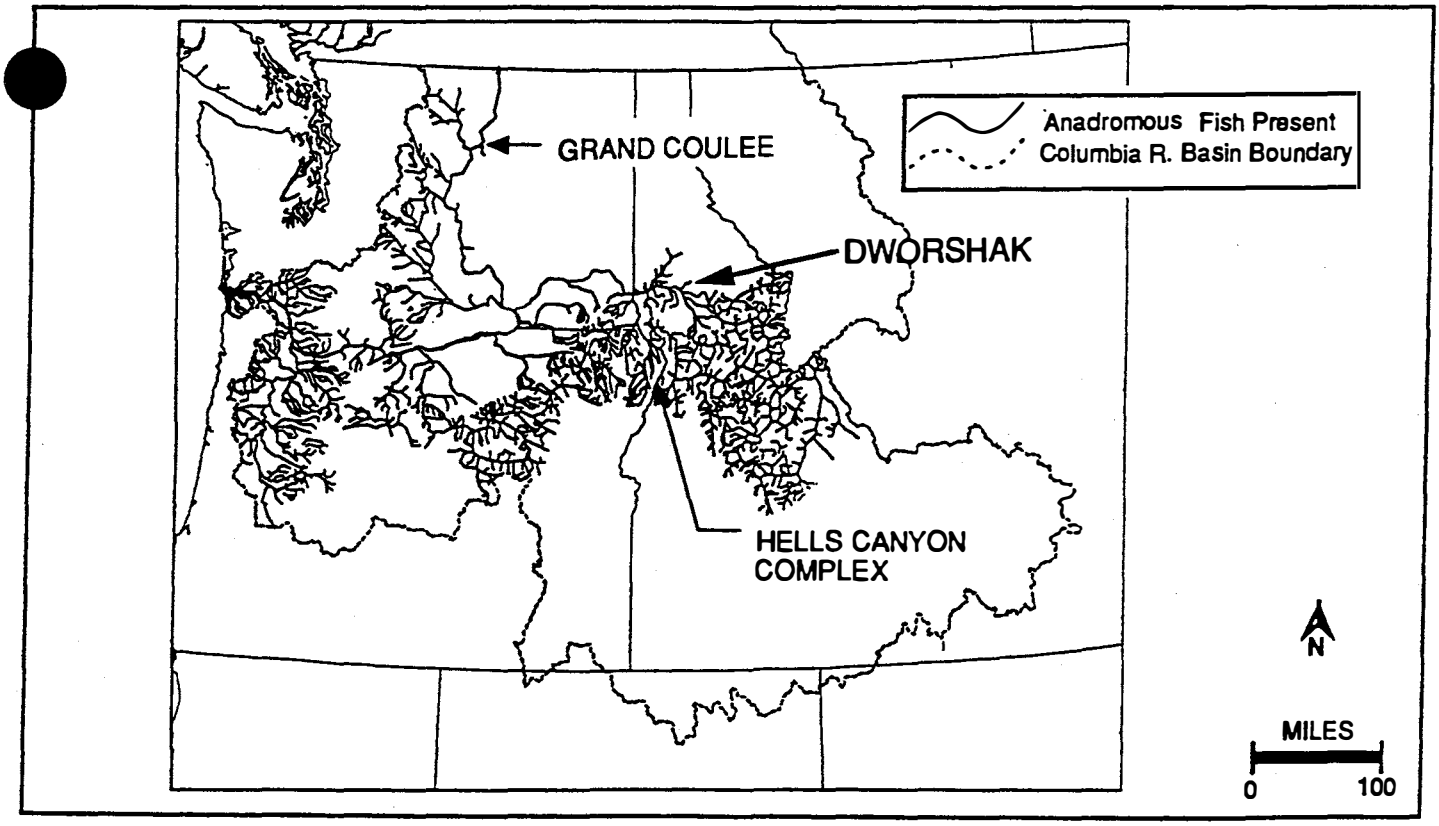


Figure A-4. Present distribution of anadromous fish in the Columbia River Basin (U.S. portion) (Source: BPA).

Table A-2. Lost and presently available salmon habitat in the Snake River Basin, by major tributary drainage.[a/]

Major Drainage	Miles of Lost Habitat	Miles of Habitat[b/] Presently Available
Mainstem Snake and minor tributaries	440	175
Tucannon	0	55
Clearwater	627	1,248
Grande Ronde	0	647
Salmon	88	1,834
Imnaha	0	223
Powder	200	0
Burnt	140	0
Weiser	256	0
Payette	470	0
Boise	520	0
Owyhee	485	0
Malheur	205	0
Total	3,431	4,182

Source: NPPC, 1986.

a/ This report applies to salmon, but it is probably generally applicable to steelhead also.

b/ Current available habitat greatly underseeded with chinook stocks (Strategies for Recovery of Snake River Salmon, State of Idaho, 1991, 31 pages).

above Hells Canyon Dam. Blockage of the Northfork Clearwood by Dwoshak Dam equaled 140 miles of habitat (4 percent of the total Snake River Basin loss). Additionally, many miles of stream that are still accessible to fish have been converted from free-flowing water to slackwater reservoir conditions; accessible reservoirs account for 362 miles on the mainstem Columbia River and 140 miles on the Snake River. These areas generally no longer supply spawning habitat for anadromous stocks because of inundation of former spawning beds, although juvenile rearing is possible, and fall chinook spawning may occur in tailrace areas where adequate velocities can be maintained over suitable substrate.

While the loss of habitat has been pronounced, its effect on the total runs has often been overshadowed by other environmental and habitat effects. For example, the NPPC (1987) estimated that approximately 8 million salmon and steelhead below historical levels (of an estimated total of 10 million lost from all factors) have been lost from hydroelectric development. Of this, they consider about half (approximately 4 million) to be the result of lost habitat from Chief Joseph and Grand Coulee dams on the upper Columbia and Hells Canyon complex on the Snake. However, other factors were already affecting runs when these dams were constructed. Grand Coulee Dam, finished in 1941, blocked access to over 1,000 miles of anadromous habitat. Rock Island Dam on the mid Columbia below Grand Coulee was constructed in 1933. The average escapement of all fish passing above this site from 1933 to 1940 was only about 10,000 to 50,000 thousand salmon and steelhead. By the mid 1950s, total escapement had increased to over 100,000 fish, despite the fact that fish from above Grand Coulee had been eliminated from this run. The major cause of the increase, in spite of the loss of 1,000 miles of habitat, was a lowered harvest rate on some of the stocks in the lower river (Raymond, 1979). However, the total influence of other factors on these runs it not known, and other factors (such as upstream habitat degradation) could have influenced the run size prior to construction of the dam.

Some dams no longer operating on the system also influenced historical runs and may have resulted in a long-term depletion of adapted stocks. One of the dams with a major influence on past runs was the Lewiston Dam (Nez Perce Tribe of Idaho and IDFG, 1990). This dam was built four miles from the mouth of the Clearwater River by Washington Water and Power in 1927. It had an inadequate passage system for chinook. Chinook access above Lewiston was almost totally blocked by construction until possibly 1940, when the ladder was reworked. Counts of spring/summer and fall chinook over Lewiston Dam from 1950 to 1964, when the ladder was again improved, were usually less than 100 fish per year (Nez Perce Tribe of Idaho and IDFG, 1990). The dam was finally removed in 1973 because Lower Granite Reservoir would have reduced its use for power production (Winter, 1990).

Sunbeam Dam on the upper Salmon River near Stanley, Idaho may have been a complete block to sockeye after its construction in 1910, as it was apparently constructed without an adequate fish ladder (Chapman et al., 1990). This dam was constructed by the Golden Sunbeam Mining Company to produce power for its mill. After several years of disuse and partial erosion, the dam was partially breached in 1934, allowing better access to fish above the dam. There is some question as to whether sockeye could have successfully passed the dam during the early years after its construction. However, sockeye were either maintained or reestablished in Redfish Lake upstream of the dam by at least the mid-1950s. Sockeye salmon abundance had been greatly reduced even before any additional dams were built below Redfish Lake on the mainstem Snake River.

Escapement of only 11 fish to Redfish Lake was reported in 1961 (Hall-Griswold, 1990) although later escapement in the 1960s was much higher (Figure A-3).

2.2.2 Operations Effects

In addition to the construction effects, the operation of the dams has had other negative effects on anadromous fish stocks. The effects have varied by project, changed over time with the application of different engineering solutions, and affected juvenile and adult fish in different ways.

Juvenile Fish Passage

Juvenile salmon and steelhead migrating downstream can pass each dam they encounter in several different ways. One way is to travel over the spillway, although this avenue is only open if water is being spilled. Alternatively, fish can travel with the river flow toward the powerhouse. Fish screens and/or sluiceways are in operation at all the run-of-river dams on the Snake and lower Columbia rivers. These systems divert a portion of the downstream migrants away from the turbines. Collection systems convey fish away from the powerhouse and either bypass them back to the river downstream of the dam or route them to holding facilities for later transport by barge or truck. Some fish at these dams are not guided and pass through the turbines. At dams without screens and collection facilities, the only downstream passages are over the spillway or through the turbines or sluiceways (see Section 2.2.4 of 1992 OA/EIS).

Each passage route has distinctive fish mortality risks. Overall, the key negative factors that have been attributed to loss of juvenile fish include the following:

- turbine mortality,
- spillway mortality,
- delayed migration,
- increased predation,
- gas supersaturation, and
- increased stress.

Juvenile fish passing through turbines can be killed or injured by turbine blades or by hydraulic pressure and shear forces. Estimates of turbine mortality vary from one study to another and from one location to another in the Columbia-Snake River System. Specific estimates range from about 2 to 32 percent per project (the higher value includes unusual tailwater predator mortality) (Ledgerwood et al., 1990; Weber, 1954; Long et al., 1968). The most accepted level is about 15 percent (NPPC, 1989), which includes direct and indirect mortality. Direct mortality refers to fish loss resulting from direct lethal physical injury, whereas indirect mortality includes factors such as greater susceptibility to predators.

Spillway direct mortality is estimated to be 2 percent per project (NPPC, 1986), although specific estimates range from 0 to 27.5 percent (Long et al., 1968). Non-fatal injuries during spillway transit, such as descaling and stress, leave juveniles vulnerable to disease and delayed mortality. Stunned or disabled fish exiting

spillways are more susceptible to predation than unstunned or uninjured fish (Poe, 1992). Actual direct and indirect mortality from passing over spillways could be much higher than 2 percent; limited testing has been done, and test results are primarily based on short-term survival.

Migration delay and reduced survival of juvenile fish have been attributed to slower river velocity and increased water retention time in the reservoirs (see Section 4.2 of 1992 OA/EIS). Assessing impacts on juvenile passage is difficult because no correlation has been established between river velocity and juvenile fish survival. It is generally accepted that a variety of factors increase mortality of juvenile migrants at extreme low flows. These factors include residualism (smolted fish reverting to freshwater physiology and remaining in the reservoir), predation, stress, increased fish disease, and poor condition and improper timing of arrival at the estuary (CBFWA, 1991b), which is dependent on the level of smoltification (CBFWA, 1991b; Giorgi, 1991). The effects of reduced water travel time on fish survival during higher flows is less clear (Giorgi, 1991; Kindley, 1991).

One of the primary causes of mortality for migrating smolts passing through reservoirs is predation by birds and fish. Overall loss from fish predation on John Day Pool, for example, was estimated to be 14 percent for all smolts. During late summer, the predation rate is increased by warmer temperatures; estimated mortality in this pool for subyearling chinook migrants, which generally pass downstream mid-June through August, was 61 percent (Rieman and Beamesderfer, 1988).

Flows passing over a dam spillway can carry trapped atmospheric air deep into the waters of the stilling basin below, causing dissolved gas to be supersaturated in the water. Increased gas saturation has been found to cause significant mortality of both juvenile and adult fish. Weitkamp and Katz (1980) summarized much of the literature about the effect of gas supersaturation on fish, including those in the Columbia River (see also Section 2.1 of 1992 OA/EIS). Studies found that juveniles near the surface of the water suffer high mortality when gas saturation is greater than 120 to 125 percent. Weitkamp and Katz (1980) also cited studies that indicated an estimated 6 to 60 percent of adult salmon and steelhead were killed in the middle Columbia River from gas supersaturation from 1965 to 1970. Gas bubble disease (or trauma) was observed in juveniles at Columbia River dams during several years in this period. It was estimated that, prior to the installation of two dams on the Snake River, smolt mortality was 5 percent; after installation, mortality was 70 percent. Most of this loss, although unproven as to source, was attributed to increased gas supersaturation resulting from the dams (Rulifson and Abel, 1971), although dam passage was also a factor. Relationships between juvenile travel time, supersaturation of nitrogen, and survival of juvenile chinook from the Salmon River to Ice Harbor were developed (Ebel et al., 1975). Decreasing the travel time from 25 to 12 days, even with an increase from 130 to 136 percent of nitrogen saturation, was reported to increase survival from 25 to 50 percent. Reducing the overall saturation levels to 109 percent for part of the migration also increased the survival from 25 to 37 percent. These estimates should be used cautiously because other mortality factors were not measured. However, it appears that in years when river flows were normal to high and corresponding gas saturation levels were high, mortality from gas supersaturation levels can override other mortality factors and result in substantial losses of juvenile salmonids, ranging from 40 to 95 percent. Since this time, problems attributed to gas supersaturation and dam passage have been reduced and mortalities from this condition are believed to have

been substantially reduced (Ebel, 1979). However, high gas saturation levels still result from spill operations, and the overall effect on salmonids are not known.

Another factor with unquantified but potentially significant effect on juvenile survival is increased stress. Most fish-handling and bypass operations on the Columbia River system have been found to increase stress levels in spring chinook smolts (Matthews et al., 1986). Passage through the dams by any route, including spill, bypass, and turbines, has associated stress. This increased stress results in fish being less viable when encountering some adverse conditions. The magnitude of the effect of increased stress on downstream migrating fish survival in this system or after they enter the ocean is unknown.

While research indicates the net effect of collection and transport of fish is positive relative to untransported fish that travel through the system, some mortality does occur from collection and possibly after release. Current measured estimates of bypass collection for transport mortality range from about 0 to 2 percent (Ceballos et al., 1991), although these estimates include non-dam effects (disease, prior injury, etc.) as well. There is the possibility some additional delayed transport mortality occurs after fish are released. The details of this possible loss are discussed under Project Improvements.

Adult Passage

There is some evidence that suggests adult salmon and steelhead have been blocked from migrating during some years because of elevated temperatures. The optimum temperature range for adult chinook migration is 49 to 58°F (9 to 14°C), while suitable temperatures are 38 to 68°F (3 to 20°C) (Bell, 1986). Adult salmon migration can be blocked at temperatures over 70°F (21°C) (EPA, 1971). In the Snake River, high temperatures over 70°F (21°C) in 1967 and 1968 in late summer appeared to impede migration of some summer chinook and steelhead. Some dead fish, whose deaths were possibly caused by these temperatures, were found in the Columbia River downstream from the mouth of the Snake River (Vigg and Watkins, 1991). Measured temperatures in the Snake River before lower Snake River dam construction were higher than those recently recorded, at least through August (Vigg and Watkins, 1991). The major effects on the Snake River reservoirs has not been so much an increase in maximum temperature as a shifting of the high temperature so that warmer temperatures occur later in the year (Vigg and Watkins, 1991) and last longer.

Adult migration can be directly and indirectly impeded at dams, resulting in some mortalities. Returning adults could have difficulty locating the entrances to fish ladders and spend excess time milling about below dams. This causes the fish to use more energy, depleting stored energy reserves and potentially causing premature death. High water temperatures, particularly in the Snake River, may delay upstream migration (as discussed above). The warm temperatures that occur later in the migrating season are thought to be a result of the increased time that water is retained in the reservoirs, although this has not been proven. Adult mortality per dam has been generally considered to be between 5 and 10 percent (NPPC, 1989). More recent information indicates it is more likely 3 to 4 percent (personal communication, Ted Bjornn, Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow, Idaho, October 1991), with increasing levels of mortality occurring during high-flow years (Gibson et al., 1979). Some mortality is caused in passage independent of

flow, as was documented at John Day Dam where mortality was estimated to be 20 percent independent of flow (Gibson et al., 1979).

Differing analysis indicates that adult passage mortality varies by species (NMFS, 1992). Estimates of spring/summer chinook mortality from Bonneville to Lower Granite Dam had a total mortality of 35 percent (NMFS, 1992). Estimated mortality for fall chinook for the same region is higher, at 66 percent. Sockeye mortality is lower than the other stocks through the lower Columbia dams and reservoirs, estimated to be about 2 to 3 percent per dam (memorandum from Chris Ross, National Marine Fisheries Service, Portland, Oregon, March 7, 1991). The reasons for this loss are not completely known but include delay, injury due to passage back downstream (fall back) over the spillway or through turbines, and possibly illegal harvest. There is uncertainty in passage mortality estimates, however, because loss between dams is affected by factors such as straying, fallback, and illegal harvest. Straying or wandering could actually inflate the estimate of what appears to be loss, particularly for fall chinook in the Snake River. Fall chinook in the Columbia System have high inriver propensity to stray or wander (Chapman et al., 1991). In recent years, Umatilla stock consisted of over 30 percent of the fall chinook at the Lyons Ferry Hatchery on the Snake river. Total stray chinook at this hatchery have exceeded 40 percent. Fish are known to sometimes travel above their final destination before returning to that destination. If this many fish wandered into the hatchery, it is quite possible that many other fish actually traveled upstream, which has been suggested by tag recoveries of Umatilla Hatchery fish above Lower Granite Dam (Chapman et al., 1991). It is possible that many of these fish did not continue past all dams used for the estimate and dropped back downstream, appearing to increase the estimate of loss. This would give the appearance of very high losses between some of the dams. In fact, counts of the lowest dam on Snake River were not used in this estimation of loss to attempt to reduce this effect. However, the effect of wandering at the upper dams is unknown and could still inflate loss estimates. In the case of fall chinook, which have the highest estimated loss rate during upstream migration, the highest loss rate per dam was estimated for the Snake River (16 percent per dam) (memorandum from Chris Ross, National Marine Fisheries Service, Portland, Oregon, March 7, 1991). This suggests much of the loss measured, at least for this stock, may be just in the manner of estimation.

Project Improvements

Several project-related structural and operational measures have been implemented to reduce these adverse effects on fish. Measures designed to improve juvenile and adult fish survival include:

- fish screens and juvenile bypass and/or transport,
- designated fish spill (waters released over the spillway),
- designated fish flows (water released from storage reservoirs),
- flip lips to reduce dissolved gasses,
- improved fish ladders,
- predator removal,
- controlled peaking for power production, and
- operation of units within 1 percent of peak efficiency.

Fish screens have been installed at six mainstem dams (will be seven by 1993 and eight by 1998) to divert migrating juveniles from the turbines. Screens pass diverted fish back to the river at Bonneville and John Day dams. At Lower Granite, Little Goose, and McNary dams, fish can be diverted, collected, and transported by truck or barge to below Bonneville Dam for release to avoid the various sources of mortality on the downstream trip. In 1993, collection is also planned at Lower Monumental Dam. Some fish at these dams are bypassed back to the river to meet the fish agency management strategy of "spreading the risk." The number and proportion of fish arriving at dams that are diverted from the turbines and transported or passed back to the pool below the dam varies by species, dam, and operating guidelines governing spill quantity and when transport is to occur. At Lower Granite Dam during a typical flow year when spill does not occur, estimates of diversion screen efficiency by species indicate that about 56 percent of all yearling chinook, 79 percent of all steelhead, 35 percent of all sub-yearling chinook, and 48 percent of the sockeye are diverted from the turbines by screens. The Fish Transportation Oversight Team designated that nearly all fish collected at this site are to be transported below Bonneville. At Little Goose, where diversion screen efficiencies are similar, the relative proportion transported can be less depending on the flow quantity, which dictates what proportion of the fish diverted are transported as directed by the Fish Transportation Oversight Team guidelines. The guidelines at Little Goose generally indicate that 80 percent of all yearling chinook will be passed downstream and not transported if flow exceeds 100 kcfs. For McNary Dam, where diversion screen efficiencies are at least as high as those upstream, the guidelines on the proportion of fish generally indicate that all fish will be transported at flows less than 220 kcfs or when subyearling chinook dominate. At lower flows or when subyearling chinook do not dominate, the proportion transported varies with the fish size and species composition. The results of the diversion and transport and spill operation indicate that, with the possible exception of yearling chinook, a majority of anadromous salmon and steelhead arriving at dams are diverted from turbines. For example, in 1990, an estimated 36 percent of spring chinook and 56 percent of steelhead from the Snake River Basin were transported (see Section 4.2 of the 1992 OA/EIS for details at individual dams).

Some mortality to migrating fish occurs at juvenile bypass and transport facilities. Mortality, through juvenile bypasses, excluding outfall mortality, ranges from substantially less than 1 to 3 percent (Monk and Williams, 1991; Brege et al., 1987). An additional estimated 2 percent mortality occurs during transport. These results were based on measurements of mortality occurring during transport. Models of adult returns have sometimes suggested that additional mortality may occur after fish are released from the barge. There has been no true measurement of survival through the system, including additional loss from barging, and the apparent difference in survival of released fish from barges could be the result of the methods used for the calculation (i.e., it is based on modeled estimates of downstream mortality per project for fish not barged). Matthews (1992) noted several possible problems with models used to compare expected in-system survival to actual survival. Both the NPPC and BPA models use in-system survival estimates from studies done in the 1970s by Sims and Ossiander (1981). These studies did not account for short-term mortality and handling mortality in their measure of system passage mortality studies. Also, all projects were considered to have equal mortality effects. Since these studies were done, it has been found that handling mortality can be significant. Current handling methods have improved, and differences in mortality rate between projects have been observed. The net effect is that estimates of in-system passage mortality based on the historical data probably overestimate system passage mortality. This result would be to make fish transport appear to cause post-release mortality and may account for some of the differences between the modeled and measured survival values. Also, if differences do

occur between survival of transported and untransported fish below Bonneville, it could stem from the fact that many of the fish transported from the upstream area would not have been viable fish whether they had been transported or had been released to travel downstream through the system to the ocean without transport. The model estimates of passage mortality are based on average mortality rates. But it is possible that much of the mortality that occurs during passage happens to fish that are less adapted to survival. That is, had many of these fish not been transported, they would have suffered a higher than average passage mortality rate while passing the reservoirs and dams. This could be caused by factors that do not affect survival during the 2-day transportation period, such as greater susceptibility to predation, disease, secondary injury, or other factors that would not be manifest until after these fish are released below Bonneville. If they had not been transported, those fish more susceptible to natural and other factors would have succumbed during downstream passage. In effect, transportation may protect the less viable portions of the migrating populations that would die of events after release because they would have otherwise died during inriver migration if they had not been transported. To account for the estimated difference in survival between transported fish and nontransported fish in the life-cycle model used by the BPA (1992) in their Biological Assessment, they added a post-release additional mortality factor of 45 to 50 percent to transported fish over the estimated survival of nontransported fish. NMFS (1992) stated that there were not adequate controls to test this hypothesis and that actual post-release mortality could be much lower.

The result of the transport actions based on some of the model runs indicate that the majority of fish from the upper river arriving below Bonneville Dam, even after including the estimated post release mortality, are transported. The latest version of the BPA downstream passage model CRiSP indicates that in a median flow year over 85 percent of all Snake River salmon arriving below Bonneville dam are transported. The proportion transported would be estimated to be higher in a low flow year for most stocks, as estimated inriver passage mortality is higher during low flow years. It should be noted that these are estimates based on models and not true measures. However, it does indicate the magnitude of the effect transport has on fish from the Snake River Basin.

Designated water spilled for fish and storage releases (Water Budget) have been adopted as a component of the Columbia Basin Fish and Wildlife Program and reflect the NPPC's "spread the risk" strategy. Controlled spills divert fish from turbines in designated periods, typically during the peak downstream migration periods. Water Budget storage releases are intended to increase water velocity through the reservoirs.

Spill deflectors, called flip lips, have been installed on most major dams on the Snake and Columbia rivers to reduce supersaturated dissolved gas levels that, in the past, have been recorded during high-spill periods (see Section 2.3 of the 1992 OA/EIS for description). However, the effectiveness of flip lips varies with spill discharge and tailwater elevation. Levels above those considered safe (less than 110 percent) still occur annually on the Columbia and Snake rivers, but current levels are less than conditions recorded prior to installation of the flip lips. The extent of inriver mortality currently caused by high dissolved gas levels is unknown.

2.3 HABITAT EFFECTS

2.3.1 Overview

In general, human activities on the land have had detrimental effects on streams. Stream habitat is critical for spawning and rearing as well as migration of anadromous salmon and steelhead. Development in the Columbia River Basin has reduced both the quantity and quality of this habitat. However, it is not possible to accurately quantify these effects, singly or in combination, over the history of this development. Activities that increase sediment in streams are known to reduce the success of spawning and often reduce rearing habitat. Activities that reduce the stream bank cover and trees often reduce important pool areas in streams and increase stream temperatures, both which are adverse effects to the survival of fish. Water withdrawal for various functions can reduce the available rearing habitat in the stream, directly remove fish from the stream, and block upstream fish migration. Added toxic substances to streams can cause direct mortality or indirect effects on fish food resources.

These types of activities have been occurring in the Columbia River Basin primarily since the arrival of non-Native settlers, with some variability in types and extent of the impact by region. One of the first activities to occur in the basin was mining, which can add both sediment and toxics to the stream. Agriculture, logging, and grazing were all early activities that have varied in rate of development and impact by differing regions. Early in the region's development, for example, logging was a major activity in the lower Columbia River Basin; its major development in some of the upper watershed occurred more intensively later. Agricultural development was more of a factor in some specific regions, such as the middle Columbia and Snake River basin. Cattle grazing has had more of an effect on stream shoreline habitats in the Snake River and some other upper Columbia River drainages. Unfortunately, it is difficult to follow the individual effects of each of these activities on fish habitat, because they often occurred simultaneously with other activities and their effects may be cumulative.

Pool Habitat

While it is difficult to identify specific impact from individual activities on fish production, some summary information suggests the types of impacts that have occurred from the combined effects. While early impacts to habitat were not quantified, some recent studies indicate that reduction of habitat quality has been occurring in the last 50 years. From 1936 to 1942, the U.S. Bureau of Fisheries (now the National Marine Fisheries Service) conducted a study of the pool quantity and substrate characteristics of over 5,000 miles of Columbia River tributaries. Sedell and Everest (1990) conducted a followup survey of habitat in the Columbia River Basin to determine how stream habitat has changed. They resurveyed a selected 300 miles of these streams (see Table A-3 showing pool changes), including streams from coastal areas, the middle Columbia, and the upper Salmon River. They found that on average 50 to 75 percent of large pools (i.e., pools greater than 25 square yards and 3 feet deep) in these streams, on both public and private land, were reduced from human-induced activities. These types of pools are critical for anadromous salmonids because they are resting areas for adults

Table A-3. Changes in large pool habitats ($\geq$2.5 ft deep and $\geq$25 yd^2) in selected subbasins of the 2 Columbia River Basin over the last 50 years.

Location	Large pools/mile		
	1941	1990	% change
Middle Fork Salmon River, ID			
Marsh Creek	20.0	21.0	5
Rapid River (wilderness)	5.8	5.2	-10
Elk Creek	56.1	32.9	-41
Grande Ronde River, OR			
Grande Ronde River (mainstem)	6.1	2.0	-67
Catherine Creek	17.7	4.4	-75
N. Fk. Catherine Creek	8.6	3.1	-65
S. Fk. Catherine Creek	17.6	2.4	-86
Five Points Creek	2.5	2.5	NC
Beaver Creek	17.4	2.6	-85
Meadow Creek	3.9	3.0	-26
McCoy Creek	16.4	2.5	-85
Sheep Creek	23.8	11.3	-53
Willamette River, OR			
N. Fk. Breitenbush R. (managed)	19.0	6.6	-65
N. Fk. Breitenbush R. (wilderness)	3.0	20.0	666
Horse Creek	12.0	7.5	-37
S. Fk. Winberry Creek	14.0	7.6	-46
Fall Creek	16.6	6.5	-61
S. Fk. McKenzie River	25.4	4.5	-82
Lewis and Clark River, OR			
Lewis and Clark River	17.4	7.0	-60
Yakima River, WA			
Little Naches River	4.2	5.3	29
Taneum River	2.0	2.6	30

Source: Sedell and Everest, 1990.

prior to spawning, preferred rearing areas for many species of juveniles, refuges from drought and winter freeze-up, and critical habitats for maintenance of salmonid community diversity (Sedell and Everest, 1990).

In the Snake River Basin portion of their study, Sedell and Everest (1990) found overall reduction in pool quantity, although in some specific streams negative overall changes did not occur (Table A-3). In general, little or no change occurred in the number of pools per mile in wilderness and low-gradient meandering streams. In the Middle Fork Salmon, grazing and riparian area herbicide treatment were the dominant land uses on managed lands between surveys. In the Grande Ronde, which had substantial reductions in pool area (most tributaries lost greater than 50 percent of their large pools), road construction, stream rehabilitation after floods, dredge mining, agricultural practices, and forest management practices have all contributed to the losses.

Pollution

In Idaho, 57 percent of an assessed 16,000 miles of streams are currently considered to be negatively affected by non-point source pollution (i.e., impacts from logging, mining, livestock grazing, and irrigation) (Chapman et al., 1991). Agriculture was reported as the primary non-point source affecting beneficial uses with overgrazing, irrigated agriculture, and non-irrigated agriculture affecting approximately 50 percent of the assessed waters (Bauer, 1989). Bauer reported that sedimentation is one of the major impacts in these streams, with intermediate to high levels of sediment present in 80 percent of the streams. In drainages that support a large portion of the current anadromous stocks in Idaho, Bauer (1989 as cited by Chapman et al., 1991) listed 36 streams in the Clearwater Basin and 45 streams in the Salmon River Basin as among the highest 25 percent of affected streams in Idaho.

Overall Habitat Degradation

It is difficult to put the level of impact on fish from habitat degradation in perspective because much of the impact has occurred in the past, and few studies can directly assess its effect. Considering only what habitat is still currently accessible to anadromous stocks, NMFS (1992) concluded that it was difficult to interpret how much impact the degradation of spawning and rearing habitat had on overall survival of the endangered spring and summer chinook stocks. In light of the uncertainty, NMFS stated that the overall effect of habitat detriments was responsible for fish mortality of 10 to 40 percent prior to the smolts reaching the mainstem dams.

The overall level of impact in the region on the threatened spring/summer chinook stocks varies and the interpretation of the importance of this impact also varies. The Subbasin Planning Reports for the Salmon River indicate that 67 percent of the streams are considered to have impacts reducing production potential up to 10 percent (IDFG et al., 1990), with 25 percent of streams having reductions of up to 20 percent and the remaining no impacts. Factors listed as being major contributors to the habitat impact in the Salmon River Basin were primarily logging, road building, grazing, irrigation withdrawal, and (to a lesser extent) mining. In the Clearwater River Basin, 65 percent of the streams are listed as having a reduction in anadromous salmon and steelhead production potential by up to 10 percent, while the remainder are equally divided between higher and lower reduction in potential production (Nez Perce Tribe of Idaho and IDFG, 1990). The primary factors

affecting fish production in the Clearwater River Basin involve forestry, agriculture, and mining. Road building associated with forestry activities generally caused the greatest impacts to fish production, through sedimentation and degradation. These assessments of habitat potential do not consider other factors, such as losses from irrigation withdrawal and predation that could increase the overall loss prior to arrival at Lower Granite Pool.

The other major drainage in the system producing these stocks, the Grande Ronde, also has experienced a degradation of habitat (ODFW et al., 1990). A total of 379 miles or 60 percent of the stream miles are considered to have degraded habitat. The primary causes of damage are stream channelization for field development, livestock grazing, poor agricultural practices, poorly designed roads, and timber removal. Mining and recreation development have also contributed to riparian habitat problems.

Although somewhat degraded, the overall quality of spawning and rearing habitats currently available in the Idaho Snake River drainage is generally considered good. Rich et al. (1992) concluded that if all the considered habitat improvements were made in regions under State of Idaho jurisdiction, an estimated 17 percent and 9 percent increase in potential smolt production could occur for chinook and steelhead, respectively. They concluded that the reason for the relatively small increase was "because the productive capacity remains high for the majority of Idaho anadromous fish streams."

However, the overall effects of habitat degradation on overall production can still be significant. Chapman et al. (1991) summarized the variety of effects that reduced habitat quality can have on the current stocks even when the overall seeding level is low. (Seeding level is the proportion of fish present relative to the habitat's potential to produce fish.) Fine sediment from the many types of basin activities can reduce egg survival and emergence, which reduces wild fish production. The decreasing pool volume, as mentioned earlier, affects both adult holding and juvenile rearing habitat. With reduced pool area, juvenile chinook, which use pools extensively for both summer and winter rearing, need to travel greater distances to find this preferred habitat. This movement makes them more susceptible to predation (Chapman and McLeod, 1987). Pool volume and interstitial spaces (the spaces between rocks) available often affect whether chinook can overwinter in the stream (Hillman et al., 1987). When pool volume has been reduced and interstices have been filled with sediment from land-use activities, fish will often leave the stream in the fall and try to find overwintering areas in mainstem channels. This fall migration has been found to occur on some Idaho streams that have been extensively monitored, including the upper Salmon River, the Crooked River, and the Red River (tributaries to the Clearwater River) (Kiefer and Forster, 1992; Hillman et al., 1987). This increased movement subjects fish to greater potential for predation from birds and fish (e.g., cottids, bull trout, brook char, rainbow trout, steelhead, cutthroat, and squawfish). Also, the portion of these fall-migrating fish that find suitable overwintering habitat downstream of these tributaries is unknown.

The role of habitat quality may also affect survival during spring migration in the mainstem Salmon and Clearwater River before fish arrive at Lower Granite Pool. For example, Kiefer and Forster (1992) found that survival of spring migrating chinook smolts from the upper Snake River to Lower Granite Pool, a distance of about 440 miles, was 33.7 percent. From the Crooked River in the Clearwater drainage to Lower Granite Pool, a distance of about 125 miles, only 46.3 percent of spring chinook migrants survived. These mortality factors may be high relative to historical levels. Raymond (1979) found an 89 percent (range 85 to 95 percent) survival

for wild spring chinook migrating a distance of about 230 miles in the lower Snake River during the 1966 to 1968 period. This mortality also includes any additional mortality that would have occurred in Ice Harbor Pool. Although this mortality measurement was for a different part of the Snake River, it does suggest that some elevated migration mortality may be occurring in upstream areas above Lower Granite Reservoir. Whether reduced habitat quality or other factors are causing this mortality is not known, but change in habitat over these extended migration routes, even if minor per stream mile, could have a significant effect on survival that might not have occurred historically.

2.3.2 Grazing

More than half of the Columbia Basin is suitable for livestock grazing. Records since 1945 indicate that public land grazing peaked in the 1950s, but fell in the early 1980s by about 10 percent in Washington and Oregon and about 25 percent in Idaho (Figure A-5) (NPPC, 1986). Nevertheless, grazing acreage and intensity remain high.

Grazing is one of the major factors affecting the stream habitat quality in Idaho. Stream habitat, and its ability to produce salmonids, deteriorates in regions that are grazed. Stream bank erosion reduces pool habitat, loss of streamside vegetation allows streams to warm, and increased sediment in the water reduces egg survival.

The negative effects on production of fish in grazed streams can be quite profound. Platts (1981) noted that fish production in ungrazed streams ranged from 2.4 to 5 times greater than grazed streams. Chapman et al. (1991) indicated that cattle-grazed meadows averaged at least 35 percent less in ability to produce juvenile salmon than natural, ungrazed conditions. Meehan and Platts (1978) noted in a study of a brown trout stream in Montana that biomass of trout was 1.4 times higher in a stream segment without grazing than in a grazed portion. It was found in one Colorado study that watersheds without grazing produced 71 to 76 percent as much stream sediment as did grazed watersheds. Increased sediment in streams reduces fish survival directly by reducing fish egg survival and indirectly by reducing food production in rearing habitats (Platts, 1981).

Over 80 percent of BLM's land in Idaho is currently considered to be in a degraded state because of grazing. Similar conditions occur on USFS land, where most of the salmon stocks spawn and rear. Probably more than 80 percent of all salmon produced in the Snake River are produced on BLM and USFS land (Chapman et al., 1991). Most of the grazing on public lands in the Snake River Basin in recent years occurs in the Grande Ronde and Salmon River basins, and most salmon spawning occurs in grazed water basins (Chapman et al., 1991). While plans are underway to reduce some effects of grazing, many of the effects will continue for many years after improvements are made. Also, unless there is a change in grazing land management, grazing will continue in most areas where it now occurs; impacts may be ongoing.

Marsh Creek, on the Middle Fork Salmon River, is an example of a region where grazing impacts have occurred (Chapman et al., 1991). This is a major spring chinook spawning stream in the upper portion of the basin. Sedell and Everest (1990) evaluated the long-term changes in large pools since the late 1930s. They examined portions of Marsh Creek in 1990 and found that where grazing was actively occurring the number of large pools had been reduced by half, while in an area not used for grazing they had doubled. Studies of 8

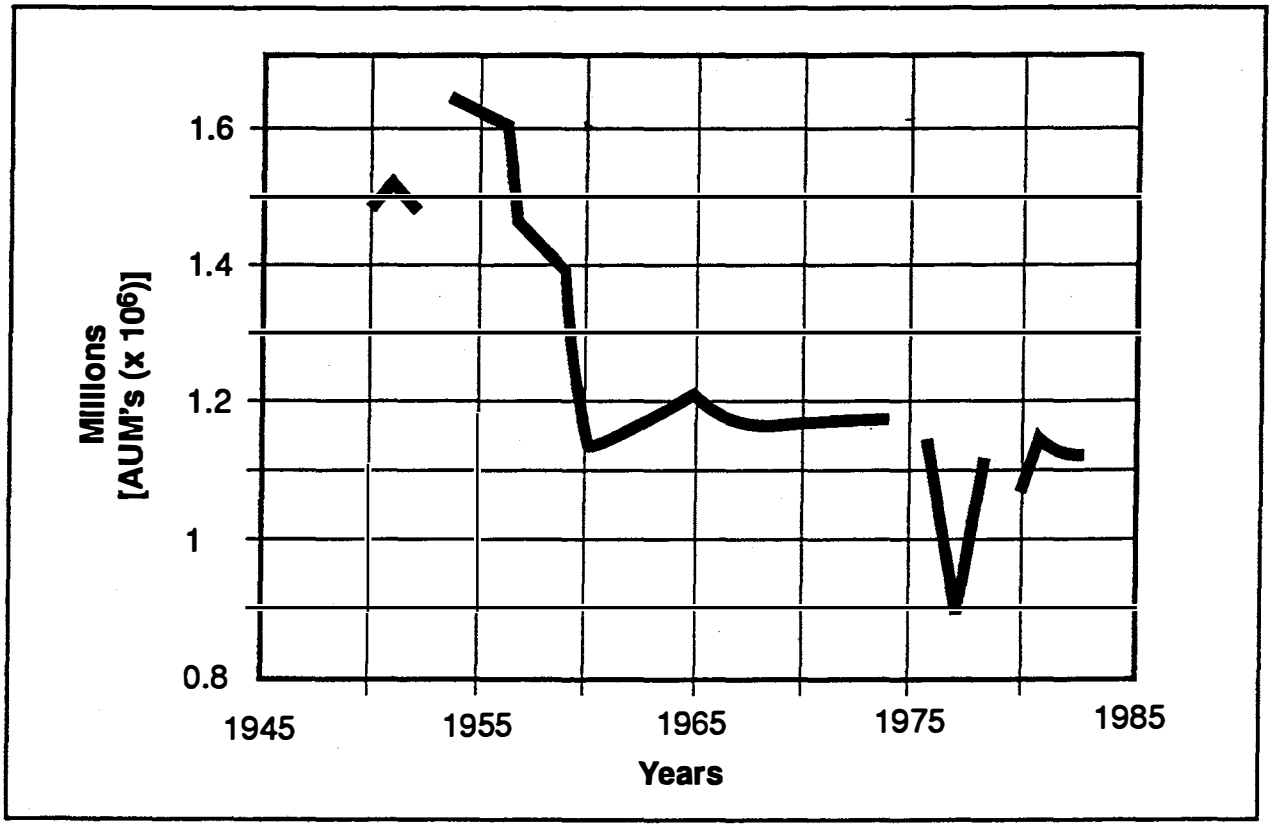


Figure A-5. Grazing intensity in Idaho in AUMs from 1945 to 1983 (discontinuous curves reflect data gaps) (Source: NPPC, 1986).

miles of this stream after grazing was initiated in selected areas also found that bank sloughing was greatest in areas where cattle or sheep grazed.

The Grande Ronde River Basin was also evaluated for changes in pool numbers over time by Sedell and Everest (1990) (see Table A-3). They found that average loss of pools in this basin was 30 to 90 percent, with the greatest loss in regions where the dominant land use was grazing. ODFW (1990) lists logging and cattle grazing as the two major factors affecting production in this basin. This basin is listed as having more than 60 percent of its stream miles in a degraded condition. Excessive livestock grazing is considered the major cause of riparian habitat loss in the upper Grande Ronde, Catherine Creek, Joseph Creek, and Wallowa River drainages. Loss of shoreline vegetation from all causes is considered a major factor limiting natural production of fish in the Grande Ronde system.

Chapman et al. (1991) summarized the effects of studies done on Bear Valley Creek on the Middle Fork Salmon River. In 1967, it was found that 34 percent of the stream transect measurements indicted impacts from grazing, including hoof shearing and caving of undercut banks. It was concluded that grazing caused greater impact to the stream than did upstream mining activity. Ten years earlier it was found that 50 percent of the stream had been affected by grazing. As late as 1984, grazing was still considered an impact to the stream.

Another example cited by Chapman et al. (1991) as having major impact from grazing is Camas Creek on the Middle Fork Salmon River, which has increased sediment and reduced riparian vegetation partly resulting from grazing. Other areas where cattle grazing occurred on parts of the Salmon and Middle Fork Salmon, including over 14 different streams and tributaries, had stream vegetation and stream bank stability significantly reduced. Pole Creek Meadow, on a tributary to the Salmon River, has been affected by sheep grazing since the late 1880s. Tests conducted here found that areas with grazing had streams with greatly increased width and were much shallower than natural streams.

2.3.3 Irrigation

Over 12 percent of the Columbia River Basin is farmland. Most of the farm acreage is in central Washington and southern Idaho. Farm acreage in the Columbia River Basin and the Snake River Basin increased gradually until 1960 and then leveled off. Irrigated farmland in the Columbia Basin has increased from 0.5 million acres before 1900 to 7.6 million acres by 1980 (NPPC, 1986). Total irrigated land in the Snake River Basin has followed a similar pattern, increasing from about 2 million acres in 1930 to 4.5 million acres in 1980 (Figure A-6) (NPPC, 1986).

Irrigation and farming began about the same time, with the first known irrigation occurring in 1840 at the missions near Walla Walla, Washington. The first major irrigation project began in 1859, also on the Walla Walla River. By 1889, 400,000 acres were being irrigated in the Columbia River Basin. Irrigated land expanded rapidly from 0.5 million acres in 1900 to 2.3 million in 1910, 2.9 million in 1925, 6.6 million in 1966, and 7.6 million in 1980. The recent rate of increase has been about 53,000 acres per year, with about 10.5 million acres predicted by 2030 (NPPC, 1986). Early irrigation relied on simple stream diversion followed by increased use of methods using large dams and diversions and large pumping systems. By the mid

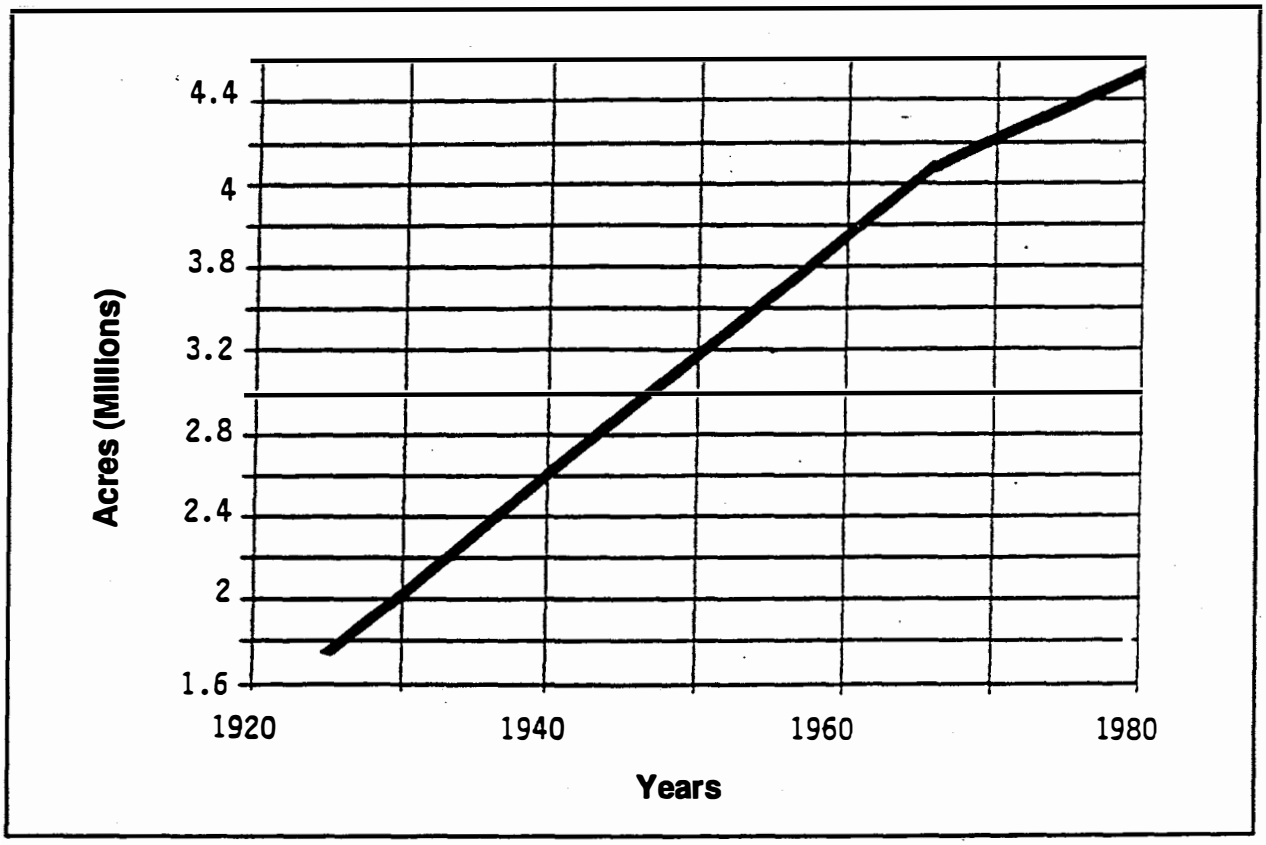


Figure A-6. Acres in farm land for Snake River area (discontinous curve reflects data gaps) (Source: NPPC, 1986).

1950s, over 700 intake structures were present in Oregon and Idaho. Water use became more efficient in diversions with improvements in methods. While the total quantity of water diverted increased from 2.6 million to 12.2 million acre-feet from 1947 to 1969, water diversion has remained between 9.5 to 12 million acre-feet since then. Currently, about half of all water diverted occurs in the Snake River Basin.

The adverse effects of irrigation and agriculture on fish are many: increased water temperature, increased erosion adding silt to spawning beds, reduced flow or complete dewatering in rearing areas, impedance to fish migration, addition of toxicants and nutrients to streams, and loss of fish in unscreened irrigation diversions. Unscreened diversions are one of the major problems. While most irrigation intakes have been screened, many screens are not functional; they wash out of the river, catching fish that stick to the moving screens (NPPC, 1986). This problem has been reduced but not eliminated.

One of the early effects of irrigation diversion was blockage of upstream migration and often direct diversion of juveniles into irrigation systems (Chapman et al., 1991). In the 1920s, dams on the Payette and Boise rivers denied fish access to upper portions of these rivers. Other dams on the Malheur, Owyhee, and Bruneau rivers eliminated anadromous runs from these systems. Barrier diversions are still present in parts of the Snake River today. Examples include an irrigation diversion on the outlet to Alturas Lake that denies access to a traditional sockeye spawning area. Also, water diversions on the upper Salmon River in the Sawtooth Valley inhibit or block upstream passage to adult salmon at times (IDFG, 1990). The upper Lemhi also has diversions that prevent upstream passage. The low flow in upstream tributaries where water is diverted, although not causing direct blocks, can cause delays because adult fish have difficulty finding suitable passage and holding areas in tributary streams with induced low flow.

The loss of water from irrigation diversion also reduces water available for downstream migration of smolts. The total average annual discharge from the Snake River is approximately 36 million acre feet (MAF). Currently, a total of 16 MAF are diverted from the Snake River, with 30 to 60 percent (5 to 11 MAF) of this subsequently returned to the river either directly or as groundwater. Not all return occurs during the period of withdrawal. However, most of Idaho's irrigation diversion occurs in the Snake River Plain away from anadromous fish spawning and rearing. The major water diversion dams on the Snake were constructed prior to the lower Snake River dams (letter from Jerry M. Conley, Director, Idaho Department of Fish and Game, Boise, Idaho, December 4, 1992). The water volume diverted for irrigation from the upper Columbia above the confluence with the Snake River is also significant at about 4 MAF (NPPC, 1986). Lower Columbia River diversions are much smaller at less than 1 MAF. In addition to reducing what is available for downstream flows during migration periods, these diversions reduce flows or completely dewater areas in upper tributaries needed for rearing of juvenile fish through the low flow summer months when major withdrawals occur.

Downstream fish losses from irrigation diversions have been significant in the past. For example, an estimated 400,000 fingerling salmon suffered mortality in diversion canals in the Lemhi River prior to installations of screens (Gebhards, 1958 as cited by Chapman et al., 1991). One screen tested in the upper Salmon River was estimated to have saved 86,000 juvenile chinook (Schill, 1984). Before major hatchery releases in the Snake River, it was estimated that total installations of screens on irrigation diversions in the Salmon River drainage would save one million juveniles per year (Delarm and Wold, 1985). Oregon estimated that in 1954, when only

half of the needed screens were installed on the John Day River, one-half million salmon and steelhead were saved. Since the institution of large hatchery programs in these watersheds, the number of fish diverted without adequate screening could be much higher.

Major screening of diversions, particularly in the Snake River Basin, has been fairly recent. The Columbia River Fisheries Development Program (CRFDP) supplied funds for screening irrigation diversions on Columbia River Basin tributary streams with anadromous fish beginning in the 1950s. Prior to this activity few tributary diversions were screened in Oregon or Idaho. Washington had already implemented screening programs independent of this activity. Up to 1985, a total of 813 screening facilities were installed in Washington, Oregon, and Idaho (Table A-4).

At least 900 intake structures, for both surface diversions and pumping stations, have been identified in Washington, Oregon, and Idaho (NPPC, 1986). However, the total number is probably much higher. Irrigation pumping stations on the mainstem Columbia River and Snake River reservoirs are under the permitting requirements of the Corps and are required to have fish screens meeting NMFS criteria. As of 1981, a total of 225 pump stations were present on the mainstem Columbia and Snake rivers with varying levels of screening for protection of fish (Swan, 1981). The number of screened diversions in the Snake River Basin supported by CRFDP is about 320, with the distribution by river indicated in Table A-5.

However, both the number of screens and the condition of those currently in place are not considered adequate in many cases. Swan (1981) surveyed all 225 pump irrigation intakes on the Columbia and Snake River reservoirs and found that 71 percent did not meet current acceptable fish screening criteria because of high velocity, damaged screens, missing screens, and improper opening. Delarm and Wold (1985) discussed the condition of the current tributary screening systems, most of which were built prior to 1970, and listed most as only being in "fair" condition with very few listed as "good" or "excellent."

Huppert et al. (1992) reported that the Fish Screening Oversight Committee identified screening needs in potential critical habitat for the endangered and threatened salmon stocks in the Snake River drainage. The majority of these screens are under Idaho's jurisdiction on the Salmon River and its tributaries, with lesser numbers in Valley Creek and the Clearwater River. Oregon's screens are in the Grande Ronde and Washington's in the Grande Ronde, Tucannon, and Asotin. Table A-6 summarizes fish screening needs in this region.

The latest list of facilities that have been scheduled by the Fish Screening Oversight Committee for replacement or repair in the Snake River System from 1992 through 1995 includes 29 new screens, 167 replaced or repaired screens, and 7 fish ladder repairs (CBFWA, 1992).

The upper Salmon River, a region containing wild spring chinook and the last remaining Snake River sockeye stock, has at least 69 irrigation diversions in the Sawtooth Valley (Chapman et al., 1991). Between 1905 and 1930, irrigation development expanded rapidly as almost all of the valley bottomland was taken up with homesteads (Andrews et al., 1987). Since 1930, water demand has increased with many of the current diversions capable of diverting entire streams. Until the CRFDP funded the construction of screens in the

Table A-4. Number of currently inventoried irrigation screens constructed by year in Oregon, Idaho, and Washington.

Year	Oregon	Idaho	Washington
Unknown	22	-	-
1953	9	-	-
1954	73	-	-
1955	153	-	-
1956	126	-	-
1957	22	-	-
1958	9	7	-
1959	7	42	-
1960	8	22	-
1961	12	43	-
1962	5	30	-
1963	12	27	-
1964	12	16	8
1965	-	8	8
1966	2	-	-
1967	2	-	-
1968	3	-	-
1969	31	-	-
1970	1	-	-
1971	1	1	-
1972	30	-	-
1973	1	1	-
1974	2	-	-
1975	-	-	-
1976	5	1	-
1977	4	4	-
1978	-	1	-
1979	-	7	-
1980	1	8	-
1981	1	6	-
1982	1	7	-
1983	-	5	-
1984	3	-	-
1985	3	-	-
	561	236	16

Source: Delarm and Wold, 1985.

Table A-5. Screened irrigation diversions in the Snake River drainage.

State/River	Number[a/]
Idaho	
Lemhi	97
East Fork Salmon	30
North Fork Salmon	18
Pahsimeroi	23
Main Salmon	52
Carmen	16
Total	236
Oregon	
Grand Ronde	84
Washington	
Tucannon	1

Source: Delarm and Wold, 1985.

a/ Number represents screened diversions supported by the Columbia River Fisheries Development Program. Washington has its own screening program that covers screens in the lower Grande Ronde and Tucannon River in the Snake River Basin.

Table A-6. Irrigation diversion screening needs (Source: Huppert et al., 1992).

State	New Screen	Replacement/ Improvement	Total
Idaho	390	154	544
Oregon	7	-	7
Washington	5	2	7
Total	402	156	554

Source: Huppert et al., 1992.

1950s, these diversions were unscreened and probably diverted large numbers of fish into the fields. Even today, many of the diversions take the entire flow during low flow periods (Andrews et al., 1987).

Prior to spring 1992 there was one diversion (Buster Black) on the upper mainstem Salmon River in the Sawtooth National Forest known to be a block to upstream passage of adults during low flow years (Andrews et

al., 1987; Kiefer and Forster, 1992). This problem has been eliminated as of spring 1992. This diversion formally dried up the river for a distance of about 1/4 mile below the diversion in late summer. A ladder was installed at this diversion in 1981, but it only had flows at night in the summer and has not aided upstream migration (Andrews et al., 1987; Kiefer and Forster, 1992). Also, a diversion on the creek leaving Alturas Lake dries up the stream for a distance of 1.6 miles for the majority of the spring chinook migration period, and for essentially all of the typical upstream migration timing of sockeye. Historically, Alturas Lake contained sockeye. However, the presence of this diversion probably contributed to the loss of anadromous sockeye from this lake. Negotiations are currently underway to remedy the Alturas Creek flow and diversion problems. Solving the diversion problems on both Alturas and the upper Salmon River could, with adequate escapement, increase potential production of sockeye and chinook by an estimated 900,000 smolts (Andrews et al., 1987).

Several other creeks in this drainage have significant flow reductions from existing diversions that seriously limit the potential production of salmon and steelhead in the upper Salmon River. These include Pole Creek, Champion Creek, Fourth of July Creek, Smiley Creek, and Valley Creek (Chapman et al., 1991).

The USFS (1980), as cited by Chapman et al. (1991), estimated that complete screening of the Salmon River and its tributaries just within the Sawtooth National Recreation Area could increase smolt migration by 100,000 to 200,000 fish. This estimate was made when the current high numbers of hatchery fish were not passing this area, so the number of smolts that could currently be saved would be even higher.

The Lemhi River, a tributary to the Salmon River, is one of the Idaho streams most heavily diverted for irrigation. In 1897, a 2-meter-high diversion near the mouth of the stream eliminated steelhead and summer chinook from the watershed, while chinook were able to pass at higher flows (Petrosky and Holubetz, 1986). This dam was breached in the 1920s and major screening of diversions began in the 1950s. Over 60 water diversions are present on the Lemhi River. There are still problems with juvenile and adult fish passage through the lower 10 miles because of low water. Prior to major screen installations on the Lemhi River, it was estimated that in 1958 421,000 juvenile fish were lost during downstream migration (Chapman et.al., 1991). Attempts to reestablish steelhead have been made from the early 1960s to present. Currently, although the total flow of the Lemhi River is appropriated for irrigation, it is considered an important salmon and steelhead producer. However, except for Big Springs Creek, tributaries in the upper Lemhi above Haysen Creek are no longer available for anadromous production because of low flows and diversions. Depending on the timing and volume of annual runoff, total or partial dewatering of the lower river can delay anadromous smolt and adult migration (IDFG et al., 1990). There are currently 228 diversions on the Lemhi system, of which 127 are in anadromous streams. However, a recent survey indicated that up to 37 of those in anadromous streams are not screened (USFS, 1992).

The Grande Ronde River is also heavily used for irrigation. Currently, water allocations from all major subbasins exceed average stream flow except in the spring high-flow months (ODFW et al., 1990), which has often resulted in very low stream flows in the summer in the major tributaries and the mainstem river. Several screening facilities are not considered suitable for juvenile fish protection. State ditch is a 4.4-mile-long channel that cuts off access to 33 former miles of the Grande Ronde River. While the State of Oregon has established minimum flow requirements, these can rarely be met because the water rights needed for the minimum flows

are junior to major water withdrawal rights. The diversion of water also causes water temperatures to become stressful to salmon and steelhead.

2.3.4 Logging

Logging was probably the first non-Native American industry to develop in the Columbia River Basin (NPPC, 1986). Early logging was typically restricted to lowland areas, resulting in little disturbance from sedimentation that can be detrimental to streams. From about 1880 to 1920, streams were often used to transport cut logs. Occasionally, dams were constructed and then breached to sluice logs. This process resulted in extensive streambed scouring, primarily in the lower reaches of the Columbia tributaries. Logging increased sharply during and after World War II. Logging in the Snake River drainage increased most dramatically in the early 1960s, from lows of 1 million to 30 million board feet per year to over 600 million board feet per year, and remained high through the 1980s (Figure A-7) (NPPC, 1986). Much of this logging does not occur in anadromous fish areas.

Logging has significant adverse effects on fish habitat. The major effects are increased sedimentation, reduced egg survival, loss of streamside cover, increased stream temperatures, and reduced instream habitat. Significant adverse effects on fish habitat and/or production in Snake River tributaries have been documented since the advent of increased logging activities in the 1960s (Chapman et al., 1991).

One of the major effects of logging has been loss of accessible habitat. Historical stream miles available for anadromous stocks in the Columbia River Basin have been reduced from 21,000 miles to 16,000 miles largely due to national forest management (NMFS, 1991). In a region of Idaho very sensitive to land disturbance (the Idaho batholith), sediment impacts have been increased due to forest management practices particularly in the South Fork Salmon River Basin.

As mentioned earlier (Table A-3), some surveyed regions have had substantial losses of pool habitat while other regions, particularly in wilderness areas where logging has not occurred, remain relatively unchanged. The Grande Ronde has lost 50 to 90 percent of its large pools since the late 1930s. Some of this loss can be attributed to logging and associated road-building activities. Logging was occurring in this watershed prior to 1940 and had already had negative effects on stream habitat.

The Salmon River drainage has several areas that have been affected by logging. Over 78 percent of the Salmon River Basin is managed by the USFS, 11 percent by the BLM, and the remainder is other public and private lands. This distribution indicates much of the region is available for logging and this has indeed been a major activity in this basin, particularly in the early 1960s. The South Fork Salmon River is an example of an area severely affected by logging. For a 20-year period prior to 1965, average harvest of timber from this basin was 16 million board feet annually; since then logging has been about 5 million board feet annually, and logging methods have been improved to reduce impacts. Prior to this reduced harvest in the 1960s, major slides in the watershed buried spawning and rearing areas under several feet of sediment. Soil erosion rates increased by over 350 percent over pre-logging levels during this period (Arnold and Lundeen, 1968 as cited by Chapman et al., 1991). An estimated 60 percent of the South Fork Salmon River drainage has been damaged by sediment.

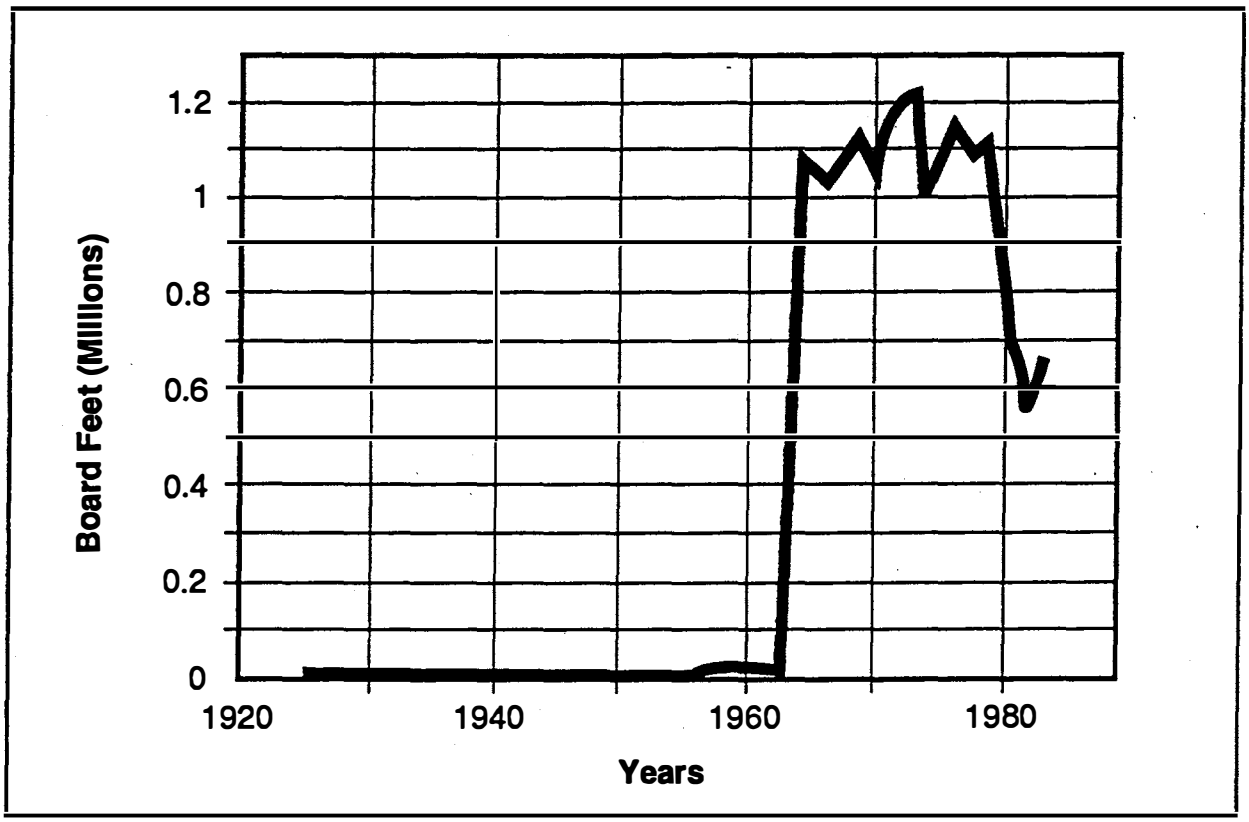


Figure A-7. Logging production for the Snake River drainage 1925 to 1983 (Source: NPPC, 1986).

Recovery from past degradation has been slow and may be negated by new land-disturbing activities (IDFG et al., 1990). Based on the reduced estimates of egg-to-fry emerging survival in the watershed, as a result of the high silt levels in the gravel, the summer steelhead potential production of this basin is 45,000 steelhead smolts compared to 200,000 if habitat were improved (Thurow, 1987).

Logging in the Clearwater River drainage has also been shown to cause impacts to some anadromous streams, particularly by increasing sediment (IDFG et al., 1990). Chapman et al., (1991) noted that two of four major streams studied in the Clearwater National Forest (60 percent of the Clearwater drainage is under the jurisdiction of the USFS) had measurable impacts from logging, including increased sediment in the stream bed and reduced large woody debris.

2.3.5 Mining

Mining was one of the earlier industries to develop in the Northwest. By the late 1800s, some of the major mining areas were in Snake River anadromous fish habitat (NPPC, 1986). Gold and silver mining were more extensive in Idaho than in Washington and Oregon. Mining methods included both underground mining and dredging or sluicing of riverine (placer) deposits. Some of the heaviest in-stream mining occurred in Snake River tributaries, destroying large areas of aquatic and riparian habitat. Other impacts from mining included acid mine leaching and heavy sediment deposition. Most of the damage from mining occurred in the first half of this century, although some degraded habitat still exists in Idaho tributaries such as the South Fork Clearwater, Bear Valley, and Crooked River (NPPC, 1986).

In the Snake River drainage, the most prominent mining occurred in the Salmon, Boise, and Clearwater districts. Placer mining, a mining technique that involves extracting and washing sediments, began about 1860 in this region. Placer mining has drastic effects on streams, as it totally alters the existing stream bed and destroys riparian vegetation; in addition, large amounts of sediment are discharged to the stream bed. This type of instream placer mining no longer occurs. Also, other detrimental effects (heavy metals, acid discharges) and heavy sedimentation have been brought under control. However, some areas, such as Panther Creek, the upper South Fork Clearwater, and Bear Valley Creek in Idaho, still have degraded habitat from earlier operations (NPPC, 1986). Streams in the Snake River Basin that still retain impacts from mining include Deadwood, Florence Basin, Warren-Burgdorf areas, Yankee Fork, Main Salmon, North Fork Salmon, East Fork Salmon, South Fork Salmon, Little Salmon, Red River, Crooked River, Sagle, Elk, Monumental, Deep, Big Boulder, Bear Valley, Loon, and Camas Creeks (Chapman et al., 1991).

No comprehensive assessment of the effects of mining on anadromous stocks in Idaho is available. However, some examples of past mining activities indicate how extensive impacts have been and continue to be. For example, dredging activities from mining in the Salmon River were considered to produce enough sediment in a 20 km region in this system to reduce spawning success by 25 percent (Spaulding and Ogden, 1968). However, much of the sediment present in the river from mining in the 1940s and 1950s in the upper Salmon River was not present in the 1960s. Chapman et al., (1991) summarized impacts from several other specific mining operations. The following is based on this report:

- The Black Bird mine was developed on Panther Creek in the Salmon River Basin beginning in 1945. Toxics from this mine greatly reduced a former salmon run of over 2,000 spawners in the 1940s. Further impacts from the mine were noted in the 1950s (dead salmon and trout from mine leachate), and the area remained absent of spawners from 1954 to 1967. Sediment from the mine is still unable to grow vegetation, and benthic populations were still depressed in the 1970s. The state of Idaho has been in litigation with the mine owners since 1983 to clear and restore the habitat. As late as 1985, mining effluent in the tributaries to this creek was still toxic to chinook and steelhead (Petrosky and Holubetz, 1986).

- The Bear Valley Creek dredge mining activity resulted in substantial impacts to spawning habitat and continues to be a problem. Sediment was carried into Bear Valley Creek and possibly into the Middle Fork Salmon River. This region is currently being rehabilitated in response to these sediment impacts.

- The South Fork Salmon River (Oxbow) mining activity resulted in construction of a breach that left dry 2,900 feet of the river channel. Additional stream bank erosion occurred from this breach. This channel is being considered for rehabilitation.

- The Crooked River gold dredge operation in the Clearwater drainage during the 1940s and 1950s removed a large section of the stream from its original channel and left tailings piles that will not grow vegetation along the stream. It also left the stream shorter, of higher gradient, and with no riparian vegetation. In other areas, tailings piles have resulted in off-channel ponds that trap juvenile fish during high flows (Petrosky and Holubetz, 1986). The stream has remained unimproved until recently, when BPA-funded activities were developed to improve the stream habitat.

2.4 HATCHERIES

2.4.1 Overview

Hatchery operations first began in the Columbia River System in 1876 on the Clackamas River in Oregon, and have grown gradually over the years. By 1909, there were 13 hatchery facilities throughout the system. By 1974, there were 44 facilities raising salmon and steelhead and releasing over 170 million fish annually (Ortmann et al., 1976). This number has grown to over 80 hatchery facilities currently in operation in the Columbia Basin. Not until about 1960 did hatcheries begin to contribute significantly to the number of fish in the system (Ortmann et al., 1976). By the late 1960s, hatchery production of chinook, coho, and steelhead surpassed natural production in the system. In the 1970s, hatchery production from the middle Columbia was estimated to comprise up to 74 percent of spring chinook outmigrants, 71 percent of fall chinook outmigrants, and 36 percent of summer chinook outmigrants (NPPC, 1986). During the same period, hatchery spring chinook outmigrants from the Snake River were estimated to consist of 75 percent hatchery fish and steelhead to consist of 80 percent hatchery fish.

Major hatchery programs for spring and summer chinook did not begin in the Snake River Basin until the mid 1960s when about 1 million smolts were released. Prior to 1968, stocks of spring and summer chinook were essentially all wild (NMFS, 1991a). Smolt releases increased to about 5 million in 1970 and generally followed

an increasing trend until 1987 when peak releases of about 16 million spring, summer, and fall chinook occurred. Fall chinook hatchery operations in the basin were not of significance until about 1983 (Chapman et al., 1991). No specific sockeye hatchery operations have occurred until the last two years, although some kokanee stocking has occurred that could have affected the existing sockeye stocks (Chapman et al., 1990).

Currently, about three-quarters of total salmon and steelhead trout runs to the Columbia River System originate from hatchery production (WDF and ODFW, 1992). Therefore, factors affecting the success of hatchery fish greatly influence total runs returning to the river. Several problems occur with hatchery fish compared to wild stocks. The rearing environment and other factors affect overall success of hatchery operations on production of adults. Generally, poor smolt quality has a negative effect on survival of smolts after they are released from hatcheries, which results in poorer smolt-to-adult survival than for wild stocks. Several factors affect the quality of the smolts and their success after release. The high rearing density in the hatcheries affects their condition prior to release. The confinement also increases the chance for disease transmission that may not have apparent effects until months after the smolts have been released. The barging of large numbers of fish together may also increase the chance for disease transmission. However, the major disease adversely affecting survival of yearling chinook in the system, bacterial kidney disease (BKD), appears to be in 100 percent of all salmon smolts (Elliott and Pascho, 1991; Pascho and Elliott, 1989) and its transmission would probably be little affected by barging (Matthews, 1992). Ever larger numbers of smolts in the river system result in greater competition for a limited food resource, particularly during the freshwater phase of their life cycle. And generations of rearing in hatcheries could negatively affect the genetic viability of the stock in the wild.

Miller et al., (1990) indicated that overall survival of hatchery spring chinook from the upper Columbia is only 25 percent of the survival goal, with only a 0.2 percent smolt-to-adult survival. Also, while the total number of hatchery smolts released in the Columbia River Basin has increased, the adult return per smolt released has decreased (McIntyre, 1987). This trend is not restricted to upper river stocks but has also been observed in coastal and lower river coho. These factors suggest that overall hatchery program operations, particularly in the upper Columbia, are not working as originally expected.

2.4.2 Snake River Basin Stocking Efforts

Spring and Summer Chinook

All hatcheries in the Snake River Basin were developed to compensate for habitat and fish losses from major hydroelectric projects (Idaho Power Company's [IPC] Fish Mitigation Program, Dworshak Dam, and the Lower Snake River Compensation Plan [LSRCP]). There are 24 facilities, including 8 primary hatcheries facilities now in operation, that have reared spring and summer chinook. With the advent of hatchery programs, there are increased chances of causing adverse effects to wild native stocks through transfer of non-native stocks from other regions of the basin. Most stocks used in the basin originated from Snake River stocks, but some outside stocking has occurred. Also, stocks have been transferred to varying degrees within the 5 major subbasins (Tucannon, Clearwater, Grande Ronde, Salmon, and Imnaha). Non-Snake River stocks that have in the past been stocked in the basin were primarily stocked into the Grande Ronde and Clearwater and to lesser degrees into the Tucannon and Salmon basins. In the Tucannon River Basin some out-of-Snake River stocks were

stocked in the early 1960s but all have been indigenous since. The Clearwater River nearly had all of its spring and summer chinook stocks eliminated between 1927 and 1940 because of the Lewiston Dam (which was removed in 1973). Early efforts (from 1947 to 1953) to restore these runs were made with stocks from the Middle Fork Salmon River. Since then, substantial stocking has occurred with stocks from both within the Snake River Basin and without. This effort undoubtedly altered any remaining native stocks. The Grande Ronde did not receive stocking until 1980, when stocking began using Grand Ronde native, Rapid River, and out-of-Snake River Basin stocks. Some genetic effects have probably occurred. The Salmon River Basin had very minor out-of-basin stocking in early 1960s. Later stockings have included stockings into the Middle Fork Salmon from Rapid River Hatchery; this operation was started with stocks originating from above the Hell's Canyon complex on the Snake River, so they are not of Salmon River origin. Most other stockings within the Snake River Basin originated from stocks indigenous to the basin. The Imnaha has received only two very minor stockings of hatchery fish, both from the Snake River Basin, probably with minor or no effects on the genetics of the wild stock (NMFS, 1991a).

Fall Chinook

Fall chinook hatchery stocking was minimal prior to 1976 (NMFS, 1991b). Some early efforts (1948 to 1955) to restore fall chinook in the Clearwater with stocks of unknown origin and later (1960 to 1967) with stocks from the lower Columbia apparently had little success but may have had an unknown influence on native fall stocks in the Snake River. As part of the Lower Snake River Compensation Plan, adult fish were captured beginning in 1976 to attempt to preserve dwindling stocks. From 1978 to 1984, fish of this origin were reared outside of the drainage and released as juveniles directly to the Snake. Since then, the Lyons Ferry Hatchery has reared this stock. Straying from other areas, particularly from the Umatilla River, has been a problem at this hatchery and in recent years has been up to 47 percent of the hatchery stock. The proportion of strays in the wild portion of this stock above Lower Granite is unknown but could be substantial, and could have a negative effect on the genetics and possibly the viability of this stock.

Sockeye

While no stocking of non-indigenous sockeye can be confirmed in Redfish Lake in the upper Salmon River Basin where the remaining sockeye originate, some kokanee stocking has occurred. Stocking of sockeye has occurred in Alturas Lake, a lake that formerly had anadromous sockeye. Also, several stockings of kokanee occurred from 1930 through 1972 into Redfish Lake (Bowler, 1990). Sockeye eggs from Canada were stocked in several lakes (but not in Redfish Lake) in the Sawtooth Valley in 1979 (Chapman et al., 1990). Also, there are records of the IDFG obtaining sockeye eggs from Canada in 1968 but no record of where they were stocked. In 1979, IDFG collected eggs from returning sockeye at Redfish Lake, reared them, and released them into Redfish Lake (Chapman et al., 1990). Currently, as part of the recovery program, the last remaining sockeye adults that returned in 1991 have been used to rear sockeye that may eventually be released in some form back into the wild. The final genetic effects of these various stockings on the original indigenous sockeye stock is not clear. However, initial genetic analysis suggests that some genetic differences occur within the outmigrant and resident sockeye/kokanee in Redfish Lake, suggesting that some genetic integrity that may differ from non-migrating sockeye/kokanee may exist.

2.4.3 Survival of Hatchery Fish

Generally, hatchery stocks have poorer smolt-to-adult survival rates than do wild stocks. Survival from a given hatchery also tends to decline over time. For example, the Pacific Salmon Commission (PSC, 1990) has kept records on the relative survival of 32 stocks of chinook salmon (all but 2 of hatchery origin) from Alaska, British Columbia, Washington, and Oregon. They found that 17 stocks (55 percent) had a long-term decreasing trend in survival, independent of fishing mortality, while only 5 stocks (16 percent) showed an increasing trend. Trends for the other stocks were either indeterminant (1 stock) or based on insufficient data (9 stocks). This study included stocks from areas above the dams on the Columbia River and from other areas not affected by the dams.

It has also become apparent that in many cases increasing production of hatchery smolts does not transfer to increasing number of adults produced. Chapman et al., (1991) examined the return rate of spring chinook produced at eight major hatcheries on the Snake River System. In his analysis, he used only data for hatchery releases after 1974 to exclude possible effects of the construction of new dams. He tested the significance of survival of smolts returning to the hatchery relative to the number of smolts released. The results produced a significant negative relationship of decreasing survival with increasing number of smolts released for five of the eight hatcheries (Lyons Ferry, Kooskia, Sawtooth, Pahsimeroi, and McCall). Only Rapid River hatchery had a positive relationship of increasing survival with number released, while two others (Dworshak and Lookingglass), although having a negative trend, had no significant relationship with survival versus number released. Many untested factors could influence this trend; however, this trend does suggest that in some cases greater hatchery production reduces relative return, which could adversely influence the total production of adults. Several factors, such as rearing density reducing the viability of individual fish, increased chance for disease transmission, and increased competition in the river after release, may contribute to this apparent reduction in survival with increased production of smolts.

Another hatchery problem that might have serious consequences on fish survival is the incidence and severity of disease. One of the most severe problems of fish in the Columbia River is bacterial kidney disease (BKD). The bacterium that causes this disease can be transmitted from parents to their eggs. BKD most seriously affects spring chinook smolts. Warren (1989) and Elliott and Pascho (1991) indicated that prevalence of the disease in smolts in Snake River federal hatcheries ranged from 15 percent to 100 percent. Juveniles reared from adults with low indicators of the disease survived from release to return to the hatchery at a rate 3 times higher than predicted, while adults with high levels of indicators of the disease survived at 70 percent of the predicted rate. Raymond (1988) believed that the lack of improvement in survival of hatchery spring chinook from the Snake River in the 1980s was caused by BKD mortalities after smolts reached the ocean. This disease theoretically could be passed on to wild fish. Its incidence in the wild currently may be high (Pascho and Elliott, 1989; Elliott and Pascho, 1991). Recent progress has reduced the level of BKD in hatchery fish in Washington State Department of Fisheries hatcheries through inoculation with erythromycin (Michak et al., 1990). However, Pascho and Elliott (1989) and Elliott and Pascho (1991) indicated that up to 100 percent of the spring/summer chinook leaving the mid-Columbia and Snake rivers tested positive for BKD.

2.4.4 Hatchery-Wild Stock Interaction

Hatchery fish that spawn in the wild may reduce the viability of the stocks. Chilcote et al., (1986) found that natural-spawning hatchery steelhead in the Kalama River produced smolts with a survival rate only 28 percent of that of wild fish. The extent of wild spawning by hatchery stocks in the basin is variable. It may be large in some areas with large hatchery runs, ultimately reducing the viability and production of wild fish. Reisenbichler et al., (1992) examined the genetic characteristics of steelhead stocks in Oregon, Northern California, and the Columbia River. They did find that the greatest portion of genetic variability occurred from interbasins; that is, the greatest overall difference in genetic identification occurred simply from one basin to the next even if adjacent. They also found that nearly all hatchery stocks examined differed significantly from the wild stocks in the same drainage. The findings showed that both wild and hatchery stocks in this region and coastal Washington had lower diversity (i.e., more similar genetically overall) than stocks found in British Columbia. Several possible reasons for this lower diversity were listed including the widespread use of hatchery fish originating from a single population. They indicated that it would be wise to retain genetic diversity to reduce the chance for extinction. As was suggested in the past, hatchery use of non-local stocks could very well contribute to lower diversity. Also, as discussed above, stocks of non-local origin are often less adapted to survive in the region in which they are used.

Chapman et al. (1991) noted that none of the chinook hatcheries in the Columbia system were begun with exclusively local stock. This lack of local stock in many cases could well contribute to lower survival of hatchery fish. Many of the stocks used in the Snake, Clearwater, Salmon, Imnaha, Tucannon, and Grande Ronde subbasins have included imported stocks from west of the Cascades. Utter et al. (1989) noted that west coast chinook stocks separated genetically into eight major groups, with the Snake River drainage differing from the upper, middle, and lower Columbia groups. This transfer could result in less adapted stocks.

In the Snake River, although large outplanting of hatchery fish to streams has occurred, wild spawning of hatchery releases of spring and summer chinook is apparently low (Matthews and Waples, 1991). However, recent (since 1983) stray hatchery fall chinook from the lower river may be entering the spawning areas of wild fall chinook in significant numbers, and hatchery fish from earlier activities (1983 or earlier) in the basin could have been spawning in the wild (Waples et al., 1991).

Another potential problem with hatchery fish is increased predation and competition with wild stocks. Hatchery smolts tend to be larger than their counterparts in the wild. This factor could result in greater competition for food or possibly predation on wild stocks. The magnitude of effects of these factors has not been measured in the Snake River. Giorgi (1991) noted that during the mid 1960s only about 4 million to 8 million smolts came down the Snake River, and nearly all of these were of wild origin. However, 28 million and 23 million smolts were released from hatcheries in this system in 1988 and 1989, respectively. This large number of fish could result in hatchery fish competing with or preying on wild stocks during migration. Poor downstream passage survival of measured natural smolts from some of the upper watersheds may be the result of this. For example, in 1990 the survival from the upper Salmon in the Sawtooth Valley to the head of Lower Granite Pool was only 34 percent and 32 percent for wild/natural chinook and steelhead smolts, respectively. This is one of the longer outmigration routes to Lower Granite Pool in the system (about 440 miles), which may add to the chance for

the many other factors affecting these fish. Even migration for a closer area suffered substantial mortality. Wild/natural chinook and steelhead smolts from the Crooked River on the Clearwater (about 124 miles from Lower Granite Pool) survived at 46 and 56 percent, respectively. It is possible the increased number of smolts reduces available food in the rivers during migration, which could reduce survival in a direct or indirect (e.g., more susceptible to predation or disease) manner. The long travel time to Lower Granite Dam in 1990, which ranged from about 20 to 60 days for spring chinook from the upper Salmon River and about 20 to 80 days from Crooked River, increases the importance of available food, particularly in the reservoir.

This greater number of fish could also contribute to low survival of hatchery stocks as well during this same migration period. Giorgi (1991) examined data describing the survival of hatchery stocks from the hatchery to their capture at Lower Granite Dam. Using PIT tag data, he estimated survival from hatchery release to capture at Lower Granite Dam for the migration years of 1989 and 1990 at 44.3 percent and 52.8 percent from Dworshak, 19.8 percent and 15.1 percent from Sawtooth, and 33.6 percent from McCall. These losses are substantial and suggest that major losses occur prior to fish arriving at the first dam. The portion of the loss that can be attributed to the passage through Lower Granite Pool and that of just the river is not possible to determine from these data. However, the magnitude of the losses of juvenile wild fish presented above suggests that much of this mortality occurs in the flowing river prior to arriving at Lower Granite Pool. Again, this high loss may be caused by many factors such as food competition, viability of hatchery stocks, disease, and inriver and in-reservoir predation.

Hatchery stocks may adversely influence the timing of outmigration of wild stocks. Giorgi (1991) cited studies on the upper Columbia that suggest timing of hatchery releases influences outmigration of wild chinook. Hillaman and Mullan (1989, as cited by Giorgi, 1991) noted that thinning releases of age-0 hatchery chinook appear to "pull" wild chinook and steelhead from the stream margins with all traveling downstream together. This may influence predation on wild stocks, which were typically smaller than hatchery stocks, often making them more susceptible to predation by fish or possibly birds.

2.5 MISCELLANEOUS

Several other factors, as yet poorly quantified, also could be having significant effects on salmon and steelhead production in the Columbia-Snake River System. These effects include increased marine mammal predation, shad competition, and high-seas drift net harvest.

Populations of marine mammals have been increasing along U.S. coastlines since the Marine Mammal Protection Act of 1972. Many of these mammals feed on salmonids. Recent records indicate that the harbor seal population has increased around the Columbia River mouth. The highest historical incidence (19.2 percent) of injuries from seal bites on spring and summer chinook was recorded in 1990 (Chapman et al., 1991). The level and proportion of this impact on salmonid populations are not clear because salmon typically make up a small portion of seals' diets.

Shad were introduced to the Columbia River from east coast stocks in the 1880s. Since fish counts began at Bonneville Dam in 1938, shad numbers have increased dramatically from less than 10,000 to over 1 million fish

annually in the 1980s. The highest number on record was counted in 1990 at 3 million fish (Corps, 1991), and counts at upstream dams are continuing to increase. The direct and indirect effects of the shad population on salmonid stocks are not well understood. However, there is a possibility of predation by shad adults on salmonid smolts. Adult shad migration may cause stress to adult salmon at ladders because of their higher numbers. Finally, competition between shad and salmonid juveniles for food resources in the estuary and possibly the ocean environment affects salmon survival (Chapman et al., 1991).

The exact effect of high-seas drift net fishing on Columbia River stocks is not known. Results from observers on legal Japanese drift net fishing vessels suggest that the effects are probably small, because less than 10,000 salmon and steelhead were reported captured in one fishing season (International North Pacific Fisheries Commission, 1991). However, recent undercover operations have indicated that thousands of metric tons of salmonids have been captured from illegal drift net operations that are not monitored by observers. The magnitude of this activity on salmonid populations remains unquantified by specific research. A recent estimate indicated that in 1990 illegal high seas harvest of Pacific salmon equalled 3.6 million fish (Norton, 1991). This is substantial considering the number of fish available for harvest. For example, the total 1990 ocean commercial and sport catch of chinook, coho, and pink salmon from Southeast Alaska to California was only 11.9 million fish (PFMC, 1992b), indicating that the high seas fisheries can be taking a substantial number of fish that would have been available for coastal harvest. However, the magnitude of the effect of this activity on regional or specific stocks is unknown.

3.0 OBSERVATIONS ON NEW ACTIONS TO IMPROVE ENDANGERED RUNS

The previous information indicates that several factors affect survival and production of endangered and other anadromous stocks in the Columbia River System. While hydroelectric system operations currently may contribute the largest portion of the loss of these stocks, other factors are also important. Therefore, it is important to consider what other actions can or should be taken to improve and preserve the runs. Recent studies conducted by the river management agencies and other parties indicate that the current ability to change system operations in the short run is limited and even changes that may contribute only slightly to overall increase in fish survival can be costly. For example, the estimated total increase in spring chinook downstream survival from the changes in operation proposed for 1992 (e.g., lower reservoir pools, increased augmentation flow) only resulted in an estimated increase in total survival of 1 to 3 percent, or a relative change in survival of an estimated 3 to 8 percent for wild spring, summer, and fall chinook, and sockeye salmon from the Snake River Basin (BPA, 1992). It is apparent that changes in other areas that affect the total survival can contribute to increases probably in the range of those currently being considered for the hydrosystem operation.

Under the Northwest Power Planning Act many programs have been initiated and are ongoing that are intended to increase runs of salmon and steelhead to the Columbia Basin. While these activities are considerable, and in many cases already contribute to helping restore the endangered salmon stocks, this appendix focuses on new actions that could benefit endangered stocks.

Currently, many different modifications are occurring or being considered that will increase the overall survival of these stocks in addition to those taking place as part of changes in hydroelectric operation and project modification. Many of these actions were presented in the NPPC Phase I, Phase II, and Phase III proposals (NPPC 1991a, 1991b, and 1992a) and are presented here by major activity category. Additional actions that also may benefit the anadromous stocks that are not discussed in these documents are also presented in this appendix.

Many different hydroelectric system modifications, both operational and structural, have been proposed to help the endangered stocks. These are presented in general terms discussing their expected benefits and problems in enhancing the endangered stocks.

3.1 Land Management and Habitat Enhancement

Land use has had and continues to have significant effects on salmon survival and production. Activities such as grazing, logging and road building, and lingering mining effects contribute to the deterioration of stream rearing, spawning, and migration habitat quality. Irrigation diversion reduces stream habitat area, causes fish losses from unscreened diversions, limits upstream migration success, increases stream temperature, and may add toxic substance to the river. Based on the NMFS Biological Opinion (1992), habitat and hatchery impacts on fish prior to downstream passage of endangered spring/summer chinook and fall chinook equal about 8 to 27 percent and 4 to 14 percent of total human-induced mortality, respectively.

Because of the concern for the adverse effects of grazing on riparian areas, the NPPC (1991a) has requested that the USFS and BLM develop grazing management plans and more adequately monitor livestock activities within their jurisdiction. Other activities to consider were developing land exchanges to obtain important riparian areas, and accelerating already existing plans for future anadromous habitat improvements.

Loss of water from the system attributable to irrigation withdrawals has adverse effects on rearing and other fish. Accordingly, the NPPC has recommended that methods be explored to reduce this withdrawal, specifically through a watershed demonstration project in a basin with at least one weak anadromous stock.

Lack of screening or inadequate screening, particularly in the Salmon and Grande Ronde River basins, may be reducing the number of fish migrating downstream. Also, improper stream diversion structures may reduce successful upstream migration. For these reasons, the NPPC requested review of all the watersheds in the upper Columbia by the federal resource agencies (USFS, BLM, and BoR) for adequacy and number of diversions under their control, and for the tribes and fisheries resource agencies to make a priority list of all screens and main river pump stations that need to be installed or repaired. Much of this proposed activity has proceeded to date, with over 500 diversions identified as needing either a new or improved screen; a few sites also needed recommended adult passage improvements (Huppert et al., 1992).

Although not directly addressed in the NPPC recommendations, other actions could be undertaken to help improve the habitat of fish in the upper watershed. For example, logging and road building could still be

having adverse effects on fish habitat in the Salmon River drainage. These activities need to be evaluated as part of the USFS management plans for the future.

Mining operation can also still be affecting streams, primarily with sediment impacts. Huppert et al., (1992) indicated that there are currently 86 gold placer mines in the Snake River Basin on USFS land. The possibility of reducing this activity should be considered in restoring habitat in the basin, as placer mining is an activity that has some of the larger and more direct effects on sediment input to streams.

3.2 HATCHERY MANAGEMENT

Hatchery operations and outplants of hatchery stocks that can result in straying of hatchery fish into wild areas can reduce native stock viability and also can affect legal harvest of wild stocks in these regions due to apparent increase in abundance. The NPPC (1991a) has recommended that several actions be conducted to reduce these potential adverse effects.

Some tributaries to the Grande Ronde have had infusions of hatchery stocks on the native wild stock that could be adversely affecting the future viability of the wild stock. The NPPC has recommended that all hatchery stocks from this system be marked and that structures be built on the system to remove the returning hatchery fish.

Supplementation should be considered to help restore specific portions of some wild stocks. For this reason some satellite collection and acclimation facilities (tributary sites away from hatching facilities) need to be built that would allow for improvement in this process while minimizing impacts to the remaining wild stocks.

While 75 percent of the current runs to the Columbia River System are generated by hatcheries, the awareness of the effects of hatchery operations on the wild stocks has become more apparent and of concern. The NPPC has requested that the best experts in the field of genetics evaluate what effect hatchery operation have on wild stocks and how best to manage existing and future operation. Since this recommendation, documents summarizing the current knowledge on the effects of hatchery management have been produced (NPPC, 1992b).

An extremely low number of sockeye salmon (4 total in 1991, and to date only one in 1992) have recently returned to the Snake River spawning and rearing area (Redfish Lake in the Sawtooth Valley). In response, an experimental captive rearing program of spring outmigrants from Redfish Lake and offspring of the captured adults has been tentatively approved by the NPPC. The objective of this program is to maintain the limited genetic stock of this run.

Straying of hatchery fish can have significant adverse effects on wild stocks. The threatened fall chinook salmon in the Snake River are known to have a large component of stray fish from other regions, particularly the Umatilla River. The NPPC recommended that total marking of hatchery-released fall chinook stocks that appear to stray into the Snake River be considered. Also, other hatchery stocks that have a high stray rate to other areas should be considered for total marking for release.

Not directly addressed in the NPPC directives is the potential problem of hatchery disease effects on both wild and hatchery fish. BKD, for example, may be one of the major causes of poor hatchery fish survival; wild fish sampled from the Snake River currently have a high incidence of the bacteria that causes the disease. While substantial efforts are underway in all hatchery operations to reduce and control fish disease, greater efforts at studying and eliminating the effects of the disease should be emphasized in the future plans for hatchery operation.

3.3 Predation Control

Predation in reservoirs currently accounts for a primary component of downstream passage mortality in the inter-dam region of the Columbia. It also may play a major role in fish loss prior to their arrival at the first reservoir on the Snake River. The NPPC (1991b) has directed that a goal of reducing in-reservoir squawfish (the major predator in reservoirs) abundance by 20 percent per year be undertaken to reduce predation by 50 percent, based on the expected predation intensity. This BPA-sponsored program has been in operation for the last two years and will continue.

Another possible source of predation not recommended for study by the NPPC is the effects of game fish stocking in lakes and rivers in regions of the threatened and endangered stocks. Huppert et al., (1992) noted that Washington, Oregon, and Idaho stocked substantial numbers of trout into waters containing salmon stocks. Oregon has stocked over 46,000 rainbow trout into the upper Grande Ronde and 10,000 into the Imnaha River. Washington State has stocked over 27,000 rainbow into the Tucannon and Asotin rivers combined. And Idaho has stocked 76,000 legal-sized and 780,000 fingerling rainbow trout into the Snake and Salmon rivers. Huppert et al., (1992) state that NMFS has requested that these programs be reviewed to determine what effects they may be having on these threatened salmon stocks. These fish at times can be predatory on other fish, but the extent of this effect has not been determined. Some illegal stocking of other predatory fish (northern pike, smallmouth bass) that also could affect survival of salmon stocks has occurred in these regions. With predation in reservoirs considered a major component of downstream migrant loss, it is possible that predation in rearing and other migratory areas could also be a problem. The low survival from upper river areas suggests that some significant loss factors are operating in the basins before the fish reach the reservoirs; predation could be one of those factors.

3.4 Harvest Management

Harvest of the endangered stocks of spring/summer and fall chinook significantly influences the number of fish escaping to the upper Snake River to spawn. Data presented in the NMFS Biological Opinion (1992) suggest that harvest accounts for about 6 to 11 percent and 31 to 39 percent of the human-induced mortality of Snake River spring/summer and fall chinook, respectively. Control of harvest to varying levels has been recommended by the NPPC (1992a) to help restore runs.

The NPPC (1992a) recommended some limitations on harvest of stocks. They recommended that only limited subsistence and ceremonial fishery be allowed on sockeye below the confluence of the Snake and Columbia

Rivers until Snake River runs are enlarged. This is little changed from what currently occurs most years, although harvest has been as high as 49 percent in 1988. Harvest of Columbia River sockeye stocks is almost non-existent in the ocean so no change in harvest is recommended here. The NPPC recommended restrictions on the Columbia River nontreaty spring chinook harvest in the lower river, maintaining harvest at less than 4 percent (total inriver harvest ranged from 7.7 to 13.7 percent with a midpoint of about 11 percent for spring and summer chinook; NMFS, 1992) and maintaining ocean harvest at less than 2 percent (current ocean harvest is measured at less than 1 percent). Harvest of summer chinook has been incidental since 1964, with about 1,000 harvested for tribal ceremonial and subsistence use and 100 for nontreaty incidental harvest in the river. The NPPC made no recommended changes in the current recommended summer chinook harvest. However, harvest effects and proposed changes for fall chinook are quite significant. The NPPC recommended programs to reduce total ocean and inriver harvest rates of fall chinook from 77 percent of all adults in 1990 to 63 percent in 1991. The goal is to reduce further the overall harvest rate to 55 percent of the adult population in the 1992 to 1995 period.

The NPPC (1992a) also recommended a voluntary lease-back and voluntary nontreaty fishing permit buy-back program for current river fisherman to reduce in river harvest for a period through 1995. This would be used to reduce proportionally the harvest of each license leased back from the individual permittee. The lease program would pay the individuals proportional to their traditional harvest, while the buy back would reduce the number of permittees at least on a temporary basis. These reductions, if implemented, are intended to further reduce the in-harvest over those recommendations addressed above.

Another recommendation was to review and consider catch and release regulations to reduce incidental catch in regions where endangered species occur. In addition, increased monitoring of ocean harvest and considerations of methods to better account for and regulate ocean harvest of Columbia River stocks was recommended.

Illegal harvest in the river is believed to cause some untold loss of salmon. Increased enforcement is recommended by NPPC (1991b) and has been implemented by BPA, with increase in enforcement effort from 26 to 49 full-time equivalent employees. The expected increase in survival is estimated to be between 2 and 10 percent for the endangered stocks (NMFS, 1992).

NPPC (1991b) also has recommended that efforts be increased to enforce bans against high seas drift nets that may harvest substantial numbers of salmon and steelhead.

3.5 Hydroelectric System Modifications

As has been suggested by several studies, the majority of human-induced mortality to salmon stocks on the Columbia system is the result of hydroelectric system construction and operations. As such, it has received the greatest emphasis regarding improvements and modifications to help improve endangered runs. The NPPC in its Phase III document (NPPC, 1992a) details goals and plans it deems most suitable at this time to enhance and rebuild not only these endangered stocks but also other Columbia River stocks. The Phase III document is the most current thinking by the NPPC on what changes in hydroelectric operations should be made to improve stocks. This document outlines measures it claims "can and should be implemented immediately," stating

"Enhanced flows and reservoir drawdowns appear to be the most promising way to speed inriver fish migration." But they also state "the Council is not choosing inriver migration to the exclusion of options such as transportation. The Council has not found sufficient biological evidence on which to make such a choice. It is choosing to use either or both, as long as they are consistent with improved survival. The Council is proposing to improve conditions for survival in both modes of migration to the greatest extent practicable."

The following summary will not attempt to list in detail all of the hydroelectric system changes that should be implemented or considered at this time, but will present a brief review of these categories as presented by the NPPC. For a more complete discussion of the various proposed activities that might be implemented, readers should review the Phase III NPPC document (NPPC, 1992a). It should be noted that various activities that are considered appropriate at this time may in the future be found either too costly for the benefits gained or ineffective, or alternative actions might be more effective. The presentation of the NPPC recommendations here does not imply endorsement of all of the proposed actions, as many of these actions have yet to be proven biologically or cost-effective. The final outcome of many of the proposals has yet to be determined.

The Phase III document lists five general categories of hydroelectric system improvements to enhance stocks: 1) increase river velocity, 2) reduce river temperatures, 3) improve fish screening on mainstem dams 4) improve fish transport, and 5) improve upstream passage. General actions in each category will be summarized.

3.5.1 River Velocity and Temperature

River velocity improvements are based on the premise that increased velocity through the reservoirs reduces downstream fish mortality. River temperature reductions are considered important for Snake River fall chinook upstream migration. Activities to enhance river velocity come in two categories, reservoir drawdown and increased flow at critical periods. The SEIS is evaluating the effects of some of the Council proposals; those evaluations are not presented here.

The NPPC's immediate goal on the Snake River is to use a combination of drawdown to near minimum operating pool (MOP) and additional flow from Dworshak Reservoir and the upper Snake River Basin to enhance these flows to achieve 85-kcfs-equivalent flow during spring outmigration of yearling chinook. The long-term plan for the Snake River includes a recommendation to have a major reservoir drawdown plan (e.g., all or some reservoirs to spillway crest) implemented by April 1995, unless found to be structurally or economically infeasible or biologically imprudent, or inconsistent with Sections 4(h)(5)-(7) of the Northwest Power Act.

For the Columbia River, the recommendation is to operate John Day at minimum levels that still allow suitable irrigation withdrawal immediately (e.g., approximately 262.5 feet) and that level to be lowered further (e.g., possibly 257 feet) than is currently practical by 1994 during the spring and summer migration season.

To enhance flows in the spring, the NPPC recommends altering procedures of system operation to enhance storage to allow for greater flow releases. To enhance and study July to August summer migrants, the NPPC recommends obtaining additional flow from the upper Columbia basin from U.S. Non-Treaty Storage water and

other sources. Other activities directed at increasing flow include: considering additional water storage sites in the Snake River Basin, modification of water management by states, modification of power agreements and sources to enhance available flow, flood control evaluation, and studies of effects of the considered upper river reservoir flow and level operations on other fish and wildlife resources. Summer temperature reductions to enhance fall chinook migration should be considered for the Snake River by increasing cool water releases from Dworshak Dam during August and September.

3.5.2 Mainstem Fish Screening

Currently, fish screens that are in place improve downstream passage survival. For example, fish passing through turbines have a mortality rate of about 15 percent, while those diverted from turbine intakes by fish screens have a mortality rate of about 2 percent. The proportion of all fish arriving at dams that would enter the turbine intakes and be successfully diverted by the screens varies by fish species, spill quantity, and project. All but two lower Columbia River and Snake River mainstem Federal projects have turbine screens installed. The Corps is already actively pursuing increasing both the number and quality of screens on the Snake and Lower Columbia River System. The goal of the NPPC, as stated in the Phase III document, is to have operational screens installed at Lower Monumental by 1992 (it is currently in operation), Ice Harbor by 1994, and The Dalles by 1998. The NPPC wants to achieve passage goals of 70 percent of spring migrants and 50 percent of summer migrants past each dam without going through the turbines, with currently operating screening systems. It has been found through studies at some sites that extending the existing screens increased the proportion of fish diverted away from the turbines. Another recommendation is to test, and if successful install, extended length screens at McNary, Lower Granite, Little Goose, John Day, and The Dalles between 1995 and 1998. Extending the length of time screens are in place has also been recommended and methods to improve the current guidance efficiency should be explored. Because the currently installed screens at the Bonneville first powerhouse are not operating effectively, there is a need to improve the guidance efficiency at this site. In addition, there is a need to better understand the causes and levels of mortality when the fish pass through bypass facilities and turbines at Bonneville as well as the other mainstem dams. In conjunction with the juvenile fish bypass program (i.e., turbine intake screens), a spill program at several of the sites is proposed to provide improved fish passage survival pending installation of more efficient bypass facilities.

3.5.3 Fish Transport

While fish transport is controversial, it has proven to increase survival of fish over those not transported under the current operating conditions. It is currently one of the best methods to increase downstream passage survival, and has been an integral part of the fish passage program since 1981. Greatest benefits appear to be for subyearling chinook and steelhead in the Columbia, while benefits are less clear for sockeye and spring and summer chinook stocks in the Snake. However, most recent information indicates that significant benefits do occur for spring chinook stocks in the Snake River (Matthews et al., 1992). This program is especially important during low-flow years when low flows in the river can not be adequately augmented. Improvements in the transport operations are recommended by the NPPC and many have already been implemented by the Corps. Recommended transport improvements include reducing fish holding time, reducing density of fish during transport, adding shading at holding facilities, and developing different smolt release strategies (e.g.

greater dispersion, release closer to the river mouth) to increase survival. Activities proposed to be evaluated to possibly enhance the number of fish that ultimately survive the migration include consideration of collection facilities above Lower Granite Dam, installation of a new fish migratory channel, and net pen transport.

3.5.4 Adult Passage

Adult passage losses account for nearly as great a loss as downstream passage for some stocks (NMFS, 1992). Total loss of stocks has ranged from an estimated 66 percent for fall chinook to less than 25 percent for sockeye destined for areas above Lower Granite Dam. These high losses suggest that there are substantial benefits to be gained by improving upstream passage. While some of the measured loss of adults could be from factors other than dam and reservoir effects, passage appears to be the major source of lost fish from factors such as fallback and delay. Actions recommended by the NPPC to improve passage include:

- leave juvenile passage screens in longer than needed for juvenile protection at selected projects, to intercept adult passing back downstream;
- determine if American shad in ladders are a problem with adult salmon passage, and consider removal of shad at selected sites;
- upgrade passage facilities and ensure adherence to passage system operation guidelines, including: a) automation of control systems b) placement of staff gauges in areas that are accessible for both cleaning and reading and c) providing velocity meters in areas of known low velocity in collection channels;
- consider methods to identify and possibly remove weak stocks from ladders; and
- evaluate the effectiveness of releasing cool waters from Dworshak Reservoir to improve upstream passage.

The Corps has already implemented several of these actions including longer operation of juveniles screens, upgrading some of the passage systems, and closer adherence to the operation guidelines. Current and ongoing actions are described in more detail in Sections 2.2 and 3.2 of the SEIS.

4.0 CAN THE FISH STOCKS BE SAVED?

While most of the efforts being considered or proposed are intended to benefit the anadromous salmonid stocks on the Columbia River System, the main question that must be assessed is will these efforts prevent the continued decline and ultimate extinction of the threatened and endangered stocks? Also, it is important to determine where the major benefits to the stocks can be developed within existing constraints on these activities.

One of the best ways to estimate the effects of the combined activities (habitat, hydropower, hatchery, harvest, etc.) on the stocks is by using fish life-cycle models. While these models are controversial in both their use and the assumptions used in their analysis, they currently provide the best way of combining the effects of each of

the activities to determine what the likely effects will be to species of concern. They also help to identify where the benefits occur from each of the proposed actions if these actions are modeled separately.

Recent reductions in wild stocks of spring, summer, and fall chinook and sockeye salmon of the Snake River are a dangerous sign of problems affecting each phase of their life cycle. Available information indicates that this trend could continue if actions are not taken soon. However, to have the greatest chance of preserving these stocks, the actions taken must be broad-based, without relying only on changes in one area of their life cycle. These actions must include rearing habitat changes, hydroelectric system modifications, hatchery modifications, and harvest changes. If significant actions are taken that affect all life stages where mortality occurs, available information suggests that these stocks will be preserved.

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Appendix B

Lower Granite and Little Goose 1992 Reservoir Drawdown Test

APPENDIX B
LOWER GRANITE AND LITTLE GOOSE 1992 RESERVOIR DRAWDOWN TEST

1.0 INTRODUCTION

In March 1992, the U.S. Army Corps of Engineers (Corps) conducted a test of the reservoir drawdown concept using Lower Granite and Little Goose projects on the lower Snake River (see Figure B-1). Because the hydroelectric project facilities on the lower Snake River are not currently equipped to safely pass adult and juvenile fish at lowered pool elevations, this test was conducted during a month when there were few migratory fish present in that part of the river. It was primarily designed to provide information regarding the physical effects of reservoir drawdown operations, rather than biological information on the migratory response of juvenile salmon. Information on a host of physical features was gathered, including impacts to the dams and other project structures, reservoir embankments, and cultural resource and recreation sites in the project area. Environmental data, such as effects on water quality and aquatic organisms (including resident and anadromous fish), were also obtained for subsequent analyses. Test results will help the Corps design future drawdown scenarios to potentially improve the survival rate of juvenile salmon migrating downstream.

Realizing the importance of evaluating the reservoir drawdown concept as a means to improve the Snake River salmon runs, major efforts were made to gather as much data as possible during the March drawdown test. Although the Corps was the lead agency responsible for the test, numerous agencies, organizations, and private companies participated in the effort. Primary participants included the Idaho Cooperative Fish and Wildlife Research Unit, Battelle-Pacific Northwest Laboratories, U.S. Geological Survey, the Washington Department of Wildlife, Washington State University, and the Nez Perce and Umatilla Tribes.

This appendix report, which summarizes the purpose and preliminary observations of the drawdown test, is organized as follows:

- Background
- Test Objectives and Procedures
- Monitoring Objectives and Procedures
- Results
- Conclusions and Continuing Actions

Please note that the primary purpose of this appendix report is to inform the public on what took place during the drawdown test and is not intended to present comprehensive or conclusive results of the test. Some of the data collected to date are still being compiled and organized and some have not yet been delivered to the Corps.

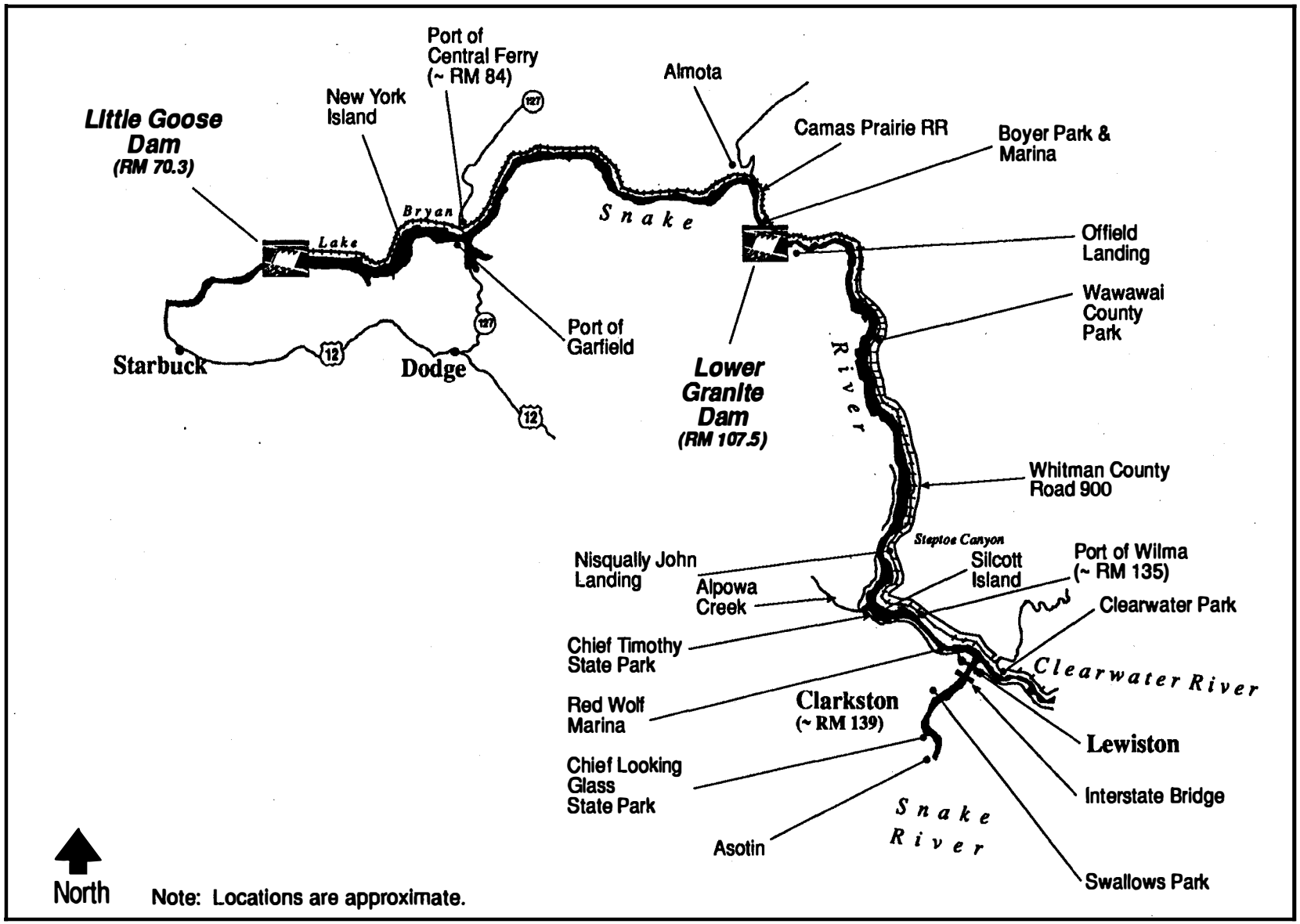


Figure B-1. Primary study area, 1992 reservoir drawdown test.

The Corps released a draft comprehensive 1992 Reservoir Drawdown Test Report in October 1992. This report includes more detailed analyses of observations and results of the 1992 drawdown test than are presented in this appendix.

2.0 BACKGROUND

2.1 HISTORICAL CONDITIONS LEADING UP TO THE TEST

In spring and summer 1990, the Snake River sockeye and spring, summer, and fall chinook were petitioned for protection under the Endangered Species Act (ESA). The NMFS then initiated the process of gathering all the information on these stocks to determine whether these fish should be proposed for listing. At the same time, the region responded with a desire to increase efforts to improve survival for these fish, and maybe even to avoid a listing by implementing measures that would reverse the declining numbers.

Senator Mark Hatfield (Oregon) tasked a group of representatives from fish and power agencies, river users, and other interest groups to develop regional consensus on a recovery plan for the Snake River salmon runs. This group, known as the Salmon Summit, met over a period of several months in late 1990 and early 1991. Although no consensus was reached on a long-term solution, many ideas were generated and measures were proposed to improve salmon survival.

One of the ideas proposed during the Salmon Summit involved lowering the elevations of the reservoirs behind Columbia and Snake River dams to increase water velocities and potentially reduce the amount of time it takes for juvenile salmon, migrating downstream, to get from their birthplace and rearing areas to the ocean. Before the dams were constructed, estimates for travel time through the lower Snake and Columbia rivers were anywhere from 15 to 60 days. It is now estimated that it takes from 30 to 90 days, depending on water flows, for those fish that remain in the river throughout the course of their downstream migration.

Lowering the elevations would reduce the cross-sectional area of the reservoir and increase the average velocity of the water moving through, potentially improving fish travel time. Other methods to reduce travel time and improve survival are currently in use: additional releases of water from storage projects during low flows, and juvenile fish transportation. Although research data support both of these tools, the stocks of sockeye and chinook salmon in the Snake River Basin have not improved. Several years of drought have exacerbated conditions; all measures, existing and potential, that can be used to improve the situation are now being reevaluated.

The regional fish agencies and tribes currently recommend an average flow in the lower Snake River of 140,000 cubic feet per second (cfs) throughout the downstream migration period of the juvenile salmon (approximately April 15 through June 15 or longer) (CBFWA, 1991). During a low-flow year, it is not possible to achieve these flows using water from storage projects. However, it is estimated that lowering the reservoirs approximately 40 to 50 feet could achieve equivalent average velocities during lower flows. The spillway crest

at each of these projects is approximately 50 feet below the normal minimum operating pool (MOP), although water surface elevations as flows pass over the spillway can be up to 25 feet higher than the spillway crest, depending on discharge.

Members of the Salmon Summit requested that the Corps test the reservoir drawdown concept as quickly as possible. The Corps evaluated the possibility of doing such a test in spring 1991, but concluded that potential significant environmental and socioeconomic effects necessitated completion of an Environmental Impact Statement (EIS). This process was initiated in May 1991 to allow the drawdown test to be conducted in 1992. Salmon Summit representatives, and other technical personnel from the agencies and groups involved, continued to meet throughout 1991 and early 1992 to develop the details of the reservoir drawdown test. Several alternatives were developed and evaluated in the Corps' 1992 Columbia River Salmon Flow Improvement Measures Options Analysis/Environmental Impact Statement. The Snake River sockeye salmon were proposed for listing (April 1991) and listed (effective December 20, 1991) as endangered. The Snake River spring/summer and fall chinook were proposed for listing (June 1991) and listed (effective May 22, 1992) as threatened under the ESA.

On February 14, 1992, the Corps signed a Record of Decision (ROD) to implement a drawdown test in March 1992. All personnel involved agreed that this test should be completed during a window of opportunity in which there would be a minimal amount of anadromous fish in the reservoirs because this operation could have significant negative effects to these stocks. A detailed plan, encompassing all aspects of the test, had been developed over the course of the year with help from the interagency/river user/interest group coordination. The desire was to maximize the amount of information gained from the test, especially in any area where data cannot be obtained from simulated situations (such as laboratory or physical models), while minimizing impacts to humans, fish, and wildlife.

2.2 Pre-Test Activities and Project Preparations

To gather information about what drawdown tests might be possible in 1992, the Corps conducted a test of 100 percent spill at Lower Granite Dam on June 1, 1991. For this test, flows of approximately 100,000 cfs were discharged over the spillway with no flow passed through the powerhouse. The test was conducted for 4 hours using three different water flow patterns over the spillway. The purpose of the test was to observe conditions comparable to those expected during some of the proposed reservoir drawdown tests and future long-term operations. The primary focus of the test was to observe adult fish passage conditions and determine dissolved gas supersaturation conditions immediately below the project.

In addition to the June 1991 spill test, many coordination activities were required to prepare for implementation of the March 1992 drawdown test. In January and February 1992, Corps personnel met with the Camas Prairie Railroad, local ports, county highway departments, and state parks to discuss the drawdown test and associated impacts. At these meetings, it was made clear that the Corps did not have the authority to be responsible for repairing or funding the repairs of any damages that might occur to any non-Corps structures.

To prepare for any failures or damages to the Lewiston levee system and reservoir embankments that could occur during the drawdown test, earth moving equipment and extra riprap material were stockpiled and placed on standby at different locations near the Lower Granite Project.

Other activities to prepare for the drawdown test included moving the juvenile fish transportation barges moored below Lower Granite, procuring jet boats for use during the tests, conducting a procedural and safety meeting with all Corps and contractor personnel involved, and establishing six field offices for Corps personnel working on the project.

3.0 OBJECTIVES and PROCEDURES

3.1 Reservoir Drawdown and Spill Tests

A two reservoir drawdown test involving both Little Goose and Lower Granite reservoirs was developed as a means to simulate, at the Lower Granite project, the effects of substantial reservoir drawdowns currently proposed for all four lower Snake River projects. These reservoirs (Ice Harbor, Lower Monumental, Little Goose, and Lower Granite) are currently operated within a 3- to 5-foot range at the top of pools that are approximately 100 feet deep. Once the pool elevation drops below the normal minimum operating level, most of the project facilities (such as the navigation locks and juvenile and adult fish passage facilities) become inoperable. Although the effects of lowering the pool on certain facilities were known ahead of time, the effects on others (such as the turbines) were not; this information is important in evaluating the long-term possibilities of reservoir drawdown.

The two possible methods of passing large volumes of water at a project are either through the powerhouse or over the spillway. Since the best route for passing fish under measures proposed for the long term is yet to be determined, it was important to evaluate the conditions created by both methods, wherever possible. Beginning on March 1, 1992, Lower Granite Reservoir was drafted from its starting point of normal MOP (elevation 733) at a rate of 2 feet per day for 14 days. Drawing down too quickly would endanger the stability of road and railroad fills along project reservoirs. A slower drawdown rate would result in an unacceptably long test period. Therefore, the 2-foot-per-day drawdown rate was determined to be the best balance for this test. Drafting was accomplished by passing the water through the turbines. Elevation 705 (28 feet below minimum operating pool) was achieved at Lower Granite on March 15. This began the second phase of the test and drafting was initiated at Little Goose. Spill tests (described below) were conducted at Lower Granite from March 15 through March 28. Upon reaching a free-flow river section for approximately 100,000 cfs below Lower Granite, the third phase of the test was initiated. As Little Goose Pool was refilled, drafting of Lower Granite Pool continued until elevation 697 was reached, at which point refill, the fourth and final phase of the test, began. Both reservoirs were refilled to MOP by April 1.

Once the Lower Granite Pool elevation was reduced to 705 feet below mean sea level, several spill tests were conducted to monitor conditions under a variety of tailwater elevations. Different spill tests were conducted to

evaluate various types of operation as a means to eliminate problems associated with dissolved gas and flow patterns noted during previous tests of high spill. Tests of 100 percent spill were conducted to examine project conditions when water was discharged over the dam spillway. Combination spill and powerhouse tests examined project conditions when water was passed both over the spillway and through the turbines. In total, 9 spill tests were conducted as part of the March drawdown test (Table B-1 presents information regarding elevations and flow velocity during this period). Tests of 100 percent spill, ranging from 28.5 to 114,000 cfs, were conducted between March 15 and March 28 (see Table B-2). Combination spill and powerhouse tests, conducted on March 16, 22, and 28, involved spilling discharges ranging from 23,000 to 81,400 cfs over the spillway while simultaneously passing flows ranging from 23,000 to 84,000 cfs through the turbines.

The objective of each spill test, besides monitoring what was physically occurring within and downstream of the basin, was to both observe tailrace flow patterns and obtain dissolved gas supersaturation levels resulting from various spill, head, and tailwater levels. Each test consisted of passing 100 percent of the natural inflow over the spillway for 2 hours to obtain baseline information. Then reservoir storage was used to simulate higher flows over the spillway—ranging from 55,000 to 114,000 cfs. Inflows were substantially lower than average, approximately 30,000 cfs (March average is approximately 60,000). Reservoir storage was used to create the higher spill levels for simulation of typical spring discharges. Spills of approximately 100,000 cfs were tested every other day as Little Goose Reservoir was lowered (also at a rate of 2 feet per day, but only during daylight hours). In addition, a combination of approximately 70 to 80 percent spill, 20 to 30 percent powerhouse flows was tested at 108,000 and 80,000 cfs total flow, and an approximately 25 percent spill, 77 percent powerhouse combination was tested. All three tests were conducted when the Lower Granite tailwater was within normal operating ranges. Free-flow over the spillway (no control of the water gate) was tested for approximately 114,000 cfs down to 88,000 cfs (with normal tailwaters).

3.2 The Monitored Environment

To evaluate the effects of reservoir drawdown, four main aspects of project operations were monitored during the test:

1. Project facilities and structures
2. Water resources
3. Biological resources
4. Cultural resources and recreation

Data were collected for each of these components for subsequent analysis to help determine the feasibility of future drawdown operations. Monitoring objectives and procedures for each of these aspects are discussed below.

Table B-1. Lower Granite Drawdown Test Project Operations.

Date	Lower Granite Elevation 0800	Little Goose Elevation 0800
1 Mar	733.07	633.86
2 Mar	731.07	633.63
3 Mar	729.04	634.09
4 Mar	727.18	633.56
5 Mar	725.18	634.66
6 Mar	723.17	634.53
7 Mar	721.18	634.74
8 Mar	719.18	633.95
9 Mar	717.18	634.77
10 Mar	715.18	636.23
11 Mar	713.15	636.14
12 Mar	711.12	636.13
13 Mar	709.08	636.85
14 Mar	707.04	637.15
15 Mar	705.14	637.67
16 Mar	705.00	635.80
17 Mar	706.00	633.69
18 Mar	706.00	631.63
19 Mar	706.00	629.71
20 Mar	706.02	627.52
21 Mar	705.98	625.56
22 Mar	706.01	623.60
23 Mar	705.89	621.14
24 Mar	702.97	623.52
25 Mar	701.30	628.11
26 Mar	700.00	631.75
27 Mar	704.11	633.77
28 Mar	712.51	633.19
29 Mar	716.51	634.69
30 Mar	723.23	634.42
31 Mar	729.25	633.68
1 Apr	734.00	633.29

3.2.1 Project Facilities and Structures

Lower Granite and Little Goose Dams

Ensuring that these structures were not damaged was an important aspect of the test. Instrumentation was in place to monitor potential water flow through the earthen-fill portion of the dams, and settlement and/or cracking of the concrete structures. Specific components of the structures monitored at each project include the navigation lock, powerhouse, nonoverflow section, and spillway structure (see Figure B-2).

Table B-2. Elevations and flows associated with spill tests.

		Weighted Flows			Weighted Elevation	
Date	Test #	Powerhouse (kcfs)	Spill (kcfs)	Total (kcfs)	Forebay (ft)	Tailwater (ft)
15-Mar-92	1A	0.0	28.5	28.5	705.1	637.3
15-Mar-92	1B	0.0	105.5	105.5	704.4	638.9
16-Mar-92	2A	0.0	28.5	28.5	705.5	635.0
16-Mar-92	2B	23.0	81.4	104.4	704.0	637.2
17-Mar-92	3A	0.0	35.2	35.2	706.0	633.3
17-Mar-92	3B	0.0	106.8	106.8	704.5	635.4
19-Mar-92	4A	0.0	35.2	35.2	706.0	629.2
19-Mar-92	4B	0.0	106.7	106.7	704.6	632.4
21-Mar-92	5A	0.0	29.0	29.0	706.0	625.6
21-Mar-92	5B	0.0	106.7	106.7	704.5	630.4
22-Mar-92	6A	0.0	29.0	29.0	706.0	624.0
22-Mar-92	6B	84.0	23.3	107.3	704.5	630.7
23-Mar-92	7A	0.0	27.8	27.8	706.0	622.3
23-Mar-92	7B	0.0	65.6	65.6	704.9	626.2
23-Mar-92	7C	0.0	103.6	103.6	703.4	628.3
26-Mar-92	8A	0.0	26.3	26.3	700.0	631.7
26-Mar-92	8B	0.0	107.2	107.2	698.5	634.9
28-Mar-92	9A	0.0	27.2	27.2	712.9	633.3
28-Mar-92	9B	0.0	65.5	65.5	712.4	634.6
28-Mar-92	9C	24.1	53.4	77.5	711.1	635.4

Turbines

Instrumentation to monitor turbine operation for both safety and performance was installed on representative units at Lower Granite Dam. These units were designed to operate at a minimum head (difference between upstream and downstream water elevations) of 76 feet, but they had never been operated below approximately 95 feet. In addition, the test was designed to reduce the head to as little as 64 feet. Another major concern is the effect of lowered tailwaters (the water immediately downstream of the dam) on turbine operation. This water exerts a back pressure on the turbine blades that is important for proper operation.

Key parameters that were measured to evaluate the effect of operating under a reduced pool included how well the turbine shaft rotated within its designed axis ("shaft runout"), the extent of vibration, bearing temperatures, generator and bearing cooling water flows, noise level, and efficiency/generation capability.

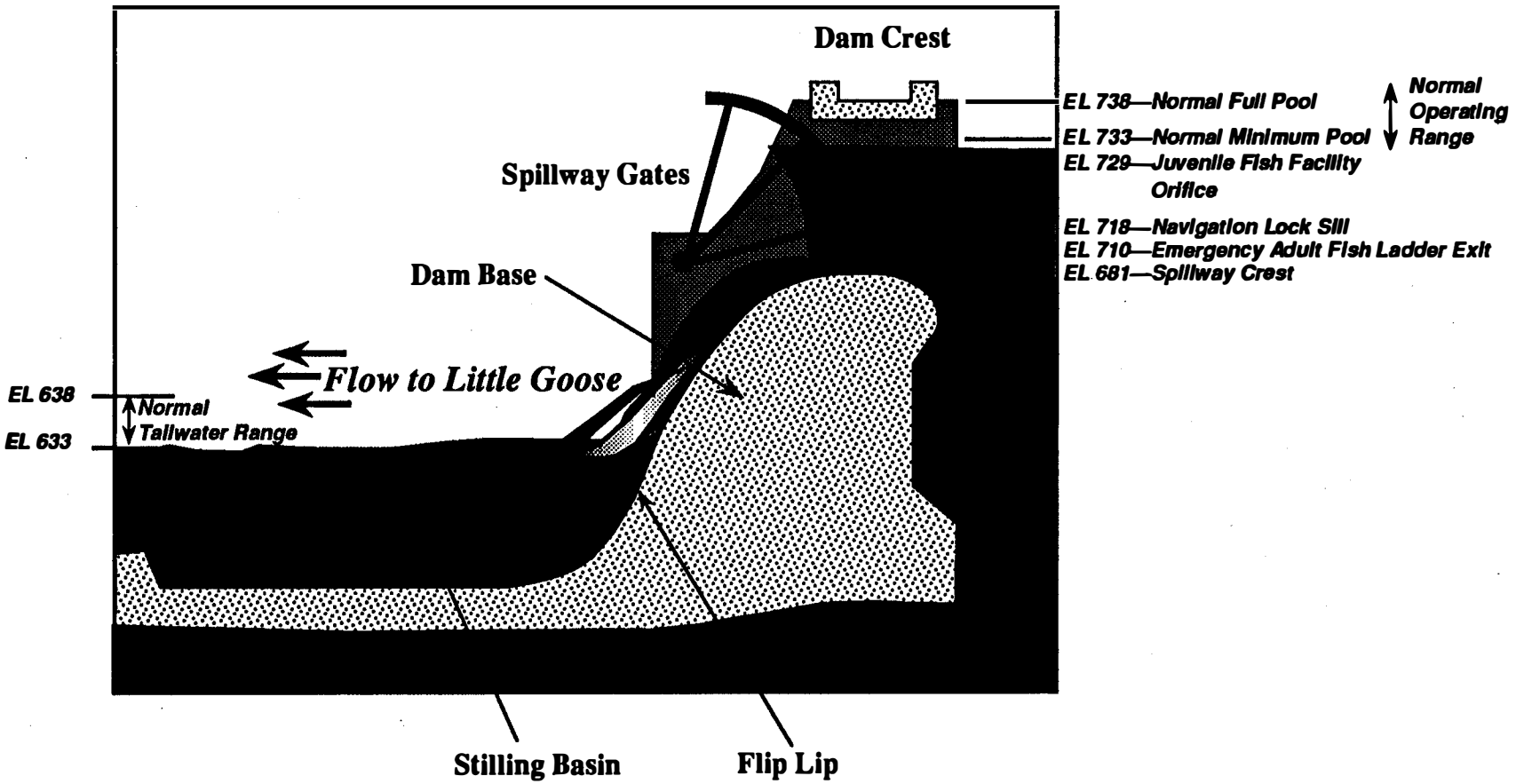


Figure B-2. Operating characteristics of Lower Granite.

Stilling Basin

The stilling basin is the area immediately below the spillway. The concrete-lined basin is designed to dissipate the energy of the spilled water. The amount of energy the basin can dissipate depends partly on the depth of water, and each stilling basin is designed to function safely within the normal operating elevations of the downstream pool (in the case of Lower Granite, the Little Goose Pool). If the energy dissipation within the basin is not adequate, erosion in areas downstream of the project can occur. In addition, rock material downstream can be carried back into the basin and cause damage to the structure.

To determine what levels of spill could be safely passed under lowered tailwater elevations, a physical scale model of a cross section of the Lower Granite spillway was built at the Corps' Waterways Experiment Station in Vicksburg, Mississippi. Using this model, which duplicates the conditions at the project, a variety of head, flow, and tailwater conditions were tested. From this model, it was observed that rock materials downstream could be pulled into the basin under higher tailwater and flow conditions. It was also determined that flows in excess of approximately 100,000 cfs over the spillway under lower tailwater conditions for any length of time would risk damage to the stilling basin because the spill would cause rocks within the basin to roll around, eroding away the toe of the spillway.

Prior to the drawdown test, existing rock material was removed from the stilling basin. Instrumentation was installed at the end of the stilling basin to monitor velocities and the direction of the water flow. In addition, both sonar monitoring and divers were used to examine the floor of the stilling basin between spill tests. Vibration and pressures in the spillway area, including the spillway deflectors or "flip lips," were also monitored. (Flip lips are structures that have been added to the project to deflect flows and help reduce the deep plunging flows that create high dissolved gas levels.)

Visual observations were constantly made throughout the actual spill tests to observe any changing flow patterns in the stilling basin and surrounding areas. Videos were taken both from the south shore, from a helicopter, and from other locations to document the test.

Reservoir Embankments and Levee System

In addition to the earth-fill portion of the dams themselves, many areas of the two reservoirs are lined with railroad and highway embankments. These embankments are protected from wind and wave erosion by riprap within the designed operating ranges of the pools. The Camas Prairie Railroad runs along the north shore of Lower Granite and Little Goose pools from the Lewiston, Idaho area. Highway embankments sections have been constructed on both reservoirs. The Lewiston levees protect the City of Lewiston from the waters of Lower Granite Reservoir. These structures were designed to operate at normal pool elevations, and damage to the embankments, railroads and/or highways, and the levee system was a significant concern to the local residence and businesses.

Reservoir embankments were monitored by helicopter on a daily basis. Any signs of problems noted from the air were more closely investigated later in the day by vehicle. Stream drainage ponds and embayments behind reservoir embankments were monitored to ensure proper drainage. Most of these ponds have both upper and lower level culverts through which the water levels adjust as the reservoir elevation changes. Improper drainage could result in differential water pressures, with the embankment acting as a dam. Because the embankments were not designed for this purpose, improper drainage could result in weakening or failure.

Damage to the levee system from deep drawdowns could potentially occur as seepage channels or sinkholes. In addition, there is a concern about groundwater contamination resulting from exposure to contaminants. When the Lewiston levee system was constructed, waste materials from the construction process, along with potentially hazardous materials from local dumps and industries, were placed in an encapsulated fill area within the levee. The encapsulated fill was designed to prevent the hazardous materials from contaminating the groundwater and reservoir. There was concern about significant increases in groundwater flow through this area inducing migration of contaminants. Monitoring wells were installed to allow sampling and testing of the groundwater before, during, and after the drawdown.

Port and Private Facilities/Structures

Port facilities along both the Lower Granite and Little Goose reservoirs include the Ports of Clarkston, Lewiston, Whitman, Almota, Central Ferry, and Garfield. A structural survey of the port and private facilities was completed prior to the drawdown to note existing conditions and to identify potential problems that could be induced or aggravated by the drawdown. Facilities were visually monitored from a helicopter on a daily basis during the drawdown in conjunction with Corps embankment monitoring activities.

3.2.2 Water Resources

Water Velocity

Theoretically, increasing the water velocity will reduce the migration time for juvenile salmonids, thus potentially increasing their survival rate. Average water velocities at cross sections in the reservoir are calculated based on a knowledge of channel morphology and flow. These data are combined, using a mathematical model, to calculate an average water particle travel time for various flows and reservoir elevations. The average time it takes a water particle to travel through the reservoir can be calculated in the same way or by using the reservoir replacement method or exchange rate, which is based on knowing the volume of water (acre-feet) and flow.

Although the existing information on average velocities is good, it does not reflect the total picture. During the drawdown test, the U.S. Geological Survey (USGS) used an acoustic Doppler profiler to obtain velocity profiles at cross sections throughout Lower Granite Reservoir before, mid-way through, and at the lowest point of the drawdown. These data help to evaluate the range of velocities present under different flows and elevations. In addition, the USGS released a large quantity of red dye into the confluence of the Snake and Clearwater rivers

and monitored the amount of time it took for both the leading edge and the majority of the dye to pass several different points within the reservoir.

Flow Patterns

Because flow patterns affect migratory success of both juvenile and adult salmon, these patterns were monitored in the Lower Granite tailrace during each of the spill tests. In addition, each of the tests was videotaped for closer evaluation. The fish pumps, which provide increased flows to attract fish to the adult fish collection facilities, were operated whenever the tailwater was high enough to permit. This allowed observation of the effects of flow patterns on collection channel entrance flows.

Dissolved Gas Supersaturation

Operation of the dam spillways results in an increase in the level of dissolved gases in the water. Air is entrained in the water as it passes over the spillway, and is then dissolved into the water under pressure when the turbulent water is plunged deep into the stilling basin. Water that is supersaturated with atmospheric gases can be lethal to aquatic organisms, including salmon, depending upon the level of supersaturation, the length of exposure, and the life stage of the organism. This condition is referred to as "gas bubble trauma."

During each of the spill tests, the level of dissolved gas supersaturation was monitored approximately 0.5 mile and 4 miles below Lower Granite. A stationary tensionometer (an instrument used to measure dissolved gas) was mounted on the north shore (same side as the spillway) and boats were used to take transects of the levels in three locations across the river (north, middle, and south). The information was collected throughout the course of each test.

Turbidity, Erosion, and Sediment Transport

Substantial drawdown could potentially disturb fine and coarser sediments that have been deposited within the reservoir. As river velocities increase, these sediments can be resuspended and carried farther down the river system and be redeposited in new areas, changing the nature of both the river and the reservoir; suspended sediments can have both positive and negative impacts to reservoir ecosystems, and organisms within it.

The USGS monitored the movement of sediments caused by the drawdown. In addition, a light transmissometer was used to obtain profiles of water turbidity (cloudiness) throughout the water column at selected ranges. Surface turbidity data were also collected at a variety of points in both Lower Granite and Little Goose reservoirs by Corps personnel.

The USGS measured suspended and bedload transport before and during the drawdown at selected locations on the Snake and Clearwater rivers. Cross-sectional surveys were completed before and after the drawdown to identify the location and magnitude of geometric changes in the channel bed resulting from sediment movement during the drawdown.

Contaminants

Exposure of sediments to increased wind and wave action, and also transport by rain, can result in contaminants contained within those sediments being re-exposed to the water column and potentially affecting living organisms. Water and sediment samples were taken from several locations, including Lower Granite Reservoir, downstream of Red Wolf Bridge and at Red Wolf Marina, at the Lewiston drinking water intake, mudflat ponds in Port of Clarkston, downstream of the Potlatch effluent diffuser, at the confluence of the Clearwater and Snake rivers, and at the mudflats near the Clarkston wastewater treatment plant. Samples were analyzed for a wide range of compounds, including dioxins, polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs).

Groundwater

The USGS conducted a study to measure the effects, if any, of the short-term drawdown of Lower Granite Reservoir on local groundwater conditions. The USGS selected 16 groundwater monitoring wells to monitor prior to, during, and after the drawdown period. These wells were located in the immediate vicinity of Lewiston and Clarkston, in the Silcott area, at Wawawai Park, and in the uplands area east of Wawawai Park. Most of the wells were within 0.5 mile of the reservoir and ranged in depth from 69 to 600 feet.

3.2.3 Biological Resources

Resident Fish

The effects of lowered pool elevations and increased reservoir velocities on resident fish populations, including sturgeon and squawfish, were monitored. A variety of methods were used to gather the information, including beach-seining and electroshocking to gather fish to be tagged for release and subsequent recapture. Resident fish were sampled in both reservoirs before and during the drawdown. This work was completed by the U.S. Fish and Wildlife Service's Idaho Cooperative Fish and Wildlife Research Unit at the University of Idaho.

In addition to the above work, the Oregon Department of Fish and Wildlife initiated activities early for their ongoing evaluation of squawfish populations in the lower Snake River pools. Squawfish in Lower Granite Reservoir were tagged and released for subsequent recapture.

The Washington Departments of Wildlife and Fisheries and the Idaho Department of Fish and Game were responsible for monitoring reservoir embankment ponds and shallow water embayments to minimize loss of resident fish populations resulting from the drafting. These agencies, primarily the Washington Department of Wildlife, monitored these areas on a daily basis, coordinating rescue efforts as needed. Battelle-Pacific Northwest Laboratories conducted surveys to determine the abundance of fish species in nearshore areas affected by the drawdown of Little Goose Pool. These surveys examined a 4-mile stretch of river below Lower Granite Dam.

Anadromous Fish

As previously described, the timing of the 1992 drawdown test was chosen because relatively few migratory fish are present in this part of the river in March, and the Corps could collect data with minimal risk to adult and juvenile fish. However, the Corps did monitor and collect data on anadromous stocks present during the test period, concentrating on the four specific concerns discussed below.

Operation of Fish Ladder Auxiliary Exit. The Lower Granite Project was designed to be able to draft to elevation 710 to prevent the Lewiston levee system from being overtopped in case of an extremely high water event. Because of this possibility, the Lower Granite adult fish ladder was designed with an alternative exit system that could operate as low as 710 and still provide enough head on the pumps to keep the fish ladder full (normal operation is gravity flow of water into the ladder). This system was in place but had never been used. It was operated and monitored for the first 12 days of the drawdown test, and adult fish were counted as part of the normal adult fish counting program.

Movement Through Reservoirs. Prior to the initiation of drawdown, the Idaho Cooperative Fish and Wildlife Research Unit sampled juvenile salmonids throughout Lower Granite and Little Goose reservoirs, using beach seines and electroshocking. In addition, twice weekly the Corps removed fish that had been diverted from the turbine intakes into vertical slots (gatewells) at Lower Granite Dam (the juvenile fish facility is nonfunctional below normal MOP). See Figure B-3 for a cross section of the dam showing the gatewells and other components of the juvenile bypass system. Juvenile salmonids, as well as resident fish, were anesthetized, counted, and released below the dam. Any adult salmonids collected were counted and released above the dam. Lastly, as part of an ongoing lower Snake River project adult fish passage evaluation, radio-tagged steelhead in the vicinity of Lower Granite were monitored during the test.

Effects of Spill Tests. Following spill tests, electroshocking was used in the first few miles below Lower Granite Dam to collect anadromous (juveniles only) and resident fish and examine them for symptoms of gas bubble trauma, the condition that results from exposure to excessive levels of dissolved gas supersaturation. (No effects were expected, but this measure was requested to ensure protection for then-proposed ESA stocks.)

Fall Chinook Redds (nesting sites). Sampling efforts performed in Little Goose Reservoir in past years, along with other data such as discovery of at least one redd below Lower Monumental this past winter, suggest that fall chinook are spawning in the lower Snake River pools. Battelle-Pacific Northwest Laboratories and Corps personnel intensively monitored the shoreline and other potential spawning areas for signs of fall chinook redds as Little Goose Pool was lowered. Testing protocol was to cease drafting the Little Goose Pool if signs of fall chinook redds were observed, and to consult NMFS on further test actions that would be acceptable.

Bottom-dwelling Organisms

Substrate samples of selected areas in both reservoirs were taken before and during the drawdown test. Organisms residing within the sediments were identified and counted. In addition, qualitative observations of the effects of drawdown on more mobile organisms, such as crayfish, were made.

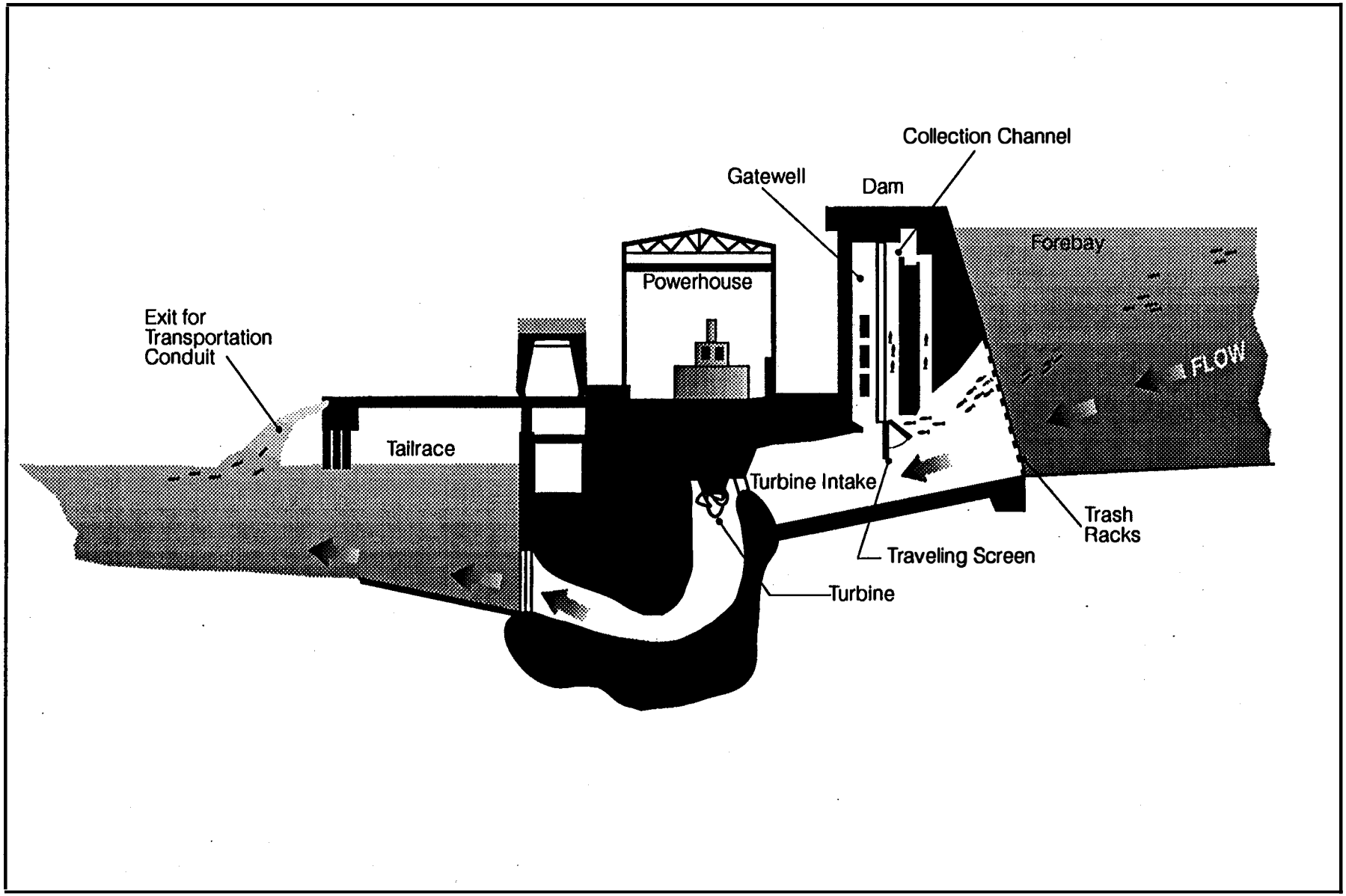


Figure B-3. Juvenile bypass facilities.

Wildlife

Terrestrial wildlife species of concern in the vicinity of the project area include geese, furbearing mammals, Federally listed threatened and endangered and state-listed species (for example, the bald eagle), big game (particularly mule deer), and song-birds. The effects of the drawdown test on wildlife were qualitatively assessed throughout the drawdown. In addition, aerial photography was performed on both reservoirs before and during the drawdown (both at mid- and lowest points). Battelle-Pacific Northwest Laboratories monitored the shoreline on all four lower Snake reservoirs for impacts to riparian and wetland vegetation, which are important wildlife habitats.

3.2.4 Cultural Resources and Recreation

Cultural Resources

Washington State University and the Nez Pierce and Umatilla Tribes participated in monitoring of selected archaeological sites in both Lower Granite and Little Goose reservoirs throughout the drawdown test. Washington State University monitored and documented selected sites to determine the potential impacts of increased erosion. All personnel assisted in efforts to minimize vandalism of exposed cultural resource sites.

The objectives of the archaeological monitoring were to document the kinds of impacts to cultural resources resulting from reservoir drawdown and refill, and to assess the condition of the inundated sites exposed during the drawdown. Previously identified archaeological sites in both the Lower Granite and Little Goose reservoirs were selected for mapping and impact assessment. Field inspections of the selected sites included a surface survey to identify features, artifacts concentrations, and diagnostic artifacts. In addition, any impacts occurring at sites (from vandalism, slump blocks, erosion gullies, deflation areas, etc.) were noted. Field inspections also included an assessment of site conditions.

Recreation

The Corps gathered routine visitation data from existing traffic counters at each of the recreation sites on Lower Granite and Little Goose reservoirs.

3.3 Other Test Activities

3.3.1 Navigation Lock Outages

Lowering the water levels of Lower Granite and Little Goose reservoirs required the navigation locks to be taken out of service because the minimum navigation channel depth of 14 feet cannot be maintained below minimum pool level. (The locks are normally out of service for a 2-week maintenance period.) The floating guidewalls also had to be moved because they were not designed to function at the low elevations achieved

during the test. The Lower Granite navigation lock was taken out of service from February 28 and returned to service on April 1. The Little Goose navigation lock was out of service from March 11 to March 26.

3.3.2 Natural Resource Management Activities

The drawdown test resulted in a drastic change to the operating project and a completely different environment for the visiting public. When the reservoir was drawn down, large mud and sand flats appeared that were attractive to the public for walking and beach combing activities, but were also very hazardous areas until the soil drained and firmed up. Boat ramps on Lower Granite were closed on March 1 to prevent accidents when the reservoir levels dropped below the bottom of the concrete boat ramps. Ramps in the lower Clearwater River and at Asotin, Washington, were left open because these ramps are in the free-flowing river areas under normal conditions and were not affected by the fluctuating pool level. The boat ramps on Lower Granite were reopened on April 1 when the reservoir reached MOP. The Corps boat ramps on Little Goose Reservoir were closed from March 15 through March 28. However, visitor information centers were maintained at Clarkston and at the Lower Granite juvenile fish facility.

During the drawdown test, resource management personnel were heavily involved in patrolling project lands and waters to monitor visitor activities and newly exposed archaeological sites and in looking for safety problems. Resource management personnel patrolled project areas by road several times per day. Boat patrols were made several times each week, and three helicopter patrols were conducted during the test. Overall, very few problems were encountered with the large increase of public activities associated with the drawdown test.

3.3.3 Public Information Services

To help the public understand activities associated with the 1992 drawdown test, the Corps used several methods to provide information on the 1992 drawdown test, including: (1) public information meetings, (2) news conferences, (3) operation of two public information offices, (4) information published for public distribution, (5) work with news media representatives, and (6) tours and briefings. Each of these methods is described below.

Two public information meetings were held prior to the drawdown test (one in Lewiston, Idaho, the second in Pasco, Washington). Meetings were undertaken to inform and educate the public on the decision to proceed with the drawdown action. Many issues were discussed, including the need for the test, the monitoring programs that would be involved, environmental and structural issues, responsibilities for damage, and how the outcome could affect future decisions regarding operation of the lower Snake River.

Several days prior to the test, a news conference was held in Lewiston. This conference provided an opportunity to explain how the action would proceed, discuss schedules, and explain the preparation involved, including preparation for any emergency actions that might be necessary. During this conference, a toll-free information number was introduced that could be called to keep individuals updated on test activities and provide emergency numbers for public contact. The number was in operation through March.

News releases and advisories were provided to the region's media contacts on a daily basis through March. In addition, to explain the activity to visitors and local residents, a flyer was published and distributed to local businesses, visitor information offices, and recreation facilities throughout the area. Public Service announcements presented a strong safety message to protect reservoir users, awareness for protection of natural resources during the action, and messages to prevent disturbance of cultural resources along the reservoirs.

Two public information offices were established to respond to questions from the public, resolve problems associated with use of facilities and the reservoir, and to work with the media. The Clarkston Public Information Office was planned primarily to deal with local citizens, while the Lower Granite Public Information Office generally worked with the news media. Substantial efforts were made to provide news media staff with timely, updated information and interviews with drawdown activity leaders.

Briefings and tours were provided throughout the activity to more than 300 individuals, including Idaho Governor Cecil Andrus, Congressional representatives, staff members from regional governmental leadership, agency heads, special interest groups, and Corps officials.

4.0 RESULTS

Lower Granite and Little Goose reservoirs were drafted a total of 36 and 12.5 feet below MOP, respectively, and were completely refilled in time to provide fish passage for migrating salmonids. Overall, the test went very smoothly. Several hundred people were involved, including Corps and contract personnel, and no major logistical problems were encountered in obtaining the desired information. Involved parties worked well to adjust plans during the month.

4.1 Project and Reservoir Facilities and Structures

4.1.1 Lower Granite and Little Goose Dams

Instruments indicated no changes or movements in the dam structures during the drawdown. In general, engineered fill embankments at the dam suffered no major structural failures and showed no external signs of distress. Because of the relatively calm weather, embankments were not eroded by wind and wave action.

4.1.2 Turbines

Analyses conducted to date show that the turbines operated safely during the drawdown, with bearing temperatures remaining within safety limits. Shaft runout began to increase with low head/low generation load conditions, but all readings were within the mechanical safety criteria. Vibration levels, although acceptable, increased substantially under low tailwater conditions. As expected, the performance of the turbines dropped with decreased head levels. Turbine efficiency decreased approximately 40 percent when the project went from

100 feet of head to 64 feet, which could substantially affect survival of anadromous fish that pass through the turbines.

4.1.3 Stilling Basin

Problems with material in the stilling basin were noted during the drawdown test. Under normal tailwater elevations, materials already within the basin remained relatively stable, but materials downstream were pulled into the basin at flows greater than 60,000 cfs. As tailwater elevations dropped closer to the top of the flip lip, churning within the basin began to increase causing material movement. Some of the rock material inspected between the drawdown tests was fist sized. Inspection after the test revealed that the surface of the stilling basin floor was substantially pitted, probably caused by rock movement during the test.

Based on these conditions, it is probably unacceptable to operate the spillway and stilling basin for an extended time under lowered tailwater conditions unless a method to keep rock material out of the basin is devised.

4.1.4 Engineered Reservoir Embankments

Lewiston Levees

No adverse conditions, except in an area of past seepage problems, were detected for the Lewiston levee system. The seepage problem area is along the west levee where, during previous construction, a number of sink holes developed in the backfill material. After the drawdown, increased seepage was noted through the gravels at a nearby pond. Additional investigations will determine the seepage amount and if any remedial action will be necessary.

Road and Railroad Embankments

The embankments along Whitman County Road 900, which runs along the north shore, were adversely affected by the drawdown operations. Extensive movement was noted in 33 areas, evidenced by cracks, depressed and raised areas within the road, and guardrail movement. Cracks were 1/8 inch to 15 inches wide and up to several hundred feet long (see Figure B-4). Because of these problems, the road was closed toward the end of the test. The road was reopened following repair, several weeks after refill. State Highway 193 from Red Wolf Bridge to Steptoe Canyon experienced much less substantial cracking during the drawdown period, but cracking has been noted in this area before the drawdown test. Two minor slides were observed along U.S. Highway 12 immediately downstream of Red Wolf Marina; they were probably associated with seepage from bank storage held in alluvial deposits by the reservoir.

Railroad operations were not interrupted during the test, but indications of movement and slight cracking caused speed restrictions until tracks could be realigned.



Figure B-4. Cracks along Whitman County Road 900 from drafting Lower Granite Reservoir.

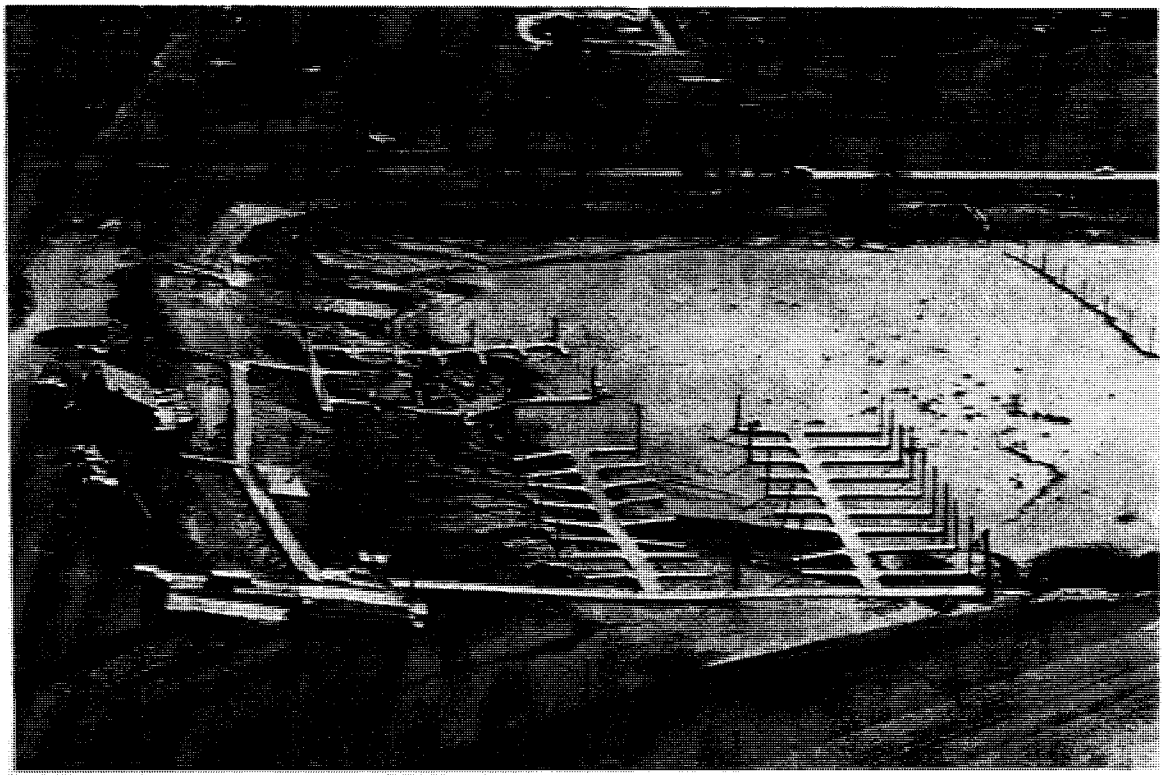


Figure B-5. Red Wolf Marina at pool elevations below MOP.

4.1.5 Natural Slopes and Embankments

The majority of sliding activity associated with the drawdown occurred within slopes consisting of natural deposits of silts, sands, and gravels. Noticeable areas of extensive sliding were at the Port of Clarkston, Red Wolf Marina, Nisqually John Landing, Offield Landing, Port of Wilma, and numerous locations along the south shore of Lower Granite and Little Goose reservoirs. Minor sliding activity was also observed at the ports of Garfield and Central Ferry.

4.1.6 Encapsulated Fill

The integrity of the encapsulated fill did not appear to be affected by the test drawdown.

4.1.7 Port and Private Facilities

Some movement associated with a downstream sheetpile dock was observed at the Tidewater terminal at the Port of Wilma. It appears that a concrete cap slab in one of the cellular sheetpile docks at the Port of Lewiston experienced some settlement, but the cracks could not be investigated because of difficulty of access. The Port of Garfield's small craft landing platform suffered bent hinges as the platform settled on the bank.

Red Wolf Marina suffered substantial damage, particularly to its boat landings (see Figure B-5). A creek formed when water held within the alluvial materials drained and eroded a channel through the accumulated silt, undermining the wood boat landing. As a result, platform fasteners sheared, walkways and canopies buckled, and some of the piles tilted. During reimpoundment, the piles, landings, and canopies re-established themselves. In addition, the landing at the Quality Inn in Clarkston suffered some tilting of landing bumper piers. Several of the piles were later replaced.

4.2 Water Resources

4.2.1 Water Velocities

The objectives of the USGS velocity monitoring efforts were two-fold: 1) validate existing mathematical models, and 2) obtain information regarding the range of velocities at various drawdown levels. Although fluctuations in reservoir elevation and flows made data analyses and interpretation more difficult, both the dye test and velocity mapping confirmed that existing estimates of average water particle travel time are accurate. Maximum and minimum velocity information will be useful as more knowledge is gained about fish behavior and migration characteristics.

Dye travel time was slightly slower than was predicted by the mathematical models but this may be a function of the unsteady flow conditions within the reservoir during the test. Velocity mapping showed a substantial increase (5-fold) in velocities at the head of Lower Granite Reservoir, as was expected. Maximum velocities in the confluence area were approximately 4.5 fps. This area was transformed from a pool to a free-flowing river

section. Farther downstream, where the reservoir remained, less effects were produced by the drawdown. Changes near the dam were minor; maximum velocities remained less than 0.6 fps.

4.2.2 Water Quality

Dissolved Gas Supersaturation

One of the primary objectives of the drawdown test was to monitor dissolved gas supersaturation levels at a variety of head, spill, and tailwater conditions using both 100 percent spill and combination spill and powerhouse flows to be used in evaluation of proposed future operations. As with results for water velocity data, the short surge tests necessary to simulate high spill levels created additional variables that made it difficult to conclusively define the relationship between head, discharge, tailwater, and dissolved gas supersaturation. Valuable data were obtained that accurately characterize dissolved gas levels, but the precision of the results was affected by the short length of the tests and subsequent data collection techniques.

During the test, high dissolved gas levels were documented at a variety of spill and tailwater conditions with levels ranging up to 135 percent from a background level of 100 to 104 percent (see Figure B-6). It generally took about one-half hour for the effects of spill to substantially increase over background levels at a monitoring point near the dam; it took approximately 3 hours after the spill began for supersaturated water to reach a monitoring point approximately 4 miles downstream of the dam. Higher flows spilled through the dam shortened this time.

In general, dissolved gas levels appear to be very sensitive to the spill rate—the greater the spill rate, the higher the dissolved gas levels. A reduction in tailwater elevation tended to increase dissolved gas supersaturation; however, levels were high whether the tailwater was high or low. Similarly, dropping the forebay elevations below MOP (reducing the head) did not significantly reduce dissolved gas levels.

When spill and powerhouse flows were combined, discharges did not mix within the first few miles downstream of the dam. This may indicate that any dilution effect of powerhouse discharges on high dissolved gas levels generated by spill may be minimal over a sizable length of river. Unless powerhouse discharges are a majority of the total flow, they may have no real effect on reducing dissolved gas levels.

Despite the level of uncertainty, results of the March drawdown test indicate that discharges from both spill and combination spill and powerhouse flows typical of spring discharge result in supersaturation exceeding levels considered safe for aquatic organisms, including salmon.

Turbidity

Just prior to the March drawdown test, turbidity levels were slightly elevated at Lower Granite from rainfall. During the test, turbidity increases in Lower Granite Reservoir were greatest at the head of the pool where riverine conditions were restored to areas that, at normal pool elevations, experience lower velocities. The

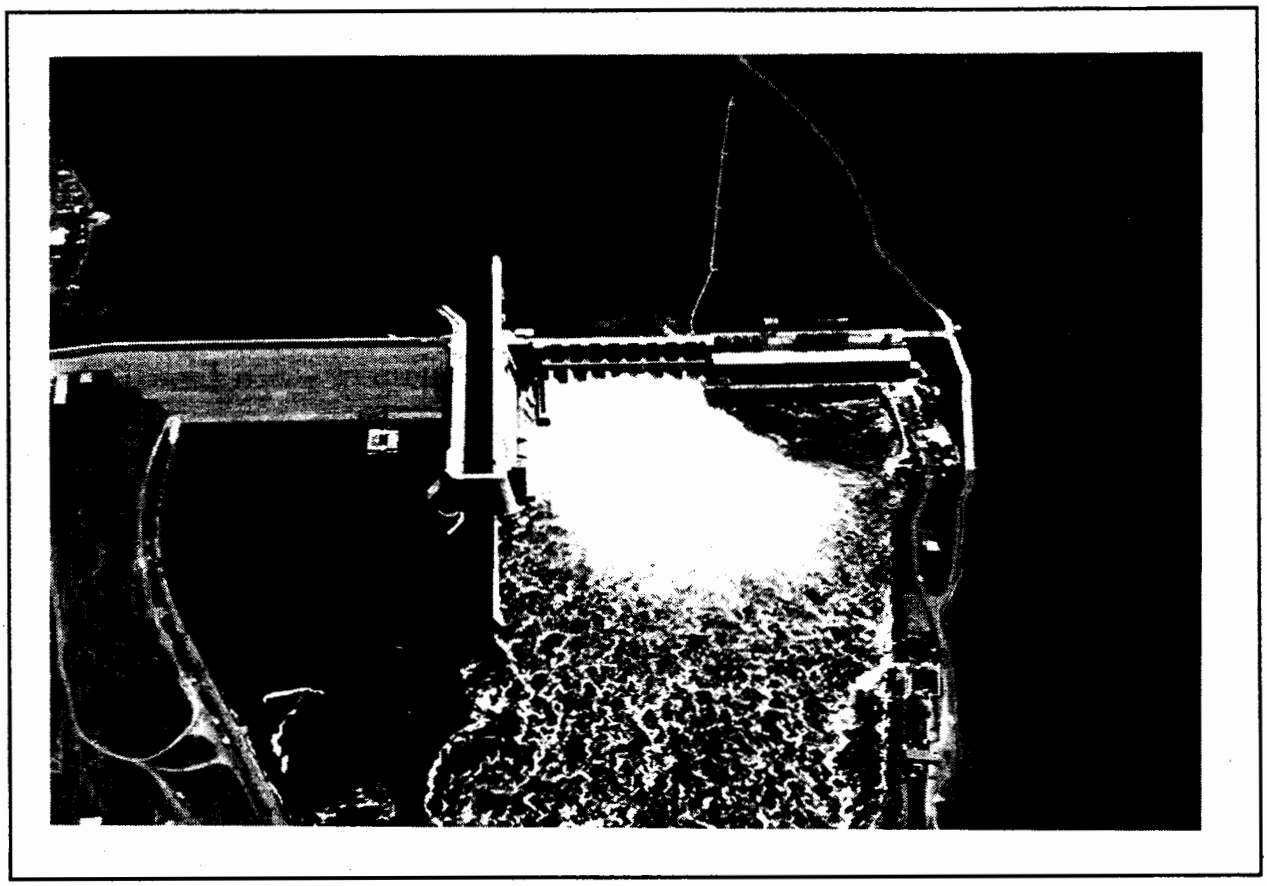


Figure B-6. Dissolved gas supersaturation levels up to 135 percent were documented during the drawdown test.

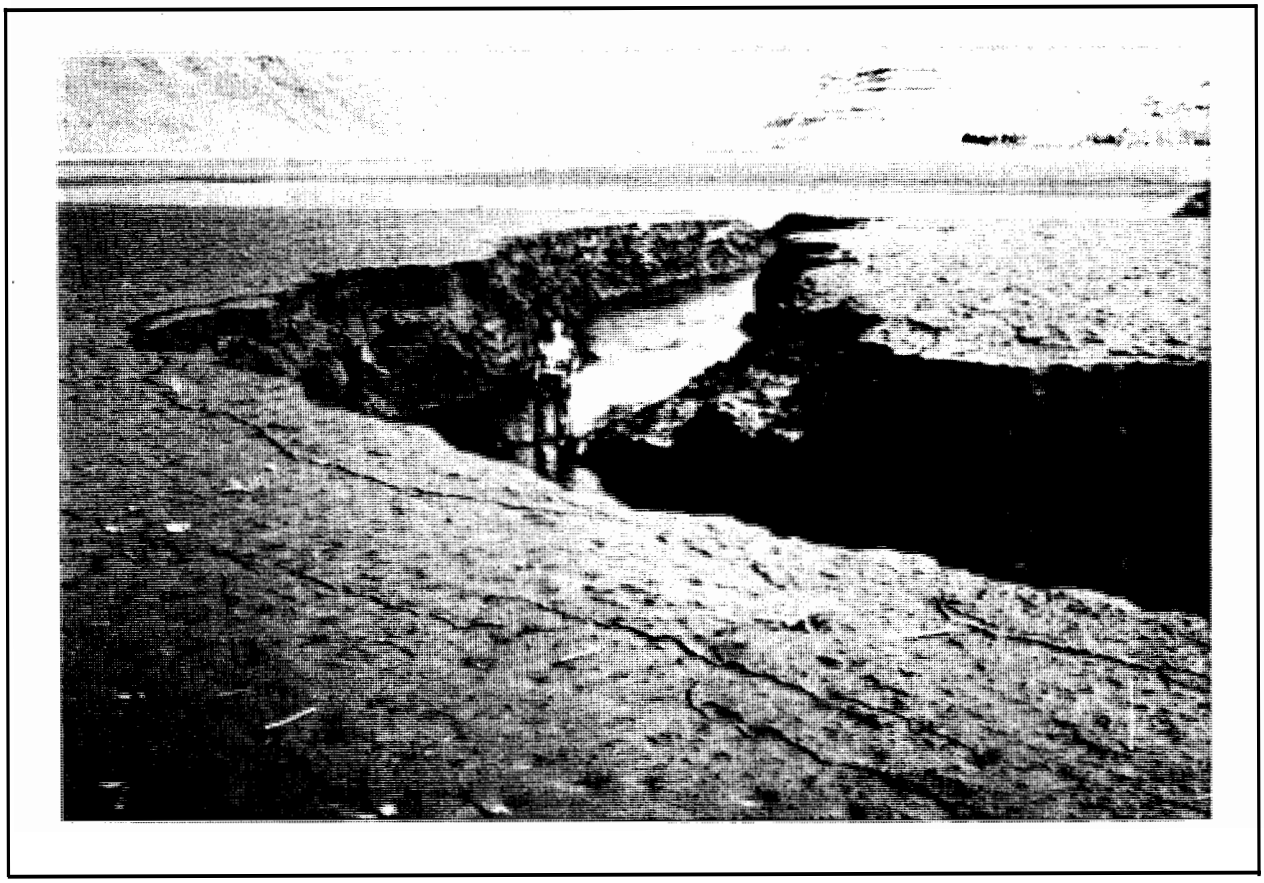


Figure B-7. Streams channeling through sediment deposits resulted in turbidity plumes during the drawdown. Alpowa Creek is pictured here at pool levels below MOP.

scouring effect of increased velocities moved downstream as the pool was drafted, moving the turbidity peak downstream. As the pool was initially drafted, coarser sediments were resuspended and resettled relatively quickly, resulting in upstream turbidity increases that were gradually reduced downstream. At lower pool elevations, the finer sediment deposits were resuspended. These sediments did not settle out readily and caused significant turbidity increases farther downstream later in the drawdown test. A small increase in turbidity was recorded at Little Goose in late March.

Turbidity plumes were present where streams (e.g., Alpowa Creek and Red Wolf Marina) channeled through sediment deposits and along shorelines where bank storage was released (see Figure B-7). Although extensive mud flats were exposed during the test, the lack of wind and rain in March prevented any transport of fine sediments that might have affected water quality, and no data could be collected on this phenomenon.

Erosion and Sediment Transport

Very little sediment was carried into Lower Granite Reservoir by inflow at any time during the drawdown test, and only minimal increases in sediment transport occurred within the reservoir until maximum drawdown. At maximum drawdown, sediment transport in the Snake River increased to nearly 39,000 tons per day, with 18,000 tons per day coming from within the reach of the reservoir above the confluence with the Clearwater. After March 18, sediment transport in the Snake probably increased to at least 68,000 tons per day below the confluence because the Clearwater River was discharging 50,000 tons per day. These sediments had been deposited at the head of the reservoir over the last 17 years. The increased velocities resulting from recreating a riverine condition in this area resuspended sediment and moved it. These data suggest that over 1 million tons of sediment could have been in transit during the 15 days of 28 foot drawdown. Sediment transport only increased from 1,000 to nearly 5,000 tons per day just above Silcott Island; this low transport rate indicates that nearly all of the sediment was picked up and redeposited in the portion of Lower Granite Reservoir upstream of Silcott Island.

The Port of Lewiston turning basin area experienced substantial erosion during the test, but the material was only carried a short distance before being redeposited. About 390,000 cubic yards of material was eroded immediately downstream of the Interstate Bridge between Lewiston and Clarkston and redeposited a short distance farther downstream. About 7,000 cubic yards of material were eroded between river mile (RM) 139.64 and 138.34. An additional 346,000 cubic yards of material were eroded on the Clearwater River just above its confluence with the Snake River. Heavy deposition occurred downstream of the Port of Clarkston. Nearly 600,000 cubic yards of deposition can be accounted for in the reach between RM 136.29 and 138.

Contaminants

Approximately 50 surface water and sediment samples were collected for subsequent laboratory analysis. No PCBs, semivolatile organics, pesticides, or PAHs were detected in any of these samples. In addition, toxicity tests performed on some of the samples demonstrated that none contained constituents that were lethal to a test organism after 48 hours of exposure. *Daphnia magna* was chosen as the test organism because of its sensitivity to most toxicants. Samples from mudflat ponds and a stream flowing from Red Wolf Marina, however,

contained metals far above levels considered safe for aquatic organisms. If contaminated sediments were transported by the stream as it channeled through the mudflats, toxic conditions could exist in localized areas along shore lines, particularly during storm events.

Groundwater Levels

Results of groundwater monitoring indicate that water levels in wells immediately adjacent to the reservoir lowered the same amount as the reservoir. Those wells somewhat removed from the reservoir lowered with the reservoir at first, but then stabilized at their former elevations. Wells farthest away from the reservoir showed the least hydraulic connection to the drawdown event.

No wells in the vicinity of the reservoir were damaged by the drawdown test. The owner of one well reported a water level drop below the pump intake early in the drawdown phase, but there have been no problems since refill.

4.3 Biological Resources

4.3.1 Resident Fish

Fish in embankment ponds or shallow water embayments that were unable to follow receding water levels did not survive unless rescued by participating agency personnel or the public. Many instances of fish kills were documented, either in locations where rescue was prohibited because of dangerous conditions, or where personnel were unable to reach them in time. Rescue efforts were fairly extensive, with participation by the Washington Department of Wildlife, the Idaho Cooperative Fish and Wildlife Research Unit, the National Marine Fisheries Service, the Corps, and others. An estimate of approximately 35,000 fish (mostly resident) were observed dead during the test. While the vast majority of these (80 percent) were brown bullhead and crappie, other species included sunfish, bridgelip sucker, carp, smallmouth bass, squawfish, yellow perch, redside shiner, largemouth bass, peamouth, and sculpin. The total extent of fish lost cannot be quantified; this is only an estimate of the number of fish observed. Predation by birds, raccoons, and other animals tend to make these estimates somewhat conservative. Gulls were observed feeding on stranded fish, and raccoon tracks were noted at most stranding sites.

4.3.2 Anadromous Fish

Adult Passage

The auxiliary exit for the adult fish ladder at Lower Granite appeared to function as designed. Fish were observed exiting the pipe, and no build-up of fish at the top of the ladder was apparent. Daily counts of adult steelhead during the 12 days the system was in operation ranged from 14 to 202. During dewatering of the ladder (March 12), very few fish were observed passing downstream through the fish-counting window (see Figure B-8). Upon refill of the system on March 31, over 1,000 steelhead passed through the ladder the first

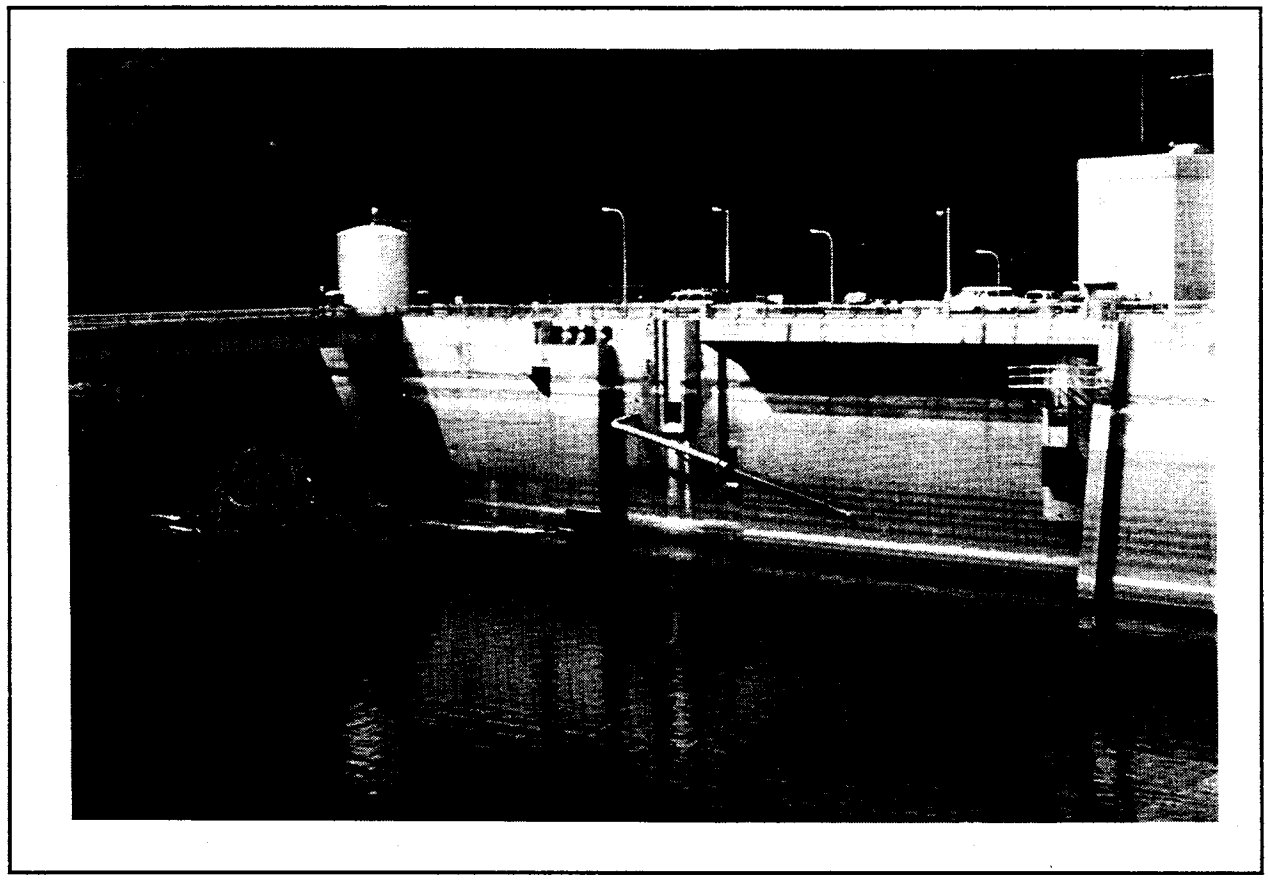


Figure B-8. The auxiliary exit for the adult fish ladder at Lower Granite Dam was dewatered for approximately 19 days during the drawdown test.

day, and over 800 the next. At that point, counts returned to levels expected for the late March to early April time frame. It appears that the fish ladder outage delayed some upstream migrating adult steelhead. Further details are included in the drawdown report.

Initial observations of tailrace flow patterns during spill tests indicated that delay of adult fish during substantial spills, even with some powerhouse flow, could be considerable. Flow patterns appeared to be undesirable for fish passage at the main adult fishway entrances for all the tests with either no or two units operating. Some type of surface eddy was always apparent downstream of the powerhouse, which would probably make it difficult for fish to locate the entrances near the powerhouse and south shore. Very turbulent flow conditions with high velocities were also apparent at the entrance north of the spillway. The only test that appeared to have acceptable flow conditions at the adult fishway entrances was the test with full powerhouse operation and the low spill discharge. This condition is similar to normal operating conditions that currently pass fish through the project.

Juvenile Passage

Sampling of salmonids within Lower Granite Reservoir before the drawdown test resulted in preliminary population estimates of 12 ($\pm$8) juvenile chinook salmon, 95 ($\pm$51) hatchery steelhead, and 176 ($\pm$63) wild steelhead. Population estimates for the steelhead have not been completed.

Fish were rescued from the Lower Granite gatewells nine times during the drawdown test. A total of 1,717 juvenile salmonids were obtained: approximately 759 chinook, 717 wild steelhead, and the remainder hatchery steelhead and *Oncorhynchus nerka*. A sample taken by NMFS indicated that the *O. nerka* were most likely Dworshak kokanee.

These gatewell data, however, cannot be compared to a nondrawdown scenario. The juvenile fish facility is not operated during March, so there are no past data for comparison.

Data were inconclusive regarding the effects of gas bubble trauma (GBT). Of the 1,600 fish examined for symptoms following the spill tests, about 123 were anadromous fish. No symptoms of gas bubble trauma were noted in these fish, but it was very difficult to determine the location of fish that were potentially affected by this condition. No signs of GBT were expected since the duration of spill tests was minimized.

Salmon Spawning

Known locations of present and past fall chinook redd sites in areas upstream of Lower Granite Reservoir were not influenced by the drawdown. Within Little Goose Reservoir, the majority of gravel and cobble areas exposed appeared to be unsuitable for spawning because of the presence of embedded fine material, indicative of low velocities. However, a large area of potential suitable spawning gravels, composed of clean gravels and cobbles, was located immediately downstream of Lower Granite Dam. This bed extended for at least one-quarter mile downstream of the dam, which was the length of area exposed during the 12.5-foot drawdown of Little Goose. Some of this material was in a very similar location to the area where the chinook redd was

found below Lower Monumental Dam during February 1992 dredging operations, but no fall chinook redds were observed during the drawdown test.

Anadromous Stranding

A total of 22 salmonids were documented as lost by stranding during the drawdown test. All but one of these fish were juveniles. Nine of the juvenile salmonids were threatened or endangered fish, but evidence suggests that the *Oncorhynchus nerka* found were likely kokanee from Dworshak and the three chinook found were likely subyearling spring chinook from the lower Clearwater River.

Bottom-dwelling Organisms

Many species of bottom-dwelling organisms, including clams and crayfish, were affected by the drawdown. Many of those in the drawdown zone were unable to follow the retreating water. It is important to note that two candidate species (under the ESA) were found within the drawdown zone or its influence in small amounts (Frest, 1992), but studies regarding these species are independent of the Corps' efforts. The two species are *Anodonta californiensis*, a freshwater mussel, and *Fisherola nuttalli*, a type of limpet.

Wildlife

Observed effects to wildlife were primarily limited to exposure of goose nesting habitat. The occurrence of land bridges to nesting islands, which allows increased predator access, was much greater than anticipated. All nesting islands were exposed, except for New York Island in Little Goose Reservoir. Waterfowl continued to be present in the reservoirs, but geese tended to use different areas than under normal pool operations. There were no signs of increased predator problems along the reservoir. Although predators were of concern around the nesting islands, it appears that the nesting birds avoided problems by delaying nesting or moving to safer areas.

Despite the concerns about potential impacts to furbearers, no problems were observed during the drawdown test. One beaver family was temporarily displaced when their lodge was exposed during drawdown, but they returned when water levels rose to previous levels.

Changes in wildlife habitat were also observed with invasion of pioneering vegetation, including reed canarygrass, cattails, willow, and alder. These invasions primarily occurred in the normal water fluctuation zone and not in the newly exposed mudflats, which may be the result of a drafting to MOP in the summer of 1991. Nondesirable plant species, including cocklebur, were observed.

Evaluation of effects to wildlife and wildlife habitat are continuing. Aerial photographs taken during the drawdown are being scanned, and the digital data will be entered into a Geographical Information System (GIS) for subsequent evaluation to determine the relationship of the drawdown to specific wildlife habitat.

4.4 Cultural Resources and Recreation

4.4.1 Cultural Resources

Thirty archaeological sites located in the Lower Granite and Little Goose reservoirs were originally planned to be monitored. Of these, 15 were inspected during the test. In addition, 2 new sites were identified and 2 other previously recorded sites were monitored, bringing the total sites inspected to 19. The remaining sites could not be monitored because of time constraints, changes in the drawdown schedule, inability to locate sites, and unexpected situations. Also included in the field activities was the recovery of 7 Native American burials exposed during the drawdown. Sites in Lower Granite Reservoir, for the most part, were covered to varying degrees by a mantle of redeposited silt, which prevented full examination of many of the sties. Sites in the upper reservoir area close to Lewiston and Clarkston have suffered from human development. Sites in Little Goose Reservoir, however, experienced much less siltation and development.

Despite patrolling efforts and anti-collection press releases, collecting and vandalism at cultural resource sites occurred during the drawdown at a greater scale than anticipated. Several sites near Lewiston and Clarkston received heavy impacts from collecting. Overall, the drawdown provided access to almost every site that was monitored.

4.4.2 Recreation

Visitation in general increased significantly. A rough estimate shows that many of the areas where people could view the drawdown experienced an increase of visitation of approximately 100 percent. Prior to the drawdown, it was anticipated that visitation could be down substantially due to closed boat ramps and the less appealing low water levels. However, because of the unique nature of this test drawdown, the number of visitors who were sightseeing during this test time frame appeared to increase dramatically.

Most boat ramps and state parks showed substantial drops in visitation as all boat ramps were closed. There was virtually no boating on the Lower Granite Pool throughout the month. This same situation resulted on the Little Goose Pool during the period that the reservoir was below its normal minimum operating level; however, because of the shorter duration, the overall impact was much less. Sightseeing was the primary use at boat ramp locations during the drawdown.

The usual forms of recreation, such as boating, fishing, and camping, were decreased substantially during the test drawdown. Most parks that offer camping showed a decrease in visitation. At most of the other areas, visitation by sightseers was up.

During the first 2 weeks of the drawdown test, large numbers of visitors were observed coming out to see the activities, even on days when the weather was cloudy. Visitors from outside the local area spent the night in local motels specifically to see the drawdown. However, after the first 2 weeks, the weather was sunny and visitors seemed to be involved in a variety of nonwater dependent activities like picnicking. The increase in

picnicking was likely attributable to the sunny weather and not the drawdown test, and would likely have occurred anyway.

4.5 CONCLUSIONS

The March 1992 reservoir drawdown test was designed to obtain as much information as possible in a short time to assist in evaluation of reservoir drawdown as a long-term operation to improve survival of salmon through the lower Snake River. The following statements can be made in conclusion from this test:

General

1. Although the test provided substantial amounts of information regarding the physical effects of reservoir drawdown on the project and reservoir facilities and structures, the effects of such an operation on many aspects of the environment, including effects on travel time and survival of anadromous fish, remain uncertain.

Project and Reservoir Facilities and Structures

1. Although the existing turbines functioned during the test period, their efficiency was substantially lowered, which could result in substantially lowered survival of juvenile fish.

2. It is likely that drainage of saturated soils would limit the rate of future drawdowns to the limit used in this test.

3. To prevent damage to the spillway, modifications related to the stilling basin would be required for future operations with a lowered tailwater.

4. Modifications would have to be made to other project structures, port, and private facilities to minimize damage of repeated drafting and refill should regular reservoir drawdowns be implemented.

5. Reservoir embankments would have to be protected to the drawdown level.

Environmental

1. Spill results in increased gas supersaturation levels and turbulent conditions at adult fish passage facility entrances, as well as downstream where these fish approach the project.

2. Average water velocities increase as the reservoir is drafted (as was predicted), but since a large pool remains, there are substantial areas in which velocities are not greatly increased (remaining below 0.6 fps).

3. The March 1992 reservoir drawdown had substantial negative impact on benthic organisms residing in the drawdown zone. The effects of these impacts on the ecosystem, including the food webs for resident and anadromous fish, are unknown but probably significant.

4. The effect on the ecosystem on resuspension of contaminated sediments by the drawdown is unknown.

5. Future reservoir drawdowns would require substantial efforts to protect cultural resources.

6. The Lower Granite and Little Goose reservoir ecosystems have been disturbed because of the drawdown tests. This will affect future studies designed for continued environmental evaluation of the reservoir drawdown concept.

5.0 CONTINUING ACTIONS

The 1992 March Drawdown Test was only one component of the regional effort underway to reverse the depletion of Columbia and Snake river salmon stocks. As described in Section 2.0 of this appendix report, this recent effort began in 1990 with the petitioning of Columbia-Snake River stocks under the ESA, and all parties concerned are working toward a solution to this problem. Specific upcoming efforts managed by the Corps are discussed briefly below.

6.0 LITERATURE CITED

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Appendix C

SEIS Background Information—Regional and Corps Studies

APPENDIX C
SEIS BACKGROUND INFORMATION
REGIONAL AND COOPERATING AGENCY STUDIES

1.0 INTRODUCTION

Effective December 1991, the Snake River sockeye was declared an endangered species, and in May 1992 the spring/summer and fall chinook were added to the list of threatened species. Under the requirements of the Endangered Species Act (ESA), the National Marine Fisheries Service (NMFS) will produce a Draft Recovery Plan for listed species, expected in the first part of 1993. Until then, Federal agencies with responsibility for operations on the river system will consult with NMFS on planned operations.

Numerous regional and agency initiatives are being studied or are in place to address the issue of salmon survival in the Pacific Northwest, many of which concentrate on a particular aspect, such as hatchery practices, habitat conditions, or improvements in fish migration success. The final solution must address all phases in the salmon life cycle and represent a regional choice pursuant to the ESA.

The U.S. Army Corps of Engineers (Corps) fish initiatives are designed to improve passage through its dams and reflect regional recommendations, coordination, and consultation with NMFS under the ESA. The Corps has conducted a number of programs and studies, some jointly with other agencies, to determine optimum operating conditions for the Columbia River Basin projects. The various Corps and regional efforts are coordinated or linked through joint committees and through formal and informal coordination and consultation.

In January 1992, the Corps, with the cooperation of Bonneville Power Administration (BPA) and the Bureau of Reclamation (BoR), released an Environmental Impact Statement (EIS) that analyzed the effects of various alternative operation changes and water management options for dams and reservoirs on the lower Columbia-Snake River System to improve juvenile and adult salmon migration conditions. The Corps is preparing this Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon Supplemental EIS (SEIS) to plan interim operations, with BPA and BoR as cooperating agencies. The SEIS will address actions for 1993 and future years. The plan of action may be modified in the future as a result of the NMFS Recovery Plan, the System Configuration Study (SCS), the System Operation Review (SOR), and/or other studies addressing long-term improvement measures for salmon.

2.0 DEVELOPMENTS IN THE REGION

2.1 NORTHWEST POWER PLANNING COUNCIL - FISH AND WILDLIFE PROGRAM

The Northwest Power Planning Council (NPPC) offers a regional perspective on salmon issues. The NPPC, authorized by the Pacific Northwest Electric Power Planning and Conservation Act of 1980, is made up of

representatives of the States of Idaho, Montana, Oregon, and Washington and is entrusted with finding ways to acquire and market new power sources while giving equitable treatment to fish and wildlife. In 1982, the NPPC issued a comprehensive Columbia River Basin Fish and Wildlife Program addressing salmon and steelhead production, safe passage, and harvest management; resident fish and wildlife protection; future hydroelectric development; and coordination among Federal agencies with responsibility for Columbia River Basin resources.

In 1991, the NPPC began a series of amendments to its Fish and Wildlife Program to institute a salmon rebuilding plan. In August 1991, the NPPC issued Phase I Fish and Wildlife Program amendments, giving high priority to production and habitat measures for salmon and steelhead stocks. The amendments called for screening of water diversions, measures to protect the genetic integrity of salmon stocks, and an emergency captive broodstock program for Snake River sockeye. These measures have been or are being implemented.

Phase II Fish and Wildlife Program amendments, issued in December 1991, identified some mainstem survival, harvest, and production and habitat measures, concentrating on increased flows in the Columbia and Snake rivers to improve survival chances between dams, and on fish passage improvements at Federal dams to provide better predator controls and better juvenile transportation past the dams. The Phase II amendments contained many recommendations concerning operation of the Corps' lower Columbia-Snake River System projects.

The NPPC approved Phase III Program amendments (System Integration) in September 1992 to address efforts to produce more fish, broad issues of fish production and habitat, and rebuilding schedules and biological objectives. Phase III amendments will provide program goals and performance standards.

Phase IV, scheduled for 1993, is slated to address protection of resident fish and wildlife.

The NPPC's Fish and Wildlife Program amendments contain recommendations for all of the Federal agencies whose activities have had impacts on salmon populations. Although the NPPC does not have legislated authority to enforce its recommendations, agencies cooperate to the extent possible in evaluating and implementing them.

Some Phase II amendment recommendations are contained in the Corps' 1992 Operations Plan, and others are being evaluated in the SCS (see description below). One of the alternatives being proposed for further study under the SOR (Alternative No. 1 under that subheading below) consists primarily of the operation suggested in the Phase II amendments.

2.2 Salmon Summit, Endangered Species Act Listings

In April and June of 1990, petitions to list Snake River sockeye salmon and fall, spring, and summer chinook were submitted to NMFS. Shortly thereafter, Senator Hatfield of Oregon convened a series of regional meetings (known as the Salmon Summit) to address solutions for the substantially reduced salmon stocks. A number of ideas surfaced at these meetings, and although no comprehensive plan was developed, two major considerations for regional dam-operating agencies were identified: decreased water particle travel time

(faster-moving water) for juvenile migrants, and reduced water temperatures in the lower Snake River during late summer adult migration.

In December 1991, the Snake River sockeye was declared endangered, and in May 1992 the Snake River spring/summer and fall chinook were added to the list of threatened species.

2.3 National Marine Fisheries Services (NMFS)

NMFS is responsible for decisions to list petitioned anadromous fish species within the Columbia River Basin under the ESA. After the December 1991 listing of the Snake River sockeye, the Corps, BPA, and the BoR began consultation with NMFS on listed and proposed species for coordinated Columbia River System operations. In response to Biological Assessments on river operations submitted to NMFS by the three agencies, NMFS issued a Biological Opinion dated April 10, 1992, which concluded that the proposed operations were not likely to jeopardize the continued existence of listed or proposed salmon species. A NMFS-sponsored Recovery Team is in the process of formulating a Recovery Plan for the listed Snake River salmon species.

2.4 1992 Columbia River Options Analysis/Environmental Impact Statement

In May 1991, as a result of the Salmon Summit discussions and recommendations in the NPPC's Fish and Wildlife Program amendments, the Corps, with cooperation of BPA and BoR, began preparation of the 1992 Columbia River Salmon Flow Measures Options Analysis/Environmental Impact Statement (OA/EIS). This OA/EIS, issued in final form in January 1992, analyzed effects of various alternative operation changes and water management options for dams and reservoirs on the lower Columbia-Snake River System to improve juvenile and adult salmon migration conditions.

2.5 1992 Operations Plan

The December 1991 ESA listing of the Snake River sockeye added consultation requirements to the process of selecting the preferred river operation alternative in the 1992 OA/EIS. Upon receipt of a Biological Opinion from NMFS, the Corps in April 1992 issued its Record of Decision (ROD) and began implementing the 1992 Operations Plan described in that ROD. The following measures were included in the plan:

- Conduct a drawdown test at Lower Granite/Little Goose (completed in March 1992 - further explanation below)
- Operate lower Snake projects near minimum operating pool (MOP) April 1 to July 31
- Operate John Day Reservoir near 262.5 feet elevation May 1 to August 31, unless impacts to irrigation intakes result

- Conduct various flow augmentation releases from Dworshak Dam during salmon migration periods
- Release water from Grand Coulee and Arrow dams for flow augmentation May 1 to June 30
- Monitor and evaluate use of available water throughout the fish passage season
- Continue release of additional water over spillways according to Spill Agreement
- Continue fish transport
- Continue improvements of fish passage systems

2.6 DRAWDOWN TEST

In concert with regional recommendations, the Corps conducted a test drawdown at Lower Granite and Little Goose projects on the lower Snake River. The idea behind the drawdown concept is to increase river velocities to more closely resemble natural juvenile migration conditions; some research studies indicate that water flow may be important to juvenile survival during migration. In March 1992, the Corps drafted Lower Granite 36 feet and Little Goose 12.5 feet below the MOP levels for which they were designed. Nine spill tests were also conducted during the drawdown to determine impacts to structures, gas supersaturation levels from spilling, and potential adult passage conditions at these lower reservoir elevations. Appendix B provides more detail on the drawdown test.

The Corps has published a draft report on the test, which is currently undergoing public review. Conclusions in the draft report include:

- There was no major damage to facility structures, and minor stilling basin damage.
- Turbines continued to operate safely, but efficiency decreased (potentially indicating increase in juvenile fish mortality); there was some vibration in the turbines.
- Water velocity measurements confirmed existing mathematical model predictions.
- There was an increase in dissolved gas supersaturation in the stilling basin (which may result in gas bubble trauma in fish) during spill. The supersaturation level was related to total spill discharge.
- Some road surfaces were damaged and embankment sloughs occurred in various areas along the reservoir.
- Large numbers of resident fish, clams, mussels, and crayfish were lost.

The test stopped commercial barge traffic and caused some damage to floating docks; recreation areas were affected by lack of water. Exposed cultural resources were mapped and documented during the test and precautions were taken to protect exposed artifacts.

The analysis of data collected during the drawdown test is being used in the Corps' SCS described below.

3.0 UPPER SNAKE RESERVOIR STORAGE SYSTEM

For the purposes of this SEIS, reference to the upper Snake River storage system encompasses the watershed basin of the Snake River above Idaho Power Company's Brownlee Dam located at River Mile (RM) 285.0. This drainage area covers 72,590 square miles in parts of western Wyoming, southern Idaho, northern Nevada, and southeastern Oregon. Total reservoir capacity in this basin is estimated at 11.63 million acre-feet, which includes about 8.09 million acre-feet of Bureau of Reclamation (BoR) project storage.

Because of periodic drought conditions, flood control requirements and other operational considerations, the upper Snake River storage system does not fill to capacity every year. Most of the Federal storage space in the upper Snake Reservoir System has been contracted for irrigation purposes. However, the dams and reservoirs are operated to meet a variety of other water resource needs such as flood control, hydroelectric production, recreation, fish and wildlife, and municipal and industrial supplies. None of the upper Snake River storage reservoirs presented in this discussion are included in the coordinated Columbia River System and all are operated independently of that hydroelectric system, the Pacific Northwest Coordination Agreement, and the Columbia River Treaty.

BoR operates 23 dams throughout the Snake River Basin above Brownlee Reservoir. Their locations are depicted on Figure C-1. The dams are managed and operated by BoR's Minidoka Project Office, in Burley, Idaho, and the Central Snake Project Office in Boise, Idaho. The following section provides information on BoR operations within the Minidoka and Central Snake Projects. Table C-1 provides storage data on the reservoirs that are operated by BoR on the upper Snake River.

3.1 MINIDOKA PROJECT

Three irrigation project units receive water from BoR's Minidoka Project facilities. The Minidoka Project provides water to a total of 1,189,458 acres, including full-service irrigation water supply to 223,985 acres, a supplemental supply to 908,741 acres, temporary irrigation service to 2,369 acres, and a supply to 54,363 acres of residential, commercial, and industrial needs. As illustrated on Table C-1, the Minidoka Project operates a series of eight dams and reservoirs in the upper Snake River Basin in eastern Idaho and western Wyoming. These reservoirs account for active storage space totaling 4,067,800 acre-feet. Jackson Lake, Palisades Reservoir, and American Falls Reservoir account for 3,719,600 acre-feet of the active storage in the system and 63 irrigation spaceholder entities contract for the bulk of this water. Currently, there is 99,980 acre-feet of uncontracted space left in Ririe and Palisades reservoirs. However, under a recent water rights settlement with the Fort Hall Shoshone-Bannock Indian Tribes, this remaining space was dedicated by Congress to the non-Native irrigation entities that were damaged by the settlement. Minidoka Project reservoirs are operated to meet multipurpose uses in accordance with project authorizations, contractual obligations, and various operating constraints. Flood control shares joint storage space with other uses, depending on the time of year. American Falls, Palisades, and Minidoka dams have operating powerplants, but they are operated only as water is released for other purposes.

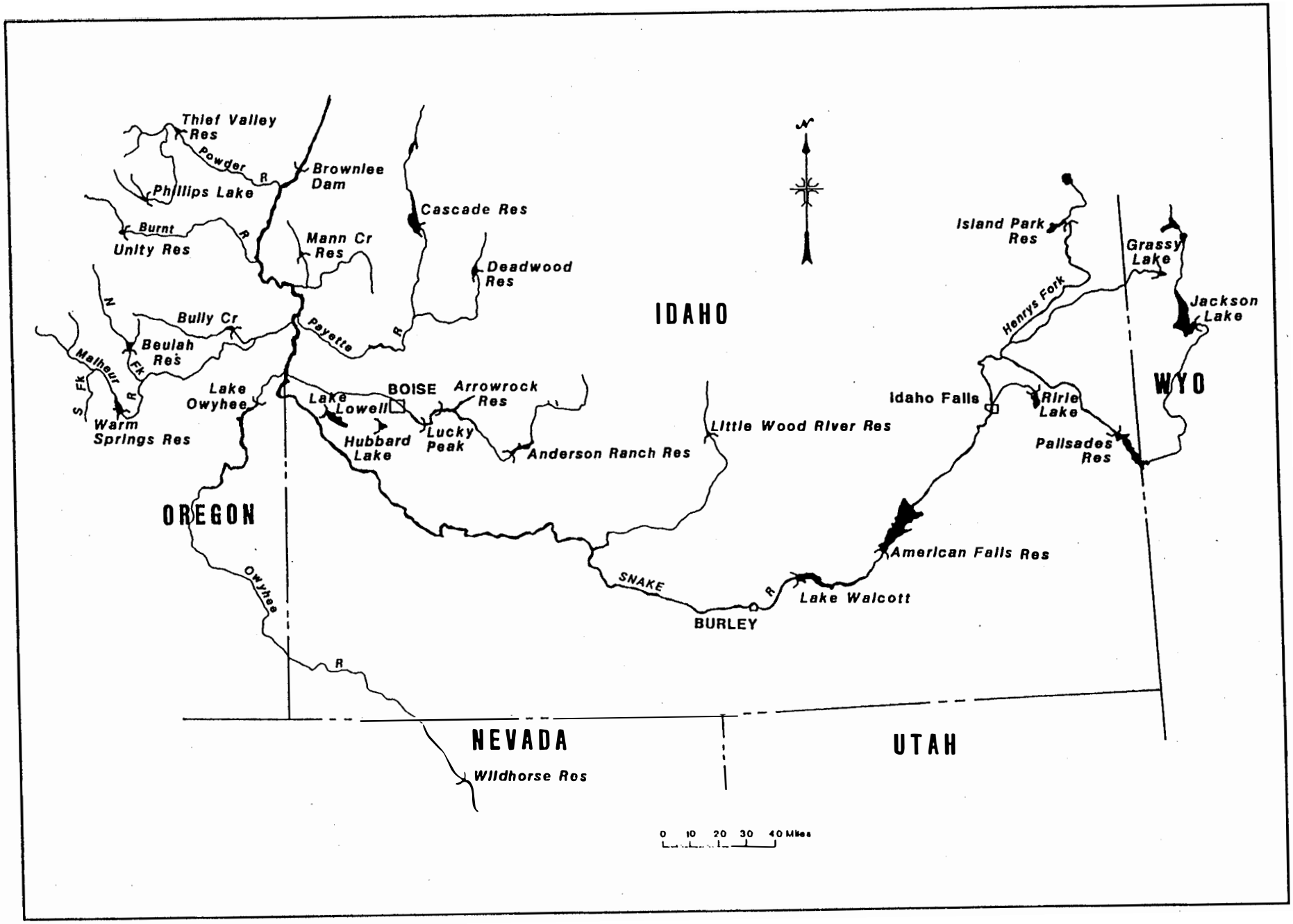


Figure C-1. Upper Snake reservoir map.

Table C-1. Storage data on projects operated by BoR.

	Storage Space			
	Active [2]	Inactive [3]	Dead [4]	Total
	acre-feet (1000's)			
MINIDOKA PROJECT				
Jackson Lake (715.2) [1]	847.0	0	0	847.0
Palisades (616.6)	1,200.0	157.0	44.0	1,401.0
American Falls (429.0)	1,672.6	0	0	1,672.6
Lake Walcott	95.2	115.0	0	210.2
Island Park (645.4)	134.8	0.4	0	135.2
Grassy Lake	15.2	0	0.3	15.5
Ririe (546.1)	80.5	6.0	4.0	90.5
Little Wood	30.0	0	0	30.0
CENTRAL SNAKE PROJECTS				
Anderson Ranch (228.8)	423.2	41.0	29.0	493.2
Arrowrock (181.7)	286.6	0	0	286.6
Lucky Peak (170.1)	264.4	0	28.8	293.2
Deadwood (210.0)	112.0	50.0	0	162.0
Cascade (192.7)	403.2	250.0	50.0	703.2
Hubbard	4.1	0	0	4.1
Lake Lowell	169.0	8.0	13.0	190.0
Mann Creek	11.1	0.2	1.6	12.9
Owhyee	715.0	405.0	0	1,120.0
Warm Springs	191.0	0	1.4	192.4
Beulah	59.9	0	0	59.9
Bully Creek	30.0	0	1.7	31.7
Unity	25.2	0	0.6	25.8
Phillips Lake	90.5	1.5	3.5	95.5
Thief Valley	17.4	0	0.2	17.6
Total	6,877.9	1,034.1	178.1	8,090.8

[1] Numbers in parentheses are the distances in river miles from the respective reservoir downstream to Brownlee Dam. These are the reservoirs most likely to contribute to lower Snake River fish flow augmentation.

[2] Active storage - The portion of storage capacity in which water normally will be stored or withdrawn for beneficial uses (irrigation, municipal and industrial), in compliance with operating agreements or restrictions.

[3] Inactive storage - The portion of storage capacity from which water normally will not be withdrawn, in compliance with operating agreements.

[4] Dead storage - The volume of a reservoir which is below the invert of the lowest outlet and cannot be evacuated by gravity.

Water use for recreation, fish and wildlife, and water quality control is, for the most part, incidental to other water uses with established irrigation water rights. During the flood control and irrigation seasons, rapid and extreme fluctuations in flows are minimized to reduce flood damage and to meet fishing, boating, goose nesting, and other recreational needs. Reservoir system operations for irrigation and flood control can be accomplished so that Snake River and Henrys Fork minimum fishery flows are normally maintained except under extreme drought circumstances. Water levels in Jackson Lake and in the river below Jackson Lake are kept at higher levels during the summer recreation season whenever possible.

In 1980, the Upper Snake Water Bank was created. This organization allows unused storage water to be placed in and consigned to a water bank for rental between "consenting owners and consenting renters." This water rental pool gives priority to renting water for irrigation purposes, but during 1991, approximately 99,000 acre-feet was rented by Idaho Power Company for hydroelectric production and concurrent anadromous fish flow improvements in the lower Snake River. Because of the continuing drought in 1992, irrigation water rental requests were far greater than consignments to the rental pool, and no water could be made available from Minidoka Project reservoirs for downstream salmon flow improvements.

3.2 CENTRAL SNAKE PROJECT

BoR provides water management for a number of irrigation projects on the Boise and Payette rivers in southwestern Idaho and the Malheur, Owyhee, and Powder rivers in eastern Oregon. Table C-1 lists the 15 dams and reservoirs administered from the Central Snake Project Office. These reservoirs have active storage capacity totaling 3,170,200 acre-feet. There remains 450,573 acre-feet of uncontracted space in Cascade and Deadwood reservoirs. Of this amount, a total of 350,000 acre-feet is dedicated to minimum conservation pool maintenance in the two reservoir bodies.

Central Snake reservoirs are operated in a multipurpose fashion as directed under Congressional authorizations, contractual obligations, and operating restrictions to meet flood control, irrigation, hydropower, recreation, and fish and wildlife purposes. Anderson Ranch, Lucky Peak, and Owyhee dams have operating hydropower plants. The Anderson Ranch powerplant is operated by BoR while Lucky Peak and Owyhee powerplants are owned and operated by irrigation districts. A total of 597,381 acres of land receive water from the Central Snake storage facilities, including 339,417 acres that receive a full-supply water service; 220,732 acres receive a supplemental supply; and 37,232 acres deliver water to residential, commercial, and industrial purposes.

BoR reservoirs are authorized mainly for irrigation, but also have informal flood control operating plans that provide for winter and spring flood space. For instance, 300,000 acre-feet of winter flood space is set aside in the Boise River Reservoir System. Owyhee Reservoir reserves 70,000 acre-feet for winter flood space. In all cases except for 17,000 acre-feet of space in Phillips Lake set aside exclusively for year-round flood storage, Central Snake Project flood space is managed jointly with other uses. This means that after the threat of flooding is over, flood control space can be filled to meet other authorized purposes, such as irrigation and recreation.

BoR has established minimum flow and minimum reservoir pool operations at several Central Snake Project locations to provide for multipurpose fish and wildlife, recreation, and water quality benefits. These operations are outlined below:

- Year-round minimum flows are maintained below Anderson Ranch Dam to sustain a renowned trout fishery and below Lucky Peak Dam through the City of Boise, Idaho, in the winter to protect fish, wildlife, and water quality. Winter minimum flows are also provided below Cascade and Deadwood dams for fishery resources.

- Minimum reservoir conservation pools of 300,000 acre-feet and 50,000 acre-feet are administered by BoR at Cascade and Deadwood reservoirs, respectively. These pools are provided to meet resident fisheries, wildlife, recreation, water quality, and endangered species (bald eagle) needs. To accommodate heavy summer recreational use, BoR also attempts to maintain a high pool elevation at Lucky Peak Reservoir between the Memorial and Labor Day holidays.

- BoR has facilitated recent creation and operation of the Boise and Payette water bank programs. These programs allow temporary and voluntary consignments of both contracted and noncontracted water supplies to a water bank whereby it can be rented out for a variety of uses. During 1991 for instance, about 100,000 acre-feet were rented by Idaho Power Company to generate hydropower while improving flow conditions downstream in the Snake River for migrating anadromous fish. In 1992, 90,000 acre-feet accruing to BoR uncontracted space was made available through the water bank for a combination of hydropower generation and salmon flow augmentation.

4.0 FUTURE ACTIONS AND LONG-TERM STUDIES IN THE REGION

4.1 COLUMBIA AND SNAKE RIVERS INTERIM FLOW IMPROVEMENT MEASURES FOR SALMON SEIS

The Corps is preparing this SEIS with BPA and BoR as cooperating agencies. The SEIS will address river system operations to benefit salmon over an interim period while long-term solutions are being evaluated. The NMFS Recovery Plan, the SCS, and the SOR address long-term improvement measures for salmon.

4.2 SYSTEM CONFIGURATION STUDY

The Columbia River SCS is a two-phase Corps study of structural alternatives in the Columbia River Basin to improve salmon migration conditions. The SCS responds to the NPPC's Phase II amendments, other regional ideas resulting from the Salmon Summit, and input from Corps and regional technical experts. The Phase I report is scheduled for completion in fall 1993. A status report was submitted to the NPPC in December 1992.

The study will be closely coordinated with the SOR (described below) since some changes proposed in the operation of the system will require structural changes to the projects, and vice versa.

Alternatives to be examined under Phase I, a reconnaissance level screening of alternatives, include: (1) changes to existing facilities to improve passage and survival rates of juveniles and adults; (2) the possible addition of upstream water storage sites to be used for river flow and temperature modifications (the BoR is leading an interagency assessment of potential new dam sites); (3) annual drawdowns of four lower Snake and the John Day (lower Columbia) reservoirs to various levels during juvenile migration periods; (4) the addition of new facilities, upstream of Lower Granite Dam, to collect juveniles and divert them onto a barge or into a migratory canal or pipeline and move them below the lower Columbia-Snake dams; and (5) construction of a migratory canal along the river, or a floating or underwater pressurized pipeline (in conjunction with alternative No. 4).

The Corps has completed initial screening of approximately 20 alternative scenarios under (3) above pertaining to possible drawdowns of lower Snake projects (Lower Granite, Little Goose, Lower Monumental, and Ice Harbor). About half of the alternatives will be studied further under the Phase I of the SCS. These alternatives represent various levels of drawdowns of the lower Snake projects with or without turbine modification, at variable or constant pool levels. One alternative looks at operation of reservoirs at (as nearly as possible) natural river flow levels. Drawdowns of 2-month and 4 ½-month durations will be evaluated.

A Technical Advisory Group (TAG) will assess the biological impacts and effectiveness of alternative measures being considered under Phase I of the SCS. The TAG includes representatives from the Corps and other Federal and State agencies, interest groups, and the biological community.

The second phase of the SCS will further study the costs and design requirements of the alternatives determined to be the most promising by the region's review of Phase I study results.

The results of the SCS, along with the SOR and the requirements of the NMFS Recovery Plan, will provide the basis for future Corps operation of projects in the coordinated Columbia River System.

4.3 Columbia River System Operation Review

The Columbia River SOR is a joint effort by the Corps, BPA, and the BoR to review multipurpose management of the Columbia River System and provide a strategy for system operation. Begun in 1990, it is a comprehensive, long-term study to review current system operations of Federal water resource projects on the Columbia River and its tributaries in view of present and future needs of all users. The study will provide a technical, social, economic, and environmental analysis of alternatives for operation of the Federal system of Columbia River water projects. The scope of the review includes 14 major Federal projects on the Columbia River and its tributaries. A final EIS for the SOR is expected to be completed in 1994.

The SOR will also provide NEPA documentation to review and renew the Pacific Northwest Coordination Agreement (PNCA).

Work on the SOR is conducted by ten functional work groups and four analysis groups. The functional work groups evaluate the impacts of system operation alternatives under consideration for the particular functional area represented by each work group. For example, the anadromous fish work group evaluates the alternatives to determine impacts on anadromous fish, and the water quality work group focuses on water quality. Representation on each of the work groups includes staff from each of the three lead Federal agencies, in addition to the States, other Federal agencies, utility and other interest groups, the tribes, and the general public.

The analysis groups examine the alternatives from a broader perspective. The River Operation Simulation Experts (ROSE) used computer models to determine flows and elevations for each of the 90 alternatives for further evaluation of impacts by the technical work groups. The Economics group will analyze direct and indirect economic impacts of the alternatives during full-scale analysis. The NEPA group guides preparation of the draft and final EIS to document all aspects of the review. The fourth group, PNCA Alternatives, is concerned with alternative forms of coordination for power.

Out of 90 alternatives for operating the river system, the work groups and project managers have identified 6 operating strategies to be considered for full-scale analysis and inclusion in the Draft EIS. Briefly, the system operations studies currently proposed for further analysis are:

SOS 2: Current Operations

Under this scenario, the operating strategy would be that selected as a result of this SEIS project. The John Day Reservoir would be drafted to near 262.5 feet (unless there are impacts to irrigation) and the lower Snake River projects would operate to within one foot of MOP during juvenile migration periods. Water budget flows from Dworshak, Brownlee, Arrow, and Grand Coulee would be as contained in the ROD for SEIS.

SOS 5: Natural River Operation

This alternative includes drawdown of the lower Snake River projects to near natural river levels (approximately 100 feet). New open channel flow outlets would be constructed at each dam. Periods of drawdown being considered range from 2 months (April 16 to June 15) to 4 1/2 months (April 15 to August 31) (not including drafting and refill periods).

SOS 6: Fixed Drawdown

This alternative calls for drawdowns of the four lower Snake River projects to 33, 43, or 52 feet, below MOP for 2 or 4 1/2 months. This alternative also includes the option for drawdown of only the Lower Granite Project.

SOS 3: Flow Augmentation

This SOS represents an operation that attempts to maximize monthly flows to benefit anadromous fish migration. Realistic flow targets are established that vary with water condition. Flow targets with and without water from the upper Snake will be evaluated.

SOS 4: Stable Storage Operation

Storage reservoirs would attempt to follow elevation targets to meet recreation, resident fish, and wildlife needs. Options which attempt to meet anadromous fish and sturgeon flow needs as well as storage requirements are also included.

SOS 1: Pre-ESA Operations

This alternative would reflect how the Columbia River System operates without all special requirements for fish and wildlife. One option removes water budget operations, spill agreements, and other fish measures. Another option represents operations as they existed from 1983 through the 1990 to 1991 operating year.

10. National Marine Fisheries Service (NMFS) Recovery Plan

This alternative would reflect the Recovery Plan to be adopted by NMFS under the ESA (a draft expected in summer 1993). One of the other nine candidate strategies may encompass the Recovery Plan and negate Alternative 10.

4.4 Relationship of SOR and SCS

The SOR and the Corp's SCS are two comprehensive studies that examine the most promising long-term alternatives for operating and configuring the Columbia River System for multi-purpose functions. These two studies are closely coordinated by Corps participants to minimize duplication of effort and ensure consistency. Study activities are also coordinated with the Corps' current activities to improve existing systems. The overall objective of the combined SOR and SCS studies is to determine how the Columbia River System should be operated and configured to best serve competing needs of all users and ensure improved salmon survival.

4.5 Federal Agency Programs for Anadromous Fish

The region's rate-payers, through the BPA, provide the major source of funds to rebuild endangered and threatened salmon stocks as mitigation for past impacts. BPA and the Corps fund research, monitoring and evaluation, habitat improvement, new hatcheries, and many other regional activities aimed at reversing the decline in Columbia-Snake River salmon populations. BPA and the Corps work with regional fishery agencies, tribes, and other interest groups in deciding where to invest in fish and wildlife.

4.6 Flow Augmentation from the Upper Snake Basin

In 1991 and 1992, the NPPC Fish and Wildlife Program was substantially amended to accelerate Snake River salmon recovery and conservation. The program amendments included a number of new measures, which addressed the perceived need for improved fish migration flows. The Council's flow improvement program requested BoR and BPA to annually secure 427,000 acre-feet from the Snake River Basin above Brownlee Reservoir to help meet flow objectives through the lower Snake River reach below Idaho Power Company's Hells Canyon complex. The 427,000 acre-feet supply was meant to "backfill" Brownlee Reservoir in

coordination with Idaho Power Company's scheduled salmon flow augmentation releases from Brownlee. The upper Snake water was to be acquired from uncontracted reservoir space, water banks, and other available water marketing transactions. Under this program directive, BoR was requested to secure 258,500 acre-feet and BPA the remaining 168,500 acre-feet.

There are, however, a number of factors that can constrain the ability to acquire and deliver water from the upper Snake River System for fish flow water in the quantity and timing identified under the NPPC's amended Fish and Wildlife Program. The following information is provided to explain these factors and to further expand on the challenges before BoR in the salmon recovery program.

4.6.1 Project Authorization

Project authorizations specify the purposes for which a project is to be constructed and operated. In the upper Snake River Basin, the primary beneficial use addressed in the authorizations was irrigation. Secondary beneficial uses, such as flood control, hydropower, fish and wildlife, and recreation, are also served to the extent that they do not adversely affect achievement of the primary beneficial purposes. The Interior Department Solicitor has frequently advised BoR that it may not modify operations outside of authorized limits without a clear expression of affirmative authority from Congress. Managing upper Snake reservoirs for lower Snake River flow augmentation is not presently a project authorized function. As such, it is considered a secondary purpose.

4.6.2 Contractual Obligations

Except for the irrigation space in Lucky Peak Reservoir in the Boise River drainage, the contracts for water from BoR's upper Snake reservoirs, are "spaceholder repayment contracts." This type of contract obligates the contract holder to pay BoR: (1) an annual construction charge repayable over a specified period, and (2) the annual cost incurred by BoR for operation and maintenance of facilities. In return, the contractor (or spaceholder) secures a contractual right to the use of a specified percent of the active storage capacity of the reservoir(s) for which it contracted.

Under spaceholder contracts, the right to beneficially use water accruing to the storage space belongs to the spaceholder. Each year the spaceholder may use the water accumulated in its storage space, assign it to a rental pool for possible lease, and/or carry over into the next year any unused stored water.

Inflow available for storage is generally proportioned on an equal basis among the spaceholders; however, different fill priorities apply in some cases. In any year, the stored water accumulated by a spaceholder (carryover from the prior year plus current year storage accruals) cannot exceed his contract storage space. In effect, the spaceholders are the managers of their storage space. The spaceholder contracts do not have expiration dates.

The disposition of the 112,000 acre-feet of irrigation storage in Lucky Peak Reservoir is accomplished under a "water service" contract. This allows irrigation water to be delivered similar to spaceholder repayment

contracts, except that the Lucky Peak contracts are subject to renewal starting in the year 2004. Lucky Peak contractors only pay for the water they use in a given year.

The irrigation contractual realities at BoR storage facilities in the upper Snake basin make it necessary for the spaceholders to be willing participants in providing water for other purposes, either through consignment of stored water to a rental pool or through other market transactions.

4.6.3 Rental Pool Regulations

The construction of Palisades Dam and Reservoir in the 1950s precipitated the execution of a number of new and amendatory contracts providing for the integrated operation of BoR reservoirs in the upper Snake Basin. These were the first BoR contracts to provide for contractor rental of water accumulated in his or her storage space.

There are three water rental organizations in Idaho: Water District No. 1 covers the upper Snake River Basin rental program above Lake Walcott; Water District No. 63 covers the Boise River storage system; and Water District No. 65 covers the Payette River drainage reservoirs. Rules and regulations governing the management of the rental pools are promulgated by the State Water Resources Board (Board). The Board has authority to appoint local committees to "market stored water between consenting owners and consenting renters under the rules and regulations adopted by the Board. The terms and conditions of rentals must be approved by the Director of the Idaho Department of Water Resources.

Some rental pool rules limit the flexibility in using water rentals for flow augmentation purposes. For example, Boise and Payette rental pool regulations do not allow rentals for nonirrigation use until after July 15. Upper Snake River Basin rules restrict rentals for nonirrigation purposes until after June 1 and July 1 depending on consignment deadlines. These limitations restrict the opportunity to use the rental pools as a source for spring flow augmentation. Irrigation water needs have first priority call on the rental pools. Without overriding action by the Idaho Water Resources Board, water consigned to the rental pools, including BoR consignments of uncontracted storage, would currently be available first to irrigation and secondly to other uses. Years of drought compound the challenges placed by this rule because consignments of water to the rental pools during drought are minimal and lease requests are high. Both the Payette and the upper Snake rental pool rules contain a "last refill" rule, which stipulates that any storage space leased for out-of-basin uses, such as flow augmentation, will be the last space to fill the next year. In a series of 2 dry years or more, the very real possibility exists that any storage space used to provide water for flow augmentation 1 year would not yield water the next year because it would have the lowest priority for refill.

4.6.4 State Water Statutes

In the Reclamation Act of 1902 (Section 8), Congress directed BoR to plan, construct, and operate its water resources projects in accordance with State water rights policy and laws. Therefore, BoR project operations abide by the requirements of State-issued water rights, unless there is a specific countervailing Federal project purpose to be met. Thus, BoR's flexibility to supply water for salmon recovery purposes to this point has been dependent on flexibility in State water law to recognize and concur in such use.

The water rights held in conjunction with BoR's Idaho reservoirs do not expressly provide for use of stored water for flow augmentation purposes.

Accordingly, as a precursor to securing and using storage water in its Idaho reservoirs for this purpose, BoR filed applications with the Director of the Idaho Department of Water Resources for modifications to its water rights, which would permit this use. This process was preempted with enactment of H.B. 796 by the Idaho Legislature in 1992, which temporarily set aside certain provisions of State law with regard to use of water from Idaho reservoirs out-of-state and for purposes inconsistent with the water rights under which such reservoirs store and release water. Under provisions of this law, water may be secured from Idaho reservoirs for flow augmentation purposes through December 31, 1994, provided that such actions are part of a comprehensive annual flow augmentation plan, and that water rentals are made through Idaho rental pools under applicable rental pool rules.

4.6.5 Resident Fish and Wildlife Needs

For several years, BoR has had an ongoing program of evaluating minimum pool and instream flow needs for resident fish and wildlife resources and, where possible, using uncontracted, unused, and inactive storage space to meet those needs. Uncontracted and contracted but unused space has been used to provide minimum conservation pools at Cascade, Deadwood, and Arrowrock reservoirs and to provide minimum instream flows below Deadwood, Lucky Peak, and Jackson Lake reservoirs. Inactive and dead storage has provided minimum conservation pools at Anderson Ranch, Lucky Peak, Owyhee, Palisades, Ririe, and Jackson Lake reservoirs.

Release of uncontracted or inactive storage that currently provides minimum conservation pools or minimum instream flows for resident fish and wildlife could have significant adverse affects on these resources. Impacts to resident fish could range from flushing large numbers of fish out of the reservoir (at Deadwood and Palisades) to causing significant fish kills during winter from deteriorated water quality (oxygen depletion). In either case, resident fish populations at affected reservoirs would be substantially reduced, and even with mitigating measures, would require several years to recover to previous levels. If the release of uncontracted or inactive storage reduced BoR's ability to provide instream flows in affected streams, then impacts to resident fish populations in these streams would also be severe.

Adverse impacts to water/wetland dependent wildlife from release of uncontracted and inactive storage could also be significant. Wetland habitat associated with the reservoirs could be lost or reduced, causing reductions in populations of dependent wildlife such as ducks, grebes, herons, and the endangered bald eagle. Inadequate instream flows could adversely impact the high value riparian zone of affected streams, thereby impacting a large variety of wildlife for breeding, feeding, and wintering habitat.

4.6.6 Competing Endangered Species

Augmentation flows for the lower Snake River may adversely impact at least one endangered species and five proposed endangered and threatened species. The bald eagle (*Halieetus leucocephalus*), a listed endangered species, nests in three primary areas in Idaho. The South Fork and Henry's Fork of the Snake River and the

North Fork of the Payette River (vicinity of Cascade Reservoir) and the South Fork of the Boise River (vicinity of Anderson Ranch) may be adversely affected by changes in water flow regimes through these areas.

In its plan to use uncontracted and uncommitted storage space in Cascade Reservoir for flow augmentation, BoR finds competition between Endangered Species Act listed species—the bald eagle and Snake River stocks of spring/summer and fall chinook and sockeye salmon. Cascade Reservoir provides habitat for the bald eagle and the health of the lake and its resident fish population is an important consideration in the recovery plan for this endangered species.

Maintaining a winter minimum pool of at least 300,000 acre-feet to avoid catastrophic fish kills and a depleted prey base is mandatory to avoiding a U.S. Fish and Wildlife Service jeopardy opinion on the eagle. This requires that BoR annually review Cascade Reservoir conditions with the U.S. Fish and Wildlife Service and NMFS to evaluate how best to use the 95,000 acre-feet of uncontracted space dedicated for protection of threatened and endangered species.

Five snail species that have been proposed for listing occur in the upper Snake River and may be affected by efforts to change the flow regime through their habitat. Life-cycle and habitat requirements for the snail species are not fully known. Other listed species may depend on stream habitats in certain situations, but these have not been considered because their populations as a whole are not dependant upon streamflow.

4.6.7 Channel Capacity and Water Travel Time Considerations

River channel capacity, time of year, and weather conditions would play an important role in determining how much water could be physically passed downstream for salmon flow augmentation from upper Snake reservoirs. Mainstem Snake River channel capacity appears to be most restricted near Burley, Idaho. At flows above 13,000 cubic feet per second (cfs), flood damages begin. During the irrigation season (May to October) in this river reach, only about 3,000 cfs could be passed for flow augmentation because up to 10,000 cfs is sometimes needed to meet downstream irrigation diversion demands. On the Boise River, flooding is experienced above 6,500 cfs flows below the City of Boise. Again, during the irrigation season (mid-April to mid-October), a lesser amount of flow could actually be devoted to flow augmentation due to local irrigation demands. During the nonirrigation season, the Payette River floods at Horseshoe Bend above 12,000 cfs, but can pass no more than 2,000 cfs through the lower river reach during farming season. Maintaining full channel flows during the irrigation season also could potentially cause damage to some in-river irrigation diversion works.

Cold weather conditions in January and February typically cause ice to form on several sections of the mainstem Snake and tributaries. Ice jamming can result and natural ice dams are formed, causing floods to occur during the coldest winter weather. Releases from upper Snake River Basin reservoirs could therefore be constrained by severe icing conditions.

Under the very best of water management, weather, and timing circumstances, it would appear that a maximum instantaneous inflow totaling about 31,000 cfs to Brownlee Reservoir could be provided for flow augmentation purposes. Given the complex nature of upper Snake Basin water management considerations, a more realistic expectation would probably be 5,000 to 10,000 cfs. It takes about 10 days travel time for water from Jackson Lake and Palisades Reservoir to reach Brownlee Reservoir (715 and 617 miles distance, respectively).

4.6.8 Flow Shaping From Brownlee Reservoir

Idaho Power Company's Brownlee Dam is located on the Snake River at RM 285. As such, all water released from BoR upper Snake reservoir storage for flow augmentation purposes would either pass through, be reregulated, or stored for some time in Brownlee Reservoir. The ability to meet anadromous fish target flows in the lower Snake River would directly depend on the release regimes provided by Idaho Power from Brownlee Reservoir. In absence of a cooperative operating agreement providing for desirable "shaping" of flow release storage from Brownlee, the value of upstream storage for salmon migration would be highly problematic. Idaho Power is a key entity in the management, use and provision of salmon flow water from the upper Snake and the overall flow augmentation program must take into account its interests.

Appendix D

Wildlife Biological Assessments

APPENDIX D
WILDLIFE BIOLOGICAL ASSESSMENTS

1.0 INTRODUCTION

1.1 DESCRIPTION OF PROPOSED PROJECT

The U.S. Army Corps of Engineers (Corps), in cooperation with the Bonneville Power Administration (BPA), and Bureau of Reclamation (BoR), is evaluating a proposal to improve flows on the lower Columbia and Snake rivers by modifying operations at 8 reservoirs on the lower and middle Columbia, lower Snake, and North Fork Clearwater rivers during spring and summer 1993 and the future. This proposed action, in turn, could have direct or indirect consequences on other areas of the Columbia River Basin. The purpose of this proposed action is to increase river velocities, either by lowering mainstem reservoirs or releasing additional flows from storage reservoirs, to assist juvenile salmon during migration from their spawning areas to the Pacific Ocean. Three species of wild Snake River salmon have been listed by NMFS as threatened or endangered under the Endangered Species Act (ESA). The river management agencies are proposing these actions as part of a regional recovery effort.

Several water management actions are being considered for implementation in 1993 and subsequent years, as follows:

1) Draw down all four lower Snake River reservoirs (Lower Granite, Little Goose, Lower Monumental, and Ice Harbor) to near minimum operating pool (MOP) from approximately April 1 to July 31;

2) Operate John Day Reservoir at minimum irrigation pool (defined in this SEIS as elevation 267.5 to 265 feet, depending on flow levels and irrigation demands) from April 1 to August 31;

3) Increase flows on the lower Snake from Dworshak and Brownlee reservoirs and shift flood control space to Grand Coulee Dam;

4) Increase flows on lower Columbia by modifying releases from Grand Coulee, Arrow and/or Libby; and

5) Combinations of the above.

Specific details on five alternatives under consideration are presented in Section 3.2 of the Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon Supplemental EIS (SEIS). The project area for these actions includes the 8 U.S. dam and reservoir projects identified above and their associated downstream reaches.

In addition, the cooperating agencies are investigating the possible indirect effects of these actions on the operation of Libby and Hungry Horse dams in Montana. Therefore, the two Montana projects and the downstream reaches of the Kootenai and Flathead rivers are included in the scope of the analysis.

There are four Federally listed threatened or endangered bird and mammal species occurring in the Oregon, Washington, Idaho, or Montana project areas that could potentially be adversely affected by the proposed actions. These species include the bald eagle (*Haliaeetus leucocephalus*), peregrine falcon (*Falco peregrinus anatum*), and grizzly bear (*Ursus arctos*). The bald eagle is Federally listed as threatened in Washington and Oregon and endangered in Idaho and Montana, and the American peregrine falcon is Federally listed as endangered throughout its range. The grizzly bear is Federally listed as threatened in Montana. The gray wolf is Federally listed as endangered in Oregon, Washington, Idaho, and Montana. All four of these species inhabit portions of the project area.

1.2 Study Objectives

This Biological Assessment was prepared in compliance with Section 7 of the ESA of 1973. The purpose of this assessment was to evaluate whether the proposed actions are likely to affect any bald eagles, peregrine falcons, grizzly bears, or gray wolves that use the project area. Specific objectives were to: (1) describe overall use of the project area by bald eagles, peregrine falcons, and grizzly bears; (2) describe the habitat features important to these species; and (3) determine the effects the alternative actions might have on these species.

2.0 METHODS

The methods used to determine potential use of the project area by bald eagles, peregrine falcons, and grizzly bears included a search of the existing literature and interviews with agency biologists.

3.0 RESULTS AND DISCUSSION

3.1 Bald Eagle

Bald eagle reproduction throughout North America declined dramatically between 1947 and 1970 (Sprunt et al., 1973) largely due to intake of organochloride pesticides. By 1978, the bald eagle was Federally listed as an endangered species in the lower 48 states, excluding Oregon, Washington, Michigan, Minnesota, and Wisconsin, where it was considered threatened (FWS, 1986). Historically, bald eagles nested throughout most of the continent; however, bald eagle nesting is currently limited primarily to the Pacific Northwest, Alaska, Canada, the Great Lake states, Chesapeake Bay, Arizona, and Florida, although in 1990, bald eagles nested in all but 5 of the 50 states. The wintering range of bald eagles in the Pacific Northwest extends farther south than the breeding range.

3.1.1 Habitat Requirements

Foraging Habitat

Bald eagles are opportunistic foragers throughout their range in North America; however, their predominant prey is fish (Hunt et al., 1992). Nesting eagles appear to depend on fish more than wintering eagles; however, waterfowl, upland game birds, and mammals also contribute to their diets.

In northern California, Biosystems Analysis researchers (Pacific Gas and Electric Co., 1988) found that several pairs of eagles nested on reservoirs dominated by hatchery trout. Trout were taken alive and as carrion. Kokanee and other salmon species contribute significantly to eagle diets, generally as carrion, but also as spawners (see SEIS Section 4.4). Regardless of the species, much of the diet is composed of carrion, either scavenged or stolen as freshly caught prey from osprey, heron, or gulls.

Most of the fish species known to occur in northwestern lakes and rivers have been cited as prey items in one study or another. Often, the predominant prey species are those species most available as carrion. Some species are available generally only during certain stages of their life cycle (i.e., spawning suckers, spawned or spawning salmon, and game fish as carrion during the fishing season).

Bald eagles in the Pacific Northwest primarily consume fish, waterfowl, jack rabbits (*Lepus* spp.), and a variety of mammal carrion (Fielder, 1982; FWS, 1986; Stalmaster, 1987). On the lower Columbia River below Bonneville Dam, fish are the most prevalent year-round prey; waterfowl are consumed primarily during the winter (Garrett et al., 1988). Mammal carrion (e.g., big game and livestock) appear to be an important alternative winter food source in Washington (FWS, 1986). The primary fish species consumed by eagles on the lower Columbia River, in descending order of importance, include the largescale sucker (*Catostomus macrocheilus*), American shad (*Alosa sapidissima*), common carp (*Cyprinus carpio*), peamouth (*Mylocheilus caurinus*), salmon (*Oncorhynchus* spp.), and steelhead (*O. mykiss*) (Garrett et al., 1988). Because of the way storage reservoirs are operated for power generation and flood control, waterfowl populations are limited throughout the year and probably are not significant food items on Lake Roosevelt, Lake Koocanusa, or Hungry Horse Reservoir, and limited riparian habitats around these reservoirs do not draw large populations of small mammals. Therefore, the major food items are fish, either freshly caught or as carrion. In Montana, approximately 60 percent of the bald eagle diet consists of fish, followed by birds (25 percent) and mammals (15 percent) (personal communication, D. Flath, Montana Department of Fisheries, Wildlife and Parks [MDFWP], August 31, 1992). This diet varies locally depending on the availability of prey. For example, at Hungry Horse Reservoir, the resident pair of nesting eagles appears to subsist primarily (77 percent of 30 samples) on mountain whitefish (*Prosopium williamsoni*) and the largescale sucker. In the surrounding Flathead Lake area, the largescale sucker and northern squawfish (*Ptychocheilus oregonensis*) are the main diet components (personal communication, D. Flath, MDFWP, August 31, 1992). At Lake Koocanusa (the reservoir behind Libby Dam), kokanee (*Oncorhynchus nerka*) and, probably to a lesser extent, the largescale sucker and mountain whitefish are the predominant prey species. Coots (*Fulica americana*), mallards (*Anas platyrhynchos*), and chukars (*Alectoris chukar*) are also important food sources for bald eagles wintering on the

Columbia and Snake rivers (Fielder, 1982; personal communication, R. Taylor, Washington Department of Wildlife (WDW), July 23, 1991).

Nest Habitat

The nesting season for bald eagles generally extends from mid-February through August (Isaacs et al., 1983). Availability of suitable nest and perch trees is critical to bald eagle populations (FWS, 1986). Bald eagle nest sites are invariably located near water (Stalmaster, 1987). In the Pacific Northwest, bald eagles typically nest in multi-layered, mostly coniferous stands containing old-growth trees that are located within 1 mile of large bodies of water (i.e., lakes, reservoirs, large rivers, or coastal estuaries) with adequate food supplies (Anthony et al., 1982). Nest trees in the Pacific Northwest are primarily in ponderosa pine (*Pinus ponderosa*), mixed-conifer, Douglas-fir (*Pseudotsuga menziesii*), and Sitka spruce (*Picea sitchensis*)/western hemlock (*Tsuga heterophylla*) forest types (Anthony et al., 1982). Species of trees used for nesting, however, vary among areas. On the lower Columbia River, nest trees are generally located in mixed-mature and old-growth Douglas-fir/western hemlock forests (Garrett et al., 1988) although some nests occur in black cottonwoods (*Populus trichocarpa*) in riparian communities along large river systems (Anthony et al., 1982). In Idaho, nests are typically found in large cottonwoods (*Populus* spp.), ponderosa pines, and Douglas-firs (FWS, 1986). In Montana, eagles nest predominantly in ponderosa pines (55 percent of 375 nest trees since 1979); however, nests have been found in 8 to 9 other large, riparian tree species (personal communication, D. Flath, MDFWP, August 31, 1992).

Wintering Habitat

Over 25 percent of the wintering bald eagles in the lower 48 states occur in the Pacific Northwest (FWS, 1986). Bald eagles winter in the Northwest from approximately November through March (personal communication, K. Steenhof, Boise District Bureau of Land Management [BLM], July 18, 1991). Bald eagles in the Pacific Northwest use a variety of trees for perching, depending largely on tree species availability and proximity to food sources (FWS, 1986). Important characteristics of diurnal perch sites for bald eagles in western Washington include: (1) height and morphological aspects of the perch tree; (2) proximity to water, feeding sites, and open regions; and (3) sighting distance from the perch (Stalmaster and Newman, 1979). Preferred trees typically provide an unobstructed view of the surrounding vegetation and are usually either snags or have relatively open foliage (Stalmaster and Newman, 1979). Bald eagles strongly prefer snags as daytime perches on the Nooksack River in northwestern Washington; bigleaf maple (*Acer macrophyllum*) and black cottonwood are the preferred deciduous trees, and Sitka spruce is the preferred coniferous tree (Stalmaster and Newman, 1979). Eagles on the lower Columbia River have been observed perching primarily in Sitka spruce, black cottonwood, and Douglas-fir (Garrett et al., 1988). Including the Columbia River in eastern Washington, eagles primarily use ponderosa pines, snags, and cottonwoods for perching (Fielder and Starkey, 1986). In northern Idaho, bald eagles roost in western white pine (*Pinus monticola*) and western larch (*Larix occidentalis*) (Lint, 1975). In Montana, bald eagles roost in a variety of tree species but particularly ponderosa pine (personal communication, D. Flath, MDFWP, August 31, 1992).

Characteristics of communal winter roost sites differ considerably from those of diurnal perch sites (FWS, 1986). Winter roost sites and diurnal perch sites are invariably located near concentrated food sources, such as anadromous fish runs or high concentrations of waterfowl, but roost sites tend to provide more protection from weather than diurnal perch sites (Hansen, 1977; Keister, 1981; Keister and Anthony, 1983). Communal roosts in the Pacific Northwest tend to be located in uneven-aged forest stands with some degree of old-growth forest structure (Anthony et al., 1982). In western Washington, bald eagles prefer dense stands of live conifers (e.g., Douglas-fir and western red cedar [*Thuja plicata*]) for night roosting (Stalmaster and Newman, 1979; Anthony et al., 1982). Conifers might provide a more thermally favorable microenvironment than dead or deciduous trees, which might explain their high use by wintering eagles. In eastern Washington, bald eagles have been observed roosting in mixed stands of Douglas-fir and ponderosa pine and in stands of black locusts (*Robinia pseudoacacia*) and black cottonwood (FWS, 1986).

3.1.2 Use of the Project Area

Breeding

Currently, 12 to 13 bald eagle breeding territories are associated with or are reasonably close to reservoirs in the project area (personal communication, K. McAllister, WDW, July 18, 1991; D. Flath, MDWFP, August 31, 1992). One bald eagle nest site is located on the lower Columbia River, in Washington, immediately above Bonneville Dam (personal communication, D. Anderson, WDW, July 18, 1991). In addition, five to six bald eagle territories are located on the shoreline of Lake Roosevelt (personal communication, K. McAllister, WDW, July 18, 1991).

Nesting

No bald eagle nest sites have been located on either the lower Snake or Clearwater rivers (personal communication, K. McAllister, WDW, July 18, 1991; G. Stevens, Idaho Natural Heritage Program [INHP], July 18, 1991). Five bald eagle nest sites are currently located along Lake Koocanusa, including one territory near Libby Dam. An additional five nest sites occur in the surrounding Kootenai River Valley (personal communication, D. Flath, MDWFP, August 31, 1992). One pair of bald eagles nests along the shoreline of Hungry Horse Reservoir, while 15 nest sites are located along the surrounding Flathead River drainage from Columbia Falls south to the southern end of Flathead Lake (personal communication, D. Flath, MDWFP, August 31, 1992).

Wintering

Results of Washington mid-winter bald eagle surveys showed that approximately 150 to 200 eagles wintered on Lake Roosevelt, 25 wintered on the lower Columbia River, and 10 wintered on the lower Snake River (personal communication, R. Taylor, WDW, July 23, 1991). Oregon mid-winter 1991 counts showed 40 bald eagles wintering on Umatilla National Wildlife Refuge and 15 wintering elsewhere on the lower Columbia (letter from F. Isaacs, Oregon Eagle Foundation, November 23, 1991).

Results of Idaho mid-winter bald eagle surveys from 1980 to 1991 showed that from 4 to 29 eagles wintered on Dworshak Reservoir; 19 eagles wintered in 1991 (personal communication, G. Stevens, INHP, July 18, 1991; K. Steenhof, BLM, July 18, 1991). Brownlee Reservoir is apparently an important wintering area for bald eagles, and approximately 150 eagles were counted in the winter of 1989 (personal communication, K. Steenhof, BLM, July 18, 1991). Brownlee Reservoir generally freezes during winter, so annual mid-winter counts for this reservoir vary widely. Approximately 50 to 100 transient eagles annually use Kikomun Creek, a tributary to Lake Koocanusa, and spawning grounds for kokanee (personal communication, Don Skarr, MDFWP, September 2, 1992).

3.1.3 Project Effects

Bald eagles inhabiting the project area could be affected by the proposed flow improvement measures on the lower Columbia, lower Snake, and North Fork Clearwater rivers if one or more of the following items were affected:

- Food sources (primarily fish and waterfowl) during the nesting season (mid-February through August) on Lake Roosevelt, Lake Koocanusa, or Hungry Horse Reservoir;

- Wintering food sources (primarily waterfowl and upland gamebirds; spawning kokanee are important in Montana) in the project area between November and April; and/or

- Potential perching, roosting, or nesting trees in the project area (primarily cottonwoods and ponderosa pines).

Temporarily lowering water levels at any of the project pools during spring and summer has the potential to both positively and adversely affect bald eagles using the Columbia, Snake, Clearwater, Flathead, and Kootenai or upper Columbia rivers. Bald eagles could benefit from lowered pools in the following ways:

- More adult salmonids might eventually return to the project area for spawning, providing more potential food for bald eagles foraging along the Columbia, Snake, and Clearwater rivers (but not the Flathead and Kootenai rivers) in the future (see SEIS Section 4.2);

- More fish might become stranded or concentrated in resultant shallow-water areas, temporarily increasing their availability to bald eagles (see SEIS Section 4.3).

- More nesting waterfowl might become vulnerable to predation because of a loss of nesting and escape cover from temporary drought and/or an increase in distance between shoreline escape cover and the water's edge (see SEIS Section 4.4.5).

Likewise, pool lowering associated with the proposed actions could adversely affect bald eagles using the Columbia, Snake, Clearwater, Flathead, and Kootenai rivers in the following ways:

- Overall numbers of resident fish might decline because of reduced shallow-water spawning habitat (see SEIS Section 4.3).

- Overhead numbers of resident fish might decline because of reduced water retention times, increased entrainment of Kokanee and rainbow trout through Grand Coulee Dam, and increased drafting of Lake Roosevelt during May to June (see SEIS Section 4.3).

- A decrease in waterfowl production might occur (see SEIS Section 4.4.5), decreasing bald eagle foraging opportunities, especially for nesting birds but with a possible small effect for wintering eagles.

- A decrease in waterfowl wintering in the project area might occur (see SEIS Section 4.4.5), decreasing winter food sources for bald eagles.

- A decrease (although slight) in upland gamebirds might occur (see SEIS Section 4.4.7), decreasing bald eagle foraging opportunities.

The extent to which these potential impacts might affect bald eagles would depend largely on the location, time of year, and duration and degree of pool lowering. Potential effects on bald eagles would be greatest where they are most concentrated and the degree of drawdown is relatively high or where nesting occurs, and least significant where eagles are uncommon and drawdown is minimal. In general, however, pool lowering will fall within normal ranges at areas where bald eagles nest, and lowering will not occur in fall and winter when wintering eagles are most concentrated (although there may be a carryover effect if local prey populations are reduced by spring and summer pool lowering). Also, because of their opportunistic diet habits, bald eagles appear to be more dependent on availability of prey biomass and diversity, particularly fish, than on any one species. For example, despite a decline in the preferred kokanee prey species in the Lake Flathead area in recent years, the number of nesting bald eagles has increased overall, and these birds now subsist primarily on the largescale sucker and squawfish (personal communication, D. Flath, MDFWP, August 31, 1992).

Nesting

Nesting bald eagles occur at Lake Roosevelt, Lake Koocanusa, and Hungry Horse Reservoir. Based on analysis of comparable actions on the 1992 OA/EIS, adverse impacts to eagles nesting at Lake Roosevelt change little from existing conditions, except in certain years when flow augmentation actions would occur. Resulting deep drafting of the reservoir during the spring may severely impact fish resources in the reservoir (see SEIS Section 4.3.6). Information on diets of breeding bald eagles at Lake Roosevelt is presently not available. However, if these birds are dependent on fish during the nesting season, nest failures may be expected during years of low fish availability. Fish may be lost from entrainment, net pen operation failures, and spawn destruction during the flood control and flow augmentation proposals. Long-term failures of fish production may eventually result in the reduction of nesting bald eagles at Lake Roosevelt.

Adverse impacts to the 10 eagle pairs nesting at Lake Koocanusa and in the surrounding Kootenai Valley, and to one pair nesting at Hungry Horse Reservoir, are expected to be insignificant based on Alternatives 2, 4, and 5,

which are not anticipated to result in any significant changes to the existing aquatic environment. Effects on these nesting eagles from Alternative 3 will be related to the availability of kokanee, mountain whitefish, and largescale suckers, their predominant prey items at Lake Koocanusa and Hungry Horse Reservoir. Based on available data, Alternative 3 would result in a slight increase in fish prey, except kokanee. Kokanee numbers might be reduced if pool lowering impedes their ability to reach spawning tributaries. However, the positive and adverse effects on fish will probably balance out in respect to eagles with no overall impacts. Although waterfowl are more abundant at Hungry Horse Reservoir, waterfowl (e.g., American coot) comprised only 7 percent of 30 prey remain samples collected at the nest site at Hungry Horse Reservoir (personal communication, D. Flath, MDFWP, August 31, 1992), so any reductions in waterfowl would probably have minimal effect on that nesting pair. No adverse impacts are expected on prey fish used by bald eagles in the Flathead Lake area, and the availability of largescale sucker and squawfish prey might actually be augmented by increased river flow in spawning areas.

Wintering

Wintering eagles are concentrated where food sources are adequate: Lake Roosevelt, Brownlee and Dworshak reservoirs, and Umatilla NWR. The flow augmentation plan for the Columbia and Snake rivers could cause changes over the long term during the bald eagle wintering period (November to April) between the Lake Roosevelt and Dworshak Reservoir operational base condition and the condition with augmentation and/or flood control storage shifting. Therefore, there should be some impacts on local prey production, especially fish, that would carry over to the bald eagle wintering period. The drafting of John Day Reservoir also would be within the normal operating range for the project; therefore, there should not be increased impacts to waterfowl. Waterfowl do not appear to compose a substantial portion of the bald eagle diet in the Montana project areas, particularly at Lake Koocanusa or at Lake Roosevelt, since suitable waterfowl habitat is currently limited. Since the effects to upland gamebird populations are expected to be negligible or nonexistent with the proposed action, bald eagles, depending on upland prey during the winter, would not be adversely affected. Upland gamebirds move as larger groups during the bald eagle wintering period, using not only the reservoir but also the side canyons and draws for sources of water.

Habitat Trees

Provided erosion is not magnified by these flow augmentation alternatives, no adverse impacts to bald eagle perching, roosting, or nesting trees are expected. The flow augmentation contributed by Lake Roosevelt and Dworshak Reservoir would have negligible effect on the normal operational drawdowns of these two reservoirs and would not result in the desiccation of the existing trees. Similarly, the proposed action for John Day does not represent a marked change from normal reservoir elevations. On the lower Snake River, any sizeable trees used by bald eagles adjacent to the reservoir are snags or are located in the side draws and canyons, which would not be adversely affected by reservoir drawdown to MOP. Conifer trees used predominantly by bald eagles in the Montana project areas occur beyond the affected area and should not experience any adverse effects.

Summary

The operation of John Day Reservoir within the normal spring operating range and the operation of the four lower Snake River reservoirs near MOP from April 1 to July 31 are not likely to adversely affect bald eagle food sources or habitat trees. The long-term production of offspring from waterfowl and fish is not expected to be adversely affected, given the minor departures from the normal operating patterns of these five reservoirs.

If the proposed flow improvement measures indirectly change normal operation of the Hungry Horse and Lake Koocanusa reservoirs, it is conceivable that this might adversely affect long-term recruitment rates of kokanee, reducing availability of this preferred eagle prey. However, reduction of kokanee would probably be offset by increases in other prey sources (whitefish, suckers, etc.) and the foraging behavior of bald eagles. The greatest impacts may occur at Lake Roosevelt where flow augmentation proposals would probably further reduce an already impacted resident fishery possibly resulting in bald eagle nesting failures. Therefore, although a more detailed assessment of the potential effects on bald eagles is not possible at this time, based on existing information, the proposed flow options are not likely to adversely affect bald eagle use of the project reservoirs, except at Lake Roosevelt under certain flow augmentation conditions.

3.2 Peregrine Falcon

Peregrine falcon populations began experiencing large declines following World War II because of contamination from chlorinated hydrocarbon pesticides and a loss of nesting habitat (Pacific Coast American Peregrine Falcon Recovery Team, 1982). In 1973, the peregrine falcon was Federally listed as an endangered species. Since 1973, peregrine falcon populations have gradually increased primarily because of protection and recovery efforts. Increases in the number of sightings and reoccupation of historical nest sites have recently occurred in Washington, southern Oregon, and northern California (Pacific Coast American Peregrine Falcon Recovery Team, 1982).

3.2.1 Habitat Requirements

Foraging Habitat

Peregrines feed almost exclusively on avian prey captured in flight, including ducks, upland game birds, shorebirds, and small perching birds (Bent, 1961). Peregrines have also been known to feed occasionally on mammals (e.g., hares, squirrels, and mice), fish, and insects. However, rock doves *(Columba livia)*, mourning doves *(Zenaida macroura)*, and band-tailed pigeons (*C. fasciata*) are preferred prey, especially late in the nesting season (Hunt, 1979; Weinstein, 1979). In Washington, shorebirds and waterfowl compose the majority of the peregrine diet at Grays Harbor (central Washington coast) and Skagit Flats (northern Puget Sound) (Pacific Coast American Peregrine Falcon Recovery Team, 1982). Overwintering and migrating peregrines in the project area probably feed on abundant concentrations of waterfowl, shorebirds in delta mudflats along the Columbia River and wetlands along tributaries leading into the Columbia, starlings, rock doves, and a variety of songbirds.

Nesting Habitat

Peregrine falcons almost always nest on ledges located on sheer cliffs greater than 150 feet high that are close to water (Pacific Coast American Peregrine Falcon Recovery Team, 1982). Nest sites have been documented on cliffs from near sea level to over 11,000 feet, in virtually every habitat but desert (Pacific Coast American Peregrine Falcon Recovery Team, 1982). Most peregrine nest sites in the west occur below timberline in areas with adequate prey resources (Bond, 1946). The majority of peregrine nests in the southwestern Rocky Mountains are located within 1 mile of a stream or river, areas often associated with lowlands providing abundant birds and open areas to hunt (Call, 1978). In Oregon, historical nest sites occur in the coastal and western parts of the state, the Columbia River, the Cascade mountains, and eastern Oregon (Henny and Nelson, 1981).

Wintering Habitat

Little information is available regarding habitat requirements of peregrines wintering along the Pacific Coast (Pacific Coast American Peregrine Falcon Recovery Team, 1982). In Washington, wintering areas most commonly used by peregrines include intertidal mudflats and estuaries of the Skagit Flats, Grays Harbor, and Willapa Bay (southern Washington coast). Migrant peregrine falcons are occasionally detected at Flathead Lake, where waterfowl are abundant (personal communication, D. Flath, MDFWP, August 31, 1992). The valley area surrounding Flathead Lake might also receive use by wintering falcons that may periodically use Flathead Lake or Hungry Horse Reservoir, although no wintering falcons have been identified recently (personal communication, D. Flath, MDFWP, August 31, 1992).

3.2.2 Use of Project Area

The only documented use in or near the project area by nesting peregrine falcons is on the lower Columbia River. One pair of peregrines nests approximately 5 miles downstream of Bonneville Dam; 4 pairs nest between Bonneville and The Dalles Pools; and 1 pair nests immediately above The Dalles Dam (personal communication, K. McAllister, WDW, January 3, 1992). An additional nest site, last active in 1976, is located 7 miles south of Hungry Horse Reservoir and might still be suitable for future reoccupancy.

Peregrine falcons might occasionally use portions of the project area during migration. Sporadic sightings of migrating peregrines have occurred throughout eastern Washington; however, most peregrine sightings are associated with coastal areas (personal communication, K. McAllister, WDW, July 24, 1991).

3.2.3 Project Effects

The proposed actions are not likely to adversely affect peregrine falcons because the peregrine falcon only uses the project area sporadically during migration. Because no operating changes are proposed for Bonneville or The Dalles, all of these sites are located beyond the areas that would be affected by the proposed action.

3.3 GRIZZLY BEAR

The grizzly bear once ranged throughout most of western United States south into central Mexico (FWS, 1982). However, between 1800 and 1975 the population of grizzly bears declined from more than 100,000 to less than 1,000 (FWS, 1982). Current population estimates range between 600 and 900 bears for the lower 48 states (Servheen, 1985), most reside in Montana. Approximately 440 to 680 bears are estimated to inhabit the 8,900-square-mile Northern Continental Divide Grizzly Bear Ecosystem (Martinka, 1974; Servheen, 1985), which lies along the eastern edge of the Rocky Mountains in northern Montana and contains the Kootenai and Flathead River drainages. An estimated 150 to 180 of these bears inhabit Flathead National Forest lands within the drainage encompassing the 3 forks of the Flathead River (U.S. Forest Service, 1983), and the South Fork of the Flathead River supports one of the highest densities of grizzly bears in Montana (Jonkel, 1982). A significant but unknown number of grizzly bears occupy the Cabinet/Yaak Grizzly Bear Ecosystem in western Montana. Both ecosystems are within or adjacent to the Montana portion of the project area.

3.3.1 Habitat Requirements

Human-caused death rates exceeding the grizzly bears' ability to reproduce has been a more critical factor in the species' decline than habitat loss (Craighead and Mitchell, 1982). Grizzly bears generally survive only where spacious, rugged physiography or inaccessibility has insulated them from excessive human-caused mortality. Within their range, grizzly bears use a wide variety of habitats to survive. Key habitat types are alpine meadows, snowslides, fire-caused early seral stages, dry forb grasslands, ridgetop glades, and forest types with an abundance of food plants, especially huckleberry (*Vaccinium* spp.) (Craighead et al., 1982). The higher elevation alpine and subalpine zones are most important during the summer and fall.

Foraging

Between 50 and 60 percent of the grizzly bear diet is thought to be animals, suggesting that this species prefers high-protein animal food but also readily eats plants when animals are unavailable (Craighead and Mitchell, 1982). Grizzly bears feed on emerging grasses and forbs and malnutritioned or winterkilled big game during the spring; grasses, forbs, berries, elk calves, and rodents during the summer; and pine nuts before hibernation (Craighead and Mitchell, 1982). No information on grizzly bear use of kokanee or trout in the lower 48 states was found in the literature.

Territory

The grizzly bear has omnivorous food habits, complex social interactions, and aggressive behavior. All behaviors require extensive movement throughout a wide range of habitats. Home ranges are among the largest of any mammal, especially for adult males. One male in the Yellowstone ecosystem ranged over a 2,600-square-mile area (Craighead and Mitchell, 1982). Females generally range in areas between 50 and 250 square miles (Craighead and Mitchell, 1982).

3.3.2 Use of Project Area

Hungry Horse Reservoir lies within an area supporting one of the highest densities of grizzly bears in Montana. Jonkel (1982) estimated a density of 1 bear per 10 square miles for an area that includes the South Fork of the Flathead River drainage. Lake Koocanusa lies between the Cabinet/Yaak and Northern Continental Divide grizzly bear ecosystems. Historically, grizzly bears occurred in the Kootenai River Valley, but recent reports from this region could not be found (BPA, 1984).

3.3.3 Project Effects

The project is not likely to adversely affect the Montana grizzly bear population because they: (1) do not depend on the fish or waterfowl species, which might be affected by changes to the annual drawdown patterns of Lake Koocanusa and Hungry Horse Reservoirs, for food; (2) occur infrequently at Lake Koocanusa or downstream of Hungry Horse Reservoir; and (3) would probably be inhabiting the higher elevation alpine and subalpine zones when reservoir elevations might be changed.

3.4 Gray Wolf

The gray wolf once inhabited all of the conterminous U.S., Canada, and Alaska except the southeastern coastal plain where it was replaced by the red wolf (*Canis rufus*) (Paradiso and Nowak, 1982). Seton (1925) estimated that the primeval continent-wide population was about 2 million. The introduction of strychnine in the 1880s almost resulted in a virtual extinction of the gray wolf in the conterminous U.S. by 1930 (Peterson, 1986). With the ban of the use of poison in the 1960s, gray wolves have shown modest recoveries in some areas, especially Alaska and Minnesota. An estimated 1,000 to 2,000 wolves currently inhabit Minnesota (Mech, 1977; Peterson, 1986).

In recent years, gray wolves have been reported from or killed in Idaho, Oregon, Washington, North Dakota, South Dakota, Arizona, New Mexico, and Texas (Paradiso and Nowak, 1982). They have apparently been recolonizing the North Fork of the Flathead River and Wigwam River drainages of northwestern Montana where researchers have recently estimated that 34 wolves live in three packs (Ream et al., 1990). In Idaho, an estimated 10 to 15 single wolves have recently moved in from surrounding areas such as Canada and Montana (telephone conversation, B. Zoellich, FWS, Boise, Idaho, September 30, 1992).

3.4.1 Habitat Requirements

Gray wolves are apparently not limited to any particular habitat and historically had the greatest range of any living wild animal (Paradiso and Nowak, 1982). Their present distribution is confined largely to areas with suitable prey populations where human interaction is limited. In the U.S., most wolves live within or near national parks or designated wilderness areas.

Forage

In general, gray wolves prey on large ungulates such as deer, elk, moose, mountain sheep, and caribou (Nowak, 1991). The major prey items in Montana are white-tailed deer, elk, moose, and mule deer (Ream et al., 1989). Smaller prey, such as beavers (*Castor canadensis*) and snowshoe hares (*Lepus townsendii*), contribute a significant portion of the diet of some populations (Nowak, 1991; Paradiso and Nowak, 1982).

Territory

Home ranges of wolf packs vary greatly depending on the characteristics of the local habitat and prey densities. In Minnesota, pack home ranges vary between 20 to 217 square miles (Fritts and Mech, 1981), while in Alberta summer home ranges are 76 to 244 square miles (Fuller and Keith, 1980). Packs can remain stable up to 10 years (Mech, 1979).

Individual wolves sighted well outside the range of existing packs are usually dispersing subadults that have been excluded from packs. Dispersing wolves have been known to emigrate 13 to 217 miles (Fritts and Mech, 1981) with known records of 554 and 458 miles (Fritts, 1983; Ballard et al., 1983). Records from Washington, Idaho, and Oregon might represent dispersing individuals that have traveled for several hundred miles.

3.4.2 Use of the Project Area

Three packs of approximately 34 animals are known to occur in the North Fork of the Flathead River and Wigwam River drainages (Ream et al., 1990). Unconfirmed sightings of wolves have occurred recently near Dworshak Reservoir (telephone conversation, B. Zoellich, FWS, Boise, Idaho, September 30, 1992). A single radio-collared wolf moved from Glacier National Park in January 1992 to Kelly Creek in Idaho approximately 30 miles east of Dworshak (telephone conversation, B. Zoellich, FWS, Boise, Idaho, September 30, 1992). An unconfirmed sighting of a single wolf was made at the southern end of Lake Roosevelt in September 1991 (telephone conversation, Karen Taylor Goodrich, Coulee Dam National Recreation Area, Coulee Dam, Washington, October 1, 1992).

3.4.3 Project Effects

No information was found in the literature that showed that the northwestern Montana wolf packs ranged to the shorelines of Lake Koocanusa and Hungry Horse Reservoir. Furthermore, Montana wolves feed primarily on big game species, which would not be adversely affected by project actions in Montana. Wolf occurrences at Lake Roosevelt and Dworshak are unconfirmed, with possible sightings sparse and sporadic. If wolves do occur in these areas, they are probably dispersing individuals preying on medium and large game not adversely affected by project actions. Consequently, the proposed actions are not likely to adversely effect wolves in the project area.

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Appendix E

Bonneville Power Administration CRiSP and SLCM Input Parameters

Input Parameters for the Modeling of Upper Snake River Wild Chinook Salmon with The Stochastic Life-Cycle Model (SLCM)

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This document describes how Dr. Danny Lee (USFS), Jeff Hyman (RFF) and Tim Fisher (BPA) arrived at the baseline parameter values of the Stochastic Life-Cycle Model (SLCM). The document also identifies changes in parameters resulting from management actions analyzed by BPA for the 1993 Supplemental Environmental Impact Statement (1993 SEIS) in the fall of 1992. SLCM 6.1 has various input files which define the parameters used in the model: the run file, the parameter files (adult, juvenile, and passage), and the calibration file. The run

file is used to control general model parameters and call input files. The parameter files are headed by a stock identifier, so that a set of files can be created for each stock one wishes to model. The calibration file contains the initial values of all the state variables (i.e. spawners, smolts, etc.) as calculated by the calibration procedure. For complete documentation of SLCM see Lee 1992. BPA has defined the stocks modeled for the Biological Assessment as upper Snake River wild spring, summer, and fall chinook salmon; therefore there is one set of input files for each of these stocks. Each of these stocks originates above Lower Granite Dam in the model.

SCENARIOS

What follows are descriptions of the scenarios we ran for the 1993 SEIS. These describe the changes made to model parameters to simulate the populations under each of the cases. The next section describes in full detail the actual parameter values and the methodology we used to arrive at their values. Each of these cases was analyzed with 500 stochastic simulations of 40 years of the life cycle of the populations.

Baseline Conditions Case

At the present time, we have modeled a Baseline Conditions, a 1993 Proposed Actions, and a 1993 and Future Actions case for each species. For each of the latter two scenarios we modeled low, moderate, and high effectiveness of the proposed measures. The general assumptions for the Baseline Conditions case are:

1. There is no net effect of hatcheries on the wild stock; i.e., no hatchery fish are out-planted or stray, and no wild fish are removed for supplementation.

2. Mainstem passage conditions remain as they are modeled in CRiSP.0 for 1990 Baseline Conditions for the entire 40 years. Table 1 contains the mainstem survivals and coefficients of variation for each stock. See Fisher 1992 for a complete description of the assumptions and parameters in CRiSP.0.

3. Harvest levels remain at historical levels (1980's average for spring and summer and repeat of 1982-1985 broods for fall chinook). Table 2 shows the levels of escapement and harvest used for each stock in the Baseline Conditions case.

1993 Proposed Actions Case

Downstream Survival

We modeled the Baseline Conditions downstream survival for the first three years of the simulation. For the remainder of the simulation we modeled the flow augmentation levels that are used in CRiSP.0 for the 1993 Proposed Actions condition (Fisher 1992). In combination with the USACE flow option, we modeled increasing juvenile downstream survival through predation control and dam passage improvements (Fisher 1992). The downstream migration survivals produced by this case are shown in Table 1. Three levels of predation control effectiveness were modeled: low, moderate, and high.

Upstream Survival

Version 6.1 of the SLCM has the ability to incorporate changes in upstream passage survival on a brood year basis through the number of adults recovered in the subbasin. Thus we modeled the effect of measures designed to increase upstream survival of all species which are planned for 1993. We estimated the benefits of various measures that have been proposed to increase upstream survival (Table 3) under low, moderate, and high levels of effectiveness.

Harvest

The 1993 Proposed Actions case simulates changes in harvest levels of fall chinook only. We used an ODFW harvest model projection of harvest for the next four broods (starting with the 1989 brood) if harvest followed the NPPC Phase II Amendments (Northwest Power Planning Council 1991; Schaller and Cooney 1992). The resulting adult recovery numbers are shown in Table 2. This scenario simulated harvest of fall chinook at the following rates:

1990 Average of 1986-1990 harvest rates

1991 22% reduction in southern U.S. ocean and 35% reduction in river harvest from 1990 harvest rates

1992-95 5% reduction in southern U.S. ocean and 24% reduction in river harvest from 1991 harvest rates

1996- Same as 1986-1990 levels.

Habitat

We modeled the projected low, moderate, and high effects of the Idaho Power Company plan to prevent redd dewatering on fall chinook egg production (Table 4).

1993 and Future Actions Case

Downstream Survival

We used the passage survival values from the Baseline Conditions case for the first three years and the 1993 Proposed Actions case for the next five years. We then modeled future improvements that are scheduled to take place between 1994 and 1998 for the remainder of the simulation. The resulting survivals produced by this case are shown in Table 1. See Fisher 1992 for a complete description of the low future, moderate future, and high future passage modeling scenarios.

Upstream Survival

We modeled the effect of measures designed to increase upstream survival of all species which are projected to take place by 1998. We estimated the benefits of various measures that have been proposed to increase upstream survival (Table 3) under low, moderate, and high levels of effectiveness. For the 1993 and Future Actions case, we modeled law enforcement, reduction of fallback through screening, and ladder cooling through chillers and shading.

Harvest

The 1993 and Future Actions Case simulates changes in harvest levels of fall chinook only. The changes are identical to those used in the 1993 Proposed Actions case.

Habitat

We modeled the low, moderate, and high effects of projected increases in pre-smolt survival associated with habitat enhancement projects and irrigation screens on spring and summer chinook (Table 4). We also modeled the projected effects of the Idaho Power Company plan to prevent redd dewatering on fall chinook egg production.

Table 1. Mainstem passage survivals, coefficients of variation, and duration in years of the survival from CRiSP.0 for upper Snake River wild spring, summer, and fall chinook. The baseline case uses the survival for 1990 only; the proposed actions cases use each previous survival and apply them for the number of years shown in the duration column.

Species	Case	Effectiveness	Year	Survival	C.V.	Duration
Spring	1990 Baseline		1990	20.19%	11.51	40
	1993 Proposed Actions	Low	1990	20.19%	11.51	3
			1993	21.30%	8.00	37
	1993 Proposed Actions	Moderate	1990	20.19%	11.51	3
			1993	21.56%	7.86	37
	1993 Proposed Actions	High	1990	20.19%	11.51	3
			1993	21.83%	7.76	37
	1993 & Future Actions	Low	1990	20.19%	11.51	3
			1993	21.30%	8.00	5
			1998	22.04%	6.28	32
	1993 & Future Actions	Moderate	1990	20.19%	11.51	3
			1993	21.56%	7.86	5
			1998	22.84%	5.91	32
	1993 & Future Actions	High	1990	20.19%	11.51	3
			1993	21.83%	7.76	5
			1998	23.61%	5.38	32
Summer	1990 Baseline		1990	19.50%	13.59	40
	1993 Proposed Actions	Low	1990	19.50%	13.59	3
			1993	20.63%	10.10	37
	1993 Proposed Actions	Moderate	1990	19.50%	13.59	3
			1993	20.92%	9.92	37
	1993 Proposed Actions	High	1990	19.50%	13.59	3
			1993	21.21%	9.76	37
	1993 & Future Actions	Low	1990	19.50%	13.59	3
			1993	20.63%	10.10	5
			1998	21.44%	8.20	32
	1993 & Future Actions	Moderate	1990	19.50%	13.59	3
			1993	20.92%	9.92	5
			1998	22.35%	7.70	32
	1993 & Future Actions	High	1990	19.50%	13.59	3
			1993	21.21%	9.76	5
			1998	23.22%	7.13	32
Fall	1990 Baseline		1990	11.92%	33.40	40
	1993 Proposed Actions	Low	1990	11.92%	33.40	3
			1993	14.81%	27.69	37
	1993 Proposed Actions	Moderate	1990	11.92%	33.40	3
			1993	15.33%	26.83	37
	1993 Proposed Actions	High	1990	11.92%	33.40	3
			1993	15.86%	26.07	37
	1993 & Future Actions	Low	1990	11.92%	33.40	3
			1993	14.81%	27.69	5
			1998	19.26%	22.17	32
	1993 & Future Actions	Moderate	1990	11.92%	33.40	3
			1993	15.33%	26.83	5
			1998	21.23%	19.37	32
	1993 & Future Actions	High	1990	11.92%	33.40	3
			1993	15.86%	26.07	5
			1998	23.34%	16.84	32

Table 2. Adult recovery parameters for Snake River spring, summer, and fall chinook salmon.

Species	Scenario	Level of Effectiveness	Brood	Start no.	Escapement 1	Escapement 2	Escapement 3	Escapement 4	Ocean Catch 1	Ocean Catch 2	Ocean Catch 3	Ocean Catch 4	River Catch 1	River Catch 2	River Catch 3	River Catch 4
Spring	1990 Baseline	None	Calibrate	7634	253	1,144	354	1	2	7	0	0	24	215	229	4
	1993 Actions	Low	Calibrate	7634	253	1,144	354	1	2	7	0	0	24	215	229	4
			Future	7634	254	1,150	356	1	2	7	0	0	24	215	229	4
	1993 & Future Actions	Low	Calibrate	7634	253	1,144	354	1	2	7	0	0	24	215	229	4
			Future	7634	254	1,150	356	1	2	7	0	0	24	215	229	4
	1993 Actions	Moderate	Calibrate	7634	253	1,144	354	1	2	7	0	0	24	215	229	4
			Future	7634	266	1,205	373	1	2	7	0	0	24	215	229	4
	1993 & Future Actions	Moderate	Calibrate	7634	253	1,144	354	1	2	7	0	0	24	215	229	4
			Future	7634	266	1,205	373	1	2	7	0	0	24	215	229	4
	1993 Actions	High	Calibrate	7634	253	1,144	354	1	2	7	0	0	24	215	229	4
			Future	7634	279	1,261	390	1	2	7	0	0	24	215	229	4
	1993 & Future Actions	High	Calibrate	7634	253	1,144	354	1	2	7	0	0	24	215	229	4
			Future	7634	279	1,261	390	1	2	7	0	0	24	215	229	4
Summer	1990 Baseline	None	Calibrate	9229	793	1,266	517	1	6	10	5	0	80	28	25	0
	1993 Actions	Low	Calibrate	9229	793	1,266	517	1	6	10	5	0	80	28	25	0
			Future	9229	797	1,272	520	1	6	10	5	0	80	28	25	0
	1993 & Future Actions	Low	Calibrate	9229	793	1,266	517	1	6	10	5	0	80	28	25	0
			Future	9229	797	1,273	520	1	6	10	5	0	80	28	25	0
	1993 Actions	Moderate	Calibrate	9229	793	1,266	517	1	6	10	5	0	80	28	25	0
			Future	9229	835	1,333	544	1	6	10	5	0	80	28	25	0
	1993 & Future Actions	Moderate	Calibrate	9229	793	1,266	517	1	6	10	5	0	80	28	25	0
			Future	9229	836	1,334	545	1	6	10	5	0	80	28	25	0
	1993 Actions	High	Calibrate	9229	793	1,266	517	1	6	10	5	0	80	28	25	0
			Future	9229	874	1,396	570	1	6	10	5	0	80	28	25	0
	1993 & Future Actions	High	Calibrate	9229	793	1,266	517	1	6	10	5	0	80	28	25	0
			Future	9229	875	1,397	570	1	6	10	5	0	80	28	25	0
Fall	1990 Baseline	None	Calibrate	31937	176	1,182	425	51	339	4,641	3,832	414	466	1929	2712	440
	1993 Actions	Low	Calibrate	7634	176	1,182	425	51	339	4,641	3,832	414	466	1929	2712	440
			1989	3246	26	477	130	11	35	508	385	30	26	96	126	24
			1990	1418	27	110	32	5	15	221	167	13	11	42	56	10
			1991	3089	31	131	85	7	33	478	364	26	26	96	124	35
			1992	5035	28	267	86	17	53	781	599	45	43	152	338	61
			1993	1530	11	55	37	7	17	240	181	14	12	75	105	19
	1993 & Future Actions	Low	Calibrate	1530	176	1,182	425	51	339	4,641	3,832	414	466	1929	2712	440
			1989	3246	26	479	131	11	35	508	385	30	26	96	126	24
			1990	1418	27	110	32	5	15	221	167	13	11	42	56	10
			1991	3089	31	132	86	8	33	478	364	26	26	96	124	35
			1992	5035	28	268	87	17	53	781	599	45	43	152	338	61
			1993	1530	11	56	38	8	17	240	181	14	12	75	105	19
	1993 Actions	Moderate	Calibrate	9229	176	1,182	425	51	339	4,641	3,832	414	466	1929	2712	440
			1989	3246	28	513	140	11	35	508	385	30	26	96	126	24
			1990	1418	29	118	34	6	15	221	167	13	11	42	56	10
			1991	3089	33	141	92	8	33	478	364	26	26	96	124	35
			1992	5035	30	287	93	18	53	781	599	45	43	152	338	61
			1993	1530	11	60	40	8	17	240	181	14	12	75	105	19
	1993 & Future Actions	Moderate	Calibrate	1530	176	1,182	425	51	339	4,641	3,832	414	466	1929	2712	440
			1989	3246	28	518	141	12	35	508	385	30	26	96	126	24
			1990	1418	29	119	35	6	15	221	167	13	11	42	56	10
			1991	3089	34	142	93	8	33	478	364	26	26	96	124	35
			1992	5035	30	290	94	19	53	781	599	45	43	152	338	61
			1993	1530	12	60	41	8	17	240	181	14	12	75	105	19
	1993 Actions	High	Calibrate	31937	176	1,182	425	51	339	4,641	3,832	414	466	1929	2712	440
			1989	3246	30	551	150	12	35	508	385	30	26	96	126	24
			1990	1418	31	127	37	6	15	221	167	13	11	42	56	10
			1991	3089	36	152	99	9	33	478	364	26	26	96	124	35
			1992	5035	32	308	100	20	53	781	599	45	43	152	338	61
			1993	1530	12	64	43	9	17	240	181	14	12	75	105	19
	1993 & Future Actions	High	Calibrate	1530	176	1,182	425	51	339	4,641	3,832	414	466	1929	2712	440
			1989	3246	30	557	152	12	35	508	385	30	26	96	126	24
			1990	1418	31	128	37	6	15	221	167	13	11	42	56	10
			1991	3089	36	153	100	9	33	478	364	26	26	96	124	35
			1992	5035	32	312	101	20	53	781	599	45	43	152	338	61
			1993	1530	12	65	44	9	17	240	181	14	12	75	105	19

Table 3. Percent decrease in adult mortality per project associated with ladder temperature improvements and percent change in adult reach survival associated with law enforcement and screening expected from scenarios modeling low, moderate, and high effectiveness of measures for increasing adult upstream survival.

Scenario	Effectiveness	Action	Fall		Spring		Summer	
			Snake	Columbia	Snake	Columbia	Snake	Columbia
1993	Low	Ladder temp	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		Screens	5.0%	0.1%	0.0%	0.0%	0.0%	0.0%
		# Projects	2	1	0	0	0	0
		Enforcement	0.25%	0.25%	0.25%	0.25%	0.25%	0.25%
	Moderate	Ladder temp	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		Screens	7.4%	0.1%	0.0%	0.0%	0.0%	0.0%
		# Projects	2	1	0	0	0	0
		Enforcement	2.63%	2.63%	2.63%	2.63%	2.63%	2.63%
	High	Ladder temp	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		Screens	9.9%	0.2%	0.0%	0.0%	0.0%	0.0%
		# Projects	2	1	0	0	0	0
		Enforcement	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%
1993 & Future	Low	Ladder temp	0.08%	0.00%	0.00%	0.00%	0.08%	0.00%
		Screens	5.0%	0.6%	0.0%	0.0%	0.0%	0.0%
		# Projects	2	1	0	0	0	0
		Enforcement	0.25%	0.25%	0.25%	0.25%	0.25%	0.25%
	Moderate	Ladder temp	0.25%	0.00%	0.00%	0.00%	0.25%	0.00%
		Screens	7.4%	0.8%	0.0%	0.0%	0.0%	0.0%
		# Projects	2	1	0	0	0	0
		Enforcement	2.63%	2.63%	2.63%	2.63%	2.63%	2.63%
	High	Ladder temp	0.42%	0.00%	0.00%	0.00%	0.42%	0.00%
		Screens	9.9%	1.1%	0.0%	0.0%	0.0%	0.0%
		# Projects	2	1	0	0	0	0
		Enforcement	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%

Table 4. Values and percent change for parameters used to estimate the effects of habitat improvement measures on Snake River wild spring, summer and fall chinook.

Action	Species	Scenario	Effectiveness	Parameter	Value	% Increase
Habitat improvements	Spring chinook	1990 Baseline		logitscl	1	0.0%
		1993 Actions	Low		1	0.0%
			Moderate		1	0.0%
			High		1	0.0%
		1993 & Future Actions	Low		1.01	1.0%
			Moderate		1.055	5.5%
			High		1.1	10.0%
	Summer chinook	1990 Baseline		logitscl	0.75	0.0%
		1993 Actions	Low		0.75	0.0%
			Moderate		0.75	0.0%
			High		0.75	0.0%
		1993 & Future Actions	Low		0.7575	1.0%
			Moderate		0.79125	5.5%
			High		0.825	10.0%
Diversion screening	Spring chinook	1990 Baseline		inbsmsv	0.95	0.0%
		1993 Actions	Low		0.95	0.0%
			Moderate		0.95	0.0%
			High		0.95	0.0%
		1993 & Future Actions	Low		0.969	2.0%
			Moderate		0.98325	3.5%
			High		0.9975	5.0%
	Summer chinook	1990 Baseline		inbsmsv	0.95	0.0%
		1993 Actions	Low		0.95	0.0%
			Moderate		0.95	0.0%
			High		0.95	0.0%
		1993 & Future Actions	Low		0.9595	1.0%
			Moderate		0.966625	1.8%
			High		0.97375	2.5%
Hells Canyon flow	Fall chinook	1990 Baseline		prspsv	0.85	0.0%
		1993 Actions	Low		0.85	0.0%
			Moderate		0.87125	2.5%
			High		0.8925	5.0%
		1993 & Future Actions	Low		0.85	0.0%
			Moderate		0.87125	2.5%
			High		0.8925	5.0%

CALIBRATION PROCEDURE

The calibration procedure employs an iterative, deterministic version of the SLCM to fit the adult recovery parameter (adtrecv) to a series of historical subbasin escapements and mainstem survivals from CRiSP.0. This procedure is programmed in a Microsoft Excel 4.0 spreadsheet using the Excel add-in procedure "Solver" to iteratively solve for the adult recovery parameter on a yearly basis. The Excel spreadsheet consists of all the state variables used in the SLCM, a series of subbasin escapements and downstream passage survivals, and a deterministic version of the SLCM. The spreadsheet first calculates the number of eggs resulting from production of each years' spawning escapement using the pre-spawning survival, fraction female, and fecundity from the SLCM. It then calculates pre-smolts using the egg-smolt production function from the SLCM. Smolts below Bonneville are calculated by applying the probability of migrating or staying over to the previous two years' pre-smolts and the mainstem survival value for that year. Predicted spawners in year N are then calculated from the smolts below Bonneville from years N - 2 through N - 4, the ocean and inriver harvests and subbasin escapement proportions by age class, and the adult recovery percentage.

Solver then adjusts the adult recovery percentage on a yearly basis to minimize the squared error between observed and predicted subbasin escapement in each year. We set constraints on absolute value of the percentage such that in a given year the recovery rate could not fall below 0.0001 (0.1%) or above 0.5 (50%). The parameter *adtrecv* is then the average adult recovery percentage from the fourth year (when the model has fully recruited) through the third from last year of the historical data (the last year for which the adult recovery percentage is calculated).

In addition the spreadsheet adjusts the coefficient of variation (*cvadtrec*) for the *adtrecv* parameter to fit the product of all the coefficients of variation in the parameter file to the observed variance in egg to spawner survival. The SLCM currently contains coefficients of variation associated with three stages: egg-presmolt survival, downstream passage survival, and adult recovery percentage. The spreadsheet first computes the total variance in egg to adult survival as the egg to presmolt survival * adult recovery rate for each year in which the adult recovery rate is calculated. The spreadsheet then computes the variance of egg to presmolt survival and calculates the variance of adult recovery from these variances and the variance in egg to adult survival:

(1) $$\mathrm{var}(\overline{psmtsv}) = V_1 = \overline{psmtsv}^2 * (cvegsuv)^2$$

where: *psmtsv* = agerave egg to pre-smolt survival
cvegsuv = coefficient of variation of egg to pre-smolt survival (model input)

(2) $$\mathrm{var}(\overline{adtrecv}) = V_2 = \frac{\left[\mathrm{var}(allsurv) - \left(\overline{adtrecv} * V_1^2\right)\right]}{\overline{psmtsv}^2}$$

where: *adtrecv* = average percent of smolts below Bonneville recovered as adults
var(*allsurv*) = variance of egg to adult survival

(3) $$cvadtrec = CV3 = \frac{\sqrt{V_2}}{adtrecv}$$

The procedure then creates a initial numbers file for each species. This file contains the initial values of the state variables which the model uses as inputs for the first year of the simulation. These values include the initial number of spawners, pre-smolts, smolts, smolts below Bonneville, recruits, subadults in the ocean, and subbasin escapees. These values are calculated for year N, where N is the last year of the calibration period, by applying the survival of each life cycle stage in the SLCM to the historical subbasin escapement and mainstem survival:

(4) *subesp* = predicted subbasin escapement in the last year of calibration

(5) *spawners* = $subesp_{n-1} * prspsuv$ (pre-spawning survival rate)

(6) *o1sbe* = contribution of 1-ocean fish to subbasin escapement = 0 (no jacks)

(7) *o2sbe* = contribution of 2-ocean fish to subbasin escapement =

$smolts_{n-2} * adtrecv_{n-2} * ocn1suv * ocn2sbe$

(8) *o3sbe* = contribution of 3-ocean fish to subbasin =

$smolts_{n-3} * adtrecv_{n-3} * ocn1suv * ocn2suv * ocn3sbe$

(9) *o4sbe* = contribution of 4-ocean fish =

$smolts_{n-4} * adtrecv_{n-4} * ocn1suv * ocn2suv * ocn3suv * ocn4sbe$

(10) *recruits* = juveniles to be allocated next year = $smolts_{n-1} * adtrecv$

(11) *o1suv* = 1-ocean subadults = $smolts_{n-1} * adtrecv * ocn1suv$

(12) *o2suv* = 2-ocean subadults = $smolts_{n-2} * adtrecv * ocn1suv * ocn2suv$

(13) *o3suv* = 3-ocean subadults = $smolts_{n-3} * adtrecv * ocn1suv * ocn2suv * ocn3suv$

(14) *presmt0* = age 1 smolts to migrate next year = $presmolts_n * adtrecv$

(15) *smt_bonn* = smolts below Bonneville = $smolts_n * adtrecv$

PARAMETER FILES

The parameter files contain the bulk of the biological controls for the species being modeled. An adult, juvenile, and passage parameter file contain all of the scenarios for each species. Following are descriptions of the parameters and the values used in all cases for each species.

Spring Chinook

Baseline Conditions Case

CALIBRATION

We used the estimated run size of wild spring chinook over Lower Granite Dam (Pacific Salmon Commission Chinook TAC 1991; Table 5) from 1977-1990 to approximate spring chinook subbasin escapement. The 1991 value was developed by the NPPC using the average percent of wild spawners in the run over Lower Granite Dam as observed from 1975-1990. We used the estimates of passage survival from CRiSP.0 for the same years (Fisher 1992; Table 5). We also used all of the following parameters for the Baseline Conditions case in the calibration procedure. Table 5 is a printout of a portion of the calibration spreadsheet showing the fitted adult recovery parameter for each year of the routine. Initial values for the state variables are shown in Table 6. Table 7 shows a summary of parameter values for the Baseline Conditions case for all three species.

NATURAL PRODUCTION PARAMETERS

FFEM: Fraction of spawners that are female: 0.5. IDFG et al. 1990 Table 6 in appendix: F/M ratio ranges 0.33 to 1.33 (FFEM .25 to .57; ODFW et al. 1990 p. 57): F/M ratio ranges 1.2 to 1.9.

PRSPSV: Prespawning survival: 0.6 from Chapman et al. 1991. This is the high end of the range given for the Salmon River (0.6 to 0.4).

EGFEM: Average number of eggs per female: 5176 Average calculated from values in IDFG et al. 1990 Table 16

(p. 61).

STDEGG: Standard deviation of eggs per female: 400 Approximated from data in IDFG et al. 1990 Table 16, and ODFW et al. 1990.

LOGITSCL, LOGITβ_0, and LOGITβ_1:

General discussion of parameters

The parameters of the logistic response function were estimated in two steps: Using an empirical estimate of egg-pre-smolt survival, we estimated a zero-density survival probability that was slightly higher than the empirical estimate, which we assume reflects some density dependence. Because these stocks are at relatively low densities, the zero density survival should not be much greater than the survival at observed densities.

The full logistic equation is:

$$P = LOGITSCL * \frac{e^{\beta_0+\beta_1*eggs}}{1+e^{\beta_0+\beta_1*eggs}} \quad (16)$$

Here we set LOGITSCL, a scaling parameter, equal to 1.

At zero density, the logistic equation is:

$$P_0 = \frac{e^{\beta_0}}{1+e^{\beta_0}} \quad (17)$$

A little algebra will show that the following holds at zero density:

$$\beta_0 = \ln\left[\frac{P_0}{1-P_0}\right] \quad (18)$$

Since empirical evidence of density-dependent mortality in the Snake River chinook populations is lacking, we estimated a level of density dependence that would correspond to generous estimates of carrying capacity (we do not believe that Snake River spring chinook production is limited by habitat carrying capacity). We chose a value of β_1 such that a reasonable maximum production of smolts would result given maximum historical levels of spawners.

Specific calculations

(1) $LOGIT\beta_0$: Ideally, we would like an estimate of the survival from egg to the point just before the fish begin to migrate. For spring chinook ODFW et al. 1990 Table 14 gives egg to out-migration survivals ranging over time from 6.4% to 13.8%. We use 10% for the zero density survival. (See also IDFG et al. 1990 p. 62-63). Therefore,

$LOGIT\beta_0$: = -2.19722 using: $P_0 = 10\% = 0.10$.

(2) $LOGIT\beta_1$: NPPC estimated the capacity of the Snake River subbasin at approximately 11.7 million smolts. Thus we chose the number of eggs, about 298 million, which would produce a maximum of 11.7 million smolts. Using this value for eggs and the previous value for β_0,

$LOGIT\beta_1 = 1/298{,}000{,}000 = -3.36 \times 10^{-9}$.

BHINCP and BHCAP: The Beverton-Holt option was not used. Similar estimates for this option, however, could be obtained following the steps outlined above.

CVEGSV: C.V. of egg-pre-smolt survival: 0.2. This is a maximum estimate that seems reasonable given available data (see Scully and Petrosky 1990, Table 14).

STAY1: Conditional probability of overwintering the first year: 1.0. All reports that we surveyed suggested that spring chinook migrate almost exclusively as yearlings.

STAY2: 0.

STAY3: 0.

INBSMSV: In-basin pre-smolt-smolt survival: 0.95. Because essentially all fish out-migrate at age 1, and the egg to pre-smolt survival was taken from egg to out-migration survival estimates, we do not apply an in-basin survival per se. However, this parameter can be used to reflect the effect of habitat enhancement measures on the pre-smolt to smolt survival. Therefore we set the survival to 0.95 in order to allow for a 5% increase in pre-smolt to smolt survival due to diversion screening in subsequent scenarios.

ADTRECV: Fraction of those smolts arriving below Bonneville dam that are recovered as adults: 0.066. This parameter is set by the calibration procedure.

CVADTRV: C.V. of adult recovery: 0.95. Calculated by the calibration procedure.

TERMHAR: Terminal harvest rate: 0.. We assumed no harvest occurs on wild spring chinook once they enter the subbasin.

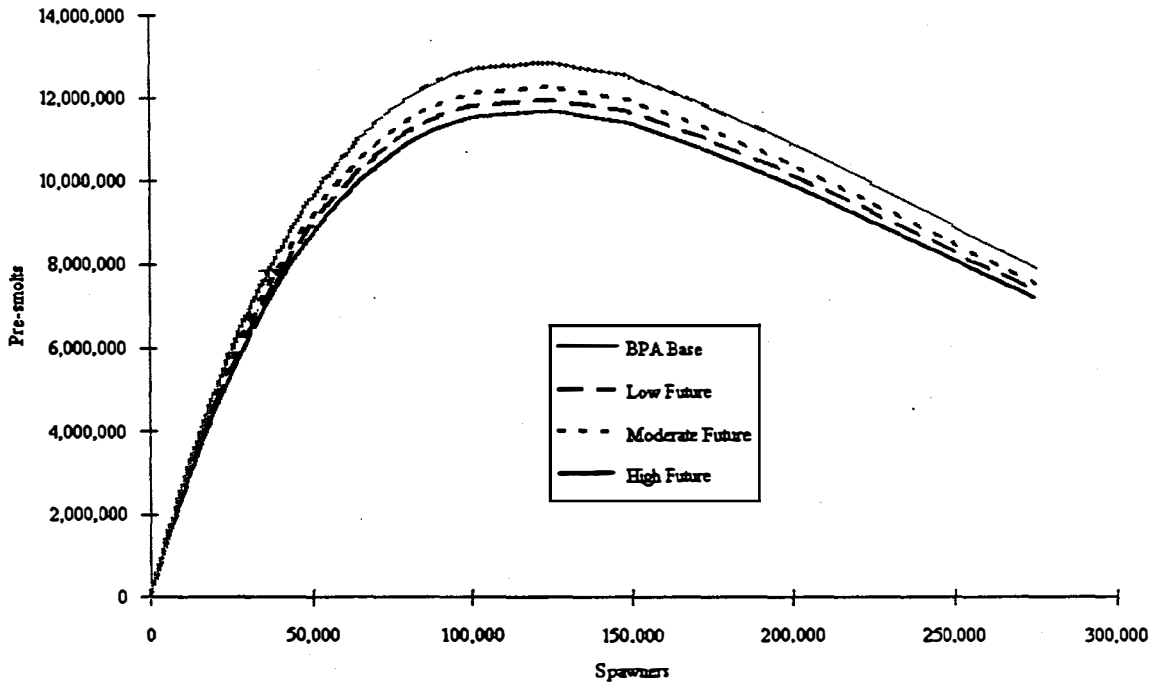


Figure 1. Logit production function for Snake River wild spring chinook.

HATCHERY PARAMETERS

COLRATE: Hatchery collection efficiency: 0. For the base case, we assumed that there was no net effect of the hatcheries. This was because we were focusing on naturally sustained populations, and not attempting to model current supplementation programs.

MINRUN: Minimum subbasin escapement necessary to permit hatchery take: 0.

HATREM: Maximum number of spawners taken by hatchery: 0.

HATFRY: Fry released by hatchery: 0.

RELTIME: Release timing of hatchery fish: 0.

HINTSV: Hatchery fry initial survival: 0.

PASSAGE PARAMETERS

MSURV: Mainstem survival rate: 0.2019. Mean of 50 CRiSP.0 simulations (one for each year in the 50-year flow record) of wild Snake River spring chinook migrants using 1990 migration conditions (Fisher 1992).

PASSCV: Coefficient of variation of passage survival: 0.1151. C.V. of the same 50 CRiSP.0 runs.

ADULT RECOVERY PARAMETERS

General discussion

The adult recovery parameter file contains starting numbers and recoveries in the ocean, river, and subbasin for a stock. The first line of a scenario is the base recovery information. This data in this line should be identical to the data entered in the calibration worksheet. The model reads in the starting number of fish (either CWT releases or some other estimate of a starting population) and the total number of recoveries for the brood. The ratio of # recovered to # released is the "base" recovery rate. In addition, each recovery number is divided by the # recovered to obtain a conditional probability of being recovered in either the fisheries or the subbasin:

Estimate [P(Tag recovered in compartment j, year i, tag recovered in year i)] =

(19) $$\frac{\text{\# tags recovered in compartment j, year i}}{\text{\# tags recovered in all compartments in all years} >= i}$$

Subsequent lines of input data are read as the "projected" adult recovery information. The probability that a fish is recovered in a fishery or escapement is calculated as for the base recovery data. The ratio of # recovered to # released is calculated and the relative difference between the base ratio and the new ratio is multiplied by the adult recovery rate (ADTRECV) to obtain a new rate of adult recovery. Thus the absolute magnitude of the number of starting fish is not used, but the starting number must be calculated consistently for the base and projected rates.

For spring chinook we used the coded wire tag recovery information for the Rapid River hatchery in the Salmon River basin (Jim Berksen, CRITFC, pers. comm.; Table 2). The starting number of fish released is simply an estimate of the number of CWT smolts that survived to below Bonneville Dam.

1993 Proposed Actions Case

We changed mainstem survival rates (Table 1) and adult upstream survival. We used a simple multiplicative model to estimate the overall percent change in adult survival from current conditions, and increased the subbasin escapement levels of the stocks by this fraction. Since the subbasin escapement fractions are estimated by brood year, the full benefit of upstream survival measures will not be realized until the first brood cycles through the model (year five for fall and year four for spring and summer chinook). Thus upstream survival improvements are phased in over the first brood. For the 1993 Proposed Actions case, we modeled a 0.25% to 5% increase in adult upstream reach survival due to law enforcement measures for both the Columbia and Snake River reaches (S. Vigg, BPA, pers. comm.; Table 3). This measure resulted in an overall 0.5% to 10.25% increase in spring chinook adult upstream survival (Table 8).

The changes in upstream adult escapement were affected through an Excel spreadsheet which uses the percent survival of adults per project (the "conversion rate") to calculate overall changes in adults to the subbasin given changes in the conversion rate. These changes in conversion rates can be applied on either a project-specific or a reach-specific (Columbia or Snake Rivers) basis. We calculated the percent change in adult upstream survival as:

(20) $$\Delta S = \frac{S_{bc}^{4} * S_{bs}^{4} - S_{nc}^{4} * S_{ns}^{4}}{S_{bc}^{4} * S_{bs}^{4}}$$

where:

S_{bc} = base interdam survival in the Columbia River
S_{bs} = base interdam survival in the Snake River
S_{nc} and S_{ns} = new interdam survival in the Columbia and Snake rivers =

(21) $$\left[S_{bc} - S_{bc} * \Delta S_c\right]^4 + \left[S_{bc} - S_{bc} * \Delta S_c\right]^4 * \sum_i \Delta S_{rc_i}$$

where:

ΔS_{rci} = percent change in reach survival due to reach measure i
ΔS_c = percent change in dam survival due to dam measures =

(22) $$\left[S_{bc} - S_{bc} * \frac{\sum_j \Delta S_{cj} * N_j}{4} \right]^4$$

where:

ΔS_{cj} = percent change in interdam survival due to dam measure j
N_j = number of projects to which each ΔS_{cj} applies

Dam measures are defined as those measures which apply to a project, such as ladder improvements and screens. Reach measures are those which apply to an entire reach, such as law enforcement and temperature control. The numbers of fish in each age class escaping to the subbasin in the SLCM are increased by the percent change in adult survival.

1993 and Future Actions Case

The parameters that changed for the 1993 and Future Actions case were adult recovery fractions, mainstem passage survival, the logit scalar parameter, and in-basin pre-smolt to smolt survival. Adult recovery numbers in the subbasin were adjusted to reflect the benefits of measures designed to improve upstream survival (Table 3), and mainstem passage increases were phased in over the first eight years (Table 1). The adult measures we modeled were the same measures we modeled for the 1993 Proposed Actions case. Note that since changes in upstream passage survival affect the returning adults after they have been exposed to the fishery and ocean mortality, the number of released fish does not change.

We also increased the logit scalar function by 1% to 10% to reflect the effect of projected habitat improvements on parr production (C. McConnaha, NPPC, pers. comm.; Table 4). We increased the in-basin pre-smolt to smolt survival by 2% to 5% to reflect the projected effects of increased irrigation diversion screening on the survival of migrating smolts (R. Austin, BPA, pers. comm.; Table 4). The effect of this function on egg to presmolt survival is shown in Figure 3.

Table 5. Partial printout of the calibration spreadsheet for upper Snake River wild spring chinook showing the fit of the procedure for historical subbasin escapements and mainstem survival values.

Year	Observed escapement	Mainstem survival	Eggs	Presmolts	Smolts	Adult recovery (%)	Predicted escapement	Error (%)	Egg to presmolt survival	Egg to adult survival
1977	23,175	6.7%	35,986,140	3,225,966					8.96%	
1978	31,375	18.4%	48,719,100	4,200,482					8.62%	
1979	2,525	16.9%	3,920,820	387,464	517,929	6.60%			9.88%	
1980	3,525	18.6%	5,473,620	538,380	742,225	6.60%			9.84%	0.65%
1981	7,900	18.2%	12,267,120	1,182,008	66,992	0.00%			9.64%	0.00%
1982	7,150	21.2%	11,102,520	1,073,576	108,430	4.93%			9.67%	0.48%
1983	6,175	20.9%	9,588,540	931,443	234,688	8.05%	7,778	25.97%	9.71%	0.78%
1984	3,100	20.6%	4,813,680	474,415	210,099	6.92%	2,762	-10.91%	9.86%	0.67%
1985	10,650	17.7%	16,537,320	1,572,952	156,622	11.17%	10,522	-1.20%	9.51%	1.10%
1986	10,600	21.1%	16,459,680	1,565,936	95,097	22.09%	10,450	-1.42%	9.51%	2.10%
1987	11,425	13.4%	17,740,740	1,681,260	200,237	0.44%	11,282	-1.25%	9.48%	0.04%
1988	13,925	14.0%	21,622,740	2,025,114	208,270	5.39%	13,543	-2.74%	9.37%	0.51%
1989	3,950	17.4%	6,133,560	602,087	277,912	0.38%	3,792	-3.99%	9.82%	0.04%
1990	6,050	16.5%	9,394,440	913,124	317,437	6.60%	5,899	-2.50%	9.72%	
1991	2,462	17.2%	3,822,994	377,908	98,381	6.60%	2,315	-5.99%	9.89%	

Average adult recovery =	6.60%
CV of adult recovery =	105.49%
Var. of adult recovery =	0.48%
Egg to smolt survival =	9.56%
Avg. mainstem survival =	17.25%
C.V. of egg-smolt survival	21.72%
Var. of adult recovery =	0.43%
CVADTREC =	99.45%

Table 6. Initial values of the state variables as calculated by the calibration procedure for each stock.

Variable	Species		
	Spring chinook	Summer chinook	Fall chinook
Hattake	0	0	0
Subesp	4,687	2,462	400
Subharv	0	0	0
O1sbe	2,373	755	41
O2sbe	535	1,041	302
O3sbe	1,779	665	43
O4sbe	0	1	14
O1suv	18,326	1,763	3,685
O2suv	275	451	2,023
O3suv	25	1	96
Recruits	6,490	2,714	1,237
Presmt0	913,124	394,507	3,707
Presmt1	0	0	0
Presmt2	0	0	0
Smolts below Bonneville	98,381	39,672	4,124
Spawners	3,539	2,365	79

Table 7. Baseline conditions case input production parameter file for the stochastic life-cycle model (SLCM) for upper Snake River wild spring, summer, and fall chinook. This scenario assumes no net effect of hatcheries.

Parameter	Description	Spring	Summer	Fall
Natural production				
stock	stock identifier	1	2	3
ffem	fraction that are female	0.5	0.35	0.583
prspsv	pre-spawning survival	0.6	0.7	0.85
egfem	average eggs per female	5,176	4,423	4,297
stdegg	Standard deviation in fecundity	400	300	233
jackspn	% of jacks which spawn	0	0	0
logitscl	logit scalar parm.	1	0.75	1
logitb0	logit density-ind. parm.	-2.20	-1.73	-1.73
logitb1	logit density-dep. parm.	-3.36E-09	-1.50E-08	-8.41E-08
cvegsv	C.V. of egg-to-presmolt surv.	0.2	0.2	0.2
stay1	cond. prob. staying over 1 winter	1	1	0.15
stay2	cond. prob. staying over 2 winters	0	0	0
stay3	cond. prob. staying over 3 winters	0	0	0
inbsmsv	inbasin presmolt-smlt. surv.	0.95	0.95	0.25
adtrecv	fraction recovered as adults	0.066	0.068	0.289
cvadtrv	C.V. of smolt to adult survival	0.950	0.208	0.259
termhar	terminal harvest rate	0	0	0
Hatchery production				
colrate	hatchery collection efficiency	0	0	0
minrun	minimum subesp to permit take	0	0	0
hatrem	maximum fish taken by hatchery	0	0	0
hatfry	fry released by hatchery	0	0	0
reltime	timing of fry release (0-100)	0	0	0
hintsv	hatchery fry initial surv.	0	0	0

Table 8. Total percent change in adult upstream survival expected from scenarios modeling low, moderate, and high effectiveness of measures for increasing adult upstream survival.

Scenario	Effectiveness	Fall			Spring			Summer		
		Snake	Columbia	Total	Snake	Columbia	Total	Snake	Columbia	Total
1993	Low	6.34%	0.33%	6.69%	0.25%	0.25%	0.50%	0.25%	0.25%	0.50%
	Moderate	11.76%	2.75%	14.83%	2.63%	2.63%	5.32%	2.63%	2.63%	5.32%
	High	17.18%	5.16%	23.23%	5.00%	5.00%	10.25%	5.00%	5.00%	10.25%
1993 & Future	Low	6.40%	0.81%	7.26%	0.25%	0.25%	0.50%	0.27%	0.25%	0.52%
	Moderate	11.96%	3.46%	15.84%	2.63%	2.63%	5.32%	2.68%	2.63%	5.37%
	High	17.53%	6.12%	24.72%	5.00%	5.00%	10.25%	5.09%	5.00%	10.35%

Summer Chinook

Baseline Conditions Case

CALIBRATION

We used the run size of wild summer chinook over Lower Granite Dam (PSC Chinook TAC 1991; Table 9) from 1976-1990 to approximate summer chinook subbasin escapement. The 1991 estimate was made by the NPPC using the actual 1991 adult count and the average fraction of wild spawners from the PSC data. We used the estimates of passage survival from CRiSP.0 for the same years (Fisher 1992; Table 9). Initial values of the state variables are shown in Table 6.

NATURAL PRODUCTION PARAMETERS

FFEM: Fraction of spawners that are female: 0.35. From Howell et al. 1984 p. 350.

PRSPSV: Prespawning survival: 0.7. The upper value of a range (0.6-0.7) given by Chapman et al. 1991 for South Fork Salmon River and Lemhi River stocks.

EGFEM: Average number of eggs per female: 4,423. Average calculated from values in IDFG et al. 1990 Table 16 (p. 61).

STDEG: Standard deviation of eggs per female: 300. Rounded from Howell et al. 1984 p. 347 (N = 5).

LOGITSCL, $LOGIT\beta_0$, and $LOGIT\beta_1$:

(1) For chinook, the Scully and Petrosky 1990 Table 14 gives egg-parr survivals ranging over time and space from 9.9% to 15%. We use 15% for the zero density survival. Therefore, $LOGIT\beta_0 = -1.73$ using Ps = 15% = 0.15.

(2) From IDFG et al. 1990 (p. 63), historically there were about 5,600 - 10,200 summer chinook spawners in the Salmon subbasin. From IDFG et al. 1990 Table 12, the smolt capacity for summer chinook in the Salmon subbasin is 3,259,590. We decided that this value is close to that estimated for fall chinook, so we used the same $LOGIT\beta_1$ value as used for fall chinook. $LOGIT\beta_1$: -1.5×10^{-8}

(3) The LOGITSCL parameter was set to 0.75 to account for spawning habitat degradation in the main spawning area for the summer chinook stocks above Lower Granite Dam, which is the South Fork Salmon River. This has the effect of decreasing subbasin production rates at higher densities (Figure 2). This was necessary to keep the model from producing more summer chinook spawners than we believe the spawning habitat could realistically sustain.

BHINCP and BHCAP: Not used.

CVEGSV: C.V. of egg-pre-smolt survival: 0.2.

STAY1: Conditional probability of overwintering the first year: 1.0. All reports that we surveyed suggested that summer chinook migrate almost exclusively as yearlings.

STAY2: 0.

STAY3: 0.

INBSMSV: In-basin pre-smolt-smolt survival: 0.25. Because essentially all fish out-migrate at age 1+ and the egg to pre-smolt survival was taken from egg to out-migration survival estimates, we do not apply an in-basin survival.

ADTRECV: Fraction of those coded tags arriving below Bonneville dam that are recovered as adults: 0.068. Calculated by the calibration procedure.

CVADTRV: C.V. of adult recovery: 0.21. Calculated by the calibration procedure.

TERMHAR: Terminal harvest rate: 0. We assumed no harvest occurs on wild summer chinook once they enter the subbasin.

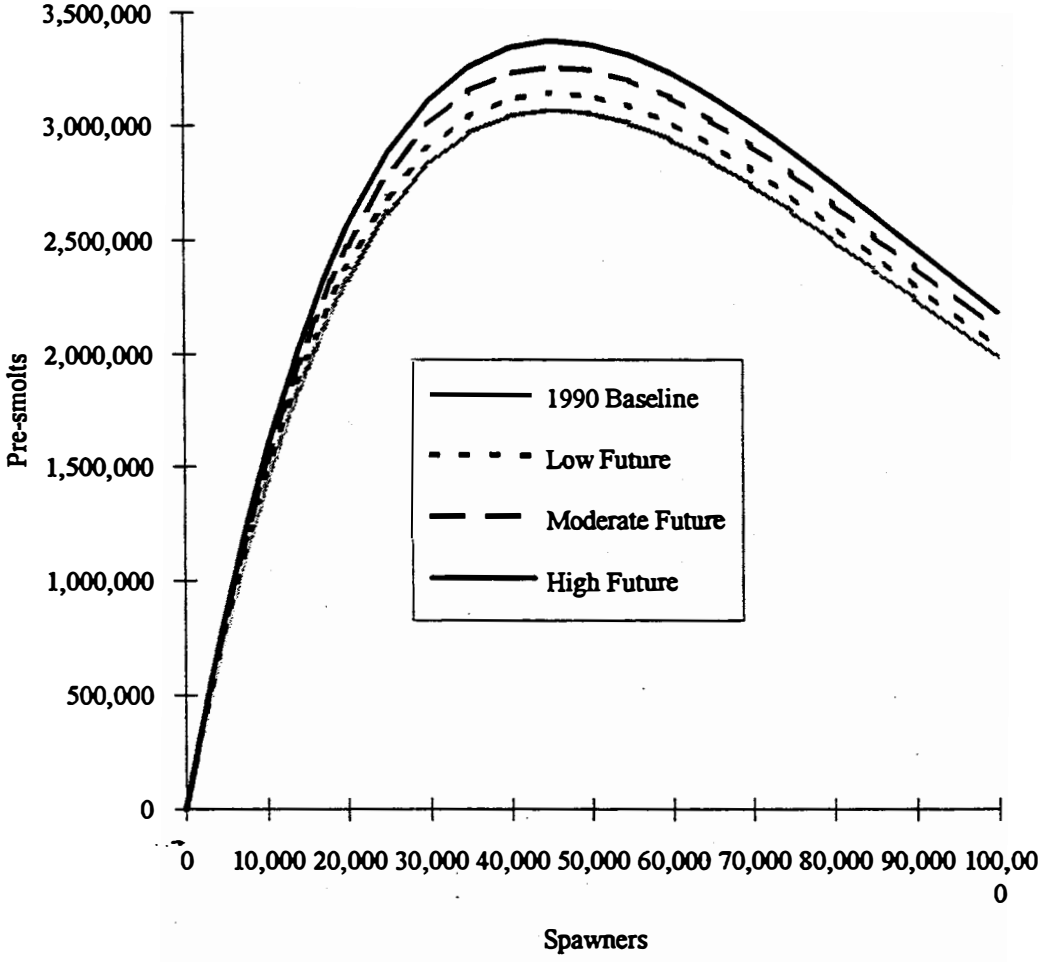


Figure 2. Logit production function for Snake River wild summer chinook.

HATCHERY PARAMETERS

COLRATE: Hatchery collection efficiency: 0. For the base case, we assumed that there was no net effect of the hatcheries. This was because we were focusing on naturally sustained populations, and not attempting to model current supplementation programs.

MINRUN: Minimum subbasin escapement necessary to permit hatchery take: 0.

HATREM: Maximum number of spawners taken by hatchery: 0.

HATFRY: Fry released by hatchery: 0.

RELTIME: Release timing of hatchery fish: 0.

HINTSV: Hatchery fry initial survival: 0.

PASSAGE PARAMETERS

MSURV: Mainstem survival rate: 0.195. Mean of 50 CRiSP.0 simulations (one for each year in the 50-year flow record) of wild Snake River summer chinook migrants using 1990 migration conditions (Fisher 1992).

PASSCV: Coefficient of variation of passage survival: 0.14. C.V. of the same 50 CRiSP.0 runs.

ADULT RECOVERY PARAMETERS

For summer chinook we used the coded wire tag recovery information for the McCall hatchery in the South Fork Salmon River basin (Jim Berksen, CRITFC, pers. comm.; Table 2). The starting number released is simply an estimate of the number of CWT smolts that survived to below Bonneville Dam.

1993 Proposed Actions Case

We changed mainstem survival rates (Table 1) and adult upstream survival. We used a simple multiplicative model to estimate the overall percent change in adult survival from current conditions, and increased the subbasin escapement levels of the stocks by this fraction. Since the subbasin escapement fractions are estimated by brood year, the full benefit of upstream survival measures will not be realized until the first brood cycles through the model (year 4). Thus upstream survival improvements are phased in over the first brood. For the 1993 Proposed Actions case, we modeled a 0.25% to 5% increase in adult upstream reach survival due to law enforcement measures for both the Columbia and Snake River reaches (Table 3). These measures resulted in an overall 0.5% to 10.25% increase in summer chinook adult upstream survival (Table 8).

1993 and Future Actions Case

The parameters that changed for the 1993 and Future Actions case were adult recovery fractions, mainstem passage survival (Table 1), the logit scalar parameter, and in-basin pre-smolt to smolt survival. For the 1993 and Future Actions case, we modeled a 0.25% to 5% increase in adult upstream reach survival due to law enforcement measures for both the Columbia and Snake River reaches (S. Vigg, BPA, pers. comm.; Table 3), and an 0.08% to 0.4% decrease in mortality per project for ladder cooling measures in the Snake River (T.C. Bjornn, U of Idaho, pers. comm.; Table 3). These measures resulted in an overall 0.52% to 10.34% increase in summer chinook adult upstream survival (Table 8).

We also increased the logit scalar function by 1% to 10% to reflect the effect of projected habitat improvements on parr production (C. McConnaha, NPPC, pers. comm.; Table 4). We increased the in-basin pre-smolt to smolt survival by 1% to 2.5% to reflect the projected effects of increased irrigation diversion screening on the survival of migrating smolts (R. Austin, BPA, pers. comm.; Table 4).

Table 9. Partial printout of the calibration spreadsheet for upper Snake River wild summer chinook showing the fit of the procedure for historical subbasin escapements and mainstem survival values.

Year	Observed escapement	Mainstem survival	Eggs	Preamolts	Smolts	Adult recovery (%)	Predicted escapement	Error (%)	Egg to preamolt survival	Egg to adult survival
1979	2,714	14.7%	2,940,985	319,901					10.88%	
1980	2,700	16.0%	2,925,815	318,313					10.88%	
1981	3,300	16.0%	3,575,996	385,817	48,625	6.84%			10.79%	
1982	3,529	20.0%	3,824,148	411,277	60,479	6.84%			10.75%	0.74%
1983	3,233	19.7%	3,503,392	378,336	72,206	7.20%			10.80%	0.77%
1984	4,200	19.5%	4,551,267	484,921	76,189	8.35%			10.65%	0.90%
1985	3,196	16.4%	3,463,297	374,199	58,945	4.42%	3,196	0.00%	10.80%	0.47%
1986	3,934	20.2%	4,263,020	455,897	93,056	4.10%	3,934	0.00%	10.69%	0.44%
1987	2,414	12.6%	2,615,895	285,728	44,792	7.84%	2,414	0.00%	10.92%	0.84%
1988	2,263	12.5%	2,452,266	268,418	54,138	10.81%	2,263	0.00%	10.95%	1.18%
1989	2,350	16.0%	2,546,542	278,401	43,431	5.17%	2,350	0.00%	10.93%	0.57%
1990	3,378	14.9%	3,660,519	394,507	37,995	6.84%	3,378	0.00%	10.78%	
1991	2,150	15.0%	2,329,815	255,415	39,672	6.84%	2,150	0.00%	10.96%	

Average adult recovery =	6.84%
CV of adult recovery =	35.45%
Var. of adult recovery =	0.06%
Egg to smolt survival =	10.83%
Avg. mainstem survival =	16.42%
Var. of egg-smolt survival	0.05%
C.V. of mainstem survival	16.22%
CVADTREC =	33.13%

Fall Chinook

Baseline Conditions Case

CALIBRATION

We used the run size of wild fall chinook over Lower Granite Dam (H. Schaller, ODFW, pers. comm.) from 1975-1991 to approximate fall chinook subbasin escapement. We used the estimates of passage survival from CRiSP.0 for the same years (Fisher 1992; Table 11). Initial values of the state variables are shown in Table 6.

NATURAL PRODUCTION PARAMETERS

FFEM: Fraction of spawners that are female: 0.583. WDF et al. 1990 Table 17 (FFEM = 0.58)

PRSPSV: Prespawning survival: 0.85. A maximum value given by Chapman (pers. comm.) for upper Snake River stocks.

EGFEM: Average number of eggs per female: 4297. WDF et al. 1990 Table 17.

STDEG: Standard deviation of eggs per female: 233. WDF et al. 1990 Table 17 (N = 11).

LOGITSCL, LOGITβ_0, and LOGITβ_1:

(1) From H. Schaller, ODFW.

$LOGIT\beta_0 = -1.73$ using $P_0 = 15\% = 0.15$.

(2) Maximum production should occur at about 4,800 adult spawners (Tom Cooney, WDF, pers. comm.). We matched the shape of the logit curve to Schaller and Cooney's Ricker function for Snake River fall chinook (unpublished data) so that maximum production occurs at 4,800 spawners (Figure 3).

The resulting maximum production of smolts is about 730,000 (Figure 3).

$LOGIT\beta_1$: -8.41×10^{-8}

LOGITSCL: 1

BHINCHP and BHCAP: Not used.

CVEGSV: C.V. of egg-pre-smolt survival: 0.2.

SMTAGE1: Fraction that migrate at age 1+: 0.15. Estimated from information in Howell et al. 1984 and Netboy 1980.

INBSMSV: In-basin pre-smolt-smolt survival: 0.25. Kiefer and Forster 1990 p. 11-60 give a parr to smolt survival of 21.5%. We rounded up to 25%.

ADTRECV: Fraction of those coded tags arriving below Bonneville dam that are recovered as adults: 0.29. Calculated by the calibration procedure.

CVADTRV: C.V. of adult loss: 0.26. Calculated by the calibration procedure.

TERMHAR: Terminal harvest rate: 0. We assumed no harvest occurs on wild fall chinook once they enter the subbasin.

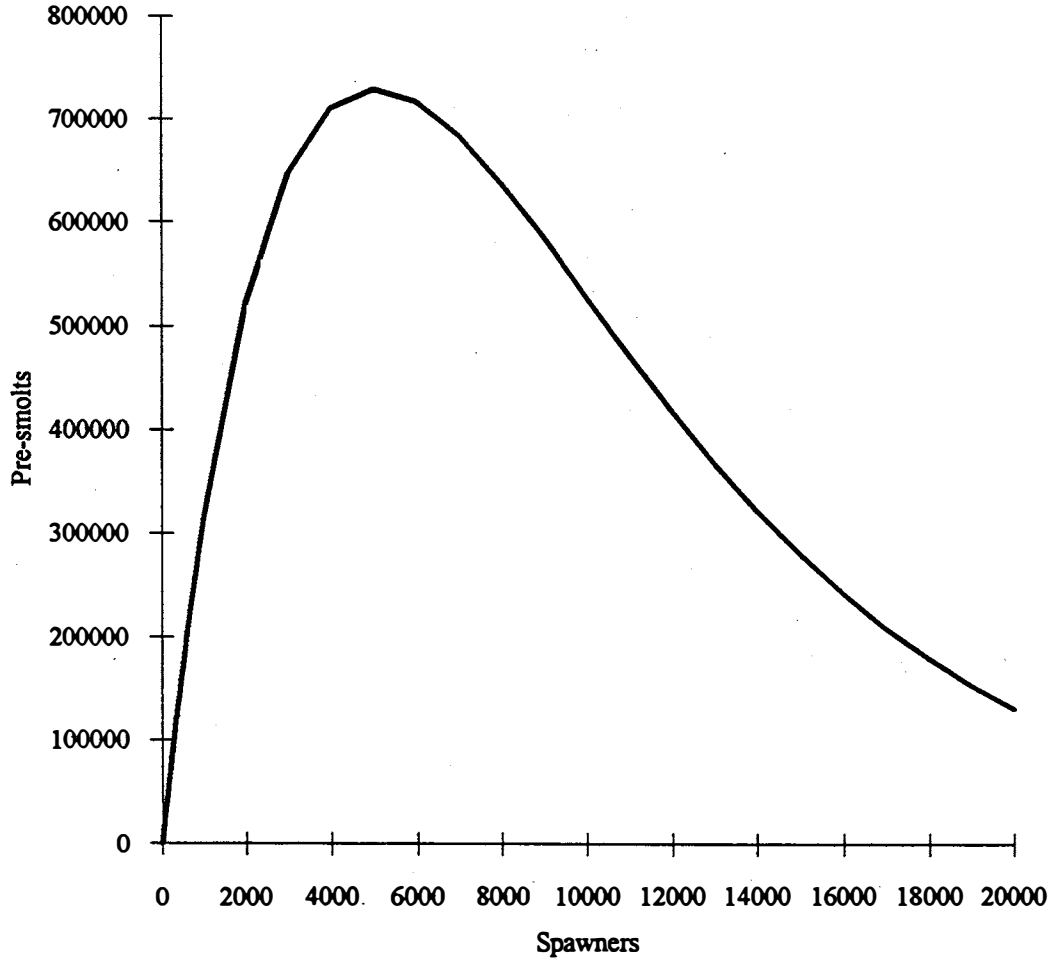


Figure 3. Logit production function for Snake River wild fall chinook.

HATCHERY PARAMETERS

COLRATE: Hatchery collection efficiency: 0. For the base case, we assumed that there was no net effect of the hatcheries. This was because we were focusing on naturally sustained populations.

MINRUN: Minimum subbasin escapement necessary to permit hatchery take: 0.

HATREM: Maximum number of spawners taken by hatchery: 0.

HATFRY: Fry released by hatchery: 0.

RELTIME: Release timing of hatchery fish: 0.

HINTSV: Hatchery fry initial survival: 0.

PASSAGE PARAMETERS

MSURV: Mainstem survival rate: 0.12. Mean of 50 CRiSP.0 simulations (one for each year in the 50-year flow record) of wild Snake River subyearling chinook migrants (Fisher 1992).

PASSCV: Coefficient of variation of passage survival: 0.33. C.V. of the same 50 CRiSP.0 runs.

ADULT RECOVERY PARAMETERS

Adult recoveries were based on a PSC harvest model simulation of coded wire tag recoveries from the 1980-1984 broods from Lyons Ferry Hatchery (H. Schaller, ODFW; Table 2).

1993 Proposed Actions Case

We changed mainstem survival (Table 1), adult upstream survival, and harvest. We used a simple multiplicative model to estimate the overall percent change in adult survival from current conditions, and increased the subbasin escapement levels of the stocks by this fraction. Since the subbasin escapement fractions are estimated by brood year, the full benefit of upstream survival measures will not be realized until the first brood cycles through the model (year five). Thus upstream survival improvements are phased in over the first brood. For the 1993 Proposed Actions case, we modeled a 0.25% to 5% increase in adult upstream reach survival due to law enforcement measures for both the Columbia and Snake River reaches (Table 3). We also modeled an 0.1% to 0.2% decrease in mortality at McNary and a 5% to 9.9% decrease at Lower Granite and Little Goose for the effect of screens to prevent fallback (Table 3). These measures resulted in an overall 6.7% to 23.2% increase in fall chinook adult upstream survival (Table 8). We also increased pre-spawning survival by 0% to 5% to reflect the effect of projected flow improvements on egg production (D. Daley, BPA, pers. comm.; Table 4).

1993 and Future Actions Case

We changed the pre-spawning, adult upstream, and mainstem passage survival parameters for the 1993 and Future Actions case. Adult recoveries were changed based on projected harvest of the 1989-1993 broods (H. Schaller, ODFW; Table 2) if harvest patterns followed NPPC 1991. This simulation included a 5% increase in upstream survival from the first future year.

We changed mainstem survival rates (Table 1) and adult upstream survival. For the 1993 and Future Actions case, we modeled an 0.25% to 5% increase in adult upstream reach survival due to law enforcement measures for both the Columbia and Snake River reaches (S. Vigg, BPA, pers. comm.; Table 3). , and an 0.08% to 0.4% decrease in mortality per project for ladder cooling measures in the Snake River (T.C. Bjornn, U of Idaho, pers. comm.; Table 3). We also modeled an 0.1% to 0.2% decrease in mortality at McNary and a 5% to 9.9% decrease at Lower Granite and Little Goose for the effect of screens to prevent fallback (Table 3). These measures resulted in an overall 7.3% to 24.7% increase in fall chinook adult upstream survival (Table 8).

The changes in upstream adult escapement were affected through an Excel spreadsheet which uses the percent mortality of adults per project (the "conversion rate") to calculate overall changes in adults to the subbasin given changes in the conversion rate. These changes in conversion rates can be applied on either a project-specific or a reach-specific (Columbia or Snake Rivers) basis. See the spring chinook 1993 and Future Actions Case section for a complete description of this spreadsheet.

We used another Excel spreadsheet to estimate the benefits of the addition of screens to prevent adult fallback. The basic relationship between the addition of screens and the change in dam mortality was derived from information supplied by C. Pinney and T. Barila, USACE Walla Walla District, and Wagner 1992. We used this basic relationship to estimate the decrease in project mortality at McNary Dam from extending the screening season from October 31 to December 15. Table 10 shows the data used for McNary Dam. The information for counts of adults came from Wagner and Hillson 1992 and the fallback mortality range was from steelehad trubine mortlaity estimates (Teri Barila, COE, pers. comm.). The formula for estimating the percent change in adult reach

survival due to extending the screening period at McNary is:

$$(23) \qquad \Delta S = \frac{C_e}{C_n} * \frac{G_e * m}{C_e} * N$$

Where:

C_e = McNary chinook count - extended screening period
G_e = adult chinook guided - extended screening period
C_n = McNary chinook count - normal screening period
m = mortality of fallbacks
N = number of projects at which the screening period is extended

We used information for Lower Granite Dam fallback (T. Barila, COE, pers. comm.; preliminary counts of fallbacks through the juvenile guidance system in 1991) to model the effect of extending the screening period there. We applied the estimated percent change in adult reach survival to both Little Goose and Lower Granite dams. Table 10 shows the data used for the Snake River projects. We did not attribute any benefit to fall chinook adult survival of adding screens at any of the unscreened Snake or Columbia River projects since these benefits are unknown at the present.

Table 10. Data used for calculating the benefits of screens to adult survival at McNary and the Snake River dams.

Variable	McNary	Snake
C_e	618	1033
G_e	85	143
C_n	22974	0
m	0.22, 0.33, 0.44	0.22, 0.33, 0.44
N	1	2
normal screening period	through 10/31	not normally screened during fall chinook mirgation
extended screening period	11/1 to 12/15	11/1 to 12/15

We also increased pre-spawning survival by 0% to 5% to reflect the effect of projected flow regime changes by Idaho Power Co. from Hells Canyon Dam on egg production (Table 4).

Table 11. Partial printout of the calibration spreadsheet for upper Snake River wild fall chinook showing the fit of the procedure for historical subbasin escapements and mainstem survival values.

Year	Observed escapement	Mainstem survival	Eggs	Preamolts	Smolts	Adult recovery (%)	Predicted escapement	Error (%)	Egg to preamolt survival	Egg to adult survival
1975	1,000	9.5%	2,129,378	274,869					12.91%	
1976	470	11.3%	1,000,808	140,248	26,401	30.01%			14.01%	
1977	600	11.0%	1,277,627	175,486	1,295	30.01%			13.74%	
1978	640	8.3%	1,362,802	186,032	12,817	45.09%			13.65%	6.19%
1979	500	8.3%	1,064,689	148,512	13,671	22.22%			13.95%	3.03%
1980	450	11.8%	958,220	134,694	15,719	50.00%	444	-1.28%	14.06%	6.97%
1981	340	13.4%	723,989	103,504	16,208	18.98%	364	7.12%	14.30%	2.67%
1982	720	18.9%	1,533,152	206,710	17,210	18.14%	653	-9.33%	13.48%	2.59%
1983	428	14.8%	911,374	128,544	26,579	18.50%	428	0.01%	14.10%	2.49%
1984	324	18.0%	689,919	98,876	21,062	21.06%	324	0.01%	14.33%	2.97%
1985	438	9.4%	932,668	131,345	8,353	20.16%	438	-0.02%	14.08%	2.89%
1986	449	12.3%	956,091	134,416	14,188	32.77%	450	0.17%	14.06%	4.61%
1987	252	2.8%	536,603	77,757	3,337	50.00%	248	-1.69%	14.49%	7.03%
1988	368	5.4%	783,611	111,548	3,841	13.16%	386	5.00%	14.24%	1.91%
1989	295	8.7%	628,167	90,427	8,503	50.00%	242	-17.92%	14.40%	7.12%
1990	78	16.1%	166,092	24,716	13,048	30.01%	93	18.82%	14.88%	
1991	360	16.9%	766,576	109,257	4,124	30.01%	320	-11.21%	14.25%	

Average adult recovery =	30.01%
CV of adult recovery =	48.71%
Var. of adult recovery =	2.14%
Egg to smolt survival =	14.05%
Avg. mainstem survival =	10.98%
Var. of egg-smolt survival	0.08%
C.V. of mainstem survival	46.21%
CVADTREC =	48.51%

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Input Parameters for the Modeling of Snake River Salmon With the Columbia River Salmon Passage Model (CRiSP.0)

December 30, 1992

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DESCRIPTION OF ANALYSES

1993 Supplemental Environmental Impact Statement

This document describes the input parameters for CRiSP.0 runs by BPA for the USACE, BPA, and BOR 1993 Supplemental Environmental Impact Statement (1993 SEIS). We modeled three scenarios for the 1993 SEIS: 1990 Baseline Conditions, 1993 Proposed Actions, and 1998 Proposed Actions and Future Conditions. In addition we modeled three levels of effectiveness of the mitigation measures under the 1993 Proposed Actions and Future Conditions cases. The baseline conditions case models downstream survival under 1990 migration conditions, with a base HYSSR flow file supplied by the USACE. The 1993 proposed actions conditions simulates passage improvements that have taken place or are scheduled to take place between 1990 and 1993, with a 1992 operations and three alternative 1993 operations flow files. The future conditions case models scheduled actions that are to take place between 1993 and 1998, modeled only with the preferred 1992 operations flow.

SLCM Calibration and Transportation Survival

The document also describes parameters for the Stochastic Life Cycle Model (SLCM) calibration runs and post-Bonneville transportation survival calculations. The CRiSP.0 model was run for 1977 to 1991 passage conditions in order to obtain yearly estimates of mainstem passage survival for use in the calibration routine of the SLCM (Fisher et al. 1992). CRiSP.0 runs were also made in order to estimate the survival of the in-river control groups released for various transportation benefit experiments performed by NMFS between 1968 and 1986. These will allow the use of CRiSP.0 output in the SLCM calibration routine and allow a better simulation of transportation for the SEIS.

Sensitivity Analyses

In addition to the scenarios we modeled for the 1993 SEIS, we examined the sensitivity of the model results to different assumptions regarding transportation survival and the subyearling chinook flow-travel time relationship. We modeled two options for each of these parameters. Option 1 is the default option for each parameter, and is used in the full analysis. We then examined the sensitivity of the model results under the Baseline Conditions and Future Conditions - Moderate Effectiveness scenarios using Option 2 for each parameter. A sensitivity analysis was performed on the three flow options for 1993. The USACE provided three HYSSR flow files for the 1993 Proposed Actions scenarios. For a complete description of these options see the SEIS. We modeled the "preferred alternative" (1992 flow operations) in the full model runs and performed a sensitivity analysis on the three 1993 flow options in the 1993 Proposed Actions scenario under Moderate Effectiveness of the mitigation actions. We also modeled a No Action Case, which models only non-flow related mitigation actions under 1993 Conditions - Moderate Effectiveness. This uses the 1990 flow conditions and does not include reservoir drawdowns to MOP.

DAM PASSAGE PARAMETERS

1993 SEIS

Spill Efficiency

CRiSP.0 values are from FISHPASS model parameters established by the NPPC Mainstem Passage Advisory Committee (MPAC 1986). We believe that spillway efficiency is not significantly different from 1:1 (percent of fish passing over spillway : percent of river being spilled) at all projects except The Dalles, where two studies have shown that spillway efficiency is about 2:1 under conditions of 10% instantaneous spill (1986 Spill Agreement MOU levels). There is no empirical evidence that spill efficiency will decrease to 1:1 (letter from NMFS ETSD 11/92) for the 1993 Actions and Future Conditions cases because of a shift of spill to the north shore spillgates (B. Maslen, BPA). Table 9 shows the data from hydroacoustic studies and from CRiSP.0.

Table 1. Spill efficiency data (% of fish passing over spillway/% of river being spilled) for all projects for the Baseline Conditions, 1993 Actions, and Future Conditions scenarios.

Project	Research data	Spill efficiency
Lower Granite		1
Little Goose		1
Lower Monumental	1.34[1], 1.17[2], 1.3[3]	1
Ice Harbor	0.89[4]	1
McNary		1
John Day	1.1[5], 1.36[8]	1
The Dalles	1.06 (2.24)[6], 2.3[7]	2
Bonneville		1

1 Johnson et al. 1986
2 Ransom and Sullivan 1989
3 McFadden 1988
4 Oulette 1988
5 Sullivan et al. 1986
6 Steig and Johnson 1986; higher value is for summer period
7 Johnson et al. 1987
8 McFadden and Hedgepeth 1990; summer period

Sluiceway Fish Guidance Efficiency

CRiSP.0 values: 43% for The Dalles and 43% for Ice Harbor (letter from NMFS ETSD 2/92). The value for The Dalles is close to a the hypothetical FGE for a no-spill condition calculated by Willis (1982). Willis (1982) found a strong relationship between sluiceway FGE and spill at The Dalles:

Sluiceway FGE = $40.6e^{-0.03}$ x spill rate

Therefore if the instantaneous spill rate is 0 then sluiceway FGE is 40.6 and if spill is 10% (Spill Agreement) then FGE is expected to be 30%. Since CRiSP.0 applies the sluiceway FGE to the remaining migrants after the spill efficiency has been applied, under 10% spill the model would guide 40% of the remaining 80% (spill efficiency of 2:1) or 32% of the total migrants. This value compares favorably with the Willis relationship. Steig and Johnson (1986) found sluiceway FGE for The Dalles of 23% during the spring and 49% during the summer (no spill condition and mostly subyearlings). Sullivan et al. (1986) reported an FGE at Ice Harbor of 13% in 1982, 30% in 1983, and 50% in 1986.

Diel Passage Distribution

Data for mid-Columbia projects is from curves developed by MPAC (1986) of cumulative fish passage by hour, adapted for the spill hours at each project. Snake and lower Columbia River values were determined by MPAC (1986), NMFS ETSD, and an analysis of available research data. Diel passage data is summarized in Table 2.

Table 2. Diel passage data for all projects. For Snake and Lower Columbia River projects with no fish spill, the hours are from 18:00 to 06:00; 20:00 to 06:00 for mid-Columbia projects. See Table 9 for hours at projects with spill.

Project	Research data	Hours	CRiSP.0 value (% passing during spill)
Lower Granite		2000 - 0600	82
Little Goose		2000 - 0600	82
Lower Monumental	83[1], 80[2], 88[3], 77[13], 76[14], 77[15], 70[11]	2000 - 0600	82
Ice Harbor	50[4]		50[11]
Wells - Spring Chinook			71
Summer Chinook			58
Steelhead			58
Sockeye			43
Rocky Reach			43
Rock Island			71
Wanapum			58
Priest Rapids			58
McNary		2000 - 0600	82
John Day	74[5], 73[6], 86[6a], 72[7], 80.5[22], 77[23]	2000 - 0600	79[12]
The Dalles	62.5[8], 44[9], 30[9], 45[16], 52[17], 48[20], 51[21]	2000 - 0400	48[12]
Bonneville	50[10], 43[18], 59[19]	2000 - 0600	50[10]

[1] Ransom and Sullivan 1989; from 1800 to 0600
[2] McFadden 1988; from 1800 to 0600
[3] Johnson et al. 1985; during hours of darkness
[4] Sullivan et al. 1986; from 1800 to 0600
[5] Magne et al. 1987; 2100-0500
[6] Magne et al. 1983; 2000-0500 during spring period
[6a] Magne et al. 1983; 2000-0500 during summer period
[7] Magne et al. 1983a; 2000-0600 during spring period
[8] Johnson et al. 1987; 1800-0600 for turbines only
[9] Steig and Johnson 1986; 2000-0600
[10] USACE 1991; during hours of darkness
[11] Letter from NMFS ETSD 2/92
[12] Letter from NMFS ETSD 11/5/92
[13] Letter from PNUCC 11/19/92; 1987 2000-0600 (from McFadden 1988)
[14] Letter from PNUCC 11/19/92; 1987 2000-0600 (from Ransom and Sullivan 1989)
[15] Letter from PNUCC 11/19/92; 1987 2000-0600 (source?)
[16] Letter from PNUCC 11/19/92; 1986 spring turbine 2000-0600 (from Johnson et al. 1987)
[17] Letter from PNUCC 11/19/92; 1986 summer turbine 2000-0600 (from Johnson et al. 1987)
[18] Letter from NMFS ETSD 11/5/92; spring (L. Hawkes, NMFS, pers. comm. 1992)
[19] Letter from NMFS ETSD 11/5/92; summer (L. Hawkes, NMFS, pers. comm. 1992)
[20] Letter from NMFS ETSD 11/5/92; spring turbine 2000-0400 (from Johnson et al. 1987)
[21] Letter from NMFS ETSD 11/5/92; summer turbine 2000-0400 (from Johnson et al. 1987)
[22] Letter from NMFS ETSD 11/5/92; spring (L. Hawkes, NMFS, pers. comm. 1992)
[23] Letter from NMFS ETSD 11/5/92; summer (L. Hawkes, NMFS, pers. comm. 1992)

Spill Survival

The value we used is 98% survival for fish passing over the spillway for all projects (MPAC 1986). This value reasonable given the following research. Schoeneman et al. (1961) found that the survival of fish which traveled over t spillway at McNary and Big Cliff dams was 98%.(96%-100%). Raymond and Sims (1980) found a spill mortality below John Day Dam which was not significantly different from zero. Actual survival estimates ranged from 96.5-119%. Long et al. concluded that survival was 97.8% with flip lips in place at Lower Monumental Dam. Holmes (1952) found a total dam-related mortality of 11-15% for Bonneville I. His non-statistically significant estimate of spillway survival was 96-97%.

Turbine Survival

The value we used is 89% survival for fish passing through the turbines for all projects (letter from NMFS ETSD 11/92). A value between 80% and 91% is reasonable given the following research. Holmes (1952) estimated indirect turbine survival of 85-89% at Bonneville Dam Powerhouse I for subyearling chinook. Schoeneman et al. (1961) estimated 89% (range 87-91%) survival for McNary Dam subyearling chinook. Long(1968) estimated 80-90% survival for coho at Ice Harbor Dam (85% mean). These results were adjusted to account for predation loss of control fish. Long et al. (1975) estimated 80% survival for coho at Lower Monumental Dam (range 76-83%). Ledgerwood et al. (1990;1991) estimated survival for subyearling chinook at Bonneville Dam at 90% (range 90-91%) for turbine vs. downstream released controls.

Bypass Survival

The value we used in CRiSP.0 was derived from estimates of collection and bypass survival: collection survival = 99%; bypass survival = 99%; therefore bypass survival = 0.99^2 = 98% (MPAC 1986). This value is reasonable for the direct effects of passage through the bypass system given the following research. Ceballos et al. (1991), as quoted in Giorgi 1991, reported bypass survival as 99.8% during 1990 at all federal projects. These were direct effects only. DeHart (1987) reports an average of 97-99% survival for bypass systems (direct mortality only). Matthews et al. (1987) report a 4.4-7.6% (mean 5.8%) 43 day mortality associated with the bypass system from the *gatewell*. We do not simulate indirect effects of bypass systems; however recent research (Ledgerwood et al. 1990;1991) suggests that indirect bypass mortality may be as great as turbine mortality at Bonneville Dam. Ledgerwood reported an average of 8% bypass mortality from combined direct and indirect effects for subyearling chinook at Bonneville powerhouse 2. These results are an average of estimated survival w compared with control fish released at various points downstream of the dam.

Fish Guidance Efficiency

CRiSP.0 fish guidance efficiencies were obtained from various sources, all of which are listed in Table 3. In addition, we have gathered together many of the estimates of FGE from USACE research reports in order to show the sometimes wide range of FGE estimated at a project. In many cases researchers did not estimate FGE for all species at a project and under a certain set of bypass conditions. In these cases we had to use the FGE from a similar species.

Table 3. Fish guidance efficiency values from the literature and values used in CRiSP.0 for wild Snake River stocks. STS = submersible traveling screen, LTS = long traveling screen, and GR = 20-foot raised head gates.

Project	Conditions	Steelhead		Yearling chinook		Subyearling chinook		Sockeye	
		Literature	CRiSP.0	Literature	CRiSP.0	Literature	CRiSP.0	Literature	CRiSP.0
Lower Granite	STS	75, 76(61-93)[2,16], 77[6]	76[16]	52, 53(35-74)[2,16], 57[6]	53[16]	52, 35[2,16]	35[16]	52, 41[2]	41[2]
	GR	81(63-91)[2], 79[16]	79[16]	63(40-75)[2], 77[16]	56[17]	40[2], 48[16]	35[17]	48[2]	48[2]
	LTS and GR[b]	88[16]	88[16]	88[16]	70[f]	60[16]	50[f]		60[16,c]
Little Goose	STS	75, 69[1], 70(61-93)[2,16]	70[16]	52, 61[1], 60(43-74)[2,16], (52-77)[7]	60[16]	52, 35[16]	35[16]	52	41
	STS and GR	74 (63-90)[1], 79[16]	79[16]	74 (57-81)[1], 77[16]	70[17]	40[1], 48[16]	35[17]	52[1]	60[17]
	LTS[1]	81		81		50		65	
	LTS and GR[b]	88[16]	81[g]	88[16]	81[g]	60[16]	50[g]		65[g]
Lower Monumental	None	4	4	2	2	2	2	2	2
	STS[8]	76-83, 79[16]		60(52-66), 77[16]	65[21]	35(30-40), 48[16]	31[21]		60[21]
	STS and GR		84[18]	73(66-78)[8]	69[18]		35[e]		60[17]
Ice Harbor	Sluiceway	51	51	51	43[17]	51	43[17]	51	43[17]
	STS[9]	92(88-95)	92	78(73-85)	71[21]		31[21]		60[18]
	LTS and GR[b]	88[16]		88[16]		60[16]			
McNary	STS	76, 75(48-89)[2,16]	75[16]	74, 75(51-94)[2,16]	70[21]	36, 40(12-60)[2,16], 46[10]	47[21]	55, 60(27-83)[2]	62[17]
	GR	87(85-89)[3]		88(85-89)[3]		52(40-71)[3]			
	LTS and GR[b]	90[16]	90[16]	90[16]	90[16]	60[16]	60[16]		80
John Day	STS	85, 84-86[11], 86[16]	86[16]	72[16], 63-73[11]	72[16]	20, 21[11], 35[11], 30[16]	26[21]	41	41
	LTS[c]	90[16]		90[16]		60[16]			
The Dalles	Sluiceway	45, 40[16]	43[17]	45, 40[16]	43[17]	45, 40[16]	43[17]	45	43[17]
	STS[4]	70, 68-71[12]	70	63, 56-63[12]	60[18]	38, 8-46[13]	14[18]	54, 52[12]	52
	LTS[4]	85, 83[16]		80[16]		63[16]		83	
Bonneville 1	STS[5]	56, 80[14], 78[16]	78[16]	42, 42(35-50)[14], 76[16]	37[21]	10, 11[15], 4[14],72[16]	10[21]	23	23[21]
Bonneville 2	STS[5]	35[16]	35[16]	19[16], 44-78[15]	19[16]	24[16], 22-28[15]	24[16]	14[5]	14
	STS and Other[a5]	62, 50[16]	62[20]	67, 65[16]	67[20]	24[16]	24[20]	37	37[20]

References for Table 3:

[1] McKern 1987.
[2] McKern 1986.
[3] Beechie 1986
[4] USACE 1988
[5] USACE 1991; subyearling FGE values are for summer migrants
[6] Swan et al. 1990
[7] Ledgerwood et al. 1988

[8] Ledgerwood et al. 1987
[9] Brege et al. 1988
[10] Brege et al. 1988a; nighttime guidance
[11] Krcma et al. 1986
[12] Monk et al. 1987
[13] Monk et al. 1986
[14] Gessel et al. 1990; subyearling FGE values are for summer migrants
[15] Gessel et al. 1989; subyearling FGE values are for summer migrants
[16] USACE 1988a.
[17] Letter from NMFS Portland 2/92
[18] Discussion with J. Ceballos, NMFS Portland, 8/92
[20] M. Smith, USACE NPD, pers. comm., 11/1/92
[21] Letter from NMFS Portland 11/92

Comments for Table 3:

[a] Other improvements scheduled for Bonneville Powerhouse 2 include: turbine intake extensions, streamlined trash racks, and lowered screens (USACE 1991).
[c] Sockeye FGE was assumed to be similar to subyearling FGE.
[e] Data available for Lower Monumental STS FGE for subyearlings was used for STS and GR at Lower Monumental and for STS at Ice Harbor for subyearlings and sockeye.
[f] Data available for Little Goose STS and GR FGE for yearlings and subyearlings was used for LTS and GR at Lower Granite.
[g] Data available for Little Goose LTS FGE was used for LTS and GR at Little Goose.
[h] Data available for Lower Monumental STS and GR FGE was used at Ice Harbor.

SLCM Calibration and Transportation Survival

In calibration analyses using historic data, when a project did not exist, we set the spill, turbine, collection, and bypass survivals to 1. This, combined with a fish guidance efficiency of 1, allows to effectively remove the project from the model on a year-by-year basis. It should be noted, however, that the flow-mortality and flow-travel time relationships still reflect a reservoir condition where the project does not exist. Therefore we are probably overestimating both travel time and mortality in this situation.

BYPASS SYSTEM IMPROVEMENTS AND TIMING

1993 SEIS

Fish guidance efficiency (FGE) values projected for future bypass improvements at Federal projects are estimates provided by the USACE based upon research such as USACE 1988 and 1991. Some more recent estimates of FGE were supplied by NMFS during consultations in August, October, and November 1992, and with the USACE North Pacific Division in November 1992. Table 4 shows both current and future projected FGE values used in the analyses.

We used the FGE values in Table 3 for various bypass systems in all the scenarios. We used the values for bypass systems as they existed in 1990 for the 1990 Baseline Conditions case. We simulated standard length screens at Lower Monumental and Ice Harbor, raised gates at Lower Granite and Little Goose, and interim bypass improvements at Bonneville powerhouse 2, which include streamlined trash racks, turbine intake extensions, and lowered screens for the 1993 Proposed Actions Case. Bypass system improvements for the Future Conditions case are those currently proposed by the USACE through 1998: long screens at Lower Granite and Little Goose, raised gates at Lower Monumental, raised gates and long screens at McNary, and standard screens at The Dalles.

Table 4. Past, present and future estimated fish guidance efficiency used in CRiSP.0 for all species and all projects.

Project and Bypass Alternative	SEIS Case	Year Implemented	Yearling Chinook	Subyearling Chinook	Steelhead	Sockeye
Lower Granite						
No project		1968	100	100	100	100
1/3 units screened		1975	20	13	28	15
Standard length screens	1990 Baseline	1976	54	35	76	41
Gate Raise	1993 Proposed Actions	1991	56	35	79	48
Long screens	Future Conditions	1996	70	50	88	60
Little Goose						
No project		1968	100	100	100	100
Sluiceway		1970	2	2	4	2
2/3 units screened		1975	41	25	49	29
Standard length screens	1990 Baseline	1977	60	35	70	41
Gate Raise	1993 Proposed Actions	1991	70	35	79	60
Long screens	Future Conditions	1996	81	50	81	65
Lower Monumental						
No project		1968	100	100	100	100
Sluiceway	1990 Baseline	1970	2	2	4	2
Standard length screens	1993 Proposed Actions	1992	65	31	76	60
Gate Raise	Future Conditions	1996	69	35	84	60
Ice Harbor						
Sluiceway		1968	2	2	4	2
Sluice as fish passage	1990 Baseline	1984	43	43	51	43
Standard length screens	1993 Proposed Actions	1993	71	31	92	60
McNary						
Sluiceway		1968	2	2	4	2
1/14 units screened		1978	7	5	9	6
2/14 units screened		1979	12	9	14	11
6/14 units screened		1980	31	22	35	28
Standard length screens	1990 Baseline	1981	70	47	75	62
Gate Raise		1994?	85	50	87	70
Long screens	Future Conditions	1995	90	60	90	80
John Day						
No Project		1968	100	100	100	100
Sluiceway		1971	2	2	4	2
9/16 units screened		1985	42	16	50	25
12/16 units screened		1986	55	21	66	32
Standard length screens	1990 Baseline	1987	72	26	86	41
The Dalles						
Sluiceway	1990 Baseline	1968	43	43	43	43
Standard length screens	Future Conditions	1998	60	14	70	52
Bonneville I						
Sluiceway		1968	20	15	20	20
Standard length screens	1990 Baseline	1984	37	10	78	23
Bonneville II						
No Project		1968	100	100	100	100
Standard length screens	1990 Baseline	1983	19	24	35	14
Interim Improvements	1993 Proposed Actions	1993	67	24	62	37

[1] Includes raised spillgates

SLCM Calibration and Transportation Survival

We used actual dates of installation of turbines and screens (B. Brown, NMFS ETSD, pers. comm.) to estimate FGE for all species for the years 1968-1991 (Table 5). FGE values for when the project did not exist are set to 1. The FGE for all projects was set to sluiceway FGE before any screens were installed. The sluiceway FGE was updated to reflect operation of the sluices as fish passage devices before screens were installed at certain projects. FGE for the period between no screens

and full screening of all turbines was estimated from the formula:

$$(1) \qquad P_{FGE} = L_{FGE} + \frac{S \bullet S_{FGE} \bullet (1 - L_{FGE})}{T}$$

where: P_{FGE} = project fish guidance efficiency
L_{FGE} = sluiceway fish guidance efficiency
S_{FGE} = screens fish guidance efficiency
S = number of turbines screened
T = number of turbines

The FGE values after all screens have been installed at a project are the currently accepted values for all projects. FGE for some projects changes after screens are installed to reflect other improvements such as raised headgates and long screens.

Table 5. Number of turbines and screens by year for each of the Federal hydroelectric dams on the lower Snake and Columbia Rivers.

Year	Bonneville 1		Bonneville 2		The Dalles		John Day		McNary		Ice Harbor		Lower Monumental		Little Goose		Lower Granite	
	Turbines	Screens	Turbines	Screens	Turbines	Screens	Turbines	Screens	Turbines	Screens	Turbines	Screens	Turbines	Screens	Turbines	Screens	Turbines	Screens
1968	10	0	8	0	14	0	0	0	14	0	3	0	0	0	0	0	0	0
1969	10	0	0	0	14	0	0	0	14	0	3	0	0	0	0	0	0	0
1970	10	0	0	0	14	0	0	0	14	0	3	0	3	0	3	0	0	0
1971	10	0	0	0	14	0	16	0	14	0	3	0	3	0	3	0	0	0
1972	10	0	0	0	14	0	16	0	14	0	3	0	3	0	3	0	0	0
1973	10	0	0	0	22	0	16	0	14	0	3	0	3	0	3	0	0	0
1974	10	0	0	0	22	0	16	0	14	0	3	0	3	0	3	0	0	0
1975	10	0	0	0	22	0	16	0	14	0	3	0	3	0	3	2	3	1
1976	10	0	0	0	22	0	16	0	14	0	6	0	3	0	3	2	3	3
1977	10	0	0	0	22	0	16	0	14	0	6	0	3	0	3	3	3	3
1978	10	0	0	0	22	0	16	0	14	1	6	0	6	0	6	6	6	6
1979	10	0	0	0	22	0	16	0	14	2	6	0	6	0	6	6	6	6
1980	10	0	0	0	22	0	16	0	14	6	6	0	6	0	6	6	6	6
1981	10	0	0	0	22	0	16	0	14	14	6	0	6	0	6	6	6	6
1982	10	0	0	0	22	0	16	0	14	14	6	0	6	0	6	6	6	6
1983	10	0	8	8	22	0	16	0	14	14	6	0	6	0	6	6	6	6
1984	10	10	8	8	22	0	16	0	14	14	6	0	6	0	6	6	6	6
1985	10	10	8	8	22	0	16	9	14	14	6	0	6	0	6	6	6	6
1986	10	10	8	8	22	0	16	12	14	14	6	0	6	0	6	6	6	6
1987	10	10	8	8	22	0	16	16	14	14	6	0	6	0	6	6	6	6
1988	10	10	8	8	22	0	16	16	14	14	6	0	6	0	6	6	6	6
1989	10	10	8	8	22	0	16	16	14	14	6	0	6	0	6	6	6	6
1990	10	10	8	8	22	0	16	16	14	14	6	0	6	0	6	6	6	6
1991	10	10	8	8	22	0	16	16	14	14	6	0	6	6	6	6	6	6
1992	10	10	8	8	22	0	16	16	14	14	6	0	6	6	6	6	6	6
1993	10	10	8	8	22	0	16	16	14	14	6	0	6	6	6	6	6	6
1994	10	10	8	8	22	0	16	16	14	14	6	6	6	6	6	6	6	6
1995	10	10	8	8	22	0	16	16	14	14	6	6	6	6	6	6	6	6
1996	10	10	8	8	22	0	16	16	14	14	6	6	6	6	6	6	6	6
1997	10	10	8	8	22	0	16	16	14	14	6	6	6	6	6	6	6	6
1998	10	10	8	8	22	22	16	16	14	14	6	6	6	6	6	6	6	6

TRANSPORTATION

1993 SEIS

Fish transportation levels at Lower Granite, Little Goose, Lower Monumental, and McNary are based upon current guidelines developed by the Fish Transportation Oversight Team (FTOT). Transportation parameters (Table 6) reflect these guidelines as well as we can model them, since they are, for the most part, "soft" criteria. For example, the FTOT criteria for Little Goose state that full transportation should occur when indices show that the chinook migrants have switched from spring to summer run fish. CRiSP.0 simulates this by implementing full transportation on the predicted date on which 80% of yearling chinook will pass the project. FTOT flow is the flow over which all fish are returned to the river, and is 100 kcfs in the Snake and 220 kcfs in the Columbia. The fish level is the cumulative number of migrants that need to be guided before transportation starts. This level is decreased to 0 in the Proposed Actions case to model the start of the transportation season as beginning on April 1, regardless of the number of fish present. This is to take into account the FTOT Opera

Criteria for 1992, which state that transport will begin in the last two weeks of March at Lower Granite and Little Goose if fish are present at the project.

Transport was ended in the Baseline Conditions case on the date on which the USACE ended transport in 1990. These were July 26 for Lower Granite, July 21 for Little Goose, and September 14 for McNary. Transportation was extended until September 30 in the 1993 Proposed Actions case. Transportation is simulated at Lower Monumental in the 1993 Proposed Actions case, operating with the same FTOT guidelines as Little Goose Dam.

Table 6. Transportation parameters for transport projects in the Base, 1993 Proposed Actions, and Future Conditions cases.

Parameter	Lower Granite	Little Goose	Lower Monumental	McNary
Year Operational	1990	1990	1993	1990
Start Date – 1990 Baseline Conditions	—	—	—	—
Proposed Actions	4/1	4/1	4/1	4/1
Future Conditions	4/1	4/1	4/1	4/1
End Date – 1990 Baseline Conditions	7/26	7/21	—	9/14
Proposed Actions	9/30	9/30	9/30	9/30
Future Conditions	9/30	9/30	9/30	9/30
Flow Level (kcfs)	100	100	100	220
Fish Level – 1990 Baseline Conditions	500	500	—	1000
Proposed Actions	0	0	0	0
Future Conditions	0	0	0	0
Full Transport - all cases	80% yearlings	80% yearlings	80% yearlings	80% yearlings

The transportation efficiency is the proportion of fish collected in the bypass system that are actually transported when the flow is above the FTOT level. In actual practice it reflects the percentage of the fish that go over the "small fish" slots and into the "large fish" slots, and thence into the barge, in the wet separators at Little Goose and McNary dams. This was set to 80% for steelhead, 20% for yearling chinook, and 10% for sockeye (J. McKern, USACE, pers. comm.). We assumed an efficiency of 10% for subyearling chinook due to their small size.

Transportation Survival

Transport survivals are adjusted to include a differential post-Bonneville Dam survival rate between transported and non-transported fish using existing data on transportation benefit ratios (TBRs) of smolts released between 1968 and 1989. The CRiSP.0 model is run in order to determine the post-transportation survival rate at each transportation facility. The USACE transportation studies (see Fisher 1992) released control and transported yearling and subyearling chinook and steelhead from McNary, Ice Harbor, Little Goose, and Lower Granite dams from 1968 to 1989. I calculated the Transport Benefit Ratios as the ratio of the number of adults returning to all recapture points (in most cases; see Fisher 1992) from transported fish to the number of adults returning from in-river migrants (the control releases). I calculated the in-river survival of control fish releases using flow, spill, and bypass conditions from each of the years. Once these in-river survivals are established they are multiplied by the appropriate TBR values, producing the adjusted transportation survival rate:

(2) Post-Bonneville transport survival = TBR * in-river survival

There are two options used for transportation survival in the 1993 SEIS. The default option, Option 1, is the "average" wherein transport survival is the average of all modeled survivals at each project in all years (Table 7). In most cases I used the transportation survivals for each species at each project to obtain post-transport survivals for all species. For example, subyearling survival at Ice Harbor = subyearling survival from McNary * yearling survival from Ice Harbor / yearling survival from McNary. Transport survivals from Ice Harbor were applied to Lower Monumental in the 1993 Proposed Actions scenario.

Option 2 is the "modern" option wherein transport survival is calculated as the modeled survival from only the 1986-1989 experiments (Table 7). Since experiments took place only at Lower Granite and McNary, I applied the survi from Lower Granite to all Snake River projects. Since subyearlings were only released at McNary, I calculated subyearling transport survival from the Snake River projects as following the same pattern as yearling chinook for Lower Granite.

Table 7. Post - transportation survival for all species calculated first with all years' data (1968-1989; Option 1) and second with only 1986 and later experiments (Option 2).

Species	McNary	Ice Harbor	Little Goose	Lower Granite
	Option 1 - All Years			
Subyearling chinook	68%	52%	49%	39%
Yearling chinook	46%	35%	33%	26%
	Option 2 - 1986 and Later			
Subyearling chinook	66%	52%	52%	52%
Yearling chinook	55%	43%	43%	43%

SLCM Calibration

We researched the historical dates of transportation and the criteria used to determine transport levels in the years 1975 – 1991 (DeLarm et al. 1984, Koski et al. 1985, 1986, 1987, 1988, 1989, 1990, Ceballos et al. 1991, 1992; Table 8). The fish level needed to start transportation at each project was not used since we know the actual dates of transport at each project.

Table 8. Transportation parameters for transport projects in the SLCM calibration years of 1975-1993.

Year	Project	Start Date	End Date	Flow Level	Criteria
1975	Little Goose				All species
1976	Lower Granite	4/12			No separation;
					All species – 50% of run
	Little Goose				All species – 50% of run
1977	Lower Granite	4/5	6/5		All species – transport all
	Little Goose	4/29			All species – transport all
1978	Lower Granite	4/4	6/21		All species – transport all
	Little Goose	4/10	6/15		All species – transport all
1979	Lower Granite	4/11	7/4		All species – transport all
	Little Goose	4/17	7/4		All species – transport all
	McNary	4/9	8/24		All species – transport all
1980	Lower Granite	4/3	7/7		All species – transport all
	Little Goose	4/7	7/7		All species – transport all
	McNary	4/3	9/22		All species – transport all
1981	Lower Granite	4/2	7/30		All species – transport all
	Little Goose	4/7	7/24		All species – transport all
	McNary	3/30	9/11		All species – transport all
1982	Lower Granite	4/4	7/29	85	Full trans at 80% yearlings
	Little Goose	4/8	7/21	85	Separation;
					Full trans at 80% yearlings
	McNary	3/30	9/24	220	Separation;
					Full trans at 50% subyearlings
1983	Lower Granite	4/2	7/30	85	Full trans at 80% yearlings
	Little Goose	4/4	7/8	85	Full trans at 80% yearlings
	McNary	4/3	9/22	220	
1984	Lower Granite	4/1	7/26		Full trans at 80% yearlings
	Little Goose	4/5	7/28	85	Full trans at 80% yearlings
	McNary	4/16	9/28	220	
1985	Lower Granite	4/1	7/23		Full transportation
	Little Goose	4/1	7/23	85	Full trans at 80% yearlings
	McNary	4/6	9/26	220	
1986	Lower Granite	4/1	7/24		Full transportation
	Little Goose	4/1	7/3	85	Full trans at 80% yearlings
	McNary	4/1	9/26	220	
1987	Lower Granite	4/1	7/31		Full transportation
	Little Goose			100	Full trans at 80% yearlings
	McNary			220	
1988	Lower Granite	4/1	7/24		Full transportation
	Little Goose			100	Full trans at 80% yearlings
	McNary			220	
1989	Lower Granite	4/1	7/30		Full transportation
	Little Goose			100	Full Trans at 80% yearlings
	McNary			220	
1990	Lower Granite	4/1	7/26		Full transportation
	Little Goose		7/21	100	Full trans at 80% yearlings
	McNary		9/14	220	Full trans at 80% yearlings
1991	Lower Granite	4/1	9/30		Full transportation
	Little Goose	4/4	8/31	100	Full trans at 80% yearlings
	McNary	4/1	9/30	220	Full trans at 80% yearlings
1992	Lower Granite	4/1	9/30		Full transportation

	Little Goose	4/1	9/30	100	Full trans at 80% yearlings
	McNary	4/1	9/30	220	Full trans at 80% yearlings
1993	Lower Granite	4/1	9/30		Full transportation
	Little Goose	4/1	9/30	100	Full trans at 80% yearlings
	Lower Monumental	4/1	9/30	100	Full trans at 80% yearlings
	McNary	4/1	9/30	220	Full trans at 80% yearlings

FLOW INPUTS

1993 SEIS

We used different HYSSR flow files from the USACE for the Baseline Conditions (file "hm92a"; Alternative 1) case and the Proposed Actions case (file "jb92d"; Alternative 4). We also used the USACE HYSSR files for three other options under the 1993 Proposed Actions case in the sensitivity analysis for flow (files "jb92b"; Alternative 2, "jb92c"; Alternative 3, and "jb92e"; Alternative 5). Period average flows from HYSSR simulations of hydrosystem operations are modulated to daily average values using 1991 flows at Wells Dam, Lower Granite, and McNary dams for the mid-Columbia, Snake, and lower Columbia rivers respectively.

SLCM Calibration and Transportation Survival

Flows for the SLCM calibration and transportation survival analyses were from USACE, FPC, CRITFC, and NPPC actual flow data for each project. We obtained actual daily flow and spill for all projects from 1968 – 1991 from the various agencies. Flow was summed over SAM periods for input into CRiSP.0. Period average flows were modulated to daily average values using the actual daily flows for each year at Wells Dam, Lower Granite, and McNary dams for the mid-Columbia, Snake, and lower Columbia rivers respectively.

SPILL INPUTS

1993 SEIS

Planned fish spill at Federal projects in the 1990 Baseline Conditions case is based upon the 1989 Fish Spill Memorandum of Agreement (Table 9). The planned fish spill at mid-Columbia PUD projects is based upon the Federal Energy Regulatory Commission stipulation agreement current in 1991. Planned spill is assumed to be eliminated as a passage improvement device at each project when bypass systems are completed. Fish spill was modeled in the Proposed Actions and Future Conditions cases based on the actual spill which took place in 1992 (USACE; Table 9). Forced spill is determined on a daily basis from the modulated daily flow and the hydraulic capacity at each project. There was no overgeneration spill (spill due to a lack of load) in this analysis.

SLCM Calibration and Transportation Survival

Spill inputs for the SLCM calibration and transportation survival analyses were from USACE, NPPC, CRITFC, and FPC actual flow data for each project. Total spill in kcfs was converted to spill as a percentage of period average flow. Forced spill was calculated as total spill minus powerhouse capacity. Spill shaped for fish passage was then total spill – forced spill.

Table 9. Instantaneous fish spill rates from the 1989 Fish Spill MOU, as occurred in 1992, and as modeled.

Project and Conditions	Spill (%)	Spill Hours	Hours/Day	Days of Spill
Lower Monumental				
Spill Agreement	70	18:00 - 6:00	12	April 15 – July 22
1992	40		12	April 15 – May 31
	43		12	June 1 – August 15
1990 Baseline Conditions	70	18:00 - 6:00	12	April 15 – July 22
1993 Proposed Actions	0			
Future Conditions	0			
Ice Harbor				
Spill Agreement	25	18:00 - 6:00	12	April 15 – July 22
1992	60		12	April 15 – May 31
	30		12	June 1 – August 22
1990 Baseline Conditions	25	18:00 - 6:00	12	April 15 – July 22
1993 Proposed Actions	60		12	April 15 – May 31
	30		12	June 1 – August 22
Future Conditions	0			
John Day				
Spill Agreement	20	20:00 - 6:00	10	June 7 – August 22
1992	20		10	June 7 – August 22
1993 Proposed Actions	20		10	June 7 – August 22
Future Conditions	0			
The Dalles				
Spill Agreement	10	20:00 - 4:00	24	May 1 – June 6
1992	30		8	May 1 – June 6
	15		8	June 7 – August 22
1993 Proposed Actions	30		8	May 1 – June 6
	15		8	June 7 – August 22
Future Conditions	0			
Bonneville				
Spill Agreement		18:00 - 6:00		
1992	53		24	April 15 – June 11
	41.5		24	June 12 – August 23
1993 Proposed Actions	53		24	April 15 – June 11
	41.5		24	June 12 – August 23
Future Conditions	0			

FLOW – TRAVEL TIME RELATIONSHIPS

For all species except subyearling chinook, we used a flow travel-time equation to compute fish travel time from pool length and flow (Boyer 1974):

(3) $$T = \frac{lpool}{(k_1 + k_2 \bullet \overline{flow})}$$

where: T = travel time through the pool (days)
$lpool$ = pool length (km)
$flow$ = project outflow (kcfs)

The parameters k_1 and k_2 are based upon a regression of water particle velocity for all reservoirs (Table 10) for all pools (Boyer 1974). Therefore this flow-travel time relationship essentially models yearling chinook and steelhead as water particles. There is evidence from brand and PIT tag data that yearling chinook travel slower than water particles. Figure 1 shows the results of this relationship for Snake River pools.

Subyearling chinook migrants are modeled with two options. The default option, Option 1, is a unique flow travel-time equation which incorporates fish length. This relationship applies only to Lower Granite Pool, which is the only pool for which data has been collected. The relationship is of the form:

$$(4) \qquad T = lpool \bullet \left[k_3 + \frac{k_4}{(k_1 + k_2 \bullet \overline{flow})} + \frac{k_5}{l} \right]$$

where: T = travel time through the pool (days)
$lpool$ = pool length (km)
$\overline{flow}$ = project outflow (kcfs)
l = fish length (mm)

The parameters k_1 and k_2, are from the water particle velocity regression performed for yearling chinook. The parameters k_3, k_4 and k_5 are based upon an inverse regression of data presented in DeHart 1991. The regression was of the form:

$$(5) \qquad \frac{1}{tspeed} = \alpha + \frac{\beta}{(k_1 + k_2 \bullet \overline{flow})} + \frac{\varphi}{l}$$

where: $tspeed$ = fish velocity (km/day)
$\overline{flow}$ = mean project outflow (kcfs)
l = fish length (mm)

For Lower Granite Pool, $lpool$ = 60.2, k_1 = 1.118, k_2 = 0.136, k_3 = –0.77, k_4 = 2.87, and k_5 = 72.11 (Table 10). Length is set to 95 mm, and is held constant (average migration length from DeHart 1991). The regression has an adjusted R^2 value of 0.47. Figure 2 shows the results of this equation at different flows. Some concern has been expressed over the species composition of the PIT tagged subyearling chinook that make up this dataset. Of the 75 fish released by USFWS and detected at Lower Granite, 57 were analyzed as to species (electrophoresis) and age (scale annuli). Of these, 46, or 81%, were confirmed to be age 0 fall chinook (D. Rondorf, USFWS, pers. comm.). About 50% of the fish released by IDFG and detected at Lower Granite were confirmed to be age 0 fall chinook by the same methods (D. Rondorf, pers. comm.). The dataset we used was primarily composed of USFWS releases.

Travel time through pools from Little Goose Pool to Bonneville Pool under Option 1 is computed from data in Berggren and Filardo (1990). The equation is of the form:

$$(6) \qquad T = \frac{lpool}{e^{(k_3 + k_4 \bullet \ln(k_1 + k_2 \bullet \overline{flow}))}}$$

where: T = travel time through the pool (days)
$lpool$ = pool length (km)
$\overline{flow}$ = project outflow (kcfs)

The parameters k_1 and k_2 are based upon a regression of water particle velocity and flow in each pool (Boyer 1974). These are the same parameters as used for yearling chinook and steelhead above. The parameters k_3 and k_4 are based on a log-log regression of 1981 - 1988 brand release groups in John Day reservoir from Berggren and Filardo (1990) for all pools except Lower Granite (Table 10). The regression has an adjusted R^2 value of 0.31 in John Day pool. Figure 3 shows the results of this equation at different flows in John Day pool.

Option 2 assumes that subyearling chinook travel at a constant rate. We applied a travel speed of 5.62 km/day to all pools except Lower Granite, which is the median travel rate through John Day pool from the brand data collected in 19[illegible]

1988 (Figure 2; S. Bledsoe, CSC, pers. comm.). We applied the rate of 3.71 km/day in Lower Granite pool, which is the average travel speed of the 1991 PIT tagged subyearling migrants (DeHart 1991; Figure 3).

Table 10. Parameters k_1 and k_2 for the travel time equation for yearling chinook, steelhead, sockeye, and coho migrants and parameters k_3, k_4, and k_5 for subyearling chinook in the 1990 Baseline Conditions scenario. Note that parameter k_5 is applicable only to subyearling chinook in Lower Granite pool; see text.

River reach	Yearling chinook		Subyearling chinook		
	k1	k2	k3	k4	k5
Lower Granite	1.118	0.131	-0.771364	2.871617	72.11195
Little Goose	1.76	0.206	-0.902345	0.809054	—
Lower Monumental	2.17	0.235	-1.023646	0.812123	—
Ice Harbor	1.119	0.283	-1.057468	0.788581	—
South Confluence	0.537	0.24	-0.890684	0.78089	—
Wells	0.7359	0.3169	-1.109653	0.78127	—
Rocky Reach	1.0238	0.297	-1.084188	0.786311	—
Rock Island	2.262	0.539	-1.571607	0.78966	—
Wanapum	0.604	0.199	-0.394839	0.793596	—
Priest Rapids	0.916	0.404	-1.298063	0.781024	—
North Confluence	0.539	0.5	-1.43514	0.775684	—
McNary	1.525	0.09	-0.376129	0.846216	—
John Day	1.038	0.05	0.065686	0.862973	—
The Dalles	5.607	0.277	-1.400275	0.860701	—
Bonneville 1	6.394	0.177	-1.334872	0.92978	—

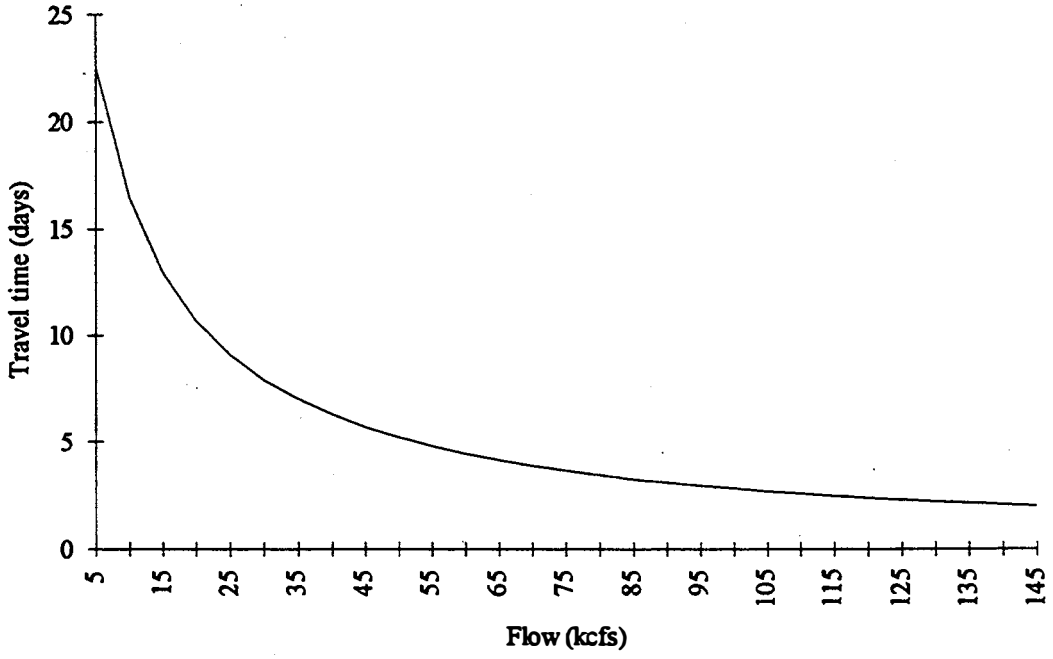


Figure 1. The CRiSP.0 flow-travel time relationship for yearling chinook in Lower Granite Pool.

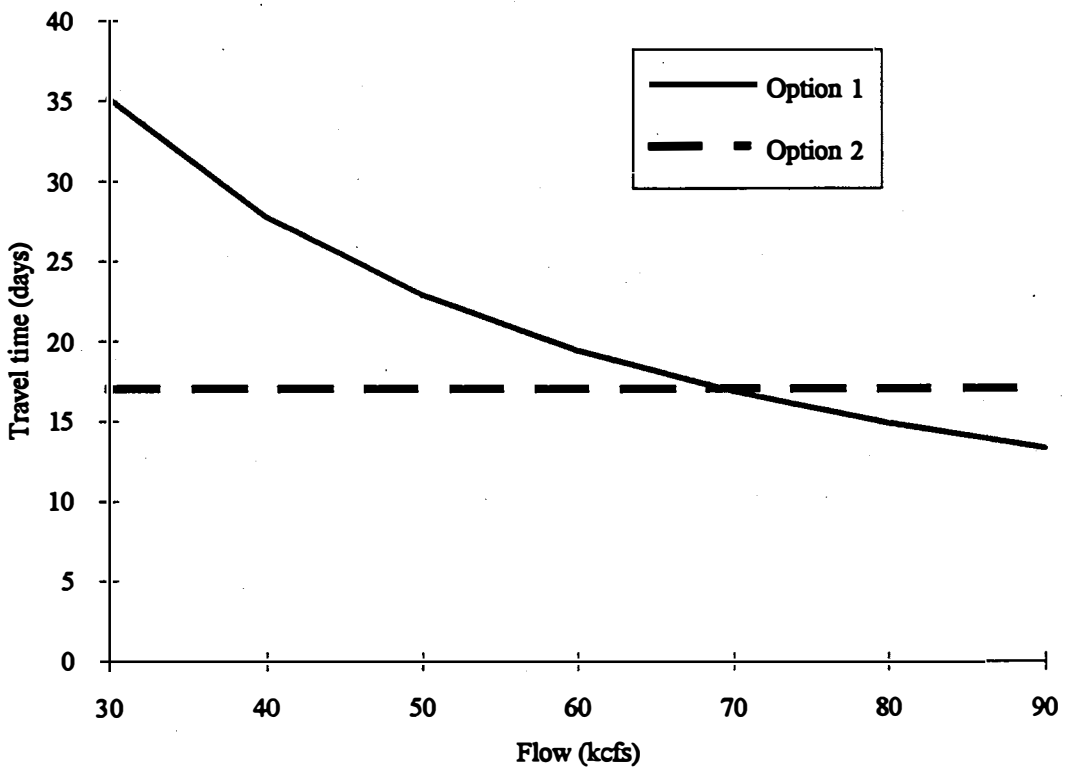


Figure 2. The CRiSP.0 flow-travel time relationship for subyearling chinook in Lower Granite Pool under both Option 1 and Option 2.

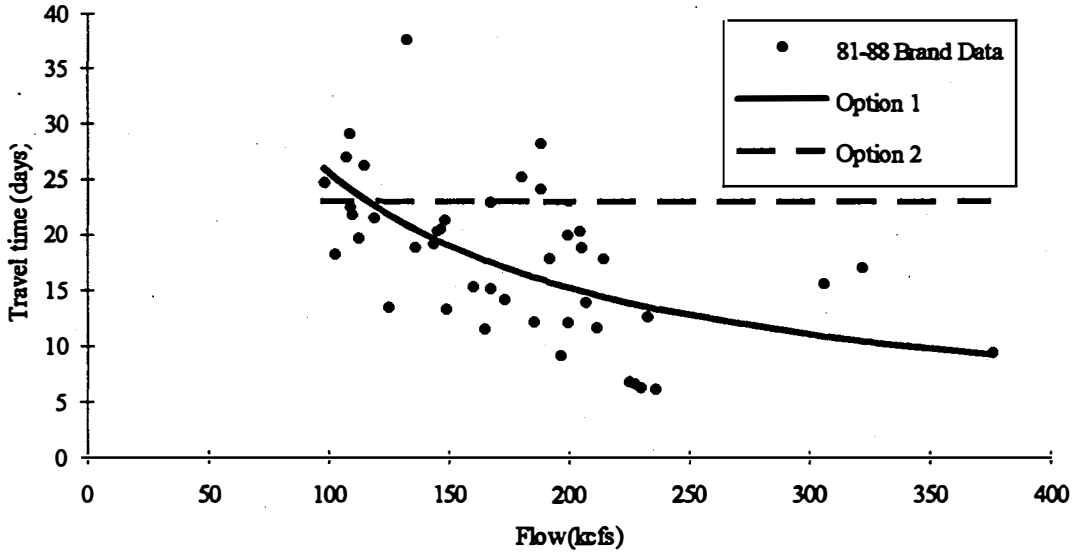


Figure 3. The CRiSP.0 flow-travel time relationship for subyearlings in John Day Pool under Options 1 and 2, along with the 1981-1988 brand data.

FLOW – SURVIVAL RELATIONSHIPS

For all species except subyearling chinook, the flow-survival relationship for the lower Columbia and Snake reservoirs is based upon a quadratic flow survival relationship (CRiSP.0 Documentation, Eq(11)):

(8) $$sres = \{1 - predmrt \bullet (k_3 + k_4 \bullet \overline{flow} + k_5 \bullet \overline{flow}^2)\}^{lpool}$$

where: *sres* = survival through the reservoir
predmrt = predation multiplier
lpool = pool length

The parameters are calibrated with observed system survival estimates for marked spring chinook and steelhead reported in Sims and Ossiander 1981 and Raymond 1979. The interpretation and regression of the data was performed by the Northwest Power Planning Council. A cutoff value was used to hold survival constant above a specified threshold flow. This flow level at which survival becomes constant corresponds with the highest flow level for which data was available. Figure 4 shows the results of this relationship for Lower Granite pool. Equation parameter values are given in Table 11.

Subyearling chinook are modeled with a flow-survival relationship computed from the Columbia River Ecosystem Model (CREM). The reservoir mortality of subyearling migrants traveling at the median velocity of 5 km/day was computed in CREM. This mortality is converted to a constant mortality/day which is used in CRiSP.0 (Table 11):

(7) $$sres = (1 - mrtday \bullet T)$$

where: *sres* = reservoir survival
mrtday = fraction killed each day
T = time in days to traverse the reservoir

The results of this relationship are shown in Figures 5 and 7 for Option 1 and Figures 6 and 8 for Option 2.

Table 11. Parameters for the flow-survival equation for yearling chinook, steelhead, sockeye, and coho migrants.

Species/River reach	k_3	k_4	k_5	Cutoff	Mrtday
Subyearling chinook	—	—	—	—	0.035
Mid-Columbia[1]					
Snake & L. Columbia	—	—	—	—	0.0226
All others	0.0239	-0.000359	0.00000151	141 kcfs	—
Snake River					
Lower Columbia	0.03179	-0.000203	0.000000353	341 kcfs	—
Mid-Columbia[1]	—	—	—	—	0.035

[1] An assumed 3.5 percent mortality per day (based upon a review of FERC and mid-Columbia Proceedings) is applied to the flow - survival relationship for all mid-Columbia projects.

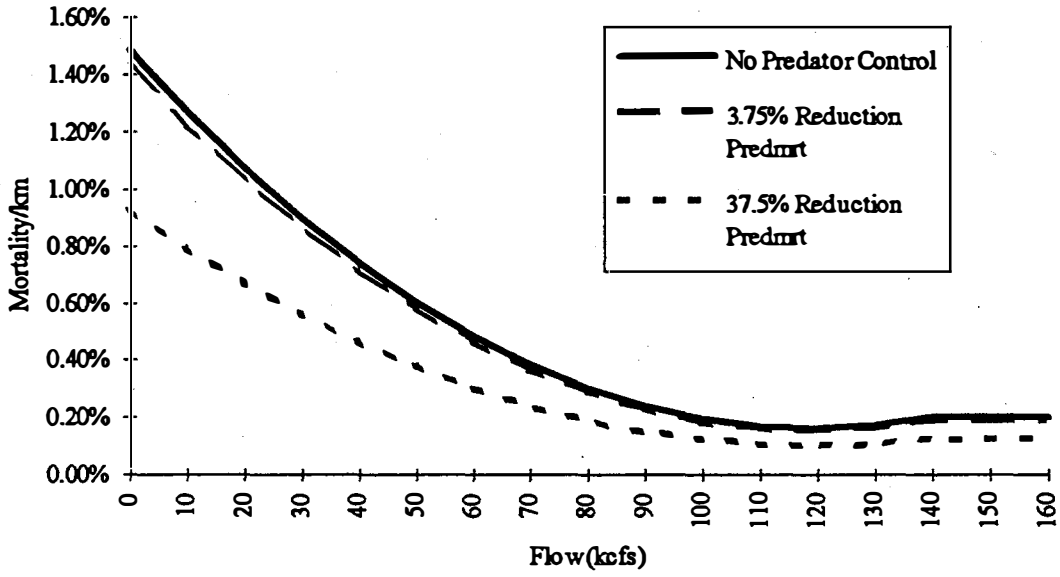


Figure 4. Results of the flow-survival equation for yearling chinook in the Snake River reach.

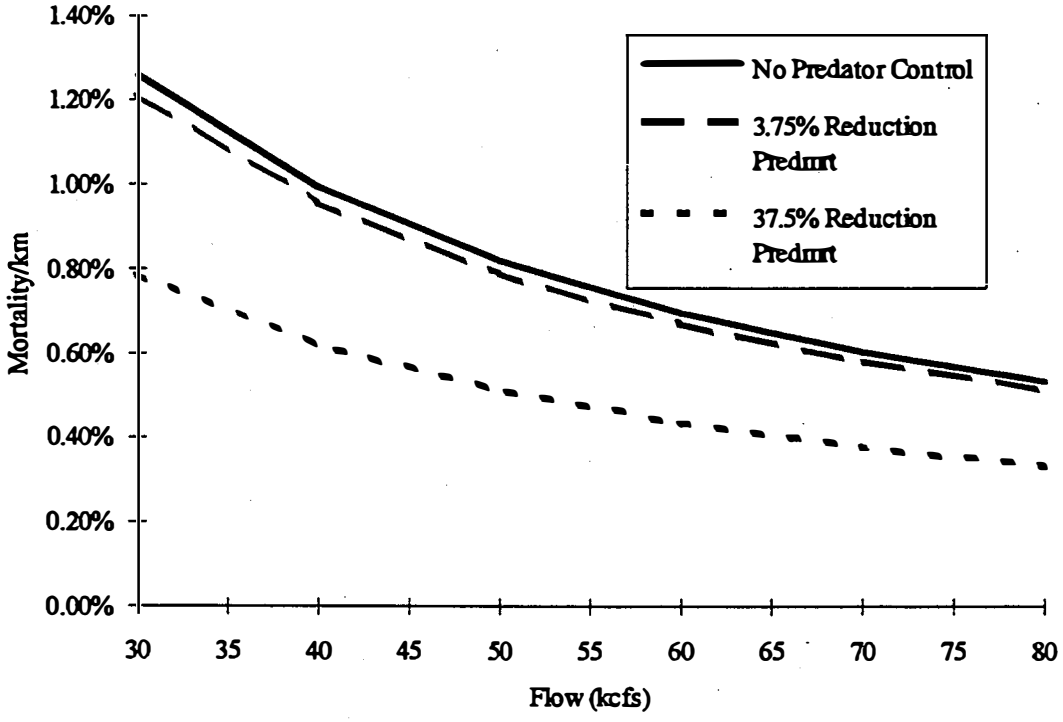


Figure 5. Results of the flow-survival equation for subyearling chinook in Lower Granite pool under Option 1.

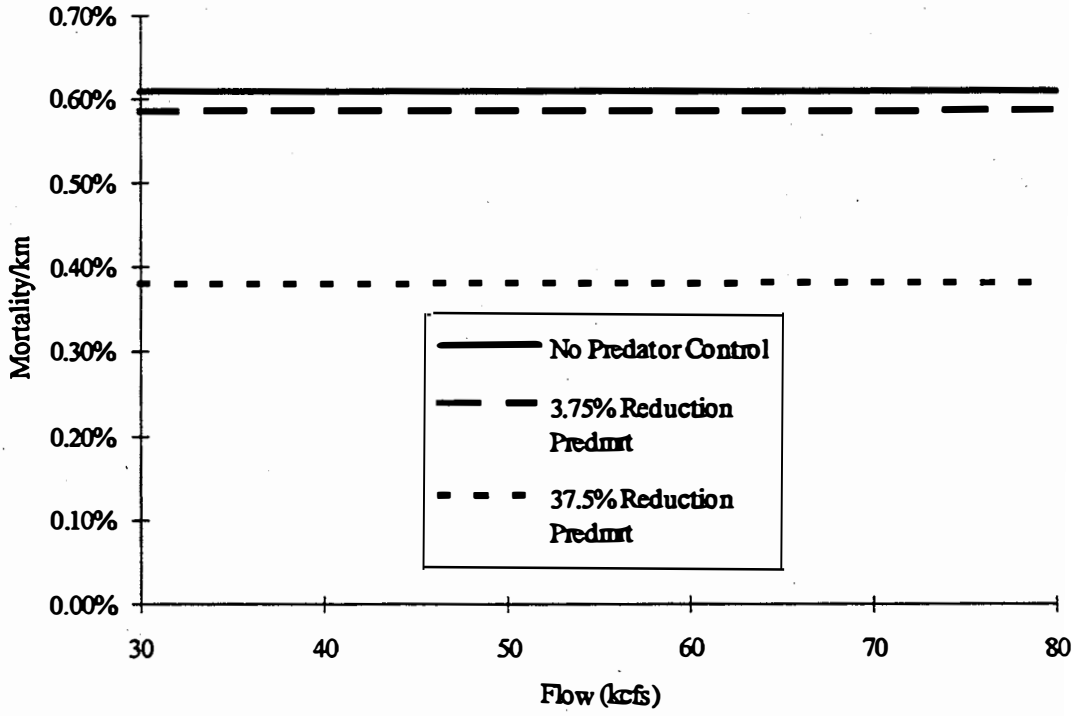


Figure 6. Results of the flow-survival equation for subyearling chinook in Lower Granite pool under Option 2.

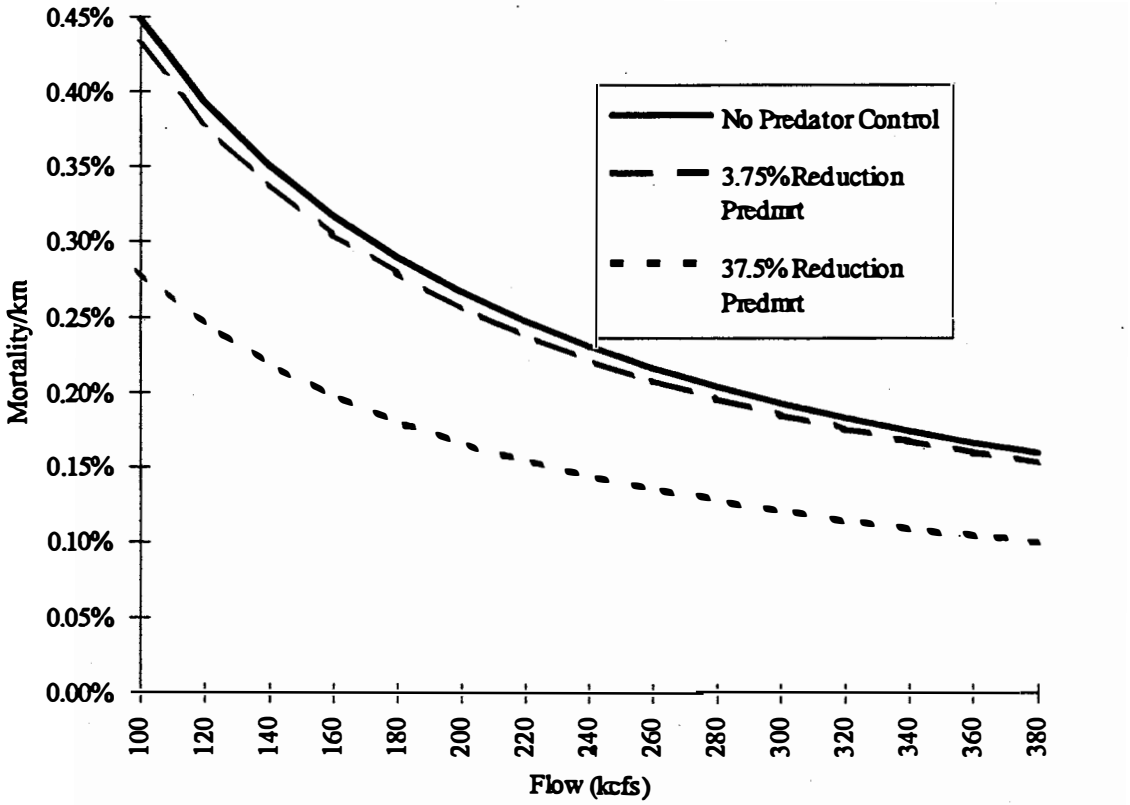


Figure 7. Results of the flow-survival equation for subyearling chinook in John Day pool under Option 1.

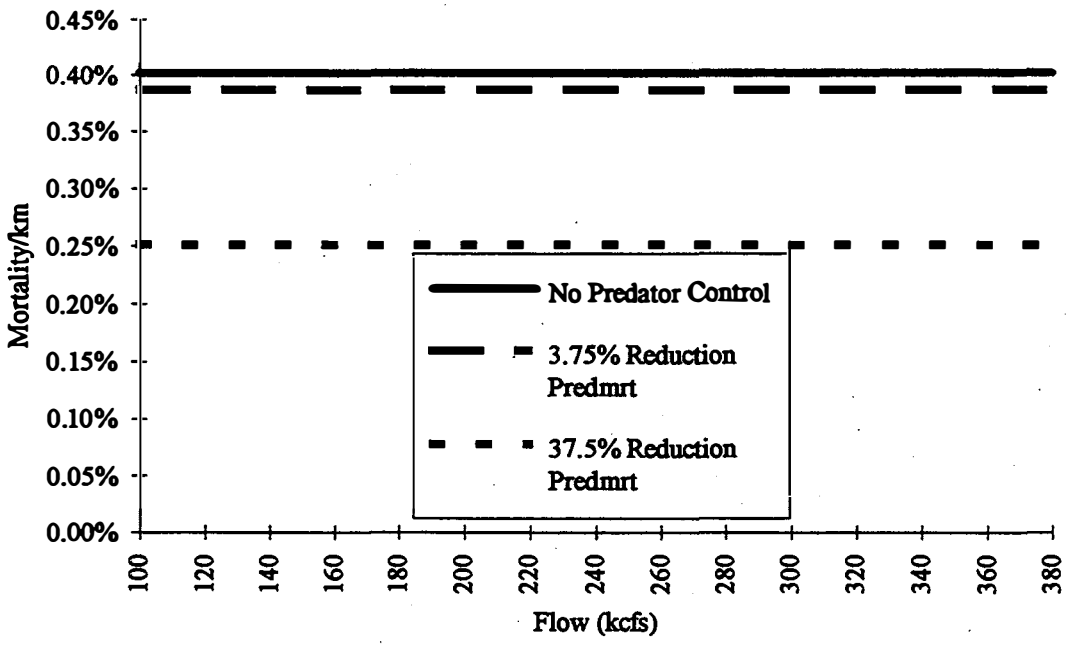


Figure 8. Results of the flow-survival equation for subyearling chinook in John Day pool under Option 2.

SQUAWFISH MANAGEMENT

1993 SEIS

We modeled the effect of squawfish management through a reduction of reservoir mortality for the 1993 Proposed Actions and Future Conditions cases. A 7.5% reduction in mortality per day (*mrtday*) for subyearling chinook and mortality per mile (via *predmrt*) for all other species was modeled as the moderate effectiveness level of predation reduction in the 1993 Proposed Actions relative to the 1990 Baseline Conditions (NMFS; Table 12). An overall 25% reduction in mortality per mile (day) was modeled as the moderate effectiveness level of predation reduction for the Future Conditions case. We varied the reduction in predation mortality by 50% about its mean for the low and high effectiveness scenarios for both the 1993 and Future cases. Figures 4 through 8 show the results of the lowest and highest reductions in predation mortality that we modeled on the survival of chinook migrants.

This levels of predation reduction we modeled are based upon predation modeling which projects that a sustained 10 to 20% harvest of adult northern squawfish may result in a 50% or more reduction in predation mortality within a 10 year period (Rieman and Beamesderfer 1990). Based on the uncertainty regarding the potential benefit of squawfish management and the unknown proportion of reservoir mortality associated with squawfish predation, the projected 50% reduction in predation mortality was halved to 25% in reservoir mortality. Additional research has indicated that previously unexplained losses of juvenile salmonids in the John Day reservoir can be accounted for by predation (Rieman et al. 1991). Estimates are that approximately 3 million juvenile salmonids are lost to predation annually in the John Day reservoir. This translates to approximately 14% of all juvenile salmonids entering the John Day pool (monthly mortality ranged from 7% in June to 61% in August).

Table 12. *Mrtday* (for subyearling chinook) and *predmrt* parameters for all species and all levels of predation control effectiveness we modeled.

Scenario	Reduction in mortality	Predmrt	Mrtday
Baseline Conditions	0%	1	0.0226
1993 Proposed Actions			
Low Effectiveness	3.75%	0.9625	0.0217525
Moderate Effectiveness	7.5%	0.925	0.020905
High Effectiveness	11.25%	0.8875	0.0200575
Future Conditions			
Low Effectiveness	12.5%	0.875	0.019775
Moderate Effectiveness	25%	0.75	0.01695
High Effectiveness	37.5%	0.625	0.014125

MODIFICATIONS TO RESERVOIR ELEVATIONS

1993 SEIS

We modeled reservoir elevation changes in all Snake River and John Day reservoirs for the Proposed Actions and Future Conditions cases with the following assumptions: 1) changes in yearling chinook and sockeye fish travel time throughout the reservoir are equivalent to changes in water particle travel time; and 2) changes in the flow-survival relationship are based upon equivalent flows derived from changes in particle travel time. The subyearling chinook travel time equation was computed as above for all pools, but the k_1 and k_2 parameters from the lowered pool condition (Table 13) were used in the regression for Little Goose, Lower Monumental, Ice Harbor, and John Day pools.

Since both travel time and reservoir survival are determined with average flow over the time period fish are in a reservoir, lowered reservoir flow needs to be expressed in terms of normal reservoir elevation flow rate. Therefore the flow rate at normal reservoir elevation was determined that would result in a similar water particle travel time at the reduced pool elevation. See CRiSP.0 Documentation Equation (28) for a complete description of the changes in the flow-travel time and flow-survival equations.

We modeled a reservoir elevation of 0.5 feet above normal minimum operating pool for the Snake River projects (Lower Granite, Little Goose, Lower Monumental, and Ice Harbor) and the John Day reservoir elevations as they occurred in 1992 (Table 13). Note that under the second flow-travel time equation for subyearling chinook travel time is independent of flow; therefore this parameter does not change with lowered pools.

Table 13. Parameters for the travel time equation for yearling chinook, steelhead, sockeye, and coho, and subyearling chinook migrants in the pools which were lowered for the 1993 Proposed Actions and Future Conditions cases.

Project	Yearling chinook		Subyearling chinook			Yearling chinook	
	Flow - travel time		Flow - travel time			Flow - survival	
	k_1	k_2	k_3	k_4	k_5	k_4	k_5
Lower Granite	1.118	0.136	–0.768973	2.946191	72.105152	-0.000372	0.00000162
Little Goose	1.76	0.217	–0.935338	0.807128	—	-0.000378	0.00000167
Lower Monumental	2.17	0.239	–1.034041	0.811436	—	-0.000366	0.00000157
Ice Harbor	1.119	0.287	–1.06731	0.788334	—	-0.000364	0.00000155
John Day	1.038	0.051	0.054568	0.861188	—	-0.000205	0.00000036

FISH RELEASES

In general, the method for developing input distributions of Snake River wild chinook and sockeye salmon was as follows. The daily collection totals or PIT tag detections at Lower Granite Dam were obtained for all years for which data exists (Fish Passage Center and PTAGIS). Each day's collection or detection total was computed as a percent of total numbers collected for each stock (spring, summer, and fall chinook and sockeye) in each year. This daily percent of total collections or detections was then summed across years and divided by the number of years. This results in an average percent of total collections for each stock and each day. The average daily percent of total collections or detections was then multiplied by the number of smolts produced for each stock to arrive at daily number of fish for input to CRiSP.0. Approximate numbers of smolts were calculated by multiplying the distribution by a factor approximating the number of wild smolts produced upstream of Lower Granite Dam (Table 15). This calculation assumed the number of spawners, survival, sex ratios, and production functions used in the SLCM calibration for spring, summer, and fall chinook (see Fisher et al. 1992). We used the average number of sockeye collected at Lower Granite Dam (Fish Passage Center) for Redfish Lake sockeye smolt numbers.

Finally, since we model the smolts through Lower Granite pool, we had to back up the input distributions in time in order to simulate their arrival at the head of the pool. We used various sources for the travel time for each stock and then adjusted the input distribution backwards by the travel time of each stock through the pool. Table 14 describes the data used to arrive at distributions and timing, and Table 15 shows the number of smolts and the travel time for each species. Although the calculations of the number of wild smolts are rough, the arrival distribution of smolts at Lower Granite is much more important than the number of smolts for calculating hydrosystem mortality for wild sockeye and chinook salmon from the Snake River for two reasons:

- The large numbers of hatchery smolts being released into the head of Lower Granite Pool in the model (over 5 million) determine the smolt indices which are used in the model to turn full transportation off and on.
- There are no other density-dependent functions in the model.

Figure 9 shows the final input distributions for the Snake River wild stocks in CRiSP.0. Hatchery fish release locations, numbers, and timing for 1990 were provided by the Fish Passage Center. Wild fish numbers, other than those released above Lower Granite Dam, came from USACE 1991, Anon. 1985, and consultation with NMFS.

Table 14. Data sets and methods used for calculating the input distributions of Snake River wild salmon for CRiSP.0.

Stock	Spring chinook	Summer chinook	Fall chinook	Sockeye
Data used for distribution	1989-1991 PIT tag detections of wild stocks at LWG	1989-1991 PIT tag detections of wild stocks at LWG	1985, 86, and 91 collections at LWG and 1991 PIT tag detections at LWG	1991 PIT tag detections at LWG and LGS
Source	Matthews et al. 1991; PTAGIS	Matthews et al. 1991; PTAGIS	Fish Passage Center and PTAGIS	PTAGIS
Data used for timing adjustment	CRiSP.0 flow-ttime with LWG flow	CRiSP.0 flow-ttime with LWG flow	Average travel time of 1991 PIT tag groups	CRiSP.0 flow-ttime with LWG 1991 flow
Source	Buettner 1991	Buettner 1991	PTAGIS	USACE flows
Remarks	PIT tag used since LWG collections include hatchery fish	PIT tag used since LWG collections include hatchery fish	All available data used because of highly variable timing	PIT tag data used since LWG collections probably include kokanee

Table 15. Some additional variables used to calculate the number and timing of wild salmon stocks above Lower Granite Dam.

Measure	Spring Chinook	Summer Chinook	Fall Chinook	Sockeye
Number of Spawners	6,065	2,195	391	
Number of Smolts	2,210,491	367,490	137,337	10,182
Travel Time (days)	6	6	30	4

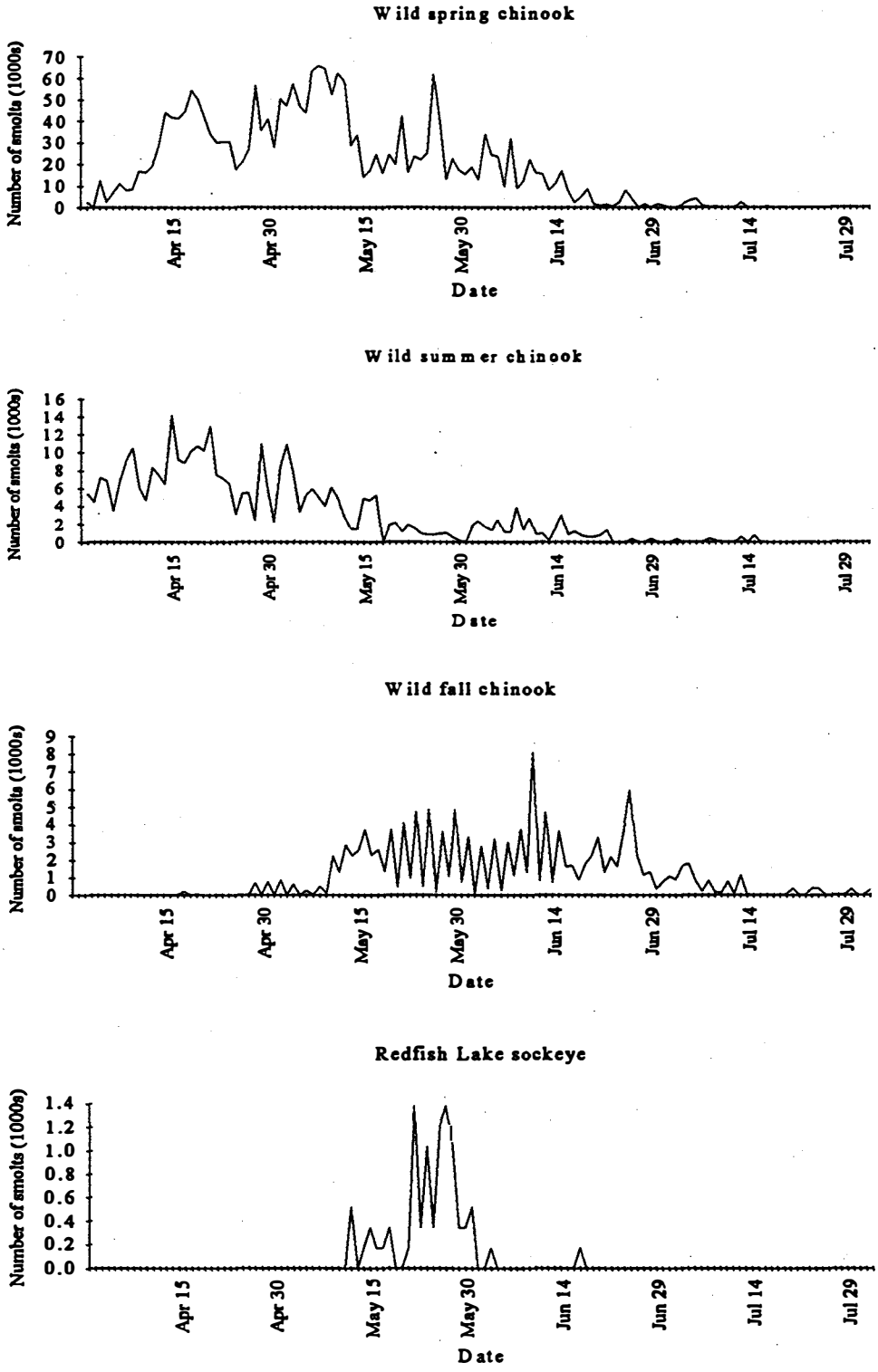


Figure 9. Input distributions for wild salmon stocks above Lower Granite Dam, in thousands of smolts.

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Appendix F
Northwest Power Planning Council PAM and SPM Analysis

Effect of 1992-93 Operations on Spring Chinook Salmon In the Snake River

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Abstract

Council staff has analyzed the effect of 1993 operation on Snake River spring chinook. This was conducted in cooperation with the National Marine Fisheries Service, U.S. Army Corps of Engineers, Bonneville Power Administration and the state fishery agencies and Indian tribes. The analysis was part of a continuing process to refine analytical methods and assist regional decision makers.

We focused on two aspects of the biological impacts of 1993 operations: the change in juvenile downstream passage survival and the rebuilding of Snake River spring chinook over time. Passage survival impacts were analyzed using the Passage Analysis Model (PAM) as a probability function given a range of possible runoff conditions. Rebuilding was analyzed using the System Planning Model over a 20 year period. Conditions examined were a base condition, planned 1993 operation of the hydroelectric system (1993 static), and a futures option that included the 1993 operations plus the addition of extended screens at several projects. The latter two options were analyzed under two scenarios that assumed low and high effectiveness of predator control, adult passage survival, and stock productivity.

Our analysis of the 1993 operations showed an increase in juvenile passage survival relative to the base case or pre-1992 operations. Because flow augmentation in the Council's program was concentrated on the low flow years, the greatest increases in survival were seen when runoff and flow were the lowest. Under the lowest flow conditions, the 1993 operations increased survival by up to by 9% to 30% over the base condition depending on the option and assumed effectiveness of the actions. However, even with the 1993 operations, passage survival rates in the lower flow years remained low.

In the life cycle analysis, adult spring chinook returns in the base condition declined over time. This appears to be generally consistent with recent trends in returns and the threatened status of these stocks. The estimated increase in passage survival rate as a result of 1993 operations (assuming both low and high biological effectiveness of the actions) was insufficient to turn the trend line around and begin to rebuild the runs. Significant rebuilding was seen only when stocks were assumed to be very productive, adult passage survival was improved, predator control was effective, and all planned screening changes were in place and performed as hoped.

We stress that the rate of rebuilding is very sensitive to the starting conditions and the calibration of the model. There is sufficient scientific uncertainty in these to caution against conclusions regarding relatively minor differences in the rate of rebuilding between different options or between analyses by different parties. Within the present limitations of our knowledge, we are best able to compare the relative effectiveness of different options to change passage survival rates, how they contribute to rebuilding, and the effects of uncertainty of different options. Because of scientific uncertainties, the effect of unforeseen events and natural variability, projections of the rate of rebuilding and resulting population sizes are much less certain.

These results indicate that the existing measures, while improving the lot of Snake River spring chinook, are probably inadequate to cause substantial rebuilding of the

population. Additional actions will be needed. These conclusions are consistent with analysis conducted during the Council's phase 2 and phase 3 amendment processes.

Introduction.

In cooperation with the Bonneville Power Administration, the U.S. Army Corps of Engineers, the National Marine Fisheries Service, and fishery managers and tribes, the Northwest Power Planning Council staff is conducting an analysis to evaluate the potential biological impact of the 1992-93 operation of the hydroelectric system on salmon populations in the Snake River basin[1]. The analysis reported here was confined to Snake River spring chinook. We compared a baseline condition (pre 1992), to the effects of 1992-93 operation of the hydroelectric system (referred to as the 1993 Static Conditions) and to the potential affects of a set of future assumptions (referred to as 1993 and Future Conditions). We examined these options at two levels of effectiveness (low and high). This analysis did not examine the effect that other future actions, such as more flow or pool drawdown, for example, might have on rebuilding, and was designed to mimic the operating conditions postulated by the Corps of Engineers and the Bonneville Power Administration.

An important aspect of forecasting the biological impacts of the 1993 operations is the effect of scientific and environmental uncertainties. It is important to understand that it is not possible to forecast the biological impacts with certainty. For example, not only are we unable at this time to forecast runoff and flow for 1993 and future years, but significant scientific uncertainties exist regarding smolt transportation, the effect of water velocity on fish survival, the underlying biological productivity of important fish populations, and other factors. What is possible is to examine a range of outcomes under alternative, plausible assumptions over a range of environmental conditions. The effects of these uncertainties on our ability to forecast biological outcomes are important considerations that should affect judgments regarding the potential biological impacts of the 1993 operations.

We treated these uncertainties by providing forecasts under two levels of effectiveness of proposed actions. Because of the uncertainty regarding the runoff and flow conditions for 1993 and future years, the effect of 1993 actions on passage survival were treated as a probability function based on the 50-year record of runoff from 1929-78. An appendix to this analysis, containing the results of further work on the sensitivity of downstream passage survival rate to scientific uncertainties, will be forwarded at a later date.

We addressed two questions in the present analysis:

1) What change in juvenile passage survival rate might we expect to see under the various options?
2) How might the these changes, when combined with changes in other life cycle stages, contribute to the rebuilding of Snake River spring chinook?

[1] Results and conclusions reported here are draft. They do no represent the opinion or position of the Northwest Power Planning Council on issues pertaining to the Endangered Species Act.

These questions were addressed using two analytical models. The Passage Analysis Model (PAM) was used to examine the changes in passage survival rate over a range of possible runoff conditions. The impact of these survival changes to Snake River spring chinook was further analyzed using the System Planning Model (SPM). This model was used to project the effect of these changes on adult returns over a twenty year period.

The 1993 static operations scenario was distinguished from the baseline condition by an increase in flow, the addition of screening and transportation at Lower Monumental Dam , the addition of standard length screens at Ice Harbor, and a decrease in reservoir elevation for the lower Snake pools and McNary. The 1993 and future operations scenario included the 1993 static conditions and added extended screening at several projects. Table 5 summarizes the Passage Analysis Model input parameters (those that change are shaded).

Results of the 1993 static and 1993 and future conditions were compared to the baseline condition using a low/high range of assumptions for three areas of biological uncertainty:

1) The effectiveness of predator control to reduce reservoir mortality,
2) The effectiveness of actions to reduce adult passage mortality, and
3) The effectiveness of habitat restoration projects to increase subbasin productivity (egg-smolt, and smolt-smolt survival rate),

Description of the Options.

Mainstem Operation Variables

Baseline Conditions

Flow input was generated by the Corps of Engineers using the HYSSR model. For the baseline condition (1990-91), they included system operation prior to any of the operational modifications generated by Salmon Summit and successors. The current Water Budget was present and normal pool elevation was assumed for all reservoirs. Standard length screens were present at all projects except Ice Harbor and Lower Monumental.

1993 Static Operations

The 1993 static operations modeled by the Corps reflected the system operating strategy used in 1992. This was similar to the Northwest Power Planning Council's Phase 2 program (adopted in Dec., 1991) except that a minimum of 900 KAF in the intermediate runoff range was assured. It also allocated more water to refill in high runoff years. Lower Snake projects were operated to 1 foot over MOP , and John Day Pool was operated at an elevation of 263.5 feet. A gate raise was assumed to be implemented at Lower Granite Dam. At Lower Monumental Dam, standard length screens were assumed to be functional,

transportation was operational, and voluntary spill was discontinued. At Ice Harbor dam, standard length screens were assumed to be functional.

1993 and Future Operations

The 1993 and future operations were distinguished from the 1993 static conditions with the addition of extended screens at Lower Granite, Little Goose, and McNary, the addition of standard length screens at The Dalles, and a gate raise at Lower Monumental.

Biological Variables

Because predator control program is unproven, its effectiveness to increase reservoir survival rate was modeled at two levels for both the 1993 static condition and the 1993 and future condition. For the 1993 static option, we assumed a low value of 0% change and an upper value of 7.5% change. The futures option used values of 0% and 25%.

Upstream passage survival rates (through the whole system) were modeled at two levels for both the 1993 static and 1993 and future conditions, either the baseline value of 46.8% or an improved value (approximately a 5% overall improvement) of 48.9%. There is no data yet available on the effectiveness of measures affecting adult upstream passage survival, however, we felt that a 5% overall increase was a plausible, if optimistic, estimate for 1993.

Two production levels were explored in the 1993 and future condition to examine the sensitivity of the model to uncertainty in stock productivity and simulate the effect of improvements in habitat condition. Two parameters were manipulated here, the egg to smolt survival rate (increased by 10% from 13.75% to 15.12%), and the smolt to smolt survival rate which was increased by 3.5% (from 95% to 98%).

Analytical Methods

This analysis used several different computer models and analytical tools. This included the Corps' HYSSR modeled referenced above that was used as the hydroregulator to generate flow using the runoff for the years 1929-78. The Passage Analysis Model (PAM) was used to estimate downstream juvenile passage survival rate under each of the 50 flow estimates. These passage survival estimates were used as input into the System Planning Model (SPM). This is a life cycle model that projects, in this case, the biological effect that the various survival rate changes have on the number of adult spring chinook returning to Lower Granite Dam.

Each option was run 500 times with the System Planning Model, for a 20 year time period (5 life cycles). Downstream passage survival rates were picked randomly (year to year) from the mainstem passage file used in the particular option. For each option, actions that are taken to rebuild Snake River spring chinook remained constant for the duration of the run. That is, all assumed changes are in the input files at the start of each run. Escapement to subbasin by run and year was output (a total of 10,000 output records per option). These results were read into SAS, a statistical software package,

which calculated the median, 10 and 90% confidence limits for the escapement by year. These values were plotted, by scenario, in the results section.

The analysis and the resulting combinations of action are outlined as follows:

Table 1. Option layout for Snake River spring chinook analysis.*

PARAMETER	BASELINE	1993 STATIC		1993 AND FUTURE	
		LOW	HIGH	LOW	HIGH
PRODUCTION					
Egg-Smolt	0.1375	0.1375	0.1375	0.1375	0.1512(+10%)
Smolt-Smolt	0.95	0.95	0.95	.095	.098(+3.5%)
DOWNSTREAM PASSAGE					
Predator Control	0%	0%	+7.5%	0%	+25%
FGE's	Pre 92	1993 Vals	1993 Vals	1996 Vals	1996 Vals
Transportation	Pre 92	LoMo Online	LoMo Online	LoMo Online	LoMo Online
UPSTREAM PASSAGE					
Total Adult Survival	0.468	0.468	0.489(+5%)	0.468	0.489(+5%)

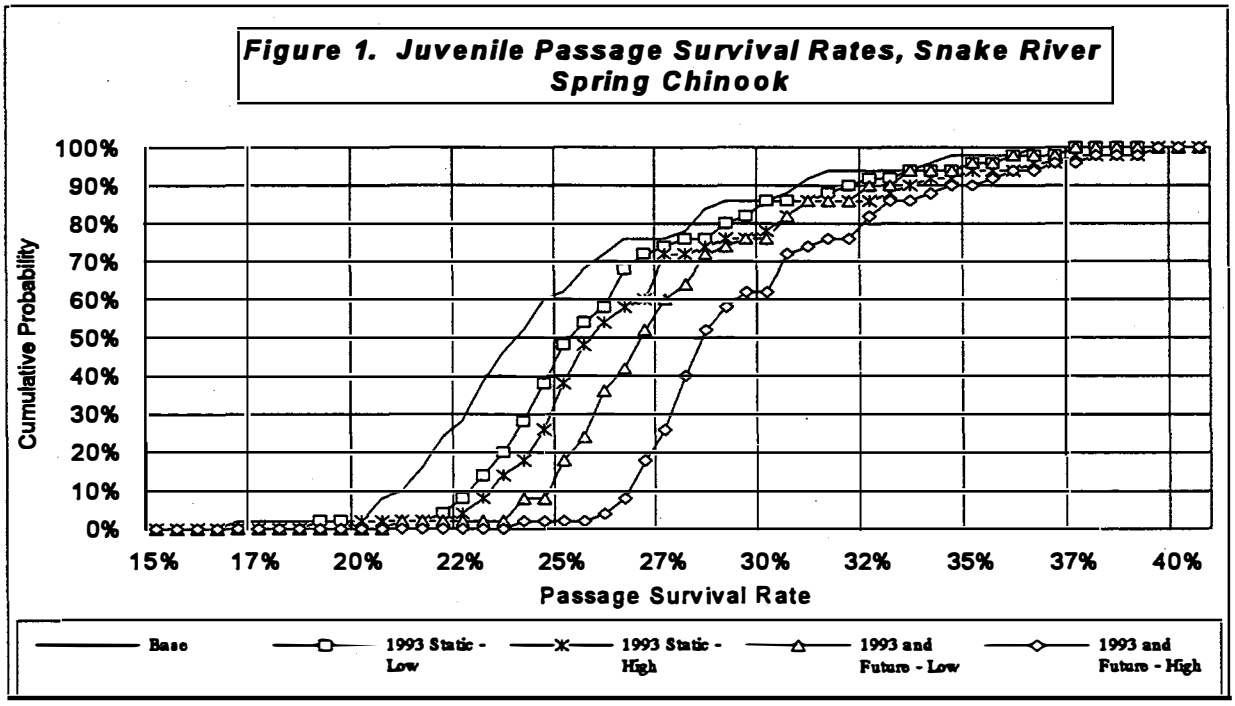
*Transportation Model 1 was used for this analysis, calibration was to wild adult counts at Lower Granite Dam from 1979-1991 (Ave. = 6879, Coefficient of Variation = 0.55), and a Smolt to Adult Survival Rate of 0.44% (to Lower Granite Dam). HIGH scenarios are set to match MEDIUM parameters from discussions with BPA on their modeling parameters.

Results.

Effect of 1993 static, and 1993 and future operations on juvenile passage survival rates.

Because we have no idea at this point what the flow in 1993 and near future years might be, survival can only be characterized as a probability function based on the 50 flow estimates from HYSSR. To do this, PAM generated 50 estimates of survival for each condition which were then summarized as cumulative probability curves (Figure 1).

Appreciable increases in juvenile passage survival are observed throughout the range of options modeled. The greatest change occurred in the lower water flow conditions when survival was worst. The average survival rate improvement compared to the baseline condition (for the 50 flow years modeled) ranged from 6% (1993 static low condition) to 20% (1993 and future - high condition, See Table 2). This reflects a fairly broad range of assumptions about the effectiveness of predator control on reservoir mortality (0% - 25% reduction), and substantial increases in fish guidance efficiency at several projects. Flow augmentation was a significant contributor to the improved passage survival while transportation at Lower Monumental Dam provided only a very small increase in average survival.



Because flow augmentation under the Council's program occurs primarily in low runoff conditions, improvements in passage survival rate relative to the base condition were highest in these years. This is seen in the following table that summarizes the passage survival rate changes in the eight lowest flow years on record:

Scenario	Survival Rate	Percent change from Base
Base	19.8%	
1993 Low	21.6%	9%
1993 High	22.3%	13%
Futures Low	23.5%	19%
Futures High	25.7%	30%

(low and high refer to assumed effectiveness of the measures)

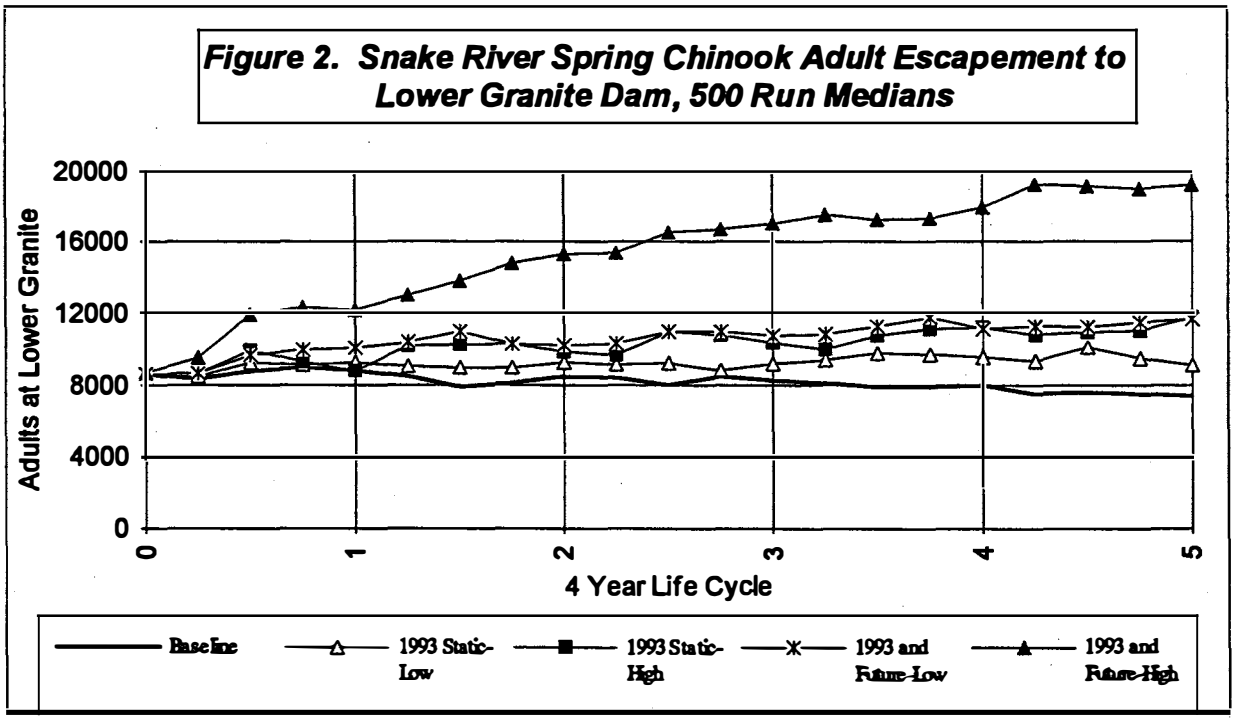
For the average flow condition, survival change was less:

Scenario	Survival Rate	Percent change from base
Base	24.3%	
1993 Low	25.7%	6%
1993 High	26.4%	8%
Futures Low	27.2%	12%
Futures High	29.1%	20%

Although passage survival increases in the lower flow years are relatively great, it is important to note that passage survival rate is still very low under all scenarios. In 1977 flow, for example, passage survival through the entire system with transportation ranged from 16% to 23%.

Effect of 1993 static, and 1993 and future operations on spring chinook rebuilding.

The results from the life cycle modeling for the five major options were expressed as the median escapement values for the 500 runs (Figure 2), and individually with confidence limits (Figure 3-4). The impacts of the options were also expressed in terms of smolt to adult return rates (figures 5-7). While the relative difference in rebuilding under the various options is instructive, it is important to note that the slope of the lines in Figure 2, for example, are very sensitive to the starting conditions and calibration. Appreciable variation in the rate of rebuilding will occur within a plausible range of assumptions. For this reason, these results are best used to compare relative effectiveness of the different options.



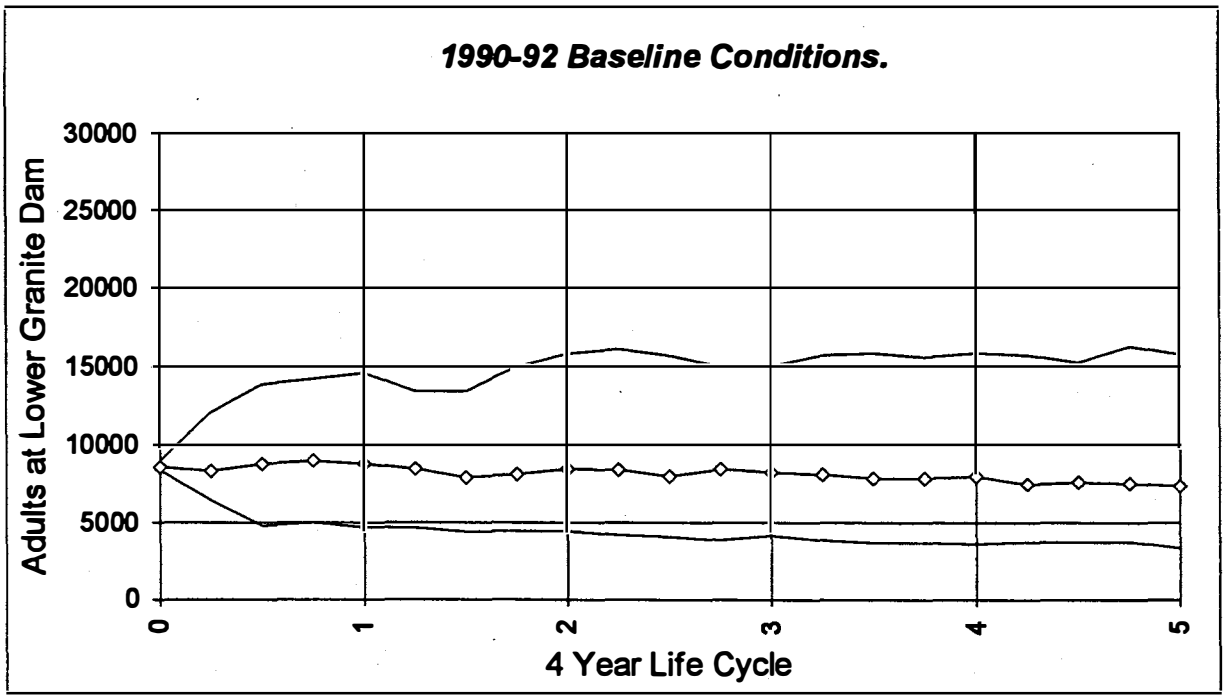
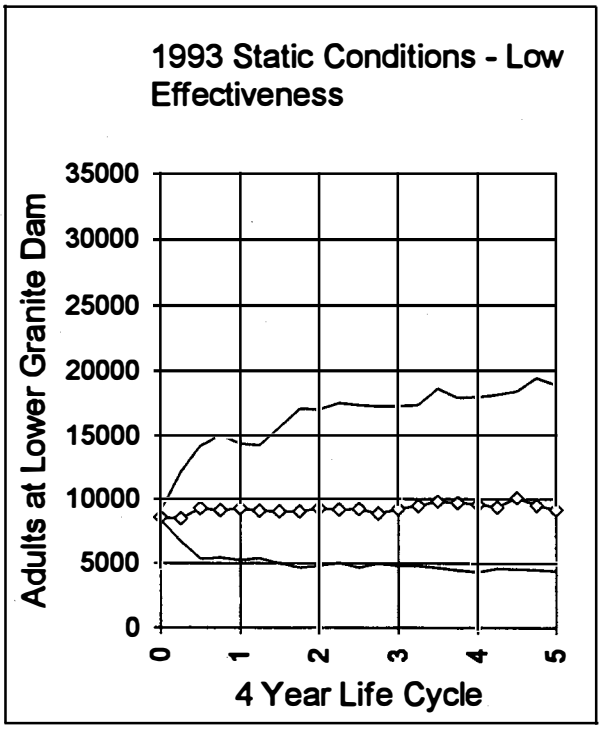
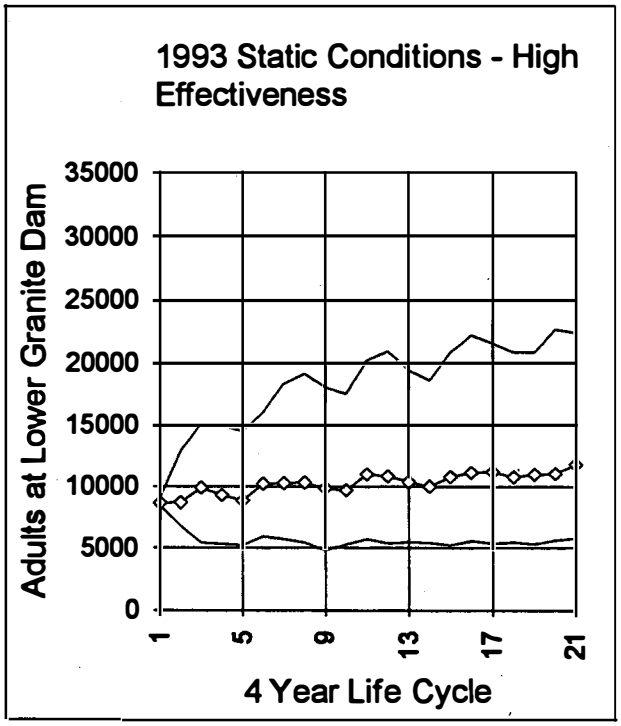
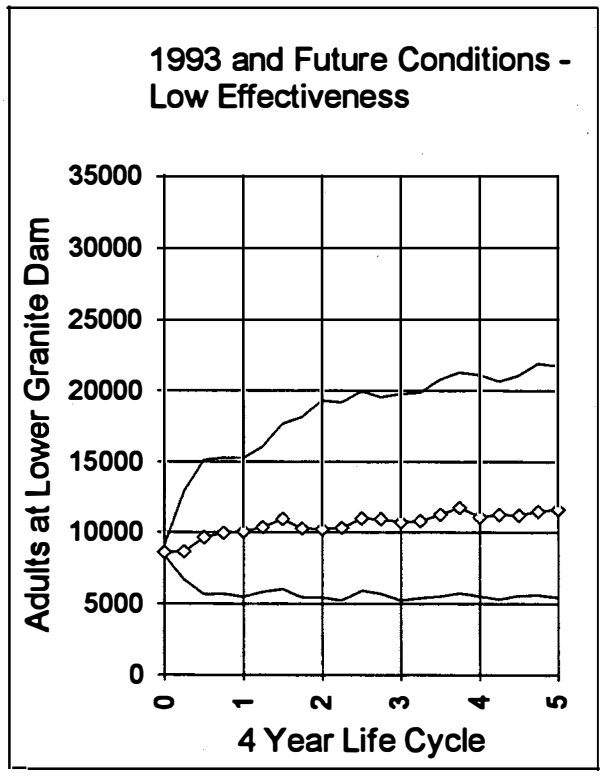


Figure 3. Snake River Spring chinook salmon escapement based on SPM 500 game and 20-year (5 life cycle) simulations for the 1990-92 baseline condition. Lines denote 90th percentile (upper), median, and 10th percentile (lower) values.







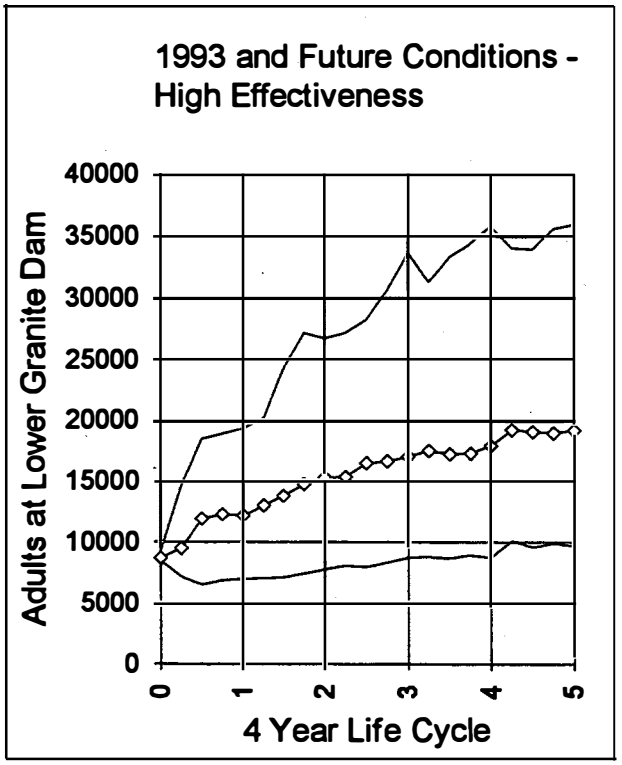
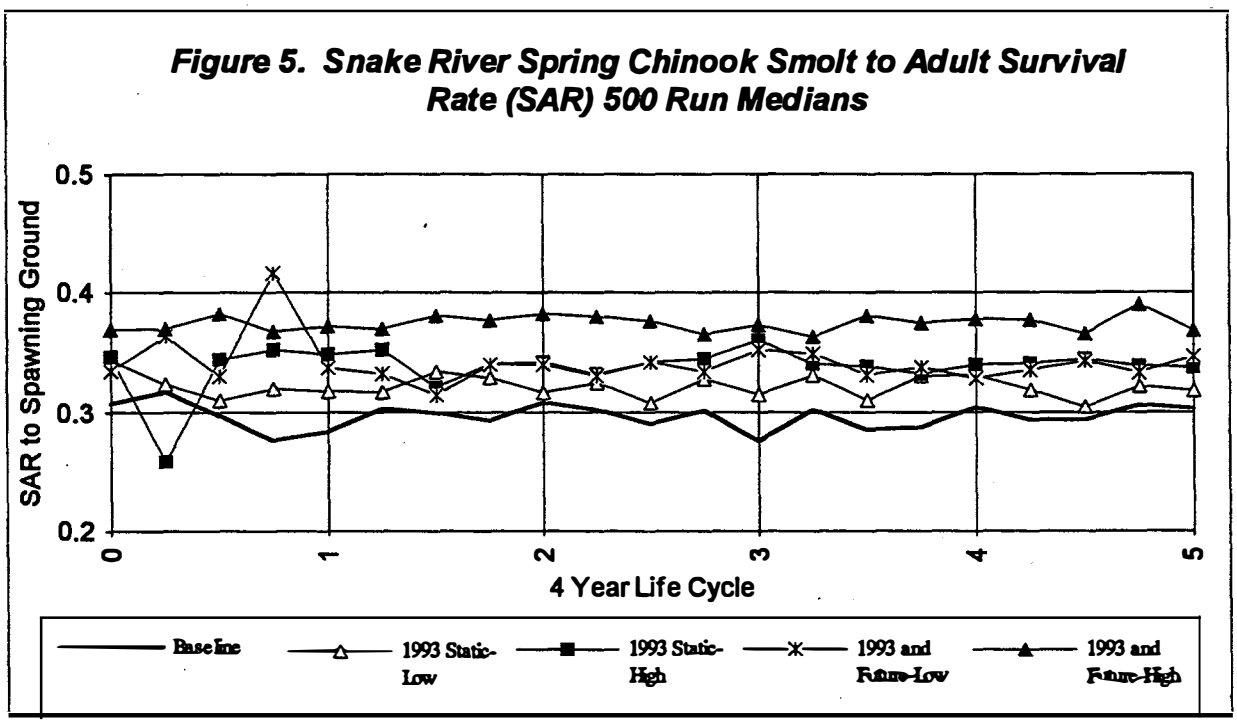


Figure 4. Snake River Spring chinook salmon escapement based on SPM 500 game and 20-year (5 life cycle) simulations for 1993 static and future conditions. Lines denote 90th percentile (upper), median, and 10th percentile (lower) values.



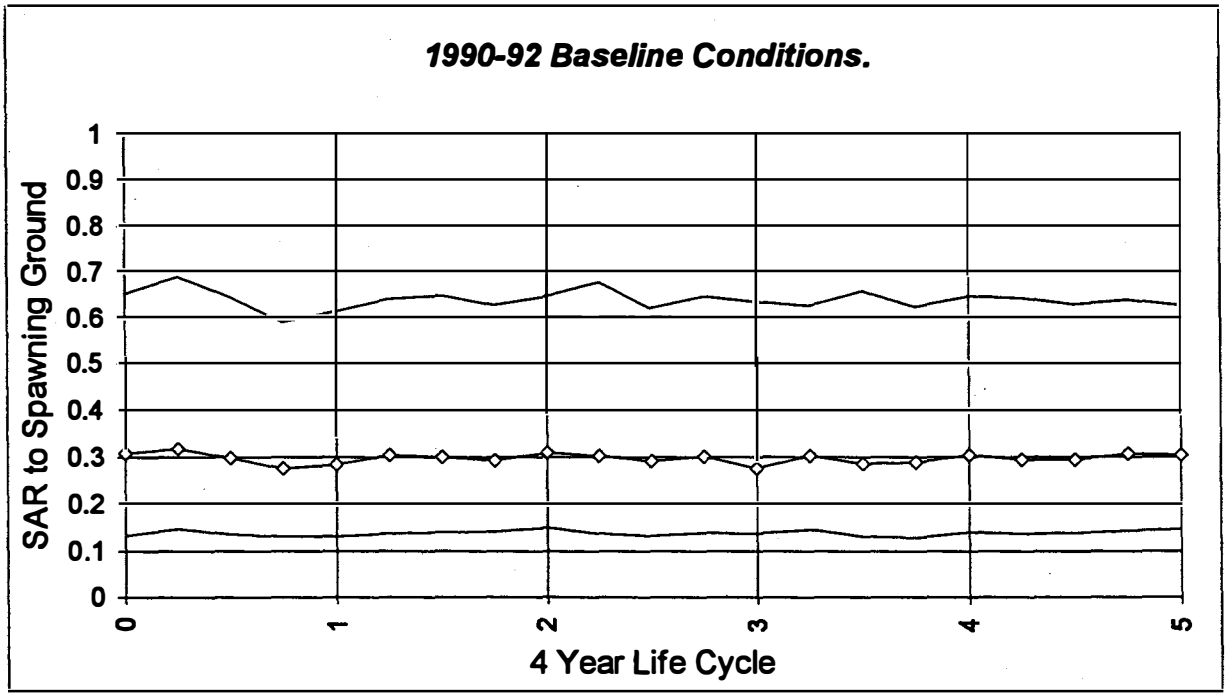


Figure 6. Snake River Spring chinook salmon smolt to adult return rate (to spawning ground) based on SPM 500 game and 20-year (5 life cycle) simulations for the baseline conditions. Lines denote 90th percentile (upper), median, and 10th percentile (lower) values.

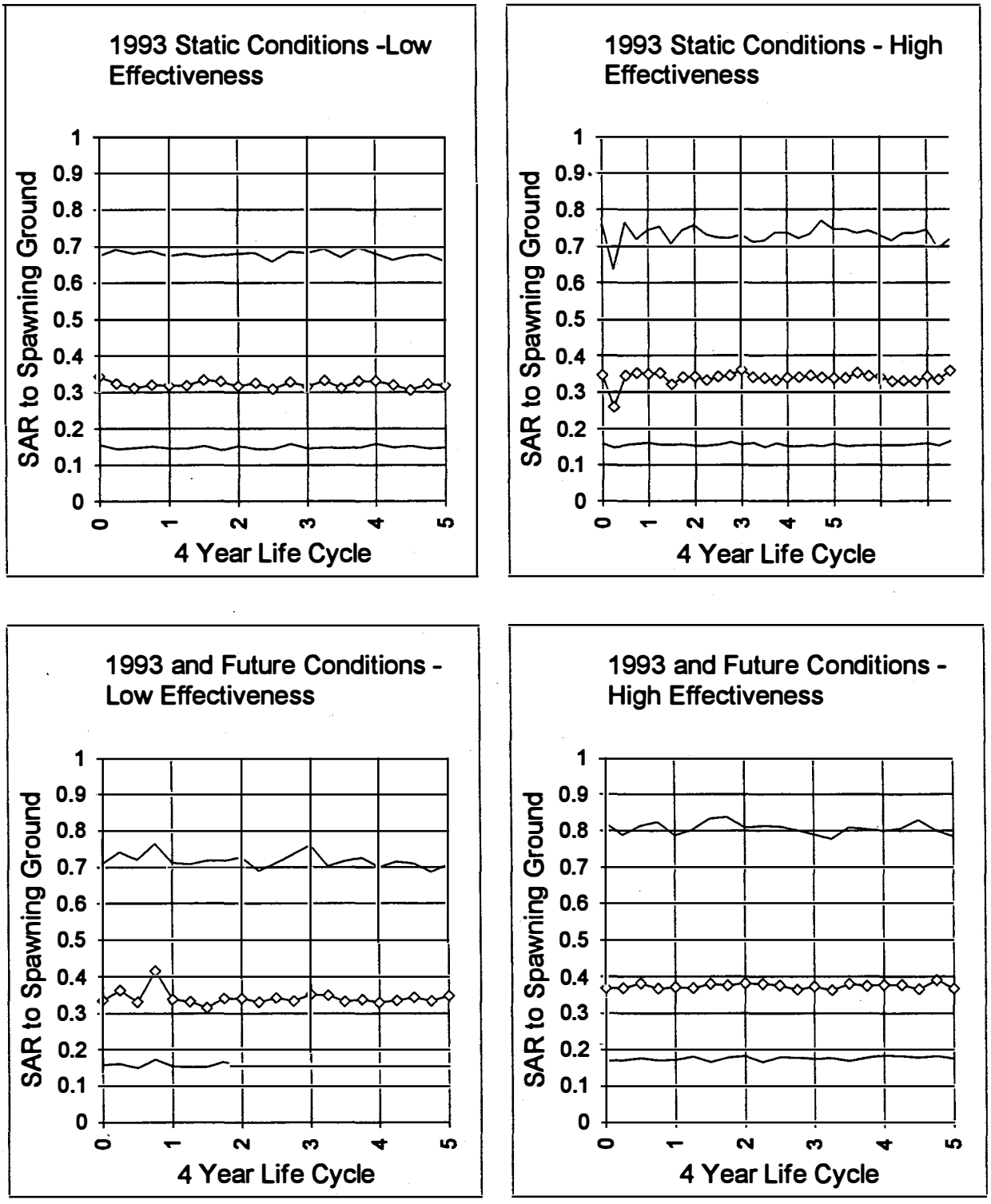


Figure 7. Snake River Spring chinook salmon smolt to adult return rate (to spawning ground) based on SPM 500 game and 20-year (5 life cycle) simulations for 1993 static and future conditions. Lines denote 90th percentile (upper), median, and 10th percentile (lower) values.

Base Case.

The baseline condition (pre -1992 operations, Figures 2 and 3) displayed a steadily declining return. The median smolt to adult return rate (SAR) hovered around 0.30% (the average was 0.35%, see Figures 5 and 6). This trend appears to be consistent with recent returns of naturally spawning spring chinook to Lower Granite Dam and the threatened status of this population.

1993 Static Operations

Low Effectiveness

The 1993 static operations as modeled here (flow, screens and transportation at Lower Monumental, reduced pool elevations, no change in reservoir mortality or upstream passage mortality) leveled the downward escapement trend seen in the baseline condition (Figures 2 and 4). The actions were enough to increase the runsizes relative to the baseline, but were not enough to begin any significant rebuilding. SAR median values were around 0.32% (average of 0.37%).

High Effectiveness

The 1993 static operations as described above, combined with modest improvements in downstream and upstream passage survival rates changed overall survival enough to produce a slightly increasing trend (Figures 2 and 4). Median SAR values hovered around 0.34% (Figures 5 and 6) while the average SAR was near 0.40%.

1993 and Future Operations

Low Effectiveness

The 1993 and future operations (flow, screens and transportation at Lower Monumental, improved screens at Lower Granite, Little Goose, McNary, and The Dalles, reduced pool elevations, no change in reservoir mortality or upstream passage mortality) produced results very much like the 1993 Static Operations, High Effectiveness scenario. That is, the option changed survival enough to produce a slightly increasing trend (Figures 2 and 4). Median SAR values hovered around 0.33% (Figures 5 and 6) while the average SAR was near 0.39%.

High Effectiveness

The actions described above, combined with significant improvements in reservoir, upstream passage, egg to smolt, and smolt to smolt survival rates was the only condition modeled which showed potential for significantly rebuilding Snake

River spring chinook (Figures 2 and 4). The median runsize increased over 100% in the five life cycles simulated. Median SAR values hovered around 0.38% (Figures 5 and 6) while the average SAR was near 0.44%.

Appendix: Detailed results and documentation of assumptions

Passage Analysis Model

Survival rate predictions from PAM for the various options are shown in Table 2.

Table 2. Predicted annual downstream passage survival rates.

Baseline	1993 Static - Low	1993 Static - High	1993 and Future - Low	1993 and Future - High
0.2108	0.2262	0.2324	0.2444	0.2643
0.2052	0.2221	0.2286	0.2404	0.2613
0.1958	0.2116	0.2187	0.2301	0.2533
0.2335	0.2461	0.2537	0.2654	0.2879
0.2220	0.2280	0.2344	0.2451	0.2654
0.2146	0.2313	0.2374	0.2486	0.2681
0.2179	0.2322	0.2383	0.2497	0.2689
0.2380	0.2578	0.2650	0.2755	0.2965
0.2096	0.2235	0.2299	0.2418	0.2623
0.2480	0.2624	0.2697	0.2787	0.2996
0.2269	0.2440	0.2493	0.2613	0.2778
0.2299	0.2437	0.2490	0.2612	0.2776
0.1979	0.2166	0.2235	0.2348	0.2573
0.2281	0.2419	0.2473	0.2593	0.2762
0.2594	0.2705	0.2774	0.2872	0.3065
0.1992	0.2163	0.2231	0.2347	0.2569
0.2209	0.2379	0.2436	0.2552	0.2731
0.2405	0.2578	0.2651	0.2753	0.2965
0.2456	0.2608	0.2679	0.2786	0.2989
0.3337	0.3414	0.3474	0.3423	0.3600
0.2752	0.2848	0.2914	0.2970	0.3157
0.2478	0.2577	0.2654	0.2728	0.2954
0.2563	0.2662	0.2736	0.2804	0.3017
0.3032	0.3179	0.3261	0.3263	0.3516
0.2318	0.2467	0.2520	0.2629	0.2792
0.2525	0.2553	0.2602	0.2699	0.2848
0.2139	0.2359	0.2418	0.2532	0.2716
0.3587	0.3694	0.3755	0.3696	0.3881
0.3002	0.3095	0.3161	0.3160	0.3350
0.2785	0.2941	0.3010	0.3045	0.3247
0.2226	0.2347	0.2408	0.2513	0.2703
0.2214	0.2402	0.2458	0.2574	0.2748
0.2173	0.2342	0.2403	0.2504	0.2697
0.2361	0.2507	0.2556	0.2671	0.2824
0.2238	0.2368	0.2426	0.2542	0.2724
0.2391	0.2468	0.2521	0.2629	0.2792
0.2731	0.2831	0.2898	0.2960	0.3150

0.2123	0.2266	0.2330	0.2446	0.2649
0.2255	0.2372	0.2431	0.2537	0.2721
0.2057	0.2359	0.2417	0.2532	0.2716
0.2799	0.2884	0.2951	0.2984	0.3171
0.2316	0.2446	0.2500	0.2609	0.2777
0.3386	0.3527	0.3589	0.3538	0.3725
0.2965	0.3135	0.3194	0.3159	0.3324
0.2044	0.2223	0.2289	0.2405	0.2617
0.3073	0.3272	0.3332	0.3292	0.3464
0.2514	0.2555	0.2603	0.2705	0.2852
0.2828	0.2921	0.2988	0.3024	0.3214
0.1634	0.1827	0.1915	0.2015	0.2310
0.2384	0.2511	0.2561	0.2673	0.2826
Average Values				
0.2433	**0.2573**	**0.2636**	**0.2719**	**0.2911**
Percent Change from Baseline	**5.74%**	**8.34%**	**11.72%**	**19.64%**

Modeled Flows

Results for the Snake and Columbia flow values (Lower Granite and The Dalles dams respectively) obtained from the Corps' HYSSR runs are shown in Table 3.

Table 3. Annual flows for 1929-1978 record for scenarios HM92A (base) and JB92E (augmented).

Year	HM92A Snake	HM92A Columbia	JB92E Snake	JB92E Columbia
1929	73.2	189.0	75.7	209.1
1930	68.8	190.3	73.4	209.8
1931	63.4	188.9	65.5	208
1932	102.9	281.6	102.9	285.8
1933	76.9	287.6	76	286.6
1934	73.3	262.1	79.1	262.3
1935	75.8	251.1	79.6	250.2
1936	112.5	268.6	112.5	294.3
1937	71.7	193.1	73.9	212.9
1938	108.8	309.1	113.3	309.1
1939	85.5	226.1	90.7	234.4
1940	88.1	218.9	90.9	224.1
1941	64.3	206.1	69	226.6
1942	85.8	228.1	89	231
1943	130.6	290.0	130.6	290
1944	65.1	193.1	68.5	211.5

1945	80.0	218.7	85.2	242.3
1946	106.2	295.2	111.7	297
1947	113.3	291.0	118.5	290.2
1948	143.1	431.9	143.1	431.4
1949	131.4	330.1	131.4	330.1
1950	100.7	333.8	101.3	334.1
1951	108.6	333.8	108.6	333.8
1952	158.1	337.0	158.1	337
1953	84.9	284.6	92.1	288.3
1954	99.3	347.6	99.3	347.6
1955	72.8	251.9	83.5	255
1956	156.2	434.3	156.2	432.6
1957	136.1	377.9	136.7	376.1
1958	131.3	338.0	137.2	338.2
1959	76.7	296.4	80.8	298.7
1960	78.6	246.3	87.3	247.3
1961	72.3	323.4	80.4	324.8
1962	91.3	258.8	97.4	261.9
1963	81.2	245.4	84.1	246.3
1964	90.8	291.6	91.6	292
1965	132.4	322.8	132.4	322.8
1966	73.1	230.1	76.3	233.1
1967	78.7	298.7	83.3	301.7
1968	68.1	241.2	83.4	253.1
1969	123.7	358.3	123.7	358.3
1970	85.2	282.5	90.4	285.6
1971	148.3	423.0	150.4	424
1972	116.9	434.0	125.6	438.1
1973	68.0	211.3	72.7	221.8
1974	129.7	421.7	136.7	424.9
1975	100.1	327.0	100.1	327.2
1976	132.6	343.9	132.6	343.9
1977	46.9	180.6	51.5	196.7
1978	92.5	262.3	96.9	275.7
AVERAGE	97.1	287.8	100.2	293.4

Flow File Inputs

A 50 year flow record (1929-1978) was generated by the Corps of Engineers for the two study scenarios with their HYSSR model. The baseline condition was designated as **HM92A**, while the 1993 static and future operations were designated as **JB92E.** For our analysis, all that was required from the HYSSR files was the period annual average flows (April 15 - May 31) for Lower Granite Dam, and The Dalles Dam (May 1 - June 15). HYSSR outputs are by month, except for April and August which are bi-monthly. For Lower Granite flows, weighted APR2 and MAY flows were used to calculate the period average using the following formula:

(APR2_FLOW * 15+MAY_FLOW * 31) / 46

For The Dalles flows, weighted and adjusted MAY and JUNE flows were used to calculate the period average using the following formula:

(MAY_FLOW * 31+JUN_FLOW * 1.06 * 15) / 46

The 1.06 factor reflects an analysis done here which showed that the flow in the first half of June was, on average, 6% higher than the monthly average flow (1961-1991, See Table 4). This equation gives us a period average from May 1 - June 15.

Table 4. Average June flows at The Dalles Dam, 1961-1991, and calculated period relationships.

	June Average Flows				
Yr	TOT: 01-30	PER1: 01-15	PER2: 16-30	PER1/PER2	PER1/TOT
61	568.55	628.41	508.69	1.24	1.11
62	371.9	404.32	341.63	1.18	1.09
63	377.07	367.55	386.59	0.95	0.97
64	576.13	531.4	617.89	0.86	0.92
65	477.94	492.27	463.6	1.06	1.03
66	336.7	363.13	310.27	1.17	1.08
67	569.24	544.19	594.28	0.92	0.96
68	357.5	353.78	361.23	0.98	0.99
69	321.12	358.68	283.56	1.26	1.12
70	327.28	358.4	296.16	1.21	1.10
71	471.11	485.57	456.65	1.06	1.03
72	557.04	568.4	545.68	1.04	1.02
73	141.42	149.55	133.28	1.12	1.06
74	468.15	389.56	546.74	0.71	0.83
75	322.14	343	301.28	1.14	1.06
76	281.42	286.31	276.54	1.04	1.02
77	123.65	136.44	110.86	1.23	1.10
78	236.8	250.7	222.91	1.12	1.06
79	172.75	192.37	153.13	1.26	1.11
80	277.42	283.09	271.75	1.04	1.02
81	359.72	396.66	322.78	1.23	1.10
82	361.83	315.02	408.64	0.77	0.87
83	280.27	337.19	223.34	1.51	1.20
84	343.72	326.64	360.8	0.91	0.95
85	184.18	208.81	159.56	1.31	1.13
86	253.62	317.09	190.15	1.67	1.25
87	147.38	171.71	123.05	1.40	1.17
88	163.89	184.15	143.63	1.28	1.12
89	189	227.04	150.97	1.50	1.20
90	302.45	329.9	275	1.20	1.09
91	272.52	306.41	238.63	1.28	1.12
Averages	328.84	342.19	315.46	1.15	1.06

Passage Analysis Model (PAM)

The downstream passage survival rates for this study were calculated using PAM, a Quattro Pro spreadsheet model written at the Council, which calculated a 50 year record of downstream passage survival rates using the flow inputs described above, and the other operational parameters described below, for each of the various scenarios.

Input Parameters

Input parameters used in Pam are shown in Table 5. Projects are ordered in a downstream fashion with project number 8 representing Lower Granite Dam down to project number 1 representing Bonneville Dam.

Bonneville FGE was weighted based on units presumed to be operating in both powerhouses:

First powerhouse FGE: 0.37
Second powerhouse FGE: 0.19

Assume 10 units operating at 0.37 FGE and 13,600 cfs/unit,
Assume 3 units operating at 0.19 FGE and 19,000 cfs/unit.

(10*0.37*13,600+3*0.19*19,000)/(10*13600+3*19,000) = 0.32

Weighted FGE= 0.32

Table 5. PAM input parameters for spring chinook options.

Scenario		Baseline	1993 Static-Low	1993 Static-High	1993 & Future- Low	1993 & Future-High
Variable	Project					
Flow File		HM92A	JB92E	JB92E	JB92E	JB92E
Turbine Survival	All	0.85	0.85	0.85	0.85	0.85
Reservoir Mort Adjuster	All	0.00	0.00	-0.075	0.000	-0.250
Bypass Survival:	All	0.98	0.98	0.98	0.98	0.98
Spillway Survival:	All	0.98	0.98	0.98	0.98	0.98
Instantaneous Spill Cap:	All	0.70	0.70	0.70	0.70	0.70
Transport Survival	All	0.3538	0.3538	0.3538	0.3538	0.3538
Daily Spill Period	8-4	0.50	0.50	0.50	0.50	0.50
	3	0.42	0.42	0.42	0.42	0.42
	2-1	1.00	1.00	1.00	1.00	1.00
Proportion Transported	8	1.0	1.0	1.0	1.0	1.0
When Flow <= Trigger	7	0.2	0.2	0.2	0.2	0.2
	6	0.0	0.2	0.2	0.2	0.2
	4	0.2	0.2	0.2	0.2	0.2
	All Others	0.0	0.0	0.0	0.0	0.0
Prop. Passing During Spill	8	0.82	0.82	0.82	0.82	0.82
	7	0.82	0.82	0.82	0.82	0.82
	6	0.70	0.70	0.70	0.70	0.70
	5	0.50	0.50	0.50	0.50	0.50
	4	0.82	0.82	0.82	0.82	0.82
	3	0.70	0.70	0.70	0.70	0.70
	2	0.66	0.66	0.66	0.66	0.66
	1	0.70	0.70	0.70	0.70	0.70
Daily Fixed Spill	8	0.00	0.00	0.00	0.00	0.00
	7	0.00	0.00	0.00	0.00	0.00
	6	0.35	0.00	0.00	0.00	0.00
	5	0.13	0.13	0.13	0.13	0.13
	4	0.00	0.00	0.00	0.00	0.00
	3	0.00	0.00	0.00	0.00	0.00
	2	0.20	0.20	0.20	0.20	0.20
	1	0.42	0.42	0.42	0.42	0.42
Pool Elevation (Backwater)	8	735.0	733.5	733.5	733.5	733.5
Pool Elevation (Backwater)	7	636.0	633.5	633.5	633.5	633.5
Pool Elevation (Backwater)	6	539.0	537.5	537.5	537.5	537.5
Pool Elevation (Backwater)	5	439.0	437.5	437.5	437.5	437.5
Pool Elevation (Backwater)	4	339.0	339.0	339.0	339.0	339.0
Pool Volume (Displacement)	3	1260.0	1172.1	1172.1	1172.1	1172.1
Pool Volume (Displacement)	2	160.0	160.3	160.3	160.3	160.3
Pool Volume (Displacement)	1	391.0	391.2	391.2	391.2	391.2
Powerhouse Capacity	8	130	130	130	130	130
	7	130	130	130	130	130
	6	130	130	130	130	130
	5	96	96	96	96	96
	4	232	232	232	232	232
	3	322	322	322	322	322
	2	375	375	375	375	375
	1	193	193	193	193	193
Fish Guidance Efficiency	8	0.54	0.56	0.56	0.70	0.70
	7	0.70	0.70	0.70	0.81	0.81
	6	0.02	0.65	0.65	0.69	0.69
	5	0.43	0.71	0.71	0.71	0.71
	4	0.70	0.70	0.70	0.90	0.90
	3	0.72	0.72	0.72	0.72	0.72
	2	0.43	0.43	0.43	0.60	0.60
	1	0.32	0.32	0.32	0.32	0.32

Calibration

Since transportation became an operational technique in 1981, only one complete evaluation of the biological benefits had, until recently, been completed. In 1986, NMFS was able to mark both transported and non transported groups of fish. Their work indicated that under 1986 passage conditions, the transport benefit ratio (TBR) for spring chinook was 1.6:1 (95% CI=1.01-2.47:1, Matthews (1992)). At the Council's working session on August 25, 1992, the Corps reported the findings of the 1989 study which are shown in Table 6.

Table 6. Preliminary results for the 1989 transportation study.

	Lower CL	Average	Upper CL
Sp/Su Chin	1.34:1	2.50:1	4.55:1
Su Sthd	1.22:1	2.20:1	3.91:1

Using Transportation Model 1 in PAM (the standardized survival of transported fish is held constant while in river conditions change), flow, spill and FGE values that were estimated for 1986 were input into PAM. Transportation survival was then calibrated to produce the same TBR reported by Matthews (1992) of 1.6:1 for spring chinook. This standardized transport survival rate was 35.38%. Flow, spill, and FGE values for 1989 were then input into PAM which predicted a TBR for that year (using the same standardized transport survival rate) of 2.44:1 (see Table 7), which is very close to the Corps average value of 2.5:1.

Table 7. PAM TBR predictions for spring chinook using transport models 1 and 2 and actual flow, spill, and FGE conditions for the given years.

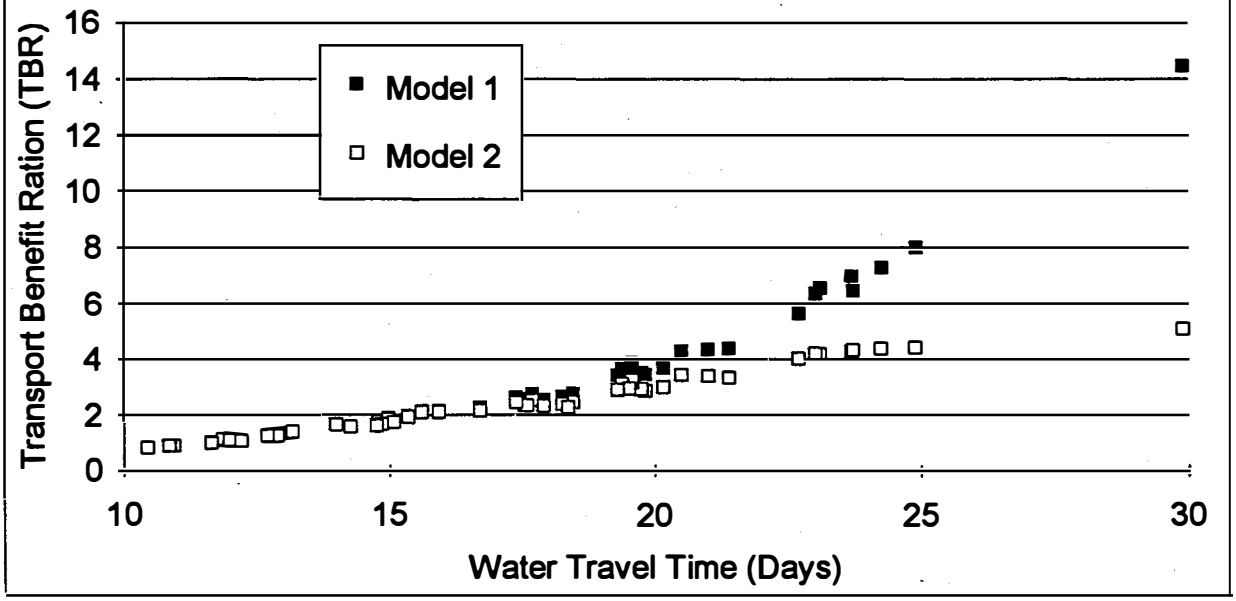
	1977	1986	1989
PAM - Model 1	29.8:1	1.60:1	2.44:1
PAM - Model 2	3.0:1	1.59:1	2.14:1

Transportation Model 2 was then tested. In this model, it is assumed that the standardized transport survival rate can never exceed the value observed in 1986 (35.38%), but that in years where travel time exceeds that of the 1986 condition, the standardized transport survival rate decreases until a TBR of 3.0:1 is achieved. PAM was then used to predict a standardized transport survival rate that would result in a 3.0:1 TBR for a very low flow year (1977). This rate was 2.84% with 1977 flow, spill, and FGE conditions. For conditions between the 1977 and 1986 conditions, standardized transport survival rates were interpolated. 1989 conditions were input and PAM predicted a TBR for that year of 2.14:1 (See Table 7).

To compare the performance of these two models under current operating conditions a 50 year record flow record was simulated with current FGE values in

place. TBR's for each model from Lower Granite where plotted against water travel time (see Figure 5).

Figure 5. Transportation Benefits from Lower Granite Dam Under Two Hypotheses For Flow Record HM92A



It appears that with the minimal number of data points currently available (all in average or slightly below average flow conditions), transportation model 1 shows the best fit. However information from 1986 and 1989 is insufficient to accept or reject either model. In figure 5, the 1986 and 1989 points from both models fall to the left of the 20 day travel time mark. Until we have more data points in the extreme low flow ranges (high travel times), the transportation model we use will remain a critical uncertainty, and should be included as a sensitivity in future analyses.

System Planning Model (SPM)

Input Parameters

Age Composition, Fraction Female, and Fecundity

Age structure, fraction female, and fecundity were all derived by using weighted averages from System Planning input data. Values were weighed by the percent of total Snake River smolt capacity a particular subbasin comprised. The initial number of fish input into the model was derived by multiplying the age structure percentage times

the average wild runsize observed at Lower Granite Dam for the years 1979-1991 (6,878 for spring chinook, TAC 1991). The results are shown in Table 8.

Table 8. Age Composition, Fraction Female and Fecundity for Spring Chinook.

	One Ocean	Two Ocean	Three Ocean	Four Ocean
Age Structure	5%	43%	53%	0%
Initial Number	327	2925	3626	2
Fraction Female	0%	44%	62%	47%
Eggs per Female	0	4287	6157	3500

Smolt Carrying Capacity

A total smolt capacity of 11.7 million was used for wild spring chinook. This value was derived by using the baseline smolt capacities calculated in System Planning by the Smolt Density Model (Salmon and Steelhead System Planning Documentation, MEG, 1989) and then applying the natural fitting parameter provided by the System Planners to these capacities.

For spring chinook, this capacity, along with and baseline egg-smolt survival rate of 10%, produced an average of approximately 1.3 million out migrating smolts per year under baseline flow conditions (average results from 50, 13 year simulations, see calibration section below). Raymond (1988) provides estimates of wild spring chinook smolts passing Lower Granite Dam from 1975-1984 that average 1,700,000.

Egg to Smolt Survival Rates

The SPM input for egg-smolt survival is actually a zero-density egg to smolt survival, that is, the intercept of the density dependent Beverton-Holt egg to smolt survival curve extrapolated to zero seeding. This rate should not be confused with the actual smolt survival rate that is a function of the Beverton-Holt function. For this analysis, the baseline value was derived as part of the calibration (see discussion under calibration section below). The value derived from the calibration was 13.75%. This translated into an actual value of around 11.25%. This value may be a little high but is well within the range suggested by the Columbia River Fish Management Plan (1991) of 12% as a maximum under excellent habitat conditions. For the improved production condition a 10% improvement was assumed, resulting in an input value of 15.12% (actual values averaged about 11.7%).

Smolt to Smolt Survival Rates

The SPM input for this value is applied to the outmigrating smolt, before they reach the mainstem system. Baseline values for this parameter were taken from the

Subbasin Plans (95%). A 3.5% improvement was assumed for the futures condition (98% total survival).

Upstream Passage Mortality Rates

Values used for adult passage survival in the analysis were derived from information provided by the fishery agencies and tribes (Matylewich and Schaller, personal communication). Matylewich compared the number of spring chinook passing the lower most dam to the number at the upper most dam in the lower Columbia and Snake reaches. After accounting for harvest and turnoff into tributaries, he derived annual per project survival rates for the two reaches (Table 9).

Table 9. Columbia and Snake River upstream survival rates per project.

Year	Snake	Columbia
1977	0.95	0.92
1978	0.94	0.86
1979	0.93	0.80
1980	0.88	0.75
1981	0.95	0.85
1982	0.96	0.79
1983	0.93	0.91
1984	0.94	0.87
1985	0.93	0.95
1986	0.95	0.93
1987	0.98	0.95
1988	0.97	0.92
1989	0.95	0.83
1990	0.96	0.91
Average	0.94	0.88
Low	0.88	0.75
High	0.98	0.95

The baseline condition for our analysis was set at the average per project conversion rate in the above table: 94% in the Snake and 88% in the lower Columbia for a total upstream survival rate of 46.8%.. The effect of the actions proposed for 1993 on these conversion rates is unknown. As a result, the need was to arrive at a plausible change given the range of observations shown above. For these purposes, a total upstream survival improvement of about 5% was postulated. This was implemented by raising Columbia project survivals to 89% and leaving the Snake projects at the 94% level resulting in an overall upstream survival rate of about 49%.

Pre-Spawning Survival

This survival rate is 'charged' to the stock after it enters the subbasin and before it arrives on the spawning ground. Estimates of this survival rate vary widely; Chapman (1991), independently estimates survivals as only 50-60% for spring chinook, and 60-70% for summer chinook while Petrosky (1992) estimates survival rates of 90%. We chose a baseline pre-spawning survival rate of 80%.

Harvest Rates

The ocean harvest rates used in this analysis were assumed to be 0% for all ages. These harvest rates were arrived at after consultation with Agency biologists. Estuary and inriver rates were derived from a status report on fish runs (ODFW and WDF, 1991) and are shown in Table 10.

Table 10. Estuary and Inriver harvest rates.

	Estuary	Bonneville Pool	The Dalles Pool	John Day Pool
Spring Chinook	2%	3.78%	0.95%	0.95%

Smolt to Adult Survival

Smolt to adult survival rate was used to calibrate the System Planning Model (see calibration section below). Estimates of wild spring chinook smolt to adult survival rate vary widely from year to year and have generally been declining since the completion of the Lower Snake dams. Raymond (1988) provides estimates as high as 6.1% in the late 1960's. He estimates an average value of 1.45% from smolts passing Lower Granite to adults arriving at Ice Harbor from 1977-1984. Applying an upstream dam survival rate of 94% and a pre-spawning survival rate of 80%, we arrive at an average spawning ground estimate of .905%. Petrosky (1991) estimated an average smolt to adult survival from 1977-1987 of 0.44% for Marsh Creek spring chinook (to Lower Granite Dam). Applying the same pre-spawning survival rate of 80%, we arrive at an average spawning ground estimate of 0. This is the value we chose to use for our calibration. We assumed that it was indicative of Snake River spring chinook in general.

Calibration

To calibrate the SPM iterative runs were made using downstream survival rates predicted by PAM for the years 1976-1990 (out migrant flow years which resulted in return years 79-91) for transportation model 1. Iterative 250 game, 15 year runs of the SPM were made (with stochastic variation turned on) varying the estuary survival rate and stochastic variation modulator until the SPM predicted smolt to adult survival rates that closely approximated those reported by Petrosky (1991, Table 9), and varying the egg to smolt survival rate until the SPM predicted average escapements and

coefficients of variation observed at Lower Granite Dam (Table 9). Because Petrosky's SAR's were calculated to Lower Granite Dam, we applied the pre-spawning survival rate in the SPM of 80% to that SAR making our target SAR 0.35%.

Table 9. TAC estimates of wild spring chinook counts at Lower Granite Dam and estimated SAR for Snake River spring chinook.

Year	Wild Escapement to Lower Granite Dam	SAR to Spawning Ground @ 80% Pre-spawning Survival
1977		0.01
1978		0.18
1979	2525	0.10
1980	3525	0.04
1981	7900	0.17
1982	7150	1.31
1983	6175	0.29
1984	3100	0.52
1985	10650	1.07
1986	10600	.14
1987	11425	.08
1988	13925	
1989	3950	
1990	6050	
1991	2462	
Avg	6880	0.35
Std	3800	0.44
Co Var	.55	1.24
Min	2461	
Max	13925	

The results of the calibration follow:

The model was calibrated using an estuary survival rate of 0.145, a stochastic variation value of 0.545, and an egg-to-smolt survival rate of 0.1375. The results of this calibration are shown in Table 10.

Table 10. Calibration results from the System Planning Model for spring chinook, transportation models 1.

	Transport	Model 1
	Escapement	SAR
Avg	6813	0.355
Std	3772	0.19

Co Var	.55	0.54

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Appendix G
State and Tribal Fishery Agencies Model Analyses

DRAFT:
AN ANALYTICAL ASSESSMENT OF CURRENT MANAGEMENT ACTIONS ON SNAKE RIVER FALL CHINOOK

by

the T.E.C.H Committee

State and Tribal Fishery Agencies

November 17, 1992

INTRODUCTION

Snake River fall chinook have been declining in number for several decades and have recently been listed as threatened status under the Endangered Species Act. The National Marine Fisheries Service (NMFS) is required to participate in a Section 7 consultation process with other federal agencies with the intent of determining the effects of 1993 actions on Snake River fall chinook. The State and Tribal fisheries agencies (STFA) have been requested by NMFS to provide analytical assessments regarding 1993 actions for use in their Section 7 consultations. The STFA modeling system (Schaller and Cooney, 1992) was not designed to evaluate the effect of a single years set of actions upon a stocks future spawning escapements. Recognizing these limitations to this and other modeling systems being employed, NMFS has asked that the assessment be run assuming the actions planned for 1992 are in place in all future years of these simulations. It should be noted that these management actions where limited to actions implemented in 1992 and earlier and do not reflect an attempt at construction of a viable recovery plan for this stock. The following describes an assessment, which was requested by NMFS, to measure the effects of continuing 93 planned operations in the future on Snake River fall chinook.

METHODS

An analytical framework was employed to systematically evaluate the effects of proposed 1993 management actions on Snake River fall chinook rebuilding progress. This framework consists of a system of models that rely, to a large degree, on empirical recruitment data and estimates of stock productivity. The productivity of the stock is directly considered through the Empirical Life Cycle Model (ELCM) within the context of empirical recruitment data (Schaller and Cooney 1992). The ELCM is integrated with a mainstem passage model, referred to as FLUSH 3.0 (Fish Leaving Under Several Hypotheses; Weber and Petrosky 1991), in order to systematically evaluate the multi-faceted management actions proposed for Snake River fall chinook. The ELCM is a cohort based approach that provides an index of year class strength and was used to evaluate Snake River fall chinook brood years 1980 through 1988 (i.e. outmigration years 1981 through 1989).

The FLUSH model was used to estimate mainstem passage survival during the outmigration years (1981 - 1989) of those fall chinook broods. During simulations into the future, the base period flows were repeated with proposed management actions superimposed on the base survivals. The relative changes due to management actions were used to adjust the ELCM scalars. With this combination of models it is possible to simulate the effects of changes due to management actions throughout all stages of the fall chinook life cycle (see Schaller and Cooney 1992).

The approach used in simulating the effects of 1993 actions was to run a number of simulations varying key input parameters over a range of values reflecting uncertainty about the parameter values. The result is a range of anticipated stock responses generated for the proposed set of management actions which reflects the uncertainty about some key input parameters (i.e. reduction in predation mortality, transportation survival).

The management actions we assessed included harvest restrictions and two mainstem passage measures; additional flow volumes and predator reduction. In addition, the sensitivity of this stock's response to supplementation and different harvest rates was tested. A more detailed description is as follows:

Harvest reduction

The level of harvest reduction introduced into all simulations is that adopted by the Northwest Power Planning Council (NPPC) in Phase 3. These simulations use harvest rates (for all years of the simulation) for Pacific Salmon Commission fisheries with ceilings, which was generated by the planned chinook rebuilding program. Southern U.S. ocean harvest rates were reduced 22 percent from the 1990 level for 1991. The southern U.S. ocean fisheries were reduced an additional 5% from the 1991 level for the period 1992 - 1995. The NPPC proposal reduces inriver harvest rates 35 percent from the 1990 level for 1991. In addition, the inriver harvest levels were reduced an additional 24% from the 1991 level for the years 1992 - 1995. Both southern U.S. ocean fisheries and inriver fisheries return to the average 1984 - 1990 harvest rate for the remainder of the simulation years.

The sensitivity of the model to changes in harvest rates was assessed by bracketing the above harvest rate scenario. The higher harvest rate consisted of keeping harvest at the 1984 - 1990 level in all out years. The lower harvest rate was simulated by using the NPPC proposal described above but with the additional restriction of imposing the 1991 harvest rate for 1996 through 1999.

Flow Augmentation

The additional volumes of water proposed in the NPPC phase 3 amendments were added to the base flows for the years and periods modeled to estimate reduce fish travel time through the mainstem system (Bergren and Filardo 1991, FPC 1991). The actual amounts of water that would be added during monthly or bimonthly periods for years 1981 through 1989 were estimated (figures A-D) (NPPC Ruff pers comm., FPC 1991).

Predator Removal

The effects of predator removal were assessed by reducing reservoir mortality by zero, 15 percent phased in over eight years and 25 percent phased in over seven years, beginning in 1991. We modeled a range of values because of the uncertainty associated with the predator removal program, which began recently, and for which complete results are not yet available. These range of values reflect consideration for the following uncertainties: effectiveness of removing squawfish; distribution of squawfish in reservoirs; consumption of dead and dying smolts; population dynamics of other species of predators; and the importance of other predators in reducing predator mortality through a squawfish bounty.

Transportation

Since 1977 an aggressive smolt transportation program has been implemented in the Snake River to attempt to compensate for reduced water velocities and poor inriver survival. Studies that compare survival rates of transported and nontransported fish have not been conducted for Snake River fall chinook. Transport experiments have been conducted in the Snake River for spring and summer chinook and the benefits have been measured as a ratio of return rates of transported to control groups. These ratios for spring and summer chinook have been estimated to exceed 1:1 (Mathews et. al, 1990), but alternative analyses of the same data set has yielded results less than 1:1 (USFWS, Olney pers com 1992). We model fall chinook transport based largely on information on their conspecifics, spring chinook, for which transport studies have been conducted. Because a large proportion of Snake River fall chinook are transported, smolt survival models are extremely sensitive to assumptions and parameter values used for transportation survival.

We assume a transport return ratio (TRR) of 1:1 bracketed on the low end by a ratio of 0.5:1 and at the high end by a ratio of 2:1. The range of values reflect uncertainty associated with transportation survival estimates for Snake River spring and summer chinook and the application of these values to Snake River fall chinook. This analysis assumes no further improvements to existing fish collection facilities or the addition of fish collection facilities.

Enhancement

The run above Lower Granite Dam consists of returns from spawning above the Dam, strays of Snake River origin fall chinook from the Lyons Ferry Hatchery (LFH) program and strays of outside stock origin. The assessments described in this paper include the assumption that strays of Lyons Ferry origin have been contributing to natural spawning up through the current run year,

1993. A detail breakdown of the composition of the run over Lower Granite Dam through 1991 can be found in Schaller & Cooney 1992, Appendix A.

Two future supplementation scenarios were assessed. The intent of this specific set of analyses was to assess the potential effect of a standardize set of actions initiated in 1992. The standardize set of actions included the assumption that all known hatchery strays above Lower Granite Dam would be removed (including LFH and outside stocks). To illustrate the potential effect of supplementation, a run was made incorporating the assumption that supplementation by Snake River origin LFH stocks would continue under an accelerated program with an effective contribution in the mid range of the scenarios described previously (Schaller & Cooney, 1992).

Other Data

The flow and temperature data that govern reservoir survival were historical observations provided by the Army Corps of Engineers (ACOE). Parameters that affect dam survival include spill, also provided by the ACOE and Fish Guidance Efficiency (FGEs) values provided by the National Marine Fisheries Service. Turbine survival was assumed to be 0.85 per dam while spill and bypass survival were set at 0.98. Due to time limitation, we were not able to perform simulations over the range of uncertainty associated with FGEs, and turbine, spill , and bypass survivals.

RESULTS

FLUSH

Nine simulations, three levels of predator reduction by three levels of transport return ratios (TRR), were conducted for Snake River fall chinook using FLUSH 3.0.

At the TRR of 0.5:1, system survival results from FLUSH 3.0 yielded the lowest levels and exhibited the least relative positive change as predation mortality decreased (Table 1). The system survival rates were .030, .035, and .039 for predation mortality reductions of 0, .15, and .25 respectively at a TRR 0.5:1.

For the TRR of 2:1 at the high range, system survival results from FLUSH 3.0 yielded the highest levels and exhibited the most relative positive change as predation mortality decreased (Table 3). However, the system survival rates results were as low as .081, .088, and .094 for predation mortality reductions of 0, .15, and .25 respectively at a TRR 0.5:1. The base average estimated system survival of .065 is low. While the relative gains for the most optimistic set of assumptions modeled are substantial, the absolute survival increases are modest.

ELCM

In addition to the nine simulations described above, three other simulations were conducted to examine the sensitivity of the model to enhancement (supplementation) and different harvest rates using ELCM.

At a TRR of 0.5:1, results generally indicate a continued decreasing trend in escapement levels over four brood cycles (Figure 1) under three assumed predator reduction levels; zero, 0.15 and 0.25. When the TRR is assumed to be 1:1 (Figure 2) or 2:1 (Figure 3) the trend lines rise to slightly higher levels. However, even at a TRR of 2:1 and the highest assumed predator reduction level (0.25), the escapement projections show no significant increase over recent levels.

Figure 4 shows the sensitivity of escapement projections to the three TRR levels when predator reduction is fixed at 0.15. Higher escapements are projected with higher assumed TRRs. However, all three simulations exhibit declining trends in escapements.

The simulation that projects the effects of enhancement (supplementation) is shown in Figure 5. The results indicate a slight increasing trend may be possible with this type of management action given the assumptions for survival of supplemented offspring relative to natural offspring.

The sensitivity of the model to different harvest rates is shown in Figure 6. The analysis indicated that projected trends in escapements are insensitive to significant changes in harvest management actions.

DISCUSSION

Our assessment of Snake River fall chinook focused on harvest reduction, water augmentation, transportation, and predator removal. Although other management scenarios are possible, the purpose of this assessment was to estimate the effects of management actions currently in place on Snake River fall chinook trends.

The management actions of primary interest, transportation, water augmentation, draw down of some reservoirs to minimum operating pool, and predator reduction, are aimed at reducing mainstem smolt mortality resulting from development of the hydropower system. The water augmentation and limited reservoir draw down actions in the 1992 management actions had a minimal impact on reducing residence time and mortality. High subyearling mortality can be associated with the combination of increased residence time and the resulting exposure to higher temperatures. Within the context of the model, these increased temperatures result in increased consumption rates of predators which is due to increased metabolic rates of predators (Beamsderfer et al.

1990). The examined set of management actions did little to reduce residence time and hence reduce mortality. This can be concluded by examination of FLUSH 3.0 results at a TRR of 1:1 and predator mortality reduction of 0 (Table 2). Therefore, changes in mainstem smolt survival rely primarily on assumptions about transportation survival and predator reduction. The stock did exhibit more of a response for assumptions on the high end for transport survival and predator mortality reduction, but even at this level the stock demonstrated no significant increase over recent levels of escapement. The fall chinook stock exhibited a decreasing trend from recent levels for a majority of the simulations. The results of this analysis are consistent with the model simulations performed to evaluate NPPC phase 2 amendments last fall (ODFW, 1991).

Predator reduction is intended to address at least part of the survival problem created by hydrodevelopement which increased smolt residence times in the reservoirs. It is too early for a complete assessment to determine the effects of the predator control program initiated two years ago. Therefore, the range of values used in the simulations (as stated above) reflect consideration for the following uncertainties: effectiveness of removing squawfish; distribution of squawfish in reservoirs; consumption of dead and dying smolts; population dynamics of other species of predators; and the importance of other predators in reducing predator mortality through a squawfish reward program. Given the range of predator mortality reductions examined, at TRR of 1:1, all exhibit declining trends in escapement from recent years. Therefore, we can conclude that additional measures beyond 1993 need to be employed even if the predator control program yields results equivalent to the high end of the range.

As exhibited by the sensitivity analysis, harvest restrictions examined had little apparent effect on escapement levels or trends. Although the harvest management actions that were simulated in the sensitivity analysis differed substantially, there was little effect on the model's results.

Our general conclusion is that there is a high likelihood, based on reasonable ranges of projected effects of management actions, continuation of the 1993 actions would not stop this stock from a continued decline in adult abundance and escapement.

Literature Cited

To be added

Table 1. Estimates of juvenile mainstem migration survival from Flush 3.0. (TBR of 0.5:1 and 3 levels of predation mortality reduction).

	Survival Rate Estimates				Relative Change from Base		
H2O Year	Base	P–red 0	P–red 15	P–red 25	(P–red 0 /Base)	(P–red 15 /Base)	(P–red 25 /Base)
1981	0.0403	0.0403	0.0403	0.0403	1.0000	1.0000	1.0000
1982	0.1010	0.1010	0.1010	0.1010	1.0000	1.0000	1.0000
1983	0.0303	0.0303	0.0303	0.0303	1.0000	1.0000	1.0000
1984	0.0750	0.0750	0.0750	0.0750	1.0000	1.0000	1.0000
1985	0.0110	0.0110	0.0110	0.0110	1.0000	1.0000	1.0000
1986	0.0178	0.0178	0.0178	0.0178	1.0000	1.0000	1.0000
1987	0.0014	0.0014	0.0014	0.0014	1.0000	1.0000	1.0000
1988	0.0025	0.0025	0.0025	0.0025	1.0000	1.0000	1.0000
1989	0.0091	0.0091	0.0091	0.0091	1.0000	1.0000	1.0000
1990	0.0403	0.0403	0.0403	0.0403	1.0000	1.0000	1.0000
1991	0.1010	0.0850	0.0859	0.0870	0.8416	0.8505	0.8614
1992	0.0303	0.0405	0.0425	0.0446	1.3366	1.4026	1.4719
1993	0.0750	0.0676	0.0709	0.0742	0.9013	0.9453	0.9893
1994	0.0110	0.0077	0.0098	0.0123	0.6982	0.8882	1.1182
1995	0.0178	0.0139	0.0176	0.0221	0.7809	0.9888	1.2416
1996	0.0014	0.0011	0.0021	0.0039	0.7518	1.4539	2.7447
1997	0.0025	0.0021	0.0039	0.0063	0.8367	1.5498	2.4900
1998	0.0091	0.0076	0.0117	0.0155	0.8375	1.2843	1.7014
1999	0.0403	0.0426	0.0512	0.0572	1.0571	1.2705	1.4194
2000	0.1010	0.0850	0.0923	0.0972	0.8416	0.9139	0.9624
2001	0.0303	0.0405	0.0483	0.0541	1.3366	1.5941	1.7855
2002	0.0750	0.0676	0.0758	0.0814	0.9013	1.0107	1.0853
2003	0.0110	0.0077	0.0120	0.0159	0.6982	1.0909	1.4455
2004	0.0178	0.0139	0.0197	0.0246	0.7809	1.1067	1.3820
2005	0.0014	0.0011	0.0024	0.0041	0.7518	1.7092	2.8936
2006	0.0025	0.0021	0.0041	0.0063	0.8367	1.6215	2.4900
2007	0.0091	0.0076	0.0117	0.0155	0.8375	1.2843	1.7014
2008	0.0403	0.0426	0.0512	0.0572	1.0571	1.2705	1.4194
2009	0.1010	0.0850	0.0923	0.0972	0.8416	0.9139	0.9624
2010	0.0303	0.0405	0.0483	0.0541	1.3366	1.5941	1.7855
1993–10 ave	0.0320	0.0298	0.0347	0.0388	0.8935	1.2495	1.6454
1993–10 min	0.0014	0.0011	0.0021	0.0039	0.6982	0.8882	0.9624
1993–10 max	0.1010	0.0850	0.0923	0.0972	1.3366	1.7092	2.8936

Table 2. Estimates of juvenile mainstem migration survival from Flush 3.0. (TBR of 1:1 and 3 levels of predation mortality reduction).

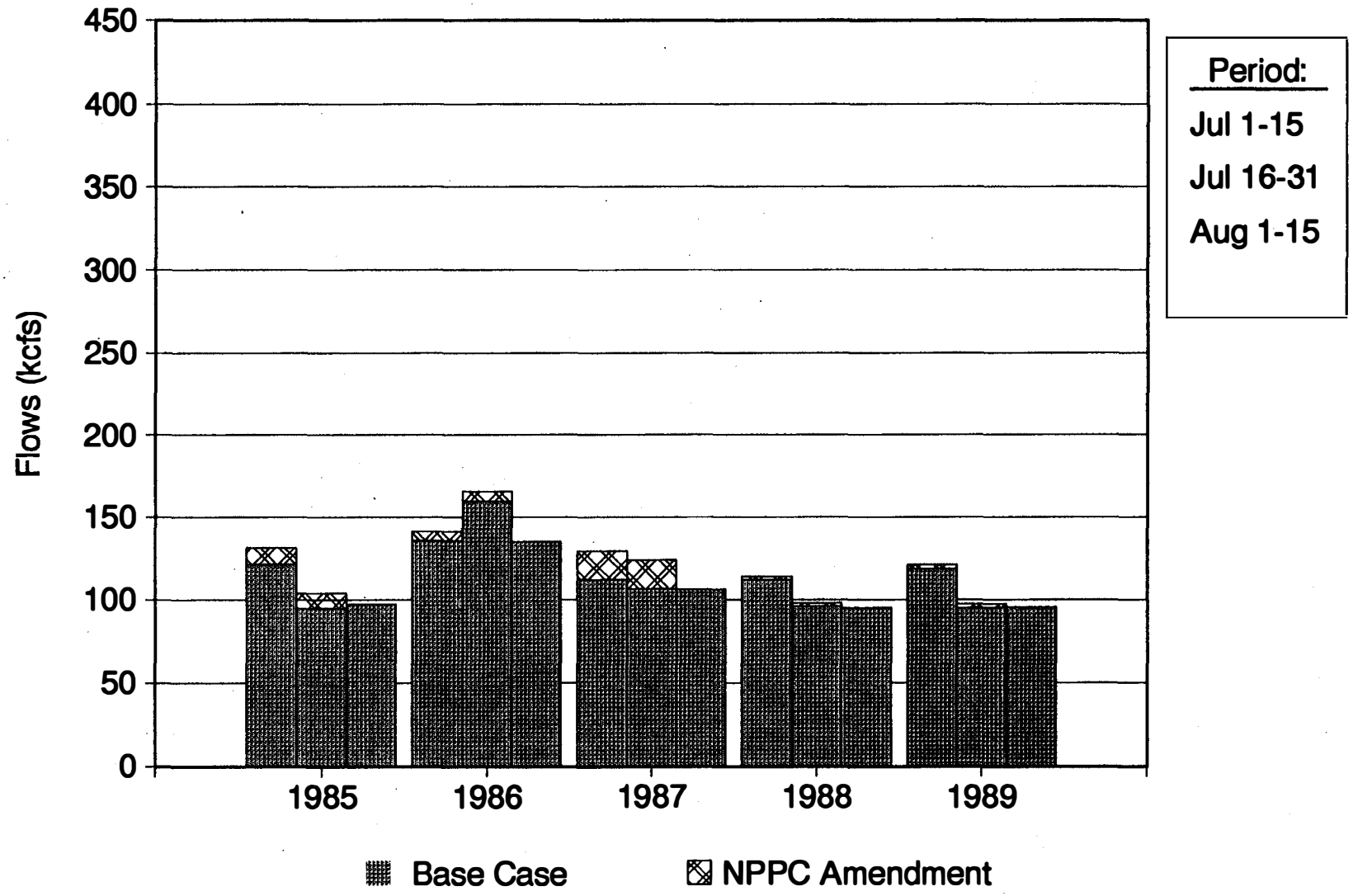
	Survival Rate Estimates				Relative Change from Base (P–red 0 /Base)	(P–red 15 /Base)	(P–red 25 /Base)
H2O Year	Base	P–red 0	P–red 15	P–red 25			
1981	0.0676	0.0676	0.0676	0.0676	1.0000	1.0000	1.0000
1982	0.1330	0.1330	0.1330	0.1330	1.0000	1.0000	1.0000
1983	0.0544	0.0544	0.0544	0.0544	1.0000	1.0000	1.0000
1984	0.0991	0.0991	0.0991	0.0991	1.0000	1.0000	1.0000
1985	0.0130	0.0130	0.0130	0.0130	1.0000	1.0000	1.0000
1986	0.0217	0.0217	0.0217	0.0217	1.0000	1.0000	1.0000
1987	0.0017	0.0017	0.0017	0.0017	1.0000	1.0000	1.0000
1988	0.0030	0.0030	0.0030	0.0030	1.0000	1.0000	1.0000
1989	0.0111	0.0111	0.0111	0.0111	1.0000	1.0000	1.0000
1990	0.0676	0.0676	0.0676	0.0676	1.0000	1.0000	1.0000
1991	0.1330	0.1350	0.1360	0.1370	1.0150	1.0226	1.0301
1992	0.0544	0.0637	0.0659	0.0683	1.1710	1.2114	1.2555
1993	0.0991	0.1070	0.1100	0.1140	1.0797	1.1100	1.1504
1994	0.0130	0.0119	0.0143	0.0173	0.9154	1.1000	1.3308
1995	0.0217	0.0216	0.0258	0.0308	0.9954	1.1889	1.4194
1996	0.0017	0.0016	0.0028	0.0048	0.9697	1.6788	2.9030
1997	0.0030	0.0032	0.0053	0.0078	1.0881	1.7831	2.6576
1998	0.0111	0.0116	0.0162	0.0203	1.0450	1.4595	1.8288
1999	0.0676	0.0669	0.0770	0.0840	0.9896	1.1391	1.2426
2000	0.1330	0.1350	0.1430	0.1480	1.0150	1.0752	1.1128
2001	0.0544	0.0637	0.0725	0.0789	1.1710	1.3327	1.4504
2002	0.0991	0.1070	0.1160	0.1220	1.0797	1.1705	1.2311
2003	0.0130	0.0119	0.0169	0.0213	0.9154	1.3000	1.6385
2004	0.0217	0.0216	0.0282	0.0336	0.9954	1.2995	1.5484
2005	0.0017	0.0016	0.0032	0.0050	0.9697	1.9273	3.0364
2006	0.0030	0.0032	0.0055	0.0078	1.0881	1.8508	2.6576
2007	0.0111	0.0116	0.0162	0.0203	1.0450	1.4595	1.8288
2008	0.0676	0.0669	0.0770	0.0840	0.9896	1.1391	1.2426
2009	0.1330	0.1350	0.1430	0.1480	1.0150	1.0752	1.1128
2010	0.0544	0.0637	0.0725	0.0789	1.1710	1.3327	1.4504
1993–10 ave	0.0449	0.0469	0.0525	0.0570	1.0299	1.3568	1.7135
1993–10 min	0.0017	0.0016	0.0028	0.0048	0.9154	1.0752	1.1128
1993–10 max	0.1330	0.1350	0.1430	0.1480	1.1710	1.9273	3.0364

Table 3. Estimates of juvenile mainstem migration survival from Flush 3.0. (TBR of 2:1 and 3 levels of predation mortality reduction).

	Survival Rate Estimates				Relative Change from Base		
H2O Year	Base	P–red 0	P–red 15	P–red 25	(P–red 0 /Base)	(P–red 15 /Base)	(P–red 25 /Base)
1981	0.0955	0.0955	0.0955	0.0955	1.0000	1.0000	1.0000
1982	0.1990	0.1990	0.1990	0.1990	1.0000	1.0000	1.0000
1983	0.0712	0.0712	0.0712	0.0712	1.0000	1.0000	1.0000
1984	0.1480	0.1480	0.1480	0.1480	1.0000	1.0000	1.0000
1985	0.0172	0.0172	0.0172	0.0172	1.0000	1.0000	1.0000
1986	0.0293	0.0293	0.0293	0.0293	1.0000	1.0000	1.0000
1987	0.0021	0.0021	0.0021	0.0021	1.0000	1.0000	1.0000
1988	0.0038	0.0038	0.0038	0.0038	1.0000	1.0000	1.0000
1989	0.0150	0.0150	0.0150	0.0150	1.0000	1.0000	1.0000
1990	0.0955	0.0955	0.0955	0.0955	1.0000	1.0000	1.0000
1991	0.1990	0.2340	0.2350	0.2360	1.1759	1.1809	1.1859
1992	0.0712	0.1100	0.1130	0.1160	1.5449	1.5871	1.6292
1993	0.1480	0.1850	0.1900	0.1940	1.2500	1.2838	1.3108
1994	0.0172	0.0202	0.0235	0.0272	1.1744	1.3663	1.5814
1995	0.0293	0.0371	0.0424	0.0484	1.2662	1.4471	1.6519
1996	0.0021	0.0027	0.0042	0.0066	1.2617	1.9720	3.0981
1997	0.0038	0.0054	0.0080	0.0110	1.4151	2.0914	2.8721
1998	0.0150	0.0197	0.0252	0.0298	1.3133	1.6800	1.9867
1999	0.0955	0.1150	0.1290	0.1380	1.2042	1.3508	1.4450
2000	0.1990	0.2340	0.2440	0.2510	1.1759	1.2261	1.2613
2001	0.0712	0.1100	0.1210	0.1280	1.5449	1.6994	1.7978
2002	0.1480	0.1850	0.1970	0.2040	1.2500	1.3311	1.3784
2003	0.0172	0.0202	0.0267	0.0320	1.1744	1.5523	1.8605
2004	0.0293	0.0371	0.0453	0.0516	1.2662	1.5461	1.7611
2005	0.0021	0.0027	0.0047	0.0069	1.2617	2.2056	3.2150
2006	0.0038	0.0054	0.0082	0.0110	1.4151	2.1514	2.8721
2007	0.0150	0.0197	0.0252	0.0298	1.3133	1.6800	1.9867
2008	0.0955	0.1150	0.1290	0.1380	1.2042	1.3508	1.4450
2009	0.1990	0.2340	0.2440	0.2510	1.1759	1.2261	1.2613
2010	0.0712	0.1100	0.1210	0.1280	1.5449	1.6994	1.7978
1993–10 ave	0.0646	0.0810	0.0882	0.0937	1.2895	1.6033	1.9213
1993–10 min	0.0021	0.0027	0.0042	0.0066	1.1744	1.2261	1.2613
1993–10 max	0.1990	0.2340	0.2440	0.2510	1.5449	2.2056	3.2150

Figure A

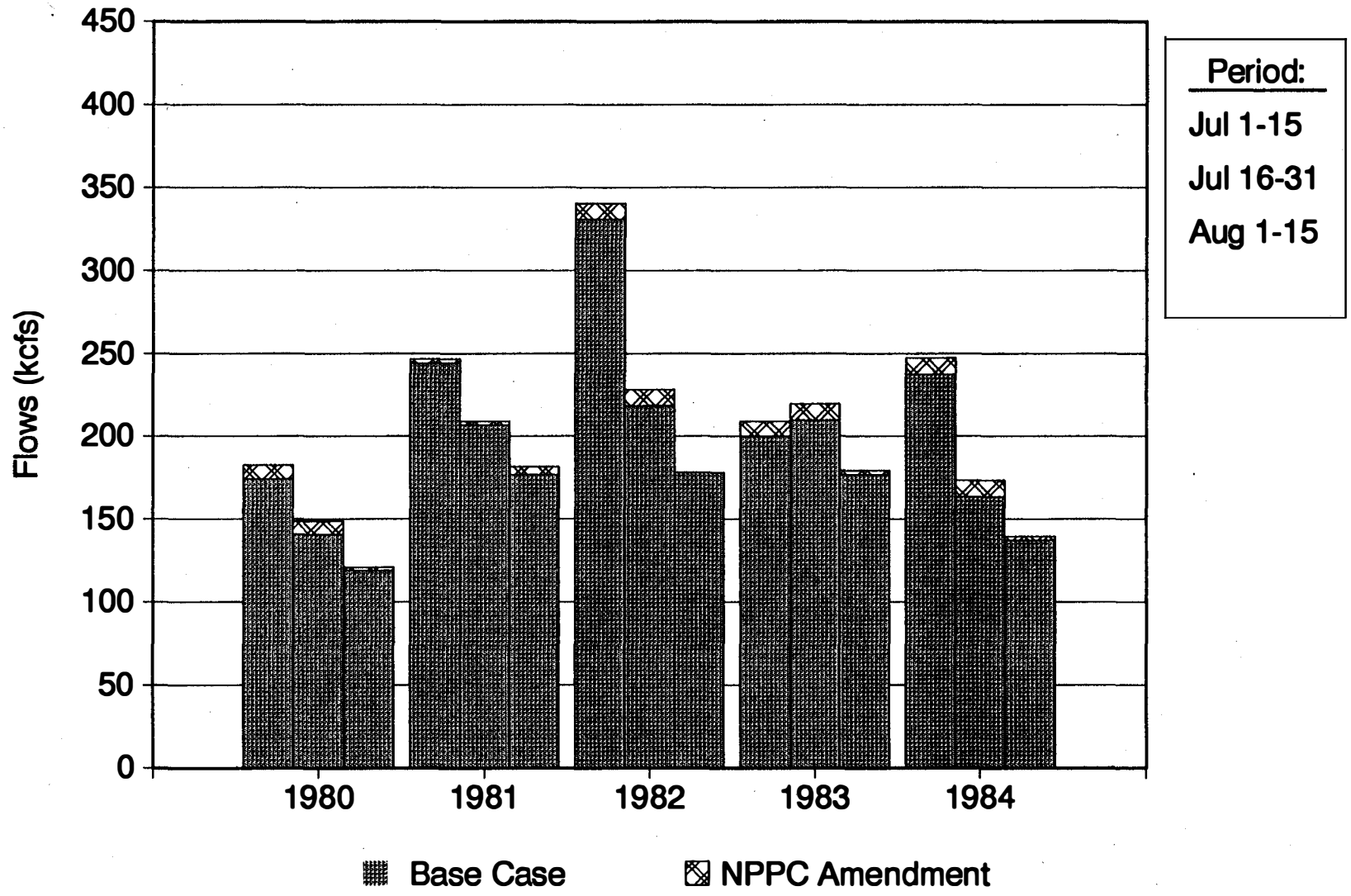
The Dalles Summer Flows
Base Case vs. NPPC Amendment



FPC 10-15-1991

Figure B

The Dalles Summer Flows
Base Case vs. NPPC Amendment

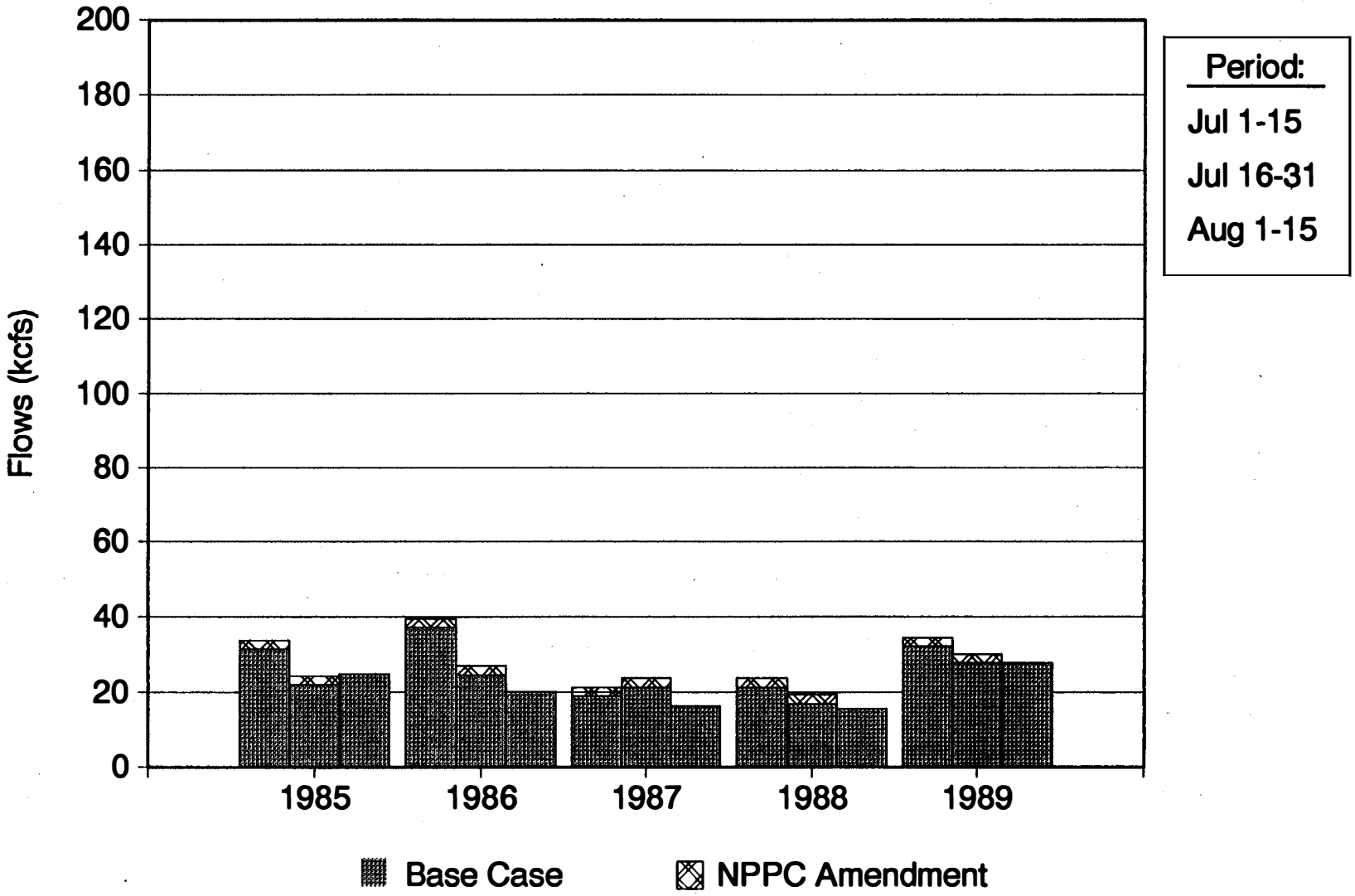


FPC 10-15-1991

Figure C

Lower Granite Summer Flows

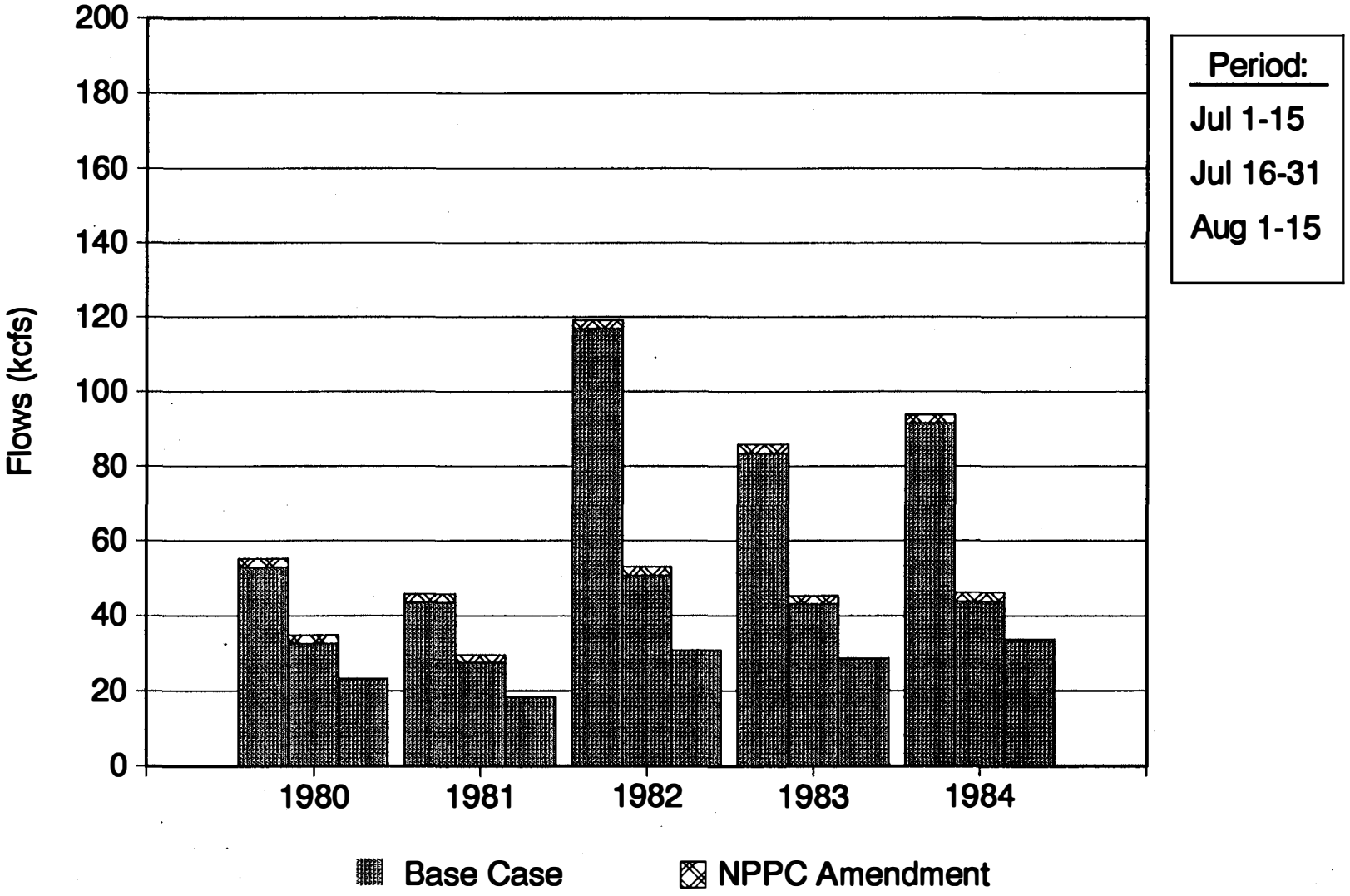
Base Case vs. NPPC Amendment



FPC 10-15-1991

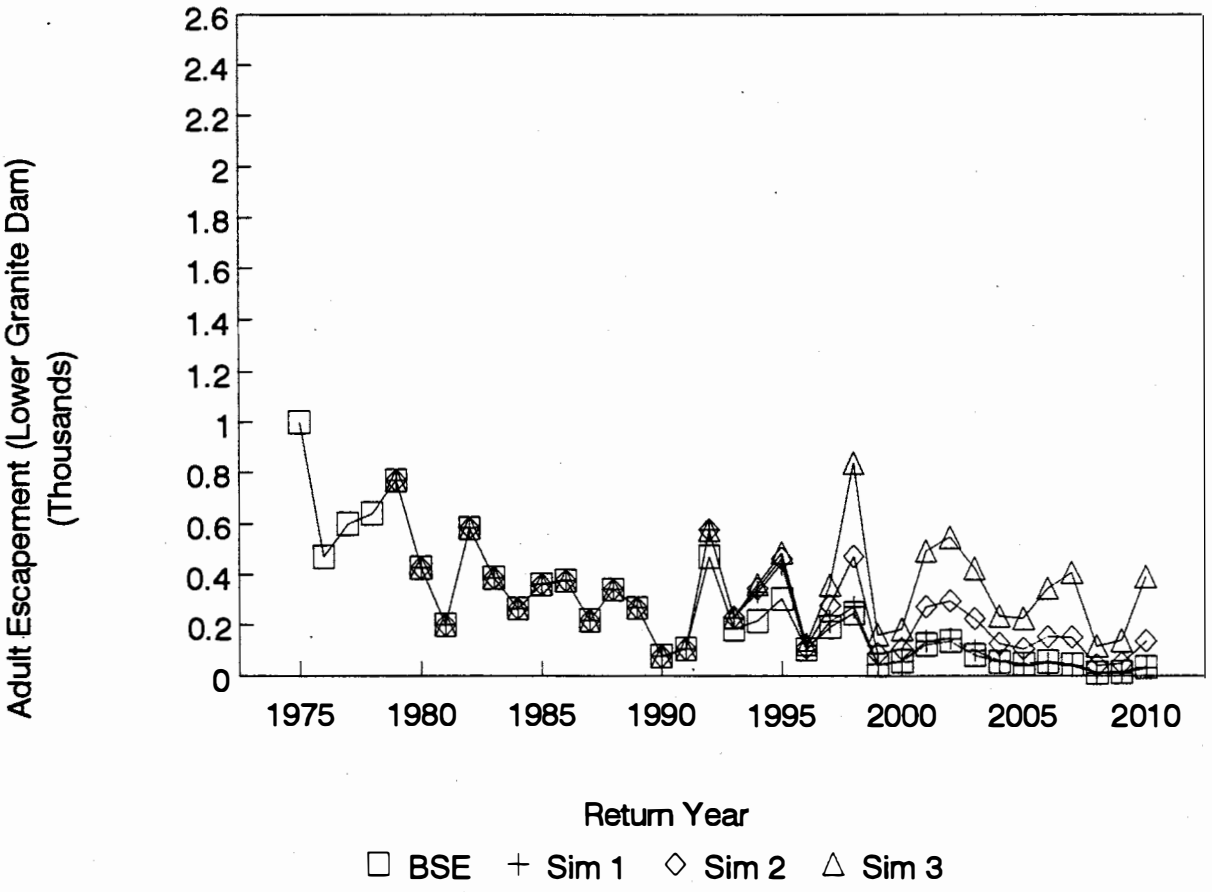
Figure D

Lower Granite Summer Flows
Base Case vs. NPPC Amendment



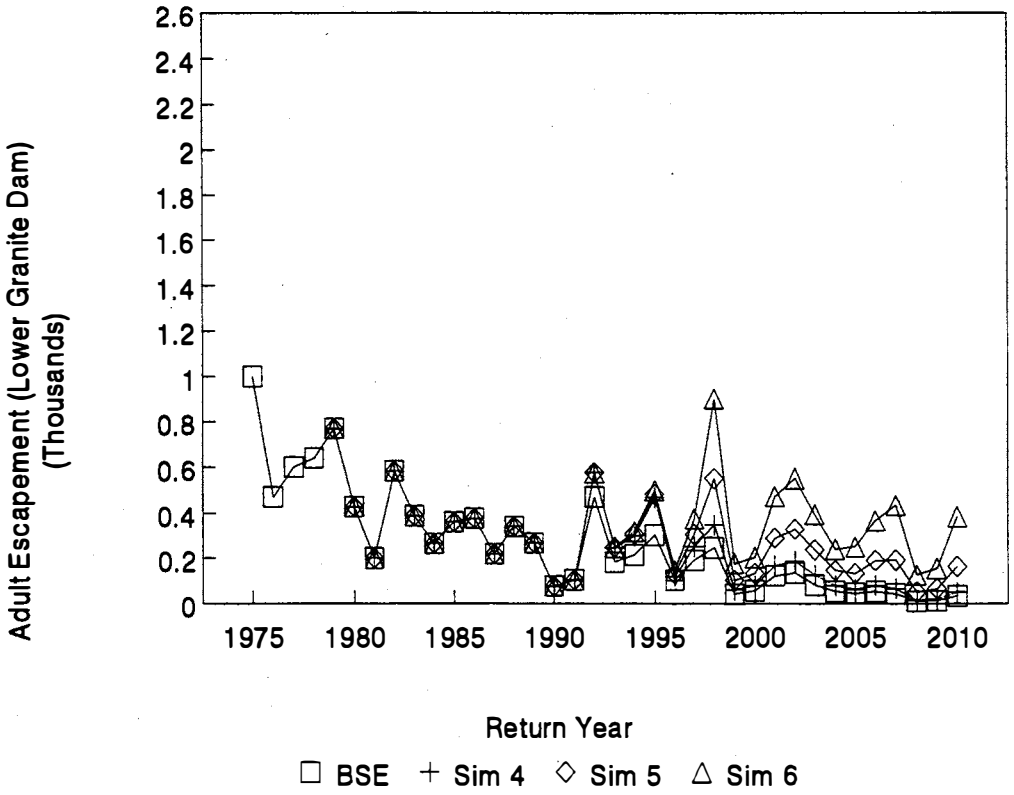
FPC 10-15-1991

Figure 01. Empirical Life Cycle model results for baseline conditions vs 93 Operation simulations, escapement measured as naturally spawning fall chinook crossing Lower Granite Dam.
(Predation Mortality Reduction assumed over length of program: Sim1 = 0; Sim2 = .15; Sim3 = .25)
(Transport Return Ratio assumed 0.50:1)



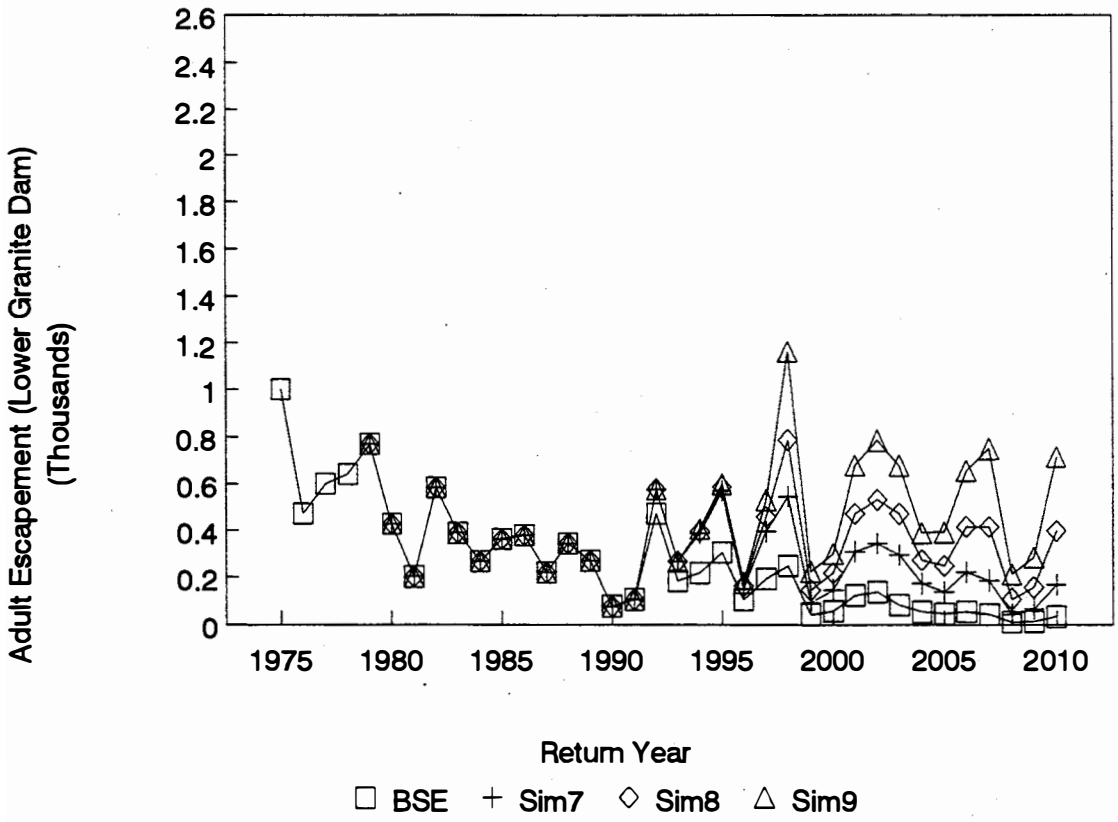
Return Years	Average Lower Granite Escapements			
	Base	Sim1	Sim2	Sim3
Ave 1979–83	474	474	474	474
Ave 1984–88	313	313	313	313
Ave 1989–91	150	150	150	150
Ave 1992–96	255	335	345	355
Ave 1997–01	132	143	242	407
Ave 2002–06	74	78	180	356
Ave 2007–10	26	22	93	264

Figure 02. Empirical Life Cycle model results for baseline conditions vs 93 Operation simulations, escapement measured as naturally spawning fall chinook crossing Lower Granite Dam.
(Predation Mortality Reduction assumed over length of program: Sim4 = 0; Sim5 = .15; Sim6 = .25)
(Transport Return Ratio assumed 1:1)



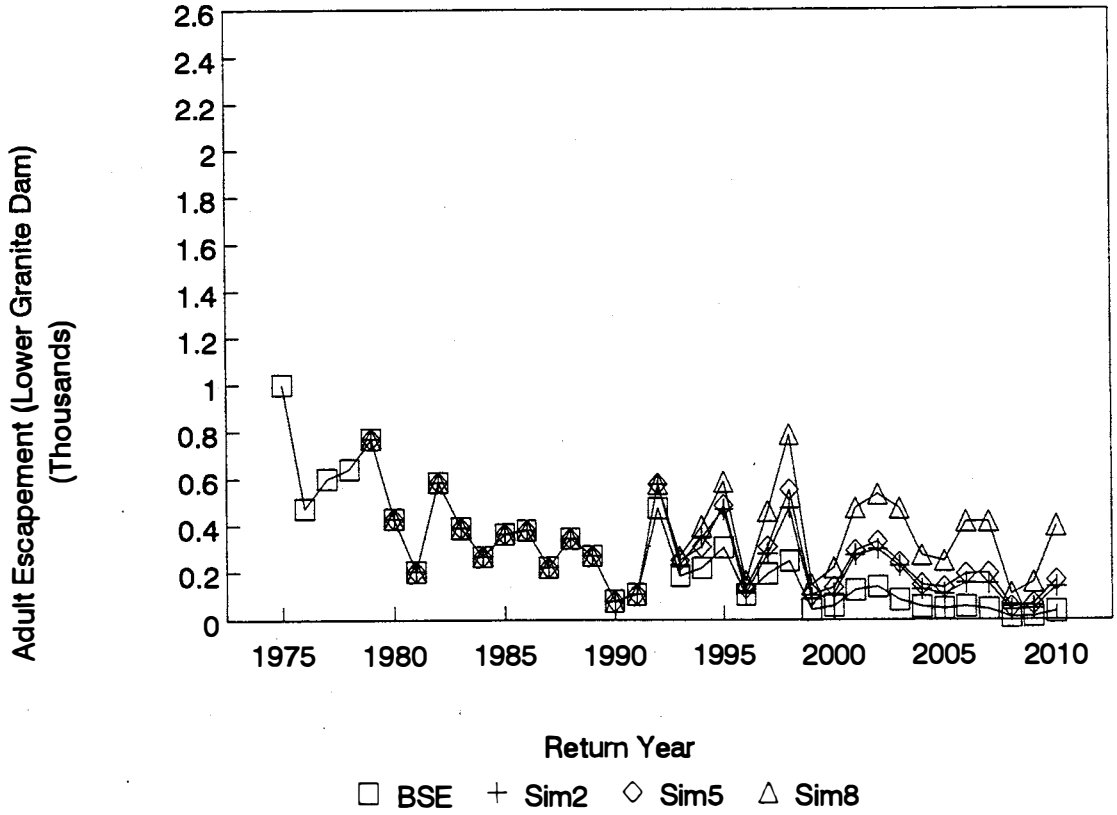
Return Years	Average Lower Granite Escapements		
	Sim4	Sim5	Sim6
Ave 1979–83	474	474	474
Ave 1984–88	313	313	313
Ave 1989–91	150	150	150
Ave 1992–96	342	349	358
Ave 1997–01	181	276	425
Ave 2002–06	107	207	361
Ave 2007–10	38	119	275

Figure 03. Empirical Life Cycle model results for baseline conditions vs 93 Operation simulations, escapement measured as naturally spawning fall chinook crossing Lower Granite Dam.
(Predation Mortality Reduction assumed over length of program: Sim7 = 0; Sim8 = .15; Sim9 = .25)
(Transport Return Ratio assumed 2:1)



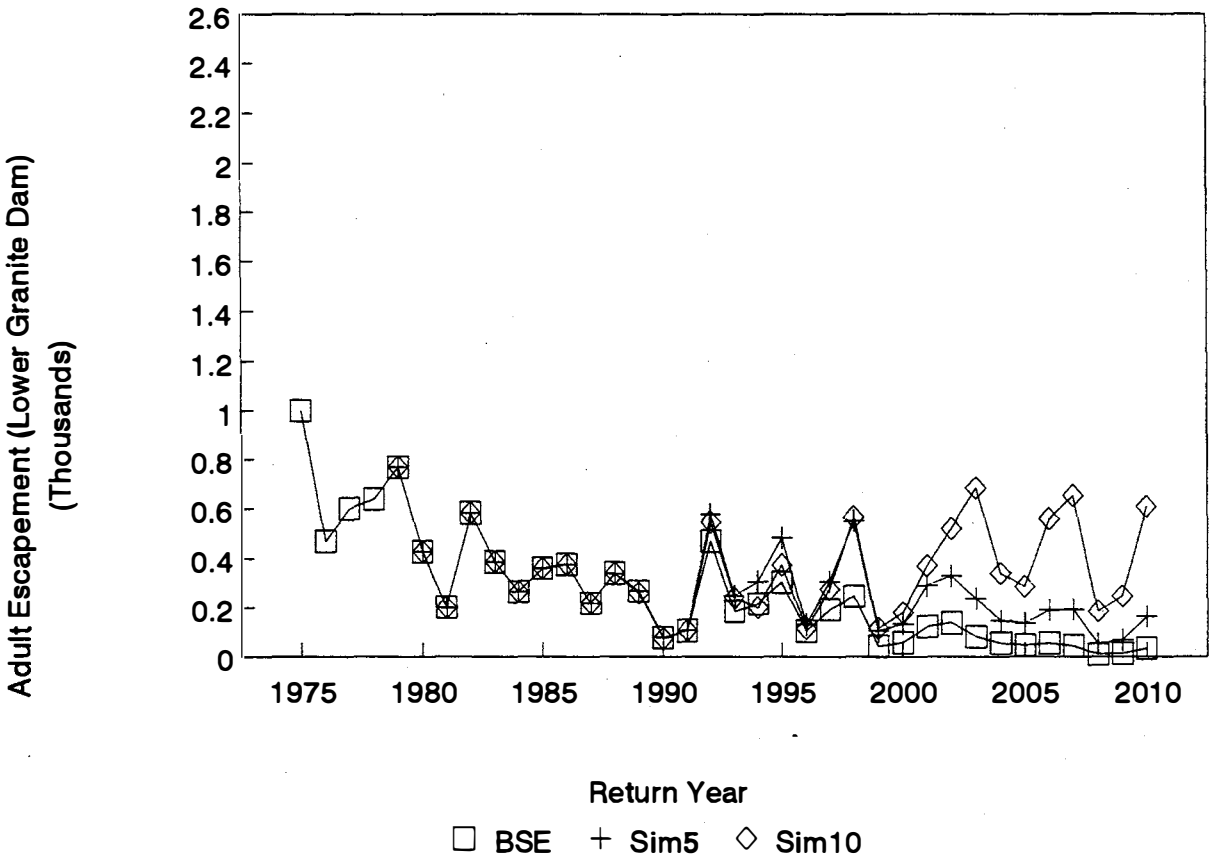
Return Years	Average Lower Granite Escapements		
	Sim7	Sim8	Sim9
Ave 1979–83	474	474	474
Ave 1984–88	313	313	313
Ave 1989–91	150	150	150
Ave 1992–96	389	396	404
Ave 1997–01	297	415	578
Ave 2002–06	232	386	579
Ave 2007–10	115	268	489

Figure 04. Empirical Life Cycle model results for baseline conditions vs 93 Operation simulations, escapement measured as naturally spawning fall chinook crossing Lower Granite Dam.
(Predation Mortality Reduction assumed over length of program: Sim2 = .15; Sim5 = .15; Sim8 = .15)
(Transport Return Ratio assumed: Sim2 = 0.50:1; Sim5 = 1:1; Sim 8 = 2:1)



Return Years	Average Lower Granite Escapements		
	Sim2	Sim5	Sim8
Ave 1979–83	474	474	474
Ave 1984–88	313	313	313
Ave 1989–91	150	150	150
Ave 1992–96	345	349	396
Ave 1997–01	242	276	415
Ave 2002–06	180	207	386
Ave 2007–10	93	119	268

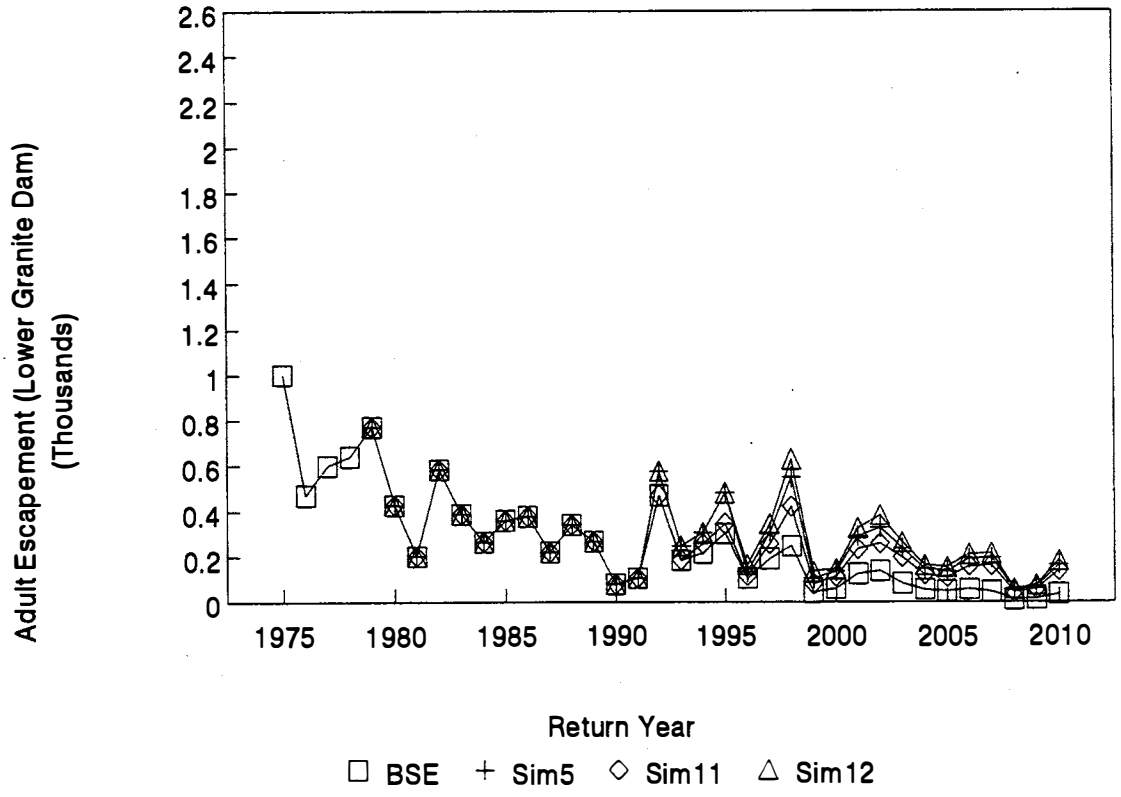
Figure 05. Empirical Life Cycle model results for baseline conditions vs 93 Operation simulations, escapement measured as naturally spawning fall chinook crossing Lower Granite Dam.
Sensitivity of the stock response to supplementaion of the natural stock.
(Predation Mortality Reduction assumed over length of program = .15)
(Transport Return Ratio assumed = 1:1) (Sim5 = No Enhancement; Sim10 = WDF Enhancement Level 1/)



1\ Sensistivity to enhancement levels proposed by WDF during the NPPC ammendment process and asuming these fish survive at 1/2 the natural stock survival rate.

Return Years	Average Lower Granite Escapements	
	Sim5	Sim10
Ave 1979–83	474	474
Ave 1984–88	313	313
Ave 1989–91	150	146
Ave 1992–96	349	295
Ave 1997–01	276	301
Ave 2002–06	207	477
Ave 2007–10	119	423

Figure 06. Empirical Life Cycle model results for baseline conditions vs 93 Operation simulations, escapement measured as naturally spawning fall chinook crossing Lower Granite Dam.
Sensitivity of stock response to changes in Harvest Rates.
(Predation Mortality Reduction assumed over length of program = .15)
(Transport Return Ratio assumed = 1:1) (Sim5 = NPPC harvest schedule; Sim11 = 84–90 ave H.R. in Southern U.S. fisheries, Sim12 NPPC Schedule + 91 HR fro 1996–99)



Return Years	Average Lower Granite Escapements		
	Sim5	Sim11	Sim12
Ave 1979–83	474	474	474
Ave 1984–88	313	313	313
Ave 1989–91	150	150	150
Ave 1992–96	349	275	356
Ave 1997–01	276	220	316
Ave 2002–06	207	168	235
Ave 2007–10	119	99	131

DRAFT:

AN ANALYTICAL ASSESSMENT OF CURRENT MANAGEMENT ACTIONS ON SNAKE RIVER SPRING AND SUMMER CHINOOK

by

the T.E.C.H Committee

State and Tribal Fishery Agencies

November 19, 1992
Revised December 1, 1992

INTRODUCTION

Snake River spring and summer chinook runs have declined dramatically in recent years and have recently been collectively listed as a threatened species under the Endangered Species Act. Under the Act, federal agencies are subject to Section 7 consultation with the National Marine Fisheries Service (NMFS) to determine if actions under their purview would result in further jeopardizing the listed species. The State and Tribal fisheries agencies (STFA) have been requested by NMFS to provide analytical assessments regarding 1993 actions for use as a starting point in their Section 7 consultations regarding 1993 actions.

The STFA modeling system for spring and summer chinook consists of a prototype spring/summer chinook empirical life cycle model (Spring/Summer ELCM) employed in combination with a model of juvenile passage survival, Spring FLUSH (FLUSH Version 4.0). Output from the modeling system is in the form of trends in future run strength. This modeling system was designed to evaluate the effect of long-term changes in factors affecting spring/summer chinook, not at determining the impact of a single year set of actions. The modeling system is described in detail in Schaller et al.(1992). Recognizing these limitations to this and other modeling systems being employed, NMFS has asked that the assessment be run assuming the actions planned for 1992 are in place in all future years of these simulations.

This document describes an assessment of continued implementation of the actions initiated in 1992 contrasted against a baseline run that assumes continued in-river operations without the actions implemented in 1992. In order to illustrate the sensitivity of the model to changes in flow conditions a second scenario was also analyzed reflecting improved in-river flow conditions and a halt to transportation after 1992.

METHODS

The ELCM is a cohort based approach that provides an index of year class strength and was used to evaluate Snake River spring and summer chinook brood years 1975 through 1986 (i.e,. outmigration years 1977 through 1988).

The modeling system described above was used to analyze the scenarios. Information from two Snake River chinook

stocks, Marsh Creek spring chinook and Imnaha River spring/summer chinook, were used in our evaluation of the effects of 1993 management actions. The Marsh Creek information is representative of Snake River spring chinook runs with average productivity, while the Imnaha run most reflects spring/summer populations of moderate to lesser productivity. Information on additional populations is under development and will be reflected in future analyses. The methodology, described in Schaller et al. (1992), incorporates assumptions based upon historical productivity analyses in combination with reconstructed mainstem survival estimates for the 1977 to 1988 water years. The FLUSH 4.0 model (Weber et al. 1992) was used to estimate mainstem passage survival during the outmigration years (1977 - 1988) of those spring/summer chinook broods. For simulation runs projecting into the future, the base period flows were repeated with proposed management actions superimposed on the base survivals. The relative changes due to management actions, output from the FLUSH model, were used to adjust ELCM recruitment scalars. With this combination of models it is possible to simulate the effects of changes due to management actions throughout all stages of the spring chinook life cycle.

The scenarios addressed in this analysis incorporated only those action initiated or in place in 1992. Additional measures, for example subbasin habitat improvements or supplementation, that are not in place were not incorporated.

Juvenile Mainstem Survival Actions

Additional Flow - The amount of additional flow assumed for the Snake River was defined by the NPPC's Phase II Amendment stipulation. The increment ranges from 1.2 to 1.4 MAF as a function of the base flow level. The amount of additional flow that would be allotted to each of the flow years in our baseline period is shown in Table 1. An additional increment of flow of 6.45 MAF was added to the base flow in the mainstem Columbia River. In some years of the base period there were additions to the flow in the Snake and Columbia River. When flow conditions corresponding to those particular base years occurred in the future phase of the simulations, we removed the increased volume from the base before adding the prescribed Phase II increments. The actual increment added in 1992 differed from the planned volume. For comparison, we simulated future years with both the planned and actual volumes observed in 1992.

The additional flow increment is distributed evenly among the time period of the 40 days (April 20 - May 30) when 80% of

the fish are in the river and, thus, increases the mean for the period. This reflects the fact that the model operates on a "yearly" time step and does not imply that an even distribution of water across the outmigration period is the optimum way to enhance fish survival.

Drawdown - The simulation of the 1992 action package as requested by NMFS incorporated minor reductions in reservoir elevations during juvenile outmigration. This action consists of lowering the four Snake River reservoirs along with the John Day pool to one foot above minimum operating pool. This action should not be confused with other, more extensive drawdown options being discussed such as the "Natural Pool Option" that would entail drawing down the four Snake River projects to approximately pre-impoundment levels.

Spill - The 1992 action scenario included spill rates as provided by NMFS and the Corps of Engineers. The comparative sensitivity analysis scenario included a higher spill rate. This scenario approximated no spill at the collector dams and John Day and daily averages of 18% at Lower Monumental, 40% at Ice Harbor, 10% at The Dalles and 53% at Bonneville.

Bypass - The NMFS requested that we use only mainstem measures in place as of 1992 in the analysis. The historic FGEs used in the baseline assessment are taken from Fisher (1992) whereas the 1992 FGE data were taken from a review by NMFS and modified for two dams by the state agencies and tribes (Heinith, CRITFC, pers. comm.).

Transport Survival - Four alternative transport survival models were used to encompass the range of survival benefits resulting from different interpretations of spring and summer chinook transportation study results. The first two variations correspond to the models used in the NPPC assessment effort. Models 3 and 4 are similar to model 2 but reflect additional interpretations of the study results (F. Olney USFWS, pers. comm.).

> Model 1 was equivalent to the NPPC's Model I, with transport survival estimated to be 1.6 times the estimated 1986 inriver smolt survival from Little Goose Dam. Model 1 transport survival was a constant 0.42 at all water travel times.
>
> Model 2 was equivalent to NPPC's Model II, with transport survival decreasing from 0.42 at 1986 velocities (15.7 days) to 0.05 at 1977 velocities (37.1 days).

Model 3 was equivalent to NPPC's Model II with the exception that transport survival decreasing from 0.28 at 1986 velocities (15.7 days) to 0.05 at 1977 velocities (37.0 days).

Model 4 was equivalent to NPPC's Model II with the exception that transport survival decreasing from 0.15 at 1986 velocities (15.7 days) to 0.05 at 1977 velocities (37.0 days).

The documentation for the FLUSH 4.0 model (Weber, et al. 1992) describes the latter two options in greater detail.

We compared the estimated smolt survival from the four transport models with observed to expected recruit/spawner ratios for four indicator stocks (Imnaha River and Marsh, Bear Valley and Elk creeks) for brood years 1975-1986. We also compared model output to Raymond's (1988) estimated smolt to adult return rates for wild spring and summer chinook, brood years 1975-82 (Weber et al., 1992).

Predator Removal - The effects of squawfish removal were simulated by assuming a mean value of 10% reduction in mortality in each reservoir based on population studies in John Day Dam. Because of the uncertainty associated with this action we bracketed the mean value with a low value of 5% and a high value of 15% reduction in mortality per reservoir. Uncertainty persists over the impacts of a number of factors including the effect of predator removal on the rate of predation on the target species, the potential for compensation by other predator species as the target species declines, and the potential that some portion of the smolts that are consumed would have died anyway during mainstem passage.

Inriver Option - Finally, to demonstrate the sensitivity to flow regimes, we modeled a combination of management actions that included drawdown to MOP, moderate predator removal (0.10), high proportions of spill at Snake River dams and additional flow augmentation of totals of 2.0 MAF in the Snake and 8.0 MAF in the Columbia River. This scenario was run with no transportation of juveniles specifically to provide for an analysis of the sensitivity of the model system to a combination of potential mainstem passage measures. While the measures incorporated are theoretically possible, the scenario does not represent a specific proposal by the tribal and state fisheries agencies involved in this assessment.

Adult Actions

Actions to increase the survival of adult spring/summer chinook are limited to harvest restrictions adopted by U.S. v Oregon.

RESULTS

FLUSH MODEL RESULTS

The FLUSH Model was used to estimate passage survival of juvenile Snake River spring/summer chinook. The results, arranged by levels of predator reduction of 0.05, 0.10 and 0.15 and by four levels of transport assumption are shown in Table 2. Table 2 contains minimum, maximum and average values for the out years (1992 through 2010).

Base survivals were computed for each of the TRR models. The average survivals for TRR model 1-4 were .21, .19 .14, and .08, respectively. To compute relative future changes in recruitment due to management actions, the action system survival is divided by the base system survival using the same TRR model. The change in system survival from base conditions to action for TRR model 1 averaged 1.27 , the change from maximum survival value was 1.43, and the change from minimum survival value was 4.11. The change in system survival from base conditions to action for TRR model 2 averaged 1.29, the change form maximum survival value was 1.20, and the change from minimum survival value was 14.35. The change in system survival from base conditions to action for TRR model 3 averaged 1.28, the change from maximum survival value was 1.23, and the change from the minimum survival value was 10.32. The change in system survival from base conditions to action for TRR model 4 averaged 1.26, the change from maximum survival value was 1.28, and the change from the minimum survival value was 5.68. Although, the relative increases are large in poor survival years the absolute gains in projected recruitment are small due to the absolute survival values.

In what we believe is our most likely simulations (predator reduction of 0.10 and TRR of 1.03:1), the average estimated system survival for 1992 implemented management actions was 0.164, improving from a base survival of 0.137. The minimum survival for these simulation years, of implemented actions, was 0.0196 and the maximum was 0.261. Using the same set of assumptions, the average estimated

system survival for 1992 planned management actions was 0.175, improving from a base survival of 0.137. The minimum survival for these simulation years, of planned actions, was 0.030 and the maximum was 0.271.

Estimated survival increases as the level of predator reduction increases and as assumed transport survival increases. At the lowest level of predator reduction (0.05) the average simulated survival increased from a base value of 0.207 to 0.250 under Model 1, the most optimistic transportation model but only increased from a base of .0785 to 0.096 under Model 4, the least optimistic. At the highest level of assumed predator mortality reduction (.15), average simulated juvenile system survival increased from a base of 0.207 to 0.265 for Model 1 and from a base of .08 to 0.10 for Model 4.

ELCM Model Results

We used the ELCM to estimate adult escapement trends reflecting changes in juvenile passage survival and harvest restrictions. Results of our simulations comparing planned versus implemented flows and their effects on Marsh Creek spring chinook escapements appear in Table 3 and those for the Imnaha River spring/summer chinook appear in Table 4. These tables also summarize results under four assumptions of transportation. Results for both stocks are similar in their projected responses to management actions. While both stocks realize some level of response to management actions, neither show dramatic responses to any individual, or combination of, management actions.

The results of our baseline analysis are depicted in Figure 1. Projections of return levels out through 2020 are combined with estimates of historic escapements returns. While observed escapements remained relatively high during the fifties and early sixties, the construction of one Columbia River and four Snake River hydroelectric projects in the period 1961 through 1975 was accompanied by a dramatic decline in escapements.

Differences in projected escapement levels for planned versus actual flow augmentation (i.e. levels observed in 1992) are shown in Figure 2 for Marsh Creek and in Figure 6 for the Imnaha River. In years of high flow the differences between resulting escapements from planned vs implemented simulations are greater. In years of low flow neither set of actions increase resulting escapements much from the base (both stocks exhibit escapements being less than 12% of MSP goal).

Assumptions regarding transportation survival have an affect on escapement in TRR models 3-4 (Marsh Creek, Figure 3 and Imnaha, Figure 7). As exhibited in TRR model 3-4 simulations, as transport survival is assumed to increase, projected escapement levels do likewise. In low flow years none of the assumptions for TRR models result in escapements increasing much above base levels (both stocks exhibit escapements being less than 12% of MSP goal).

Our scenario illustrating the sensitivity to in-river flow improvements with transportation turned off (Marsh Creek, Figure 4 and Imnaha, Figure 8) shows survival levels far above any that are projected for simulations involving 1992 actions including transportation. Under this projection the escapement trends include very large and variable responses. This is due to the fact that no harvest response is simulated, production from the resulting large over escapements is subjected to significant density dependent mortality.

DISCUSSION

This assessment was conducted in response to the request of NMFS and is intended to project expected trends of two Snake River spring chinook stocks given continuation of the management actions in place as of 1992. Other management scenarios are possible and will be analyzed in support of the development of recovery plans. Management actions addressed in this analysis focus on increasing the survival of juvenile spring chinook during mainstem passage. Within the framework of the requested action scenario, we looked at the sensitivity of the results to alternative assumptions regarding the effectiveness of predator removal and transport survival. A second scenario was included to explore the sensitivity of stock rebuilding response to the actions intended to improve mainstem juvenile survival (increased mainstem flows, additional spill, and predator removal).

Predator removal appears to improve mainstem survival to some extent. At what we feel is the most likely level, a 10 percent reduction in reservoir mortality, it does not increase mainstem survival or escapement levels dramatically (particularly in low flow years there is little change from the base). However, in conjunction with significant water velocity improvements these predator removal measures may contribute to recovery.

Assumptions regarding transport survival rates have substantial affects on mainstem survival estimates in this analysis. However, in this analysis whatever assumptions about transportation are made apply both to the base period and future simulated management actions. Therefore, the simulations of adult escapements are less sensitive to the 4 TRR model assumptions, than are the individual system survival estimates. The less optimistic TRR models and inriver survival most accurately reproduced trends exhibited by the Raymond (1988) smolt to adult return and R/S adult indices (Weber et al. 1992 , Petrosky and Schaller 1992).

The relationship between mainstem flow (fish travel time) and mainstem survival was demonstrated by a single simulation that mixed drawdown to MOP, moderate assumption regarding predator removal, ambitious spill and additional flow augmentation. Substantial increases in survival were projected for juveniles migrating in the river in the improved flow scenario analyzed for comparative purposes. Cumulative survival under this scenario was projected to exceed that under the most optimistic transport assumption.

The general pattern of all combinations of assumptions in assessing the 1992 actions show the escapement are not exhibiting significant increasing trends. An important finding is that, when poor water years cycle through the simulations, all of the combination of model assumptions for 1992 actions show little improvement in escapement over base conditions.

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Schaller, H., C. Petrosky, E. Weber, and T. Cooney. 1992. Snake River spring/summer chinook life cycle simulation model for recovery and rebuilding plan evaluation.

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Table 1. Additional Flow volumes (KAF) added to base year flows in spring/summer chinook analysis of planned 1993 operations.

Year	Snake	Columbia
1977	1440	3000
1978	1200	3000
1979	1200	3000
1980	1200	3000
1981	1200	3000
1982	1200	3000
1983	1200	3000
1984	1200	3000
1985	1200	3000
1986	1200	3000
1987	1440	3000
1988	1440	3000
1989	1200	3000
1990	1440	3000
1991	1440	3000

Table 2a. Juvenile System survival estimated from FLUSH 4.0 for base conditions and planned vs implemented actions in 1992 for the four Transportation models evaluated.

		Inriver	System Survival			
		Survival	Trans 1	Trans 2	Trans 3	Trans 4
Base:						
1977–1988	Min	0.0007	0.0240	0.0031	0.0031	0.0031
	Max	0.2330	0.2770	0.2770	0.2200	0.1580
	Avg	0.1099	0.2069	0.1872	0.1365	0.0785
Planned Action:						
1992–2010	Min	0.0149	0.0987	0.0445	0.0320	0.0176
	Max	0.3240	0.3320	0.3320	0.2710	0.2030
	Avg	0.1837	0.2637	0.2411	0.1745	0.0993
Implemented Action:						
1992–2010	Min	0.0066	0.0788	0.0259	0.0196	0.0125
	Max	0.3060	0.3210	0.3210	0.2610	0.1940
	Avg	0.1647	0.2470	0.2266	0.1639	0.0931

Table 2b. Juvenile System survival estimated from FLUSH 4.0 for base and planned actions in 1992 for the four Transportation models evaluated at three levels of predation mortality reduction.

		Inriver	System Survival			
		Survival	Trans 1	Trans 2	Trans 3	Trans 4
Base:						
1977–1988	Min	0.0007	0.0240	0.0031	0.0031	0.0031
	Max	0.2330	0.2770	0.2770	0.2200	0.1580
	Avg	0.1099	0.2069	0.1872	0.1365	0.0785
Predator Mortality Reduction at 5%:						
1992–2010	Min	0.0141	0.0964	0.0345	0.0313	0.0172
	Max	0.3120	0.3250	0.3250	0.2640	0.1970
	Avg	0.1725	0.2499	0.2341	0.1694	0.0957
Predator Mortality Reduction at 10%:						
1992–2010	Min	0.0149	0.0987	0.0445	0.0320	0.0176
	Max	0.3240	0.3320	0.3320	0.2710	0.2030
	Avg	0.1837	0.2637	0.2411	0.1745	0.0993
Predator Mortality Reduction at 15%:						
1992–2010	Min	0.0157	0.1010	0.0456	0.0328	0.0181
	Max	0.3370	0.3400	0.3400	0.2780	0.2090
	Avg	0.1941	0.2646	0.2463	0.1787	0.1023

Table 03. Empirical Life Cycle Model Results of 1993 Planned vs 1992 Implemented Actions being simulated for future Years for Marsh Creek Spring Indicator Stock (Assuming Predation Mortality Reduction at 10% Level).

Return Years		Spawning Escapement expressed as percent of goal								
		Baseline Conditions	Trans. Model 1		Trans. Model 2		Trans. Model 3		Trans. Model 4	
			Planned	Implemented	Planned	Implemented	Planned	Implemented	Planned	Implemented
57–69	Ave	91.5%								
	Min	49.7%								
	Max	150.0%								
70–79	Ave	44.1%								
	Min	10.0%								
	Max	109.6%								
80–90	Ave	17.0%								
	Min	1.9%								
	Max	45.9%								
91–95	Ave	22.4%	22.8%	22.7%	23.8%	23.2%	23.4%	23.0%	23.0%	22.8%
	Min	4.2%	5.9%	5.5%	9.4%	7.3%	8.1%	6.7%	6.7%	5.9%
	Max	46.0%	46.0%	46.0%	46.0%	46.0%	46.0%	46.0%	46.0%	46.0%
96–00	Ave	18.4%	23.3%	21.3%	26.7%	22.7%	25.2%	23.8%	23.4%	22.6%
	Min	6.9%	8.7%	8.3%	9.8%	9.0%	9.5%	8.8%	9.4%	8.7%
	Max	31.0%	45.8%	39.4%	50.0%	39.5%	45.9%	46.6%	41.5%	44.1%
01–05	Ave	25.2%	33.5%	30.6%	35.7%	33.1%	37.9%	33.1%	35.9%	32.9%
	Min	16.0%	22.1%	19.5%	23.3%	21.0%	26.3%	22.1%	23.7%	21.6%
	Max	34.7%	43.8%	40.9%	49.5%	44.2%	50.3%	43.7%	48.9%	42.9%
06–10	Ave	10.9%	15.8%	14.2%	19.0%	17.0%	18.8%	16.7%	17.8%	15.7%
	Min	5.8%	9.2%	8.4%	10.6%	9.5%	11.2%	9.3%	10.0%	8.9%
	Max	24.4%	29.5%	27.5%	31.5%	31.2%	34.5%	30.5%	33.9%	30.1%
11–15	Ave	27.8%	43.2%	37.1%	48.3%	45.3%	45.9%	45.6%	44.1%	43.1%
	Min	21.1%	31.7%	27.9%	35.4%	33.3%	32.8%	33.4%	30.8%	32.7%
	Max	35.9%	58.0%	50.2%	73.8%	64.4%	68.0%	66.3%	65.5%	60.6%
16–20	Ave	15.6%	22.9%	19.8%	26.1%	23.2%	24.5%	23.0%	23.7%	22.8%
	Min	5.5%	12.2%	10.6%	18.6%	14.9%	15.3%	15.3%	13.4%	12.9%
	Max	24.1%	32.2%	28.5%	34.8%	33.4%	33.7%	32.7%	32.8%	32.2%

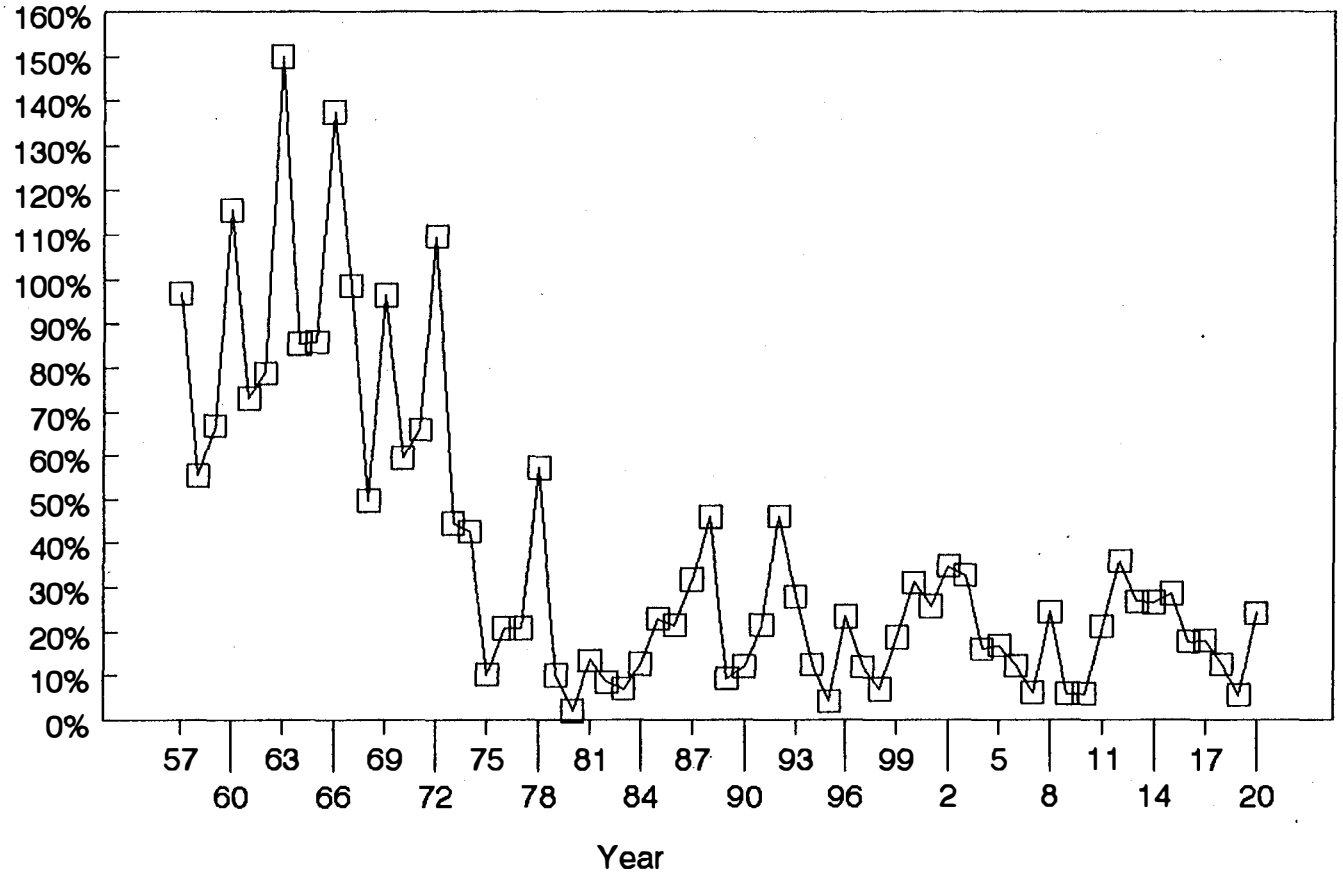
* Note Baseline values are actual from 1957–1985 model results from 1985–2010

Table 04. Empirical Life Cycle Model Results of 1993 Planned vs 1992 Implemented Actions being simulated for future Years for Imnaha River Spring/Summer Chinook Indicator Stock (Assuming Predation Mortality Reduction at 10% Level).

		Spawning Escapement expressed as percent of goal								
Return		Baseline	Trans. Model 1		Trans. Model 2		Trans. Model 3		Trans. Model 4	
Years		Conditions	Planned	Implemented	Planned	Implemented	Planned	Implemented	Planned	Implemented
57–69	Ave	74.0%								
	Min	33.1%								
	Max	215.3%								
70–79	Ave	70.4%								
	Min	15.0%								
	Max	149.9%								
80–90	Ave	24.9%								
	Min	8.7%								
	Max	24.9%								
91–95	Ave	18.9%	20.5%	20.3%	23.4%	21.7%	22.3%	21.2%	21.0%	20.5%
	Min	5.4%	8.9%	8.0%	18.1%	12.6%	14.7%	10.9%	10.6%	8.9%
	Max	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%
96–00	Ave	19.0%	25.4%	23.8%	31.5%	28.0%	30.0%	26.5%	27.7%	24.5%
	Min	8.9%	10.6%	10.3%	11.6%	10.8%	11.4%	10.6%	10.9%	10.2%
	Max	34.8%	44.5%	41.2%	57.5%	51.4%	51.7%	48.0%	49.0%	43.0%
01–05	Ave	21.7%	30.9%	28.0%	33.6%	31.3%	33.2%	30.6%	32.6%	29.0%
	Min	11.4%	20.8%	18.1%	24.6%	21.0%	25.9%	20.4%	23.6%	18.9%
	Max	30.3%	40.3%	37.2%	44.2%	43.2%	42.1%	41.7%	41.1%	39.8%
06–10	Ave	10.8%	19.8%	18.5%	28.6%	23.6%	25.5%	22.8%	22.0%	19.2%
	Min	5.3%	9.3%	8.4%	11.5%	9.9%	11.3%	9.5%	10.6%	8.8%
	Max	19.4%	24.4%	25.2%	39.2%	32.3%	33.8%	29.0%	27.1%	24.6%
11–15	Ave	25.7%	47.3%	41.0%	54.4%	46.8%	53.1%	46.1%	48.1%	44.2%
	Min	17.2%	31.7%	28.0%	39.5%	32.3%	38.9%	33.0%	36.6%	30.4%
	Max	31.6%	59.2%	52.8%	72.7%	63.1%	69.5%	60.2%	60.2%	57.1%
16–20	Ave	12.9%	25.7%	22.7%	34.7%	28.4%	31.8%	27.5%	27.8%	24.7%
	Min	7.2%	21.4%	19.8%	28.7%	24.7%	28.2%	24.3%	25.4%	20.7%
	Max	16.4%	29.7%	26.7%	42.4%	31.8%	35.5%	29.3%	30.3%	28.6%

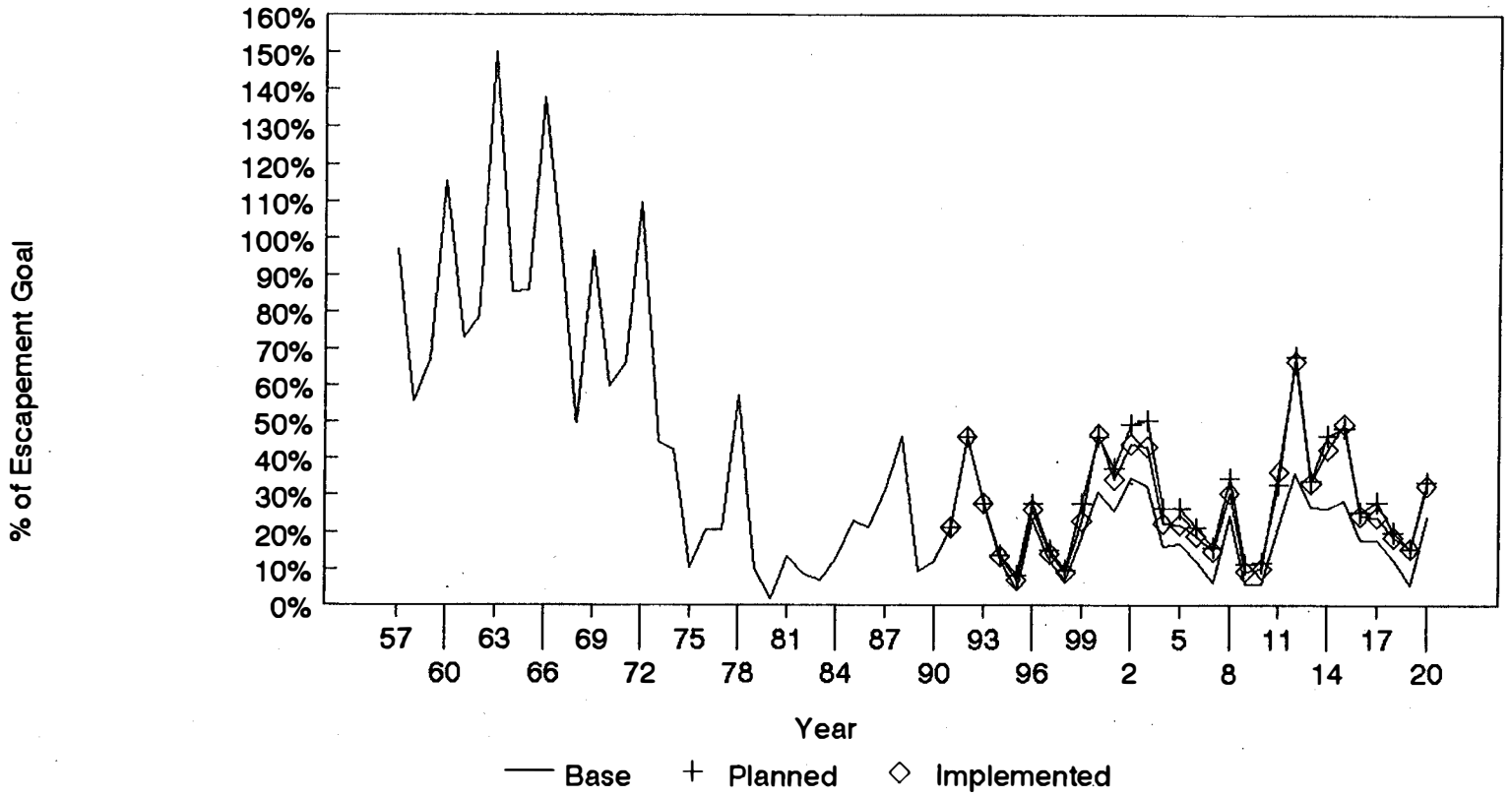
*Note Baseline values are actual from 1957–1985 and model results from 1985–2010

Figure 01. Snake River Spring Chinook (Marsh Creek Indicator Stock) Analysis Results from ELCM for Baseline Conditions.



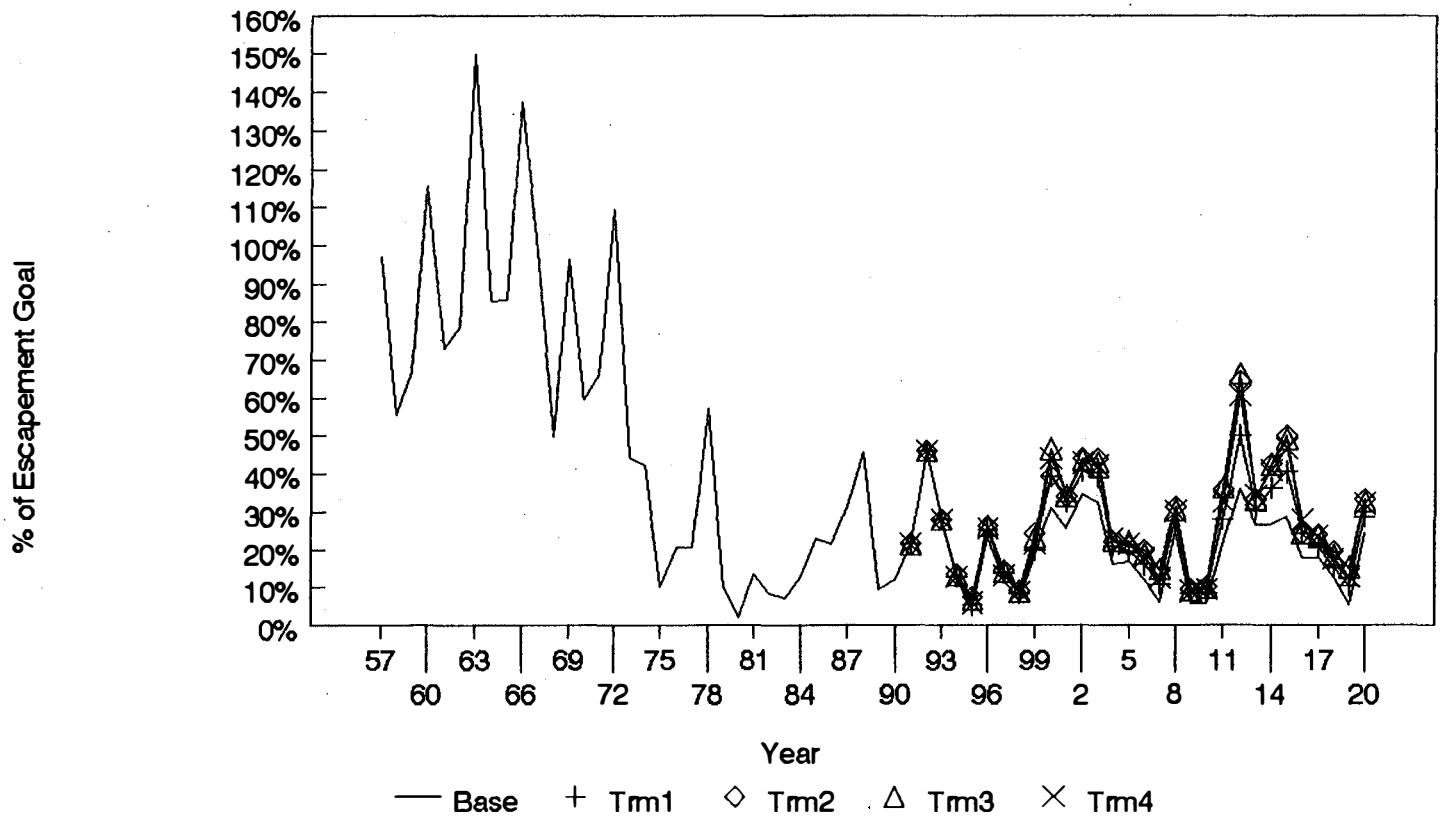
* Note Baseline values are actual from 1957–1985 model results from 1985–2010

Figure 02. Snake River Spring Chinook (Marsh Creek Indicator Stock) Analysis Results from ELCM for assuming Implemented 1992 Operations in the future vs Planned 93 Operations for the Transport Model# 3 (assume predator mortality reduction of 10%).



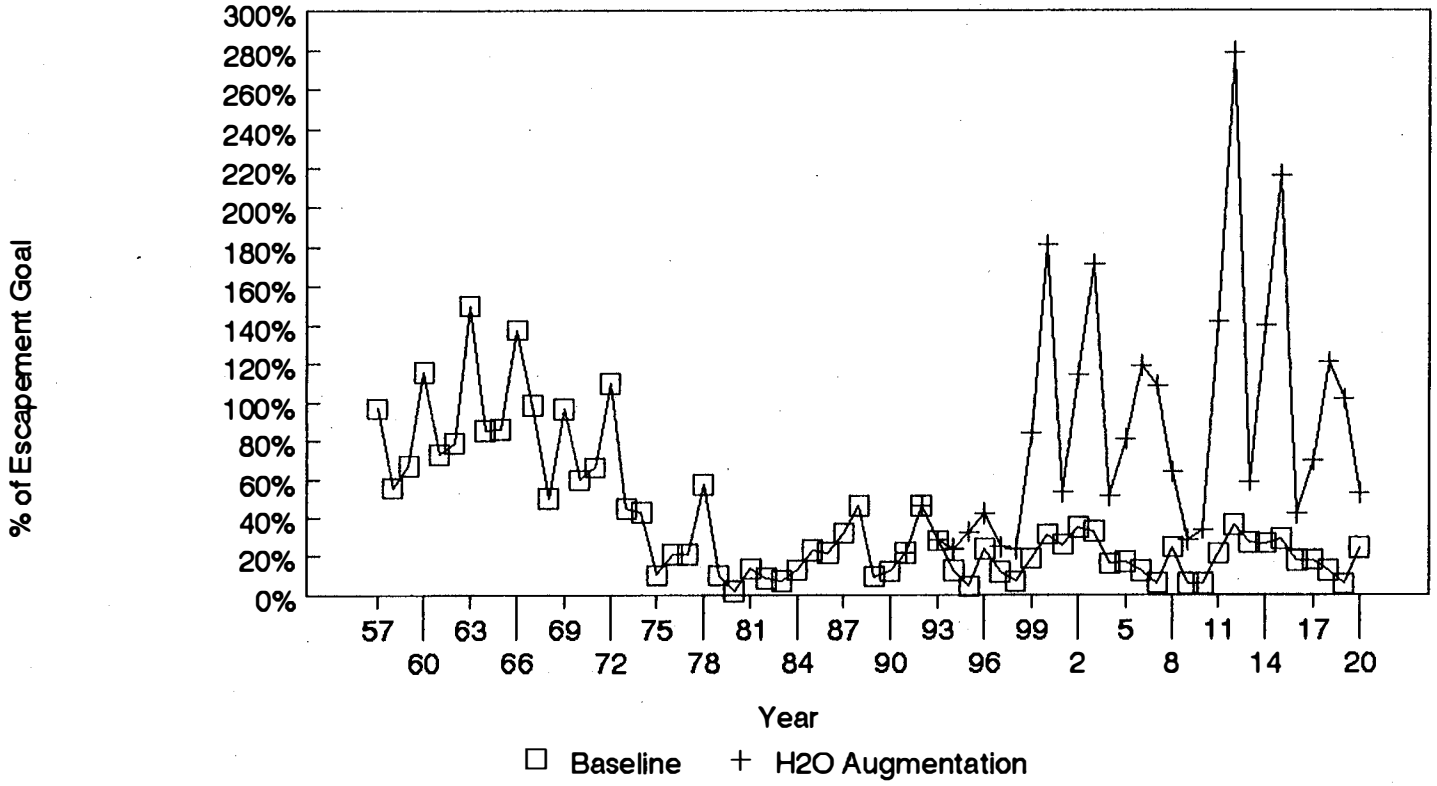
* Note Baseline values are actual from 1957–1985 model results from 1985–2010

Figure 03. Snake River Spring Chinook (Marsh Creek Indicator Stock) Analysis Results from ELCM for Baseline Conditions vs assuming Implemented 1992 Operations in the future for the four Transport Models (assume predator mortality reduction of 10%).



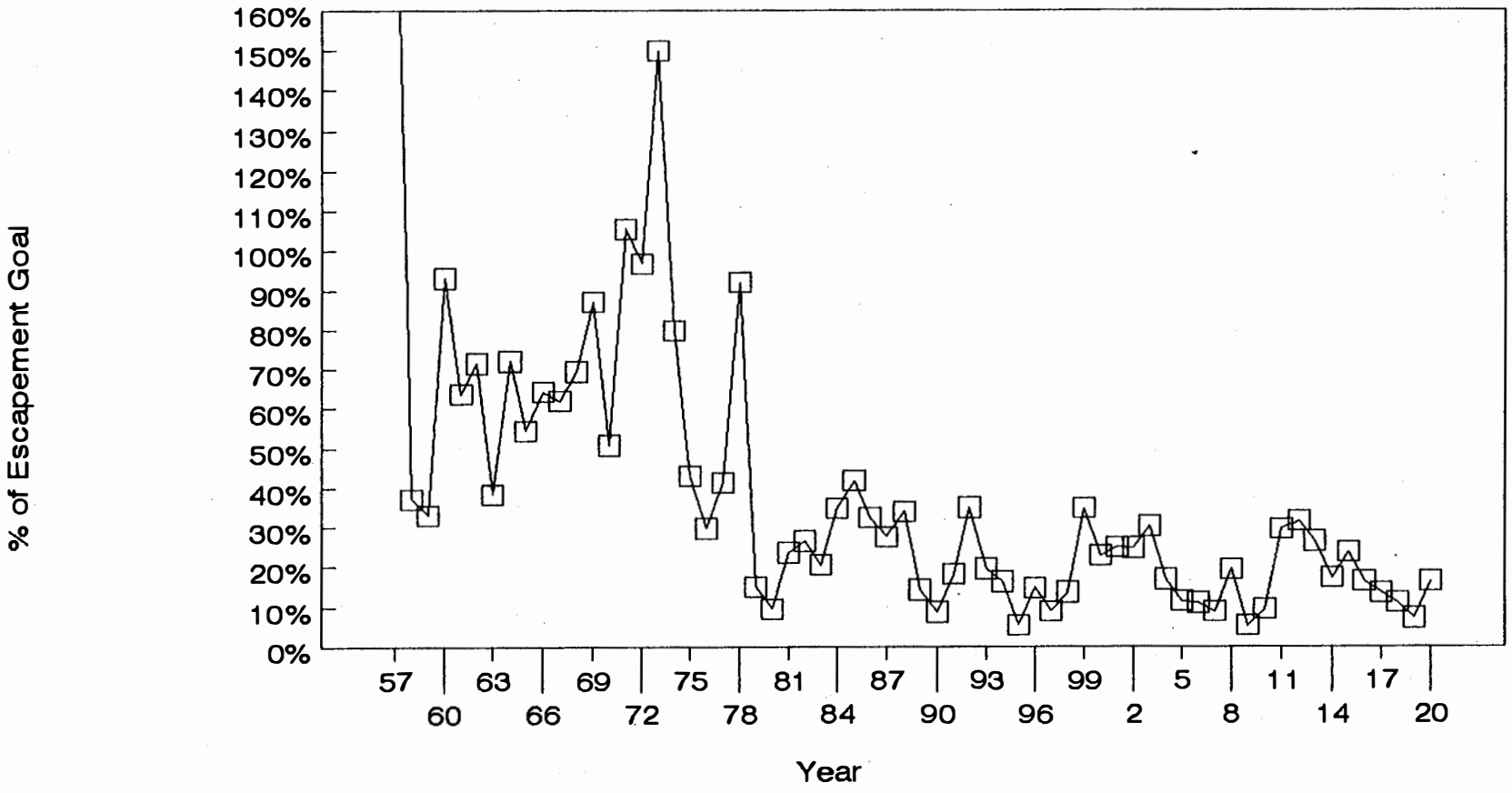
* Note Baseline values are actual from 1957–1985 model results from 1985–2010

Figure 04. Snake River Spring Chinook (Marsh Creek Indicator Stock) Analysis Results from ELCM for Baseline Conditions vs Sensitivity to High Water Augmentation Scenario (assume predator mortality reduction of 10%).



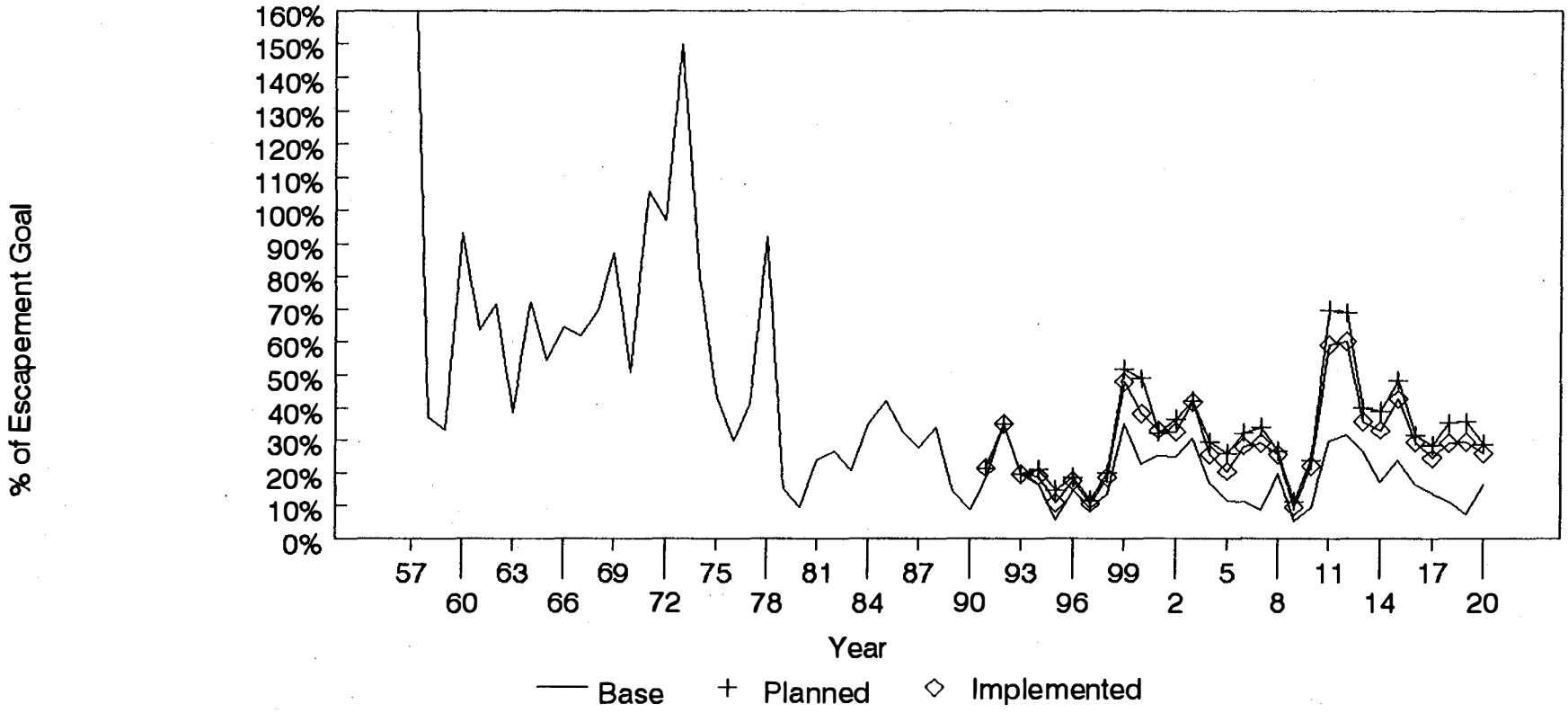
* Note Baseline values are actual from 1957–1985 model results from 1985–2010

Figure 05. Snake River Spring/Summer Chinook (Imnaha River Indicator Stock) Analysis from ELCM for Baseline Conditions.



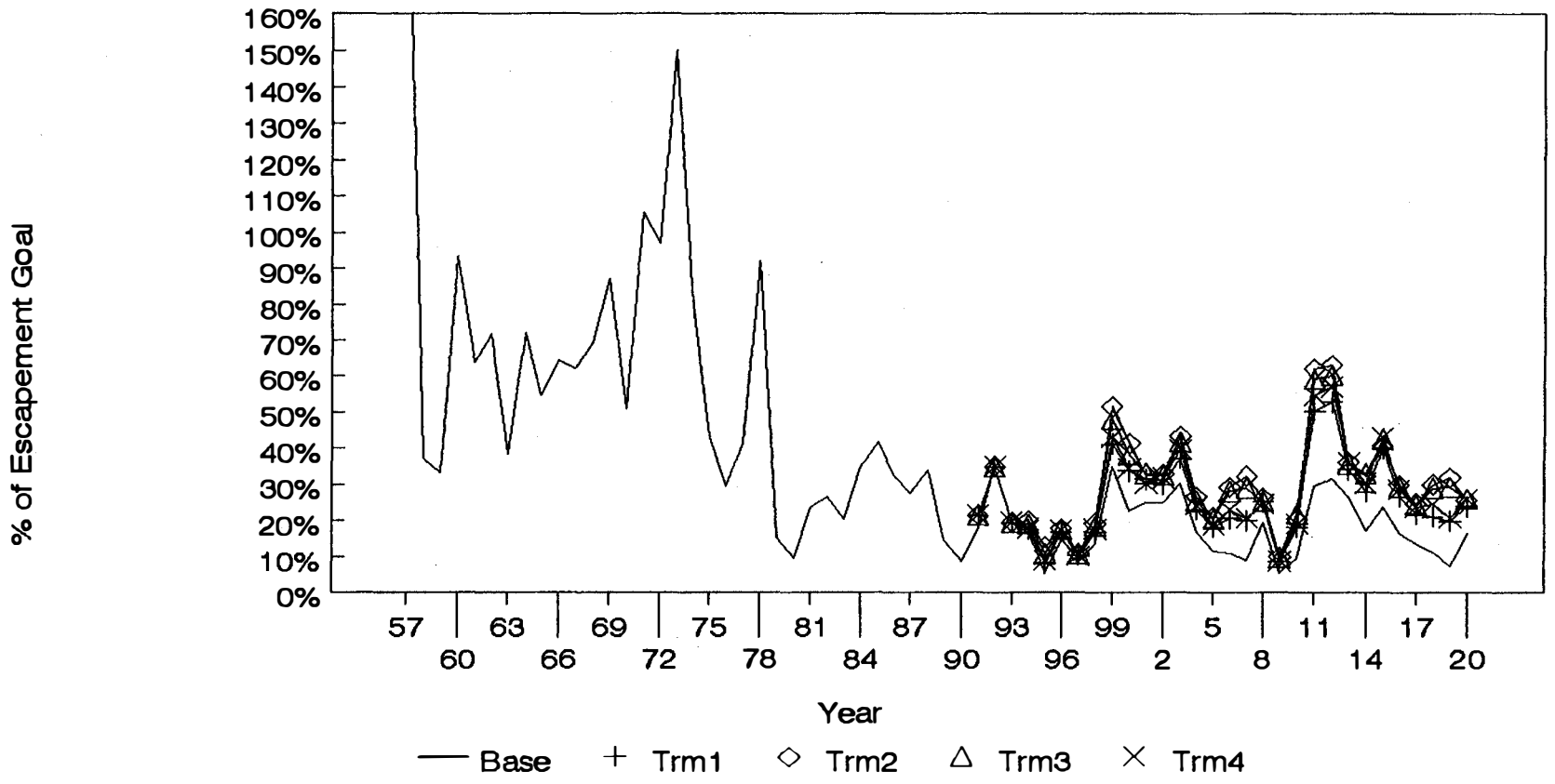
*Note Baseline values are actual from 1957–1985 and model results from 1985–2010
* 1957 value = 215%

Figure 06. Snake River Spring/Summer Chinook (Imnaha River Indicator Stock) Analysis from ELCM for assuming implemented 1992 Operations in the future vs Planned 93 Operations for the Transport Model #3 (assume Predator Mortality reduction of 10%).



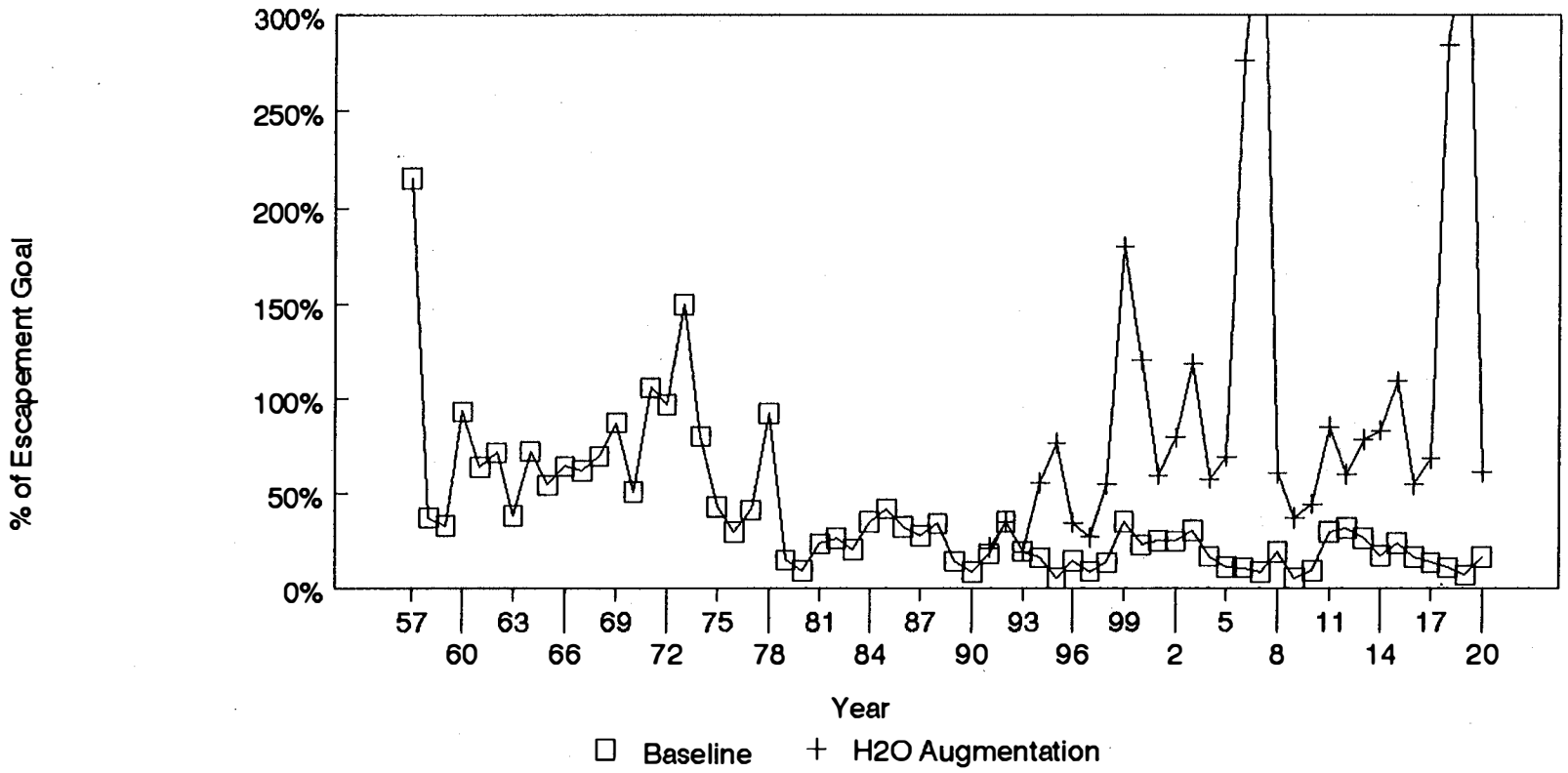
*Note Baseline values are actual from 1957–1985 and model results from 1985–2010
* 1957 value = 215%

Figure 07. Snake River Spring/Summer Chinook (Imnaha River Indicator Stock) Analysis from ELCM for Baseline vs assuming implemented 1992 Operations in the future for the four transport models (assume Predator Mortality reduction of 10%).



*Note Baseline values are actual from 1957–1985 and model results from 1985–2010
* 1957 value = 215%

Figure 08. Snake River Spring/Summer Chinook (Imnaha River Indicator Stock) Analysis from ELCM for Baseline Conditions vs Sensitivity to High Water Augmentation Scenario (assume predator mortality reduction of 10%).



*Note Baseline values are actual from 1957 – 1985 and model results from 1985 – 2010
* two years of simulation exceed 300%

Appendix H
Comments and Responses

APPENDIX H - COMMENTS AND RESPONSES

This appendix documents the public and agency review of the draft SEIS and how this review was used to formulate the final SEIS. The appendix includes a summary of the review process, discussion of the nature of the comments, a listing of all commentors, full reproduction of letter comments, and responses to all comments. Changes in the SEIS text in response to comments are noted in the responses.

1.0 Draft SEIS Review Process

The draft SEIS was officially filed with the U.S. Environmental Protection Agency and released for public and agency review on October 23, 1992. Approximately 2,200 copies of the draft SEIS were distributed to elected officials, government agencies, tribal organizations, associations, businesses, individuals, and public libraries. A 45-day period, ending December 7, 1992, was allowed for review of the draft SEIS.

Nine public meetings were held at locations throughout the region to facilitate review of the draft document. Each meeting consisted of three parts. The first part was an introductory presentation consisting of a slide show, graphics, maps, and a narrative discussion of the issues involved and the anticipated effects. The second part was a question and answer session facilitated by Corps staff. The question and answer session allowed the public to ask questions of the agency staff responsible for the preparation of the final SEIS. The third part of each public meeting was a formal public hearing open to all speakers who wished to provide formal testimony. All hearing testimony (and the question and answer session) was documented by a court reporter, and hearing transcripts are available for purchase at the cost of reproduction.

Recipients of the draft SEIS were encouraged to submit written comments on the document by December 7, 1992. Many letters were received, including some after the official closing date for the comment period, and were reviewed by the cooperating agencies as part of final SEIS preparation. Commentors were asked to direct their comments to the Corps, but comments were forwarded as necessary to BPA and BoR.

2.0 Draft SEIS Comments

The cooperating agencies received written or verbal input from a total of 115 commentors during the review process. This included 38 speakers at the public hearings, 75 letters, and 2 written statements submitted at the public meetings. The comment letters received ranged from one-page handwritten notes to large packages with lengthy reviews supported by multiple attachments. All comments were considered seriously, regardless of style or volume.

Corps and contractor staff reviewed all comment letters, statements, and hearing records and identified substantive comments on each source. Letters and written and verbal statements were all assigned alphanumeric codes, and all comments within each source were numbered sequentially to provide a unique identifier for each comment. This process resulted in the identification of 712 comments among all comment sources.

A summary of the draft SEIS review input is provided in Table H-1. Over half of the letters and written statements (48 out of 75) were from individuals and businesses from throughout the region and the project area. Comment letters were received from multiple state agencies and elected officials in Idaho, Montana, Oregon, Washington, and Wyoming. Seven Federal agencies and 1 member of Congress submitted letters, as did 5 tribal organizations. The 31 associations/ organizations submitting letters were rather evenly divided between river user interests concerned about operational impacts from various flow measures and environmentally-oriented groups emphasizing the need for urgent measures to conserve the salmon stocks. A few letters from associations were formula letters that repeated a consistent set of comment themes. Representation among comment letters from individuals was similarly divided.

A complete listing of all commentors is included as Table H-2, which follows the text discussion of this appendix and functions as a table of contents for the comments reproduced here. All comment letters and written statements submitted at the public hearings are reproduced in this appendix. Comment letter attachments that do not contain substantive comments directly addressing the SEIS are omitted. Because of the large volume of the hearing transcripts and the fact

Table H-1. Summary of draft SEIS review input.

Category	Number
Federal government (F)	10
State government (S)	12
Regional/Tribal organizations (R)	7
Local (L)	1
Association/Organization/Business (A)	31
Individual (I)	16
Testimony at hearing	38
Total	115

that most hearing testimony is repeated in letter comments, comments identified from the hearing record are also not reproduced. Copies of the hearing transcripts are available on request. The complete printed record of all comments received on the draft SEIS is maintained by the Walla Walla District of the Corps and is available for public review at the District offices.

As part of the comment review process, comments were categorized according to the issues addressed and support for or opposition to specific flow measure alternatives or options. Effects on salmon and fish modeling were the most frequent issues mentioned and were the subject of about 28 percent of all the comments (188 out of 712). The next most common issue was the scope of the SEIS, which was mentioned in 91 comments (13 percent). Other frequent issue categories were questions on the implementation or modeling of system operations (84 comments), plan selection criteria or results (62 comments), resident fish (51 comments), fish bypass and/or transportation (43 comments), economic evaluation of the actions (41 comments), electric power (36 comments), socioeconomics (26 comments), fish harvest (23 comments), and recreation (20 comments). All other issue categories received less than 20 comments, or less than 3 percent of the comment total.

About 13 percent of the comments explicitly stated support for a flow measure alternative or option. The most frequent comments in this category were support for or opposition to the mainstem drawdown strategy (14 comments on each side of the issue), and support for or opposition to the preferred alternative (12 comments each). The general concept of flow augmentation also received divided support (4 comments each). Opposing comments generally outnumbered supporting comments for Alternatives 2, 3 and 5. A total of 39 supportive comments were distributed among the 5 SEIS alternatives or other actions identified by the commentors. Three letters proposed a specific plan for interim operations that included partial or phased implementation of the reservoir drawdown strategy beginning immediately. Opposition to various flow measures was expressed in 51 comments.

3.0 Response to Comments

The cooperating agencies have prepared a response to each of the 712 comments received on the draft SEIS, regardless of whether the comment is reproduced in the appendix. These comments are provided in two formats. Certain issues or themes recurred frequently throughout the comments received on the draft SEIS. Broader recurring themes in this category generally related to various relatively well-known factors contributing to the current status of the salmon stocks or to issues generated by the specific focus of the SEIS. Many other recurring themes more narrowly targeted specific criticisms of the SEIS and/or specific resource concerns. To facilitate responding to these recurring themes, comments of this type have been grouped into 11 common issues. The common issues are listed

Table H-2. Commentors on the draft SEIS.

Comment	Organization/Person	Person	Date
	Federal		
F1	U.S. Dept of Housing and Urban Development	Myron G Eckberg	10/23/92
F2	U.S. Forest Service, Pacific Northwest Region	Gordon Haugen	11/10/92
F3	U.S. Dept of Agriculture, Soil Conservation Service	Lynn A. Brown	11/17/92
F4	U.S. Dept of Agriculture, Soil Conservation Service	Richard J. Gooby	11/30/92
F5	U.S. Dept of Agriculture, Soil Conservation Service	Randy Phelan	undated
F6	U.S. Dept of Health and Human Services, Public Health Service, Centers for Disease Control	Kenneth W. Holt	12/03/92
F7	U.S. Dept of Interior, Bureau of Indian Affairs	G.D. Ben	12/07/92
F8	U.S. Senate	Larry E. Craig	12/07/92
F9	U.S. Department of the Interior	Charles S. Polityka	12/21/92
F10	U.S. Environmental Protection Agency	Charles E. Findley	12/14/92
	State		
S1	Idaho Department of Water Resources	R. Keith Higginson	11/12/92
S2	State of Idaho, Representative	Ken Robison	11/17/92
S3	State of Montana, Dept of Natural Resources and Conservation	Gary Fritz	11/23/92
S4	State of Washington, Dept of Community Development	Robert G. Whitlam	11/24/92
S5	State of Montana, Office of Governor	Stan Stephens	12/07/92
S6	Oregon Dept of Fish and Wildlife		12/5/92
S7	Idaho Dept of Fish and Game	Jerry M. Conley	12/04/92
S8	Idaho Dept of Parks & Recreation	Yvonne S. Ferrell	12/04/92
S9	Washington State Dept of Transportation	Donald S. Senn	12/07/92
S10	State of Wyoming, Office of Governor	Mike Sullivan	12/07/92
S11	State of Washington, Department of Ecology	T.L. Elwell	12/10/92
S12	Idaho State Historical Society	Kenneth J. Swanson	12/10/92
	Regional/Tribal		
R1	Upper Columbia United Tribes Fisheries Research Center	Allan T. Scholz	10/24/92
R2	Confederated Salish and Kootenai Tribes of the Flathead Nation	Michael T. Pablo	11/05/92
R3	Confederated Salish and Kootenai Tribes of the Flathead Nation	Michael T. Pablo	12/07/92
R4	Colville Confederated Tribes	Patti Stone	12/01/92
R5	Nez Perce Tribal Executive Committee	Samuel N. Penney	12/02/92
R6	Columbia River Inter-Tribal Fish Commission	Ted Strong	12/07/92
R7	Northwest Power Planning Council	Ted Bottiger	12/10/92
	Local		
L1	Clearwater County Board of Commissioners	Donald Ponozzo	11/30/92
	Association		
A1	Wildlife Forever, Inc.	Clyde V. Brummell	11/05/92
A2	Northwest Irrigation Utilities	Darryll Olsen	11/10/92
A3	Flathead Wildlife, Inc.	Herbert Johnson	11/11/92
A4	Harney Electric Cooperative, Inc.	Jack Heaston	11/12/92
A5	Western Montana Electric Generating & Transmission Cooperative, Inc.	Ronald Wilkerson	11/12/92
A6	Stanley-Sawtooth Chamber of Commerce	Tom Stuart	11/16/92
A7	AgriNorthwest	R. Thomas Mackay	11/17/92
A8	AgriNorthwest	J. Rodney Larson	11/18/92
A9	AgriNorthwest	D. Jeffrey Mason	11/18/92

Table H-2. Commentors on the draft SEIS.

Comment	Organization/Person	Person	Date
A10	Montana Wildlife Federation	Herbert B. Johnson	11/18/92
A11	Mercer Ranch	Richard T. Beightol	11/11/92
A12	Flathead Basin Commission	Elma Darrow	undated
A13	Idaho Rivers United	Charles Ray	12/06/92
A14	Pacific Northwest Waterways Association	Glenn Vanselow	12/07/92
A15	Northwest Resource Information Center, Inc.	Ed Chaney	12/07/92
A16	Idaho Steelhead & Salmon Unlimited		11/30/92
A17	American Rivers	F. Lorraine Bodi	12/04/92
A18	Public Power Council	William K. Drummond	12/07/92
A19	Pacific Northwest Utilities Conference Committee	Al Wright	12/07/92
A20	Valley Soil Conservation District	Ken Postma	12/03/92
A21	Orofino Chamber of Commerce	H.L. "Roy" Clay	12/03/92
A22	Valley Graphics	Larry Schlieper	12/04/92
A23	Pacific Northwest Generating Cooperative	Dave Harper	12/03/92
A24	Glenwood IGA Foodliner	Doug Donner	12/03/92
A25	Direct Service Industries, Inc.	John D. Carr	12/07/92
A26	Northwest Environmental Defense Center	John K. Eltman	12/07/92
A27	Tobacco Valley Economic Development Council	Joe Gibbons	12/03/92
A28	Idaho Water Users Association, Inc.	Lynn Tominaga	12/08/92
A29	Idaho Wildlife Federation	Robert Minter, Jr.	12/04/92
A30	Flathead Lakers Inc.	Dick Wollin	12/09/92
A31	Dworshak Excursions	Jerry O. Olin	12/03/92
	Individual		
I1	Burkholder	Reed	10/28/92
I2	Schwarzkof	Lyman K.	10/29/92
I3	Waugh	Wade & Carol	11/01/92
I4	Pritchard	Jim	11/28/92
I5	Bayer	F.A.	11/13/92
I6	McClure	Linda	11/13/92
I7	Barker	Roy E.	11/16/92
I8	Mason	Warren H.	11/17/92
I9	Nielson	Kent	11/18/92
I10	Cooke	Faith	11/18/92
I11	Clouston, Jr.	Sidney N.	11/19/92
I12	Larsen	William F.	12/07/92
I13	Townsend	Thomas A.	12/06/92
I14	Chaumell	Thayne	12/03/92
I15	Gunderson	Frank	12/04/92
	Testimony		
T1-1	Kubasko	Wayne	11/04/92
T1-2	Windom	Rita	11/04/92
T2-1	Dos Santos	Joe	11/05/92
T3-1	Hanson	Keith	11/09/92
T3-2	Wilson	Jim	11/09/92
T3-3	Burnham	Bob	11/09/92

Table H-2. Commentors on the draft SEIS.

Comment	Organization/Person	Person	Date
T3-4	Isbelle	Greg	11/09/92
T3-5	Loseth	John	11/09/92
T3-6	Unidentified Speaker		11/09/92
T3-7	Isbelle	Greg	11/09/92
T3-8	Rintelen	Joe	11/09/92
T4-1	Mulligan	Bill	11/10/92
T5-1	Yost	Jim	11/12/92
T5-2	Tominaga	Lynn	11/12/92
T5-3	Minter	Bob	11/12/92
T5-4	Beightol	Richard	11/12/92
T5-5	Yost	Jim	11/11/92
T5-6	Ziari	Fred	11/12/92
T5-7	Beightol	Richard	11/12/92
T5-8	Bowler	Bert	11/12/92
T5-9	Higginson	Keith	11/12/92
T5-10	Tominaga	Lynn	11/12/92
T5-11	Robison	Ken	11/12/92
T5-12	Minter	Bob	11/12/92
T6-1	Tester	Nanci	11/16/92
T6-2	Clouston, Jr.	Sidney	11/16/92
T7-1	Ziari	Fred	11/17/92
T7-2	Satter	Craig	11/17/92
T8-1	Cooke	Faith	11/18/92
T8-2	Beightol	Richard	11/18/92
T8-3	Baker	Jim	11/18/92
T8-4	Lovelin	Bruce	11/18/92
T8-5	Walkley	Van	11/18/92
T8-6	Hossom	Charles	11/18/92
T9-1	Self	Win	11/19/92
T9-2	Cloud-Moses	Cheryl	11/19/92
T9-3	Truscott	Kirk	11/19/92
T9-4	Pelton	Randy	11/19/92

below, followed by a synopsis of the issue and the cooperating agencies' response.

Responses to all of the comments received are provided at the back of this appendix. Individual comments that relate to one of these common issues are referred to the master response for that common issue. Individualized responses are provided to all of the comments that do not represent a common issue.

Common Issues and Responses

The 11 common issues are listed as follows, in no particular order:

1. Adequacy of the range of alternatives.
2. Scope of the SEIS with respect to the types of measures considered.
3. Appropriate time horizon for the SEIS.
4. Estimation of recreation impacts and associated economic consequences, primarily at Dworshak.
5. Validity of the flow/travel time/survival relationship, and the effectiveness of flow improvements.
6. Implications of other pending or potential endangered species listings.
7. Analysis of effects on resident fish species at storage reservoirs and river reaches downstream.
8. Benefits of the juvenile fish transportation program.
9. Methods, assumptions, and data inputs for the fish passage and life-cycle models.
10. Effect of 1992 salmon flow measures on Libby and Hungry Horse operations.
11. U.S. Fish and Wildlife Service Coordination Act Report 1993 operation alternatives.

The specific positions and aspects associated with these common issues are summarized in order below, along with a response addressing each issue.

Common Issue 1: Adequacy of the range of alternatives.

Issue:

Many commentors faulted the range of action alternatives evaluated in the SEIS. Typically, these comments indicated that there were only minor differences among the four action alternatives and that the complete range of alternatives in the SEIS represented a very limited choice between no action and slight variations on the planned 1992 operations. Most stated that additional alternatives should be included in the final SEIS or that a revised draft should be issued. Several comments took the position that the draft SEIS did not meet the NEPA requirement to consider a reasonable range of alternatives.

Comments in this issue category can generally be classified into two groups based on source and nature of the comments. A number of fisheries agencies and environmental groups within the region criticized the range of alternatives. These comments typically accepted as a given that flow improvement measures were effective and appropriate, and focused on the level of action that the river-managing agencies were proposing. A common theme among these interests was that more aggressive flow improvement actions should be considered and implemented and that continuation of 1992 measures would not provide sufficient benefits to the listed salmon stocks. Several comments recommended specific measures or goals, such as actions to meet the flow targets proposed by the Columbia Basin Fish and Wildlife Authority or an operating scenario involving Snake River drawdown.

River user interests, primarily those associated with electric power, constituted most of the commentors in the second group for this issue. While these comments also requested a wider range of alternatives, they typically questioned the effectiveness or desirability of flow measures and recommended other types of measures be considered.

Response:

The range of alternatives considered was based on the alternatives evaluated in the 1992 OA/EIS, public information meetings held in the region in July 1992, and modifications which are within existing authority and implementable. The 1992 OA/EIS alternatives included several with flow measures beyond those selected in 1992. Further, the experience and analysis of information garnered from the 1992 OA/EIS and 1992 operations provided guidance in the selection of

alternatives to consider. Consideration was given to those alternatives that are implementable within the time frame of the operations addressed by the SEIS. The cooperating agencies conclude the range of alternatives considered in the SEIS is appropriate.

Alternatives beyond the scope of this SEIS, those requiring more detailed analysis, are being considered in other studies including SOR and SCS. Further description of these alternatives is found in Appendix C.

The alternatives in the SEIS are not limited by the planning done under the Pacific Northwest Coordination Agreement. Planning for the water year 1992 to 1993 started in February 1992. However, this planning does not foreclose any operation which is developed through this NEPA process and consultation with NMFS.

The historical water budget of 3.45 MAF on the Columbia River and 600 KAF from Dworshak Project is considered part of the no-action alternative (planned operations between 1985 and 1990). The suggestion that the benefit of the historical water budget be evaluated separately is currently being considered as an alternative under the SOR.

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Common Issue 2: Scope of the SEIS, with respect to the types of measures considered.

Issue:

This issue overlaps to some extent with Common Issue 1, as some of the comments in this second category stated that the river managing agencies should consider harvest, habitat, and other types of measures in addition to flow improvements. However, there was a distinct body of comments adopting the position that the draft SEIS should have made a comprehensive evaluation of all potential salmon recovery measures, without limiting the scope to flow improvements. Further, these comments stated that the costs and benefits of the proposed flow improvement measures should be evaluated along with the nonflow measures, and the most cost-effective among the entire range of possible actions should be selected. Comments in this issue group generally came from river user interests, organizations concerned about resources in the upstream portions of the basin, and individuals objecting to the cost to ratepayers of the flow improvement actions. Some river users making these comments suggested additional alternatives, most commonly harvest reductions or refinements to the juvenile fish transportation program.

Response:

After careful consideration of these comments, the Corps and the cooperating agencies have determined that the scope of the SEIS will remain as stated in the draft. The actions addressed in the SEIS are in response to the listing of the Snake River salmon species pursuant to the ESA. In exercising its responsibilities under the ESA, NMFS is generating a comprehensive consultation and recovery plan on the effects of various factors on the listed species. Additionally, the NPPC is undertaking a comprehensive evaluation to address other measures.

The purpose of this SEIS is to improve flows for salmon during 1993 and future years. The scope of the SEIS conforms to the limits of the agencies' jurisdiction and expertise in river management and power marketing. To attempt to address issues such as harvest and habitat restoration in this SEIS would be impractical. The SEIS explains in detail numerous other cooperative decision processes already in place addressing fish transportation and bypass, acquisition of additional water supplies, the long-term structural configuration of the hydro-system, generating resource acquisition, and related subject areas. Some have

existed for many years, while others were created recently to deal with salmon concerns.

Common Issue 3: Appropriate time horizon for the SEIS.

Issue:

The purpose and scope discussions of the draft SEIS indicated that the proposed actions would likely be implemented over an interim period of several years while long-term river system structural and operating plans were developed through related but separate processes. A number of commentors felt that this time horizon adopted for the SEIS was not appropriate. Most of the comments in this issue category recommended a longer-term perspective in which the SEIS would facilitate a long-term recovery strategy for the river system. Reviewers taking this position also tended to support the lower Snake River drawdown strategy and wanted actions taken under the SEIS to demonstrate physical progress toward the drawdown strategy.

Conversely, a few comments stated that the SEIS should only apply to 1993 river system operations and that further environmental analysis should be required for actions beyond 1993. These comments came from a mixture of river user interests and state and tribal agencies. Comments favoring a one-year time horizon for the SEIS appeared to be based on concern over the degree of uncertainty associated with flow improvements and the desire for flexibility in adapting recovery actions as conditions and information change.

Response:

The scope discussions in the Executive Summary and Section 1 indicated that the SEIS covered an interim period spanning from 1993 to a future time when long-term structural and operational plans for the system have been developed. With respect to river operations, the SEIS represents a link between the 1992 OA/EIS and the SCS and SOR, the long-term study processes addressing system structures and operations. The Corps and the cooperating agencies believe that this time horizon of more than one year is both necessary and appropriate. The term of the SEIS needs to extend beyond 1993 because it would not be productive or efficient to prepare an annual supplement on Federal river system operations. Future supplements should only be prepared if and when significant new information becomes available or external events, such as additional ESA listings, require an adaptive response. Conversely, it is not feasible for the SEIS to present a long-term strategy because to do so would require results from other studies that are not yet complete.

Several of the review comments indicated that the SEIS should recommend steps to facilitate and contribute toward long-term structural measures, such as initiating irrigation pumping modifications to accommodate drawdown. These comments appear to assume that implementation of the drawdown strategy is a foregone conclusion. However, the NPPC identified drawdown as the preferred long-term strategy unless it is shown to be economically and technically infeasible or biologically imprudent. Until positive results on these measures are much more certain than at present, it would be unwise and unreasonable to propose structural measures that would only be used if the drawdown strategy were implemented. The status of existing information on these measures is addressed in the SCS status report that the Corps provided to the NPPC in December 1992.

Common Issue 4: Estimation of recreation impacts and associated economic consequences, primarily at Dworshak.

Issue:

Many comments questioned the accuracy of the SEIS analysis of projected changes in recreation use and the economic value of those changes. Government agencies, a variety of associations, and individuals concerned over impacts at Dworshak dominated this issue category. A variety of specific concerns is reflected in this group of comments. Most commonly, reviewers felt that estimated decreases on the order of 3 percent from baseline use were unrealistic, particularly in view of significantly lower water levels and use actually experienced during the 1992 recreation season. Some of these reviewers questioned the validity of the SOR recreation models that were used for these projections. Many commentors also took exception to the unit day values applied to changes in recreation use in the cost-effectiveness analysis and the resulting estimates of aggregate economic loss to recreation from the proposed actions. Virtually all of the comments on this specific item referred to losses to local recreation-dependent businesses that significantly exceeded the small lost recreation value estimates presented in the draft SEIS.

Some comments addressing recreation and related economic impacts suggested that the analysis include a

cumulative impact perspective. These comments indicated that the communities that would suffer economic losses from decreased recreation use had also experienced recent declines in other resource-related activities, which would compound their hardship and raise issues of fairness.

Response:

The comments in this issue category prompted an extensive review of the original assessments of recreation and related economic activity. As a result, Sections 4.10 and 4.13 have been revised to clarify the original analysis and provide additional information.

The underlying issue for these comments was the estimation of a 3 percent decrease in recreation visitation, which was viewed as a gross underestimate in light of actual conditions during 1992. The revisions to Section 4.10 explain that the 3 percent projection represents expected results with median water conditions, based on the 50-year historical water record, while extreme low water conditions were experienced in 1992. Moreover, attributing all of the decrease in recreational use at Dworshak in 1992 to the flow augmentation operation would be an oversimplification, as there were other factors influencing visitation during this period.

The new material also acknowledges that the SOR models used for the visitation estimates understate impacts because they do not include all recreational activities. However, the SOR recreation models themselves are sound and appropriate for this type of application. The recreation models are driven by the HYSSR elevation outputs. The HYSSR results indicated relatively little change in elevations compared to Alternative 1, so the recreation models projected small changes in visitation.

The new discussion of recreation-related economic impacts in Section 4.13 explains how the disputed economic loss figures were estimated and applied. Briefly, the economic loss estimate of $5,000 or less represents the visitation change projected by the recreation models multiplied by a $5 unit day value (an updated and rounded unit day value of $7 was used in the final SEIS). This was done in accordance with standard Federal procedures for national economic development (NED), or net economic impact, accounting. The resulting value estimates represent incremental changes in value to individual recreationists; they do not correspond to the total value of a visitor day, lost revenues to recreation providers, or lost revenues to recreation-related businesses.

Virtually all of the comments addressing recreation-related economic impacts focused on this last aspect of lost business. While these impacts do not enter into a cost-benefit or cost-effectiveness analysis, they are nevertheless real and a necessary topic of coverage in a NEPA document. Section 4.13 has therefore been expanded to provide more information on potential impacts to local businesses from lost recreation expenditures. It also discusses the cumulative aspects of further economic dislocations in less-developed local economies.

Common Issue 5: Validity of the flow/travel time/survival relationship and the effectiveness of flow improvements

Issue:

This issue represents the single most common topic among the comments on the draft SEIS. Many of the speakers asking questions or providing formal testimony at the public hearings in November 1992 noted research that questions the effectiveness of flow improvements in speeding fish migration. Most of these commentors specifically referred to recent research conducted or sponsored by NMFS (Marsh and Achord, 1992) and/or the Pacific Northwest Utilities Conference Committee (Stevenson and Olsen, 1991), which they interpreted as evidence that increasing flows or velocities would have little benefit for salmon. These comments were paralleled by a number of letters making the same points, with the additional mention of work by McNeil (1992) and Krieger and McNeil (1992) for Direct Service Industries, Inc. as pertinent reference material that needed to be considered in the SEIS.

Most of the comments on this issue came from river user groups, primarily those associated with irrigation and electric power interests. In general, these groups took the position that the above studies indicated that flow improvements were ineffective, particularly in terms of their relatively higher cost, or that the studies at least highlighted the significant degree of uncertainty over the benefits of flow improvements. Many of the comments in this category were linked with comments related to Common Issue 2, requesting a full evaluation of the costs and effectiveness of all available recovery measures.

A substantial minority of the comments on this issue were from state fishery agencies and environmental

groups. These sources strongly affirmed the research supporting the existence of a flow/travel time/survival relationship, and generally were critical of the research questioning the concept or its application.

Response:

The comments on this issue demonstrate that opinion within the region on the existence of such a relationship is sharply divided, and that the debate can not be resolved in the SEIS. The text has been updated to include references to the sources identified in the comments and not already addressed in the SEIS or the 1992 OA/EIS. However, no attempt in this SEIS has been made to resolve the issue and render a firm conclusion as to the existence and strength of a flow/survival relationship, as this would be nonproductive without extensive additional research. The Corps and NMFS are starting a process to develop a test protocol to reduce the uncertainty of the flows/ travel time/survival relationship. Any biological test would require separate NEPA documentation and ESA consultation.

The lack of a conclusive relationship (i.e., one with an acceptable level of uncertainty) between flow and daily indicates that many variables in addition to flow are involved in daily fish passage at a dam.

The sources referenced above suggest there is more uncertainty about the relationship than was recognized in the 1992 OA/EIS discussions. While the models indicate greater uncertainty, with the flow/survival relationship, the cumulative weight of the research does not demonstrate that absolutely no relationship exists. The cooperating agencies have an obligation to take action to contribute to the improvement of the listed stocks. Given this uncertainty, the cooperating agencies must use available scientific information and consider levels of water augmentation that may provide benefits to fish.

Common Issue 6: Implications of other pending or potential endangered species listings.

Issue:

A number of comments requested that the SEIS address the possible listing under the ESA of additional species found within the Columbia-Snake River system. Most of these comments referenced the bull trout, and the remainder identified the white sturgeon, both of which have been petitioned for listing. In nature, these comments primarily wanted the SEIS to acknowledge the existence of these potential ESA actions. Some of the comments mentioned the possibility of conflicts between the needs of various species, but more specific concerns or direction were generally not indicated.

Response:

Sections 2.3 and 4.3 of the text have been supplemented to provide additional information on the sturgeon and bull trout issues. Beyond clarifying the existing situation, there is little that can be done in the SEIS. The schedules for decisions on these potential listings make them difficult to address with any specificity in the SEIS. In view of the available information, the needs of these species are not sufficiently known and recovery actions are not reasonably foreseeable. Consequently, the Corps and the cooperating agencies have no choice but to proceed with salmon-related actions and adapt these plans at a later date, if necessary, to accommodate recovery actions for other species.

Common Issue 7: Analysis of effects on resident fish species at storage reservoirs and river reaches downstream.

Issue:

Comments in this category generally stressed the need to consider impacts of the proposed actions on resident fish species, primarily those found in the reservoirs behind Grand Coulee, Dworshak, Libby and Hungry Horse dams or in the free-flowing reaches of the Kootenai and Flathead rivers below Libby and Hungry Horse. Typical statements included "...little attention is given to resident fish in the Flathead watershed..." A few of these comments identified specific issues that the reviewers felt had not been sufficiently addressed, such as potential thermal effects on resident fish in the Flathead River. A secondary theme among some commentors in this group was that too much attention had been given to anadromous species and that more balance with respect to resident fish was needed.

Response:

Many of the comments in this group do not request specific changes or provide new information, but rather request more attention or consideration for resident fish. The response to these comments is that resident fish resources have been given full and fair treatment in the

SEIS, along with the other affected resources. Because the storage reservoirs are the focus of flow augmentation actions, storage reservoir resources such as recreation and resident fish have been emphasized in the document. Existing conditions and impact analyses for resident fish have been presented in detail commensurate with other resources and a systemwide operational assessment.

In response to comments with more specific issues, the resident fish discussions were carefully reviewed for areas requiring supplementation. Some additional information has been included and some of the impact analysis language has been clarified, but substantial revisions were not warranted. A key consideration here is that many of the impact issues raised in the comments would only be triggered by significant changes in physical operating characteristics. In most cases the hydroregulation results indicate that there would be minor changes in flow and elevation patterns, so the suspected impacts would not occur.

Common Issue 8: Benefits of the juvenile fish transportation program.

Issue:

Comments relating to the juvenile fish transportation program were generally divided into two distinct categories. A number of river user interests advocated fish transportation as beneficial to the fish and a key recovery measure on which to focus. In direct opposition were comments from several fishery agencies and environmental groups that criticized the program, disputed the research indicating benefits from transportation, and argued for other ways to aid migration while leaving fish in the river. Some comments from both types of sources suggested that transportation alternatives should be in the scope of the SEIS.

Response:

Few aspects of juvenile salmonid migration through the Snake and Columbia rivers have received more intensive evaluation over the last two decades than the juvenile fish transportation program. Research data has consistently shown favorable benefits from transportation, particularly for wild fish, and improvements in the program (facilities and handling methods) have resulted in positive responses in fish survival and adult returns. We recognize existing skepticism by some regarding the actual survival of transported smolt; however, it is the view of the cooperating agencies that the current body of data favors continuing transportation as one aspect of the overall 1993 Federal hydropower system operations. Research is continuing to further evaluate potential program improvements, including releases farther downstream than the existing site near Skamania, to achieve even higher survival rates. Regional fish agency and tribal representatives have an active role in the formulation and conduct of that research.

Despite the demonstrated success of the program, it has not individually provided sufficient survival improvement to overwhelm all of the other factors that are also contributing to the detriment of anadromous fish stocks, nor should it be expected to. While up to 20,000,000 smolts are transported annually, this represents one half or less of the migrants in the system. Thus, the transportation program in its present form is only one important aspect of juvenile fish migration. At this time, however, both the NMFS and the cooperating agencies have concluded that it is beneficial to continue transporting smolts in concert with the other measures designed to improve overall survival, such as flow augmentation, spill, and improvements to bypass systems.

As mentioned above, transportation is not an alternative to all other survival improvement measures. It is one of a set of measures. Beyond this, the only alternative to the transport element is to not transport and this has been considered in the review of existing research data.

Common Issue 9: Methods, assumptions, and data inputs for the fish passage and life-cycle models.

Issue:

A number of reviewers provided technical comments on the BPA and NPPC modeling analyses used to assess the effects of the proposed actions on anadromous fish. Most of these comments questioned one or more of the model assumptions or input parameters, particularly those regarding fish transportation, survival benefits from the predator control program, habitat improvements, harvest rates, and adult passage improvements. Some of the comments in this category addressed the set of models developed by the state fishery agencies and tribes (FLUSH and ELCM), results from which were not available for the draft SEIS but were reported in the final SEIS. Several of these comments claimed that the states' and tribes' models were more reliable and should be used to guide decision making. Others objected to the proposed inclusion of

FLUSH and ELCM results in the final SEIS on the grounds that these models had not yet been subjected to thorough public review. A final theme among Common Issue 9 comments was that the models should be used to disaggregate the benefits of individual flow improvement actions (e.g., operating John Day at minimum irrigation pool or summer releases from Dworshak) and of potential nonflow measures (such as harvest controls).

Response:

The purpose of using passage and life-cycle models for the SEIS analysis was to evaluate, using the best available information, the cumulative effects on the threatened and endangered stocks from all actions being considered. The models can be used to project relative changes in both downstream survival and long-term escapement trends.

The cooperating agencies are aware of the uncertainties involved in biological systems. Factors contributing to these uncertainties include: (1) limited quantitative information on the relation between various actions and survival or production of wild stock; (2) limited ability to project the effectiveness of specific proposed measures; and (3) the natural variability that occurs within populations. In addition, it is not possible to predict future runoff conditions. When possible, these uncertainties have been accounted for in the analyses through use of ranges of effectiveness, sensitivity analyses, and in the case of SLCM, the use of stochasticity. The values for model parameters were based on currently available technical information and the professional judgment of qualified experts.

Two processes are currently underway to facilitate review, understanding, and coordination of the three model systems (BPA, NPPC, and STFA). The first process will provide an independent peer review of the models, while the second is a longer term effort by technical staff directly involved in usage and development of the models. These processes should also increase understanding of how the various groups are interpreting currently available data.

While is possible to use the models to evaluate individual parameter measures, the agencies did not believe it to be appropriate for the SEIS. First, the primary purpose of the analysis was to assess the cumulative effects of all proposed and scheduled actions on survival and future stock trends, rather than to evaluate measures on an individual parameter basis. Second, in some cases, the uncertainty in the level of effectiveness of certain measures could limit the ability to draw conclusions regarding individual actions.

At the outset of the SEIS process, the Corps and cooperating agencies agreed that the anadromous fish impact analyses would also include results from the STFA. Because of ongoing review of STFA analysis, the cooperating agencies believe that the results of the STFA model should not be used in the development of the conclusions of the SEIS.

Common Issue 10: Effect of 1992 salmon flow measures on Libby and Hungry Horse operations.

Issue:

Many, if not most, of the draft SEIS comments originating within the state of Montana disagreed with the SEIS presentation of 1992 operating provisions that the Libby and Hungry Horse projects would not be regulated differently in response to the 1992 salmon flow improvement actions. Most of these comments appeared to be based on observations that reservoir levels at these projects were much lower than normal in 1992, which was attributed to system operating changes to benefit salmon. Some comments stated that spring 1992 discharges from Libby and Hungry Horse were higher than usual, and/or that the Montana projects had been used more for peaking. Virtually all reflected a feeling that the Montana projects had been required to produce more power during the spring and summer of 1992 to replace power lost elsewhere on the hydro system. Some comments referred to knowledge of specific operational actions that supported the contention that Montana projects were affected by salmon flow measures in 1992. These included indications that BPA was storing excess water purchased to meet the 3.0 MAF Columbia River flow augmentation target in Libby and Hungry Horse in the spring, and that Hungry Horse was drafted in summer to help refill Grand Coulee.

Response:

The analysis of the operation of Libby and Hungry Horse projects under Alternative 3 has been updated to better reflect changes in Libby and Hungry Horse operations if these projects were operated to reduce the effects of power generation changes caused by salmon flow improvement measures. The SEIS has also been revised to describe the potential operation of Libby to store a portion of the 3.0-MAF spring flow

augmentation water and its effects. These analyses estimate the incremental change in project operations, and do not evaluate the no action alternative. It should be recognized that under the no action alternative, the operation of Libby and Hungry Horse projects varies day-to-day to meet power and non-power requirements based on actual runoff conditions. The operation of these projects in 1992 reflected this flexibility of the hydrosystem to meet all needs.

Common Issue 11: U.S. Fish and Wildlife Service Coordination Act Report 1993 Operation Alternative

The preferred alternative, as identified in the draft Fish and Wildlife Coordination Act Report (CAR) prepared by the U.S. Fish and Wildlife Service, requests the Federal agencies to implement measures designed to achieve water velocity equivalents of the Columbia Basin Fish and Wildlife Authority flow recommendations. This alternative is supported by the Oregon Department of Fish and Wildlife, Idaho Department of Fish and Game, the Columbia River Inter-Tribal Fish Commission, and the U.S. Fish and Wildlife Service, and incorporates some elements from comment letters received from the agencies in response to the Draft SEIS.

The CAR alternative calls for increased flow augmentation on the lower Columbia and Snake rivers and in-river passage (no collection and transport) of all fish from April 15 through June 15. In addition, it calls for Lower Granite reservoir to be drafted to elevation 710 feet above mean sea level for this same time period. During this period, spill is requested at the four lower Snake River projects and McNary project in the lower Columbia River to provide 80 percent fish passage efficiency (juvenile fish passed the dam through some other route than the turbines). Transportation of juvenile fish from June 16 through September 30 would depend upon river conditions and evaluation of bypass facilities.

Response

This alternative assumes that additional water for flow augmentation and drawdowns can be used to provide adequate in-river passage conditions, eliminating the need for juvenile fish transportation. Alternatives of greater spring flow augmentation were examined in the 1992 OA/EIS and were not selected for implementation at that time. The 1992 OA/EIS examined an option of drafting Lower Granite to elevation 710 for the spring period and the effects on anadromous fish, navigation, power production, resident fish and wildlife, and other uses. The cooperating agencies believe that the information available last year is still valid and the preferred plan for spring flow augmentation meets the objectives of improving migrating conditions for juvenile salmon after considering the effects on other project uses and the environment.

See response to Common Issue 8 regarding the request for elimination of juvenile fish collection and transportation program.

Spill discharge required to meet 80 percent FPE at all projects as a result of elimination of collection and transport would likely result in high levels of dissolved gas supersaturation throughout the river system; cumulative impacts from spilling at consecutive dams would increase levels beyond those recorded during recent spill studies. Existing spillway mortality estimates do not address the potential impacts to fish condition, such as increased descaling and resultant delayed mortality, as well as increased predation due to eddy conditions below the dams.

Results of the March 1992 reservoir drawdown test indicate that it is not possible to maintain a safe in-river migration environment for both juvenile and adult migrants by operating Lower Granite reservoir at elevation 710. Although dissolved gas levels may remain below 130 percent for flows up to 100 kcfs, past studies indicate adult fish passage would be substantially delayed by spill levels required to attain 80 percent FPE. Substantial amounts of turbine flow would be required to provide adult fish passage, resulting in large numbers of juvenile fish potentially diverted into the gatewells if turbine intake screens were in place (this alternative does not specify if screen placement is desired). Initial hydraulic model results indicate fish guidance efficiency is likely to be reduced under lowered pool elevations. Turbine efficiency will also be substantially reduced resulting in likely increased mortality of fish passing through turbines.

The cooperating agencies have thoroughly reviewed and considered this proposed alternative and have concluded that potential increase in reservoir survival as a result of reduced travel time would be negated by poor reservoir water quality and project passage conditions for both juvenile and adult migrants.

SPECIFIC COMMENTS AND RESPONSES

Federal

Letter F1, U.S. Department of Housing and Urban Development (Myron G. Eckberg), October 23, 1992

Comment F1-1: Draft SEIS is adequate.

Response F1-1: No response necessary.

Letter F2, U.S. Forest Service Pacific Northwest Region (Gordon Haugen), November 10, 1992

Comment F2-1: Supports flow releases.

Response F2-1: No response necessary.

Letter F3, U.S. Department of Agriculture, Soil Conservation Service (Lynn A. Brown), November 17, 1992

Comment F3-1: No comments.

Response F3-1: No response necessary.

Letter F4, U.S. Department of Agriculture, Soil Conservation Service (Richard J. Gooby), November 30, 1992

Comment F4-1: Requests that Montana Department of Fish, Wildlife, and Parks review the analysis of Alternative 3 on bull and westslope cutthroat trout prior to final SEIS.

Response F4-1: Although more hydro-regulation data and analyses were completed for Hungry Horse Reservoir, insignificant variations were indicated with additional analysis of the HYSSR model runs for elevations and refill probabilities. Some elevation numbers were modified as indicated on Table 3.5-9. Results were provided to the Montana Department of Fish, Wildlife and Parks, as requested.

Comment F4-2: Requests full consideration of biological rule curves being developed by Montana.

Response F4-2: Biological rule curves for resident fish were taken under advisement as impacts were analyzed for the alternatives which addressed Libby and Hungry Horse reservoirs. Variability in reservoir operations was more dependent on runoff volume differences from year to year than comparing differences between alternative actions identified in the SEIS. Although the health of all fishery resources in the Columbia River Basin is a concern, the listing of the salmon under the ESA has given priority to actions assisting the listed stocks.

Letter F5, U.S. Department of Agriculture, Soil Conservation Service (Randy Phelan), undated

Comment F5-1: All alternatives not addressed.

Response F5-1: This comment is assumed to address the adequacy of the range of alternatives. Please see response to Common Issue 1.

Comment F5-2: Problems associated with flushing water from upstream reservoirs not addressed.

Response F5-2: The scope discussion of the SEIS (Section 1.3) indicated that potential actions concerning water purchases in the upper Snake River basin will be addressed in the BoR flow augmentation program. Given the various interrelated processes currently underway and the distribution of expertise among the respective agencies, the Corps and the cooperating agencies do not see a need to revise this position.

Comment F5-3: Oppose any activity that may reduce water quality in Cascade Reservoir.

Response F5-3: The BoR will continue to comply with applicable environmental procedures with respect to operation of Cascade Reservoir.

Letter F6, U.S. Department of Health and Human Resources, Public Health Service Centers for Disease Control (Kenneth W. Holt), December 3, 1992

Comment F6-1: Recommend mitigation such as warning signs and public education measures.

Response F6-1: Comment noted. Many visitor information programs are already in place to notify and educate the public about operational changes at federal water resources projects. These measures will continue pending available resources.

Letter F7, U.S. Department of the Interior, Bureau of Indian Affairs (G.D. Ben), December 7, 1992

Comment F7-1: Recommend discussion of treaties, Federal trust, and Corps' obligations.

Response F7-1: The Corps recognizes the Northwest treaty tribes' fishing rights contained in the treaties negotiated by Governor Stevens in 1854 and 1855 with the Yakima Tribe, Tribes of Middle Oregon, the Umatilla Tribe, and the Nez Perce Tribe. Each of the treaties contains similar language related to tribal fishing rights, the exclusive right to take fish in streams running through or bordering reservations and the right to take fish at all usual and accustomed grounds and stations. The United States government has a trust responsibility to Native Americans and a fiduciary duty to act in a manner consistent with that responsibility. The proposed actions are intended to conserve the salmon species with the results beneficial to the Treaty tribes' fishery. The proposed actions have been coordinated with the Northwest tribes through the NEPA process. Discussion of the effects on fishing access sites at John Day Project is included in Section 4.13. Additional information on treaty fishing rights on the lower Columbia River has been added to Section 2.15.5.

Comment F7-2: Cultural resources contact.

Response F7-2: Mr. James has been contacted.

Comment F7-3: Spill levels of preferred alternative do not meet tribe/agency recommendations.

Response F7-3: Spill levels at projects for juvenile fish passage are provided under the Fish Spill Memorandum of Agreement signed by regional fisheries agencies, Indian tribes, and BPA in 1989. These levels are determined annually and are incorporated into the Fish Passage Plan. The Crops and BPA are consulting with NMFS on the 1993 Fish Passage Plan, which includes a Fish Spill Program.

Comment F7-4: Incorporate the results of the "Snake River Water Temperature Control Project" for 1991 and 1992, which would increase the understanding of temperature changes.

Response F7-4: These results for 1991 were summarized in the 1992 OA/EIS and referenced in the SEIS. Results for 1992 are not yet available.

Comment F7-5: Federal consideration of tribal fishing rights.

Response F7-5: See Response F7-1.

Letter F8, United States Senate (Larry E. Craig, U.S. Senator), December 7, 1992

Comment F8-1: Alternative 4 not physically possible.

Response F8-1: The relaxation of flow requirements at Lime Point in the fall of 1992, requested by Idaho Power, was evaluated by the Corps, coordinated with NMFS, and allowed as an interim measure for that year because of the extreme drought conditions. Future requests by Idaho Power for reduced flows at Lime Point will be considered after evaluating impacts to navigation given the current runoff conditions and consultation with NMFS.

Comment F8-2: More recent study shows improvement in transportation.

Response F8-2: Data from 1968 to 1986 was used in the draft SEIS, not just from the 1986 study. Data from 1989 were not available for the draft model runs. For the final SEIS, 1989 results were used in both the 1968 to 1989 calculations (Option 1) and the 1986 to 1989 calculations (Option 2).

FEDERAL

Letter F9, Charles S. Polityka, Regional Environmental Officer, U.S. Department of the Interior, December 21, 1993

Comment F9-1: Corps should pursue additional water in the upper Snake River.

Response F9-1: See response to Common Issue 1. See also Section 1.5, which describes related regional studies that include efforts to obtain additional upper Snake River water. Parties other than the Corps were requested to take responsibility for these efforts.

Comment F9-2: Draft Coordination Act Report should normally be included in draft SEIS.

Response F9-2: Time and resource constraints prevented preparation of a draft CAR in time for the draft SEIS. The draft CAR has been appended to the final SEIS.

Comment F9-3: SEIS to emphasize that model outputs do not predict actual fish numbers.

Response F9-3: Comparing potential results of different actions is the primary function and role of the models. Results are not intended to predict actual numbers of fish. This is obviously not possible when dealing with factors such as runoff conditions and weather patterns, over which there is no control. This has been stated in the SEIS.

Comment F9-4: Inadequate range of alternatives.

Response F9-4: See response to Common Issue 1.

Comment F9-5: Need to discuss flows for white sturgeon and bull trout.

Response F9-5:	See response to Common Issue 6.
Comment F9-6:	Models are incomplete and have not been standardized.
Response F9-6:	See response to Common Issue 9.
Comment F9-7:	The fishery benefits numbers are not precise.
Response F9-7:	See F9-15 for more information regarding predation assumptions. Decreasing transportation benefits as the fish approach their spawning areas is not modeled as no specific, statistically valid information supporting this point has been provided to date. The increase in adult survival is explained more fully in Appendix E.
Comment F9-8:	Concern about spring releases adversely affecting resident fish in Lake Roosevelt.
Response F9-8:	The SEIS has addressed resident fish concerns within the limitations of existing data. It must be recognized that the availability of data and analytical tools in this case is considerably greater for anadromous fish than for resident fish.
Comment F9-9:	DEIS needs to address mitigation for resident fish in Lake Roosevelt.
Response F9-9:	Losses for resident fish could be mitigated but are not specifically addressed in this SEIS because of the temporary nature of the currently identified flow improvement measures.
Comment F9-10:	Clarify whether squawfish or smallmouth bass is the principal predator.
Response F9-10:	We have not seen information indicating smallmouth bass are a more important predator than squawfish in the hydrosystem or in the Snake River. However, a statement acknowledging the possibility of smallmouth bass being a major predator in the Snake River has been added.
Comment F9-11:	Discuss impacts to white sturgeon in Lake Roosevelt.
Response F9-11:	This issue has been addressed in the final SEIS.
Comment F9-12:	Consideration of the bull trout for listing under the Endangered Species Act.
Response F9-12:	See response to Common Issue 6.
Comment F9-13:	Larval sturgeon could be entrained with increased drafting.
Response F9-13:	This issue has been addressed in the final SEIS.
Comment F9-14:	Statement about mortality rate in SEIS is incorrect.
Response F9-14:	This issue has been addressed in the final SEIS, Section 4.2.3.
Comment F9-15:	Squawfish management program open to several unknowns.
Response F9-15:	Reduction rates applied were half of those projected by predation researchers (15 percent in 1993 and 50 percent by 1998; Beamesderfer). In addition, the Final SEIS includes some studies using a range of effectiveness levels, and a zero benefit sensitivity study.

Comment F9-16: SEIS should address differences in treatment of models.

Response F9-16: See response to Common Issue 9.

Comment F9-17: Include several issues about modeling.

Response F9-17: No response necessary.

Comment F9-18: Effects of actions on resident fish, invertebrates and plankton.

Response F9-18: The cooperating agencies understand that studies are needed to provide quantitative data on impacts to resident fish, invertebrates, and plankton. As indicated in the text, qualitative information is presented in the absence of other data.

Comment F9-19: Need for mollusc surveys in John Day Pool.

Response F9-19: Comment noted. The cooperating agencies are investigating additional studies.

Comment F9-20: Need information about the effects of drawdown on riparian vegetation.

Response F9-20: More extensive discussion of impacts on John Day was included in the 1992 OA/EIS. A statement was added to the SEIS text recognizing that a more detailed evaluation was needed to fully assess the impacts to riparian vegetation. The SEIS discussion represents the best available information on the subject, including the most recent operating experience.

Comment F9-21: Exposed islands not suitable for waterfowl nesting.

Response F9-21: Text has been modified in this SEIS to reflect the comment.

Comment F9-22: Not appropriate to consider carp control a positive impact.

Response F9-22: This discussion did not attribute the carp control measures to the Corps or imply that they were a part of the interim flow improvement measures. Regardless of the source of the carp control measures, they are an existing factor that positively affects waterfowl populations and complicates analysis of the net impacts of the proposed action. It is necessary and appropriate to discuss potential impacts within the context of other relevant, concurrent events. The text has been modified slightly to indicate that continued carp control, whether funded by FWS or the Corps, could lead to an overall increase in waterfowl production at McCormack Slough.

Comment F9-23: Need for water depth information to determine the potential for landbridging.

Response F9-23: Some information is currently available on water depths surrounding the nesting island. The cooperating agencies felt it was inappropriate to provide this information in the SEIS.

Landbridging assessments were made based on the best information available, which ware the bathymetry data provided by the 1990 series NOAA Nautical Charts. A cautionary note on these charts states "The depths of water on this chart have been determined from conditions existing prior to the filling of the pool. Shoaler depths than charted may exist within the blue tinted areas particularly near the shoreline." Consequently, landbridging may occur where not expected if shoaling conditions have changed (e.g., sediment buildup), since filling of the pool. New information would probable require a new bathymetric survey.

Comment F9-24: Establishment and flooding of lodges.

Response F9-24: This information has been added to the SEIS.

Comment F9-25: Tree recruitment would be expected under drawdown.

Response F9-25: Tree recruitment would only be expected with a long-term drawdown.

Comment F9-26: Disagree with conclusion that there would be no negative effects on recreation at Lake Roosevelt.

Response F9-26: The text has been modified to note that the fishery is a significant attraction for recreation at Lake Roosevelt and that there are concerns over this linkage due to potential adverse effects on resident fish. However, any further conclusions, particularly a projection of decreased recreational use resulting from resident fish impacts, would be highly speculative and unwarranted in view of the available information. The quantitative significance of the fishery to Lake Roosevelt recreation has neither been established through user-specific research nor has the likely user response to a decline in the fishery been established. Please note that several other attributes of the Lake Roosevelt experience, such as sun and scenery, are prominent in advertising for the area. More importantly, the resident fish analysis did not determine that there would be significant adverse impacts to the fishery. Given the degree of change in reservoir elevations and discharges indicated by the hydroregulation models, the appropriate conclusion was that significant resident fish impacts were possible but not expected. There was no basis to predict or quantify significant adverse impacts to the fishery.

Comment F9-27: In BA, correct terminology to state "not likely to adversely affect" and revise to include several factors.

Response F9-27: The agencies are working with the Fish and Wildlife Service to determine the best course of action concerning the potential effects on bald eagles as they relate to upper Columbia flow augmentation. In light of Fish and Wildlife recommendations to increase late spring flows from Lake Koocanusa to help satisfy life-cycle requirements of the Kootenai River white sturgeon, an operational alternative for providing these flows and the 3 MAF augmentation at the same time is being considered as a test under the selected plan this year. Monitoring and analysis of impacts to resident fish and the subsequent effects on bald eagles will be determined for an operation that may include part of the 3 MAF augmentation being supplied from Lake Koocanusa. Future years' operations may be altered based on the results of the monitoring and analysis effort. The long-term operational mitigation for potential flow augmentation impacts will be analyzed and determined in the System Operation Review.

Comment F9-28: SEIS should include alternative for better in-river migration.

Response F9-28: Most of the alternatives you have listed have been analyzed or are being analyzed in the System Operation Review. Recommendations concerning these provisions in the long term will be made after extensive public review at the conclusion of the System Operation Review and System Configuration Study. Some may not be implementable unless the agencies obtained additional authority.

Comment F9-29: Need to clarify discussion of each model.

Response F9-29: See response to Common Issue 9.

Comment F9-30: Support for Alternative 4 as the most reasonable choice.

Response F9-30: No response necessary.

Letter F10, Charles E. Findley, Environmental Protection Agency, Region 10, December 14, 1993

Comment F10-1: Need to evaluate the overall net (positive and negative) effects of the alternatives.

Response F10-1: As indicated in the responses to subsequent comments on the specific issues raised in this paragraph, the Corps and the cooperating agencies believe that they have presented sufficient information to address these concerns, and to demonstrate that there would be an overall net positive effect on anadromous fish survival. The model analyses for anadromous fish incorporate the potential adverse effects as well as the migration benefits and show a modest overall improvement in migration conditions. Please see also responses to Comments F10-4 through F10-11.

Comment F10-2: Recommend initiating monitoring plan before the final SEIS is issued.

Response F10-2: The proposed measures are expected to have only minimal, if even measurable effects on water quality compared to the no action alternative. None of the alternatives propose run-of-river pool elevations below normal authorized levels. Therefore, suspended sediment loads and turbidity levels are not likely to be different from those experienced during past seasons. Nonetheless, secchi transparencies will continue to be measured daily at each lower Snake and lower Columbia River dam. If it is suspected that measure implementation is resulting in increased turbidity, an effort will be made to take background readings to assess causality. The automated dissolved gas monitoring program, including loggers in lower Snake River and McNary Dam tailwaters, will be in full swing before proposed actions are taken. Temperature and velocity monitoring from Orofino, Idaho to Burbank, Washington will be accomplished in conjunction with the Snake River Temperature Control Study.

The effects on the fisheries attributable to operation at MOP are discussed in the 1992 OA/EIS and would be minimal, if measurable, under similar spill schedules. Although turbidity levels are not likely to vary widely from levels of past seasons, much uncertainty exists as to the negative effects on salmonids. Indications are that high levels of turbidity may influence reduced growth, but high levels can also be beneficial in reducing the effectiveness of predation on outmigrating smolts. Increased monitoring efforts are currently being planned in 1993 to collect mid-reservoir seasonal turbidity data in association with benthic community transects.

Comment F10-3: EPA has rated the DSEIS EC-2 (Environmental Concerns-Insufficient Information).

Response F10-3: Additional information has been incorporated into several sections of the final SEIS.

Comment F10-4: Concern about high levels of gas supersaturation.

Response F10-4: With the HYSSR model, it is not possible to quantify predicted increases in dissolved gas over background levels (the model predicts flow, not gas saturation). It is possible to qualitatively estimate the potential for increases based on HYSSR predicted spill and the qualitative correlation between spill and dissolved gas saturation. As noted in the SEIS, the spill is not predicted to be significantly affected by the proposed alternatives (i.e., beyond present observed ranges). Therefore, dissolved gas levels are not expected to be significantly different than those currently observed under high and low

flow conditions. Given the above, it is also not possible to quantify incremental differences.

The action agencies are also concerned about the high levels of gas generation due to spill levels throughout the Columbia and Snake river systems. During the consultation process with NMFS, the Corps, BPA, and BoR plan to discuss managing spill levels to control total dissolved gas (TDG) levels from approaching high levels that have been documented to be detrimental to fish survival.

Comment F10-5: Effects associated with sediment resuspension.

Response F10-5: The potential for the hypothesized effects from turbidity, temperature, and dissolved oxygen is minimal. The proposed alternatives are still within normal operating conditions (i.e., do not draw down below MOP). The 1992 drawdown test, which was much more extreme, did indicate temporal effects to turbidity patterns. However, one could not conclude from those turbidity data that "shifts in population dominance" would be expected. Similarly, impacts associated with "disease organisms" are not expected. Note that dissolved oxygen may actually increase due to the spilling and increased circulation.

Comment F10-6: Concerned about decreases in outfall depths from reservoir.

Response F10-6: The text has been edited to clearly indicated that the information on potentially affected outfalls is limited. Nevertheless, Sections 4.1.4 and 4.7.4 report information on all known outfalls that have been identified as potential concerns during the SEIS and 1992 OA/EIS processes. It should be noted that discharge systems should be designed to adequately function under MOP conditions, which are duly authorized and occur commonly.

Comment F10-7: Concerned about high levels of gas supersaturation.

Response F10-7: Ebel et al. (1975) presented valuable information on juvenile salmon distribution during travel. This information has been used in the past to estimate effects of dissolved gas on juvenile fish, and was reported in the 1992 OA/EIS. Neither of the passage models developed and used by BPA and NPPC directly account for individual reservoir mortality factors such as gas supersaturation. Instead they use reservoir mortality relationships based on overall reach survival estimates which include all factors affecting reservoir mortality (including gas saturation at high flows).

See response to Comment F10-4.

Comment F10-8: Need more information about wetland and riparian losses.

Response F10-8: Impacts to terrestrial ecology are addressed in the 1992 OA/EIS and again in this SEIS within the limits of available information. Existing information on impacts to wetland and riparian areas is poorly documented and generally unsuitable for quantitative assessment. The assessment of impacts is consistent to the degree to which they would likely affect selection of alternatives.

Comment F10-9: Effects to anadromous fish from drastic drawdowns.

Response F10-9: No response necessary.

Comment F10-10: Provide information about effects to shallow water habitats and resident fish from dredging.

Response F10-10: See response to Common Issue 2. Environmental effects of proposed dredging operations will be considered when dredging requirements are determined and finalized.

Comment F10-11: Describe habitat restoration and creation efforts.

Response F10-11: No anadromous fish habitat restoration or creation activities are occurring as a result of the proposed actions and, therefore, no coordination is necessary.

Comment F10-12: Consider electrical conservation to reduce effects of losses in hydroelectric peaking capacity.

Response F10-12: As acknowledged in the comment, the potential for indirect effects resulting from replacement of lost hydroelectric generation is discussed in the SEIS. The text identifies these impacts, indicates this subject was covered in more detail in the 1992 OA/EIS, and references environmental documentation for resource acquisition programs that provide a thorough assessment of these impacts. Replacement of power losses associated with the proposed action would occur under the terms of the regional power plan, as developed and implemented by NPPC and BPA. Conservation has been the highest-priority resource in regional power planning for several years.

Comment F10-13: Monitor to assess water quality effects of flow measures.

Response F10-13: See response to Comment F10-2. During a high flow year, decreases in upstream flows and volumes because of proposed measures would be minimal. In a low flow year, such as 1992, upstream flows during nonaugmentation periods are likely to be set at the required minimum discharge with or without implementation of the planned measures. Augmentation in such a year actually relieves pollutant dilution problems by periodically increasing assimilative capacity of the stream when it would otherwise be low. Cumulative water quality impacts to the estuary from these measures are not likely. Corps staff have contacted EPA Region 10 personnel regarding these comments, and plan to work with them in developing monitoring plans for the drawdowns being evaluated by the SOR that hold more potential for water quality impacts.

Reservoir operation at MOP is not considered drawdown operation in that MOP is within current operational guidelines for Snake River projects. Ecological effects of operation at MOP and true drawdown operations at elevations below MOP can be vastly different depending on magnitude and duration of chosen elevation.

Comment F10-14: Study effects on aquatic community dynamics and cumulative effects.

Response F10-14: It is agreed that monitoring studies should address aquatic community dynamics and cumulative effects. The bulk of Corps data has been collected within Lower Granite Reservoir by the University of Idaho (Bennett, et al.) and Battelle PNL in association with the 1992 Drawdown Physical Test and a dredge-disposal evaluation program. These efforts are ongoing and will continue to be revised. Pre-dam flows are addressed to a degree in Appendix A. Although pre-dam hydrology is available, corresponding salmonid passage data to support hypotheses with any certainty are lacking in many respects. This is a complex issue that continues to be discussed within the region. Hatchery versus wild fish passage success is another complex issue that continues to be discussed. It is evident that mitigating with hatchery stocks under productivity objectives has produced ecological effects on the wild and natural stocks. [Studies and monitoring efforts have been constrained to disproportionate use of hatchery fish (to meet statistical demands, and recently from ESA restrictions) as indicative of the total

stock complex.] Evolutionarily, hatchery and wild obviously differ. In addition, only steelhead have been fin-clipped to allow for origin distinction. Near future studies are oriented to address these previous problems. The effects of gas supersaturation are addressed in more detail in the 1992 OA/EIS, which this SEIS supplements. CRiSP.1 is the only passage model that attempts to characterize the effects of gas supersaturation on fish. It has just recently been recalibrated to empirical data collected during the 1992 Drawdown Physical Test and the automated dissolved gas monitoring data collected in the forebays and tailraces of the Snake River projects. Studies to quantify sub-lethal effects of high dissolved gas on fish are desirable, but difficult to design and implement, as well as carrying an associated high risk to ESA- protected stocks. NMFS' PIT-tag studies since 1989 are utilized to examine outmigration patterns. Monitoring by the University of Idaho in Lower Granite and the USFWS in the lower Columbia may also utilize the PIT-tag system to assess habitat use of predominantly fall chinook. Predation is evaluated by the ODFW Predator Indexing Program, and has been expanded in recent years to include Snake River projects. Appropriate physiological parameter monitoring is associated with aspects of each type of on-going study, in addition to disease studies and stress studies associated with the Smolt Transportation Program.

Comment F10-15: Improvement of juvenile salmon outmigration through flow augmentation versus reservoir drawdown.

Response F10-15: No response necessary.

State

Letter S1, Idaho Department of Water Resources (R. Keith Higginson, Director), November 12, 1992

Comment S1-1: Must modify dams so they can operate to provide real benefits to the fish.

Response S1-1: Potential modifications and associated possible benefits are being evaluated through other studies, as is described in the text.

Comment S1-2: Flow became a factor in fish survival only after the dams were completed.

Response S1-2: Studies of the economic and technical feasibility and biological effectiveness of the drawdown strategy are continuing under other related study programs, as described in the draft SEIS. The relationship between dam construction and flows as a fish survival factor should be clear from numerous references throughout the SEIS.

Comment S1-3: Although flow augmentation was authorized by the Idaho legislature in 1992, there may be no authorization for 1993 and 1994 due to unmet conditions.

Response S1-3: The cooperating agencies have been actively working to implement the study and action requests made by the NPPC, including those concerning the drawdown strategy. All three agencies are active participants on the Drawdown Oversight Committee established by the NPPC. The Corps has been diligently responding to the request for drawdown studies, as demonstrated by the submittal of the SCS status report to the NPPC in December 1992.

Additional Snake River releases in 1992 were not used to offset Columbia River flow augmentation plans or needs. In July 1992, releases were made from Brownlee and Dworshak to meet flow objectives the lower Snake River. There is no corresponding objective of increased velocities in the lower Columbia River in July and August. In addition, since many of the summer migrants were being collected at the Lower Granite and Little Goose facilities and transported to below Bonneville Dam in accordance with the Biological Opinion, there was not a need for increased flows in the lower Columbia.

The objective of the September releases from Dworshak is to reduce Lower Snake River water temperatures. There is no objective of increased velocities in the Columbia River at this time. The 200 KAF released in September 1992 (10,000 cfs from September 10 to September 20) was to meet the objective in the lower Snake River. Appropriate management of the Columbia River was taken to meet overall system needs. In September of 1992, this resulted in a decrease in releases from the upper Columbia River projects during this same period.

The cooperating agencies must have flexibility to shape releases from the Snake River and Columbia River projects to manage for all uses. In any given year, this may mean that Columbia River flows are decreased, held even or increased when releases are made from Dworshak and other Snake River projects for the purpose of improving migrating conditions in the lower Snake River for the listed Snake River salmon. In July 1992, Columbia River flows were both decreased one week and increased another week during the same period flow augmentation releases were made from Dworshak and Brownlee.

Comment S1-4: Address an alternative examining the sensitivity of operations at Dworshak.

Response S1-4: The SEIS impact analyses of Alternatives 2 through 5, as compared to Alternative 1, provide the requested sensitivity analysis with respect to implementing any additional (beyond the existing Water Budget) flow measures at Dworshak. By comparatively assessing the effects of Alternatives 2 and 4, the draft SEIS also identifies the differential impacts associated with shifting Dworshak releases otherwise planned for September into the summer. Nevertheless, in response to this and other requests, the final SEIS has been supplemented with more specific assessment of the separable benefits and impacts of these summer releases at Dworshak.

Comment S1-5: Support for Alternative 5 as the preferred plan.

Response S1-5: No response necessary.

Comment S1-6: Corps should seek amendment to laws regarding dams to continue to legally operate dams.

Response S1-6: The Corps believes that the alternatives considered in the SEIS are within the existing authority of the projects and consistent with the responsibilities under the Endangered Species Act and Northwest Power Planning and Conservation Act. Authorized project purposes and other uses are summarized in Table 2.2.2 and references are provided. The Corps is continuing to evaluate drawdown alternatives under SCS and SOR. A further description of these studies is found in Appendix C.

Comment S1-7: The State has the authority to govern release and use of water from Snake River reservoirs.

Response S1-7: Section 7.24 has been modified to reflect this comment.

Letter S2, State of Idaho, House of Representatives, (Ken Robison, Representative District 19), November 17, 1992

Comment S2-1: Support for drawdown at lower Snake River reservoirs.

Response S2-1: The NPPC amendments establish a policy supporting a drawdown strategy unless it is demonstrated to be economically or technically infeasible or biologically imprudent. The Corps and other parties are participating in a cooperative effort to study these issues and develop plans for potential long-term actions. Meanwhile, the cooperating agencies have an obligation to conduct their operations to avoid jeopardy to the listed stocks. This requires actions, and NEPA documentation and ESA consultation addressing those actions.

Letter S3, State of Montana, Department of Natural Resources and Conservation (Gary Fritz), November 23, 1992

Comment S3-1: What actions will be implemented where in 1993 and 1998 in Table 4.2-1. Did all models assume the same implementation schedule for 1993 and 1998?

Response S3-1: Different levels of nonflow measures were analyzed—a current 1993 level and a future 1998 level. This was to account for the changing effects of programs currently or soon to be underway, such as predator control, bypass installation, and habitat improvements. These actions are documented in greater detail in Appendices E and F. Assumptions were consistent within model systems (e.g., between CRiSP and SLCM). The NPPC analysis in the draft SEIS did not analyze future measures beyond 1993.

Comment S3-2: Emphasize nonflow measures vs. flow augmentation.

Response S3-2: We agree that flow measures alone are not the answer. As a result, we are actively promoting a variety of nonflow measures, including those listed in your letter.

Comment S3-3: Explain lowered pool level analysis on page 4-16.

Response S3-3: The flow-water travel time relationship depends upon the reservoir elevation. For instance, 81,000 cfs in Lower Granite Pool at MOP (5 feet lower than full) produces the same water travel time as 85,000 cfs at full pool. Decreases in operating pool elevations were modeled by using the appropriate flow-water travel time relationship for each project.

Refer to Appendix E.

Comment S3-4: Reconsider impacts to Libby and Hungry Horse operations and resources due to flood control shift to Grand Coulee.

Response S3-4: Shift of flood control from Dworshak and Brownlee to Grand Coulee is not expected to change Libby or Hungry Horse flood control requirements. Shifts to Grand Coulee require that the space is in addition to the normal Grand Coulee flood control requirement. Grand Coulee operations and resources are therefore affected, but Libby or Hungry Horse are not.

Comment S3-5: What are R^2 values for parameters k_1 and k_2 on Table 10, page 17, Appendix E.

Response S3-5: These values are parameters used by the Corps in their flow-water travel time relationship for each reservoir.

Comment S3-6: What distances were used to establish times on y-axis in Figures 2 and 3 on page 18 in Appendix E?

Response S3-6: The assumed pool lengths are 63.2 km for Lower Granite Pool and 129 km for John Day Pool.

Comment S3-7: Explore options to better quantify relationship between flows and travel time.

Response S3-7: We agree that the R^2 values for flow-travel time relationships are relatively low. However, some studies indicate that over 30 percent of the variation in travel time is described by flow. We have examined the relationship between many variables and travel time, and concluded that the relationships we used are reasonable. In addition, a sensitivity analysis assuming no flow-travel time relationship for fall chinook was performed for the final SEIS analysis. See also response to Comment S5-4.

Comment S3-8: Table 11, page 19, Appendix E, what are the R^2 values of the parameters that predict survival as a function of flows?

Response S3-8: The parameters were adapted by the NPPC from Sims and Ossiander's flow-survival data.

Comment S3-9: Table 13, page 22, Appendix E, what are R^2 values for all parameters?

Response S3-9: The R^2 values for the subyearling flow-travel time regressions were 0.48 for Lower Granite and 0.33 for all other pools.

Letter S4, State of Washington, Department of Community Development (Robert G. Whitlam, State Archeologist), November 24, 1992

Comment S4-1: Develop a Programmatic Memorandum of Agreement among all parties for cultural resources.

Response S4-1: When a final action alternative is selected, an appropriate cultural resources program of identification, evaluation, and protection will be specifically developed in response to the selected alternative. All concerned parties will be provided the opportunity for review and comment on the developed cultural resources program. Dworshak is already covered by an existing programmatic memorandum of agreement (PMOA) under which the currently proposed actions may be included. However, if required, a new PMOA will be developed.

Letter S5, State of Montana, Office of the Governor (Stan Stephens, Governor), December 7, 1992

Comment S5-1: Include a system-wide perspective of all potential recovery actions, including those for bull trout.

Response S5-1: See response to Common Issue 6 with respect to consideration of bull trout. The Corps and cooperating agencies have attempted to consistently adopt a system-wide perspective in assessing river system operations. As required under NEPA, agency decision makers must weigh and balance the various consequences of alternative courses of action.

Comment S5-2: Montana is pleased to be included in the SEIS evaluation.

Response S5-2: No response necessary.

Comment S5-3: Recognize all fisheries resources, not just anadromous fish, in Section 1.3.

Response S5-3: The text has been modified to avoid an overly narrow focus on anadromous fish.

Comment S5-4: Need validation of assumption that juvenile salmon travel is directly related to water velocity; cooperating agencies should cooperate with NPPC evaluation.

Response S5-4: The Corps and the cooperating agencies agree that the flow/travel time/survival relationship is perhaps the most critical research and validation need in the salmon recovery program. While most of this work has been conducted by fishery agencies and universities, the Corps, BPA and NMFS in particular have been active in this area and will continue to address the issue. The Corps and the cooperating agencies have coordinated fully with the NPPC during its amendment process, and will continue to do so in providing available flow/survival information.

Comment S5-5: Alternative 2: 1992 Operations—purchase of more than required 3 MAF.

Response S5-5: The SEIS has been revised to describe the potential options and effects of storing the 3 MAF when required. Projects considered for this operation are Grand Coulee, Libby, and Arrow. Flow augmentation releases for salmon will be made with consideration of other nonpower and power requirements of the system.

Comment S5-6: Question Grand Coulee flood control capability. Examine possibility of shifting flood responsibility to John Day Reservoir.

Response S5-6: Out of the 50-year water record (1928 to 1978), it is estimated that in 27 years flood control can be shifted from Dworshak to Grand Coulee if forecasts are 3.0 MAF or less. Shifts of system flood control space are dependent upon several factors including space available at Grand Coulee. The amount of shift ranges from a low of 50,000 acre-feet to a high of 681,000 acre-feet. The amount of water stored at Dworshak because of the shift of flood control space must be used by May 1.

Comment S5-7: Why is John Day not fully utilized for flood control?

Response S5-7: The regulation of Columbia River flows for flood control in the Portland-Vancouver and downstream areas is accomplished primarily by Grand Coulee, Libby, Hungry Horse, and Columbia River Treaty projects in Canada. Snake River contributions to lower Columbia River flows are regulated partially by reservoirs above Clarkston. The remoteness of these reservoirs to the lower river control points makes achievement of the target regulation difficult because of uncertainties regarding weather conditions, intervening inflows, power discharges, travel times, and special operations at downstream projects. The 500,000 acre-feet of flood control space in John Day Reservoir between elevations 257 and 268 provides an opportunity for final regulation to the target discharges for the downstream control points. The 500,000 acre-feet is an approximate amount because the reservoir storage is a function of inflow and is more than 500,000 acre-feet for flows less than 200,000 cfs and less than 500,000 acre-feet for higher flows.

The flood control space at John Day will be used as "Factor of Safety" storage to accomplish this final regulation. The space will be evacuated during the preflood period, probably no farther in advance than necessary for assured operation based on forecasts of seasonal runoff volumes, short-term inflow forecasts, weather outlook, power demands, pondage restrictions, and current conditions on and along the river. Flood control regulation of the John Day project will be scheduled by North Pacific Division, Water Management Division to meet the criteria shown below.

Flood control evacuation requirement

Forecasted Stage at Vancouver	Maximum Elevation
12	265.0
14	262.8
16	260.5
18	258.2
19	257.0

Comment S5-8: Examine and report on the levee system in the lower Columbia River.

Response S5-8: The identified scope of the SEIS and the extremely short time period to complete the NEPA process that will allow the Federal agencies to modify operation of the projects in spring of 1993 does not allow time for an indepth study of every aspect related to the operation of the Columbia-Snake River system. Maintenance and operation of Corps levee systems is an ongoing program, periodically providing reports as to the condition of each levee. Published information is available from the managing office of the Corps in each local area. The SOR will examine the flood protection afforded by the lower Columbia River levees.

Comment S5-9: Do ratepayers fund upper Snake River water purchases and salmon restoration activities?

Response S5-9: The NPPC Phase Three amendments request the BoR and the State of Idaho to obtain 90 KAF of this figure, with no specification of funding source. The BoR, Idaho, Oregon, BPA and unspecified other parties are requested to provide the remaining 100 KAF, with half of that amount to be secured by the BoR and half through BPA financial incentives.

Comment S5-10: Libby and Hungry Horse affected by 1992 salmon operations.

Response S5-10: See response to Common Issue 10.

Comment S5-11: Address issues of Canadian water supply involvement.

Response S5-11: See response to Comment S5-5.

Comment S5-12: Review operational changes that may affect resident fish, account for mitigation actions under way.

Response S5-12: See response to Common Issue 7. BPA's Hungry Horse Mitigation Plan can be examined to aid in analysis of 1993 preferred alternative implementation.

Comment S5-13: Include information on white sturgeon in the Kootenai River.

Response S5-13: See response to Common Issue 6.

Currently, a system operating strategy is being formulated under the System Operation Review that will attempt to provide flows for protection of the white sturgeon in the future. To the extent possible, flows for flow augmentation from Libby will be coordinated to test potential benefits to white sturgeon.

Comment S5-14: Note ESA petition on the bull trout.

Response S5-14: The text has been updated to reflect the ESA petition. See response to Common Issue 6.

Comment S5-15: Note that operational damages that benefit resident fish will occur in the future, begin informal consultation.

Response S5-15: See response to Common Issue 6.

Comment S5-16: Curtail planting resident fish that are predators of salmon.

Response S5-16: Please see response to Common Issue 2 concerning measures appropriately within the scope of the SEIS. Appendix A includes some discussion of resident game fish management programs that appear to conflict with salmon recovery objectives.

Comment S5-17: Emphasize actions that provide years of returns rather than costly one-year benefits.

Response S5-17: The ESA provides that all Federal agencies consider the effects of their actions on listed species and take steps to avoid jeopardy to those species. The Corps and cooperating agencies support the concept of applying cost-effectiveness analysis in this type of comprehensive manner.

Comment S5-18: Include mean annual inflow to each project in Table 2.2-1.

Response S5-18: While this information is helpful, it can be factored into the assessment without adding another column in an already cramped table.

Comment S5-19: Include efficacy and administration of water budget in life-cycle models.

Response S5-19: See response to Common Issue 2.

Comment S5-20: Differing modeling perspectives could alter management of water budget and cloud effect on resident fish.

Response S5-20: The water budget is modeled in the hydroregulation models as a discrete volume of water, not a block of power. The total water budget volume includes up to 1.19 MAF on the lower Snake River and up to 3.45 MAF on the middle and lower Columbia River.

Comment S5-21: Although the contrary is stated, Montana did participate in the flow augmentation measures initiated in 1992.

Response S5-21: In 1992, both Libby and Hungry Horse were not affected by additional flow augmentation adopted last year. BPA purchased energy to offset the reduced power production due to increased spills, reduced project heads, and flow augmentation. Operations in 1992 at Libby and Hungry Horse reflected an operation when the water supply was the fourth lowest in 50 years. In drought years, flows greater than minimum are necessary to meet system load. However, several additional actions were taken by the cooperating agencies that lessened the impacts of such a low water year. These actions resulted in both Libby and Hungry Horse being approximately 30 feet higher in the summer of 1992 than they would be absent of those actions. The cooperating agencies continue to examine all options to balance system requirements and their impacts.

Comment S5-22: Pool elevations alone are not indicative; peaking operations affect river flows, temperatures, and influence aquatic resources.

Response S5-22: The SEIS text has been modified in selective locations to acknowledge these points concerning flow changes in river reaches below Libby and Hungry Horse. As with pool elevations, however, the hydroregulation models indicate little change in monthly flows associated with the proposed actions. Potential changes in the frequency or duration of peaking operations have not been fully investigated, but are not expected to be significant.

Comment S5-23: Note that Libby Reservoir is equipped with a selective withdrawal structure to control water temperatures.

Response S5-23: This information has been added to the text in Section 4.1.2.

Comment S5-24: Recent ESA petition and its implications for the bull trout.

Response S5-24: See response to Common Issue 6.

Comment S5-25: Include local unemployment rates and trends.

Response S5-25: Annual average unemployment rates were collected for all counties in the study area. The text has been updated to include these figures and a graph of representative county unemployment rates has been added.

Comment S5-26: Discuss Indian tribal fish rights for inland, resident, fish-dependent tribes.

Response S5-26: New information on this subject has been added to the final SEIS.

Comment S5-27: Who paid rental fee of uncontracted space in Cascade and Deadwood?

Response S5-27: BoR paid for 90 MAF in 1992.

Comment S5-28: Have proposed operations been compared to biological rule curves for Libby and Hungry Horse?

Response S5-28: The values in Table 3.5-9 have been revised to correct some errors in the draft SEIS concerning Alternative 1. With the correct base case figures, the discrepancies for September and December are no longer present.

The Hungry Horse model and the Libby and Hungry Horse biological rule curves have not been run for the SEIS analysis. The Corps does not believe that the degree of physical change indicated by the hydroregulation results warrants this additional modeling effort. Moreover, from a NEPA perspective the appropriate baseline for impact analysis is the existing or without-project condition, rather than an ideal biological condition.

While the exceedance format has some advantages in describing frequency and magnitude, use of this format would require a significant increase in the number of figures and tables required to present a complete set of results. Median elevations can be succinctly summarized for a number of periods, as was done in Section 3.5, and address the most likely condition for any given year. The discussions presented in the text address extreme conditions as well as the averages.

Comment S5-29: Question harvest rate assumption; clarify chinook harvest rate vs. harvest level.

Response S5-29: See response to Comment A23-11.

Comment S5-30: Is a harvest EIS needed to discuss effects of stock harvest?

Response S5-30: See response to Common Issue 2.

Comment S5-31: Comment about one-year deep drafting on page 4-41 in error.

Response S5-31: The text has been modified for clarity. The intent of the original statement was to indicate that the operation represented by Alternative 3 would in some years add incrementally to deep winter drafts that normally occur with existing operations; it would not produce deep drafts in years when they would not otherwise occur.

Comment S5-32: Pleased that fugitive dust issue at Libby is receiving attention.

Response S5-32: No response necessary.

Comment S5-33: Boat ramps and moorage facilities at Libby require significant maintenance after reservoir drafting. Include cost in SEIS.

Response S5-33: This information on maintenance requirements at Libby has been added to the text. The hydroregulation models indicate that increased drafting would not be a normal, annual occurrence at Libby, even with Alternative 3, so these maintenance costs have not been added to the evaluation.

Comment S5-34: Flathead River incorrectly referred to as Kootenai River on page 4-80.

Response S5-34: The text has been corrected.

Comment S5-35: Rethink "insignificant differences" sentence on page 5-7.

Response S5-35: Given the current status and timelines of the sturgeon and bull trout petitions, the needs of these species with respect to river system operations are not known. The river managing agencies must therefore proceed with consideration of salmon flow measures on the basis of currently available information, which does not indicate that there would be significant changes at Montana projects, or that these changes would adversely affect sturgeon or bull trout.

Comment S5-36: Include a review of historical water forecast accuracy.

Response S5-36: The Corps, BPA, BoR, National Weather Service and the Soil Conservation Service are evaluating measures to increase the accuracy of the forecasts. A preliminary report is scheduled to be sent to NPPC in late spring 1993.

Letter S6, Oregon Department of Fish and Wildlife, December 5, 1992

Comment S6-1: Need alternatives that provide substantial river velocity improvements.

Response S6-1: See response to Common Issue 1. Substantial modifications to river operations leading to greatly increased flows for salmon within the Columbia-Snake River system are being considered in the System Operation Review.

Comment S6-2: Include improvement alternatives in final SEIS.

Response S6-2: See response to Common Issue 1 and Comment R6-13.

Operation of the projects to achieve CBFWA's 1990 flow recommendations was addressed in the 1992 Options Analysis/EIS. Since this EIS is a supplement to the 1992 OA/EIS, that analysis is incorporated by reference.

Operation of Dworshak for July and August was examined for two conditions: Alternative 2 evaluates 270 KAF in July and August and Alternative 4 evaluates 470 KAF in July and August.

The operation of Brownlee reservoir is based on Idaho Power Company's proposed operation.

Operation of the lower Snake projects, including Lower Granite, at spillway crest, was examined in the 1992 OA/EIS. This operation, and the physical modifications necessary to allow spillway crest operation, is being examined in the System Operation Review and System Configuration Study.

Comment S6-3: Establish biological objectives for flow improvements to prevent jeopardy.

Response S6-3: The analysis presented is based on existing available information. Data on fish survivability, relationship of improved fish passage to increase fish returns, and the effect of reduced migration times on actual fish run recovery are still insufficient to develop empirical relationships.

Establishment of a biological objective, i.e., recovery goals and delisting criteria, to base the value of flow improvements and any other actions to save the salmon, will be provided by NMFS designated Snake River Salmon Recovery Team sometime in 1993.

Comment S6-4: A continuation of 1993 actions would not halt decline of fish population.

Response S6-4: See response to Common Issue 9.

Comment S6-5: Describe calibrations used to link smolt survival models to production function stated in Appendices E and F.

Response S6-5: See response to Comments S7-11 and S7-12.

Comment S6-6: Three model systems (BPA, NPPC, and T.E.C.H.) produce different projections.

Response S6-6: See response to Common Issue 9.

Comment S6-7: The 1993 measures would not constitute a viable recovery plan.

Response S6-7: See response to Comment S7-14.

Comment S6-8: Smolt survival would be optimized with velocities most similar to those under which fish evolved.

Response S6-8: See response to Comment S7-18.

Comment S6-9: Ongoing review of fish transportation policy.

Response S6-9: See response to Common Issue 8.

Comment S6-10: Habitat improvement assumption only applies to specific areas and spawning populations.

Response S6-10: See response to Comment S7-19.

Comment S6-11: The claim that Model 1 is a more realistic representation of transportation survival is not supportable.

Response S6-11: See response to Comment S7-73.

Comment S6-12: Clarify the citation for the Petrosky (1992) prespawning survival estimate.

Response S6-12: See response to Comment S7-74.

Comment S6-13: Final SEIS assumptions regarding squawfish control should include an alternative that no benefit will be achieved from the squawfish program.

Response S6-13: See response to Comment S7-20.

Comment S6-14: Transport benefits are overstated.

Response S6-14: See response to Comment S7-16.

Comment S6-15: Include in modeling a provision to adjust operations mid-season based on actual 1993 flows.

Response S6-15: See response to Comment A16-3.

Letter S7, Idaho Fish and Game Department (Jerry M. Conley, Director), December 4, 1992

Comment S7-1: Lack of reasonable range of alternatives.

Response S7-1: See response to Common Issue 1. The SEIS alternative actions will most likely be modified by the Snake River Salmon Recovery Team which was designated by NMFS. Ultimately, the Recovery Plan will guide all aspects of activities that might affect salmon restoration and recovery. Also, see response to Comment A26-2.

Comment S7-2: Consider additional flow and operational measures.

Response S7-2: See responses to Comment S7-1 and to Common Issue 1.

Operation of turbines at peak efficiency is included in the planning process for the Annual Fish Passage Plan along with many other fish passage activities. The cooperating agencies do not believe it is necessary to duplicate the fish passage planning in the SEIS. Many of the activities are ongoing and will be undertaken regardless of the flow measure alternative selected.

Juvenile passage facilities at Lower Granite Dam are designed to be used down to the minimum authorized pool elevation. The minimum pool elevation is 733 feet above mean sea level, 5 feet below full pool. Lower Granite was operated within 1 foot of this elevation from mid-April to September 1992.

Federal constraints on water rental prices, negotiation of an agreement with Idaho Power Company for more water, and power marketing modifications are beyond the scope of this SEIS. Because of the urgent need to protect the Snake River salmon, the SEIS was prepared in an extremely short time frame, restricting a broader scope and long-term endeavor required to include your recommendations. These types of activities are being considered in the System Operation Review, under the Bureau of Reclamation Snake River Augmentation Program and by the NPPC.

Comment S7-3: Consider drawdown of Lower Granite Pool.

Response S7-3: See response to Comment R6-13.

Comment S7-4: Reduce lead time for a four-pool reservoir drawdown.

Response S7-4: See response to Comment A6-6.

Comment S7-5: Do not transport in lower Snake River when flows are to be above 100 kcfs for 3 days.

Response S7-5: See discussion on pages 3-11 and 3-12. The flow level that triggers bypass is currently 100 kcfs.

Comment S7-6: Assume Alternative 5 will reflect actual conditions for 1993.

Response S7-6: The SEIS alternatives are not only for 1993 but also for the interim years thereafter until a long-term plan evolves. To focus only on what might occur in 1993 would compromise the intent of this SEIS.

Comment S7-7: Analyze reduced flows from Dworshak.

Response S7-7: A qualitative assessment of the incremental benefits and impacts of the flexible portion of the summer releases (200 KAF) in Alternative 4 has been added to the final SEIS.

Comment S7-8: Ensure that proposed actions comply with ESA.

Response S7-8: The cooperating agencies have reviewed this environmental document and believe that it adequately addresses the proposed actions.

Comment S7-9: Ensure that proposed actions comply with Northwest Power Act.

Response S7-9: This change was made to the text. See response to Comment S7-8.

Comment S7-10: Continuation of proposed actions would not stop decline in escapements.

Response S7-10: See responses to Common Issue 9 and Comment S7-14.

Comment S7-11: Provide better description of recruitment projections and calibrations in Appendices E and F.

Response S7-11: See response to Comments S7-16, S7-17, and S7-73. Calibration procedures are described in the additional documentation references that are specific to each respective model group.

Additional technical references were intended for availability to individuals and agencies requesting further technical information. IDF&G is an active cooperating agency in the overall model coordination effort. The relationship between smolt survival models, calibration, and population trends will be examined in the long-term coordination effort, which is currently getting underway.

Comment S7-12: Empirical life-cycle model provides an index of specific population during brood years.

Response S7-12: A similar approach is involved for calibration of SLCM, except SLCM was developed to utilize random draws from appropriate probability distributions recognizing and emphasizing stochasticity in the movement of the population through the reservoir system. In this design, an analysis of risk of uncertainty through time can be characterized realizing that the specific annual population estimates are not absolutes.

SLCM also uses past brood year performance and smolt survival to project future population trends, and can compare past smolt survival to observed population trends.

Comment S7-13: Three model systems (BPA, NPPC, and T.E.C.H.) produce different projections of proposed actions.

Response S7-13: The 1993 SEIS has been a catalyst in reinitiating this comparative process. Coordination in developmental revisions, additions, and usage of these modeling efforts will need to continue past the model coordination comparison process if all agencies wish to put the recovery of the ESA stocks as top priority.

We agree review and coordination of regional passage and life-cycle models is of utmost importance. In support of these efforts, we are proceeding with two critical endeavors—an independent peer review and a longer-term, more detailed coordination process. Through the peer review, models will be examined by a panel of fishery and modeling experts from the United States and Canada. Focus will be on methodologies, applicability, and documentation. The peer review should also provide key information to aid in focusing the longer-term effort. The longer-term process will involve staff from BPA, the Council, and the state agencies and Tribes comparing specifics of the three different model systems.

Comment S7-14: 1993 measures will not be enough for a sufficient recovery plan.

Response S7-14: The 1993 SEIS is not intended by the cooperating agencies to constitute a long-term recovery plan. The intent is a plan designed to operate the hydrosystem with current constraints and coordination under the best available data until the NMFS Recovery Plan is produced and the System Configuration Study and System Operation Review processes provide better analysis leading to scientific-based guidance, ideally with less uncertainty. See also response to Comment R6-5.

Comment S7-15: Modeling relies on questionable assumptions about benefits of proposed salmon recovery actions.

Response S7-15: Uncertainty is accounted for in a variety of ways, including sensitivity studies, ranges of effectiveness of measures, and the stochasticity inherent in the models. The relative changes resulting from the proposed actions are not inconsistent between the BPA and NPPC analyses. Differences between BPA and NPPC model baseline results are caused primarily by differing calibration procedures. Some of these differences have been resolved in meetings between BPA and NPPC staff and the most recent analyses are much closer in the baseline results. These will be further analyzed during upcoming coordination efforts.

Comment S7-16: Discussion of transportation benefits could be in error.

Response S7-16: See response to Common Issue 8.

Comment S7-17: There are unresolved questions regarding transportation data, summaries, and conclusions.

Response S7-17: A sensitivity analysis of the effects of transportation on population trends has been performed for Snake River spring chinook (Fisher, 1993). This analysis showed that, in general, the SLCM predicts a larger percent change in the population level from 1990 Baseline to 1993 Actions conditions at higher transportation survivals.

A constant transportation survival was used in the SLCM since there has been no demonstrated mechanism by which transportation survival would change (Fisher, 1993). The predicted smolt survival from CRiSP.0 for spring chinook under 1990 Baseline Conditions was 21 percent, and ranged from 13 to 23 percent. The coefficient of variation for the 50-year flow record was 12 percent. This is a highly variable smolt survival, most of which results from differences in the flows from year to year. The model therefore is sensitive to flow changes. Most of the variability in adult recruitment has not been explained, but one would not expect all of this variation to come from flow. Variations in egg-to-smolt and ocean survival also contribute to variations in adult returns. Therefore, one would not want to match variation in smolt survival to variation in adult recruitment, and these variations would not be expected to

correlate. As a result, the set of transportation assumptions which most closely matches variations in adult recruitment is not necessarily the "best" model.

The allocation of variation within parts of the life cycle is based on matching observed variation in adult populations. The adult recruitment variation of a completely difference stock would be expected to be similar to that of Snake River stocks. Nor could all of the difference between an upriver and a downriver stock be explained by inriver migration.

Comment S7-18: Flow-survival relationship.

Response S7-18: Smolt survival does not decrease above 115 kcfs in the Snake River in CRiSP.0 as stated in the comment. Survival is held constant above 115 kcfs. Analysis of the available data does not indicate that survival increases at extremely high flows in the Snake River. Gas supersaturation problems still exist in the Snake River at flows over 115 kcfs. Even at moderately high flows, supersaturation routinely exceeds the EPA's 110 percent (up to 120 percent below Ice Harbor) limit in the lower Snake. The adult recruitment analyses mentioned are not sensitive enough to detect any differences in the benefits of 140 versus 115 kcfs in the Snake River.

Comment S7-19: Don't apply habitat improvement assumptions to the aggregate run.

Response S7-19: Habitat improvements and diversion screening improvements were very general in nature and apply to the entire subbasin above lower Granite Dam. They cannot be applied to specific areas until a methodology is developed to do so.

Comment S7-20: Doubt about predator control benefits.

Response S7-20: See responses to Comments F9-7 and F9-15.

Comment S7-21: Law enforcement won't likely increase chinook returns.

Response S7-21: Uncertainty is associated with these estimates; hence, this assumption was modeled with a range of 0.25 to 5 percent each for both the Snake and the Columbia rivers.

Comment S7-22: Doubt about the benefits of screening irrigation diversions.

Response S7-22: Uncertainty warranted that this assumption be modeled with a range of 2 to 5 percent for spring chinook and 1 to 2.5 percent for summer chinook.

Comment S7-23: No basis for benefits of habitat improvement.

Response S7-23: See response to Comment S7-19. Coordination for the final SEIS reduced the lower bound for the range modeled from 2.5 to 1.0 percent. Considerations under discussion include the assumption that optimal maximum sustainable yield (MSY) or desired stocking levels are achieved in pristine habitat for natural spawners, not supplemented fish. Wilderness or roadless designation does not guarantee habitat with excellent condition ratings under U.S. Forest Service guidelines. Impacts could have occurred prior to wilderness designation where recovery may not be complete under natural successional processes. Naturally occurring phenomena such as fires, landslides, etc, are typically random events, although management actions over time may act to skew the probability of occurrence. Suppression crew responses to wildfires that occur within wilderness areas are dispatched with high probability even though let-burn policies may be in effect. Grazing and mining can be grandfathered into wilderness designation plans. These activities carry their own degrees of direct or indirect impacts

to the aquatic resources. Any estimate of potential improvement to the production curve of an early life stage projected over time should be monitored over that time frame in the field to verify the projections. Benefits attributable to habitat improvements, even short-term planning, typically will not manifest themselves in a measurable way during a short time frame.

Comment S7-24: Key assumptions about models have little empirical evidence.

Response S7-24: The comment stresses why multiple model sets are used for the SEIS impact analysis. Coordinated runs for the final SEIS have clarified discrepancies in both SLCM and SPM preliminary runs for the draft SEIS. This point has been addressed in the context of the final SEIS model parameter run analysis of all three modeling sets.

Comment S7-25: Straying and loss of homing capability.

Response S7-25: There are no data to support that straying is a problem for fish transported as juveniles (Matthews, 1992).

Comment S7-26: Accuracy of control group results is questioned.

Response S7-26: Truck transport of control fish to below Little Goose Dam was evaluated. Results indicated that fish were not stressed as a result of the transport operation. The agreement among fishery experts was that if this was true, this was an acceptable means to determine the benefits of transportation.

The statement that 1989 was a "drought year" is incorrect; it was considered to be slightly below average. The transport research would not have been allowed in a drought year. Poor returns for both chinook and steelhead in the Snake River system, as well as elsewhere in the region, indicate that ocean survival conditions were poor in 1989.

Comment S7-27: Fish transportation success.

Response S7-27: Transportation can only protect fish from the effects of the dams and reservoirs. Other factors that have acted on the fish since dam construction, such as changes in water quality, estuary conditions, marine mammal numbers, hatchery production, disease, etc, continue to have impacts on the fish independent of transportation. See response to Comment S27-26. Also, 1986 was in top 10 percent of flow years during the last 30 years.

Comment S7-28: Barging was never part of the original project.

Response S7-28: No response necessary.

Comment S7-29: Note that drawdowns in lower Snake River would provide adequate velocities in low-water years.

Response S7-29: The note requested in this comment has not been added; the referenced discussion is merely a basic description of the Water Budget, and not a review of alternative means to achieve flow targets.

Comment S7-30: Rewrite section on "Flow Effects on Juvenile Salmonids."

Response S7-30: The section entitled "Flow Effects on Juvenile Salmonids" is not intended to be a complete review of all information presented on the relationship between flow, river

velocity, water particle travel time, smolt migration rate, and smolt survival. As stated in the first paragraph of Section 4.2.1, these relationships were discussed in the 1992 OA/EIS and are not repeated in the SEIS. The statement made in the SEIS is correct in the context used, if one does not go into all of the details of where it appears to apply and where it does not. Many studies have been completed since Raymond (1979), and the current situation involves reservoirs, not just a free-flowing river.

Comment S7-31: Account for confounding effect of gas supersaturation.

Response S7-31: Some text changes have been made. While the methods used by Petrosky (1991) are plausible, there is insufficient information to conclude that one method's results are superior to others.

Comment S7-32: Correct representation of Sims and Ossiander (1981) finding.

Response S7-32: Some text changes have been made. The Sims and Ossiander (1981) data show that the 5 of 7 years with higher flow would reveal no significant relationship between flow and survival. Only when the 2 low flow years are included in their data is there a significant flow survival relationship. In fact, Sims and Ossiander stated, "When the Snake River flows were in excess of 100,000 cfs, survival of yearling chinook and steelhead remained somewhat constant . . ." We agree that gas saturation adversely affected survival at higher flow; however, the implication that the relationship would definitely increase at higher flows cannot be determined from Sims and Ossiander's data.

Comment S7-33: Consider studies other than Sims and Ossiander (1981).

Response S7-33: See response to Comment S7-30 concerning summary information.

Comment S7-34: Contradiction in first paragraph of page 4-11 about reduced pool area.

Response S7-34: There is no contradiction. Less pool volume concentrates existing predator populations. Stabilizing the current pool level oscillation during the normal spawning season will enhance egg survival by reducing desiccation of spawned eggs. Several potential actions cause both positive and negative effects, the balance of which is difficult to determine.

Comment S7-35: Spill efficiency assumption in CRiSP is contrary to empirical data.

Response S7-35: Refer to response to Comment S7-72.

Comment S7-36: Draft SEIS relies on flawed research documents.

Response S7-36: In order to analyze the impacts of flow/travel time/survival relationships the Corps and the cooperating agencies choose to use relationships suggested by certain studies, in spite of some errors and debate over the manipulation of data in these documents. However, these agencies recognize there are differences of scientific opinion about interpretation of the data and more research is needed

Comment S7-37: Objection to statement on fish transportation on page 4-16.

Response S7-37: Pascho and Elliott note that up to 100 percent of the fish tested at the projects are infected with BKD. In addition, many fish have fungi, injuries, etc. The statement that fish have "an uncanny ability to survive" in higher runoff conditions ignores the

potential that many other factors may be affecting fish survival. Also, see response to Comment S7-27.

Comment S7-38: Include review of 1991-1992 operational strategy to store water in Columbia River reservoirs.

Response S7-38: In 1992, the 3 MAF Columbia River flow augmentation volume was obtained at a significantly lower expense than expected. This was due to an oversupply of gas resulting in low prices in California and ample energy supplies from B.C. Hydro during the time the 3 MAF was being stored. The purchase prices averaged only 20 mills/kwh, rather than the 40 mills assumed for a long-term average. Since the water conditions were so poor in the U.S., and since all of the 3 MAF was released in June and July, rather than May, much of the energy was usable by BPA, resulting in a net salvage rate of about 17 mills/kwh. This resulted in a net cost to BPA of about $7 million.

Comment S7-39: Include in discussion of Northwest Power Act that NPPC directed to restore anadromous fish runs in the Columbia River Basin, provide necessary flows.

Response S7-39: The Northwest Power Planning and Conservation Act is accurately described in Paragraph 7.12.

Comment S7-40: Include cited documents in final SEIS.

Response S7-40: Documents cited were incorporated in this section. Those not cited were not incorporated.

Comment S7-41: Update redd count declines to 1992.

Response S7-41: The text has been revised.

Comment S7-42: Information on runs is misleading.

Response S7-42: Information about Snake River coho was added.

Comment S7-43: Count of summer steelhead has been below goals of the Columbia River Fish Management Plan.

Response S7-43: The text has been revised to incorporate objectives and escapement for the whole upper river area above Bonneville Dam as reported in the WDF and ODF&W 1992 document.

Comment S7-44: Note that Idaho sport harvest has not occurred since 1978.

Response S7-44: The text has been revised.

Comment S7-45: Note that Clearwater habitats increased because of two dam removals.

Response S7-45: The table has been revised.

Comment S7-46: Add stress to list of negative factors attributed to loss of juvenile fish.

Response S7-46: The text has been revised.

Comment S7-47: Hall-Griswold (1990) comment is misleading.

Response S7-47: Reference to the subsequent increase in escapement has been added. The intent of the original statement, which was to indicate that sockeye abundance was once at a very low level prior to construction of the lower Snake River dams, is accurate.

Comment S7-48: Two CBFWA citations are contrary to SEIS citation.

Response S7-48: Citation moved. The CBFWA (1991b) citation is for the entire list of factors affecting smolts, not only the last statement (see page 9 of CBFWA, 1991b).

Comment S7-49: Statement is unclear and fails to address gas supersaturation.

Response S7-49: See response to Comment S7-36.

Comment S7-50: Rewrite juvenile bypass and transport facility discussion.

Response S7-50: See response to Common Issue 8.

Comment S7-51: Habitat degradation does not affect salmon population because of already existing low population.

Response S7-51: We have cited Rich et al. (1992) who stated that productive capacity remains high in most streams and the estimated benefit of improved habitat is 17 to 9 percent (page A-23). We see no reason to add the statement about seeding level quantity because we discussed the effect of seeding level and concluded that even at very low seeding levels, habitat quality can affect returns per spawner. While Marsh Creek might be less affected, there is still the problem of migration corridor survival prior to arrival at Lower Granite Pool, which is also an in-system habitat factor. The Marsh Creek example suggests that habitat improvements alone will not stop the decline of Snake River chinook but habitat will still have an effect.

The discussion about habitat is for historical and current effects. The information in the SEIS suggested that habitat degradation has historical and current effects on run size. It also appears to be true that returns per spawner for the same seeding level on average would be greater if habitat improvements were made. The main point is that habitat quality has an overall effect on system run size. Appendix A Section 2.0 discusses all factors affecting run status.

Comment S7-52: Objection to fish transportation statement.

Response S7-52: The text has been revised on page A-19. See responses to Comments S7-27 and S7-36.

Comment S7-53: Food limitations during downstream migrations.

Response S7-53: The text has been revised.

Comment S7-54: Figure A-5 has little use.

Response S7-54: The information was taken directly from a document assessing impacts on anadromous stocks of the Columbia River Basin (NPPC, 1986). While it would be preferable to have an overall assessment only in drainages that have salmon populations, we believe the information presented is informative, so it will be retained.

Comment S7-55: Hydroelectric system mortality negates effectiveness of screened diversions.

Response S7-55: Appendix A is intended to discuss all factors affecting run status, in both the past and present. This section was intended to discuss the effects of screens and lack of screens on migrants. The lack of screens causes smolt loss. If screens are installed on streams that have migrants, losses will be reduced. Appendix A does not state that simply improving screening can alone increase run sizes. However, dam and reservoir mortality is typically accounted for in percentage terms, as a mortality rate for a given set of conditions. Therefore, if the number of downstream migrants reaching the dams is increased while other factors remain constant, the number of adults returning will increase. The point of this entire section is that many factors affect run size and returns, but not all are equal in all areas.

Comment S7-56: Discussion of Snake River Basin irrigation is misleading.

Response S7-56: The effect of dams on flow was presented under hydroelectric effects. This section discusses the effects of irrigation. We do not believe the statements are misleading as presented; they discuss the current situation. Irrigation diversion affects river flow, which is important to fish under the current operating regime.

Page A-29 states the quantity of water diverted and returned to the river.

The text has been revised concerning the region of diversion.

Comment S7-57: Unclear histogram.

Response S7-57: The figure has been changed and includes all irrigated farmland.

Comment S7-58: Historical effect of flow depletion.

Response S7-58: The text has been revised.

Comment S7-59: Identify diversions in upper Salmon River.

Response S7-59: The text has been revised.

Comment S7-60: Parr production in South Fork Salmon River.

Response S7-60: The text has been revised.

Comment S7-61: Figure showing logging production is not geographically specific.

Response S7-61: This section emphasizes the endangered stocks in the Snake River and includes general assessments of all factors and regions affecting anadromous stocks. The figure was taken directly from a NPPC document that discussed salmon and steelhead losses in the Columbia River Basin. While river drainage and stock specific information would give a more detailed view of factors affecting these fish, we believe the information presented is adequate for illustrative purposes.

Comment S7-62: Adult escapement is inadequate to seed available habitat.

Response S7-62: Comment noted.

Comment S7-63: Note that Idaho is in litigation with Blackbird Mine over clean-up issues.

Response S7-63: The text has been revised.

Comment S7-64: Inriver migration may reduce disease transmission.

Response S7-64: The text has been revised. Research indicates the vast majority of salmon (up to 100 percent) carry BKD, so transmission may not be an issue. If stress causes loss as a result of increased infection levels, then operations such as turbine, spill, bypass, and reservoir passage, which are also "stressful" may result in loss due to BKD equivalent to that from transport.

Of the high flow years, 1982 to 1985, 1985 had the lowest flows but produced the highest adult returns. This comment does not take into account the multitude of other variables affecting the fish that are also changing during this time period (1980s and early 1990s).

Comment S7-65: Accompany mortality causes with research.

Response S7-65: The lack of tests showing significant relationships does not preclude the discussion of possible effects of competition and predation. Competition and predation with regard to hatchery and wild fish are valid concerns, especially because of the high in-river mortality that occurs prior to arriving at Lower Granite Dam. The effects of food competition or predation among salmonids in the rivers and reservoirs above Lower Granite Dam have not been directly tested. However, the high mortality rate in the river (Kiefer and Forster, 1992) compared to what has been recorded in the flowing portions of the Snake River in the past (Raymond, 1979) suggest some additional factors may be occurring that may not have occurred in the past. Giorgi (1991) reviewed available information on the potential competition for food (i.e., migration corridor carrying capacity) and stated it could be a problem, but insufficient data precluded a definite answer. It is true that many of the factors that cause migration losses may be "natural" and out of human control, but the quantity of hatchery fish released is under human control. If hatchery fish are causing adverse effects such as competition for food, then a reduction of hatchery releases could benefit wild stocks.

Comment S7-66: Change in mainstem operations may help bring adults back.

Response S7-66: There are no further changes in mainstem operation, other than those identified in this SEIS and being conducted under other programs (PIES, etc.) that are considered to be definite improvements in survival through this reach.

Comment S7-67: Supplementation may assist recovery of threatened fish.

Response S7-67: Comment noted.

Comment S7-68: Elimination of BKD is not realistic.

Response S7-68: Comment noted. The overall effect of hydroelectric operation on the development of Bacterial Kidney Disease symptoms are unknown. Whether modifications to the hydroelectric operations will reduce the outbreak and effects of this disease also remain speculative.

Comment S7-69: Overstatement of effectiveness of transportation.

Response S7-69: See responses to Common Issue 8 and Comment S7-27.

Comment S7-70: State that hydroelectric system is the most important factor in recovery of Snake River salmon stocks.

Response S7-70: Comment noted. We agree operation of the hydroelectric system is an important factor in recovery of Snake River salmon stocks. However, modifying hydroelectric system operation and not concurrently correcting other factors affecting salmon survival, namely habitat, harvest, water quality, and water use will not achieve a reversed of population declines. Effective improvements in Snake River salmon populations will require a concerted effort by entities affecting all stages of the species' life-cycles.

Comment S7-71: Expect later comment on drawdown test.

Response S7-71: Comment noted.

Comment S7-72: A rather conservative parameter is indicated in CRiSP model.

Response S7-72: In the event spill efficiency is higher than 1:1, then the model results shown represent a conservative approach, and actual benefits may be even greater.

BPA is not aware of studies which suggest a greater than 1:1 spill efficiency at any project other than The Dalles. See Appendix E for a review of spill efficiency studies. If additional information becomes available, it will be considered in the future.

Comment S7-73: Statement not supportable.

Response S7-73: Discussion of the appropriateness of Model 1 is outside the scope of the SEIS and within the scope of the Analytical Methods Coordination and Documentation process. NMFS' Transportation Studies (Matthews et al. 1987, 1990, 1992) were conducted under assumption closest to NPPC's Model 1. Fisher has provided preliminary results from CRiSP.0 and SLCM analysis of transportation for comparison of modeling efforts with a correlation analysis. Model 1 appears to overestimate years of lower flows to a greater extent than the other transport models, although all models overestimate to some degree. In contrast, Fisher's draft failed to detect any significant correlations between transport survival or TBR and flow for chinook in support of a NPPC Model 1 type assumption. However, alternative models represented by Fisher. All of the alternative transportation models, excepting Model 1, appear to underestimate higher flow years. It appears obvious that all of the modeling efforts need to be involved in a more coordinated effort targeted toward more accurate modeling of transportation scenarios.

Comment S7-74: Clarify Petrosky (1992) citation.

Response S7-74: The text has been adjusted accordingly. This topic also warrants greater discussion in the scope of the Analytical Methods Coordination and Documentation process.

Letter S8, Idaho Department of Parks and Recreation (Yvonne S. Ferrell, Director), December 4, 1992

Comment S8-1: Visitation decline for recreation.

Response S8-1: See response to Common Issue 4. Sections 4.10 and 4.13 of the final SEIS have been modified to expand and clarify the analysis of recreation and related economic impacts. Among other things, this material explains that the estimated 3 percent visitation decrease is averaged over the range of water conditions and does not hold for extreme low-runoff conditions such as occurred in 1992. The text additions also discuss factors other than low pool levels that confound impact analysis based on the 1992 experience.

Comment S8-2: Question whether responsibility of providing recreation is being met if reservoir is drawn down.

Response S8-2: Using the specific authorizing legislation to construct and maintain multipurpose resource development projects, the Corps and BOR operate these projects to balance operation for individual functions with operation for all functions. By providing this equilibrium, the agencies ensure meeting their responsibilities for maximizing sustained public benefits for all desirable purposes, as provided by law. With the currently identified alternative actions, the impacts to certain uses such as recreation are recognized by the agencies. However, recreational activities are not eliminated, and the relationship with enabling legislation continues to be clear.

Major drawdowns are not included as an action within any of the alternatives. Biological drawdown test alternatives are mentioned but are being pursued through other studies or activities such as the Snake River Salmon Recovery Plan. These proposed actions, when defined and agreed upon by the region, will require separate NEPA documentation.

Comment S8-3: Explain the potential displaced value of Alternative 4 more completely.

Response S8-3: See response to Common Issue 4. The text of Section 4.13 has been changed to clarify the original analysis. The projected loss of $5,000 is applied to the measurement of incremental value changes experienced by individual recreationists, as prescribed by the U.S. Water Resources Council. This value measure of net economic impact, based on national economic development (NED) accounting procedures, is distinct from user fee revenues to recreation providers or revenues to local businesses from recreation-related expenditures. The SEIS discussion of effects on local economic activity has also been supplemented.

Letter S9, Washington Department of Transportation, District 2 (Donald S. Senn, District Administrator), December 7, 1992

Comment S9-1: Drawdowns could damage highways adjacent to mid-Columbia River. Investigate to determine if prevention such as armoring is required.

Response S9-1: The drawdown action described in Appendix B was a test conducted at Lower Granite and Little Goose projects in March 1992. The draft SEIS discussion of alternatives clearly indicated that no such drawdown is currently proposed as an interim measure. Consideration of the drawdown strategy within the region has focused entirely on the lower Snake River and John Day Pool; the Corps and the cooperating agencies are aware of no proposals to implement drawdowns on the middle Columbia River.

Letter S10, State of Wyoming, Office of the Governor (Mike Sullivan, Governor), December 7, 1992

Comment S10-1: Concerned that the proposed measures would have a negative impact on utility ratepayers.

Response S10-1: The cooperating agencies will attempt to minimize the negative impacts of the actions taken for fisheries enhancement. However, all of the actions proposed in this SEIS will negatively affect the availability of power and adversely affect the utility rate payers.

Comment S10-2: The entire cost of rectifying the salmon population problem should not be placed on ratepayers.

Response S10-2: Text has been revised in Section 4.9.

Comment S10-3: Wyoming Game and Fish Department sees no adverse effects to its fisheries.

Response S10-3: No response necessary.

Comment S10-4: Wyoming can participate in the Snake River Water Bank.

Response S10-4: No response necessary.

Letter S11, State of Washington, Department of Ecology (T.L. Elwell; with Departments of Wildlife and Fisheries attachments), December 7, 1992

Comment S11-1: Lack of a broad enough range of alternatives.

Response S11-1: See response to Common Issue 1.

Comment S11-2: Limit document to 1993 operations only.

Response S11-2: See response to Common Issue 3.

Comment S11-3: Spill is an important means of juvenile salmonid passage.

Response S11-3: Spill provisions are discussed under the separate corresponding heading in Section 2.2.4.

Comment S11-4: Transportation measured at Little Goose Dam and not at point of origin of the juveniles.

Response S11-4: Current plans are to operate collection and transportation facilities at Lower Monumental in 1993 unless the Corps is otherwise advised by the National Marine Fisheries Service. Text changes on transportation have been made, although adult returns have been measured to Lower Granite Dam, not Little Goose, in recent years (early tests were to Little Goose).

Comment S11-5: Discuss adult fallback.

Response S11-5: The incidence of fallback is appropriately discussed in other locations in the SEIS. The referenced discussion is merely a basic description of the adult passage system, and is not intended to be a thorough review of all issues relating to adult passage.

Comment S11-6: Flow augmentation releases from Brownlee and temperature control releases from Dworshak and Brownlee.

Response S11-6: See response to Comment S1-3.

Comment S11-7: Update bull trout status.

Response S11-7: The section was updated. See response to Common Issue 6.

Comment S11-8: Lack of reasonable range of alternatives.

Response S11-8: See response to Common Issue 1.

Comment S11-9: Show modeled benefits for each parameter.

Response S11-9: Sensitivities regarding flow-travel time, transport, and squawfish control are being included in the final SEIS. In addition, three different effectiveness levels are assumed for many parameters.

Comment S11-10: Modeling did not accurately predict 1992 flows.

Response S11-10: HYSSR models different water management actions over a historical 50-year period of 1928 through 1978. The purpose of the modeling is to provide an estimate of the reservoir elevations and stream flows of different management actions over a variety of water conditions. Although the 1992 water year was not modeled, the low water conditions experienced in 1992 were within the conditions experienced between 1928 and 1978. The modeling is not used to "predict" flows for 1992 or any future year because each water year is different.

Comment S11-11: Actions that occurred in 1992 are not accurately characterized.

Response S11-11: For an explanation of actions actually occurring in 1992, see Section 2 of the SEIS.

Any late summer releases from Brownlee and Dworshak reservoirs were passed through Lake Wallula. It may be that Lake Wallula filled at the same time as these releases occurred, but if so, it would have filled at this time anyway. Thus, the flows in the lower Columbia were still higher than they would have been otherwise.

The planning criteria call for 100,000 acre feet of water to be released from Brownlee in September. This would have been done if Idaho had determined that the water was available. Since it was impossible to know ahead of time that the water would not be available and it was the intent to do this, it is correct to model it that way. If the water is available in 1993, it is expected that it will be released. Likewise, 3.0 MAF was stored for 1992, a dry year, and released for fish. Depending on runoff this may or may not occur in 1993, but it will be modeled the same as it was for 1992, showing up to 3.0 MAF being stored in dry years, and nothing being stored in the wet years when runoff forecasts at The Dalles exceed 90 MAF.

Comment S11-12: Need for additional monitoring and research.

Response S11-12: Comment noted.

Comment S11-13: Discuss 1991 and 1992 flow years status of Snake River salmon stocks.

Response S11-13: The SEIS addresses the effects of proposed action in the future on juvenile survival and adult returns. This document is not intended to assess the direct effect on stocks from the last 2 years' flows and operations. The input to the models included records of water-year flows. Flows of the type occurring in 1991 and 1992 are included in the water-year record and are represented in the analysis in the proportion they would be expected to occur. The models' input parameters used recent fish numbers as representative of current and future situations. While the inclusion of estimated returns from the low flow years of 1991 and 1992 would initially decrease the analysis starting point, it would not change the trend line directions or slopes and would not substantially change the conclusions about effects of future actions.

Comment S11-14: Consider more aggressive augmentation measures in brood year classes.

Response S11-14: More long-term, but concurrent planning analysis processes such as the System Operation Review, the System Configuration Study, and the NMFS Recovery Plan must be relied upon to expand the analysis capability and scope of the 1993 final SEIS. Augmentation is likely to be only a part of the composite alternatives in these processes because of its limitations involving storage and the capability to pass large volumes of water.

Comment S11-15: Support for Alternative 4 as preferred.

Response S11-15: No response necessary.

Comment S11-16: Explore alternatives that provide greater flow augmentation.

Response S11-16: See response to Common Issue 1.

Comment S11-17: Make more conservative estimates for flow and travel time.

Response S11-17: Time frames for implementation reflect the fact that population and ecological response typically occur and manifest along a lengthy schedule. With this in mind, the draft SEIS analysis attributed more weight to low levels, or modest levels at best, while comparing the assumptions and sensitivity analysis of the two modeling efforts used. The analysis of the parameters set for the final SEIS runs are reviewed with the same considerations as to the reliability of the ranges used for the sensitivity risk analysis procedure.

See response to Comment S11-9.

Comment S11-18: Validate critical model assumptions.

Response S11-18: See response to Comment S7-10. Monitoring for effects and adequacy of any predictions should be emphasized through coordinated effort of the managing agencies so that a tracking procedure can be used to update the modeling efforts.

Comment S11-19: Evaluate possibility of loss of shallow water rearing habitats.

Response S11-19: The potential loss of shallow water habitat was addressed under "Other Effects on Juvenile Salmonids." The amount of lost productivity cannot be quantified because the overall effect of this habitat on fall chinook productivity is not known. However, the quantity of lost habitat compared to available habitat is anticipated to be small. Overall effects of this loss are not known.

Letter S12, Idaho State Historical Society, (Kenneth Swanson, State Historic Preservation Officer)

Comment S12-1: Alternative 4 will adversely affect historic properties.

Response S12-1: No response necessary.

Comment S12-2: Identify historic properties on reservoirs in Idaho.

Response S12-2: As funding and conditions allow, identification and assessment of historical properties will continue at Dworshak and Brownlee reservoirs. Information generated from these investigations will be used to help develop appropriate mitigation response.

Regional

Letter R1, Upper Columbia United Tribes Fisheries Research Center (Allen T. Scholz), October 24, 1992

Comment R1-1: Impacts to resident fish at Grand Coulee.

Response R1-1: The comment reiterates text. No change is required or requested.

Comment R1-2: Revise draft SEIS to lessen the impact at Grand Coulee.

Response R1-2: See response to Common Issue 2.

Comment R1-3: Defer any action until a thorough analysis is completed through System Operation Review.

Response R1-3: The cooperating agencies are responsible under ESA to avoid actions that would jeopardize the continued existence of a listed species and are evaluating measures in this SEIS to meet this responsibility.

Comment R1-4: Revise draft SEIS to describe mitigation of impact of fish stocks, and business and community economic losses.

Response R1-4: Although no mitigation plan is provided in this interim document, BPA monitoring plans are expected to provide information to be used to better define and quantify the impacts on resident fish; the resulting impacts on recreation will be quantified in the System Operation Review analysis due to be distributed to the public late this year. Mitigation features are also examined in this review.

Letter R-2, The Confederated Salish and Kootenai Tribes of the Flathead Nation (Michael T. Pablo, Chairman of Tribal Council), November 5, 1992

Comment R2-1: Pleased that SEIS includes Libby and Hungry Horse.

Response R2-1: No response necessary.

Letter R3, The Confederated Salish and Kootenai Tribes of the Flathead Nation (Michael T. Pablo, Chairman), December 7, 1992

Comment R3-1: Petition with U.S. Fish and Wildlife Service listing the bull trout under the ESA.

Response R3-1: See response to Common Issue 6.

Comment R3-2: Drawdowns will expose cultural resources at Libby and Hungry Horse reservoirs.

Response R3-2: To meet its cultural resources responsibilities under NHPA and ARPA, the Corps is developing monitoring and mitigation plans to address cultural resource impacts caused by changed river operations. The Corps will consult with all appropriate parties, including the tribes, in developing its mitigative measures. Cultural resources are not treaty-protection items.

Letter R4, Colville Confederated Tribes (Patti Stone, Acting Director), December 1, 1992

Comment R4-1: Detail flood control shift from Dworshak and Brownlee with Alternative 4.

Response R4-1: See response to Comment S5-6. Discussion of the flood control shift in Section 3 of the text has been expanded.

Comment R4-2: Confirm source for No Action Alternative for the 50-year period, end of month elevations.

Response R4-2: The end-of-month elevations for Alternative 1 are taken directly from the HYSSR elevation outputs for this case, the No Action Alternative. As described in Section 3.2, the hydroregulation results for this alternative represent the simulated operation of the system over the 50 years of water record using the system operating rules in place from about 1985 through 1990 (prior to flow measures in response to ESA listings) and 1991 to 1992 power loads.

Comment R4-3: Delayed/decreased zooplankton availability in modified 1992 operations.

Response R4-3: Effects of actions on zooplankton were addressed in several places in the draft SEIS. No text change is necessary.

Comment R4-4: Cumulative effects in Lake Roosevelt.

Response R4-4: This is generally consistent with the material in Section 4.3.

Comment R4-5: Lacking mitigation for effects to resident fish.

Response R4-5: Mitigation for lost resident fishery values has not been addressed in the SEIS. Water resources projects were authorized for multiple use and are being operated within legislative authority. Operational modifications which affect resident fish will be considered for mitigation in future years when a permanent plan of operation has been developed which creates significant deviations to the authorized operation. In the long term, resident fish impacts might be mitigated by resident fish hatchery restocking programs.

Comment R4-6: Forecasting is unreliable with current technology.

Response R4-6: Alternative 4 provides for storage of additional water in Dworshak, allowing a flood control storage space shift to Grand Coulee Reservoir when forecasted April-to-July inflow to Dworshak is less than 3 MAF. Variability in forecasting is recognized and considered in any selected modifications to operational strategies.

Letter R5, Nez Perce Tribal Executive Committee (Samuel N. Penney, Chairman), December 2, 1992

Comment R5-1: Tribe retains treaty rights in large portion of affected areas, exercises control, and provides input into projects that affect tribal resources.

Response R5-1: Treaty rights, trust responsibilities, and related topics are being addressed in full in the SOR.

Comment R5-2: 1989 monitoring program is incomplete.

Response R5-2: In 1989, the Center for Northwest Anthropology, Washington State University undertook a cultural resources survey within the Dworshak Reservoir drawdown zone. Approximately two-thirds of the drawdown zone was surveyed during this time. Since then, insufficient drawdowns and/or lack of funding have prevented the remaining portion of the reservoir from being surveyed. If reservoir conditions are favorable and funding is available, this work will be completed in 1993.

Comment R5-3: Final SEIS should assess effects of continued destruction of cultural deposits.

Response R5-3: The Waterways Experiment Station, a Corps of Engineers research laboratory, is developing both cultural resources monitoring and protection/preservation plans to be used at Dworshak. It is anticipated these plans will be completed by the end of 1993.

Comment R5-4: Please consult tribe before any more surveys are done.

Response R5-4: The Nez Perce Tribe has been and will continue to be notified of and provided the opportunity to comment on cultural resources undertakings. During the 1989 cultural resources survey of the Dworshak Reservoir drawdown zone, two members of the Nez Perce Tribe, including the Tribe's cultural coordinator, were part of the survey crew.

Comment R5-5: Address issues of management of cultural resources.

Response R5-5: See response to Comment R5-3.

Letter R6, Columbia River Inter-Tribal Fish Commission (Ted Strong, Executive Director), December 7, 1992

Comment R6-1: Corps' obligation to protect and maintain the tribes treaty fishing rights.

Response R6-1: See response to Comment F7-1.

Comment R6-2: Proposed actions are not favorable to rebuilding salmon runs.

Response R6-2: Although the proposed flow improvement measures may be beneficial, they are not sufficient in themselves to achieve recovery of the endangered and threatened salmon stocks. The many factors that have led to the decline of the salmon will all require improvements or modification if the region desires to save the Snake River salmon. These factors include river flow, improvement to harvest, lost and damaged habitat, water quality, and water conservation measures.

The SEIS scope is limited to those areas within the control of the Corps, BoR, and BPA. The scope includes water control measures at federal dam projects and other project specific improvements to help juvenile and adult salmon passage through those projects. The NMFS Salmon Recovery Plan and the NPPC Fish and Wildlife Amendments will better reflect the full range of actions required to rebuild the salmon runs.

Comment R6-3: Federal agencies must work with tribes to reach solutions within the boundaries of treaty rights.

Response R6-3: See response to Comment F7-1.

Comment R6-4: Address impacts to cultural resources during drawdown.

Response R6-4: See response to Comment R3-2.

Comment R6-5: Need for additional alternatives to reverse the population decline.

Response R6-5: See responses to Common Issues 1 and 2, and Comments S7-10, S7-15, and S7-24. The final SEIS analysis incorporates revised parameter sets and adjusted ranges with which to compare outputs for all three modeling efforts.

Comment R6-6: Discrepancy between BPA and other model results.

Response R6-6: See response to Common Issue 9.

Comment R6-7: A more robust analysis of alternatives.

Response R6-7: The BPA and NPPC analyses for spring chinook assume increased survival occurs with increased flow and reduced water particle travel time in the Snake and Columbia rivers. The SEIS evaluates the effect of the five alternatives on survival based on models that used flow and survival relationships developed from the Snake River. The cooperating agencies consider this analysis suitably robust. The State and Tribal agency model analysis (FLUSH and ELCM) was also presented, which we believe satisfies your request for a more robust analysis of the flow alternatives.

Comment R6-8: Lack of reasonable range of alternatives.

Response R6-8: See response to Common Issue 1.

Comment R6-9: Include an alternative with substantially increased water availability from the upper Snake River.

Response R6-9: There is uncontracted space in BoR reservoirs. Most of it, however, has been dedicated to other uses through various actions. Additionally, much of the uncontracted space is in reservoirs with poor yield, or has a later priority of fill. It is important to remember that space not contracted is often formally designated to another purpose, such as instream flow enhancement or maintenance of reservoir pool levels. At this time, 95,000 acre-feet of space in Deadwood and Cascade reservoirs has been designated for use in flows for salmon. A decision process is currently underway which includes permanent designation of the 95,000 af for use to protect endangered species, bald eagles, and the listed salmon stocks. A summary of uncontracted reservoir space is as follows:

Reservoir	Uncontracted Space (Acre-feet)	Disposition
Anderson Ranch	4,200	Joint use power and M&I.
Cascade	389,500	300,000 of (including 50,000 af inactive pool) has been formally designated as minimum pool to protect water quality and endangered bald eagle population, in accordance with biological opinion of Fish and Wildlife Service. 69,500 af is temporarily being reserved for anadromous fish. The 19,000 af is reserved for, but currently withheld from, contracting for irrigation, municipal, and industrial uses.
Deadwood	105,400	80,000 af is designated for protection of reservoir fishery (50,000 af) and local instream flows (30,000 af) for winter release which may be storable in Brownlee for later release for salmon. Some 25,400 af is temporarily reserved for anadromous fish.
Lucky Peak	116,250	All of this space has been formally designated for maintenance of instream flow during the winter.
Palisades	19,480	This space has been reserved through the Congressionally approved settlement of the Shoshone-Bannock Indian Water Rights claims to mitigate losses to non-Indian irrigations from exercise of Tribal rights. A contract is under negotiation to complete this provision of the settlement.
Ririe	80,500	The active capacity of 80,500 af has been reserved through the Congressionally approved settlement of the Shoshone-Bannock Indian Water Rights claims to mitigate losses to non-Indian irrigators from exercise of Tribal rights. A contract is under negotiation to complete this provision of the Sho-Ban settlement.

Comment R6-10: Water purchase or lease and water conservation.

Response R6-10: As discussed in the above comment, much of the "uncontracted" space has been formally reserved, through formal agency action, compliance with the Endangered Species Act, or Congressionally approved Indian water rights settlements. Some 95,000 acre-feet of space in Deadwood and Cascade reservoirs has been temporarily designated for Salmon recovery.

Water bank purchases have been pursued in past years as a means of providing additional flows for salmon, and will be considered in the future. It is important to note that the availability of water from this source is highly dependent on the water year. Recent extremely dry years have dramatically reduced the amount of water in the water bank for any purpose.

Purchase of water rights is being pursued, and involves addressing many institutional constraints. Consequently, it will not likely produce significant quantities of water in the near future.

Reclamation is taking the lead in designing and implementing water conservation demonstration projects in the Pacific Northwest. These projects will provide examples of efficiency measures that can improve tributary and mainstem flow conditions for salmon. The tributary conservation projects are part of the cooperative model watershed enhancement programs now being implemented throughout the region.

To assist in accelerating water efficiency programs, we have established a water conservation center in Reclamation's Regional Office. This staff provides technical assistance to irrigation districts in their conservation programs. We are also working with State water regulation agencies to strengthen local water measurement and management programs.

Comment R6-11: Modified flood control and power operations.

Response R6-11: Comment noted.

Comment R6-12: Sliding scale scenario of volumes from 1993 through 1998.

Response R6-12: No response necessary.

Comment R6-13: Consider a drawdown strategy for implementation in 1993.

Response R6-13: See Response to Common Issue 11.

Comment R6-14: Appendix E summarizes recommendations for project operation conditions for 1993.

Response R6-14: Improved passage operations for salmon at the Corps dams are not specifically identified as portions of each alternative. However, it is acknowledged in Section 3.2.1 of the SEIS that passage improvements at the projects are represented in the 1993 Fish Passage Plan that also reflects some general guidelines based on the Endangered Species Act Section 7 consultation with NMFS. The Fish Passage Plan is prepared by the Corps under a separate planning process already in place, coordinated each year with BPA, fishery agencies, and Native American tribes through the Columbia Basin Fish and Wildlife Authority.

The improvements to the system facilities and operations are already programmed and will be implemented regardless of whether any interim flow improvement measures identified in the SEIS are adopted.

Letter R7, Northwest Power Planning Council (Ted Bottiger, Vice Chairman), December 10, 1992

Comment R7-1: Present power costs using high and low water conditions.

Response R7-1: Text has been modified in Section 4.9.

Comment R7-2: Compare alternatives in light of biological and environmental uncertainties.

Response R7-2: This comment more accurately portrays the scope of the SEIS, not the more fully coordinated model comparison process. Revisions for the final SEIS respond to this comment.

Comment R7-3: Use ecosystem approach for 1993 operations.

Response R7-3: SEIS discussions comparing and evaluating the alternatives have been supplemented to clarify the potential tradeoffs between anadromous fish and resident fish, wildlife, and related resources.

Comment R7-4: Brownlee has limited ability to shape spring water.

Response R7-4: The text has been modified in several locations to attempt to clarify assumed aspects of the Brownlee operation. The 2,069-foot elevation constraint was taken into account in the SEIS analyses for recreation and other resources.

Comment R7-5: Concern for limiting Dworshak releases if Lower Granite flows above 100 kcfs.

Response R7-5: The proposed operation of Dworshak for water years above 16 MAF uses the two criteria of 100,000 cfs at Lower Granite and a 70-percent refill probability of Dworshak. These criteria are intended to 1) ensure 900 KAF in moderate runoff years, 2) improve the refill probability of Dworshak in high runoff years when flows at Lower Granite are at least 100,000 cfs, and 3) provide more flow augmentation in extreme runoff years when flows at Lower Granite are at least 100,000 cfs and refill probability of Dworshak is greater than 70 percent.

Comment R7-6: Caution against relying too much on small differences in models.

Response R7-6: See response to Comment R7-2.

Comment R7-7: Include recent flows or a worst-case scenario of potential biological impacts.

Response R7-7: Text has been added addressing the low flow or worst case scenarios by more structured review of the output files for the 50 year passage survival and adult recruitment estimates, and incorporating previous passage modeling analysis that are similar in parameter estimates and scope (SOR passage model runs and more recent CRiSP.1 run paralleling the draft SEIS).

Comment R7-8: Add that Libby and Hungry Horse operation "fixed" in this alternative.

Response R7-8: The text has been modified as suggested.

Comment R7-9: Change wording.

Response R7-9: This change was made to the text.

Comment R7-10: Misleading sentence.

Response R7-10: The statement has been clarified.

Comment R7-11: Revise sentence.

Response R7-11: The statement has been clarified.

Comment R7-12: Include worst-case scenario for power cost.

Response R7-12: Range of power costs are included in Section 4.9.

Comment R7-13: Correct flow with 6.45-MAF release.

Response R7-13: The text has been modified.

Comment R7-14: Note 90 KAF uncontracted storage not yet released.

Response R7-14: This information has been included in the text.

Comment R7-15: Temperature control plan differs from actions of Idaho Power Company.

Response R7-15: The text has been revised.

Comment R7-16: Note IPC's pre-1992 flow augmentation at Brownlee.

Response R7-16: The discussion of the no action alternative has been revised as noted. For the remainder of this comment, see response to Comment R7-4.

Comment R7-17: Note Dworshak 900 KAF in addition to minimum outflow.

Response R7-17: The text has been revised as suggested.

Comment R7-18: Clarify 270 KAF release.

Response R7-18: Summer flows are provided under all water conditions.

Comment R7-19: Have minimum flow constraints at Dworshak been considered?

Response R7-19: The only local flow constraints considered from October 1 through November 15 that limit Dworshak releases were those that limit the 7-day average release to not exceed inflow by more than 1,300 cfs, except during freshets or emergency power operations. These would tend to provide an upper limit on releases rather than minimum, and were considered in the analysis.

Comment R7-20: State Brownlee shaping of 190 KAF in spring.

Response R7-20: Text has been revised.

Comment R7-21: State whether analysis was refill or continuous study.

Response R7-21: The analysis was performed as a continuous study in which reservoirs start each year at the elevation where they ended the previous year. Text has been added.

Comment R7-22: Revise paragraph on monthly average versus daily flows.

Response R7-22: The comment correctly assumes the point of the example. The text has been clarified.

Comment R7-23: Revise sentence on 137 KAF from Brownlee and 270 KAF from Dworshak.

Response R7-23: The text has been modified.

Comment R7-24: Clarify sentence on system operation modeling.

Response R7-24: A release of 200 KAF from Dworshak above a base discharge of 1,200 cfs was modeled.

Comment R7-25: Include impacts to entire Snake River Basin.

Response R7-25: BoR committed last year to comply with upper Snake River augmentation features in the Council's program. Most of the flows, however, are dependent upon availability of water in Idaho Water Banks. The NEPA compliance for this commitment has been provided previously and is not a feature of this document. Only the downstream impacts of shaping this water are covered in this document.

Comment R7-26: Indicate source of 135 KAF of Brownlee water.

Response R7-26: The error has been corrected.

Comment R7-27: Include 1,285-foot minimum limit at Grand Coulee during summer months.

Response R7-27: The limit of 1,285-foot minimum elevation for Grand Coulee was active in all alternatives.

Comment R7-28: Consider daily fluctuations at Libby.

Response R7-28: Modeling for the SEIS was done on a monthly (semi-monthly in April and August) basis and no analysis was done of daily fluctuations. Modeling of daily fluctuation is not possible using HYSSR.

Comment R7-29: Clarify or resolve discrepancies in Table 3.5-8 for Libby and Hungry Horse.

Response R7-29: Incorrect entries for Alternative 1 in the original table have been revised.

Comment R7-30: Include 55-percent harvest rate in analyses.

Response R7-30: The harvest rates are estimates generated from the ODF&W Pacific Salmon Commission Chinook Model assuming that fall chinook harvest followed the NPPC Phase II Amendments, not duplicate the actual rate. For the 1992 to 1995 time frame, this resulted in an estimated harvest rate of 59 percent. In lieu of duplicating the NPPC proposal, it may be more productive to perform a sensitivity analysis incorporating a structured range (10 percent increments) to more accurately assess the incremental effects of the values on the adult recruitment estimates. The return to 1991 harvest levels in 1996 apparently reflects the assumption that typically a minimum 5-year relaxation in harvest pressure is enough to indicate a response to an entire brood year cohort. In the present case, with a high probability that ESA-listed stocks would be incidentally harvested along with expanded numbers of hatchery-produced fish, a return to 1991 harvest rates within 5 years would seem not only optimistic, but premature.

The SEIS modeling objective is to assess the effect of flow measures on wild salmonid stocks as a supplement to the more detailed OA/EIS, not to develop a long-term recovery or rebuilding schedule. The more detailed evaluations of the effects of nonflow measures, such as harvest, are beyond the scope and schedule of this SEIS.

Comment R7-31: Include cost of capacity losses as a range.

Response R7-31: The value for the capacity losses was calculated using what was considered to be a reasonable set of assumptions, given the lack of ways to precisely determine the amount of surplus capacity in the PNW and how much it is worth. The assumptions were purposely not designed to determine the maximum cost, but rather a reasonable value. If a range were to be added to these values, it probably should be a range which had the $11 million value as its midpoint, not as the high end.

Comment R7-32: Clarify presentation of nonfirm energy loss at lower Snake River operations.

Response R7-32: MW estimates of the nonfirm losses and gains due to the Columbia River additional 3 MAF operation are not included in the nonfirm energy numbers shown in the power section. This is because in the Columbia River additional 3 MAF operation the impacts only occur in some years and vary greatly for different years. Moreover, there is considerable shifting of nonfirm energy from one season to another. A spreadsheet analysis was used to work up the financial impacts of an "average year" taking these factors into account. The costs for this operation are included.

Comment R7-33: Note nonapproval of firm planning approach of Columbia River actions.

Response R7-33: The Council did not specify clearly how this was to be implemented, but did state that if there were even one failure to meet the requirement, it would be necessary to acquire firm resources to be able to provide the water in the future. Many utilities have interpreted this to be a firm requirement. In addition, the Council did not approve a firm planning approach only in the sense that they did not address the recommended actions.

Comment R7-34: Spreadsheet model to determine costs is not specific enough.

Response R7-34: These prices are intended to be reasonable and to provide a basis for comparison among alternatives. A complete economic analysis would have to include the economic impacts in Canada, the PNW, and California. It is not clear what the effect of the economics of this shift would be on California, which is a large user of PNW nonfirm energy.

Local

Letter L1, Board of Commissioners, Clearwater County, Idaho (Donald Ponozzo, Chairman), November 30, 1992

Comment L1-1: Fish migration, not even survival, is now to take precedence over all other uses of the dams.

Response L1-1: The cooperating agencies have legal obligations under the Endangered Species Act to avoid jeopardy to the listed salmon stocks. A successful solution will require improvement to survival by not just hydroelectric operations, but also all actions affecting all types of the listed species' life-cycles.

Comment L1-2: No biological evidence to support benefit to fish from changing flow.

Response L1-2: See response to Common Issue 5.

Comment L1-3: Oppose this experiment; use Dworshak as it was intended.

Response L1-3: Your opposition to the proposed action is noted. The action alternatives addressed by the SEIS are within the legal authorities for the respective projects and the general authorities under the Endangered Species Act and the Northwest Power Act.

Comment L1-4: Board opposes further drawdowns of Dworshak; no biological evidence that this will help fish; imposes undue economic burden on area residents.

Response L1-4: No response necessary.

Association or Organization

Letter A1, Wildlife Forever, Inc. (Clyde V. Brunnell), November 5, 1992

Comment A1-1: Control flow at dams.

Response A1-1: No response necessary.

Comment A1-2: Transporting fry more effective, less costly.

Response A1-2: See response to Common Issue 2.

Comment A1-3: Use volunteers for salmon habitat rehabilitation.

Response A1-3: Corps operational programs do not include stream habitat rehabilitation or hatchery release projects. See also response to Common Issue 2.

Comment A1-4: Capital loss of water lowering.

Response A1-4: No response necessary.

Comment A1-5: Control harvest and eliminate gillnetting.

Response A1-5: See response to Common Issue 2. The NPPC Phase Two/Three amendments address the buy-back of commercial fishing permits.

Letter A2, Northwest Irrigation Utilities (Darryll Olsen), November 10, 1992

Comment A2-1: Support Alternative 4 as the preferred action alternative.

Response A2-1: No response necessary.

Comment A2-2: Need to include data from two reports into SEIS: (1) *PIT-Tagged Spring Response and Summer Chinook Salmon Detection Rates Compared with Snake River Flow at Lower Granite Dam*, and (2) *Yearling Chinook Salmon Travel Time and Flow Regime Relationships in the John Day Pool, 1989 and 1990.*

Response A2-2: The cooperating agencies have noted this omission previously at the draft SEIS public meetings in November 1992. These reports have been incorporated in the final SEIS. The University of Washington developers of the CRiSP.1 versions are reviewing such recent data sets for the introduction of alternative flow-travel time assumptions.

Comment A2-3: Support for use of life-cycle models.

Response A2-3: This SEIS addresses interim flow measures and is not designed as a comprehensive set of recovery measures. The cooperating agencies will continue to coordinate with other agencies that are responsible for ESA documentation submittals for hatcheries, habitat, and harvest. The umbrella process for overall model comparison is one active vector for this coordination. The NMFS ESA program has the responsibility for the comprehensive analysis in which the confluence of the major contributing variables on stock recovery can be partitioned. Cost-effectiveness criteria based on current conditions contrived through human intervention are not totally justified within the ESA

process. The ESA requirements are based upon the best scientific knowledge and ecological needs of the listed stock.

Comment A2-4: Convene a cost-effectiveness analysis work group for the SEIS.

Response A2-4: See response to Comment A2-3. The objective of this SEIS is to evaluate flow measures until the time the SOR, SCS, and/or the Recovery Plan can be completed. The validity of how cost-effectiveness or, for that matter, incremental analysis criteria influence the decisions for ESA-listed wild salmonid stock recovery and rebuilding is a topic for discussion. The cooperating agencies are working with interested parties in the workgroups of SOR, and the suggested procedures are being considered for evaluation of alternatives.

Letter A3, Flathead Wildlife, Inc. (Herbert Johnson), November 11, 1992

Comment A3-1: 1992 should not be used as "normal" reference base for Hungry Horse and Libby.

Response A3-1: See response to Common Issue 10. Please note that Alternative 1, the base case used as a point of departure for analysis, reflects system operations prior to the ESA listings and not the 1992 operations.

Comment A3-2: Adverse impacts to resident fish.

Response A3-2: See response to Common Issue 10.

Comment A3-3: Listing white sturgeon and bull trout under ESA.

Response A3-3: See response to Common Issue 6.

Comment A3-4: Impacts of pools not reaching full pool elevation.

Response A3-4: We respectfully disagree. Refill probabilities under the various alternatives are indicated in Section 3.5 of the SEIS. The impact analyses for recreation (Section 4.10), resident fish (4.3), and other resources account for the impacts of operational changes, consistent with the degree of change projected and within the limits of available information.

Letter A4, Harney Electric Cooperative, Inc. (Jack Heaston), November 12, 1992

Comment A4-1: Opposition to flow augmentation and drawdowns, question benefits.

Response A4-1: See response to Common Issue 5. Some studies indicate that there is no flow travel time relationship for smolts. Others (e.g., Sims and Ossiander, 1981; Berggren and Filardo, 1991), however, indicate there is a weak relationship at lower flow levels. The cooperating agencies agree there is uncertainty in any conclusions about flow, travel time, and survival. In spite of this uncertainty, the cooperating agencies believe ignoring the possibility that some increased flow will enhance migration rate and survival is not prudent and eliminates one of the few available options to improve downstream fish survival of the threatened stocks.

Comment A4-2: Support for cost effectiveness.

Response A4-2: The cost-effectiveness analysis is presented in Section 5.2 of the SEIS.

Letter A5, Western Montana Electric Generating and Transmission Cooperative, Inc. (Ronald Wilkerson), November 12, 1992

Comment A5-1: Need for validation of survival in relation to travel time and water velocity, and support of cost effectiveness.

Response A5-1: See responses to Common Issues 5 and 8.

Comment A5-2: Did BPA ratepayers pay for 190,000 acre-feet from upper Snake?

Response A5-2: The NPPC Phase Three amendments request the BoR and the State of Idaho to obtain 90 KAF of this figure, with no specification of funding source. The BoR, Idaho, Oregon, BPA, and unspecified other parties are requested to provide the remaining 100 KAF, with half of that amount to be secured by the BoR and half through BPA financial incentives.

Comment A5-3: Possible future operational changes for Hungry Horse and Libby.

Response A5-3: The possibility for such changes is recognized in the discussions of biological rule curves in the resident fish sections of the SEIS.

Comment A5-4: Inclusion of all predator impacts.

Response A5-4: Indirectly, both SPM and CRiSP recognize flow effects on predation. As flow increases, the per mile reservoir survival value increases, which is primarily a function of decreased predation.

The predator control program is based primarily on studies done in John Day Pool. These studies found that squawfish were the major predators on juvenile salmonids in the system. While other fish species were found to consume salmonids, the relative percent of salmonid loss to these species was small. Mammal consumption of adult fish at the mouth of the Columbia River might be a concern, but the actual effect is unknown at this time. The abundance of shad in the system is primarily a concern in ladders, because it may possibly disrupt adult migration. The NPPC plans to study some of these effects from shad in the future, but currently the level of effect on salmon stocks is unknown.

Comment A5-5: Benefits of the Water Budget.

Response A5-5: The flow improvements effects of Water Budget (600 KAF in Dworshak and 3.45 MAF in the Columbia) is being evaluated under SOR.

Comment A5-6: Listing white sturgeon or bull trout under ESA.

Response A5-6: See response to Common Issue 6.

Comment A5-7: Did BPA rent water; concern because increased flows helping salmon is a presumption.

Response A5-7: BoR rented 90 KAF of uncontracted space in Cascade and Deadwood.

Comment A5-8: Support for established harvest levels vs. harvest rates.

Response A5-8: Please see response to Common Issue 5.

Comment A5-9: Support including harvest information in Chapter 4.

Response A5-9: See responses to Common Issues 2 and 9. This material is most appropriate in Appendix A.

Comment A5-10: Deeper drafting of Hungry Horse reservoir.

Response A5-10: No response necessary.

Letter A6, Stanley-Sawtooth Chamber of Commerce (Tom Stuart), November 16, 1993

Comment A6-1: Inadequate range of alternatives.

Response A6-1: See response to Common Issue 1.

Comment A6-2: Need for changes in hydrosystem operations.

Response A6-2: The general need for changes in previous operations is acknowledged in the SEIS. The degree of change is not yet known, and the need for "order of magnitude improvements in the hydrosystem" has certainly not been demonstrated. The life-cycle model results presented in the SEIS, which show increasing stock trends for various combinations of interim actions, are not consistent with the last statement in this comment.

Comment A6-3: 1992 operation disastrous for salmon.

Response A6-3: The flow data presented in SEIS Table 3.5-2 appear to have been misinterpreted. These are not flow histories, predictions of flows expected for 1992, or flow targets for the respective periods. Rather, these are the median flows for the respective alternatives simulated over the 50 years of water record according to the specifications for each alternative. While the alternatives were not designed to meet specific flow targets, please note that in all cases the median flows in the spring migration period approach or exceed 85 kcfs; this is the flow objective identified in the NPPC's Strategy for Salmon adopted in 1992.

Comment A6-4: 1992 "no jeopardy" judgment in error.

Response A6-4: Water flows analysis are achieved using hydroregulation models which utilize 50 water years representing high and low water years. These models allow us to plan for variations in individual water years.

Section V.D., page 49, NMFS Biological Opinion (BO) of the 1992 operation of the Federal Columbia River Power System, does not identity expected impacts to juvenile Snake River salmon resulting from low Snake River flows anticipated during the spring and summer migration periods in 1992. Additionally, the BO explains that constraints are expected to contribute to the mortality of Snake river salmon. However, NMFS concluded that overall reduction in mortality represents progress towards reversing the decline of listed salmon.

Additionally, it should be noted that the proposed flow improvements alone are not sufficient in themselves to achieve recovery of the listed salmon stocks. The many factors that have led to the decline of the salmon will all require improvement if the region desires to save the Snake River salmon. These factors including dam operations, river flow, harvest, habitat, water quality, and water conservation must all be addressed.

Comment A6-5: SEIS options lethal for salmon, not sufficient to reverse decline.

Response A6-5: The SEIS preferred alternative provides modification to the 1992 actions by allowing flexibility for release of water from Dworshak in late summer and allowing for additional storage of water in Dworshak and Brownlee for flow improvement. Additionally, the SEIS identifies many measures that are underway in the region that will improve survival of the salmon in 1993 and future years. These activities are identified in Section 1.5 and Appendix C of the SEIS.

Comment A6-6: Real actions for future years not addressed in SEIS.

Response A6-6: See response to Comment R6-13. Studies requested by the NPPC are ongoing. Until the Biological Plan is complete, a decision cannot be made on the prudency of reservoir drawdown below minimum operating pool on the lower Snake River. In addition, the Recovery Plan has not been completed. Decisions to begin plans for implementation of reservoir drawdown will be based on these efforts, and therefore will require separate NEPA coverage.

Letter A7, AgriNorthwest (R. Thomas Mackay), November 17, 1992

Comment A7-1: Include cost-effectiveness analyses in determining impacts.

Response A7-1: See response to Comment A4-2.

Comment A7-2: Support for Alternative 4 as the preferred alternative, but smolt benefits must be analyzed independently.

Response A7-2: The level of precision inherent in the models and the degree of change achievable with interim measures do not lend themselves to analysis differentiating the separable effects of the individual actions. Uncertainty will be one of many factors considered in the related studies of the drawdown strategy, which is not within the scope of the SEIS.

Comment A7-3: Biological benefits and cost effectiveness for recovery measures; best method—transportation.

Response A7-3: No response necessary.

Comment A7-4: Additional study needed for key measures.

Response A7-4: See response to Common Issue 2.

Letter A8, AgriNorthwest (J. Rodney Larson), November 18, 1992

Comment A8-1: Include cost-effectiveness analyses in determining impacts.

Response A8-1: See response to Comment A4-2.

Comment A8-2: Support for Alternative 4 as preferred alternative, but smolt benefits must be analyzed independently.

Response A8-2: See response to Comment A7-2.

Comment A8-3: Biological benefits and cost-effectiveness for recovery measures; best method—transportation.

Response A8-3: No response necessary.

Comment A8-4: Additional study needed for key measures.

Response A8-4: See response to Comment A7-4.

Letter A9, AgriNorthwest (D. Jeffrey Mason), November 18, 1992

Comment A9-1: Include cost-effectiveness analyses in determining impacts.

Response A9-1: See response to Comment A4-2.

Comment A9-2: Support for Alternative 4 as preferred alternative, but smolt benefits must be analyzed independently.

Response A9-2: See response to Comment A7-2.

Comment A9-3: Additional study needed for key measures.

Response A9-3: See responses to Comment A7-4 and Common Issue 2.

Letter A10, Montana Wildlife Federation (Herbert Johnson), November 18, 1992

Comment A10-1: Hungry Horse and Libby not operated at "normal" in 1992; should not use 1992 as base.

Response A10-1: See response to Comment A3-1.

Comment A10-2: Address recreational values of Kootenai and Flathead rivers; also daily fluctuations impact resident populations.

Response A10-2: The recreational and resident fishery resources of the Kootenai and Flathead rivers are discussed in the SEIS. Impacts to these resources are also discussed, consistent with the degree of change indicated by the hydroregulation models and within the limits of available data. The draft SEIS admittedly focused on pool elevation changes, which were used as the initial indicator of operational impacts; because the elevations did not indicate significant adverse changes, it was not necessary to make detailed inspection of flow changes. The hydroregulation model used for this type of planning study has a monthly time step, and does not identify daily fluctuations in flows. While daily fluctuations themselves can affect resident populations, there is no indication that the actions addressed in the SEIS would result in noticeable changes to daily operating patterns.

Comment A10-3: Consider resident species.

Response A10-3: No response necessary.

Letter A11, Mercer Ranch (Richard Beightol), November 11, 1992

Comment A11-1: Question benefits of altering flow; continue evaluation.

Response A11-1: See response to Common Issue 5.

Comment A11-2: Include impacts to firm power rates in Section 4.9 and Executive Summary.

Response A11-2: As explained in Section 4.9.4, the proposed alternative would result in BPA's reserves being reduced. In accordance with BPA's financial plan, BPA will set rates using a

target level of financial reserves to ensure a high probability of paying the federal debt to the Treasury. To the extent that BPA's projected financial reserves are below the target level, planned net revenues will be added to the revenue requirement to achieve the target level. In BPA's initial 1993 rate proposal, about $67 million of planned net revenues are being added to achieve the target level. However, the cost of the proposed alternative is only one of many factors which have reduced BPA's financial reserves in FY 1992/93, and no precise estimate is possible (or has been made) which addresses this aspect of how such costs affect BPA's utility rates.

Comment A11-3: Effects of increased power costs on production costs.

Response A11-3: The information on potential increased production costs has been noted. However, investigation of these figures indicates they appear to apply to the longer-term proposal (being studied under the SCS) to operate John Day at elevation 257, rather than at minimum irrigation pool. Section 4.8 of the final SEIS has been modified to include a brief assessment of this issue.

Comment A11-4: Maximize biological benefit for cost of recovery actions.

Response A11-4: The Corps intends to apply cost effectiveness analysis, as appropriate, to recovery measures within the agency's jurisdiction and authorities.

Comment A11-5: Support for smolt transportation.

Response A11-5: See response to Common Issue 8.

Letter A12, Flathead Basin Commission (Elna Darrow), undated

Comment A12-1: Appreciate the preparation of the supplement.

Response A12-1: No response necessary.

Comment A12-2: Analysis of bull trout was poor.

Response A12-2: See response to Common Issue 6.

Comment A12-3: Consider long-term marketing strategy to benefit resident fish.

Response A12-3: BPA has been investigating the potential for such marketing strategies, and a system operating strategy that incorporates similar power marketing activities is being evaluated in the Columbia River System Operating Review (SOR).

Comment A12-4: Subscribe to analysis of the Montana Office of NPPC.

Response A12-4: See responses to Letter S5.

Letter A13, Idaho Rivers United (Charles Ray), December 6, 1992

Comment A13-1: Range of alternatives does not meet requirements of NEPA.

Response A13-1: See responses to Common Issue 1 and Comment A26-2.

Comment A13-2: Recommend a revised SEIS be developed.

Response A13-2: CBFWA flow recommendations are addressed in detail in the 1992 OA/EIS, which the current SEIS document supplements and incorporates by reference. Hydroregulation modeling indicates that adequate volumes of water to meet CBFWA flow recommendations of 140 kcfs at Lower Granite during all years is not physically possible when relying principally on Dworshak Reservoir storage and operation, especially during low water years and those periods resulting from drought condition cycles. Proposed augmented volumes are scheduled and released to provide as much unallocated water as possible during critical passage time frames. The System Operation Review process is developing and analyzing more long-term alternatives designed to shape available flows in the Snake and Columbia Rivers. More detailed alternatives addressing flow improvement measures are also being addressed in the System Configuration Studies and the NMFS' Recovery Plan and are beyond the analysis scope of this SEIS.

Letter A-14, Pacific Northwest Waterways Association (Glenn Vanselow), December 7, 1992

Comment A14-1: Supports Alternative 4, with qualifications, as the preferred alternative.

Response A14-1: No response necessary.

Comment A14-2: Opposes drawdowns below MOP on Snake and below minimum irrigation pool on John Day.

Response A14-2: See response to Common Issue 2. These long-term strategies included in any of the SEIS alternatives.

Comment A14-3: Transportation improvement studies should be incorporated.

Response A14-3: See response to Common Issue 2.

Comment A14-4: Requests the Corps to dredge ports and facilities nonoperational at MOP.

Response A14-4: Facilities at Almota were dredged in 1992 and maintenance of this and other projects are authorized.

Letter A15, Northwest Resource Information Center, Inc. (Ed Chaney), December 7, 1992

Comment A15-1: The draft SEIS ignores the comments provided on the OA/EIS.

Response A15-1: Comments on the 1992 OA/EIS were presented and addressed in the final documents. Not all comments were determined to warrant changes in text or approach.

Comment A15-2: Focusing on interim measures is erroneous.

Response A15-2: The NMFS designated the Snake River Salmon Recovery Team earlier this year to prepare a Recovery Plan for the Snake River salmon. A final recovery document that covers all three species and all aspects of recovery is expected to be submitted to NMFS sometime in 1993. In the interim period, the cooperating agencies are mandated by the Endangered Species Act to ensure that their actions are not likely to jeopardize the continued existence of the species listed for protection. The SEIS is entitled an "interim plan" because long-term solutions are being analyzed under SOR, SCS and the recovery plan process; ultimately, the recovery plan will likely guide all or influence aspects of activities that might affect salmon restoration and recovery.

Comment A15-3: Draft SEIS rationalizes and defends status quo.

Response A15-3: See response to Comment A14-3.

Comment A15-4: Critical assumptions are unreliable.

Response A15-4: See response to Common Issue 9.

Critical assumptions are documented in Section 4.2.3 and further in Appendix E??

Comment A15-5: None of the alternatives benefit the fish.

Response A15-5: The modeling results presented in Section 4.2 of the SEIS indicate that the proposed actions would improve migration conditions over what would otherwise occur.

Comment A15-6: Recommends additional alternative.

Response A15-6: See response to Common Issue 1 and Section 3.4 of the text. Implementing drawdown of lower Snake River reservoirs below MOP during the fish migration season requires extensive dam operational and structural modifications, which are being evaluated under the SOR and SCS. Discharge of all or most the flow over the spillways at lower Snake River dams results in unacceptable total dissolved gas concentrations under most discharge scenarios. The supersaturation is conserved, for the most part, downstream to the next dam where spill of already supersaturated water results in even higher concentrations, and so on down the system. Blockage of migrating adults is not a viable alternative, especially for the extended time frame required to draw the pools down, hold them down, and then refill them with natural flow as suggested. Collecting and transporting migrating adults is not feasible.

Safety constraints limit pool drafting to 2 feet per day, or 12 days for the 24 feet between MOP and 710 msl. Refill time would depend on flows available in excess of minimum flow requirements. In an above average water year, barge traffic would be interrupted for a minimum of 2 weeks excluding any time the pool was held at 710. Time would also have to be allowed for barge offloading and downstream lockage before redrafting. During low water years, similar to 1992, refill could take up to 3 months, even with water from Dworshak.

Spill at projects is executed to Fish Passage Center specifications. The benefit of extending the operation into September, while impacting residents with gas supersaturation, would be minimal.

Detailed discussions regarding meeting target flows at selected points along the system were included in the 1992 Options Analysis, and are referenced in the SEIS. In below average flow years, it is impossible to meet such a flow constraint without severely impacting the other authorized project purposes.

Comment A15-7: Supplement does not consider a broad range of alternatives.

Response A15-7: See response to Common Issue 1.

Comment A15-8: The draft SEIS makes decisions with models that do not reflect actual conditions.

Response A15-8: See responses to Common Issue 9, and Comments S7-24 and S6-15. The T.E.C.H. Committee has provided the SEIS team with FLUSH documentation and analysis that compare 1992 planned flows versus 1992 actual flows as interpreted by the Fish PassagCenter. FLUSH documentation was not available prior to the printing of the

draft SEIS. This analysis, as well as other concerned party interests' analyses and interpretations, is incorporated into the final SEIS.

Comment A15-9: None of the alternatives meet the stated goal.

Response A15-9: See response to Comment S7-14. In modeling, parameters that make it difficult to establish an adequate scientifically-based estimate require sensitivity analysis to appraise the models' assumptions, as well as analysis of risk. The slope of the survival or recruitment projection lines are dependent on assumptions and the method used to initialize the simulation. Other influences on the initializing slope of the projections in the case of the draft SEIS is the failure of SPM to divide spring from summer chinook; rather, it treats the stock as a composite of the NMFS listing, whereas SLCM divides the stock. SLCM interpretation incorporates the fact that the larger spring component of the stock would be partially released from factoring out the more negative effects of the smaller summer component. It is stressed that these were preliminary coordinated runs specific to the draft SEIS and have since been recoordinated, along with the ELCM modeling effort, to achieve a more accurate representation for the final SEIS. Response A15-9 stresses why multiple model sets are used for the SEIS impact analysis.

Comment A15-10: No basis for the selection of the preferred alternative.

Response A15-10: The estimates of percent increase in survival and cost effectiveness show that all alternatives achieve similar biological results with similar costs. NMFS indicated in their 1992 Biological Opinion that additional summer flow augmentation should decrease mortality of juvenile wild fall chinook. Based on the best available scientific data, the cooperating agencies believe that Alternative 4 is the flow alternative that will provide the best survival.

Comment A15-11: The supplement justifies hydrosystem operation decisions already made.

Response A15-11: The SEIS evaluates the environmental effects of interim measures to improve flows for salmon during 1993 and future years. The cooperating agencies reviewed the previous documents and the information referenced and brought forward in the draft SEIS and believe it to be adequate.

Comment A15-12: The draft SEIS does not adequately address flow and travel time.

Response A15-12: The 1992 OA/EIS discussed the flow/travel time/survival conditions and research at great length. The SEIS includes a brief summary of this information and indicates that it is not repeated in full, as is appropriate for a supplement. Other issues raised in this comment were also addressed in the 1992 OA/EIS, while the current and future status of Snake River salmon is directly addressed in the SEIS with respect to the proposed interim actions. The term "flow" is used so frequently in the EIS that its listing in the index would serve no useful purpose.

Comment A15-13: Upstream storage projects in the Snake River Basin.

Response A15-13: In view of the migration block that the upstream storage projects created, this statement would appear to be somewhat misleading. Changes in flow conditions associated with the lower Snake River dams are acknowledged in both the SEIS and the 1992 OA/EIS.

Comment A15-14: Collection and transportation discussions are disingenuous.

Response A15-14: See response to Common Issue 8.

Comment A15-15: No actual flow comparisons.

Response A15-15: The intent and responsibility of this portion of the SEIS is to make a reasonable projection of what conditions might likely result in the future for a given set of actions. This is best done by simulating various operations over a long historical period of water conditions, and discussing probable results. Under these circumstances, it is a common and accepted practice to initially present expected results under median or average water conditions. Please note that the median values are supplemented with information on likely conditions in a relatively dry year. Assessment of Alternatives 2 through 5 is based on simulation over 50 years of water record of the effects of the 1992 operations plan, not 1992 actual conditions (which have a low probability of recurrence during the interim action period). Similarly, base conditions are modeled using the 1985 to 1990 operating rules and the historical water record, rather than the flow conditions over this comparatively short base period.

Comment A15-16: Flow augmentation inadequacy is not addressed.

Response A15-16: Appendix C, Chapter 3, and other sections of the SEIS acknowledge that the desired flow augmentation volumes from the upper Snake River may not be available, particularly in dry years. However, the hydroregulation results for Alternative 5, the sensitivity analysis where this water is not included for flow augmentation, demonstrate that this has relatively little impact on the resulting flows. Given the level of uncertainty and disagreement within the scientific community over the flow/travel time/survival relationship, it would not be prudent or appropriate to base the interim action strategies on one viewpoint concerning needed flow velocities.

Comment A15-17: Section on "Flow Effects on Juvenile Salmonids" does not include full discussion of environmental conditions.

Response A15-17: The cooperating agencies have attempted to accurately present all points of view on this issue, but not referee the debate.

Comment A15-18: BPA model assumptions are unsupported.

Response A15-18: See response to Common Issue 9.

Comment A15-19: The condition of wild salmon is not poor; transportation does not work.

Response A15-19: See response to Common Issue 8.

Comment A15-20: The final EIS should include actual migration conditions vs. projected in BA and BO.

Response A15-20: See responses to Common Issue 9 and Comment S1-3.

Comment A15-21: Section 7 should state specific requirements of Northwest Power Act and congressional intent in authorizing mainstem projects.

Response A15-21: The requirements of the Pacific Northwest Electric Power Planning and Conservation Act are listed in Section 7. Authorized purposes and other uses of the projects are listed and referenced in Table 2.2-2.

Comment A15-22: Deficiencies in Appendix A regarding transportation.

Response A15-22: Some text changes have been made. However, the concerns expressed over mortality of transported fish are addressed primarily under project improvements, because the net effect of transported versus untransported fish is positive.

Comment A15-23: No discussion of benefits of drawdowns in Appendix A.

Response A15-23: The statement in question refers to a citation from NMFS, 1992, which is the Biological Opinion on 1992 river system operations. This document only assigns survival change estimates to actions planned for 1992, and therefore should not be expected to attribute survival benefits to an action that might occur several years in the future. The net biological effectiveness of the drawdown concept is still under study and has yet to be established.

Comment A15-24: No proof offered on fish barging results.

Response A15-24: Text rewording clarifies that NMFS studies (Matthews et al., 1987, 1991, 1992) have shown that survival is greater for transported fish returning to the point of origin for the study site, Lower Granite, McNary, or Priest Rapids. More recent scrutiny of the transportation studies by CBFWA analyzes the research beyond the study assumptions, but does bring forward certain concerns worthy of refining in future research. The CBFWA analysis has resulted in alternative transportation submodels as per ELCM interpretation of additional return data collected at upstream hatchery and natal stream weirs and traps. The T.E.C.H. Committee analysis is presented in the final SEIS evaluation and documentation.

Comment A15-25: Models from fishery agencies and tribes are not included.

Response A15-25: See response to Common Issue 9.

Comment A15-26: BPA should not claim any rights to foregone opportunity costs.

Response A15-26: This portrayal of the opportunity cost concept is not consistent with standard and widely accepted economic theory. The waters of the Columbia and Snake rivers are a public resource used for power generation and other purposes on behalf of the public, as directed by Congress. Loss of some power generation benefits carries a real opportunity cost for the public, just as loss of salmon has an opportunity cost for society.

Comment A15-27: Estimate cost of failure to design dams to meet congressional intent regarding fish passage.

Response A15-27: The value of any past damages is not germane to the assessment of candidate measures for implementation in the near future.

Letter A16, Idaho Steelhead & Salmon Unlimited, November 30, 1992

Comment A16-1: Objection to all alternatives, especially Alternative 4.

Response A16-1: See response to Comment A26-2. The cooperating agencies have reviewed this document and believe it adequately addresses the proposed actions.

Comment A16-2: Alternatives need short-term and interim goals and constraints.

Response A16-2: See responses to Common Issues 1, 2, and 11.

Comment A16-3: Modeling does not accurately predict flows and adult returns.

Response A16-3: The modeling or any other kind of analysis is in no way intended to predict actual 1992 flows. This is clearly impossible, since the weather determines the timing and amount of runoff. Instead, the modeling is intended to predict the differences that would occur between two operations given identical water conditions. These studies allow statements to be made about how much the flows might change if certain actions are taken, but should not be interpreted to be an indication that any particular flow would occur. Thus the modeling did reflect what happened in 1992. The flows on the Snake River were higher than they would have been under the old Water Budget, and the flows on the Columbia were higher as a result of the 3.0 MAF released for the Phase II Amendments. This does not mean that flows were higher than 1990 or 1991, but that they were higher than they would have been without the changes. Also see response to Common Issue 9.

Comment A16-4: The draft SEIS does not set long-term objectives.

Response A16-4: See response to Common Issue 3.

Comment A16-5: The role of NMFS as a cooperating agency raises legal and ethical questions.

Response A16-5: NMFS withdrew as a cooperating agency on February 1, 1993.

Letter A17, American Rivers (F. Lorraine Bodi), December 4, 1992

Comment A17-1: The draft SEIS should address mandates required by the Pacific Northwest Electric Power Planning and Conservation Act.

Response A17-1: The identified scope of the SEIS, and the extremely short period allowed to complete the NEPA process so that the Federal agencies could modify operation of the projects in spring of 1993, did not allow time for elaborate studies of every aspect related to the operation of the Columbia-Snake River system. Many alternative actions that were eliminated from further evaluation are being considered in other studies or programs. An example of long-term programs mentioned in your letter includes mandates of the NPPC. These include the development of a conservation and electric power plan to ensure an adequate, efficient, economical, and reliable power supply for the Pacific Northwest, and preparation of a program to protect, mitigate, and enhance fish and wildlife affected by development and operation of hydroelectric projects in the Columbia-Snake River system.

Improved passage operations for the salmon at the Corps dams are not specifically discussed as alternatives in the SEIS. Fish passage actions are represented in the Annual Fish Passage Plan completed by the Corps and coordinated with other Federal, state and tribal fisheries agencies through the Columbia Basin Fish and Wildlife Authority. The cooperating agencies see no benefit to opening a duplicative process to cover actions already being addressed.

With regard to the applicable laws and regulations, the cooperating agencies have reviewed the SEIS and believe it adequately addresses the proposed actions.

Comment A17-2: Alternative 1, No Action baseline, is unjustified.

Response A17-2: See response to Common Issue 1.

Comment A17-3: Address discrepancies between predicted versus actual flows.

Response A17-3: HYSSR models display different water management actions over a historical 50-year period of 1928 through 1978. The purpose of the modeling is to provide an estimate of the reservoir elevations and stream flows of different management actions over a variety of water conditions. Although the 1992 water year was not modeled, the low water conditions experienced in 1992 were within the conditions experienced between 1928 and 1978.

Comment A17-4: The draft SEIS fails to present a reasonable range of interim alternatives.

Response A17-4: See response to Common Issue 1.

Comment A17-5: Recommends further alternatives.

Response A17-5: See responses to Common Issues 1 and 2 and Comments R 6-13, A6-6 and A28-7.

Comment A17-6: Alternatives were improperly limited based on existing hydropower plans.

Response A17-6: See response to Common Issue 1.

Comment A17-7: The draft SEIS analyses use unreliable projections of flow.

Response A17-7: The HYSSR modeling uses a 50-year water record (1928 to 1978) to estimate the results of planned actions under a variety of low, medium, and high runoff conditions. The base condition of 1985 to 1990 reflects river management action, not the runoff conditions experienced during that period. The modeling is not used to forecast flows for 1992 or any future year since each water year is different.

Comment A17-8: The models used in the draft SEIS should be revised to reflect actual, not predicted, flows.

Response A17-8: Again, HYSSR modeling uses a 50-year water record to estimate results of planned actions under a variety of runoff conditions. The overall runoff conditions in 1992 are within the range of the 50-year record. Modeling cannot predict actual flows in any future year since each water year is different.

Comment A17-9: None of the models used in the draft SEIS have been tested and verified.

Response A17-9: Model results from the state and tribal fishery agencies would have been included in the draft SEIS if they had been available; they are presented in the final SEIS. The issue of testing and verification is open to interpretation. Documentation of both the BPA and NPPC models has been published and readily available for review, and both sets of models have been in application within the region for some time.

Comment A17-10: The benefits of predator controls are questionable.

Response A17-10: The reservoir mortality reduction estimate assigned to squawfish predation is derived from the Oregon Department of Fish and Wildlife's RESPRED model developed in its initial version from the John Day reservoir studies. All three of the modeling efforts are presented for the final SEIS (State and Tribal Agencies' FLUSH and ELCM is the third) incorporate assumptions and/or predictive ranges from the RESPRED model. Predator models are and have been constrained by the availability of appropriate data. It has been felt by some interests that the RESPRED model did not incorporate piscivore recruitment based on growth and competitive release when a portion of the squawfish population was removed. Another model called CREM was developed for the squawfish removal program extrapolating from the RESPRED model and

incorporating more recently determined growth-recruitment data. Subsequent CREM versions are being developed for reservoirs beyond John Day, principally Lower Granite, based on the ODF&W Predator Indexing program. CREM results were not available for the SEIS; hence, RESPRED predictions were used. CREM, like RESPRED, is structured to simultaneously run up to five predators. Applicable studies from the reservoirs where predator population studies have been performed produced confounding results based upon methodology (capture techniques versus hydroacoustics) and location of a reservoir. Study results continue to be analyzed to derive adequate predator distribution for densities and seasonal movements. Predator population data correlated to mortality estimates for species beyond squawfish remain limited in the majority of the reservoirs. See also response S7-20.

Comment A17-11: Transportation assumptions are questionable and should be revised.

Response A17-11: The correlation between increasing transportation and decreasing run sizes is spurious. All research conducted by NMFS from 1968 to 1989 shows a positive benefit to transportation. Negative benefits at the spawning grounds are based on samples of less than 1 percent of the overall coded wire tag returns available to calculate transportation benefits, and were only made in a few years. Furthermore, they were based on hit-and-miss carcass sampling of selected redd count index areas, and thus were not a statistically valid sample. Sampling rates in the fisheries and at the dams are known and therefore can be adjusted for known bias.

Comment A17-12: The assumption of a 6-percent increase in adult survival is unsupported.

Response A17-12: This comment is unclear as to which assumption range or value, be it transportation, harvest, or some modifier it references.

Comment A17-13: Standards and strategies for long-term salmon recovery are lacking.

Response A17-13: See response to Common Issue 3.

Comment A17-14: NMFS should not be a cooperating agency.

Response A17-14: See response to Comment A16-5.

Comment A17-15: Recommend preparation of a new draft SEIS.

Response A17-15: The cooperating agencies have reviewed this environmental document and believe it adequately addresses the proposed "interim" actions. As future plans develop and changes are needed in the proposed actions, further documentation will be prepared as necessary.

Letter A18, Public Power Council (William K. Drummond), December 7, 1992

Comment A18-1: Power rates will increase in FY 94-95.

Response A18-1: Actions taken to purchase power during FY 1993 will reduce BPA's financial reserves. See response to Comment A11-2.

Comment A18-2: BPA's built-up financial reserves have impacted the welfare of consumers.

Response A18-2: Section 4.9.4 has been revised to better reflect the impact on BPA reserves. The SOR work groups are attempting to establish guidelines that consistently measure economic

costs of the many alternatives. This ongoing effort will consider suggestions in this comment.

Comment A18-3: Nonfirm losses impact consumer welfare.

Response A18-3: Section 4.9.4 has been revised to better reflect the impact on BPA revenues and rates. The incremental environment impacts outside the Pacific Northwest of replacement energy generation is considered to be small and, therefore, is not covered in the SEIS.

Comment A18-4: Objection to using percentage increase in juveniles as denominator in cost-effectiveness analysis.

Response A18-4: At the request of NMFS, the cooperating agencies agreed not to present cost-effectiveness results denominated in terms of dollars per fish. This is consistent with ESA provisions by which actions to conserve species are not subject to standard cost-benefit analysis.

Comment A18-5: There are ways to calculate adult and juvenile survival.

Response A18-5: Percent increase in survival of juveniles was used because flow measures have a more measurable and direct effect on migration of juveniles than on the entire life cycle of the salmon. The life cycle models that appear in the final SEIS do produce numbers that predict adult return back to the natal streams. However, as with any model, the more variables employed in the mathematical model, the greater the uncertainty of the results.

Comment A18-6: Disagreement with National Economic Development (NED) approach to calculating economic benefits.

Response A18-6: A thorough NED cost-benefit analysis of the alternatives would require the determination of the economic value of the fish, not the economic benefits to the fish. Any attempt to assign a monetary value to the fish, using current techniques, would not account for the full value to society. It was not the intention to present a distributional analysis of losers and gainers in this SEIS.

Comment A18-7: Reconsider method of calculating benefits.

Response A18-7: Table 5.2-1 provides a wide range of increase in survival over the no action alternative because of the variables presented by the CRiSP passage model. The low percentage is the median relative increase for spring chinook, while the high is for fall chinook. These figures are generalized for the referenced table but do not indicate that "all the alternative have exactly the same biological impact..." as indicated in your comment. Table 4.2-1 more accurately illustrates the relative increases in survival by alternative for each salmon stock.

Letter A19, Pacific Northwest Utilities Conference Committee (Al Wright), December 7, 1992

Comment A19-1: Focus of the EIS is narrow and only addresses river flows.

Response A19-1: See response to Common Issue 2.

Comment A19-2: Objection to Alternative 4.

Response A19-2: NMFS indicated in their 1992 Biological Opinion that additional summer flow augmentation should decrease mortality of juvenile wild fall chinook. This assumption is based on the most frequently accepted information available to the region at this time.

Comment A19-3: The 1992 OA/EIS should be incorporated by reference in its entirety.

Response A19-3: The SEIS indicates in several locations that the 1992 OA/EIS is incorporated by reference. The general practice in this regard is to incorporate an entire document. Given that the SEIS description of alternatives is clearly referenced with respect to OA/EIS actions, there does not appear to be a need to specifically exempt portions of the OA/EIS from incorporation.

Comment A19-4: The final SEIS should state that it is adopting the conclusion of the OA/EIS.

Response A19-4: Plan selection discussions in the SEIS have been clarified with respect to 1992 OA/EIS evaluations and conclusions.

Comment A19-5: Supports the cost effectiveness and environmental effects criteria, but opposes the juvenile salmon survival rate criterion.

Response A19-5: See response to Comment A23-3. To accept the survival rate of returning adults to Lower Granite Dam as a selection criterion would emphasize the total acceptance of the transportation studies to Lower Granite. Transportation is a controversial topic, and although the cooperating agencies accept that the current NMFS studies are valid, there remains room for improvement. Prespawning mortality between Lower Granite and the respective spawning grounds appears to be significant, whether it be because of the hatchery:wild ratio or some modifying physical factor, this parameter needs to be realistically characterized with field data to verify the life-cycle models.

Comment A19-6: No credible evidence exists to support flow augmentation for fall chinook in the preferred alternative.

Response A19-6: See response to A19-2.

Comment A19-7: Alternative 2 is the least offensive.

Response A19-7: No response necessary.

Comment A19-8: Supports the choice of operations from 1985 to 1990 as the no action alternative.

Response A19-8: No response necessary.

Comment A19-9: NEPA requires that the benefits of Alternatives 2, 3, and 5 must be reported.

Response A19-9: See response to Comment A23-22.

Comment A19-10: Data presented on the magnitude of the Columbia and Snake River flows are questionable.

Response A19-10: Without more precise definition of what is considered to be questionable, a specific response cannot be provided. The data in the tables are based on the HYSSR runs for the respective alternatives with the exception of Alternative 3, for which a new HYSSR run was prepared, the model results for the draft SEIS remain applicable for the final. Flow changes in a representative low-runoff year were included in the draft SEIS.

Comment A19-11: Support for cost effectiveness.

Response A19-11: No response necessary.

Comment A19-12: Using a relative percent increase in survival results in cost-effectiveness ranges that are too wide.

Response A19-12: See response to Comment A18-5.

Comment A19-13: Cost-effectiveness comparisons should be performed consistently and correctly.

Response A19-13: Section 5.2.2 has been revised to provide additional explanation of the cost-effectiveness analysis. Defining costs on a species-specific basis requires allocation of the costs of each alternative to all the species that will experience changes. Because of the consistent impacts on fish between the alternatives in the SEIS, this approach was not used.

Comment A19-14: The theory that increased flows benefit juvenile salmon is unsubstantiated and should be acknowledged as such.

Response A19-14: See responses to Common Issue 5 and Comment A25-23.

Comment A19-15: Objection to fall chinook study based on Fish Passage Center analyses alone.

Response A19-15: A model considering no relationship to flow and travel time was made (see BPA Model Analysis).

Comment A19-16: Objection to Fish Passage Center analysis on flow affects on the migration of juvenile sockeye.

Response A19-16: Analysis of sockeye has been removed.

Comment A19-17: Objection to the inclusion of new biological modeling in the final SEIS.

Response A19-17: See response to Comment A23-8.

Comment A19-18: Data indicating that white sturgeon spawning success is dependent on high spring flows are unreliable.

Response A19-18: The draft SEIS does not proclaim a relationship but rather indicates that researchers believe the relationship exists. There are data available that support the hypothesis that a relationship between rising spring flows and spawning success of sturgeon exists. The text has been modified to better describe the hypothetical nature of our current understanding of the situation.

Comment A19-19: The harvest rates for fall chinook should be lower than 55 percent.

Response A19-19: See response to Common Issue 2.

Comment A19-20: ELCM harvest information should be excluded from the SEIS.

Response A19-20: See response to Common Issue 9.

Comment A19-21: Data are inconsistent regarding spills at Lower Monumental in 1993.

Response A19-21: Table 3.2-1 has been modified to show proposed spill for 1993, according to the draft Fish Passage Plan for 1993. This indicates that spill would continue in 1993. The HYSSR runs on which Table 4.1-1 were based had also assumed spill would continue in 1993.

Comment A19-22: Cost estimates for the long term should be greater than represented.

Response A19-22: See response to Comment A23-18.

Comment A19-23: Cost of lost opportunities should be included.

Response A19-23: See response to Comment A23-19.

Letter A20, Valley Soil Conservation District (Ken Postma), December 3, 1992

Comment A20-1: The SEIS does not address impacts to upstream water.

Response A20-1: Cascade and Deadwood Reservoir water quality and resident fisheries should not be affected by upper Snake flow augmentation proposals as presented in the SEIS. A minimum conservation pool of 300,000 acre-feet will be maintained in Cascade and 50,000 acre-feet in Deadwood. These are the pools that have been determined to be adequate to maintain good reservoir water quality and fishery conditions. BoR will operate to maintain these pools. Any upper Snake River salmon flow augmentation, in combination with other reservoir release operations, will not be allowed to "violate" the conservation pools.

Comment A20-2: Changes on the Cascade Reservoir may impact resident fisheries and bald eagles.

Response A20-2: See response to Comment A20-1. Fishery and limnological studies carried out in the early 1980s led the Idaho Department of Fish and Game to recommend that a 300,000 acre-foot conservation pool be provided. As a result, BoR administratively established the conservation pool in 1984 as a permanent operational constraint. There currently is no strong basis to believe that water quality conditions will degrade significantly in Cascade Reservoir as long as the conservation pool is maintained.

Comment A20-3: Opposition to any activity that reduces water quality of Cascade Reservoir.

Response A20-3: No response necessary.

Letter A21, Orofino Chamber of Commerce (H.L. "Roy" Clay), December 3, 1992

Comment A21-1: Request an accounting of the specific results achieved by actions undertaken in 1992.

Response A21-1: Results achieved from the 1992 water year and river management operation continue to be analyzed but were not available in time for inclusion in the SEIS. Because of the urgent need to protect the Snake River salmon, the SEIS was prepared in an extremely short time frame, restricting the analysis and development of new information. The analysis presented is based on existing available information.

Comment A21-2: Several studies indicate that augmented flows do not significantly restore salmons runs.

Response A21-2: Some of these citations have been added to Section 4.2.1. Some discussion of the effects of potential removal of summer releases from Dworshak on survival was also presented in Section 4.2.3. Also see response to Common Issue 5.

Comment A21-3: Recreation requirements for Dworshak not being met under the proposed actions.

Response A21-3: Using the authorizing legislation, the Corps constructed and maintains multipurpose resource development projects to balance operation of individual functions with operation for all functions of the project. By providing this equilibrium, the Corps ensures their responsibility for maximizing the sustained public benefits for all desirable purposes. With the currently identified alternative actions, the impacts to certain uses such as recreation are recognized by the agencies. However, recreation activities are not eliminated but only modified, and the relationship with enabling legislation continues for Dworshak.

Comment A21-4: Unrealistic presentation of late-summer releases for Alternative 4.

Response A21-4: The hydroregulation results for Alternative 4 adequately reflect the variable and flexible timing of the late-summer releases, particularly in the indicated August elevations. The SEIS indicates reservoir elevations that would occur with both median and low water conditions.

Comment A21-5: Use of 1992 as a base year for making comparisons. Underestimation of losses in visitation, and September 200-KAF release occurring in July.

Response A21-5: Actual 1992 conditions are not used as a standard basis of comparison among the alternatives. Alternative 1, the base condition, represents a range of outcomes under system operating rules in use from about 1985 through 1990. Alternatives 2 through 5 are variations on the planned 1992 operations, as opposed to 1992 water conditions.

The recreation discussion of the SEIS has been supplemented to clarify the derivation and application of the recreation loss estimates. See also response to Common Issue 4. Dworshak recreation records indicate that July visitation is generally about 18 percent greater than August visitation.

Comment A21-6: Recreation/tourism losses greatly understated.

Response A21-6: Section 4.13 of the text has also been expanded to better explain the presentation of the recreation value figures. The issue here primarily concerns the distinction between net economic impact to recreationists, per standard procedures for national economic development accounting, and secondary or regional economic effects to local businesses. The informal survey results provided in the comment have been printed in the final SEIS and referenced in Section 4.13.

Letter A22, Valley Graphics (Larry Schlieper), December 4, 1992

Comment A22-1: Summer tourist revenue fell dramatically.

Response A22-1: See response to Common Issue 4. Because runoff was well below normal in 1992, recreational traffic patterns from 1992 are not a reliable indicator of typical future conditions with Alternative 4. As the last paragraph seems to acknowledge, factors other than Dworshak Reservoir elevations were also influencing economic activity in 1992.

Letter A23, Pacific Northwest Generating Cooperative (Dave Harper), December 3, 1992

Comment A23-1: Concurs with the need to preserve salmon runs, with limitations.

Response A23-1: No response necessary.

Comment A23-2: Purpose of the SEIS should be clearly stated.

Response A23-2: Although there is an implied purpose "...to avoid the decline of the listed Snake River salmon species and to contribute to their recovery" stated in your letter, the long-range planning for the recovery of the listed salmon stocks is entrusted to the NMFS and the Snake River Salmon Recovery Team. The cooperating agencies involved in preparation of the SEIS evaluated reasonable alternatives for inclusion in the SEIS. As explained, many alternatives were eliminated from detailed study because they could not be implemented because of limited authority or objectively evaluated within the limited time period necessary to finalize a Record of Decision on the SEIS prior to the beginning of spring 1993 juvenile salmon migration. Many alternatives eliminated from further evaluation are being considered in other studies.

Comment A23-3: Supports the cost-effectiveness and environmental effects criteria, but opposes the juvenile salmon survival rate criterion.

Response A23-3: See response to Comment A19-5.

Comment A23-4: The theory that increased flows benefit juvenile salmon is unsubstantiated and should be acknowledged as such.

Response A23-4: See responses to Common Issue 5 and Comment A25-23.

Comment A23-5: Opposition to the adoption of drawdown measures.

Response A23-5: This comment presumably addresses the strategy of deep drawdowns at the lower Snake River projects. The drawdown below MOP strategy is not a proposed action evaluated in the SEIS and is not within the scope of the SEIS.

Comment A23-6: Objection to fall chinook study based only on Fish Passage Center analyses.

Response A23-6: See response to Comment A19-15.

Comment A23-7: Objection to Fish Passage Center analysis on flow affects on the migration of juvenile sockeye.

Response A23-7: Analysis of sockeye has been removed.

Comment A23-8: Objection to the inclusion of new models in the final SEIS.

Response A23-8: See response to Common Issue 9.

Comment A23-9: Data indicating that white sturgeon spawning success is dependent on high spring flows are unreliable.

Response A23-9: The Kootenai River white sturgeon have not successfully spawned in over 20 years. Apperson and Webster (1991) suggest that historical spawning success was related to spring flows in comparison to much reduced flows in the last 20 years as a result of a change in operations at Libby Dam. All scientific designs for studies have potential flaws, hence the need for multi-year studies or monitoring. The reliability of the scientific information is an opinion and not justification for inclusion or omission in an analysis for NEPA documentation. This population of white sturgeon has been petitioned for ESA listing with the U.S. Fish and Wildlife Service, hence information relating to its status is pertinent for an EIS evaluation. Also see response to Comment A19-18.

Comment A23-10: The SEIS should encompass all areas of possible causes for salmon and steelhead decline.

Response A23-10: See response to Common Issue 2.

Comment A23-11: The harvest rates for fall chinook should be lower than 55 percent.

Response A23-11: The harvest rates used for fall chinook were supplied by ODFW, and were outputs from their Pacific Salmon Commission's harvest model runs of the Council's proposed harvest regime. BPA does not have the capability to modify these harvest rates. The value of 65% supplied by ODFW reflects the harvest rate on the dominant brood. This does not indicate what the harvest rates on the population as a whole are, since they are not explicit in the data supplied.

Comment A23-12: ELCM harvest information should be excluded from this SEIS.

Response A23-12: The SEIS harvest levels are based on the Pacific Salmon Commission Chinook Model, not the ELCM. The Oregon Department of Fish and Wildlife has the responsibility for performing the simulations. The ELCM structure is based on the Pacific Salmon Commission methodology for cohort reconstruction and analysis, but ELCM was not designed to estimate harvest rates or levels. Documentation for the current version of the PSC model has been available since 1988. Documentation for ELCM became available 17 November 1992.

The cooperating agencies have no responsibility for the management of harvestable stocks (principally hatchery produced fish), although incidental catch of ESA-protected wild stocks does occur. The state agencies have the responsibility for setting harvest allocations and reporting to NMFS for take and jeopardy determination. Interpretation of the harvest analysis is not that simplified. The NPPC analyzes only spring chinook. The SLCM applies the ODF&W PSC model estimates to age-4 hatchery fall chinook only for the four broods following the 1989 brood if harvest followed the NPPC Phase II Amendments; it does not duplicate the values in the Phase II amendments. Total harvest rates on hatchery fall chinook in 1990 are equivalent to a 65 percent harvest rate of the age-4 fall chinook produced from hatcheries in the Columbia River Basin multiplied by 22 percent of that proportion attributable to ocean removal and 35 percent of that proportion attributable to inriver removal. In 1991, a 22 percent reduction in ocean and 35 percent reduction in river harvest from the 1990 rates are equivalent to a 65 percent harvest rate of the 1991 simulation. The 1992 to 1995 simulations used a 5-percent reduction in the total 1991 harvest rates equalling a 60 percent harvest rate; then, additional inriver harvest cuts dropped the 60 percent down to 59 percent for age-4 hatchery fall chinook. In 1996, the total composite harvest rates on age-4 hatchery fall chinook (in ocean + in river) returned to the 65 percent total harvest rate of 1991. The terminal harvest rate for wild fall chinook, calculated once they enter the subbasin, is assumed to the be in the SLCM runs. Realistically, since hatchery fall chinook are not marked to distinguish them from wild fish, the probability that undetected incidental catch removes a proportion of wild fish is high. Harvest is a more recent topic within the coordinated modeling comparison effort directed by NMFS. Agencies responsible for harvest management are required to submit biological assessments relating to effects on ESA stocks to NMFS for a determination of jeopardy. This process is outside of the scope of the 1993 SEIS.

Comment A23-13: Data are inconsistent regarding spills at Lower Monumental in 1993.

Response A23-13: See response to Comment A19-21.

Comment A23-14: Models should consider hatchery production mortality effects and an increased salmon survival rate greater than 10 percent.

Response A23-14: Mortality data attributable to hatchery interactions (competition, swamping, disease vector source, harvest vulnerability, etc) are generally lacking, and it is difficult to design adequate studies to assess these factors. Further, hatchery operations are outside the scope of this SEIS. See response to Comment S7-19 regarding habitat. Habitat improvements need to be partitioned in short-term and long-term trends, for effects of certain improvement measures may not be measurable or manifest themselves for longer time frames, such as beyond 20 years for a sedimentation remediation project. Other improvement projects, such as increasing the pool ratio, may result in lifestage survivals that can be measured within a 5-year timeframe depending on the initial condition of that particular reach. A subbasin approach is more realistic; hence, the invitation to the agencies responsible for habitat management to become involved with the coordinated modeling comparison process. There is no supporting data that an across-the-board increase in survival of greater than 10 percent for listed species is reasonable.

Comment A23-15: Support for cost effectiveness.

Response A23-15: No response necessary.

Comment A23-16: Using a relative percent increase in survival causes cost-effectiveness ranges to be too wide.

Response A23-16: The draft SEIS used relative increase in passage survival based on estimates of passage models CRiSP and PAM. This is a more direct estimate of the effectiveness of flow measures, since the life cycle models SLCM and SPM use results from CRiSP and PAM.

Comment A23-17: Cost-effectiveness comparisons should be performed correctly and consistently.

Response A23-17: See response to Comment A19-13.

Comment A23-18: Cost estimates for the long term should be greater than represented.

Response A23-18: This SEIS is intended to cover only the short-term operation of the system, and the costs shown are based on using the operational approach to providing up to 3 MAF of water in the interim until the NMFS salmon recovery plan can be implemented. It is agreed that if firm resources were purchased to meet this obligation, the costs shown are probably low.

Comment A23-19: Cost of lost opportunities should be included.

Response A23-19: BPA agrees that there are some lost opportunities for winter capacity sales as a result of the Dworshak operations for fish. However, with releases in the summer, there may be some capacity gains in the summer. With the present methods for determining capacity, it is difficult to quantify the capacity losses or gains which would occur as a result of the revised operation. And there is no viable method at present for determining the magnitude of the financial impacts of these capacity changes; so, they were assumed to roughly balance and were not addressed in the power impacts section. Currently, BPA is attempting to develop a method of determining capacity that would provide meaningful answers for this type of project operation.

Comment A23-20: The SEIS only considers one alternative.

Response A23-20: See responses to Common Issues 1 and 2.

Comment A23-21: All alternatives achieve similar biological results with similar costs.

Response A23-21: No response necessary.

Comment A23-22: All alternatives should receive equal treatment.

Response A23-22: As indicated by Table 4.2-1, CRiSP results are somewhat generalized when dealing with the minute flow variations and characteristics. Only these results for CRiSP are illustrated because only Alternative 1 and Alternative 4 flow actions were utilized in the model runs. Alternatives 1 and 4 are representative of the changes in flow volumes and timing that are used in all the alternatives. Additional information on the CRiSP model is presented in Appendix E.

Comment A23-23: Use of average flows across low water conditions more informative.

Response A23-23: See response to Comment A19-10.

Comment A23-24: Supports the choice of operations from 1985 to 1990 as Alternative 1, no action.

Response A23-24: No response necessary.

Comment A23-25: Objection to the Alternative 4, the preferred alternative.

Response A23-25: The decision to provide flow augmentation during the summer to assist juvenile fall chinook migration is based on the request of NMFS in its Biological Opinion for 1992 operation.

Letter A24, Glenwood IGA Foodliner (Doug Donner), December 3, 1992

Comment A24-1: Recreation losses are underestimated.

Response A24-1: See responses to Comment A21-6 and Common Issue 4.

Comment A24-2: Negative comments from tourists were received.

Response A24-2: The SEIS acknowledges that lowered reservoir elevations would have adverse physical impacts affecting recreation.

Comment A24-3: Decline in sales during July and August were directly related to low water levels.

Response A24-3: See response to Common Issue 4 and revised text Sections 4.10 and 4.13.

Letter A25, Direct Service Industries, Inc. (John D. Carr), December 7, 1992

Comment A25-1: Assumptions about increased flow and salmon migration may be faulty.

Response A25-1: See responses to Common Issue 5 and Comment A25-23. The reports of Drs. Gall and McNeil and Karen Kreeger have been reviewed and incorporated into the analysis for the final SEIS.

Comment A25-2: The scope of the draft SEIS is limited.

Response A25-2: See response to Common Issue 2.

Comment A25-3: Alternative measures will raise the price of energy.

Response A25-3: No response necessary.

Comment A25-4: Opposition to Alternative 4, the preferred alternative.

Response A25-4: No response necessary.

Comment A25-5: The draft SEIS is not clearly written as a supplement to the 1992 OA/EIS and contains elements of a stand-alone EIS.

Response A25-5: The cooperating agencies believe that the document even though it has some of the same characteristics as a stand-alone EIS, it clearly defines that it is a supplemental EIS and provides the reasons in Section 1.1. Proceeding with a Supplemental EIS is not prejudicial to the NEPA process in any way.

Comment A25-6: Alternative 4 is more expensive than Alternative 2, and does not provide greater benefits.

Response A25-6: The estimates of percent increase in survival and cost effectiveness show that all alternatives achieve similar biological results with similar costs. NMFS indicated in their 1992 Biological Opinion that additional summer flow augmentation should decrease mortality of juvenile wild fall chinook. Based on the absence of regionally accepted hard data to refute the opinion of NMFS, the cooperating agencies believe that Alternative 4 is the alternative that will provide the best survival.

Comment A25-7: The alternatives are based on unreliable evidence.

Response A25-7: See response to Common Issue 5.

Comment A25-8: The assumption that fall chinook benefit from increased flow is faulty.

Response A25-8: See responses to Common Issue 5 and Comment A25-23. Flow-survival assumptions are weighted differently for the three modeling efforts used in the final SEIS based on the modeling group's interpretation of the available data. More recently, available PIT-tag data from NMFS may lead to modification of these assumptions by some of the model groups. Since all three models incorporate some form of the same data set, an analysis of reliability of one group's model relative to another group's model is not warranted and is beyond the scope of this SEIS process. The larger interagency coordinated model comparison effort (Analytical Methods Coordination and Documentation process as termed by the T.E.C.H. Committee) will be relied upon in further discussions of these controversial topics.

Comment A25-9: The scope of the draft SEIS is limited.

Response A25-9: See response to Common Issue 2.

Comment A25-10: The range of alternatives was limited to flow measures and should have encompassed greater options.

Response A25-10: See response to Common Issue 2.

Comment A25-11: The FLUSH and ELCM models should not be used in the final EIS.

Response A25-11: Text has been revised in Section 4.2.2 explaining inclusion of STFA model.

Comment A25-12: Cumulative effects to salmon need to be addressed.

Response A25-12: NPPC provided some parameter sensitivity analysis prior to and for the draft SEIS. BPA used the risk analysis sensitivity approach for the draft SEIS. More intensive interagency coordination following the release of the draft SEIS resulted in revised parameter and assumption range estimates for the areas carrying high uncertainties. Parameter-related sensitivity analyses and calibration procedures are priority exercises for the larger interagency coordinated model comparison effort (i.e., Analytical Methods Coordination and Documentation process) and is beyond the scope of this SEIS.

Comment A25-13: The 65 percent harvest rate assumption is improper.

Response A25-13: See response to Comment A23-11.

Comment A25-14: Measures to assist juvenile Snake River sockeye are unnecessary.

Response A25-14: The point about no juvenile sockeye migration in 1993 and 1994 is well taken; however, the time horizon for the interim actions is uncertain, and will likely extend beyond 1994. It, therefore, is appropriate to address potential benefits to sockeye in later years.

Comment A25-15: The SEIS should be a supplement, not a hybrid.

Response A25-15: The Corps believes that there are sufficient clear statements throughout the document identifying it as a supplement. Please note that Chapter 2 of the SEIS includes only brief summaries of environmental conditions in the geographic area covered by the 1992 OA/EIS; the longer descriptions in this chapter address resources at and near Libby and Hungry Horse, which were not covered by the original EIS. As noted in the SEIS, the CEQ regulations indicate supplements should be prepared when there are changes in the proposed action; the "new alternatives" evaluated in the SEIS are variations on the actions proposed in the 1992 OA/EIS.

Comment A25-16: The supplement should state that its intent is to analyze the decisions made in the 1992 OA/EIS. Does not satisfy requirements of stand-alone EIS.

Response A25-16: The purpose and need of this SEIS is explained in Section 1.1.

Comment A25-17: The supplement contains repetitive information that should be reduced.

Response A25-17: For the convenience of the reader, Section 2 repeats the 1992 OA/EIS description of the river system and includes brief summaries of existing conditions for the 1992 OA/EIS study area. The remainder of Section 2 is new material on Libby, Hungry Horse, and their downstream river reaches; these areas were not addressed in the 1992 OA/EIS. Section 4 of the SEIS omits most generic impact assessment material (e.g., discussion of impact mechanisms), which was presented in the 1992 OA/EIS. Section 4 presents primarily new impact analysis material specific to the SEIS alternatives and their corresponding hydroregulation results, much of which is based on refined analyses such as the fish passage and life-cycle models and the SOR recreation models.

Comment A25-18: Discussions and analyses from the 1992 OA/EIS should be considered to be incorporated by reference into the supplement.

Response A25-18: The 1992 OA/EIS is incorporated by reference as stated in Section 1.1.

Comment A25-19: SEIS would further NEPA analysis by extending 1992 actions to additional years and providing analysis.

Response A25-19: The substantial change in the project refers primarily to timing. The 1992 OA/EIS addressed actions proposed for 1992 only, while the SEIS addresses similar actions that would occur annually for several years. The most significant new information is the model-based analysis of fish survival. Other new information includes refined hydroregulation analyses, assessments addressing Libby and Hungry Horse, and the summary results of the March 1992 drawdown test.

Comment A25-20: An improved transportation system should have been considered in the analysis.

Response A25-20: See responses to Common Issue 2 and Comment A25-9

Comment A25-21: All river operations were not analyzed.

Response A25-21: Nonflow project operations and project improvements that will occur regardless of the selected plan are identified in Section 3.2. Improvements to irrigation diversion screening and similar measures are addressed in the fish modeling analyses.

Comment A25-22: All reasonable alternatives were not explored.

Response A25-22: See responses to Common Issues 1 and 2.

Comment A25-23: Questionable assumptions were not clearly identified as unreliable.

Response A25-23: The 1992 OA/EIS presented detailed descriptions of the types of studies and their results and uncertainties. The current document states on page 4-9 that there is uncertainty in the conclusions that flow affects survival. Whether the correlation between flow and travel time or survival is "sufficiently strong" to conclude that increased flow will increase survival is subject to interpretation, depending on species, location, and flow range. However, the Corps believes the information is sufficient to proceed with the analysis and interpretations presented and it is not necessary to state these uncertainties at every conclusion.

Comment A25-24: Should indicate flow augmentation provided because of possible benefits projected by questionable studies.

Response A25-24: The scope of the SEIS states in the Executive Summary, page ES-1, that "The interim operating plan may or may not change in the future as a result of other ongoing studies." Later in the Executive Summary, page ES-11, the statement is made that "The outcome of ongoing regional processes (such as the NMFS Recovery Plan, the SCS, and the SOR), may modify the proposed actions in the future and require additional NEPA documentation." Page 1-1, Section 1.1, Purpose and Need, paragraph one states that "This plan of action may be changed as a result of those long-term studies." Page 1-2, Section 1.3, Scope, paragraph 2 also states that "These water management activities may change as a result of long-term plan of action developed from the ongoing studies."

It is the objective of the cooperating agencies to make clear in the SEIS that the plan of action proposed for 1993 and future years may change based on new information adopted by the region through other planning processes.

Comment A25-25: The draft SEIS overstates the results of studies correlating flow and survival.

Response A25-25: Many of the studies discussing the range of data were presented in the 1992 OA/EIS and will not be repeated in the SEIS. The Corps has modified the statement about uncertainty. While the release date may affect the migration rate, most of the studies conducted on survival could not separate the effect of the release date from flow. However, that these factors have not been separated does not mean the relationship between flow and survival is invalid. Although these uncertainties exist, the Corps believes the available data are sufficient to proceed with analysis relating flow to survival for some stocks.

Comment A25-26: Objection to the high costs and questionable assumptions of Alternative 4.

Response A25-26: No response necessary.

Comment A25-27: Water particle travel time and juvenile salmonid migration time should not be confused.

Response A25-27: The Corps agrees that the model-based analysis of survival presented in the SEIS is an improved and more direct assessment than was possible in the 1992 OA/EIS. However, the OA/EIS did distinguish between water particle travel time and fish travel time, and the varying evidence of a flow/survival relationship between yearling and subyearling chinook.

Comment A25-28: Object to the use of inconclusive evidence that states Snake River fall chinook juveniles would benefit from increased flows.

Response A25-28: Many interests within the region realize that more refined studies need to be devoted to fall chinook (subyearling) outmigration cues and behavior. Subyearling outmigration travel time may be more related to how size, age, or fitness influence the degree of smoltification, which, in turn, influences the willingness to actively or passively migrate. Flow volume relationships to velocity and their influences on fish travel times may be a more critical factor for passive versus active migration. The available data for the Snake River (Berggren and Filardo 1991) is the only information to date to incorporate into a model process. Certain modeling groups (System Operation Review Anadromous Fish Workgroup and NPPC) are deferring the incorporation of subyearlings until further composite analysis can be accomplished to reduce the associated uncertainties with the significance of flow and behavior. The CRiSP.0 and FLUSH 3.0 attempts at modeling for subyearlings are worthwhile in the context as a beginning in which refinements can be structured. To ignore subyearling chinook altogether on the basis of ignorance due to lack of data would not be productive to recovery of an ESA listed stock.

Comment A25-29: Drafting Dworshak during late summer may assist adult migration, not adequate reason to choose Alternative 4.

Response A25-29: NMFS' 1992 Biological Opinion for the 1992 OA/EIS prioritized the 200 KAF release to assist juvenile subyearling outmigration over any perceived benefit to adult upstream migration. Temperature data indicate that Dworshak releases lower the temperature at the Clearwater-Snake River confluence, but do not support any significant benefit in lowering the water temperature at the Snake-Columbia River confluence. Colder water typically flows and remains distributed along the pool bottom prior to any mixing. Any beneficial effects would be modified by dissipation through volume loss and mixing through the powerhouse operation of the four projects. Preliminary analysis of historical temperature versus flow data indicates that many pre-dam flow years characteristically exceeded 68 degrees F. The blockage hypothesis situation at the Snake-Columbia River confluence needs further attention under alternate hypotheses, such as flow volume attrition in the context of temperature, turbidity, and possibly

velocity of the water. The choice of Alternative 4 is based upon the NMFS' Biological Opinion prioritization of the water release for benefiting juvenile outmigration, hence Alternative 4 would allow the flexibility in flow shaping to compensate for current uncertainties related to both of the respective juvenile and adult migration parameters.

Comment A25-30: Draft SEIS does not consider cumulative actions that affect fish.

Response A25-30: See responses to Comments T6-1-3, A23-12, and A23-14 concerning hatchery and habitat, and to Comment A25-12.

Comment A25-31: Draft SEIS does not consider cumulative effect of actions that benefit fish.

Response A25-31: The cooperating agencies are not responsible for the management of harvest or natal stream habitat quality. The SEIS addresses the effects of interim flow measures on the Snake and Columbia River environment. The models principally address the effects of interim flow measures on the wild populations of the salmon stocks. Varied assumptions and related sensitivity analyses designed to gauge the contributions of varied parameter values are beyond the scope of this SEIS and will be addressed in the larger interagency model comparison process (the Analytical Methods Coordination and Documentation process as termed by the T.E.C.H. Committee). The long-term juvenile survival and adult recruitment trends in the draft SEIS (40 years for SPM and 50 years for SLCM) are indicative of the cumulative effects to spring/summer and fall chinook stocks.

Comment A25-32: Unlikely that Snake River sockeye will migrate in 1993.

Response A25-32: Sockeye analysis has been removed from downstream survival modeling analysis because few smolts will be migrating naturally from the lake within the next 2 to 3 years. All identified adult members of the stocks have been collected for hatchery rearing and not allowed to spawn in Redfish Lake. While the statement about naturally spawning anadromous stocks in Redfish Lake is correct (that is, no ocean-migrating adults have spawned in the wild that would produce outmigrating smolts in the foreseeable future), there is another possible source of smolts from the lake. In fall 1992, beach-spawning resident *Oncorhynchus nerka* were observed spawning at a time and in a lake region previously considered only to be used by anadromous stocks. Currently, the genetic characteristics of these fish are not well enough known to determine if they closely relate to the anadromous adults found in 1991 and 1992, the outmigrating smolt of those years, or the resident spawning kokanee. The final decision of what constitutes endangered stock in this lake has not been determined, but could, in the future, include the spawning stock found on the beach and their offspring. Some of this stock could outmigrate from the lake in the near future if undetected populations of this group spawned in other years. Therefore, future migration conditions for these stocks need to be considered. In addressing issues relative to their significance, the Corps believes that any activity under its control that has the potential of affecting a federally listed endangered species needs to be evaluated, because any loss of an endangered species could be significant. Also see response to Comment A25-14.

Comment A25-33: Analysis of alternatives is confusing.

Response A25-33: The cooperating agencies have tried to present information in the most concise and effective manner. Text has been clarified where possible to respond to specific comments. The SEIS has been revised to include a discussion of the differences in passage model results for all alternatives.

Comment A25-34: Criteria for evaluating alternatives should be modified.

Response A25-34: See response to Comment A23-16. Juvenile salmon survival, cost-effectiveness, and environmental effects are the criteria used in the plan selection. Impacts to adult salmon are evaluated and considered in the SEIS under environmental effects of the actions. The use of the juvenile passage model is one measure of the effectiveness of the proposed actions. The final SEIS includes sensitivity analysis of all alternatives. The cooperating agencies use all quantitative and qualitative information available in making plan selection

Comment A25-35: Draft SEIS needs to be restructured.

Response A25-35: See responses to Comments A25-5, -15, -16, -17, -18, -19, and -33.

Comment A25-36: Reasoning behind selection of preferred alternative needs to be further defined.

Response A25-36: The text has been modified in response to this comment.

Comment A25-37: Draft SEIS is confusing and incomplete.

Response A25-37: Without reference to specific pages or paragraphs considered to be incomplete, it is difficult to provide a specific response. The SEIS preparers have attempted to clearly define the actions included in each alternative and the differences in effects among alternatives. Table 3.2-2 clearly lays out the composition of the alternatives for easy comparison. Other tables in Section 3 indicate the reservoir regulation changes for the alternatives. The impact analyses in Section 4 identify differences in effects among the alternatives, or so state when there would be no differences. For many locations or resources there would be little or no differences among the alternatives. This is particularly true for the reservoir operation and Columbia River flow augmentation components, which are common to Alternative 2 through 5.

Comment A25-38: Analyses were superficial.

Response A25-38: The final SEIS will include additional sensitivity analysis for certain measures, including transportation effectiveness and the flow-travel time relationship for fall chinook. In addition, uncertainty in a number of parameters is already accounted for by using a range of effectiveness levels (low, moderate, and high). We agree that computer modeling cannot be used to predict absolute outcomes. Instead, it is intended to provide information regarding relative direction and magnitude changes. It is especially important when dealing with the complexity and uncertainty involved in both biology and river system operations. Regarding harvest assumptions, please see the response to Comment A25-13.

Comment A25-39: Scientific methods work on unproven assumptions, and need improvement.

Response A25-39: The impact analysis matrix approach proposed would be overly complex without providing any further critical information for the decision process. SLCM was developed for risk analysis; hence, its stochastic structure utilizing probability distributions. Other Federal agencies that are more responsible for habitat management (principally the U.S. Forest Service) use impact analysis matrix evaluation where it is more fitting when quantifiable variables are characterized (e.g., acreage, dollars). One significant negative attribute is that ecological processes (e.g., recruitment via connectivity in the U.S. Forest Service case, or via flow-travel time survival) are not adequately characterized through simple counting procedures. Of course, indicators can be used in the matrix, but the weighting factor is still biased by the best argument in the

team (e.g., Model A's assumption for process #1 is more reliable than Model B's assumption for process #1). This exercise would likely be unproductive for the biological characterization.

Comment A25-40: Draft does not provide a balanced analysis of all alternatives.

Response A25-40: The primary effect of the alternatives is on migrating smolts, so the focus of the analysis was in that area. Other than underyearling chinook, fish are in areas affected by the alternatives only during downstream and upstream migration. The effects of the alternatives on areas other than smolt migration are discussed under "Other Effects on Juvenile Salmonids" and "Adult Anadromous Fish." In all cases, the differences between all alternatives except Alternative 1 would be undetectable; therefore, they were not discussed separately.

Comment A25-41: Include discussion of possible negative impacts of increased flow.

Response A25-41: Fall chinook historically developed in the free-flowing river systems of the Snake and Columbia rivers. Under these conditions, average cross-sectional river velocity, or water particle travel time was much higher than any flow situation occurring under the current reservoir environment. Under this higher velocity regime, fall chinook remained in the system long enough to adequately feed and develop before entering the marine environment. Flow modifications under consideration will result in significantly reduced flow velocity in the reservoirs compared to what fall chinook have encountered historically. Because fall chinook were very successful under the historically high velocity regime, there is no reason to be concerned that any increased flow and velocity alternative being considered will result in downstream fall chinook displacement.

Comment A25-42: Should include analysis of juvenile salmon biology and migratory behavior.

Response A25-42: The summary information is of interest in defining how salmon may respond to different environmental situations. However, the primary questions remain: (1) does increased velocity increase downstream movement of stocks? and (2) is increased movement an advantage to survival? While uncertainties about both of these questions remain, the Corps believes the majority of pertinent information on the Columbia-Snake River System suggests the answer is a qualified yes to both of these questions for the periods and flows being considered. The Corps has considered the factors adequately to address the impacts of the proposed actions on salmon stocks.

Letter A26, Northwest Environmental Defense Center (Joan K. Eltman), December 7, 1992

Comment A26-1: The SEIS is not readable or clearly understandable.

Response A26-1: The agencies have attempted to provide a readable SEIS. Because of time constraints, a full, detailed economic analysis was not possible. The costs shown are reasonable estimates rather than precise quantitative expressions.

Comment A26-2: Cannot determine if the NMFS standard of reversing salmon decline is met by the alternatives.

Response A26-2: Directed by NEPA, Section 1502.14 (a), the cooperating agencies evaluated all reasonable known alternatives for inclusion in the SEIS. As explained in the SEIS, many alternative actions were eliminated from detailed study because they could not be objectively evaluated or implemented within the limited time period necessary to finalize a Record of Decision on the SEIS prior to the beginning of spring 1993 juvenile salmon migration. Because of the urgent need to protect the salmon, this document was

prepared in an extremely short timeframe, restricting development of new actions. Many alternative actions that were eliminated from further evaluation are being considered in other studies.

The SEIS alternative actions will be evaluated by NMFS for improvement over the actual operation that took place in 1992 and the planned operation and forecasted water volume year for 1993.

Comment A26-3: The no-action alternative and baseline for computations should be 1992 operations.

Response A26-3: NEPA requires that each EIS include an existing condition or "no action" alternative against which the effects of all action alternatives are measured. Normal operations are the manner in which the projects and fish programs were operated from about 1985 to 1990. (Water years run from October through September.)

The NMFS, in their Biological Opinion for 1992, specifies that if operation of the Federal Columbia River Power System continues as proposed for 1992, it would not be sufficient to reverse the decline of the listed stocks over one life cycle. Further, they say that additional steps will likely be needed in 1993 and future years. Those additional steps are not solely flow augmentation actions, but include habitat protection, transport program improvements, predator control, natural propagation, and augmentation of salmon populations, etc.

Comment A26-4: Structural changes affecting passage must be considered.

Response A26-4: See response to Common Issue 2.

Comment A26-5: Use real numbers, not percentages, when quantifying fish survival.

Response A26-5: See response to Comment A18-4.

Response A26-5: The use of strict national economic development (NED) analyses is not considered appropriate when dealing with endangered and threatened species. Any attempt to assign a monetary value to endangered fish, given current techniques, would not account for the full value to society. Therefore, the absolute biological goal is replaced with the relative measure of percent change in juvenile survival.

Comment A26-6: The analysis of alternatives considers actions taken outside the permissible scope of the draft SEIS.

Response A26-6: Improvements to spawning and rearing habitat do not need to be included in the preferred (or any) alternative to be mentioned in the SEIS. Rather than being outside the permissible scope of the SEIS, these actions meet the definition of "reasonably foreseeable" future events or conditions that must be taken into account. The existing screening program for irrigation diversions, which is discussed in Appendix A and elsewhere, is one of the key habitat improvements. Inclusion of habitat measures in the NPPC amendments, which will apparently influence the NMFS recovery plan, will also increase the likelihood that habitat improvements will occur.

The SEIS is specifically not restricted to 1993 operations, but rather addresses an interim period of uncertain duration. Changes that will occur in other parts of the system through 1998 are quite relevant to the assessment of the interim actions and should be included in the analysis. Differences in assumptions are one reason why the analysis was done with multiple models.

Comment A26-7: No long-range plan for salmon recovery.

Response A26-7: See response to Common Issue 3.

Comment A26-8: The NEPA process in subsequent years is unclear.

Response A26-8: See responses to Comments A15-2 and S7-8.

Letter A27, Tobacco Valley Economic Development Council (Joe Gibbons), December 3, 1992

Comment A27-1: Data are insufficient to support fugitive dust statements.

Response A27-1: The statement in question refers to the incremental change resulting from the proposed action. The SEIS acknowledges an existing concern over blowing dust, but the hydroregulation results do not indicate this situation would be measurably worsened.

Comment A27-2: Sediments from Lake Koocanusa contribute to dust problem.

Response A27-2: The statement quoted in the comment is correct; sediments in Lake Koocanusa are fine enough to become airborne when dried and exposed to wind. Air quality impacts are discussed in Section 4.6.

Comment A27-3: Recreation statistics are outdated.

Response A27-3: The draft SEIS reports current (1991) figures for total visitation, but a detailed breakdown of use was not available. The 1985 data were the most recent available for distribution of use by site, season, or activity. Other items from this comment have been used to modify the text.

Comment A27-4: Lake Koocanusa extends into British Columbia, not Alberta.

Response A27-4: The text has been modified.

Comment A27-5: Incomplete presentation of unemployment statistics.

Response A27-5: Unemployment statistics for three Montana counties in the study were collected. The text has been updated to include these figures, and a graph of representative county unemployment rates has been added.

Comment A27-6: Dust problems with lower reservoir levels.

Response A27-6: Silt is deposited in the reservoirs annually; drawdown exposes the silt deposited along the shoreline. The effects of Alternatives 2 through 5 on sedimentation would be to shift the location of sediment delivery to lower parts of the reservoir as stated in Section 4.5.4. This does not increase the amount of silt deposited in the drawdown zone. The overall effect of Alternatives 1, 2, 4, and 5 are negligible. The effects of Alternative 3 would be minor and would only occur during a few months in low-water years.

Comment A27-7: Constraints on facility use caused by drafts.

Response A27-7: The qualifier here reflects the fact that when such deeper drafting would occur, it would usually be in winter or spring when few recreationists would be using the reservoir. The analysis included much more than just Forest Service campgrounds.

Comment A27-8: Visual impacts of Lake Koocanusa drafts.

Response A27-8: The statement in question here refers to incremental effects, the change from what already occurs. Most viewers would consider an additional 20-foot draft from 120 to 140 feet to be an insignificant change.

Comment A27-9: Drawdowns would increase negative effects.

Response A27-9: See response to Comment A27-8.

Comment A27-10: Recreation loss estimates are faulty.

Response A27-10: See responses to Common Issue 4 and Comment A21-6.

Letter A28, Idaho Water Users Association, Inc. (Lynn Tominaga), December 8, 1992

Comment A28-1: Lack of alternatives other than flow considerations.

Response A28-1: See response to Common Issue 1. Alternatives 2 through 5 include components for both storage and run-of-river projects. Elevations for the run-of-river projects are provided in Section 3.2.

Comment A28-2: Use of Idaho water to increase flow velocity.

Response A28-2: The March 1992 drawdown test provided information on water particle travel time and dissolved gas levels. A future biological drawdown test(s) may be needed to collect much of the biological data, but technical experts have not reached consensus on a test design that would provide this information.

Comment A28-3: Interim measures should have a time limit established.

Response A28-3: Many other activities, identified in the SEIS, Section 1.5 and Appendix C, will also eventually modify the preferred alternative identified in the SEIS. Also, see response to Comment A15-2.

Comment A28-4: Water quantity jurisdiction may go to federal agencies.

Response A28-4: If and when any of the proposed interim alternatives are recommended for permanent implementation, those actions will be evaluated and further environmental documentation will be completed to address the effects of the proposed permanent implementation.

Comment A28-5: Range of alternatives is restricted to augmentation vs. drawdown.

Response A28-5: See response to Common Issue 2.

Comment A28-6: Question the validity of using water from Idaho.

Response A28-6: Alternatives evaluated in the SEIS are those that cooperating agencies could implement to contribute to the survival of the salmon. Relying on flow actions alone will likely not stop the decline of the Snake River salmon. Modifications to other contributing factors such as habitat, harvest, predation, water quality, etc., must also be achieved. Although the proposed flow improvement measures show small incremental improvements, these flow actions are critical to an overall recovery program.

Comment A28-7: Question the logic of flows at Columbia and Snake Rivers being reduced concurrently with release from Dworshak Reservoir.

Response A28-7: See response to Comment S1-3.

Letter A29, Idaho Wildlife Federation (Robert Minter, Jr.), December 4, 1992

Comment A29-1: Range of options is limited in scope.

Response A29-1: See response to Common Issue 2.

Comment A29-2: Hydro system operations need to be changed.

Response A29-2: See response to Comment A6-2. Section 1.5 and Appendix C of the SEIS discuss the many other programs and activities currently underway to modify operation of the hydro system and improve other factors that have caused the decline of the listed salmon stocks.

Comment A29-3: 1992 operation of the Snake/Columbia rivers hurt salmon stocks.

Response A29-3: There are no empirical analytical results available yet that address survival conditions in 1992. The HYSSR results and fish passage models indicate that the proposed actions would improve flows, and provide benefits to fish, compared to what would otherwise occur. The degree of improvement would also be greater in a low-flow year. The SEIS modeling analyses made no attempt to project what actual flows would be in any given year, as they operate over a 50-year historical water record.

Comment A29-4: Oppose the models used.

Response A29-4: See response to Comment A16-3.

Comment A29-5: Request use of a historical baseline (1984 to 1991) and projected vs. actual analysis.

Response A29-5: Hydroregulation model numbers detailing flow volume, pool elevations, discharges, etc. for the upper Snake River were not included in the draft SEIS and will not appear in the final SEIS because of the large amount of space required to reprint this information. Water flow analysis is achieved for every water project in the Columbia-Snake drainage system using mathematical computer models based on 50 years of actual water records, providing a large variation in possible water volumes. Impacts derived were based on the analysis of the computer model that simulate conditions depicted in the alternative.

Comment A29-6: Draft SEIS offers no guidance for long-term recovery.

Response A29-6: See responses to Common Issue 3.

Comment A29-7: Recommend activities to be incorporated.

Response A29-7: See response to Common Issues 1 and 2.

Comment A29-8: Questions the role of NMFS as a cooperating agency.

Response A29-8: See response to Comment A16-5.

Letter A30, Flathead Lakers Inc. (Dick Wollin), December 9, 1992

Comment A30-1: Urge an ecosystem approach to evaluating dam operations.

Response A30-1: The objective of the SEIS is to evaluate the incremental effects of the proposed action, which appear to be minor based on small changes in flows and elevations. Existing impacts from operation of Hungry Horse and Kerr are being appropriately studied in other forums.

Comment A30-2: Recognize Northwest Power Planning Council approval of a selective withdrawal structure at Hungry Horse Dam.

Response A30-2: This information has been added to the text in Section 4.1.2.

Comment A30-3: Impacts of drawdowns at Hungry Horse are direct.

Response A30-3: The term indirect was used because the Montana projects would not be action sites for flow improvement measures, but in Alternative 3 they would be allowed to respond to system demands.

Comment A30-4: Concerns regarding bull trout in Flathead Lake.

Response A30-4: The discussion was expanded.

Comment A30-5: Potential impacts of Flathead and Kootenai drainages have been ignored.

Response A30-5: See responses to Comment A30-3 and Common Issue 1.

Letter A31, Dworshak Excursions (Jerry O. Olin), December 3, 1992

Comment A31-1: History of patterns of bookings for Dworshak Excursions show effect on drawdown on business.

Response A31-1: See response to Common Issue 4. Impacts to recreation have been given substantial consideration in the SEIS.

Individual

Letter I1, Reed Burkholder, October 28, 1992

Comment I1-1: Best solution for restoring salmon is to remove all 8 dams between Lewiston and Portland.

Response I1-1: See response to Common Issue 2.

Letter I2, Lyman K. Schwarzkof, October 29, 1992

Comment I2-1: Need to maximize opportunities for food production/transport from irrigated lands.

Response I2-1: The Endangered Species Act obligates the cooperating agencies to ensure that actions taken with regard to system operations do not jeopardize the continued existence of a species that has been listed as threatened or endangered. Additionally, agencies are directed under ESA to use their authorities to carry out programs that contribute to the conservation of listed species. The listing of the Snake River sockeye as endangered and the spring/summer and fall chinook as threatened requires that the Corps, BPA, and BOR comply with ESA.

Letter I3, Wade and Carol Waugh, November 1, 1992

Comment I3-1: Opposed to further drawdowns.

Response I3-1: No response necessary.

Comment I3-2: Drawdown in March had devastating effect; was not a smart idea.

Response I3-2: See response to Common Issue 4.

Comment I3-3: Idahoans being asked to pay for losses for which they are not responsible.

Response I3-3: The attached order concerning Washington Water Power Company's request for a 2.59-percent surcharge to WWP customers identifies the sources of the need for the surcharge as primarily poor hydro conditions at WWP projects, not projects included in the SEIS. Therefore, it seems erroneous to conclude that salmon actions caused the need for the surcharge. Also, the available evidence from an analysis of the model results indicates that it is not too late for recovery actions to have a positive effect on salmon recovery.

Comment I3-4: BPA is wasteful in spending money; resent paying higher power rates to subsidize waste.

Response: I3-4: The expenditures listed are not within the scope of this EIS.

Comment I3-5: No more drawdown; no more rate increases. How much spent for November public meetings?

Response I3-5: It is not easy to separate among the several cooperating agency budgets the personnel and direct expenditure costs incurred for the draft SEIS public meetings. The agencies believe that these meetings were valuable in meeting the obligation to obtain public

input into the process. Moreover, numerous attendees expressed appreciation to the agencies for listening to what the people had to say at these meetings.

Letter I4, Jim Pritchard, November 28, 1992

Comment I4-1: Support Alternative 1.

Response I4-1: No response necessary.

Comment I4-2: Preferred alternative in SEIS too costly.

Response I4-2: Drafting the Lower Snake pools is not proposed as an interim action in this SEIS.

Comment I4-3: Too many uncertainties to implement preferred alternative.

Response I4-3: The cooperating agencies have been forthcoming in acknowledging uncertainties associated with the proposed actions in the SEIS. However, they have an obligation take action under the ESA and that uncertainty is not sufficient reason to delay actions that might help listed salmon.

Letter I5, F.A. Bayer, November 13, 1992

Comment I5-1: Support Alternative 2.

Response I5-1: No response necessary.

Comment I5-2: Oppose any drawdown.

Response I5-2: No response necessary.

Letter I6, Linda McClure, November 13, 1992

Comment I6-1: Drawdown of Lake Koocanusa will have negative effects on resident fish and air quality.

Response I6-1: No response necessary.

Comment I6-2: Need to assess impact on deteriorating air quality.

Response I6-2: The obligation of the SEIS is to address incremental air quality impacts associated with the proposed actions. The document has established that there would not be significant changes at Libby under the preferred alternative; therefore, there would not be significant incremental impacts to air quality. The Corps is aware of the concerns over respiratory and bronchial illness in Tobacco Valley and is working with agencies and residents in monitoring and evaluating the existing problem insofar as such activities fall within the Corps' jurisdiction.

Comment I6-3: Need to assess impact on resident fish.

Response I6-3: Items listed in the letter are covered in text. No response necessary.

Comment I6-4: Discuss siltation of lightweight dirt residue on receding shorelines.

Response I6-4: Addition of this possible effect has been noted in Section 4.1.3. However, based on the proposed operating conditions, this effect is not likely to be significant.

Comment I6-5: Discuss economic impacts to recreation due to reduced pool elevations at Libby.

Response I6-5: Section 4.10.10 presents the estimated changes in visitor hours with each alternative. Alternative 3 is the only alternative with lower Libby Pool elevations from the base condition and has about a 3-percent reduction in visitor hours on average. Section 4.13.1 discusses in qualitative terms the likely resulting economic impacts. Additional information concerning ongoing activities in SOR to quantify economic impacts to regional economics due to recreation loss has been added to this section.

Comment I6-6: Must consider and accept responsibility for impacts.

Response I6-6: The SEIS has attempted to carefully document impacts identified from the proposed actions, and the agencies are giving careful consideration to such impacts. Based on our consideration of impacts, the Corps believes it has fulfilled its obligations under NEPA.

Letter I7, Roy E. Barker, November 16, 1992

Comment I7-1: Support no action alternative.

Response I7-1: No response necessary

Letter I8, Warren H. Mason, November 17, 1992

Comment I8-1: Appears study has been thorough; continue plan development in cost-effective manner.

Response I8-1: No response necessary.

Comment I8-2: Support Alternative 4.

Response I8-2: No response necessary.

Comment I8-3: Believe transportation will be most cost-effective way to improve salmon runs.

Response I8-3: No response necessary.

Comment I8-4: Do not understand why harvest is permitted to continue.

Response I8-4: No response necessary.

Comment I8-5: Support efforts to determine benefits from various methods of improving salmon runs.

Response I8-5: No response necessary.

Letter I9, Kent Nielson, November 18, 1992

Comment I9-1: Economic well-being of Pacific Northwest is of primary importance.

Response I9-1: No response necessary.

Letter I10, Faith Cooke, November 23, 1992

Comment I10-1: What agency is responsible for study of juvenile fish maturation.

Response I10-1: The cooperating agencies are not aware of a specific study being undertaken of the relation of drawdown to maturation of young salmonids. Many agencies are involved in studies of anadromous fish resources. NMFS has overall responsibility for compliance with the Endangered Species Act.

Comment I10-2: What agency is responsible for ensuring cold, clean, quality water?

Response I10-2: Federal water quality standards under the Clean Water Act are monitored by the EPA. Water quality standards within each State's jurisdictions are established and enforced by the States, i.e., the Idaho Department of Health and Welfare, the Oregon Departmental of Environmental Quality, the Washington State Department of Ecology, and the Montana Department of Health and Environmental Sciences.

Letter I11, Sidney N. Clouston, Jr., November 19, 1992

Comment I11-1: Why no mention of renewable power sources as alternatives to hydropower?

Response I11-1: Impacts to air quality are only generated by fossil resources, not by clean, renewable energy sources. The SEIS, which examines potential environmental effects of actions, focuses on fossil resources as the usual reliable alternative energy source to determine environmental effects and costs to region.

Comment I11-2: Agencies need update on Energy Policy Act of 1992.

Response I11-2: This comment and the subsequent material to which it refers addresses the subject of resource acquisition, which is outside the scope of this SEIS.

Comment I11-3: Need to consider photovoltaic systems in SEIS.

Response I11-3: See response to I11-2.

Letter I12, William F. Larsen, December 7, 1992

Comment I12-1: Need to consider access for disabled at Dworshak during "season of use."

Response I12-1: The cooperating agencies have considered the laws applicable to Federal agencies concerning access for the disabled with regard to the proposed actions and will comply with the applicable laws.

Letter I13, Thomas A. Townsend, December 6, 1992

Comment I13-1: How can an alternative be selected before SCS is completed?

Response I13-1: The SCS is a long-term study; a Phase I report is not due until mid-1993. Under ESA, the agencies are required to take action now to contribute to the recovery of listed salmon stocks. The actions in the SEIS are clearly interim, pending the results of the long-term studies, including the SCS. When these studies are completed, structural changes, including design criteria, will be taken into account along with other long-term actions and interim actions examined to create an integrated recovery plan to restore declining salmon stocks.

Comment I13-2: Lacking SCS, no alternative is supportable.

Response I13-2: See response to Comment I2-1. The agencies have a responsibility under the ESA for current action.

Letter I14, Thayne Chaunell, December 3, 1992

Comment I14-1: Lack of urgency present in document.

Response I14-1: Comment noted. See response to Comment I13-1.

Comment I14-2: Should distinguish between indigenous and nonindigenous resident fish.

Response I14-2: We do not believe a distinction between indigenous and nonindigenous species would be appropriate. Some nonindigenous species are managed as game fish by state agencies. The treatment of resident fish in the SEIS reflects the general regulatory and management status of the respective species.

Comment I14-3: Have a series of questions regarding draft SEIS.

Response I14-3: See responses to Comment A13-2 and Common Issue 5. Velocities related to flow volumes and fish travel time are not a direct or linear relationship. The degree of smoltification and influences on stock behavior modify passive versus active migrational patterns related to adequately characterizing fish travel time. See also responses to Common Issues 3, 8 and 9 and Comments S7-10, 16 and 73.

Comment I14-4: Do not believe that barging fish from Snake works.

Response I14-4: See response to Common Issue 8.

Letter I15, Frank Gunderson, December 4, 1992

Comment I15-1: No consideration is given to adverse effects of proposed drawdowns on existing fish populations.

Response I15-1: The SEIS tiers to the 1992 OA/EIS, which discussed the effects of lowering lower Snake River pools to MOP on anadromous fish other than salmon and on resident fish. No alternative in the draft SEIS calls for a drawdown below MOP.

Comment I15-2: No consideration given to possible loss of birds and other wildlife from riparian habitat loss.

Response I15-2: See response to Comment I15-1.

Comment I15-3: No consideration given to alternative methods of increasing fish survivability at sea.

Response I15-3: The SEIS, like the 1992 OA/EIS, is limited in scope to consideration of water management activities in the Columbia-Snake River System. Other studies, including several listed in Section 1.5 of the SEIS, address actions that could be taken regarding fish survival at sea.

Comment I15-4: No consideration given to constructing ways to bypass dams.

Response I15-4: The System Configuration Study is the vehicle for consideration of structural changes in the Columbia-Snake River System. Such action is outside the scope of the SEIS. See response to Common Issue 2.

Comment I15-5: No consideration given to removal/replacement of dams.

Response I15-5: See responses to Comments I15-3 and I15-4.

Comment I15-6: No hard data exists to support contention that drawdown will increase fish populations.

Response I15-6: See responses to Comment I4-3 and Common Issue 5.

Comment I15-7: No consideration given to where more dams might be located and their impacts.

Response I15-7: See response to Comment I15-4.

Comment I15-8: No consideration given to equitable distribution of effects among those to benefit from action.

Response I15-8: In meeting NEPA requirements, the objective of the SEIS is not to determine how to "apportion" effects, but rather to analyze them and come up with a preferred alternative that meets the selection criteria of (1) juvenile salmon survival rate, (2) cost effectiveness, and (3) environmental effects.

Comment I15-9: No consideration given to remediation of obstacles to fish by those responsible for obstacles in violation of law.

Response I15-9: The identity of the obstacles referenced in the comment is unclear. If the reference is to the mainstem dams, it should be noted that the extensive Federal agency involvement in construction and operation of fish passage facilities constitutes remediation for the obstacles represented by the dams.

Testimony

Public Hearing Testimony, Libby, Montana, November 4, 1992

T1-1, Wayne Kubasko

Comment T1-1-1: Local impacts may not be worth the price tag.

Response T1-1-1: The actions proposed in the SEIS would not have a great effect on pool elevations or on recreational facilities at Libby. Furthermore, as noted in Section 4.10, the Corps has identified a future objective of maintaining stable flows of between 12,000 cfs on the Kootenai River from May 31 and September 31 to benefit anglers, drift boaters, and other recreational boaters and canoeists.

Comment T1-1-2: Cost vs. benefits to salmon.

Response T1-1-2: See response to Comment I2-1. A key component in considering actions to help conserve listed species is cost effectiveness.

T1-2, Rita Windom

Comment T1-2-1: Validity of information from consulting firms doubted.

Response T1-2-1: The System Operation Review (SOR) Recreation Pilot Models were executed to provide a preliminary estimate of the quantitative effect of SEIS alternatives on recreation visitation at the four major storage reservoirs. Additional information has been added to the final SEIS to better explain the parameters of the SOR recreation models. The model results identified in the SEIS are preliminary and should be treated as approximate indicators of expected change.

Comment T1-2-2: People from Lincoln County have not received proper mitigation.

Response T1-2-2: Mitigation for the effects of proposed action are considered in the appropriate section of the SEIS and the 1992 OA/EIS. Direct and indirect impacts to people potentially include employment and related economic losses. Employment, income, and production impacts associated with the affected industries in the study area as well as indirect impacts to the regional economy may be mitigated by are not specifically addressed in the SEIS because of the temporary nature of the currently identified flow improvement measures and the lack of jurisdiction of the federal water management agencies to mitigate for such impacts.

Public Hearing Testimony, Kalispell, Montana, November 5, 1992

T2-1, Joe Dos Santos, Fisheries Manager of Confederated Salish and Kootenai Tribes

Comment T2-1-1: Investigate inland tribes' treaties responsibilities.

Response T2-1-1: The Corps is sensitive to the cultural ties of the Native American tribes to salmon resources and is making every effort through its consultation process to consider those ties in its decision-making process. The Corps of Engineers recognize the treaty and other rights of Native Americans throughout the Pacific Northwest. We also recognize the United States government's trust responsibility to Native Americans.

Comment T2-1-2: Work with the Kootenai people on the cultural resources of Hungry Horse Reservoir.

Response T2-1-2: As funding and conditions allow, identification and assessment of historical properties will be made at Hungry Horse Reservoir. Information generated from these investigations will be used to help develop appropriate mitigation response.

Comment T2-1-3: Deal with white sturgeon and more with other resident fish populations.

Response T2-1-3: See response to Common Issue 6. The draft SEIS acknowledged the work on biological rule curves for the Libby and Hungry Horse projects. More discussion of the white sturgeon and bull trout has been added to the text.

Comment T2-1-4: Effects of transferring flood control from Dworshak to Grand Coulee on Hungry Horse and Libby operations.

Response T2-1-4: Transferring flood control from Dworshak to Grand Coulee does not affect the operation of Libby or Hungry Horse.

Comment T2-1-5: Revise deep drafting statement to significant.

Response T2-1-5: See response to Comment S5-31. The statement has been withdrawn.

Comment T2-1-6: Preferred alternative will not extend beyond 1993.

Response T2-1-6: The SEIS is presented as a document addressing actions that may occur over a period of years, and not just in 1993.

Public Hearing Testimony, Orofino, Idaho, November 9, 1992

T3-1, Keith Hanson

Comment T3-1-1: Elimination of Dworshak from model runs.

Response T3-1-1: Because each alternative was considered as a group of actions, individual actions were not modeled separately. To do so would add considerable bulk to the document and would not directly address the total effect of all actions for each alternative. However, we have discussed in general terms the possible effects of removing these summer flows from Dworshak (see Section 4.2.3).

T3-2, Jim Wilson, Clearwater County Commissioner

Comment T3-2-1: Clearwater County Commissioners oppose drawdown of Dworshak.

Response T3-2-1: No response necessary.

Comment T3-2-2: Unacceptable for citizens of Clearwater County to pay entire burden of Dworshak drawdown; reduce electrical rates.

Response T3-2-2: See responses to Comment I2-1 and Common Issue 4. While it is true that the alternatives will have a greater impact on facilities at Dworshak than other projects, those impacts are not expected to result in large changes in use under typical water conditions. Longer-term studies are examining ways to mitigate such costs, but mitigation is not a part of the SEIS process.

Comment T3-2-3: Clearwater County has updated a comprehensive plan.

Response T3-2-3: The Comprehensive Plan for Clearwater County, Idaho is a land-use planning document for future development and use of local property to meet certain long-range goals. Although the SEIS describes flow measures that may temporarily affect users in Clearwater County, the action alternatives do not suggest modifications to local land uses or development.

The NEPA process has provided opportunity for discussion with the local community prior to the decision being made. A public information meeting was held in July 1992, to discuss the SEIS. In November 1992, public hearings on the draft SEIS were held. Additionally, a 45-day public review/comment period on the draft SEIS was provided and a 30-day public review of the final SEIS will be provided.

T3-3, Bob Burnham

Comment T3-3-1: Subsidized costs included as part of economic impacts.

Response T3-3-1: Because of the urgent need to protect the Snake River salmon, the SEIS was prepared in an extremely short time frame, restricting the development of new data and the accumulation of elaborate information necessary to develop secondary and cumulative economic impacts in all regions. To solicit and assemble all subsidized costs to the public for water, power, and transportation, etc. is beyond the scope of the SEIS.

T3-4, Greg Isbelle

Comment T3-4-1: Houseboat business owner had negative economic impact in 1992.

Response T3-4-1: See response to Common Issue 4.

Comment T3-4-2: Include population and median income statistics.

Response T3-4-2: A discussion of the study area population is included in the SEIS. Median income data were collected for the study-area counties and added to the discussion of per capita income already presented in the text.

Comment T3-4-3: National Marine Fisheries Service was not available to comment.

Response T3-4-3: See response to Comment T5-4-1. Remainder of comment noted.

T3-5, John Loseth

Comment T3-5-1: Over harvest.

Response T3-5-1: Harvest is outside the scope of this SEIS. See response to Common Issues 1 and 2.

T3-6, Unidentified speaker

Comment T3-6-1: Put money back into community with positive public relations.

Response T3-6-1: The federal agencies already have visitor information programs in place to notify and educate the public about operational changes at federal water resources projects. The agencies have and will continue to invite the public to their projects, emphasizing the positive aspects and the availability of facilities at lower pool elevations.

T3-7, Greg Isbelle

Comment T3-7-1: Press releases about Dworshak directly affect local businesses.

Response T3-7-1: Comment noted. See response to Common Issue 4.

T3-8, Joe Rintelen

Comment T3-8-1: Orofino economy directly affected by the condition of Dworshak.

Response T3-8-1: See response to Common Issue 4.

Public Hearing Testimony, Lewiston, Idaho, November 10, 1992

T4-1, Bill Mulligan

Comment T4-1-1: Data about Smith Ridge is not accurate.

Response T4-1-1: The original sources of the information on Dworshak log dumps used in the 1992 OA/EIS and the SEIS were recontracted, and additional sources were queried, to confirm or revise the analysis of impacts on log rafting activity. The information on this subject from the various parties is not entirely consistent, but the SEIS text has been revised to reflect what appears to be the most current and authoritative information on the operating ranges of the log dumps. This information indicates that Smith Ridge is operable to elevation 1,570 feet for green logs, rather than the 1,565 feet reported in the draft SEIS.

Public Hearing Testimony, Boise, Idaho, November 12, 1992

T5-1, Jim Yost, Idaho Farm Bureau

Comment T5-1-1: Impacts to Cascade when drafted 90,000 acre-feet.

Response T5-1-1: The Cascade 90,000 acre-feet referenced in this comment actually totals 95,000 acre-feet of uncontracted space in Cascade and Deadwood reservoirs that is to be reserved and managed for endangered species uses (listed bald eagles and salmon stocks). Based on BoR reservoir refill studies incorporating 61 years of historical runoff data, there is a 98 percent chance of the 95,000 acre-feet filling every year. Additionally, current Idaho water bank rules require that to the extent reservoir water is used for salmon flow augmentation that space will be the last to fill the following year. These circumstances should fully preserve the existing irrigation water storage supplies in Cascade and Deadwood reservoirs.

T5-2, Lynn Tominga, Idaho Water Users Association

Comment T5-2-1: No net gain of water going through system.

Response T5-2-1: See response to Common Issue 11 (Summer flows)

T5-3, Bob Minter, Idaho Wildlife Federation

Comment T5-3-1: Include walleye as predator in model.

Response T5-3-1: The models that predict predation use information gathered from John Day Pool, which has squawfish, walleye, and smallmouth bass. Models estimating losses indirectly

considered the effects of all fish predators found in John Day Pool. Estimates of reduced predation, however, were based on reductions in squawfish populations, the major predator in John Day Pool. Other populations were not considered because they are not major predators in the system.

Comment T5-3-2: Check affect of drawdowns in Idaho on resident fish and game species.

Response T5-3-2: The SEIS analyzes the impacts of all the alternatives on resident fish (Section 4.3) and terrestrial resources, including riparian zones and wildlife (Section 4.5) at all of the potentially affected reservoirs.

Comment T5-3-3: Support for drawdowns of lower four dams in the Snake River.

Response T5-3-3: Drawdown of the four lower Snake River reservoirs to both MOP and near spillway crest was analyzed in depth in the 1992 OA/EIS. It was determined that drawdown to near spillway crest would have impacts too negative (e.g., adult and juvenile passage facilities would be inoperable, severe impacts would result to other resources, including navigation and power) to make this a viable alternative without structural modification. Thus, it was not an acceptable alternative in the short term either for the OA/EIS or the SEIS. The System Configuration Study is examining Snake River drawdown and structural modifications required to make this a viable alternative. The NPPC has adopted the lower Snake River reservoir drawdown strategy for long-term implementation unless it is shown to be structurally or economically infeasible, biologically imprudent, or otherwise inconsistent with the Northwest Power Act.

T5-4, Richard Beightol, Mercer Ranches

Comment T5-4-1: Is National Marine Fisheries Service public involvement similar to Corps'?

Response T5-4-1: The NMFS has had some meetings around the region concerning the ESA salmon listings, and presumably will have a full public involvement process associated with the recovery plan. Written input may be provided at any time to:

National Marine Fisheries Service
Environmental and Technical Services
911 NE 11th Avenue, Room 620
Portland, Oregon 97232
Attn.: Mr. Merritt Tuttle

T5-5, Jim Yost, Idaho Farm Bureau

Comment T5-5-1: Oppose all alternatives.

Response T5-5-1: No response necessary.

T5-6, Fred Ziari, Chairman, Eastern Oregon Irrigators Association

Comment T5-6-1: Proposed drawdown would disable majority of pumping stations.

Response T5-6-1: All of the action alternatives are based on 1992 operations. In 1992, John Day was operated at minimum irrigation pool not at MOP. Alternatives 2 through 5 stipulate that John Day will be lowered to minimum irrigation pool (approximately 262.5 to 263.5 feet) and raised accordingly if irrigation pumping problems occur.

Comment T5-6-2: Need for additional storage.

Response T5-6-2: Identifying new reservoir projects as possible sources of supplies for flow augmentation is a part of the New Storage Appraisal Study being undertaken by representatives of water-user organizations, fish and wildlife experts, and State and Federal Agencies and also under the System Configuration Study. This is not within the scope of the SEIS.

Comment T5-6-3: Include PNUCC flow vs. travel time, study from John Day.

Response T5-6-3: The citation you mentioned has been added to Section 4.2.1. A more detailed discussion of the travel time and flow relationship was originally presented in the 1992 OA/EIS and will not be repeated in this SEIS.

Comment T5-6-4: Flows do not significantly affect travel time between 200,000 to 300,000 cfs.

Response T5-6-4: While some interpretations of the available data suggest that flows between 200 and 300 kcfs in John Day Pool do not affect travel time, other interpretations of the same data disagree. We cannot conclude with certainty that flows over 200 kcfs do not benefit travel times in John Day Pool. We discussed this literature more fully in the 1992 OA/EIS.

Comment T5-6-5: Support for work by Corps.

Response T5-6-5: No response necessary.

T5-7, Richard Beightol, Mercer Ranches

Comment T5-7-1: Evaluate all options, biologically and economically.

Response T5-7-1: No response necessary.

Comment T5-7-2: National Marine Fisheries Science PIT tag report.

Response T5-7-2: This work has been acknowledged in the final SEIS.

Comment T5-7-3: Include a comparison of cost of Alternative 4 to the priority firm rates.

Response T5-7-3: The information presented in the National Marine Fisheries Service Quarterly Report is preliminary and still lacks hard data to develop empirical relationships. Also, see response to Comment A5-1

Comment T5-7-4: Significant increase in power costs.

Response T5-7-4: Based on review of the various current studies addressing operation of John Day Pool, it appears that this applies to increases in pumping costs for irrigators if the John Day Pool were operated at elevation 257. (This potential plan is being evaluated in the SCS.) The text has been clarified on this issue.

Comment T5-7-5: Economically analyze all proposed recovery measures.

Response T5-7-5: The difference in costs among Alternatives 2 through 5 is negligible. Alternative 4 offers the additional advantage of flexibility to shift the timing of flow augmentation to assist either wild juvenile or adult fall chinook migration in late summer or early fall. NMFS indicated in their 1992 Biological Opinion that additional summer flow augmentation should decrease mortality of juvenile wild fall chinook. The cooperating agencies felt that, with costs being generally comparable among the alternatives,

Alternative 4 offered greater cost-effectiveness by providing greater enhancement of fish survival.

Comment T5-7-6: Support for fish transportation.

Response T5-7-6: See response to Common Issue 8.

T5-8, Bert Bowler, Idaho Department of Fish and Game

Comment T5-8-1: Lack of broad range of alternatives.

Response T5-8-1: See response to Common Issue 1.

Comment T5-8-2: Contradictions for flow augmentation.

Response T5-8-2: See response to Comment S1-3.

Comment T5-8-3: Operation of Lower Granite below MOP.

Response T5-8-3: See response to Comment R6-13

Comment T5-8-4: Model assumptions have little basis of producing adult fish.

Response T5-8-4: Analysis shows that even with a low effectiveness assumption, the number of returning adults increases due to measures which control predators, use transport, and increase adult passage survival.

Comment T5-8-5: SEIS does not provide solutions.

Response T5-8-5: Alternative actions identified in the SEIS are operational changes in management of the river flows and changes to specific project operations. Actions evaluated are those that water management agencies could implement to contribute to the survival of the salmon listed under the Endangered Species Act by NMFS. Relying on flow actions alone will likely not stop the decline of the Snake River Salmon. Although the proposed flow improvement measures identified in the SEIS are necessary, they are not sufficient in themselves to achieve recovery of the listed salmon. The many factors that have led to the decline of the salmon will all require improvement or modification if the region desires to save the Snake River salmon. These factors, including flows, harvest, habitat, water quality, and water conservation measures are beyond the scope of the SEIS.

T5-9, Keith Higginson, Director, Idaho Department of Water Resources

Comment T5-9-1: Flow augmentation did not benefit fish population.

Response T5-9-1: The 1992 OA/EIS and the SEIS both indicate that a correlation between flow augmentation and fish survival likely exists to some limited degree. No alternative considered proposes to address fish survival through flow augmentation alone, but rather through a combination of actions, including in some instances drawdown, to which flow augmentation contributes.

Comment T5-9-2: Cascade Reservoir water is last to fill in a drought.

Response T5-9-2: See response to Comment T5-1-1 for explanation. Even with this situation, there is a very high likelihood of refill of Cascade Reservoir every year.

Comment T5-9-3: Contracted vs. uncontracted water in upper Snake River.

Response T5-9-3: Of the 190,000 acre-feet of upper Snake River reservoir storage referenced in the SEIS, 95,000 acre-feet is uncontracted/uncommitted water in Cascade and Deadwood reservoirs, and 95,000 acre-feet is contracted water that is consigned on a willing-seller basis to the Idaho water bank program.

T5-10, Lynn Tominga, Idaho Water Users Association

Comment T5-10-1: Support for Alternative 5.

Response T5-10-1: No response necessary.

Comment T5-10-2: For extraction of water from Idaho.

Response T5-10-2: No response necessary.

Comment T5-10-3: More concern of water extraction from Idaho through conservation.

Response T5-10-3: Water originating in Idaho has indeed received considerable attention in recovery efforts to date, because the salmon stocks listed under ESA are Snake River stocks and virtually all of the storage capacity in the Snake River Basin is located in Idaho. However, many actions are being taken in other states and Idaho is not being made the only solution. For example, flow augmentation volumes on the Columbia River (currently 6.45 MAF), which are released from reservoirs in Washington and Canada, are more than four times the Idaho volumes represented by the actions included in Alternative 4. The NPPC's Strategy for Salmon identifies a large number of measures requested of a correspondingly large number of Federal, State, tribal, and private-sector entities throughout the Northwest.

Comment T5-10-4: Conflict arising between chinook salmon and bull trout.

Response T5-10-4: See response to Common Issue 6.

T5-11, Ken Robison, Idaho State Legislature

Comment T5-11-1: Support for Lower Snake River drawdown.

Response T5-11-1: See response to Comment T5-3-3.

Comment T5-11-2: Extra storage in a series of dry years not beneficial.

Response T5-11-2: No response necessary.

T5-12, Bob Minter, Idaho Wildlife Federation

Comment T5-12-1: Oppose all alternatives.

Response T5-12-1: See response to Comment I2-1.

Comment T5-12-2: Support for drawdown the four lower Snake River dams.

Response T5-12-2: See response to Comment T5-3-3.

Public Hearing Testimony, Portland, Oregon, November 16, 1992

T6-1, Nanci Tester, Direct Service Industries

Comment T6-1-1: Increased flow to improve salmon run is based on weak scientific evidence.

Response T6-1-1: See response to Common Issue 5.

Comment T6-1-2: Evidence does not exist to support need for additional flow to help ocean-type salmon.

Response T6-1-2: See response to Comment A25-23. Fall chinook travel time is characterized by the Berggren and Filardo 1991 data set, which incorporates size of smolt as indicative of degree of smoltification adjusting travel time in Lower Granite only.

Comment T6-1-3: Transportation and harvest rates need further discussion.

Response T6-1-3: See responses to Common Issues 2 and 8.

Comment T6-1-4: FLUSH and ELCM models are not available for public comment.

Response T6-1-4: See response to Common Issue 9.

Comment T6-1-5: Support for choosing preferred alternative on scientific evidence, not politics.

Response T6-1-5: The effects of Alternatives 2 through 5 are basically indistinguishable because of the methodology of the modeling efforts. The two modeling efforts used for the draft SEIS introduce flow files at the beginning of the Lower Granite Pool (Clearwater River confluence) for the Snake River and typically the Wells Pool for the Columbia River. Flow input is not sensitive to the exact origin of the water release. Any benefit based on the origin of the water contributing to the flow shaping would be undeterminable between Alternatives 2 through 5 and based upon the same degree of scientific evidence or support. Alternative 4 does allow flexibility in release schedule from Dworshak Dam, which has to be relied upon as the principle contributing source for available water. This flexibility would allow reshaping of the augmented volumes based upon the water year and smolt outmigration timing and distribution.

T6-2, Sidney Clouston, Jr.

Comment T6-2-1: Possibly supplement hydroelectric power with solar power.

Response T6-2-1: See response to Comment I1-2

Public Hearing Testimony, Umatilla, Oregon, November 17, 1992

T7-1, Fred Ziari, Chairman, Eastern Oregon Irrigators Association

Comment T7-1-1: Support for selection of life-cycle model.

Response T7-1-1: No response necessary.

Comment T7-1-2: Support for Alternative 4.

Response T7-1-2: No response necessary.

Comment T7-1-3: Assure irrigators that, under Alternative 4, they would have water available.

Response T7-1-3: The comment implies a misconception that water would be taken from Idaho water users, or taken without compensation. All of the actions specifically discussed in the SEIS involving acquisition of upper Snake River Basin water would be done on a willing-seller, willing-buyer basis from whatever supply of water would be available in a given year. Holders of valid existing water rights could choose to make water available for rent if it were surplus to their needs, but would presumably use their full water rights in dry years. In the future, the demonstration programs described in Appendix C may result in the purchase and retirement of some existing water rights. In either case, holders of existing water rights would be compensated fairly and their livelihoods would not be adversely affected.

Comment T7-1-4: Support for transportation and habitat improvement.

Response T7-1-4: No response necessary.

T7-2, Craig Satter, Umatilla Electric Cooperative

Comment T7-2-1: No scientific evidence to support lowering John Day. Some ranges of flow increases migration rate and, in some areas, survival. Lowering John Day Pool contributes to increasing water velocity and, therefore, contributes to reduced migration rate and probably increased survival.

Response T7-2-1: There is evidence that increasing reservoir water velocity over some ranges of flow increases migration rate and, in some areas, survival. Lowering John Day Pool contributes to increasing water velocity and, therefore, contributes to reduced migration rate and probably increased survival.

Comment T7-2-2: Support for transportation.

Response T7-2-2: See response to Common Issue 8.

Comment T7-2-3: Harvest, habitats, and hatcheries.

Response T7-2-3: See response to Common Issue 2.

Public Hearing Testimony, Pasco, Washington, November 18, 1992

T8-1, Faith Cooke

Comment T8-1-1: Study effects of forced passage of young fish.

Response T8-1-1: The development level of fish affects their rate of migration. However, none of the actions being considered would result in forced passage. No fish would be forced to leave the system before they are ready to enter the salt water environment.

Comment T8-1-2: Determine agency that oversees entire operation.

Response T8-1-2: Chapter 1, Section 1.5, lists the many studies currently underway in the region that are directly or indirectly related to salmon survival. As that list indicates, there are many agencies and entities involved in this issue, each with different authority. There is no one agency acting as an umbrella for these studies. The NMFS recovery plan presumably will be the ultimate repository of the findings of these studies in terms of actions mandated under ESA. The System Operation Review, also likely will incorporate actions concerning operation of the Columbia River System to benefit salmon.

Comment T8-1-3: What is outgrowth of this study?

Response T8-1-3: See response to Comment T8-1-2.

T8-2, Richard Beightol, Mercer Ranches

Comment T8-2-1: Impact to retail power costs.

Response T8-2-1: Effects on power rates are addressed to the extent possible in Section 4.9. It is difficult to estimate the separable impacts of the specific proposed actions.

Comment T8-2-2: Support of Corps' economic justification for improvements.

Response T8-2-2: No response necessary.

Comment T8-2-3: Support for Alternative 4.

Response T8-2-3: No response necessary.

Comment T8-2-4: Support for existing and expanding smolt transportation.

Response T8-2-4: No response necessary.

T8-3, Jim Baker, Sierra Club

Comment T8-3-1: Inappropriate that NMFS is listed as author of draft SEIS.

Response T8-3-1: See response to Comment A16-5.

Comment T8-3-2: Modeling, basis for EIS, is questionable.

Response T8-3-2: See responses to Common Issues 5 and 9, and Comments A13-2, S11-14, S7-10, and S6-15. The T.E.C.H. Committee representing the State and Tribal Fisheries' modeling effort has provided FLUSH and ELCM run analysis for incorporation into the final SEIS analysis. Each modeling effort carries its own assumptions and interpretations of the available data collected on the parameters.

Comment T8-3-3: Need ways to combine flow augmentation with drawdowns.

Response T8-3-3: See responses to Comments R6-13, S6-2, and S7-3. To date, drawdown alternatives continue to carry unacceptable levels of uncertainties and risks to juvenile salmonid passage survival and reservoir ecology. This analysis best remains with the coordinated efforts of the Technical Advisory Group of the System Configuration Study and System Operation Review. The SEIS relies on the drawdown discussions within the 1992 OA/EIS and the Draft Drawdown Report provided in the draft SEIS as Appendix B.

Comment T8-3-4: 1992 operations should be considered no-action alternative.

Response T8-3-4: The point about 1992 operations representing the no action alternative, with no return to pre-ESA listing status, might be valid if the SEIS were an entirely new NEPA document and not a supplement. Because it supplements and is tiered to the 1992 OA/EIS, however, it would be confusing and inconsistent to change the definition of the no action alternative.

Comment T8-3-5: Lack of adequate range of alternatives.

Response T8-3-5: See responses to Common Issues 1 and 11. Improved passage operations for the salmon at the Corps dams are not specifically discussed as alternative actions in the SEIS. Spill and other passage actions are represented in the Annual Fish Passage Plan completed by the Corps and coordinated with other federal, state, and tribal fisheries agencies through the Columbia Basin Fish and Wildlife Authority.

The upper Snake River Basin activities are being undertaken by BoR, including acquisition of uncontracted storage space, new storage appraisal, water rental group study, water conservation programs, and water acquisition. BoR has agreed to seek and facilitate securing flow augmentation water from the upper Snake River Basin to improve conditions for salmon migration. However, this work is ongoing or not scheduled for completion in the same time frame as the alternative actions so therefore is not covered by this SEIS.

Comment T8-3-6: Opposition to preferred alternative.

Response T8-3-6: Comment noted.

T8-4, Bruce Lovelin, Northwest Irrigation Utilities

Comment T8-4-1: Support for Alternative 4 as interim solution only.

Response T8-4-1: No response necessary.

Comment T8-4-2: Look at studies by PNUCC.

Response T8-4-2: See response to Common Issue 5.

Comment T8-4-3: Reservoir drawdowns compared to 1992 EIS.

Response T8-4-3: Comment noted.

Comment T8-4-4: Study John Day drawdown more extensively.

Response T8-4-4: As stated in Section 1.1, *Purpose and Need,* the purpose of the SEIS is to examine interim, short-term actions that can be implemented while further long-term approaches to increasing salmon survival are examined in other studies. Operation of John Day at elevation 257 is being studied in detail in the SCS, for which a status report was submitted to the NPPC in December 1992.

T8-5, Van Walkley

Comment T8-5-1: Support for Alternative 4.

Response T8-5-1: No response necessary.

Comment T8-5-2: Concern for irrigation costs.

Response T8-5-2: No response necessary.

Comment T8-5-3: Appreciation for cost-effectiveness study.

Response T8-5-3: No response necessary.

T8-6, Charles Hossom, Columbia-Snake Irrigators Association

Comment T8-6-1: Support for Alternative 4 as interim solution.

Response T8-6-1: No response necessary.

Comment T8-6-2: Support for transport and captive breeding programs.

Response T8-6-2: See responses to Common Issues 2 and 8.

Comment T8-6-3: Single solution to problem is not appropriate.

Response T8-6-3: No response necessary.

Comment T8-6-4: Support for use of full life-cycle models.

Response T8-6-4: No response necessary.

Comment T8-6-5: Support for cost-effectiveness study in SEIS.

Response T8-6-5: No response necessary.

Public Hearing Testimony, Grand Coulee, Washington, November 19, 1992

T9-1, Win Self

Comment T9-1-1: Concern over resident fish study in upper Columbia.

Response T9-1-1: See response to Common Issue 7.

Comment T9-1-2: Request for help in supplying Columbia River with rainbow trout.

Response T9-1-2: See response to Common Issue 7.

Comment T9-1-3: Disagreement on Snake River drawdown.

Response T9-1-3: No response necessary.

Comment T9-1-4: Disagreement on flushing anadromous fish downstream.

Response T9-1-4: No response necessary.

T9-2, Cheryl Cloud Moses

Comment T9-2-1: Include water temperature in SEIS analysis.

Response T9-2-1: Thermal impacts were extensively discussed in the 1992 OA/EIS and did not differ in the SEIS. Thus, because the SEIS is tiered to the OA/EIS, only new information concerning temperature impacts, e.g., with regard to Hungry Horse and Libby, were discussed in this EIS.

T9-3, Kirk Truscott

Comment T9-3-1: Question if HYSSR model with 50 year simulation is a median or average.

Response T9-3-1: The 50-year simulation with the HYSSR model is the median, or 50-percent exceedance level, for the spring and summer. The 50-percent exceedance level is the median elevation from the 50-year simulation. For any given year, there is a 50-percent probability that this elevation will be equaled or exceeded at the end of a given month.

Comment T9-3-2: Include elevations of different alternatives and flow ranges in a table.

Response T9-3-2: Providing complete tabular coverage of high, medium high, medium low and low flow conditions would be impractical and would add unnecessarily to the bulk of the SEIS due to the large number of projects and time periods of interest. The draft SEIS reflected an attempt to indicate likely elevations in low-runoff years, however, and additional information of this type has been added for the final SEIS.

T9-4, Randy Pelton

Comment T9-4-1: Consider effect to people's lives when protecting fish under ESA.

Response T9-4-1: The SEIS addresses socioeconomic concerns, as required by NEPA.

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
(MYRON G. ECKBERG)

U.S. Department of Housing and Urban Development
Denver Regional Office, Region VIII
Executive Tower
1405 Curtis Street
Denver, Colorado 80202-2349

October 23, 1992

Lieutenant Colonel Robert D. Volz
Department of the Army
Walla Walla District, Corps of Engineers
ATTN: CENPW-PL-ER
Walla Walla, WA 99362-9265

Dear Lieutenant Colonel Volz:

This is in response to your request for comments on the Draft Supplemental Environmental Impact Statement (DSEIS) for the Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon, Montana, Idaho, Washington.

F1-1 The Department of Housing and Urban Development, Region VIII, has reviewed your DSEIS with consideration of the areas of responsibility assigned to Region VIII. This review considered the impact of the preferred alternative 4 on housing and community development. Within these parameters we find the DSEIS adequate for our purposes.

If I may be of further assistance, please contact me at (303) 844-3102.

Sincerely yours,

Myron G. Eckberg
Environmental Protection Specialist
Office of Operational Support

U.S. FOREST SERVICE
(GORDON HAUGEN)

United States Department of Agriculture | Forest Service | Pacific Northwest Region | P.O. Box 3623, Portland, OR 97208-3623, 333 S.W. First Avenue, Portland, OR 97204

Reply To: 2610

Date: November 10, 1992

U.S. Department of the Army
Walla Walla District, Corps of Engineers
ATTN: CENPW-PL-ER
Walla Walla, WA 99362-9265

Dear Sir:

F2-1 In reference to the Draft Supplemental Environmental Impact Statement, Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon, the Forest Service supports flow releases that will maximize returns of anadromous fish to National Forests within the Columbia River Basin, and that will ensure the full utilization of anadromous fish habitat managed on these Forests. Please note that during the period 1981 to 1991, the Forest Service has spent in excess of $30,000,000 on anadromous fish habitat, as documented in the GAO report dated July 1992.

If you require further assistance in the review of this document, please contact me at 503-326-4929.

Sincerely,

GORDON HAUGEN
Columbia River
Basin/Pacfish Coordinator

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

(LYNN A. BROWN)

United States Department of Agriculture
Soil Conservation Service
ROCK POINTE TOWER II, SUITE 450
W. 316 BOONE AVENUE
SPOKANE, WA 99201-2348

November 17, 1992

Lieutenant Colonel Robert D. Volz
District Engineer
Department of the Army
Walla Walla District, Corps of Engineers
Walla Walla, Washington 99362-9265

Dear Colonel Volz:

F3-1 Thank you for the opportunity to review the Supplemental Environmental Impact Statement for the Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon.

We have no comments to offer on this document.

Lynn A. Brown (actg)

LYNN A. BROWN
State Conservationist

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

(RICHARD J. GOOBY)

United States Department of Agriculture
Soil Conservation Service
Federal Building, Room 443
10 East Babcock Street
Bozeman, MT 59715

November 30, 1992

Department of the Army
Walla Walla District, Corps of Engineers
ATTENTION: CENPW-PL-ER
Walla Walla, Washington 99362-9265

Dear Pete Poolman or Sandy Shelin:

Thank you for the opportunity to comment on the Draft Supplemental Environmental Impact Statement, Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon.

F4-1 Pages 3 through 22 of the Draft SEIS indicates that more complete data and analysis regarding the effects of Alternative 3 on the operation of Libby and Hungry Horse Reservoirs will be presented in the final SEIS. We request that this information be submitted to the Montana Department of Fish, Wildlife and Parks prior to publishing the final SEIS so that the effects of this alternative on bull trout and westslope cutthroat trout can be fully evaluated. As you know, the U.S. Fish and Wildlife Service is considering listing the bull trout as threatened or endangered under the Endangered Species Act and the westslope cutthroat is a Species of Special Concern.

F4-2 We also request that you fully consider the biological rule curves being developed by the Montana Department of Fish, Wildlife and Parks to define recommended reservoir operations for protecting fisheries in Libby and Hungry Horse Reservoirs. The final SEIS will have to carefully consider all fishery resources in the Columbia and Snake River drainages to prevent one group of threatened/endangered species to be protected at the expense of another.

Sincerely,

RICHARD J. GOOBY
State Conservationist

cc:
Peter Husby, Biologist, SCS, Bozeman

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

(RANDY PHELAN)

Soil Conservation Service
1805 Highway 16 Rm 1
Emmett, Idaho 83617

To: Department of the Army
Corps of Engineers
Building 602
City-County Airport
Walla Walla, Wa 99362-2965

Re: Draft SEIS Colombia and Snake River Flows

F5-1 All the alternatives were not addressed in the draft SEIS.

F5-2 The draft SEIS only addresses the effects on water quality and the fisheries of the Brownlee Reservoir. The draft does not address the problems associated with flushing water from upstream reservoirs for salmon augmentation.

F5-3 My major concerns with the draft SEIS are the same concerns expressed in the enclosed Valley Soil Conservation District's letter on Uncontracted Space in Cascade and Deadwood Reservoirs dated April 30, 1992 and the Cascade Interagency Task Force dated May 20,1992.

The normal operating procedure on Cascade Reservoir has been to start with a full pool and the level would gradually decline into October for irrigation purposes. This process was used to maintain a 300,000 acre foot conservation pool to maintain resident fisheries. The resident fisheries maintains our endangered species, the bald eagle.

Any change in the normal operation or flushing of water to fill lower reservoirs will degrade the water quality in Cascade Reservoir adversely effect the resident fisheries and the bald eagle, endangered species population.

For the above reasons, I would be opposed to any activity that would reduce the water quality in Cascade Reservoir.

Thank you for the opportunity to comment on this matter.

Sincerely,

Randy Phelan
District Conservationist

cc: Larry Koning, DEQ
Paul Malone, SCS

DEPARTMENT OF HEALTH AND HUMAN SERVICES, PUBLIC HEALTH SERVICE
(KENNETH W. HOLT)

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Centers for Disease Control
Atlanta GA 30333

December 3, 1992

Lt. Col. Robert D. Volz
Department of the Army
Walla Walla District, Corps of Engineers
ATTN: CENPW-PL-ER
Walla Walla, Washington 99362-9265

Dear Lt. Col. Volz:

We have completed our review of the Draft Supplemental Environmental Impact Statement (DSEIS), Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon. We are responding on behalf of the U.S. Public Health Service.

F6-1 The goal of the actions considered in the DSEIS is to improve fish migration conditions in the Columbia and Snake rivers. Our review reveals that there would be little difference in impacts among the alternatives, and we would not expect health impacts to result from the proposed action. We note, however, that while consideration of structural modifications to recreational facilities is being deferred to long-term studies, some effective shorter-term measures could be incorporated into project operations and maintenance. We recommend that mitigation such as warning signs and public education measures be implemented as was suggested in the DEIS.

Thank you for the opportunity to review and comment on this draft document. Please ensure that we are included on your mailing list to receive a copy of the Final EIS, and future DEIS's which may indicate potential public health impacts and are developed under the National Environmental Policy Act (NEPA).

Sincerely yours,

Kenneth W. Holt

Kenneth W. Holt, M.S.E.H.
Special Programs Group (F29)
National Center for Environmental Health

U.S. DEPARTMENT OF THE INTERIOR, BUREAU OF INDIAN AFFAIRS

(G.D. BEN)

United States Department of the Interior

BUREAU OF INDIAN AFFAIRS
Portland Area Office
911 N.E. 11th Avenue
Portland, Oregon 97232-4169

IN REPLY REFER TO:

DEC 7 1992

Department of the Army
Walla Walla District
Corps of Engineers
Attention: CENPW-PL-ER
Walla Walla, Washington 99362-9265

Dear Sir:
We have reviewed the Draft Supplemental Environmental Impact Statement (DSEIS), Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon dated October 1992. The following comments are provided:

Comment

F7-1 | 1. Section 2.15.5 Indian Fishing Rights. The DSEIS discusses In-Lieu sites and fishing techniques in two paragraphs. A discussion of Treaties, Federal Trust and the Corps' obligations as a Federal Trustee should be included.

F7-2 | 2. Section 4.12.7 Cultural Resources Evaluation. Bureau of Indian Affairs (BIA), Portland Area Office (PAD) Archaeologist, Mr. Chuck James, is the cultural resources contact for the DSEIS. He may be reached at (503) 231-6749 and should be contacted.

F7-3 | 3. Section 5.3 Preferred Alternative. The Preferred Alternative (Alternative 4) advocates spill levels inadequate to meet tribe and agency recommendations. Recommended spills are 60% for Ice Harbor Dam, 40% for John Dam Dam and 40% for the Dalles Dam. The DSEIS does not call for timely improvements to juvenile and adult fish passage facilities. Project operations that could be modified or delayed to improve fish survival need to be discussed in detail.

F7-4 | 4. Page A-17 Adult Passage. The DSEIS should incorporate the results of the "Snake River Water Temperature Control Project" for 1991 and 1992. The level of increased understanding of water temperature changes and the ability to control these changes are important adult migrant issues.

F7-5 | The Corps has a fiduciary responsibility to evaluate flow management options in relation to the sovereign tribes' treaty reserved fishing rights. The DSEIS does not identify each tribe affected by the proposed action. Effective coordination with each affected tribe on a Government-to-Government basis is necessary. We are available to assist you in this endeavor. The proposed actions preferred alternative has the potential to impact fishing techniques and access to the fishery. The only way for the "Federal Decisionmaker" to have knowledge of this information is for the Corps to include the results of coordination efforts in the final EIS. Each tribe's cultural resources require federal consideration and cultural resource issues vary from tribe to tribe as do fisheries issues.

We appreciate the opportunity to evaluate the DSEIS. For further information, please contact Dan Thayer, Environmental Protection Specialist at (503) 231-2326.

Sincerely,

D. D. Gen

ACTING Area Director

LARRY E. CRAIG
[illegible]
[illegible]

United States Senate

WASHINGTON, DC 20510-1203

UNITED STATES SENATE
(LARRY E. CRAIG, U.S. SENATOR)

AGRICULTURE, NUTRITION AND FORESTRY
ENERGY AND NATURAL RESOURCES
SPECIAL COMMITTEE ON AGING

December 7, 1992

Department of the Army
Walla Walla District
Corps of Engineers
Building 602
City-County Airport
Walla Walla, WA 99362-6619

Dear Colonel Volz:

Thank you for the opportunity to comment on your draft SEIS titled "Interim Columbia and Snake River Flow Improvement Measures for Salmon."

I compliment you on the analysis you have displayed in the SEIS regarding a very complex set of circumstances. I find it a thorough and well-organized document.

F8-1 Regarding the preferred alternative, I am told by Idaho Power officials that they find it physically impossible to meet the varied demands of maintaining downstream flows and shaping the volume of water required, at the times required in the alternative. Some alteration in timing combined with relaxation of minimum flow requirements at Lime Point would permit Idaho Power the flexibility they need. I encourage you to hear their proposed modifications to the alternative and incorporate them in the final decision to the extent possible.

F8-2 I also note the analysis covering Environmental Effects of the Alternatives does not utilize the most recent data available as regards the transportation of juvenile fish. Your life-cycle modelling (page 4-25) uses the 1986 study, which showed a survival benefit of 1.6 to 1 of transported fish over those not transported. I suggest you use the more recent results from the 1989 juvenile migration (see attached letter), which document an improved survival ratio of 2.5 to 1. I don't expect this information to change the preferred alternative, but it should show that salmon populations will rebuild faster than projected in the draft SEIS. That is a very positive development, and should weigh somewhat in favor of fish transportation as opposed to other rebuilding options.

I hope you find my comments useful in drafting the final SEIS.

Sincerely,

LARRY E. CRAIG
United States Senator

LEC/na
Enc.

[illegible] 304 North 8th Street, Room 149, Boise, Idaho 83702
[illegible] 304 North 8th Street, Room 148, Boise, Idaho 83702
903 Northern Pacific Street, Coeur d'Alene, Idaho 83814
823 Main Street, Lewiston, Idaho 83501
200 South 4th Avenue, Pocatello, Idaho 83201
1292 Addison Avenue East, Twin Falls, Idaho 83301
2120 Channing Way, Idaho Falls, Idaho 83404

UNITED STATES SENATE

(LARRY E. CRAIG, U.S. SENATOR)

Northwest Fisheries Science Center
Coastal Zone & Estuarine Studies Division
2725 Montlake Boulevard East
Seattle, Washington 98112-2097

August 27, 1992

MEMORANDUM FOR: F/NWO3 - Merritt Tuttle

FROM: F/NWC1 - Michael H. Schiewe

SUBJECT: Smolt Transportation Research Update

The following is an update of smolt transportation research on spring/summer and fall chinook salmon and steelhead in the Snake and Columbia Rivers. This information was requested by Dr. Peter Bergman in a recent phone conversation, and supplements the information provided to the Team in May 1992 in the review paper written by Gene Matthews.

Adult returns of spring/summer chinook salmon transported in 1989 from Lower Granite Dam are now complete, and returns of steelhead are nearly complete. In-river controls for both species were released below Little Goose Dam. For spring/summer chinook salmon, the transport to control ratio was 2.8 with a 95% confidence interval of 1.3 to 4.5. For steelhead, the transport to control ratio was 2.2 with a 95% confidence interval of 1.2 to 3.9.

Adult returns of fall chinook salmon transported from McNary Dam from 1986 through 1988 are still incomplete, hence there is little value in calculating a 95% confidence interval yet. However, the current transport to control ratios based on returns to date for the respective outmigration years are 2.7, 3.7, and 3.0.

Please pass this information on to the Recovery Team. If you or any members of the Team have any questions regarding these data, please feel free to contact either Gene Matthews (206-553-1451) or myself.

cc: F/NWC - Berry
F/NWC - Matthews
F/NWO - Smith
F/NWO3 - Jones

U.S. DEPARTMENT OF THE INTERIOR

United States Department of the Interior



OFFICE OF THE SECRETARY
Office of Environmental Affairs
500 NE Multnomah Street, Suite 960
Portland, Oregon 97232-2036

ER 92/977

Lieutenant Colonel Robert A. Volz
District Engineer
Department of the Army
Corps of Engineers, Walla Walla District
Walla Walla, Washington 99362-9265

Dear Lieutenant Colonel Volz:

The Department of the Interior (Department) has reviewed the Draft Supplemental Environmental Impact Statement (DSEIS), Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon in the States of Idaho, Oregon, and Washington. The following comments are provided for your use and information when preparing the final document.

GENERAL COMMENTS

F9-1 In general, the Department finds that the DSEIS adequately addresses flow impacts and that the preferred alternative theoretically maximizes benefits to anadromous fish within the physical constraints of the system and the arbitrary limits on the geographic scope of the alternatives. We believe, however, that the Corps of Engineers (Corps) needs to pursue additional water more aggressively in the Upper Snake River in order to meet the flow targets proposed by Columbia Fish and Wildlife Authority.

F9-2 The Corps did not formally discuss preparation of a Fish and Wildlife Coordination Act Report (CAR) with the Fish and Wildlife Service (Service) prior to release of the draft EIS. Because of the short time frame now available, the scope of the CAR will be limited, and will only address project impacts, monitoring needs and future operational needs. Normally, the draft CAR should be included as part of the draft EIS.

F9-3 The Department has not been involved with the modeling efforts that apparently were the basis for much of the analysis of potential environmental effects in the DSEIS. We are concerned with the current high level of interest in basin-wide models for simulating and predicting the long term (up to 40 years) operation impacts of the Columbia and Snake River projects on salmon stocks that are now listed under the Endangered Species Act. We recommend that the authors of the DSEIS emphasize that the model outputs are useful only for comparing potential results of different actions, not for predicting actual numbers of fish. We could hypothesize that if previous modeling efforts were correct, they would have either predicted the present decline of salmon or provided information to avert the current situation. Neither scenario for past models is true. We, therefore, cautiously support those fish survival equations.

F9-4 The five alternatives considered do not represent a wide range in operations. The no-action alternative is described as the 1985 through 1990 hydro system operation. The other four alternatives are variations of the 1992 operations or the Northwest Power Planning Council's (NPPC) Fish and Wildlife Program and

F9-4 (cont.) are not substantial changes in the operation of the hydrosystem. Due to the narrow scope of these alternatives the document is limited in its ability to analyze a true range of impacts and benefits which could aid in the recovery of listed fish species and provide necessary benefits to all the fish and wildlife resources of the Columbia River basin.

F9-5 The alternatives are deficient in discussing Kootenai River white sturgeon and bull trout flow needs and possible Libby Reservoir operations. Only cursory mention is made to Kootenai River white sturgeon.

F9-6 The comparison of the five limited alternatives is dependent on the use of two sets of theoretical models: 1.) Columbia River Salmon Passage Model and Stochastic Life-Cycle Model, developed for Bonneville Power Administration (BPA), and 2.) System Planning Model and Passage Analysis Model, developed by the NPPC staff. An additional set of models, Fish Leaving Under Several Hypotheses Model and Empirical Life-Cycle Model, being developed by the tribes and agencies, is also being considered for inclusion in this analysis. These models have not been thoroughly tested, inputs have not been standardized, and outputs are not well understood. The various models also lack documentation. It is understood that the evolution of these models is ongoing and details such as documentation, testing, and calibration were sacrificed due to time constraints. Time constraints, however, should not be used as justification for using incomplete analytical tools for a decision of this magnitude.

F9-7 The fishery benefits identified in the document are achieved from assumptions surrounding predator control, transportation, and adult passage improvements. The northern squawfish removal program is experimental. The benefits in smolt survival or impacts to the fisheries community are unknown. Benefits may be offset by compensatory responses from other predators or fish species, such as shad, which compete with juvenile salmonids for food. Specific comments concerning this program are included. The transportation program is also controversial. Transport benefit ratios appear to decrease as adult fish approach their area of origin. Adult passage improvements are estimated to increase adult survival by six percent. This figure is optimistic and needs to be supported.

F9-8 The primary concern with modification of spring releases from Grand Coulee Dam is the potential adverse effect such modification may have on resident fish of Lake Roosevelt. The DEIS needs to address the loss of resident fish in the same detail as anadromous fish.

F9-9 The mitigation measures for losses to resident fish needs to be referenced. Ongoing efforts to mitigate for anadromous fish losses by enhancing Lake Roosevelt fish may be seriously compromised by implementation of the preferred alternative. The DEIS needs to address the extent of the conflict and propose mitigation.

SPECIFIC COMMENTS

F9-10 Page 2-17, Northern Squawfish Management: Recent Service research in the lower Snake River shows that smallmouth bass are likely to be the principal predator in this section of the river. Whether northern squawfish or the small mouth bass is the principal predator in the lower Snake should be clarified.

U.S. DEPARTMENT OF THE INTERIOR

F9-11 Page 2-26, Paragraph 1: Possible impacts to the white sturgeon in Lake Roosevelt should be discussed, as Grand Coulee operations would be affected by the proposed flow measures.

F9-12 Page 2-29, Paragraph 4: The Service is evaluating a petition, dated October 30, 1992, for listing the bull trout (Salvelinus confluentus), under the auspices of the Endangered Species Act. Within 30 days, the Service must make a determination as to whether a valid petition for listing has been submitted. Within 90 days, the Service is required, to the maximum extent practicable, to make a finding as to whether the petition presents substantial scientific or commercial information indicating whether the petitioned action may be warranted. Only then, if the petition to list bull trout is found to be warranted, may the Service commence a review of the status of the bull trout. It should also be noted that the Washington Department of Wildlife considers that the bull trout population in Lake Roosevelt already has a high risk of extinction.

F9-13 Page 4-12, Paragraph 1: The larval sturgeon in Lake Roosevelt could be entrained with increased drafting.

F9-14 Page 4-16, "The mortality rate per day of travel time is 2.56 percent per day based on output from CRSM...": This mortality is due only to predation. Recent revised analysis of John Day mid-reservoir area conducted by Service researchers suggest this mortality rate is too high, maybe 3-5 times too high (this information was recently provided to the modelers but was not available for this analysis).

F9-15 Page 4-16, "Northern Squawfish Management": The effectiveness of this removal program is open to several unknowns. These unknowns include attainment of the target exploitation rate, compensatory responses from other fish species and fish community changes to name a few. Service research into predator indexing suggests that predation from northern squawfish is not a problem in all reservoirs or throughout an entire reservoir. Because of this it is unrealistic to apply a uniform mortality reduction figure of 7.5% during 1993-1997 and 25% for 1998 and beyond.

F9-16 Page 4-31, The comparison of the model results in the summary suggests different trends for the various populations: This suggests that model assumptions or components are treating the data differently. These differences should be addressed.

F9-17 Page 4-34: There are several issues which should be added to this list:

- An increased abundance of resident predators, such as walleye and smallmouth bass, may result due to northern squawfish control.
- Predation of smolts by walleye or smallmouth bass may increase or decrease due to prey density and reduced competition.
- Abundance of other prey fish may be changed following removal of northern squawfish.
- Abundance of benthic invertebrate predators such as crayfish may be changed following northern squawfish removal.

F9-18 Page 4-35 and 36: This discussion of how these actions may influence resident fish, invertebrates and plankton communities seems to be based on unfounded assumptions. The authors seem to agree at the end of the discussion when they say that "No specific estimates of population change...can be made..."

F9-19 Page 4-43, Paragraph 2: There is a paucity of information on invertebrate, and particularly mollusc, species occurring in the reservoirs. The unexpected exposure and death of a significant number of California floaters (*Anodonta californiensis*), a candidate for threatened/endangered species status, indicates the need for mollusc surveys within areas not normally exposed for prolonged periods during normal operations. We, therefore, recommend that mollusc surveys be conducted between the elevations of 262.5 and 264 feet in the John Day reservoir in appropriate habitat, such as tailwaters and river mouths. If native species of limited numbers or distribution are exposed, an attempt should be made to salvage these individuals.

F9-20 Page 4-43, Paragraph 4: Although concern continues to be expressed regarding effects to riparian vegetation under a 262.5 ft. drawdown alternative at John Day, actual impacts have not been systematically examined. An evaluation of reganaration and soil moisture availability for riparian species is needed as part of the drawdown. This information is critical in evaluating the effects of annual drawdowns to riparian vegetation.

F9-21 Page 4-45, Paragraph 2: Islands which are exposed will not be suitable for waterfowl nesting as suitable nesting cover would not be present.

F9-22 Page 4-46, Paragraph 2: Actions such as carp control are implemented by the Service as part of refuge operations and are not being carried out by the Corps as part of the Interim Flow Measures. It is, therefore, inappropriate that they be considered a positive impact that balances negative impacts from the drawdown. However, carp control which is funded by the Corps on the Umatilla National Wildlife Refuge may be an appropriate short-term mitigative measure for impacts to breeding waterfowl.

F9-23 Page 4-46, Paragraph 4: As stated, water depth information in the vicinity of islands is needed to determine potential for landbridging. This information has been repeatedly requested and should be obtained.

F9-24 Page 4-47, Paragraph 5: Lodges may also be established during low water periods and flooded when the pools are raised.

F9-25 Page 4-48, Paragraph 1: Tree recruitment would only be expected under a permanent drawdown.

F9-26 Page 4-78: The conclusion that . . ."there would be no negative effect on recreational . . .use at Lake Roosevelt", does not seem warranted in light of potential loss of resident fish and negative effect on the resident fishery. General recreation use at Lake Roosevelt is tied, in large part, to fishing success. A family outing may include many recreation activities, however, the decision to make the trip may be due to good fishing.

F9-27 Appendix D, Biological Assessment (dated October 16, 1992): The Biological Assessment (BA), which is required for compliance to section 7 of the Endangered Species Act, evaluates the impacts of the 1993 Interim Flow Measures on the federally listed endangered bald eagle (Haliaeetus

F9-27 (cont.)

leucocephalus), peregrine falcon (Falco peregrinus), gray wolf (Canis lupus), and grizzly bear (Ursus arctos (-horribilis)). The Corps concluded in the biological assessment that the peregrine falcon species "would likely not be adversely affected", "none of the flow options is expected to affect bald eagle use of reservoirs", and that the project "would not likely affect gray wolf and grizzly bear." The Service advises that the correct terminology for the finding of effect should be "not likely to adversely affect."

Based on the information provided, the Service can concur with the determination for the peregrine falcon, gray wolf and grizzly bear for projects in the State of Washington. However, the Service cannot concur with the finding that "none of the flow options is expected to affect bald eagle use of the project reservoirs" and with the determination as it specifically applies to bald eagles on Lake Roosevelt.

We advise revising the biological assessment for the bald eagle to include the following evaluation factors:

1. A thorough evaluation of bald eagle food habits in light of the proposal to shift more flood control storage to Lake Roosevelt during median water years. This shifting would increase kokanee entrainment and affect nat pen operation (Section 4.3.6). Water retention times would be reduced; and

2. An assessment of the cumulative effects of this type of operation on an annual basis.

SUMMARY COMMENTS

F9-28

The involved agencies (the Corps, BPA, Bureau of Reclamation, and the National Marine Fisheries Service) should undertake and promote all possible efforts to improve passage conditions for anadromous fish.

The Department recommends that the document should include an alternative that provides for better in-river migration conditions. This alternative should include the following provisions:

- Use all available reservoir storage (in addition to the 3 MAF identified in the NPPC program from mid-Columbia) and other means to meet flow targets identified in the Columbia Basin Fish and Wildlife Authority's flow proposal.
- Allow for the Firm Energy Load Carrying Capability to be impacted in low flow years to achieve flowtargets in the lower Columbia River.
- Increase spill levels at all projects within the physical and structural constraints of the system.
- Provide 400 KAF from the Dworshak Reservoir for summer operation (July-August) in addition to available storage from the upper Snake River.

F9-28 (cont.)

- To achieve greater flexibility in operation of Brownlee reservoir an elevation limit of 2,048 feet MSL should be used rather than the current 2,068 elevation limitation.
- Maximize power exchanges with the southwestern United States in the spring and summer.

Provisions for 35 kcfs in the Kootenai River at the Bonners Ferry gauging station from the last week in June to the first week in August need to be included.

F9-29

The assumptions for each theoretical model used should be clearly and concisely discussed. A clearer discussion of the derivation of survival increases due to various activities, such as adult passage improvements, should be provided to improve understanding of the alternatives and their theoretical impacts and benefits.

F9-30

The Department believes that the hydropower system is stressed very little compared to the continued marginal conditions for salmon and steelhead throughout most of their migration through the reservoir dams. Alternative 4 (Preferred) is probably the most reasonable action alternative given the limited alternatives presented in the DSEIS. We caution that continued operation in an interim mode could lead to extinction of the listed stocks of salmon.

We appreciate the opportunity to comment.

Sincerely,

Charles S. Polityka
Regional Environmental Officer

U.S. ENVIRONMENTAL PROTECTION AGENCY, REGION 10

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue
Seattle, Washington 98101

REPLY TO
ATTN OF: WD-126

DEC 14 1992

Robert D. Volz
District Engineer
Department of the Army
Walla Walla District, Corps of Engineers
ATTN: CENPW-PL-ER
Walla Walla, Washington 99362-9265

Re: Interim Columbia and Snake Rivers Flow Improvement Measures For Salmon Draft Supplemental Environmental Impact Statement

Dear Colonel Volz:

The Environmental Protection Agency (EPA) has reviewed the Interim Columbia and Snake Rivers Flow Improvement Measures For Salmon Draft Supplemental Environmental Impact Statement (DSEIS). The DSEIS evaluates Columbia River and Snake River flow modification alternatives intended to assist the downstream migration of juvenile anadromous fish in 1993 and future years until a comprehensive plan of action is developed from long-term studies. Our review is conducted in accordance with the National Environmental Policy Act, and EPA's authorization under Section 309 of the Clean Air Act to determine whether the overall impacts associated with federally authorized actions are acceptable in terms of environmental quality, public health, and welfare.

The DSEIS supplements the Columbia River Salmon Flow Measures Environmental Impact Statement (EIS), completed in January 1992, which addressed flow improvement measures considered for implementation in 1992. EPA expressed, in our comments on that EIS, concerns regarding impacts to water quality, wetlands, and aquatic habitat which could result from various optional flow measures which were analyzed.

The SDEIS evaluates four alternatives which include combinations of measures similar to those which were implemented in 1992, and the no-action alternative. The common features of the DSEIS action alternatives include operation of the Lower Snake reservoirs near minimum operating pool, operation of the John Day reservoir at minimum irrigation pool and operation of the other lower Columbia River reservoirs near full. Flow augmentation measures are also included in the alternatives. A preferred SDEIS alternative, Alternative 4 - Modified 1992 Operations, was identified.

F10-1 The DSEIS alternatives, while intending to aid the downstream migration of juvenile salmon, could result in other potentially offsetting environmental impacts. EPA has concerns about water quality impacts resulting from increases in dissolved gas levels, turbidity, and resuspension of sediments, and potential reductions of wetland, riparian, and shallow water habitat. The flow measures identified in the DSEIS would generally result in less impact to these resources than the more significant reservoir drawdown options identified in the previous EIS. The proposed flow measures also have the potential to yield beneficial results to migrating juvenile salmon. Additional information is needed to fully assess the impacts and to evaluate the overall net (beneficial vs. adverse) effect of the flow measures on anadromous fish survival.

F10-2 We emphasize the importance of developing a comprehensive monitoring program to better assess the water quality and fisheries effects of the proposed flow measures. Water quality and substrate monitoring should be conducted before, during, and following implementation of the flow measures. Monitoring studies should also address overall aquatic community effects as well as the net effects of flow measures on juvenile salmon survival. We recommend that the monitoring plan be initiated prior to issuance of the final SEIS. EPA is available to assist in developing that plan.

F10-3 Based on our review we have rated the DSEIS EC-2 (Environmental Concerns-Insufficient Information). A summary of EPA's EIS rating system is enclosed for your reference. The rating and a summary of our comments will be published in the Federal Register. Our detailed comments on the DSEIS are enclosed.

Thank you for the opportunity to review the DSEIS. We would be pleased to provide assistance in addressing our comments. Rick Seaborne in the Environmental Review Section is the lead contact person for this review and can be contacted at (206) 553-8510.

Sincerely,

Charles E. Findley
Director, Water Division

Enclosures

U.S. ENVIRONMENTAL PROTECTION AGENCY, REGION 10

U.S. Environmental Protection Agency (EPA) Region 10
Detailed Comments On Interim Columbia and Snake Rivers
Flow Improvement Measures for Salmon
Draft Supplemental Environmental Impact Statement (DSEIS)

Water quality

Section 4.1.1, Gas Saturation: EPA previously expressed concern in our comments on the Columbia River Salmon Flow Measures Draft Environmental Impact Statement (DEIS) and Final Environmental Impact Statement (FEIS) regarding the increases in dissolved gas levels associated with the various drawdown options analyzed. As the Lower Granite and Little Goose 1992 drawdown test results indicate (Appendix B of the DSEIS) drawdowns to near spillway significantly increase dissolved gas levels above background levels, and dissolved gas levels are very sensitive to spill rates.

F10-4 The standard of 110 percent saturation is already exceeded (up to 140 percent saturation) under existing conditions in the lower Columbia and Snake Rivers during spring/summer high flow periods. The SDEIS indicates that, based on the water modeling results it is not expected that the SDEIS alternatives, which do not entail deep run-of-river dam reservoir drafts, would significantly raise gas supersaturation levels. The maximum predicted increases in dissolved gas over background levels in the affected reaches, during periods of high flow, should be quantified and compared directly with the standard in the final SEIS (FSEIS) to ascertain the significance of the incremental and cumulative effects. Also to what extent do the drawdown test results (taking into account the complete spill rate gradient) validate the HYSSR model?

F10-5 Section 4.1.3, Turbidity: Physical habitat and water quality effects associated with sediment resuspension and input under the SDEIS alternatives may be less than those associated with the more drastic drawdown options previously analyzed, however this remains an area of concern. These effects include loss of habitat complexity (e.g., simplification of bottom topography), increased sedimentation, decreased pool depth, increased water temperatures, and lowered dissolved oxygen (DO). Changes in physical parameters may, in turn, lead to further reductions in native populations and increased predator (non-native) populations and pathogen loads. Alterations of physical parameters often lead to shifts in population dominance. The FSEIS should discuss the potential for these effects associated with sediment transport and also provide information on potential impacts from disease organisms.

F10-6 Section 4.1.4, Contaminants and Other Water Quality Parameters: Decreases in outfall depths resulting from reservoir drawdowns could result in inadequate mixing of effluent with the receiving waters on a localized basis. Under the current range of alternatives addressed in the SDEIS, this is not expected to be a significant concern however it must be acknowledged that information regarding the number, locations, and types of discharges which may be potentially affected is limited (and not presented in the SDEIS).

F10-7 Section 4.2.1, Review of Anadromous Fish Impact Issues, Section 4.2.2, Modeling of Flow Improvement Effects: Section 4.2.1. discusses the effects on fish of gas supersaturation caused by increased spillage over dams (additional discussion of these effects is provided in the FEIS). EPA concerns regarding exceedances of the dissolved gas standard are indicated in comment 1, above, and in our previous comments on the DEIS and FEIS. The major impact on fish of water containing excessive dissolved gases is the release of gases from their circulatory system in the form of bubbles which block the flow of blood through the capillaries. This "gas bubble disease" not only affects fish but may also impact aquatic invertebrates. Adult and subadult salmon mortality can occur when gas levels exceed 110% saturation, which is below levels currently encountered in the system.

Studies which document fish mortality from gas supersaturation form the basis for the Water Quality Criteria (and subsequently State Standards). Mortality decreases with water depth (effective gas concentration is reduced by 10% for every 3 foot increase in depth). More information is needed regarding the depth at which salmon spend most of their time during migration to ascertain probable effects.

The downstream passage and life cycle salmon survival models presented in Section 4.2.2 of the DSEIS do not appear to take into account the negative effects of gas supersaturation. The "net" adverse or beneficial effect resulting from decreased juvenile salmon migration times coupled with corresponding increases in the incidence of gas bubble disease remains unknown. Continued monitoring and analysis of salmon responses to gas supersaturation needs to be an integral component of the ongoing operations measures analysis process.

Wetlands, and riparian areas

F10-8 Section 4.4, Terrestrial Ecology: The drawdowns would impact riparian zones, grass/forb communities, wetlands, migration corridors, and wildlife. The drawdowns would affect surface and subsurface flows required to maintain riparian and wetland areas. Riparian zones are highly productive and valuable areas,

F10-8 (cont.) especially in the arid west. The SDEIS presents limited information on the existing extent of these areas, and includes a qualitative assessment of existing conditions and likely effects. We continue to have concerns regarding losses of wetland and riparian area functions and values associated with the SDEIS alternatives.

Fish habitat and migration

F10-9 Section 4.2.1, Review of Anadromous Fish Impact Issues: Adult Anadromous Fish, pages 4-56 through 4-59: Operation of the reservoirs at minimum operating pools, as addressed in the DSEIS, is not expected to impede fish ladder access or juvenile bypass systems. These were concerns associated with more drastic drawdown alternatives addressed in the DEIS and FEIS.

F10-10 Section 4.3, Resident Fish and Aquatic Ecology: Additional dredging may be required as a result of the alternatives identified (as discussed in Section 4.7.1, Navigation, DSEIS). Continued loss of shallow water habitats through dredging and operational alterations could further reduce resident fish stocks. Information regarding habitat loss and possible white sturgeon and shad population responses to dredging should be provided. Baseline data and monitoring plans should be identified for associated dredging activities.

F10-11 Section 4.2, Anadromous Fish, and Section 4.3, Resident Fish and Aquatic Ecology: The FSEIS should describe habitat restoration and creation efforts which may be affected by the flow measures alternatives and indicate how habitat and flow measures would be coordinated.

Indirect effects

F10-12 Section 4-6, Air Quality, and Section 4.9, Electric Power: Losses of hydroelectric generating capacity associated with the DSEIS alternatives may result in increased generation at other projects in the system, acquisition of additional capacity from thermal plants, or purchase of power from outside the region (as discussed in the DEIS and FEIS). Increases in air emissions would occur as a result of acquisition of replacement power from thermal plants. Electrical conservation should be considered along with other mitigation to reduce indirect effects associated with losses in hydroelectric peaking capacity.

Baseline conditions & monitoring

F10-13 Water quality/sediments

We stress the need for sufficient monitoring to provide the additional information necessary to assess the water quality effects of the flow measures. Drawdowns and flow changes could

F10-13 (cont.) result in downstream scouring, increased gas supersaturation, decreased dissolved oxygen in deeper waters, increased turbidity, and resuspension of contaminated fine sediments. Upstream impacts may include decreased water volumes and flows, increased temperatures, decreased dissolved oxygen concentrations, increased pollutant concentrations, and altered mixing of outfall discharges. These effects could result in violations of water quality standards.

We strongly encourage that water column and substrate monitoring be conducted upstream and downstream of the proposed measures before, during, and following implementation of the measures. Monitoring of sediments, sediment resuspension, and sediment contaminants needs to be included in the monitoring plan. Cumulative impacts to the estuary below Bonneville Dam should also be monitored.

The monitoring efforts should be coordinated with present water quality management efforts. We urge that a monitoring plan be initiated as soon as possible prior to issuance of the Final SEIS. EPA is available to participate in the development of that plan.

Fisheries

F10-14 Monitoring studies should also address aquatic community dynamics and cumulative effects (other anadromous fishes, resident species, wildlife, wetlands/riparian zones). Pre-dam flows should be reviewed to adequately understand the evolutionary requirements of juvenile salmon. The relative passage success of hatchery vs. wild fish should be studied.

Information regarding the sub-lethal effects of gas supersaturation, as well as mortality information, should be provided in the Final SEIS. Alternatively, a study of sub-lethal effects should be coordinated with the implemented measures.

A juvenile salmon tracking study should be conducted to examine outmigration patterns, habitat selection, predation, and physiological parameters. A long-term study should also be conducted to assess the effects of flows on short and long-term survival.

General

F10-15 As we previously indicated in our comments on the DEIS, flow augmentation is preferable to reservoir drawdown to the extent that outmigration of juvenile salmon could be improved while minimizing the impacts associated with lowered reservoir pools. Water quality in the Lower Snake would be slightly improved by releases from Dworshak, however it would be degraded by releases from Brownlee. Where flow augmentation would potentially

F10-15 (cont.) decrease water quality, pool drawndown should be combined with augmentation measures, as proposed. Increased water velocities and depths may contribute to improved reservoir water quality (e.g., DO, temperature) thereby further assisting outmigrating juveniles and reduoing predator and pathogen populations. In addition, riparian, backwater, and wetland habitat may be protected.

SUMMARY OF THE EPA RATING SYSTEM FOR DRAFT ENVIRONMENTAL IMPACT STATEMENTS: DEFINITIONS AND FOLLOW-UP ACTION *

Environmental Impact of the Action

LO–Lack of Objections

The EPA review has not identified any potential environmental impacts requiring substantive changes to the proposal. The review may have disclosed opportunities for application of mitigation measures that could be accomplish with no more than minor changes to the proposal.

EC–Environmental Concerns

The EPA review has identified environmental impacts that should be avoid in order to fully protect the environment. Corrective measures may require changes to the preferred alternative or application of mitigation measures that can reduce the environmental impact. EPA would like to work with the lead agency to reduce these impacts.

EO–Environmental Objections

The EPA review has identified significant environmental impacts that must be avoided in order to provide adequate protection for the environment. Corrective measures may require substantial changes to the preferred alternative or consideration of some other project alternative (including the no action alternative or a new alternative). EPA intends to work with the lead agency to reduce these impacts.

EU–Environmentally Unsatisfactory

The EPA review has identified adverse environmental impacts that are of sufficient magnitude that they are unsatisfactory from the standpoint of public health or welfare or environmental quality. EPA intends to work with the lead agency to reduce these impacts. If the potential unsatisfactory impacts are not corrected at the final EIS stage, this proposal will be recommended for referral to the CEQ.

Adequacy of the Impact Statement

Category 1–Adequate

EPA believes the draft EIS adequately sets forth the environmental impact(s) of the preferred alternative and those of the alternatives reasonably available to the project or action. No further analysis or data collection is necessary, but the reviewer may suggest the addition of clarifying language or information.

Category 2–Insufficient Information

The draft EIS does not contain sufficient information for EPA to fully assess environmental impacts that should be avoid in order to fully protect the environment, or the EPA reviewer has identified new reasonably available alternatives that are within the spectrum of alternatives analyzed in the draft EIS, which could reduce the environmental impacts of the action. The identified additional information, data, analyses, or discussion should be included in the final EIS.

Category 3–Inadequate

EPA does not believe that the draft EIS adequately assesses potentially significant environmental impacts of the action, or the EPA reviewer has identified new, reasonably available alternatives that are outside of the spectrum of alternatives analyzed in the draft EIS, which should be analyzed in order to reduce the potentially significant environmental impacts. EPA believes that the identified additional information, data, analyses, or discussion are of such a magnitude that they should have full public review at a draft stage. EPA does not believe that the draft EIS is adequate for the purposes of the NEPA and/or Section 309 review, and thus should be formally revised and made available for public comment in a supplemental or revised draft EIS. On the basis of the potential significant impacts involved, this proposal could be a candidate for referral to the CEQ.

*From EPA Manual 1640 policy and Procedures for the Review of Federal Actions Impacting the Environment.

IDAHO DEPARTMENT OF WATER RESOURCES

(R. KEITH HIGGINSON, DIRECTOR)

Statement of
R. Keith Higginson, Director
Idaho Department of Water Resources
Draft SEIS Workshop/Hearing
Boise, Idaho, November 12, 1992

The following comments are provided on the draft SEIS on Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon.

Executive Summary

S1-1 1.1 Purpose and Need - Third paragraph acknowledges that "...changes to the previous operation of the Columbia-Snake River System are needed to reverse the population decline and to contribute to the recovery of these salmon stocks." We support this conclusion and are pleased that the COE, BPA, BOR and NMFS have finally recognized this fact. This does not mean, however, that the status quo in power generation and navigation should be maintained at the mainstem dams while attempting to find additional water from upstream and to then consider that to be a change in the previous operation. Real change means that the dams are fixed so they can operate in a manner which will provide real benefits for the fish.

S1-2 1.4 Scope - Comment is made that "...one factor known to affect the overall health of salmon stocks is river flow during downstream migration of juvenile salmon." This is only true because of the existence of the dams. If the dams were not there the river flow through the natural river channel, even during the current drought period, would be adequate for the fish. The fish successfully survived earlier low flows during drought periods in their natural environment before the dams were built. Therefor, the fix should not be an attempt to augment flow through the unnatural slackwater pool environment if no change is going to take place in the operation of the dams. Drawdown is still the simplest and most direct means of impacting fish protection. The final EIS should reflect the fact that flow became a factor only after the dams were completed.

S1-3 2.2 Alternative 2: 1992 Operations - The alternative refers to actions "...that are actually occurring in the 1992 operating year." Among the 1992 measures were a number related to flow augmentation such as 100 KAF from Brownlee in September and 190 KAF from Upper Snake River April 15 to June 15. Most of this water was not provided because the water was not physically available due to drought.

The provision of the water from these sources would have been enabled by the passage of two Idaho legislative measures during the 1992 session. Continued and future provision of water from Idaho reservoirs through 1994 is specifically conditioned by those measures upon there being an annual flow augmentation plan, which

S1-3 (cont.) I am required to approve, which demonstrates a commitment to implementation of the reservoir drawdown strategy. I must also find that other parties are making a proportional contribution to solving the salmon migration problem. Actions taken by BPA of reducing Columbia River flows when water was furnished from Idaho reservoirs this last season raises the question of whether Idaho can continue to be cooperative. We have asked for a report on this matter from BPA and the COE. The matter will be reviewed with the legislature when it convenes again in January 1993. There may be no authorization for water from Idaho reservoirs for 1993 and 1994.

S1-4 Page ES-7 - A sixth alternative needs to be examined which would address the sensitivity of Dworshak operations. Such sensitivity analysis has been directed at Hungry Horse/Libby and at upper Snake River but has not considered the major impacts which releases at Dworshak are having on the local environment.

S1-5 4.3 Preferred Plan of Action - Alternative 5 would be a better selection due to the uncertainty of both the physical and political availability of water for flow augmentation. Continuation of the drought as well as the preference given by BPA to power over any benefits of Idaho reservoir water to augment Columbia River flows leads us to conclude that such flow augmentation is found by the BPA to serve no useful purpose. Alternative 5 at least acknowledges that there may be no water from the Snake River basin in Idaho. Alternative 5 should be selected as the preferred plan.

General

S1-6 7.0 Compliance with Applicable Federal Environmental Statutes and Regulations - Paragraphs need to be added to this section specifically describing the Congressional authorization for the mainstem Snake and Columbia River dams and for Dworshak. When drawdown has been suggested as a strategy, the COE has thrown up a defense that such operation would be contrary to the congressional authorization. Yet the COE finds it completely acceptable to arbitrarily modify the authorized operation of Dworshak without seeking concurrence from the Congress. A detailed description of the authorization for each of the involved dams and reservoirs needs to be a part of this SEIS. We are particularly concerned that when Congress authorized the dams on the lower Snake River in 1945 it required that passage be provided for anadromous fish. Since the salmon have been impacted by the dams to the extent they are now listed under the ESA, we conclude that the mainstem dams were not built and are not being operated pursuant to law. The COE should seek amendment of the authorizations if present and modified operations are not covered.

S1-7 Paragraph 7.24 needs to be rewritten to acknowledge that state water right laws will govern the release and use of water from Snake River reservoirs, particularly Brownlee and those operated by the BOR. It is incorrect to conclude that state laws have "...typically limited applicability ... to the Federal multi-purpose projects...".

HOUSE OF REPRESENTATIVES, STATE OF IDAHO
(KEN ROBISON)

KENNETH L. ROBISON
DISTRICT 19
ADA COUNTY

HOME ADDRESS
1119 NORTH 18TH
BOISE, IDAHO 83702
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COMMITTEES
HEALTH & WELFARE
RESOURCES & CONSERVATION

House of Representatives
State of Idaho

Nov. 17, 1992

Department of the Army
Walla Walla District
Corps of Engineers
CENPWPL-ER
Walla Walla, WA 99362-9265

Dear Corps,

These comments are a response to your request for comments on interim flow measures for 1993 and beyond.

I believe the people of Idaho are being very poorly served by the Corps and the other agencies involved in this issue. You continue to pursue measures which will not save the salmon.

S2-1 Millions of dollars have been wasted in the pursuit of failed strategies, while our salmon runs continue to decline. The proposed measures for 1993 and beyond are more of the same.

While the drawdown of the lower Snake dams has impacts that would require significant mitigation, it is the only measure identified so far which appears to have the potential to bring back Idaho salmon runs.

Instead of wasting time on useless interim strategies, you should be making plans to implement the drawdown. It is very frustrating for the people of Idaho to watch the continued decline of our salmon runs while the Corps and Bonneville waste more time and money on failed strategies.

Sincerely,

Ken Robison

Ken Robison

DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION, STATE OF MONTANA

(GARY FRITZ)

DEPARTMENT OF NATURAL RESOURCES
AND CONSERVATION

STAN STEPHENS, GOVERNOR

LEE METCALF BUILDING
1520 EAST SIXTH AVENUE

STATE OF MONTANA

DIRECTOR'S OFFICE (406) 444-6699
TELEFAX NUMBER (406) 444-6721

HELENA, MONTANA 59620-2301

November 23, 1992

Department of the Army
Walla Walla District, Corps of Engineers
ATTN: CENPW-PL-ER
Walla Walla, Washington
99362-9265

Attached you will find comments from the Montana Department of Natural Resources and Conservation (DNRC) to the *Draft Supplemental Environmental Impact Statement (SEIS), Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon.* The DNRC appreciates the opportunity to comment on the SEIS.

Sincerely,

Gary Fritz

GF:na

Attachments

Comments on the *SEIS, Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon* from the Montana DNRC

S3-1 1. In Table 4.2-1 on page 4-18, 1993 and 1998 are referred to as level of action years in regard to fisheries. Exactly what actions are scheduled to be implemented and at which facilities in 1993 and 1998? Did each model (CRiSP.0, SLCM, PAM, and SPM) assume the same implementation schedule for 1993 and 1998?

S3-2 2. Page ES-3 contains the following statement:

However, it must be stressed that the relationship between travel time and survivability is a general one, not a precise, quantitative expression.

While much emphasis is being placed on flow augmentation to produce increased velocities and improve survivability of smolts, only limited studies support this theory. The models (CRiSP.0, SLCM, PAM, and SPM) indicate flow augmentation alone will not reverse the decreasing trends of chinook and sockeye populations. However, when nonflow measures were implemented, the decreasing trends were reversed. Would it be more worthwhile to emphasize these nonflow measures, such as screen installations at turbines, habitat improvements, and predation control?

S3-3 3. Please explain in more detail the lowered pool level analysis presented on page 4-16:

Decreases in operating pool levels at the Snake River dams and John Day Dam are modeled by converting reservoir flows to equivalent flow rates at normal pool elevations.

S3-4 4. In Section 5.0, Plan Selection and Implementation, it was assumed that a shift of flood control from Dworshak and Brownlee to Grand Coulee would not impact Libby and Hungry Horse dams. The potential impacts to Libby and Hungry Horse dams should be studied. It certainly seems that if more flood control demands are placed on Grand Coulee, this could possibly require Libby and Hungry Horse to operate at lower spring and early summer levels to provide flood control capacity lost at Grand Coulee. This altered mode of operation could substantially impact resident fisheries, recreation, power generation, and cultural resources at Libby and Hungry Horse. If this scenario is possible, then Libby and Hungry Horse are potentially affected in every alternative.

DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION, STATE OF MONTANA
(GARY FRITZ)

S3-5 | 5. What are the R^2 values for parameters k_1 and k_2 used at each reservoir in Table 10 on page 17 in Appendix E?

S3-6 | 6. What distances were used to establish the travel times for the y-axis on Figures 2 and 3 shown on page 18 in Appendix E. Which geographical features and distances were used for these figures? For instance, in Figure 2, is the travel time representative of the time it takes an out-migrating juvenile salmonid to travel through Lower Granite Pool? If so, what is the assumed pool length?

S3-7 | 7. Much emphasis is placed on travel time, even though the parameters used to compute travel time have rather low R^2 values, as presented on page 15 in Appendix E (.466 for Lower Granite Pool and .3141 in John Day pool). Alternative methods should be explored to better quantify the relationship between travel time and flows.

S3-8 | 8. In Table 11 on page 19, Appendix E, what are the R^2 values of the parameters used to predict survival as a function of flows?

S3-9 | 9. What are the R^2 values for all parameters presented in Table 13 on page 22 in Appendix E?

DEPARTMENT OF COMMUNITY DEVELOPMENT, STATE OF WASHINGTON
(ROBERT G. WHITLAM, Ph.D., STATE ARCHAEOLOGIST)

BARBARA GOODING
Director

STATE OF WASHINGTON
DEPARTMENT OF COMMUNITY DEVELOPMENT
OFFICE OF ARCHAEOLOGY AND HISTORIC PRESERVATION
111 21st Avenue S.W. • P.O. Box 43843 • Olympia, Washington 98504-8343 • (206) 753-4011 • SCAN 234-4011

November 24, 1992

Lt. Colonel Robert D. Volz
District Engineer
Walla Walla District, Corps of Engineers
Department of the Army
ATTN: CENPW-PL-ER
Walla Walla, WA 99362-9265

Dear Lt. Colonel Volz:

Thank you for the opportunity to review the Draft Supplemental Environmental Impact Statement, Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon.

S4-1 The document correctly notes the significance of cultural resources along the Columbia and Snake Rivers and the potential for impacts to those resources under the considered alternatives.

We would recommend that you develop a Programmatic Memorandum of Agreement among the concerned parties to assure a coordinated and comprehensive program of cultural resource identification, evaluation, and protection.

Please feel free to contact our office at (206) 753-4405, should you have any questions.

Sincerely,

Robert G. Whitlam, Ph.D.
State Archaeologist

RGW:lms

STATE OF MONTANA, OFFICE OF THE GOVERNOR
(STAN STEPHENS, GOVERNOR)

Fax-it® brand fax transmittal memo 7671 | # of pages ▸ 9
To Peter Paulsen | From NWPPC (Ti)
Co. | Co. Helena, MT
Dept. | Phone (406) 444-3952
Fax # | Fax #

e of Montana
of the Governor
, Montana 59620
406-444-3111

STAN STEPHENS
GOVERNOR

December 7, 1992

Lieutenant Colonel Robert D. Volz
Department of the Army
Walla Walla District, Corps of Engineers
ATTN: CENPW-PL-ER
Walla Walla, WA 99362-2965

Dear Colonel Volz:

Attached is a copy of Montana's comments on the Draft Interim Columbia and Snake Rivers Flow Improvement Measures For Salmon Draft Supplemental Environmental Impact Statement (SEIS).

I am pleased that Montana's reservoirs have been recognized as a component of the Columbia River's integrated hydro system and included in your evaluation. I hope that our comments will contribute to a more accurate evaluation of system-wide impacts.

S5-1 As the salmon recovery process proceeds, it is important that the impacts of recovery actions are carefully evaluated. This issue is underscored by the recent Endangered Species Act petition for listing of the bull trout. This potential listing affects not only Montana bull trout, but bull trout all across the region. Thus, a system-wide perspective is truly required. It would not be wise to implement recovery actions in one area that lead to environmental damage in another area.

Thank you for the opportunity to comment. Please contact Mark Reller of my staff if you have any questions or need clarification of our comments.

Sincerely,

STAN STEPHENS
Governor

MONTANA'S COMMENTS
on
Draft Interim Columbia And Snake Rivers Flow Improvement Measures For Salmon Draft Supplemental Environmental Impact Statement (SEIS)

Headings and section numbers correspond to the SEIS layout. Page numbers and paragraph numbers are listed as needed for clarity.

Executive Summary

1.2 Location of Study Area

S5-2 Comment: Montana is pleased that its reservoirs and rivers are included in the SEIS evaluation.

1.3 System Description

S5-3 Comment: In describing the annual plans, the document states that, "Water use and control plans may be adjusted at projects to provide water flows and elevations that might better meet the needs of anadromous fish." This statement appears to outline the perceived or real bias of the region to anadromous fish. It should be restated to recognize all fisheries resources. Suggested change: ". . . needs of resident or anadromous fish."

1.4 Scope

S5-4 Comment: p.3 "Based on the assumption that the rate of juvenile salmon travel is directly related to water velocity . . ."

What is being done to test and validate this assumption? Given the expense of the program, validation of the assumption is needed before long-term expensive mitigation programs are implemented.

The Northwest Power Planning Council is considering an independent evaluation of the flow/survival relationship. We encourage the cooperating agencies in the SEIS to provide all information requested by the contractor in a timely fashion to facilitate a prompt and accurate evaluation.

2.2 Alternative 2: 1992 operations

S5-5 Comment: During the 1992 operations, more water than the required 3 MAF was purchased. Some of this water was subsequently stored in Libby and Hungry Horse. Will this component of the 1992 operation be repeated? If so, releases of all stored water must comply with all nonpower constraints at the projects.

STATE OF MONTANA, OFFICE OF THE GOVERNOR
(STAN STEPHENS, GOVERNOR)

S5-6 Comment: We question the practicality of transferring flood control from Dworshak to other projects. How can Grand Coulee both store more water budget water and take on additional flood control responsibility? If power operations routinely exceed flood control rule curves, this appears to be merely a paper shift or responsibility. Are other paper shifts available to benefit salmon or resident fish? It appears that the operation of shifting flood responsibility to John Day reservoir has not been examined.

S5-7 John Day is authorized for flood control but it is not fully utilized for flood control; why not? If irrigation constraints preclude flood control use, it could be argued that upstream reservoirs are subsidizing irrigation on the John Day pool. The result of historic operations has been poor passage conditions for anadromous fish and damages to resident fish in upstream storage reservoirs.

S5-8 The SEIS should examine and report on the levee system in the Lower Columbia system. It should report on the current state of maintenance and the frequency that these levees are utilized to 80% and 90% capacity. Fuller utilization of these structures would reduce flood drafting of headwaters reservoirs and allow increased spring time flows.

S5-9 Who funds the Upper Snake water purchases and participation of Brownlee in salmon restoration activities? If the ratepayers are funding, it should be brought out in this document.

2.3 Alternative 3: 1992 Operations with Libby/Hungry Horse Sensitivity

S5-10 Comment: The document states, "A basic premise of the 1992 OA/EIS and the 1992 plan was that system operations would be conducted such that Libby and Hungry Horse would not be operated differently to compensate for flow improvement changes in system operations." Unfortunately, this premise was not observed. It was violated in at least two different ways. First, while Libby and Hungry Horse have traditionally not released water directly for water budget one releases, in 1992 it appeared that because of water budget two operations at Grand Coulee, Libby and Hungry Horse were drafted harder during the spring months. Second, Hungry Horse was drafted in July to "back fill" Grand Coulee after it was drafted for a fall chinook operation. At the time, BPA stated that the water removed from Hungry Horse was water stored above rule curves as a result of water budget two over purchases. While Montana was pleased to be above rule curves, this action illustrated that Montana was affected by salmon operations.

S5-11 The document should address what actions will be taken if Canadian water supplies are not available for salmon flows. The document should specify which reservoirs, if any, will be required to make up for Canadian shortfalls and in what order will they be drafted.

S5-12 The document takes a tone that 1992 operation or the status quo is acceptable with respect to resident fish and local concerns. In doing so it fails to mention or realize that, in fact, actions are under way to mitigate for historic and ongoing impacts to resident fish and wildlife populations. Part of that effort is evident in the BPA funded Hungry Horse Mitigation Plan. Part of that plan includes efforts to change operations at Hungry Horse to reduce impacts on resident fisheries resources. Therefore, to assume that the status quo is acceptable is in error. Changes in operations to benefit anadromous fish, thus, should not be measured against the baseline of 1992, but rather against the proposed changes needed to benefit resident fish. If operational changes are made to benefit salmon at the expense of native resident fish populations, then such changes create a waste of mitigation funds and efforts.

S5-13 Extensive effort has also been focused on refining actions to benefit white sturgeon in the Kootanai River. This work should be examined by the SEIS team and incorporated into the SEIS document.

S5-14 The document needs to be modified to include the recent ESA petition on the bull trout. This petition underscores the current impact of system operations on resident fish.

S5-15 At a minimum, the document should note that operational changes for the benefit of resident fish populations may occur in the future. In light of the current ESA petition for bull trout, informal consultations should start immediately between the federal agencies and the Montana Department of Fish, Wildlife and Parks to determine the impacts of 1993 operations on these fish.

3.1 Juvenile Fish Survival

S5-16 Comment: Predator control appears to be a significant factor in increasing juvenile fish survival. While the effort to contain squawfish is commendable, but expensive, questions arise regarding other predators. Generally, squawfish are credited as being the dominate predator. However, other predators also consume smolts. Bass, walleye, and catfish limits should be liberalized to reduce these predators' impacts on salmon. This would reduce populations and predation on salmon at a zero cost to regional ratepayers. Are these predators actively planted into salmon waters by state, federal or tribal hatcheries? If so, these plants should be curtailed until salmon populations recover.

S5-17 It is unfortunate that results from fish survival models are only preliminary at this time. The results of sensitivity analysis should be included in this document for public scrutiny. Later in the document (page 5-3) it notes, ". . . that some of the greatest enhancement to adult returns would be from improving the spawning and rearing habitat." If the model analysis shows this, why are millions of dollars being spent annually on changes in reservoir operations? It would seem logical that spending priority and

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S5-17 (cont.) emphasis should be on spawning and rearing habitat that provide years of returns rather than just one year of assumed benefit. Prioritizing expenditures in this manner would provide time to validate the assumptions that passage improvements increase survival.

Chapter 2 Description of Existing Environment

S5-18 Comment: Table 2.2-1 Characteristics of projects should include mean annual inflow to each project. With this information, the reservoir capacity is put into perspective. For example, with inflow data you will see that Hungry Horse capacity is large with respect to inflow. As a result, a heavy draft may take more than one year of inflow to recover the reservoirs.

Page 2-16

S5-19 Comment: A water budget has been in existence for ten years. Since alternatives 2 through 5 increase this water budget by 1 MAF, the efficacy and administration of the historic water budget should be included in this document. The life cycle models now available should model the efficacy of the historic water budget. An accounting procedure should be outlined to show the historic contribution of all storage reservoirs to the water budget. With this information in hand, the region would be in a better position to examine the tradeoffs associated with the historic water budget and determine if increases in the water budget are warranted.

S5-20 This document refers to the water budget as a discrete volume of water. Is this consistent with the hydroregulation models? It is our understanding that these models assume that the water budget is a block of power. These differing perspectives could alter the management of the water budget and cloud the actual impact to resident fish populations.

Page 2-19

S5-21 Comment: Once again, the document states a fallacy that the Montana reservoirs did not participate in the flow augmentation measures initiated in 1992. Operations in 1992 at both Montana projects deviated from historic norms. Although many officials have argued that power demands drove the operations, it must be noted that power production was reduced on the system as a result of the drawdown experiment, increased spills, and reduced project heads.

S5-22 It should also be noted that large reaches of river are below Libby and Hungry Horse reservoirs. Thus, pool elevations alone are not indicative of changes in operation. Power peaking operations affect river flows and temperatures and influence aquatic resources.

Page 2-23

S5-23 Comment: It should be noted that Libby Reservoir is equipped with a selective withdrawal structure to control water temperatures, while Hungry Horse is not.

Page 2-29

S5-24 Comment: The section on bull trout should be updated to include the recent ESA petition and its implications on reservoir operations and river flows.

Page 2-48

S5-25 Comment: Under the employment section, local unemployment rates and trends should be included. Areas with chronically low unemployment may be less able to incur further hardship.

Page 2-49

S5-26 Comment: Indian tribal fish rights for inland, resident fish-dependent tribes should be discussed.

Chapter 3 Proposed Actions and Alternatives

Page 3-8

S5-27 Comment: The document states, "In 1992, 90 KAF of uncontracted space in Cascade and Deadwood was rented to support salmon flow augmentation." Who paid the rental fees? If it was the ratepayers, they should be informed through this document.

Page 3-22

S5-28 Comment: The document appears to downplay the decreased reservoir levels by calling reduced refill probabilities and reduced median elevations nearly the same as alternative 2. Table 3.5-9 reveals that Hungry Horse levels are lower on a median basis by five to nine feet in September and December. Has the Hungry Horse biological model been run to determine the effects of these decreases? Have these reservoir and river operations been compared to the Montana Department of Fish, Wildlife and Parks Biological Rule Curves for Libby and Hungry Horse? These curves are available in the Hungry Horse mitigation plan and in the SOR process and should be used to examine relative impacts. Median elevations may not be the best data format. An exceedance format may be more descriptive of the frequency and magnitude of changes.

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Chapter 4 Environmental Effects of Alternatives

Page 4-15

S5-29 Comment: For modeling purposes, harvest reductions on fall chinook are reduced in the near term but assumed to increase to 1991 levels in 1996. This appears to be a highly optimistic assumption and, at a minimum, the expected increase in harvest should be explained. It should also be explained why fall chinook harvest rates have not been reduced to 55% as called for by the Northwest Power Planning Council.

It should be noted in this document that harvest, in the NPPC models at least, is a harvest rate as opposed to a harvest level. This should be explained so that the reader is aware that harvest interests begin to reap the benefits of recovery actions as soon as they occur, and, as a result, slow the recovery.

S5-30 Except for Appendix A, little other mention of harvest is made in this document. On page A-46 it notes that 6 to 11 percent and 31 to 39 percent of the human-induced mortality of Snake River spring/summer and fall chinook, respectively, is caused by harvest. Given the magnitude of these impacts, significant curtailment of harvest should be considered. Harvest on strong stocks should be shifted to other areas to curtail the impact on weak stocks. Such shifting of harvest may have local impacts; but, much like the treatment of recreational shifts in this document, benefits are merely reallocated within the region.

The standard argument presented by federal entities is that harvest is outside the scope of this EIS. If this is true, a harvest EIS is warranted and should accept public comment from this region as well, since it is potentially impacted by harvest impacts on recovery efforts.

Page 4-41

S5-31 Comment: "One year of deeper drafting of the reservoir would not likely have a major effect on the reservoir's aquatic resources."

This statement is grossly in error. Research on Hungry Horse has shown that single year deep drafts have long lasting consequences. Missing or weakened year classes occur, nutrient flushing issues arise, predator prey densities change, access to spawning tributaries may be curtailed or eliminated, and thermal issues in the reservoir and in the river are of concern.

This statement must be removed and the appropriate language inserted.

Page 4-59

S5-32 Comment: We are pleased that the fugitive dust issue at Libby is receiving serious attention.

Page 4-78

S5-33 Comment: It should be noted that boat ramps and moorage facilities at Libby require significant maintenance after reservoir drafting. Wave action redistributes gravel and cobble that must be removed before the boat ramps are safe to use. Increased drafting will necessitate increased funding for this maintenance. This cost should be included in the SEIS evaluation.

Page 4-80

S5-34 Comment: The Flathead River is incorrectly referred to as the Kootenai River under the Flathead River section.

Chapter 5 Plan Selection and Implementation

Page 5-7

S5-35 Comment: "However, these differences are insignificant when compared to either Alternative 2 or the base condition."

The authors of this statement may wish to rethink this comment. Considering the fact that under "base conditions" additional ESA petitions have been filed on sturgeon and bull trout, "insignificant changes" may well be the proverbial straw that breaks the camel's back. If such insignificant changes occur for the sake of insignificant gains for anadromous fish, a grave injustice will have occurred.

Other Important Issues

S5-36 Water Supply Forecasts

All of the options examined in the SEIS document rely on water supply forecast accuracy. For example:

1) flow augmentation,
2) shifts in system flood control,
3) refill of storage projects, and
4) refill or run-of-river projects drafted for fish passage.

A review of historic forecast accuracy should be provided so that the risk associated with forecast error can be evaluated. In addition, contingency plans for both over-estimated and under-estimated water supplies should be prepared and presented.

OREGON DEPARTMENT OF FISH AND WILDLIFE

Oregon

DEPARTMENT OF
FISH AND
WILDLIFE

December 5, 1992

Lt. Col. Robert D. Voltz
Department of the Army
Walla District
Corps of Engineers
Building 602 City County Airport
Walla, WA 99362-6619

Dear Colonel Voltz:

The Oregon Department of Fish and Wildlife has reviewed the document "Interim Columbia and Snake River Flow Improvement Measures for Salmon Draft Supplemental Environmental Impact Statement (SEIS)" developed by the Corps of Engineers in cooperation with the Bonneville Power Administration, Bureau of Reclamation, and National Marine Fisheries Service and is providing the following comments for use in development of the Final SEIS.

Flow Improvement Alternatives

S6-1 The SEIS is being developed in response to the listing by the National Marine Fisheries Service of the Snake River sockeye salmon as an endangered species under the Endangered Species Act (ESA) and Snake River fall and spring/summer chinook salmon as threatened species. The SEIS purpose is to evaluate the impacts of flow improvement alternatives to be implemented in 1993 and future years pending results of long-term studies such as the Corps System Operation Review System Configuration Study and the Bureau's Snake River Augmentation Study. In regards to causes for the decline in Columbia River salmon, the SEIS states "Although many factors contribute [to the decline], one factor known to affect the overall health of salmon stocks is river flow during downstream migration of juvenile salmon." Despite this recognized need to improve flows to prevent further decline of Columbia River salmon, the SEIS offers no alternative which provides a significant improvement in mainstem flow during critical migration periods. For example, compared to the No Action Alternative, Alternatives 2-5 would increase flows at Lower Granite by only 2.6-4.4% during April 16-30 (81.7 kcfs to 83.8-85.3 kcfs), 4.3-4.4% in May (95.8 to 99.9-100 kcfs), and less than 1% in June (90.9 kcfs to 91.3 kcfs).

The SEIS is simply a justification for hydrosystem operations identified by the Northwest Power Planning

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S6-1 (cont.) Council and incorporated into the Pacific Northwest Coordination Agreement for 1993 Columbia River operations. The stated goal of improving flows in the SEIS "would be accomplished by modifying the manner in which existing projects (dams and reservoirs) are operated during 1993 and future years until a long-term plan of action is developed..." without "significant physical modifications of the dam and reservoir projects". This "fine-tuning" of the hydrosystem will not result in significant increases in flow nor will it provide significant recovery of Columbia River fish populations. The Final SEIS should identify alternatives that provide substantial improvements to river velocity in the Snake and Lower Columbia rivers. The Columbia Basin Fish and Wildlife Authority (CBFWA 1990) established recommended long-term flows to restore salmon and steelhead in the Columbia and Snake rivers. The Department recommends that the Corps model flows contained in CBFWA's flow proposal as an alternative and determine necessary changes in system operations to achieve these flows to the maximum extent possible. Specifically, the

S6-2 Department urges the Corps include the following river velocity and passage improvement alternatives in the Final SEIS:

1. Use of system flexibility, marketing strategies, storage, and reservoir operations to achieve the velocity equivalents of the CBFWA's 1990 flow recommendations to the maximum extent possible.

2. Provide 400 kaf from Dworshak during July and August to augment Snake River flows.

3. The use of a minimum reservoir elevation of 2048 feet for Brownlee Reservoir to allow greater drafting of Brownlee for flow augmentation.

4. The operation of Lower Granite at near spillway sill with powerhouse discharge and spill balanced to optimize adult and juvenile passage. Transportation may have to be discontinued at Snake River projects to avoid holding fish in shallow water under high levels of dissolved gas that would result from the heavy spill. Gatewells would need to be dipped to remove juvenile migrants and spill levels would have to be adjusted to keep dissolved gases below 130%. The ladder exit would require modification.

5. Adjustment of power rule curves to allow more flexibility to augment flows for fish.

S6-2 (cont.) 6. Increase spill levels at each project to achieve CBFWA's recommended 80/70 fish passage efficiency during 80% of migrations.

S6-3 The Department suggests that the Corps adopts a different approach in identifying flow alternatives for the Final SEIS. The Corps needs to establish a biological objective for Columbia River salmon in order to determine flow improvements needed to prevent jeopardy and ultimately provide recovery of threatened and endangered stocks. For the Final SEIS, the Department recommends that the Corps includes flow alternatives that will achieve biological objectives for each of the ESA listed stocks. Without the statement of a biological objective it is impossible to select and evaluate the effect of various flow alternatives on recovery of fish populations. For example, in the Draft SEIS, model results of alternatives from BPA's SLCM and NPPC's SPM models for spring and summer chinook show static or downward trends where low measure effectiveness is assumed. Without an understanding of what population levels constitute jeopardy in these stocks it is not possible to judge the impacts of the measures on the fish populations.

Models and Analysis of Alternatives

These comments on modeling reflect joint efforts by ODFW and IDFG technical staff.

These model assessments were performed to assist the NMFS in developing a Biological Opinion on the effect of Columbia-Snake River hydrosystem operations (during 1993 and the future) on reversing the population decline and contributing to the recovery of Snake River chinook. In addition this same information is being utilized in the SEIS toward the same purpose. The modeling systems employed in this assessment were not designed to evaluate the effect of a single year's set of actions on a stock's future spawning escapements. Recognizing these limitations, NMFS has requested that the assessments be run assuming the actions plannned for 1992 are in place in all future simulation years. It should be noted that these management actions were limited to actions implemented in 1992 and earlier and do not reflect an attempt at construction of a viable recovery plan for these stocks.

S6-4 The state and tribal fishery agencies T.E.C.H. Workgroup assessment of the 1993 proposed actions has been submitted

S6-4 (cont.) to NMFS. In addition, it has been stated in the draft SEIS that these assessments will be included in the final SEIS document. We provided this assessment (see attachments). In general, this assessment indicates that Snake River spring, summer and fall chinook populations do not rebuild under the proposed actions, and frequently cycle to extremely low escapement levels. An important finding for spring/summer chinook index populations is that, when poor water years cycle through the simulations, all the combinations of model assumptions show minimal improvement over base conditions. The T.E.C.H. conclusion for fall chinook is that there is a high likelyhood that, based on a reasonable range of management actions, a continuation of the 1993 actions would not halt the decline in escapements.

S6-5 Smolt survival models used to evaluate mainstem management actions can be highly sensitive to both the form of the relationship between survival and water velocity, fish travel time or flow and to assumptions about survival of transported fish. Because the use of different functions and assumptions can often yield widely varying responses to proposed management actions, it is important that smolt survival models used to forecast responses can also realistically hindcast recent adult recruitment trends. Reliability of a life cycle model to forecast future adult trends will also be very sensitive to the calibrations used to link the smolt survival models to production functions. These calibrations and their effect on adult recruitment projections are not well described in Appendices E and F.

An important characteristic of the Empirical Life Cycle Model (ELCM) developed by the state and tribal fishery agencies T.E.C.H. Workgroup is that the ELCM is a cohort-based approach that provides an index of brood year strength for specific popualtions. The brood year recruitment observed in past years corresponds directly to specific smolt migration years and conditions. This allows for the direct comparisons between behavior of the smolt survival models and adult recruitment needed to verify a model system's reliability in hindcasting.

S6-6 The 1993 proposed actions are very modest regarding mainstem velocity improvements. The three model systems (BPA, NPPC and T.E.C.H.) produce different projections of these proposed actions, which cannot be fully reconciled at this time. A comparison of the performance of different model systems and their sensitivity to different assumptions is cursory. A more comprehensive understanding of performance

S6-6 (cont.) of model systems developed by BPA, NPPC and the state and tribal fishery agencies should be forthcoming from the Analytical Methods Coordination and Documentation process. It will be extremely difficult to identify what is causing the differences in the three model systems without going through the rigorous model comparison and sensitivity analysis scheduled for this coordination process. Priorities for modeling in the region should focus on this process, and not on other activities that delay or deter understanding of these analytical methods.

S6-7 Only the BPA analysis suggests rebuilding might occur for any of the chinook runs; the NPPC and T.E.C.H. analyses show the threatened runs not responding significantly to the proposed actions. It is alarming that a number of NPPC and T.E.C.H. simulations show declining trends in escapement or seemingly stable trends at extremely low escapement levels. Given the precarious nature of these depressed stocks and the uncertainties inherent in life-cycle modeling, it is our opinion that the 1993 measures would not constitute a viable recovery plan or be sufficient to initiate recovery within a reasonable time frame. The T.E.C.H. modeling of 1993 proposed measures indicates spring and summer chinook populations cycling to extremely low escapements following poor water years, and fall chinook likely showing a further decline. This is reason for serious concern that, if another drought cycle occurs soon, the continued existence of these stocks could be threatened.

The following specific comments on Appendices E and F primarily address spring and summer chinook:

Appendix E--BPA's CRiSP and SLCM

Flow-Survival Relationship

S6-8 CRiSP.0, used in this analysis, describes the relationship between flow and smolt mortality (from the Sims and Ossiander data) with a quadratic equation (see Input Parameters CRiSP.0, page 20). This form of equation predicts maximum survival at about 115 kcfs for the Snake River, at which point survival begins to decrease. In the model this would negate any benefits of flows (or equivalent velocities) greater than this level. There seems to be little biological justification for this form of equation for this data set, other than mortality from chronic gas

S6-8 (cont.) supersaturation conditions at high flows in the early 1970s. Those conditions do not apply to the situations modeled.

In view of the major improvements made in control of gas supersaturation since the early 1970s, a negative exponential relationship would more accurately describe the current situation, and also better mimic flow-travel time relationships. Absent the gas supersaturation problem, it is logical to assume that smolt survival would be optimized with velocities most similar to those under which the fish evolved. Recent adult recruitment data from Marsh Creek, Idaho and Imnaha River, Oregon (Petrosky and Schaller 1992) also suggest significant survival benefits up to at least 140 kcfs, consistent with the CBFWA (1991) biological justification for mainstem flow.

Transportation Survival

S6-9 The Columbia Basin Fish and Wildlife Authority at the request of NMFS has an ongoing review of the transportation policy. Many unresolved questions continue to be raised about the transportation data, summaries and conclusions. CRiSP.0 treated transport survival as a constant, whereas treating it as an uncertainty for sensitivity analyses and comparisons to adult recruitment trends would have been more appropriate.

Use of a constant transport survival (see Input Paramaters CRiSP.0, pages 11-12) will have the effect of minimizing variation in annual smolt survival estimates in the analysis. The result is that the model becomes less sensitive to changes in water velocity or flow because a large proportion of smolts are transported in the simulations. The reported mean spring chinook smolt survival rate was 0.188 (for the 50 year flow record), but the coefficient of variation (C.V.) was only 10% (see Input Parameters SLCM, page 11).

The nearly constant annual smolt survival estimates produced by CRiSP.0 does not correspond well with the highly variable adult recruitment observed in recent years (C.V. range, 75% to 119%). The T.E.C.H. Workgroup sensitivity analysis of transport assumptions indicated that adult recruitment trends were most accurately reproduced by the less optimistic assumptions about transport and by estimated inriver survival (without transport).

S6-9 (cont.) Apparently the variation not explained by CRiSP.0 (with the constant transport survival assumption) was partitioned into an ocean/estuary scalar for SLCM during the calibration. The BPA analysis appears to allocate too little variation to annual smolt survival and too much variation to random processes, based on the T.E.C.H. review of recruitment and variation of a downriver stock in recent years (which is not exposed to the same high levels of hydropower mortality) and of Snake River stocks before full hydropower development. The result likely would be to understate effects of future, potential velocity improvements.

Habitat Improvement

S6-10 Habitat improvement assumptions were applied to the aggregate run (see Input Parameters SLCM, page 7) in the model. These would more appropriately apply only to specific areas and spawning populations, not the aggregate. For example, screening improvements would improve survival only where there are diversions; in the Salmon River subbasin, this would not be applicable to most areas below the North Fork Salmon River.

Appendix F--NPPC's PAM and SPM

Transportation Survival

S6-11 The NPPC analysis used two transport models. Model 1 assumes that survival of fish after release is constant, Model 2 assumes that transport survival (post-release) decreases at lower flows.

The statement in Section 4 (Environmental Effects of Alternatives, p. 4-25) that "(f)urther analysis by NPPC has determined that transportation Model 1 reflects a more realistic representation of transportation survival" is not supportable. The two alternative values of TBR calculated by PAM for 1989 (Appendix F, p. 16) both fall well within the confidence intervals of the estimate. As noted above, both the 1986 and 1989 transport studies are under review by CBFWA at the request of NMFS.

S6-11 (cont.) Transport survival assumptions should be tested in the context of estimated smolt survival and empirical adult recruitment data. As noted above, the T.E.C.H. Workgroup sensitivity analysis about transport assumptions indicated that adult recruitment trends were most accurately reproduced by the less optimistic assumptions about transport and by the estimated inriver survival. In particular, the NPPC Model 1 assumption used in the FLUSH model produced smolt survival estimates that deviated widely from the recent adult recruitment.

Prespawning Survival

S6-12 Some clarification is needed on the citation for the Petrosky (1992) prespawning survival "estimate" of 90%. The actual rate is unknown and difficult to quantify, as stated in a March 31, 1992 memo to Anderson and McConnaha. The memo further stated that there was not much evidence to support the Chapman et al. (1991) estimate of 40-50% prespawning loss as typical for Snake River wild spring and summer chinook. One reason is that an average 51% of the Lower Granite run can be accounted for in rack returns and harvest of Rapid River fish. If prespawning mortality was 50%, there would be no other spawners "at large" in areas not indexed. Second, tributary redd counts account for most of the females counted crossing weirs, in the few streams where appropriate comparisons can be made. Further, field observations and the proportions of unspawned carcasses do not support an assumption of high mortality in the spawning tributaries.

The NPPC assumption of 80% prespawning survival seems reasonable, and is identical to the TAC assumption for hatchery fish used to generate estimates of the wild run size at Lower Granite. The run reconstructions in the T.E.C.H. analysis used a 90% prespawning survival assumption.

S6-13 Modeling for the Final SEIS should be done using more realistic and biologically defensible ranges of benefits from predation, bypass, and transportation improvements. We find BPA'a assumed modeling parameters to be particularly unrealistic especially the assumed benefits for the squawfish management program. We do not support BPA's claim that the program will result in a 7.5% reduction in

S6-13 (cont.) reservoir mortality for 1993-97 and a 25% reduction for 1998 and beyond. It is premature to assume that the theoretical reservoir smolt survival benefits from squawfish removal will be realized prior to completion of the ongoing evaluation designed to determine if squawfish fishery exploitation rates and subsequent increases in reservoir survival are achieved. There are questions whether the squawfish removals will be compensated by other species that prey on or compete with salmonids and, as data from the U.S. Fish and Wildlife Service indicates, whether squawfish are preying primarily on substandard and injured smolts which would not survive even if not consumed by a squawfish. For the Final SEIS, assumptions regarding squawfish control should include an alternative that no benefits will be derived from the program.

S6-14 We also believe that the benefits of transport are over-stated in the SEIS and do not take into account the possibility of lower transport benefits under higher flows. The Department will be providing alternatives to modeling transport benefits in the Final SEIS.

S6-15 We are extremely concerned with the use of models to project 1993 flows without any provisions to adjust operations based on actual flows that occur in 1993. You are undoubtedly aware of the problems in the modeling for the Corps and BPA's 1992 Biological Assessments for hydrosystem operations which resulted in a gross over-estimation of 1992 flows and under-estimation of the effects of 1992 hydro-operations on ESA listed fall and spring/summer chinook. This, coupled with NMFS's objection to re-open the Biological Opinion in 1992 after it was apparent that 1992 flows were much lower than assumed, resulted in a disastrous passage season causing further decline of salmon stocks. It is simply not possible to model flows with any accuracy and large errors like what occurred in 1992 can lead to serious errors in operational decisions and subsequent impacts on fish migrations. The Final SEIS needs to include a provision to adjust operations in-season based on actual flows that occur in 1993.

We appreciate the opportunity to provide you these comments and look forward to working with you on development of the Final SEIS.

IDAHO FISH & GAME
600 South Walnut / Box 25
Boise, Idaho 83707

December 4, 1992

Peter Poolman, Study Manager
Department of the Army
Walla Walla District, Corps of Engineers
Walla Walla, Washington 99362-9255

Dear Mr. Poolman:

Enclosed are the Idaho Department of Fish and Game's comments on the Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon Draft Supplemental Environmental Impact Statement. If you have any questions, please contact Bert Bowler of my staff at 208-334-2646. Thank you for your consideration.

Sincerely,

Jerry M. Conley, Director

JMC/cjc
Enclosure
L2339NWA

Cecil D. Andrus / Governor
Jerry M. Conley / Director

IDAHO DEPARTMENT OF FISH AND GAME
(JERRY M. CONLEY, DIRECTOR)

IDAHO DEPARTMENT OF FISH AND GAME'S COMMENTS ON:

INTERIM COLUMBIA AND SNAKE RIVERS FLOW IMPROVEMENT MEASURES DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

December 4, 1992

Thank you for the opportunity to comment on the Draft Supplemental Environmental Impact Statement (DSEIS) for 1993 flow measures.[1]

In April, 1992, the National Marine Fisheries Service issued its biological opinion on 1992 hydrosystem operations and explained the need to improve salmon survival in future years:

> [W]e are concerned that if the operation of FCRPS continued as is proposed for 1992, it would not be sufficient to reverse the decline [of listed salmon stocks] over one life cycle of the salmon; therefore additional steps will likely be needed in 1993 and future years.[2]

The Idaho Department of Fish and Game (IDFG) concurred in this view and looked forward to new proposals to improve salmon survival. However, the flow measures proposed in the 1993 Supplemental EIS essentially repeat 1992 operations. We conclude that the proposed 1993 flow measures do not adequately provide for the biological needs of threatened and endangered salmon stocks.

Major points of the Idaho Department of Fish and Game's comments include the following.

- The range of alternatives considered is too narrow. Additional measures to improve salmon survival and to further the Snake River reservoir drawdown strategy should be considered.
- Proposed 1993 operations do not adequately protect Snake River salmon. There is no reasonable assurance that 1993 actions will prevent the further decline of listed salmon stocks.

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[1] We assume that the record for purposes of the 1993 Supplemental EIS includes the comments received on the original 1992 Flow Options OA/EIS. Please consider the State of Idaho comments and appendices on the 1992 OA/EIS, which are incorporated herein by this reference.

[2] Letter to Major General Ernest J. Harrell, U.S. Army Corps of Engineers, North Pacific Division, from William W. Fox, Jr., Assistant Administrator for Fisheries, U.S. Department of Commerce. April 10, 1992.

- Analysis by the T.E.C.H. group of biologists from the state fisheries agencies and tribes indicates that proposed 1993 operations will not rebuild listed spring and summer chinook stocks.

- Many of the assumptions underlying the analytical models (CRiSP/SLCM and PAM/SPM) cited in the DSEIS are unsupported.

- SPM results show an unacceptably low level of rebuilding and even show decline in some stocks. SPM results support a finding that listed salmon stocks are in jeopardy.

- National Marine Fisheries Service should not be a cooperating agency. The cooperating agency role creates an appearance of conflict with the agency's responsibilities under the Endangered Species Act.

Given the current configuration of the system, the fate of Snake River salmon stocks hinges on the weather and resultant run-off. Obviously, this is not a reliable approach to salmon recovery.

GENERAL COMMENTS

I. The DSEIS Does Not Present a Reasonable Range of Alternatives; Additional Measures Must Be Considered.

S7-1

A. The Alternatives Presented in the SEIS Represent Only Minor Variations on 1992 Operations.

NEPA requires the agencies to "[r]igorously explore and objectively evaluate all reasonable alternatives...."[3] The DSEIS fails to meet this mandate by analyzing a range of alternatives that includes only minor variations on the actions adopted in 1992. The DSEIS includes five very similar alternatives: a no action alternative reflecting 1985-90 operations, 1992 operations, 1992 operations without Hungry Horse and Libby participation, 1992 operations with a slight increase in summer releases from Dworshak Reservoir, and 1992 operations without upper Snake River Basin participation. None of these flow measures provide meaningful survival improvements for salmon.

The absence of a reasonable range of alternatives is of particular concern because the proposed interim measures are apparently intended to remain in effect until completion of the System Operation Review (SOR). The SOR could be years away from implementation. The indefinite duration of the 1993 measures

[3] 40 C.F.R. § 1502.14(a).

S7-1 (cont.) underscores the need to include actions that offer greater benefits for salmon.

B. Additional Alternatives To Be Considered.

S7-2

IDFG requests that following alternatives be considered for 1993 operations.

1. Additional Flow and Operational Measures.

The SEIS should consider an alternative or a mix of alternatives that includes the following elements.

- Do not decrease Mid-Columbia flows to offset Snake River flow augmentation.

- Operate all turbine units at peak efficiency.

- Operate Lower Granite at a lowest elevation consistent with maintaining effective adult passage and juvenile bypass facilities.

- Remove federal constraints on the price that can be offered to rent water from existing water rights holders under the Idaho water bank statute. A higher water rental price may increase the willingness of existing water rights holders to offer water into the water bank.

- Seek to negotiate an agreement, including compensation, with Idaho Power Company to provide for greater water budget participation from Brownlee Reservoir consistent with resident fish and recreation needs.

- Use available storage, power marketing, and other actions to attempt to achieve the Columbia River flow targets sought by the Columbia Basin Fish and Wildlife Authority. Store additional water for this purpose in the Columbia River.

2. Lower Granite Drawdown Alternative.

S7-3

The DSEIS unjustifiably omits all alternatives that would change current system configuration. IDFG recommends that a one-pool drawdown alternative focused on Lower Granite Pool be considered in the SEIS for the following reasons. First, recent analysis by the fisheries agencies and tribes indicates that transportation is not providing the benefits indicated in the SEIS. In many instances, it appears that in-river migration is superior to transportation. Second, the SEIS is intended to govern operations until the SOR EIS -- which may still be years away. A broader range of drawdown options should be considered given this duration. Third, Lower Granite Pool is a relatively large mainstem reservoir and is thought to have a

S7-3 (cont.) disproportionately large adverse impact on downstream migrants. Fourth, the 1991 drawdown test indicated that the turbines operated at lower pool levels, that adult fish ladders also worked at lower levels, and that gas problems were controllable by combining spillway and powerhouse discharges.

IDFG recommends this alternative for consideration in the SEIS process. Any decision to implement the option would, of course, follow further analysis and interagency consultation. The alternative consists of the following elements:

- Draft Lower Granite Reservoir to near-spillway crest so as to maintain a free-flow discharge over the spillway beginning about 15 April. Actual drafting would begin 1 April.
- Extend the adult ladder exit to accommodate the lowered pool elevation below 710 fmsl.
- Refill to minimum operating pool (MOP) immediately after 15 June, using storage in Dworshak and/or Brownlee reservoirs. Reduce spring storage releases to provide refill.
- For the period of the lowered reservoir elevations, manage flow between the powerhouse and the spillway to meet the following objectives:
  - Maintain a safe in-river migration environment for both juveniles and adults (with no collection and no transport);
  - Pass the maximum number of juveniles possible over the spillway by optimizing spill consistent with adult passage and dissolved gas constraints;
  - Remove juveniles trapped in the gatewells by dipping or other methods;
  - Dissolved gas levels below the project should not exceed 130 percent saturation for an extended period of time (gas levels between 120% and 130% should be acceptable if juveniles are allowed to sound to depth -- i.e., no collection, holding or transport).
- Adaptive Management:
  - Manage Lower Granite Dam by adjusting powerhouse discharge and spill rates to meet the inriver needs of migrating salmonids.
  - Balance discharge between spillway and powerhouse based on temporal (seasonal,

S7-3 (cont.) weekly, daily, diel) movement of both juveniles and adults.

  - Carry out an intensive monitoring program to make in-season adjustments in project operations based on arrival timing of juveniles and adults at the project.
- Contingency Action: If conditions are deemed unsafe for either juveniles or adults, the river should be returned to normal operations at MOP.
- Prototype Modifications: As soon as possible, prototype modifications should be installed to improve guidance of juveniles in the forebay toward the spillway. Options include a sluiceway along the dam, angled curtain, sound and/or light guidance mechanisms.
- Impacts identified in the 1992 test should be mitigated to the maximum extent possible.

S7-4 In addition to this one-pool drawdown alternative, the operating agencies should ensure that all possible steps to reduce the lead time for a four-pool reservoir drawdown occur in 1993 and beyond. The agencies have deferred all action until the completion of the System Operation Review EIS and the System Configuration Studies. The SOR EIS and SCS may be years away from completion. The listed salmon runs are severely underescaped and cannot afford to wait years for a more meaningful resolution of this issue.

S7-5 (3) No Transport in Under Favorable Run-Off Conditions.

The SEIS should include an alternative of not transporting fish when flow conditions make in-river migration more favorable to survival than transportation. IDFG recommends that no transport occur in the Lower Snake River when flows are forecast to be above 100 kcfs for three days.

S7-6 c. Upper Snake River Contribution.

Reservoirs in the upper Snake River Basin finished the 1992 water year at some of the lowest levels on record. Although the Idaho water bank will permit upper Snake River Basin water rental in 1993, there may be little water to available to rent. Therefore, the SEIS should realistically assume that Alternative Five will reflect actual conditions in 1993. This alternative contemplates upper Snake River water will not likely be available for water bank rental. This is a conservative, and in our opinion more realistic alternative, given the current reservoir conditions. A snowpack of roughly 150 percent of normal will be necessary to fill the upper Snake River system and provide

S7-6 (cont.) additional water for the Water Banks. If the upper Snake River area receives 150 percent of normal precipitation, it is likely the Clearwater and Salmon basins (which contribute roughly two-thirds of the inflow to Lower Granite Reservoir) will experience high run-off conditions.

S7-7 In addition to a sensitivity on upper Snake River contribution, the SEIS should analyze reduced flows from Dworshak, which has borne a disporportionate share of the burden for augmenting flows in the lower Snake River.

II. Criteria for Evaluating Anadromous Fish Actions.

S7-8 The SEIS should discuss anadromous fish issues in context of biological criteria arising from applicable laws, including the Endangered Species Act and the Northwest Power Act. We request that the SEIS state whether the proposed actions comply with the following statutes.

(A) Endangered Species Act.

The Endangered Species Act's requires that federal actions not "jeopardize" the continued existence of threatened or endangered species.[4] To jeopardize the continued existence of a species is defined by regulation to mean "to reduce appreciably the likelihood of both the survival and recovery" of that species.[5] Thus, the jeopardy standard requires a risk assessment: any "appreciable" reduction in a species chances for survival is proscribed.

Predicting future salmon population trends is an uncertain undertaking because salmon are sensitive to changeable environmental conditions such as drought and because the models used to predictive tools depend on uncertain assumptions regarding salmon productivity and survival.

Given this uncertainty, a federal action appreciably reduces the chances salmon stock survival if it is not capable of preventing species decline over a broad range of potential future outcomes. This range of outcomes includes both potential adverse environmental conditions and failure to achieve expected response to recovery actions. In essence, the jeopardy standard requires an assurance that a proposed federal action will not cause species decline under pessimistic but reasonable scenarios.[6]

[4] 16 U.S.C. § 1536(a)(2).

[5] 50 C.F.R. § 402.02. (emphasis added).

[6] The disastrous downstream migration conditions experienced in 1992 illustrate this point. Even though the volume of water dedicated to the water budget was significantly increased in 1992, flow conditions were far below acceptable

S7-8 (cont.) The Endangered Species Act also requires federal agencies to take actions to affirmatively recover listed species to the point that the protections of the Act are no longer needed.[7] Thus, a second ESA-based biological criterion is to rebuild the species.

S7-9 (B) Northwest Power Act.

The Northwest Power Act also provides legal mandates that should be translated into criteria under which to judge the alternatives. The Northwest Power Act requires the federal project operators to provide equitable treatment and to consider the Northwest Power Planning Council's program to protect, mitigate, and enhance the fish and wildlife of the Columbia River Basin.

The Northwest Power Planning Council's Columbia River Basin Fish and Wildlife Program contains goals for the basin's salmon runs. For Snake River spring and summer chinook, the Council calls for rebuilding to productive, fishable levels as rapidly as possible. The program calls for an annual average of 50,000 natural spring chinook and 20,000 natural summer chinook counted at Lower Granite Dam.

An additional source of legal guidance is legislation regarding the lower Snake River projects. Congress authorized the lower Snake River dams based on the express representation from the Secretary of the Army that adequate fish passage would be provided and that salmon and steelhead fisheries would be sustained. These representations to Congress were repeated when Congress adopted the Lower Snake River Fish and Wildlife Compensation Plan, which was based on providing smolt-to-adult return rates of about 0.8 percent. The ability of the alternatives to meet these promises should be a decision-making criteria.[8]

levels. The likely result will be that the 1992 operations failed to prevent the further decline of listed salmon stocks.

[7] 16 U.S.C. § 1536(a)(1).

[8] The Corps' projects do not provide adequate fish passage for downstream migrating smolts, particularly in low run-off years. The salmon runs and fisheries that the Corps promised to maintain have declined to critically low levels. The LSRCP goals have never been achieved and the Corps has never met the expectations of Congress.

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III. The Proposed Action Does Not Adequately Protect and Enhance Salmon Stocks.

(A) Analysis by the Fisheries Agencies and Tribes Indicates Proposed 1993 Flow Measures Will Not Produce Recovery.

At the request of the National Marine Fisheries Service, the T.E.C.H. Committee -- composed of biologists from the state and tribal fisheries agencies -- has prepared an analysis of the trends in future run strength for spring and summer chinook salmon. (T.E.C.H. 1992) The analysis indicates that continuation of 1992 flow augmentation measures will not rebuild spring and summer chinook populations even assuming some success in predator control efforts. The balance of this section III.A. reflects the comments of the joint technical staffs of the Oregon Department of Fish and Wildlife and the Idaho Department of Fish and Game.

These model assessments were performed to assist the NMFS in developing a Biological Opinion on the effect of Columbia-Snake River hydrosystem operations (during 1993 and the future) on reversing the population decline and contributing to the recovery of Snake River chinook. In addition, this information is being utilized in the SEIS toward the same purpose. The modeling systems employed in this assessment were not designed to evaluate the effect of a single year's set of actions on a stock's future spawning escapements. Recognizing these limitations, NMFS has requested that the assessments be run assuming the actions planned for 1992 are in place in all future simulation years. It should be noted that these management actions were limited to actions implemented in 1992 and earlier and do not reflect an attempt at construction of a viable recovery plan for these stocks.

S7-10 The state and tribal fishery agencies T.E.C.H. Workgroup assessment of the 1993 proposed actions has been submitted to NMFS. In addition, it has been stated in the draft SEIS that these assessments will be included in the final SEIS document. In general, this assessment indicates that Snake River spring, summer and fall chinook populations do not rebuild under the proposed actions, and frequently cycle to extremely low escapement levels. An important finding for spring/summer chinook index populations is that, when poor water years cycle through simulations, all the combinations of model assumptions show minimal improvement over base conditions. The T.E.C.H. conclusion for fall chinook is that there is a high likelihood that, based on a reasonable range of management actions, a continuation of the 1993 actions would not halt the decline in escapements.

S7-11 Smolt survival models used to evaluate mainstem management actions can be highly sensitive to both the form of the relationship between survival and water velocity, fish travel time or flow and to assumptions about survival of transported

S7-11 (cont.) fish. Because the use of different functions and assumptions can often yield widely varying responses to proposed management actions, it is important that smolt survival models used to forecast responses can also realistically hindcast recent adult recruitment trends. Reliability of a life cycle model to forecast future adult trends will also be very sensitive to the calibrations used to link the smolt survival models to production functions. These calibrations and their effect on adult recruitment projections are not well described in Appendices E and F.

S7-12 An important characteristic of the Empirical Life Cycle Model (ELCM) developed by the state and tribal fishery agencies T.E.C.H. Workgroup is that the ELCM is a cohort-based approach that provides an index of brood year strength for specific populations. The brood year recruitment observed in past years corresponds directly to specific smolt migration years and conditions. This allows for the direct comparisons between behavior of the smolt survival models and adult recruitment needed to verify a model system's reliability in hindcasting.

S7-13 The 1993 proposed actions are very modest regarding mainstem velocity improvements. The three model systems (BPA, NPPC and T.E.C.H.) produce different projections of these proposed actions, which cannot be fully reconciled at this time. A comparison of the performance of different model systems and their sensitivity to different assumptions is cursory. A more comprehensive understanding of performance of model systems developed by BPA, NPPC and the state and tribal fishery agencies should be forthcoming from the Analytical Methods Coordination and Documentation process. It will be extremely difficult to identify what is causing the differences in the three model systems without going through the rigorous model comparison and sensitivity analysis scheduled for this coordination process. Priorities for modeling in the region should focus on this process, and not on other activities that delay or deter understanding of these analytical methods.

S7-14 Only the BPA analysis suggests rebuilding might occur for any of the chinook runs; the NPPC and T.E.C.H. analyses show the threatened runs not responding significantly to the proposed actions. It is alarming that a number of NPPC and T.E.C.H. simulations show declining trends in escapement or seemingly stable trends at extremely low escapement levels. Given the precarious nature of these depressed stocks and the uncertainties inherent in life-cycle modeling, it is our opinion that the 1993 measures would not constitute a viable recovery plan or be sufficient to initiate recovery within a reasonable timeframe. The T.E.C.H. modeling of 1993 proposed measures indicates spring and summer chinook populations cycling to extremely low escapements following poor water years, and fall chinook likely showing a further decline. This is reason for serious concern that, if another drought cycle occurs soon, the continued existence of these stocks could be threatened.

The following documentation for this analysis is included in the appendices to these comments:

Appendix 1: T.E.C.H. Committee, State and Tribal Fishery Agencies. 1992. An Analytical Assessment of Current Management Actions on Snake River Spring and Summer Chinook. November 19, 1992.

Appendix 2: Schaller, H., C. Petrosky, E. Weber, and T. Cooney. 1992. Snake River Spring/Summer Chinook Life-Cycle Model for Recovery and Rebuilding Plan Evaluation.

(B) Modeling Analysis Presented in the DSEIS Is Based on Speculative Assumptions, Contains Important Flaws, and Reveals Unacceptable Risks to Listed Salmon Populations.

(1) General Comments on Modeling.

S7-15

The DSEIS' analysis of alternatives rests almost exclusively on the results of modeling analysis from the Bonneville Power Administration's CRiSP and SLCM models and the Northwest Power Planning Council's PAM and SPM models. These models, particularly CRiSP and SLCM, rely on questionable assumptions regarding the benefits of proposed salmon recovery actions. There is a high degree of uncertainty inherent in these models' prediction of future trends.

This uncertainty is demonstrated by the extent to which the two models differ. SPM and SLCM produce a materially projections of future escapement trends. For instance, SLCM's baseline projections actually indicate a slightly increasing trend in spring chinook escapement even prior to ESA-related actions.[9] This baseline trend is difficult to reconcile with the declines in actual spring chinook escapement and casts doubt on SLCM other results. In sharp contrast to SLCM, SPM shows as declining baseline trend for spring chinook.[10]

Both models, and particularly SPM, reveal negative results. SPM actually shows a continuing decline in medium and low productivity Snake River spring chinook stocks.[11] SLCM shows a significant risk of continuing decline in summer chinook stocks.[12] These analyses provide no reasonable assurance that the listed salmon stocks will not continue to decline as a result of 1993 operations.

[9] DSEIS at 4-19.

[10] DSEIS at 4-28 and 4-29.

[11] *Id.*

[12] DSEIS at 4-20.

(2) Comments on CRiSP/SLCM and PAM/SPM Model Analysis.

Like all modeling, the results of CRiSP/SLCM analysis depends on the assumptions used. In this case, the benefits to salmon depend on a number of unsupported assumptions regarding the benefits of actions, including predator control, transportation, adult passage improvements, and habitat actions. Several critical assumptions appear to be based on speculation. For example, that fish ladder temperature improvements may increase survival is based on "no data; personal communication with Teri Barila, Corps, Walla Walla District...."[13]

Comments on specific assumptions follow:

S7-16

Transport Benefits: The Columbia Basin Fish and Wildlife Authority, at the request of the National Marine Fisheries Service is conducting an on-going review of transportation policy. The Idaho Department of Fish and Game is participating in an evaluation of transportation research studies as part of this review.

The evaluation has identified a number of potentially serious problems with the studies and past inferences about transportation benefits for spring and summer chinook. Given these problems, much of the analytical treatment and discussion of transportation benefits in the draft SEIS could be in error.

The ratio of return rates to control groups (T/C ratio) appears to decrease, progressing upstream. The reported T/C value of 1.6 at Lower Granite Dam in 1986 does not translate to the spawning grounds. the T/C ratio of coded wire tag recoveries at all hatcheries, traps and stream surveys was only 1.1. Excluding hatchery recoveries, a smaller portion of transported than control fish was recovered (T/C = 0.6%).

In addition the 1986 and 1989 study designs had a number of problems. These include a substantial proportion of unreadable brands and potential differences in stress levels and protection from predators due to different methods of handling the transport and control groups. The 1986 study lacked true controls; the comparison was actually between short haul and long haul transport.

Preliminary results of this evaluation are attached at Appendix 3.

S7-17

Transportation Survival: Many unresolved questions continue to be raised about the transportation data, summaries and conclusions. CRiSP.O treated transport survival as a constant, whereas treating it as an uncertainty for

[13] DSEIS at 4-14.

S7-17 (cont.)

sensitivity analyses and comparisons to adult recruitment trends would have been more appropriate.

Use of a constant transport survival (see Input Parameters CRiSP.O, pages 11-12) will have the effect of minimizing variation in annual smolt survival estimates in the analysis. The result is that the model becomes less sensitive to changes in water velocity or flow because a large proportion of smolts are transported in the simulations. The reported mean spring chinook smolt survival rate was 0.188 (for the 50 year flow record), but the coefficient of variation (C.V.) was only 10% (see Input Parameters SLCM, page 11).

The nearly constant annual smolt survival estimates produced by CRiSP.O does not correspond well with the highly variable adult recruitment observed in recent years (C.V. range, 75% to 119%). The T.E.C.H. Workgroup sensitivity analysis of transport assumptions indicated that adult recruitment trends were most accurately reproduced by the less optimistic assumptions about transport and by estimated inriver survival (without transport).

Apparently the variation not explained by CRiSP.O (with the constant transport survival assumption) was partitioned into an ocean/estuary scalar for SLCM during the calibration. The BPA analysis appears to allocate too little variation to annual smolt survival and too much variation to random processes, based on the T.E.C.H. review of recruitment and variation of a downriver stock in recent years (which is not exposed to the same high levels of hydropower mortality) and of Snake River stocks before full hydropower development. The result likely would be to understate effects of future, potential velocity improvements.

S7-18

Flow-Survival Relationship: CRiSP.O, used in this analysis, describes the relationship between flow and smolt mortality (from the Sims and Ossiander data) with a quadratic equation (see Input Parameters CRiSP.O, page 20). This form of equation predicts maximum survival at about 115 kcfs for the Snake River, at which point survival begins to decrease. In the model this would negate any benefits of flows (or equivalent velocities) greater than this level. There seems to be little biological justification for this form of equation for this data set, other than mortality from chronic gas supersaturation conditions at high flows in the early 1970s. Those conditions do not apply to the situations modeled.

In view of the major improvements made in control of gas supersaturation since the early 1970s, a negative exponential relationship would more accurately describe the current situation, and also better mimic flow-travel time relationships. Both PAM and FLUSH use the exponential

S7-18 (cont.)

function. Absent the gas supersaturation problem, it is logical to assume that smolt survival would be optimized with velocities most similar to those under which the fish evolved. Recent adult recruitment data from Marsh Creek, Idaho and Imnaha River, Oregon (Schaller and Petrosky 1992) also suggest significant survival benefits up to at least 140 kcfs, consistent with the CBFWA (1991) biological justification for mainstem flow.

S7-19

Habitat Improvement: Habitat improvement assumptions were applied to the aggregate run (see Input Parameters SLCM, page 7) in the model. These would more appropriately apply only to specific areas and spawning populations, not the aggregate. For example, screening improvements would improve survival only where there are diversions; in the Salmon River subbasin, this would not be applicable to most areas below the North Fork Salmon River.

S7-20

Predator Control: There is substantial doubt regarding the benefits of predator control. The squawfish program remains experimental. The smolt survival benefits of this program are unknown and may be offset by compensatory responses in other predators or fish species. Moreover, current research suggests that squawfish select for dead, sick or injured fish. The CRiSP/SLCM analysis should include a run showing no benefit from predator control.

S7-21

Law Enforcement: Increased expenditures on law enforcement is assumed to increase adult spring, summer, and fall chinook returns by up to 10 percent (5% each for lower Columbia and Snake Rivers).[14] This estimate -- based on the professional judgment of a BPA employee -- seems excessive. The cumulative spring chinook harvest rate in ocean and in-river fisheries is roughly 10-15 percent. The summer chinook harvest rate is lower still. It is hard to imagine how additional law enforcement could produce increased escapement of this magnitude.

S7-22

Irrigation Screens: Screening irrigation diversions is assumed to increase escapements by 2 to 5 percent based on "limited research" in the Salmon River Basin. This assumption does not seem justified given that there are no irrigation diversions in the Salmon River Basin below North Fork and few if any diversions in the lower Snake River above Lower Granite Pool. Thus, the entire production of the Middle Fork, South Fork and mid- and lower-Salmon tributaries are unaffected by irrigation diversions. Roughly 50 percent of the salmon habitat in the Salmon River Basin lies below the lowest diversion in the basin. Thus, to meet the assumed survival improvement for the entire ESU, there would have to be a very large benefit for fish

[14] DSEIS at 4-15.

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S7-22 (cont.) originating in the Salmon River Basin above North Fork. Moreover, most major diversions have been screened for many years. A benefit of this magnitude does not seem likely.

S7-23 Habitat Improvement: Habitat improvements are assumed to increase spring and summer chinook pre-smolt survival by 2.5 to 10 percent based on "professional judgement" of a BPA employee. Again, the DSEIS reveals no basis for this assumption, which apparently does not account for variations of productivity in existing habitat. Pristine habitat in excellent condition will not improve in productivity. Roughly 50 percent of the salmon habitat in Idaho is located within designated wilderness or roadless areas. Thus, there would have to be tremendous improvement in pre-smolt survival for this assumption to hold true for the entire population in just 6 years.

We cite these instances to point out that several key assumptions have little empirical basis yet can easily skew modeling results.

S7-24 The SPM model results are considerably more pessimistic than SLCM and support a finding that the spring and summer chinook are in jeopardy. SPM indicates low and medium productivity stocks in decline in nearly all cases. Assuming the productivity characterizations are accurate, the trend for medium productivity stocks would best reflect the fate of the overall ESU. It is questionable that the ESU could survive only on the basis of the modest rebuilding shown for high productivity stocks. Decline or loss of medium or low productivity stocks must be regarded as a significant threat to the survival of the overall ESU. In any case, given the uncertainty inherent in predicting future escapement, there is no reasonable assurance that even the high productivity stocks are not in decline.

Specific comments on SPM modeling are contained in comments on Appendix F.

SPECIFIC COMMENTS

S7-25 Page 2-14 Transport: - The statement that barges constantly recirculate river water so that smolts will be able to locate their home stream when they return as adults should also acknowledge that transportation studies have found increased straying and loss of homing capability relative to in-river migrants. See Appendix 3.

S7-26 Page 2-15: The statement that control groups were transported to below Little Goose Dam for release and therefore benefit from transport reveals the so-called controls were in fact transported, and thus faced the rigors of the artificial collection and transportation process. This claimed "benefit" is

S7-26 belied by the fact that adult returns have consistently failed to replace the previous generation in years of low flows and maximum collection. Also, the fact that "controls" were given the same exposure to conditions as the treatment group seriously undermines the integrity of the transport study.

S7-27 The "latest results" cited in Matthews et al., (1992) that transported chinook survive at twice the rate as non-transported should acknowledge the 1989 migration year when the latest experiment occurred was a drought year with below run-off conditions, and that non-transported fish had to migrate through full reservoirs in the mainstem. We also note the migrants of 1989 produced an SAR too low to even replace their parent generation.

The statement that the debate regarding transportation revolves around concerns that transportation is "artificial" misses the point. Actually, the concern centers on the fact that transportation has failed to stem the decline of the Snake River chinook and sockeye runs. In some years, record collection of juveniles led to adult returns that did not even perpetuate the species in the long term.

The statement that transportation studies were conducted in good flow years should be changed. If the authors are referring to 1986 and 1989, these years were average or below average in the Snake River, respectively. Even high flow years fail to approach velocities similar to pre-project conditions. In addition, in 1986 the peak of the chinook migration occurred prior to the high flows and most of the chinook were barged.

S7-28 The barging program was never part of the original project authorization legislation. Rather, the program was an unintended outgrowth of the fact that juveniles were caught in the gatewells and had to be removed. Transportation started with trucking the fish from the top of the dam (after removal from the gatewells) to the tailrace below the dam. Research then commenced with hauling collected fish to below Bonneville Dam, and comparing the results to "controls."[15] See Appendix 3

S7-29 Page 2-17: The final statement in the section on the Water Budget should note the drawdown strategy in the lower Snake River would provide adequate velocities in low water years.

S7-30 Page 4-9: The section "Flow Effects on Juvenile Salmonids" needs to be completely rewritten. First, the initial statement that "quantity of flow has various levels of correlation with travel time and smolt survival" is true only for the period after the lower Snake River was impounded behind the mainstem dams.

[15] This background is explained in a Corps of Engineers information paper on juvenile fish transportation dated December 12, 1992.

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S7-30 (cont.) The SEIS should state that there was no such correlation when the river was in a free-flowing condition. Information comparing Raymond (1979) survival estimates to average flow (cubic feet per second) for the April 15 through June 15 period each year shows no correlation because flow is not the main variable, velocity is. The data covers a wide time period when the mainstem dams were being built. The charts comparing the survival estimates to velocity show a statistically significant relationship.

S7-31 The paragraph cites Giorgi (1991) that the relationship of flow and survival is less clear at higher flows of about 80 to 100 kcfs in the Snake River. Giorgi (1991) failed to take into account the confounding aspect of gas supersaturation, which caused mortalities in the higher flow years. The SEIS should note Petrosky (1991) and the State of Idaho (1992) analyses superior to the others for accounting the countering effects of gas supersaturation. The 1992 OA/EIS put into proper perspective the issue in discussing Ebel et al. (1975):

> However, it appears that in years when river flows were normal to high and corresponding gas saturation levels were high, mortality from gas supersaturation can override other mortality factors and result in substantial losses of juvenile salmonids, ranging from 40 to 95 percent.

S7-32 The draft SEIS is incorrect stating "Sims and Ossiander (1981) found survival of yearling chinook increased with increasing flow, but only up to a point." This is revisionism not based in fact. Actually, that tables and graphs in Sims and Ossiander (1981) concluded survival increases as flow increases, that there was no "up to a point," except for the highest flow and survival values observed. In addition to citing Petrosky (1991), the final SEIS should note that CBFWA (1991) and Sims and Ossiander (1981) suggest significant relationships continue between flow and survival at higher flows.

S7-33 The SEIS must state that the Sims and Ossiander (1981) study is not the only study of the relationship between river flow/velocity and smolt survival. A NMFS study conducted by Raymond (1979) relies on a variation of the NMFS data set, containing specific survival estimates in the Lower Snake River. The Raymond (1979) data have certain advantages that deserve mention. First, the data are based on survival rates for chinook smolts in a combination of free-flowing river and reservoir conditions that changed as the additional mainstem dame came on line. The Raymond (1979) data provides useful information on smolt migration under both conditions. Second, the Raymond (1979) data includes years of high velocity with low nitrogen gas supersaturation levels. All of the Sims & Ossiander (1981) data for high flow years reflects the effect of high nitrogen gas supersaturation levels. Third, the Raymond (1979) data is for the Snake River only, whereas the Sims & Ossiander (1981) data set involved smolt migration through portions of the Columbia

S7-33 (cont.) River as well as the Snake River. Petrosky (1991b) reviewed Raymond's work (1979) concerning survival estimates and relationship to velocity conditions. Additional information is found in IDFG (1991) and Idaho (1992). Further, both PAM and FLUSH incorporate the exponential function.

S7-34 Page 4-11: There is an apparent contradiction in the first paragraph, which states on the one hand that reduced pool area would increase the density of predators and on the other hand that stable pool levels favor increased resident fish numbers. The analysis should acknowledge that drawdowns from normal operating pool would likely reduce predator densities by affecting northern squawfish and other predator recruitment.

S7-35 Page 4-15: The spill efficiency assumption used in CRiSP appears to be downgraded in the model despite empirical data to the contrary. Please refer to the comments on Appendix E, the documentation of CRiSP.

S7-36 Page 4-16: The DSEIS continues to rely on documents by Giorgi and Kindley despite comments on the O/A EIS indicating that these papers are flawed and should not be relied upon. The Fish Passage Center provided extensive comments showing that these papers are erroneous. Thus, the DSEIS fails to incorporate and consider the comments received on last year's EIS.

S7-37 Page 4-16: We object to the statement in the paragraph discussing fish transportation that "many of the fish that are transported are in poor condition and are unlikely to survive whether transported or passed in-river." This diverts attention from the poor conditions in the mainstem reservoirs and the mortalities induced from mechanical bypass, turbines, and spill which are well documented as major sources of mortality. In addition, the fish that are supposedly "unlikely to survive" have an uncanny ability to survive under high runoff conditions like occurred in 1982 and 1984 and return as adults. (Petrosky 1991). Finally the statement demonstrates a self-defeating and ahistorical agency thought process. The challenge is to change migration conditions so that the fish are likely to survive.

S7-38 Page 4-70: The discussion on nonfirm energy should include a review of the 1991-1992 operational strategy to store additional water in the Columbia River reservoirs for additional flows in the spring of 1992. Was the projected impact on BPA revenues realized? What sources of replacement energy were available in the winter months to allow water storage? What did BPA pay for this power? What was the price received for the additional energy generated in the spring during the augmentation period? Please answer these questions in the final SEIS.

S7-39 7-4 7.12 The discussion of the Northwest Power Act should mention that the Act directed the Northwest Power Planning Council's plan to restore the anadromous fish runs in the Columbia River Basin and called on the Council to incorporate

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S7-39 (cont.) flows of necessary quality and quantity at and between the federal hydroelectric projects. It did not provide for barging fish has a means to improve survival.

S7-40 Page 11-1: The final SEIS should incorporate the documents cited in the References section of these comments.

APPENDIX A

S7-41 A-4 The discussion on redd count declines should be updated to include the 1991 and 1992 counts.

S7-42 A-8 The information on lower river coho and summer steelhead conveys a misleading portrayal of Snake River run status for these two species. Snake River coho are, in fact, extinct. The last coho was observed at Lower Granite Dam in (1986). Table A-1 indicates appropriately a 0 average escapement for the 1986 - 1991 period.

S7-43 Snake River wild summer steelhead are depressed below interim management goals of the Columbia River Fish Management Plan (Plan). Counts of wild steelhead at Lower Granite Dam have been below the interim management goal of the Plan since 1985. The interim goal at Lower Granite is for 20,000 wild A-run steelhead and 10,000 wild B-run steelhead. Counts of wild steelhead have declined from 88 percent of the goal for the 1985-1988 period to 26 and 37 percent in 1990-91 and 1991-92, respectively. The status review for the Plan in 1991 concluded that the status of wild/natural upriver steelhead is a significant concern. Also, the text is in error in attributing escapement objectives to the Columbia Basin Fish and Wildlife Authority. That body does not operate in a management forum requiring a fishery management plan.

S7-44 A-11 The discussion on sport harvest should note Idaho sport harvest on naturally spawning chinook has not occurred since 1978. The discussion should also note that wild steelhead in Idaho are protected by catch and release and barbless hook regulation.

S7-45 A-14 The table should note the available habitat in the Clearwater drainage is an expansion of habitat from the removal of dams in 1964 and 1973. These are fairly recent events. The increase production from the Clearwater and harvest rate reductions had the effect of masking the tremendous increase in migration mortality resulting from the mainstem dams.

S7-46 A-15 The list of key negative factors attributed to loss of juvenile fish should also include increasing stress levels. Fish physiologists and biologists are clear that stress reduces the ability of fish to adapt to seawater, their resistance to disease and their swimming stamina (Barton 1987). High levels of stress result in direct mortality (Love 1970). Stress is induced by unnatural migration conditions and accumulates as smolts move

S7-46 (cont.) through the system (Matthews et al. 1986). Death of fish may be delayed and remain unapparent for a time after stress is induced (Bouck and Ball 1966).

S7-47 The statement citing "Escapement of only 11 fish to Redfish lake was reported in 1961 (Hall-Griswold 1990)" is misleading to the reader by ignoring the following years when escapement through the rest of the 1960s was several hundred. The year-class that returned in 1961 apparently spawned a succeeding generation that returned several hundred adults. Thus, the population was more abundant in the 1960s than the 1961 count taken alone would indicate.

S7-48 Page A-16, Para. 3. The SEIS cites the CBFWA for attributing "poor condition and improper timing of arrival at the estuary, which is dependent on the level of smoltification." In fact the CBFWA 1991b citation states "Since smolt migration is mostly passive their migration rate is controlled primarily by river water velocity." "Flow not only determines the time required by smolts to reach the ocean, but it ensures that smolts are at the appropriate location and time in an acceptable condition." These quotes are contrary to the SEIS citation.

S7-49 A-16 The statement "The effects of reduced water travel time of fish survival during higher flows is less clear (Giorgi, 1991; Kindley, 1991)," ignores all the other mainstem studies that conclude a significant relationship at higher velocities, and also overlooks the fact that both Giorgi, (1991) and Kindley, (1991) failed to address other intervening factors like gas supersaturation. Please refer to our comments regarding the draft DEIS at 4-7.

S7-50 Project Improvements. The juvenile bypass and transport facility discussion is flawed and should be rewritten. The discussion "suggests" that additional mortality of transported smolts occurs after they are released from the barge, but then attempts to disregard this because no true measurement of post-transport mortality has been possible. Transport benefit experiments and results are discounted. The reason given is that transported fish would have died prior to returning as adults independent of whether they successfully passed all dams or were transported. This apparently implies that non-transported fish are somehow different from transported fish. They would not have died when exposed to the same causes of mortality to transported fish. Either the non-transported fish are better suited for survival and avoid collection or they are better suited for survival and avoid the mortality factors that effect transported fish after their collection and transport. Neither condition makes sense. While the transport fish survival discount of 45 to 50 percent is applied to compensate for transport mortality, this discount is not high enough to account for the reported TBR's of 1.6 to 2.0.

If transport is effective at reducing adverse effects of the projects on anadromous fish, transporting over 85 percent of all

IDAHO DEPARTMENT OF FISH AND GAME
(JERRY M. CONLEY, DIRECTOR)

S7-50 (cont.) Snake River salmon in median flow years should at least prevent declining populations. This is, of course, not the case. An explanation is available from the recently reported rates of smolt-to-adult survival for transported and nontransported spring chinook and steelhead in NMFS research 1986 and 1989. Mathews (1992) reported approximate transport benefit ratios of 2 to 1 for both spring chinook and steelhead each year. However, smolt-to-adult survival rates for the two species were much different. Spring chinook survival was 0.06 and 0.16 percent for 1986 and 1989 respectively. Steelhead survival rates were much higher, 0.54 and 1.10, respectively. Transport provides the same benefit to each species, but the transport benefit did not compensate for low spring chinook survival. To be effective for spring chinook, transport benefit would have had to have been increased 4 to 16 times. This improvement is virtually unattainable considering the extensive effort already extended by all involved to make collection and transportation the best possible.

S7-51 Overall Habitat Degradation. Prior to 1978, Snake River spring chinook provided fishable supplies of salmon to Idaho and other fisheries. Habitat degradation in spawning, rearing and over-wintering streams has gotten no worse in that time and in general habitat conditions have improved. The SEIS cites reduced production potential because of habitat reduction in Idaho salmon streams of about 20 percent (IDFG Subbasin Planning Reports, Rich et al. 1992). However, Rich et al. also concluded that 90 percent of the current chinook carrying capacity is unoccupied. It should be noted that since Idaho salmon streams are so far below carrying capacity regardless of the quality of habitat in each, smolt capacity is not limiting production of adult runsizes. Smolt production is limited to 10 percent of its potential because too few adults return to utilize the production habitat available. Marsh Creek is an example of good habitat in Idaho (Table A-3). Despite good habitat conditions for spawning, rearing and over wintering, Marsh Creek spring chinook are in decline along with other wild populations in even better and worse habitat.

Improvement of spawning and rearing habitat will not benefit threatened populations in pristine habitat. Any benefit of habitat improvement of that nature will not help the entire listed ESU but only small components in degraded habitat.

S7-52 A-19 The discussion on fish transportation contains the same errors and problems we commented on at 2-14, 2-15, and 4-16. We must again object to the statement "many of the fish transported from the upstream area would not have been viable fish whether they had been transported or had traveled downstream to the ocean without transport."

S7-53 A-23 The first paragraph under "Overall Habitat Degradation" fairly discusses the problems in assessing impacts to Snake River salmon in tributaries with varying degrees of degradation. Redd counts indicate no significant difference in decline rates

S7-53 (cont.) between stream with degradation and streams that are not degraded.

Mention of food limitations during downstream migration as a result of habitat degradation is highly speculative and not supported as a contributor to smolt mortality in any scientific study. The fact that higher survival rates are experienced in higher flow years appears to suggest that factors other than food limitations are the problem. (Petrosky 1991, Idaho 1992 *citing* Raymond 1988 SARs).

S7-54 A-25 Figure A-5 is of little value because it reflects grazing intensity in Idaho, not in the areas of Idaho inhabited by anadromous fish. Any assessments of the effects of grazing should be specific to watersheds inhabited by salmon and steelhead.

S7-55 A-27 Despite the decades of irrigation and unscreened diversions described in this section, adult runsizes in Idaho and Northeast Oregon supported fishable populations until recently. It was only after completion of the federal hydroelectric system in 1975 that viable runs were eliminated. This occurred despite reductions of mortality by screening irrigation diversions since the 1950's and reductions in harvest. Hydroelectric system mortality negated the benefits of Idaho's 236 screened diversions.

In addition, populations of salmon in the Middle Fork Salmon River, South Fork Salmon River and mainstem Salmon River tributaries, without significant irrigation diversions, have also been reduced to threatened status. Without improved survival of migrating smolts through the hydroelectric system, benefits of irrigation and other habitat projects will not be realized. Irrigation improvement will not recover populations not impacted by irrigation. Many of these are unique genetic components of the listed spring and summer chinook ESU.

S7-56 A-28 The discussion of irrigation in the Snake River Basin provides three misleading impressions. First, the analysis should characterize impacts on the lower Snake River in terms of water particle travel time, not flow. An analysis by the Idaho Department of Fish and Game indicates that flows of roughly 670,000 cfs through the current hydrosystem would be necessary to equal the velocity of the pre-impoundment Snake River at 85,000 cfs. The point is that upstream depletion has had a minimal impact on river velocity relative to the effect of the mainstem impoundments. Second, focusing on the volume of irrigation diversions ignores the fact that more than half of the water diverted in Idaho returns to the hydrologic system as return flow. Third, there is very little irrigated agriculture in the anadromous zone of Central Idaho, which is characterized by steep mountainous terrain and narrow valleys. Most irrigated agriculture occurs in the Snake River plain, well away from anadromous fish spawning and rearing habitat.

IDAHO DEPARTMENT OF FISH AND GAME
(JERRY M. CONLEY, DIRECTOR)

S7-57 The histogram illustrating acres in farmland is not clear as to whether this includes dryland farms, farms irrigated from groundwater wells as well as farms irrigated with natural flow and storage water rights. More accurate information is available than presented here by the NPPC.

S7-58 A-29 The discussion on water diverted and consumed in the Snake River Basin fails to point out that all the major irrigation storage dams in the upper Snake River Basin were constructed prior to the advent of the dams in the lower Snake River. Before the lower Snake River dams were built, flow depletion had an infinitesimal effect on velocities in the lower Snake River.

S7-59 A-32 The discussion on the one known diversion in the upper Salmon River known to block upstream migration should be identified. The statement is based on Anderson et al. (1987) which may be dated, especially if the statement is referring to the diversion at Busterback Ranch. This diversion problem was resolved in early 1992.

S7-60 A-33 Parr production in monitoring stations of the South Fork Salmon River is at only 22 percent of the existing habitat for that stream. Even though habitat has been degraded in that system, more smolts could be produced there then is currently occurring. Low adult escapement to the spawning areas of the South Fork preclude full juvenile seeding of existing habitat. Migration habitat and resultant poor smolt to adult survival is limiting adult runsize.

The SEIS citation and information for Thurow (1987) is wrong. This work and the production potential numbers listed are for summer steelhead not summer chinook.

S7-61 A-34 Again, the figure showing logging production in the Snake River Basin is not specific to anadromous fish habitat. Any discussion of the effects of logging must refer to areas that are actually used for salmon spawning and rearing. In fact, there is relatively little logging occurring in the arid Salmon River drainage, the primary spawning and rearing area for listed spring and summer chinook. There is virtually no logging in areas adjacent to Snake River fall chinook habitat.

S7-62 A-35 Parr production in Bear Valley Creek is at 3.4 percent of its current habitat production potential. Even though degraded by historic mining, it is far short of its existing carrying capacity for smolts. Once again adult escapement is inadequate to seed the habitat available.

S7-63 A-36 The reference to Blackbird Mine should note the state of Idaho has been in litigation with the owners of the Mine to force clean-up and restore the spawning and rearing capability of the streams. This litigation was initiated in 1983.

S7-64 A-37 The discussion of barging hatchery and wild smolts together as a factor in disease transmission leaves out the fact that in-river migration may reduce disease transmission. Flow conditions in the early to mid 1980s led to years with less transported fish since more fish were spilled and bypassed than in low flow years when collection and transportation is maximized. Coincidentally, the years of high flows, spill and bypass were followed by higher return rates for both hatchery and wild fish (Petrosky, 1991; Raymond 1988). The years of low flow and barging were followed by near collapse of both hatchery and wild fish populations.

S7-65 A-41 The speculation on the various causes of mortality attributed upstream of lower Granite Dam should be accompanied by any scientific research to yield whether there are any statistically significant relationships. Secondly, many of the posited causes of mortality are natural factors and as such fall outside the control of man. Without the ability to significantly influence predation in natural rivers, food sources in natural rivers, water temperature, turbidity, photoperiod, and smoltification, the management options available appear to be limited to influencing the water velocity conditions in the reservoirs of the mainstem dams.

S7-66 A-43, General observations on new actions to improve endangered runs: The candid admission by the DSEIS that proposed operations for 1992 only increase total downstream survival by 1-3 percent is startling. It is apparent that those proposed actions are insufficient to improve survival of listed fish and halt the decline threatening them. The DSEIS logic that other changes can achieve similar increase in smolt survival is not a solution since excessive mortality will still exist and the runs will remain in decline or at low level in jeopardy of extinction. Major change is needed in mainstem operations if benefits of other actions will result in more adults back. Continued excessively high mortality of increased smolt production during and because of stressful and unnatural migration conditions will not result in recovered runs.

S7-67 A-44 Idaho views supplementation as an experimental approach to assisting recovery of threatened species. It offers potential benefit to limited numbers of threatened populations not the entire ESU. Benefits can only occur if the smolt survival bottleneck in the mainstem migration corridor is removed. Satellite collection and acclimation facilities are just another form of hatchery production and release. Supplementation research is underway in the Snake and Columbia Basins which should provide answers for proper supplementation once improved migration survival is assured and provided to the supplementation product.

S7-68 BKD management is an important aspect of hatchery operations. However, expecting to eliminate this disease is not

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(JERRY M. CONLEY, DIRECTOR)

S7-68 (cont.) realistic. This pathogen is a background disease in the environment. Like most diseases the symptoms appear after stress inducement. Continued operation of the mainstem hydroelectric system in a stressful manner to migrating fish, particularly to spring and summer chinook, will continue to induce the symptoms of BKD. Hatchery managers can reduce the level of the bacteria responsible, but a stressful migration event will still induce outbreak of the pathogen and disease symptoms. The migration corridor must be managed differently if BKD management efforts at the hatcheries will produce benefits.

S7-69 A-49 The SEIS overstates the effectiveness of transportation. A major part of the controversy is whether transportation has increased the survival of transported fish over those not transported. Empirical evidence proves that collection and transportation has not halted the decline of the threatened species or kept Snake River coho from going extinct.

The section on fish transport states in part that barging "has been proven to increase survival of fish over those not transported under the current operations." This statement masks several facts: 1) the years of study 1986 and 1989, were years of average or below average runoff respectively. Therefore, the comparison to in-river migrants, which experience poor survival at low flows, is likely to be more favorable to transportation. In addition, in 1986 the peak of the chinook migration occurred prior to the high flows and most of the chinook were barged; 2) barging fish over the past seventeen years has failed to stem the decline of the Snake River chinook and sockeye runs, as evidenced by record collection of juveniles leading to adult returns inadequate to perpetuate the species in the long term. Therefore, the statement in the draft SEIS should be rewritten to state that lack of acceptability of the program is based on its failure; 3) transportation studies suggest increased straying and loss of homing capability relative to in-river migrants. *See* Appendix 3.

The "most recent information indicates that significant benefits occur for spring chinook stocks in the Snake River" cites Matthews et al., (1992) which found that transported chinook survive at twice the rate as non-transported chinook in a migration year that was a drought year with below run-off conditions, and that non-transported fish had to migrate through full reservoirs in the mainstem. The "significant benefits" should be put into perspective. In 1989, the latest year of transport/control studies, collection and barging of smolts was maximized due to low flows. Adult returns from the 1989 migration indicate a spawner/recruitment ratio of roughly .5:1, meaning that this year class in question was reduced by half from its parent generation. At this rate towards extinction, one may question just what these "significant benefits" are.

S7-70 A-50 The COE SEIS should be up front with their burden that the major and most significant factor influencing the continued

S7-70 (cont.) decline and recovery of Snake River salmon stocks is the mainstem hydroelectric system (SEIS sections 3.0, 3.5. Changes in how the system is operated and configured is where the major benefits to the stocks can be developed.

The last paragraph of the section should be rewritten. Recent reductions in wild stocks of spring, summer and fall chinook and sockeye salmon are indeed a dangerous sign of problems. Available information indicates that this trend could continue if actions are not taken soon. To have the greatest chance of preserving and recovering these stocks, changes to hydroelectric system operations must be made as a prerequisite for success of other actions. Broad based actions are essential if these stocks are to recover and provide the greatest benefits possible to the nation, region and nation. These actions must include hydroelectric system modification, habitat changes, hatchery modifications and harvest changes. If significant actions are taken that improve migration conditions and survival of smolts to adulthood, available information suggests that those species will be preserved and rebuilt.

APPENDIX B

S7-71 B-1 We will comment on the drawdown test in a separate document in response to the report recently issues by the Corps of Engineers. We are, however, concerned about apparent bias on the part of the Corps in their portrayal of the March drawdown. We have also uncovered differences between the actual test findings and implications and public statements and press releases from the Corps of Engineers.

APPENDIX E

S7-72 E-3 Documentation of the CRiSP model on spill efficiency indicates a rather conservative parameter considering the research results. Other studies not cited corroborate a better than one to one proportion of water to fish spilled. Yet this model assumption seems to downplay spill efficiency in favor of running more water through the power houses and exposing a higher proportion of the run to turbine and bypass mortality.

APPENDIX F -- PAM AND SPM

S7-73 Transportation Survival: The NPPC analysis used two transport models. Model 1 assumes that survival of fish after release is constant, Model 2 assumes that transport survival (post-release) decreases at lower flows.

The statement in Section 4 (Environmental Effects of Alternatives, p. 4-25) that "(f)urther analysis by NPPC has determined that transportation Model 1 reflects a more realistic representation of transportation survival" is not supportable. The two alternative values of TBR calculated by PAM for 1989

S7-73 (cont.) (Appendix F, p. 16) both fall well within the confidence intervals of the estimate. As noted above, both the 1986 and 1989 transport studies are under review by CBFWA at the request of NMFS.

Transport survival assumptions should be tested in the context of estimated smolt survival and empirical adult recruitment data. As noted above, the T.E.C.H. Workgroup sensitivity analysis about transport assumptions indicated that adult recruitment trends were most accurately reproduced by the less optimistic assumptions about transport and by the estimated inriver survival. In particular, the NPPC Model 1 assumption used in the FLUSH model produced smolt survival estimates that deviated widely from the recent adult recruitment.

S7-74 Prespawning Survival: Some clarification is needed on the citation for the Petrosky (1992) prespawning survival "estimate" of 90%. The actual rate is unknown and difficult to quantify, as stated in a March 31, 1992 memo to Anderson and McConnaha. The memo further stated that there was not much evidence to support the Chapman *et al.* (1991) estimate of 40-50% prespawning loss as typical for Snake River wild spring and summer chinook. One reason is that an average 51% of the Lower Granite run can be accounted for in rack returns and harvest of Rapid River fish. If prespawning mortality was 50%, there would be no other spawners "at large" in areas not indexed. Second, tributary redd counts account for most of the females counted crossing weirs, in the few streams where appropriate comparisons can be made. Further, field observations and the proportions of unspawned carcasses do not support an assumption of high mortality in the spawning tributaries.

The NPPC assumption of 80% prespawning survival seems reasonable, and is identical to the TAC assumption for hatchery fish used to generate estimates of the wild run size at Lower Granite. The run reconstructions in the T.E.C.H. analysis used a 90% prespawning survival assumption.

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December 4, 1992

Lt. Col. Robert Volz
Department of the Army
Walla Walla District
Corps of Engineers
Building 602
City-County Airport
Walla Walla, WA 99362-6619

Lt. Col. Volz:

S8-1 The recent Supplemental Environmental Impact Statement on Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon includes only a very cursory review of impacts upon recreation. We believe that more work needs to be done in order to portray the full impact the proposed measures could have on economic and social values derived from recreational opportunities.

The Statement estimates that visitation will drop only an additional 3% under option 4,(Page 4-80). This estimate does not measure up against the impact we witnessed at Dworshak State Park last summer. During the month of August, when reservoir levels were lowest, visitation was down more than 50% from the previous year. If these minimum levels occur earlier in the recreation season, during the peak month of July as called for under option 4, then it is likely that the overall decline for the season will be greater than just 3%.

S8-2 We are concerned that there is no discussion in this report about the relationship between the proposed actions and enabling legislation for those federal projects which list recreation as a project purpose. Major drawdowns, as described in this DEIS, raise the legitimate question as to whether the responsibility to provide recreation is being met. This is a critical issue at this point, and it needs to be discussed.

S8-3 The statements on pages 4-90/92 describe the potential displaced value of recreation under option 4 to be about $5000 based on a general recreation value of $2 to $6 per day. This needs more explanation. Our revenue at Dworshak State Park declined by $20,000 during 1992, primarily due to low water levels. Recreational user fees represent only a fraction of the total economic benefit of recreation, and the daily impact on the local economy during the peak months would easily surpass the $5000 that the statement describes as a seasonal impact.

We would appreciate a response to these questions.

Sincerely,

Yvonne S. Ferrell
Director

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WASHINGTON STATE DEPARTMENT OF TRANSPORTATION
(DONALD S. SENN, DISTRICT ADMINISTRATOR)

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December 7, 1992

Department of the Army
Walla Walla District
Building 602, City County Airport
Walla Walla, WA 99362-2965

ATTENTION MR. PETER POOLMAN, SEIS MANAGER

RE: Interim Columbia and Snake River Flow Improvement Measures for Salmon Draft Supplemental Environmental Impact Statement

Dear Mr. Poolman,

S9-1 Thank you for the opportunity to review the Draft SEIS. Our Agency has determined that the draw down action described on pages B-20, B-21, and C-4 in the Draft SEIS could be detrimental to the State Routes that closely parallel pools adjacent to the Columbia River in District 2. State Routes 2, 28, 97, 97A, 150, 243, and 971 in Adams, Chelan, Douglas, Ferry, Grant, and Okanogan Counties will be affected.

The draw downs could induce erosion of the lower portions of existing fills and allow banks to slump. When low water levels are combined with high wind actions, the erosion potential will be dramatically increased. We are already experiencing similar problems along Lake Chelan with State Routes SR-97 Alternate, SR-150 and SR-971 due to current water levels. A complete evaluation of existing bank and or fill stability will need to be performed to determine if preventative action such as armoring is required.

Please feel free to contact our office phone number (509) 662-0504 if you have any questions or need additional information.

Sincerely,

Donald S. Senn
District Administrator

David B. House

BY: DAVID B. HOUSE, P.E.
Project Development Engineer

DSS:DAH
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STATE OF WYOMING, OFFICE OF THE GOVERNOR
(MIKE SULLIVAN, GOVERNOR)

STATE OF WYOMING
OFFICE OF THE GOVERNOR
CHEYENNE 82002

MIKE SULLIVAN
GOVERNOR

December 7, 1992

Lieutenant Colonel Robert D. Volz
District Engineer
U.S. Army Corps of Engineers
Walla Walla District
Walla Walla, WA 99362-9265

Dear Lieutenant Colonel Volz:

Agencies of the State of Wyoming have reviewed the Draft Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon, Supplemental EIS. Enclosed for your review and use are comments resulting from that review.

Please keep my office informed about this effort, particularly with respect to any affects that may occur in Wyoming resulting from flow modifications on the subject rivers. The State of Wyoming appreciates this opportunity to provide input.

With best regards, I am

Very truly yours,

Mike Sullivan

MS/rms

Enclosures

THE STATE OF WYOMING

MIKE SULLIVAN
GOVERNOR

Public Service Commission

700 W. 21ST STREET (307) 777-7427 FAX (307) 777-5700 CHEYENNE, WYOMING 82002

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ADMINISTRATOR

MEMORANDUM

TO: ROD MILLER
FEDERAL LANDS COORDINATOR
STATE PLANNING COORDINATOR'S OFFICE

FROM: JON F. JACQUOT
CHIEF ENGINEER
PUBLIC SERVICE COMMISSION

DATE: DECEMBER 4, 1992

RE: INTERIM COLUMBIA AND SNAKE RIVERS FLOW IMPROVEMENT MEASURES FOR SALMON - DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

S10-1 The Commission is concerned that the proposed measures and the related Environmental Impact Statement have far reaching negative implications for utility rate payers. The process can cause utilities to incur greater costs than would otherwise be prudent or necessary. The Commission requests that the Corps of Engineers, Bonneville Power Administration, National Marine Fisheries Service, and Bureau of Reclamation take steps to insure that their actions do not adversely affect the availability of power or adversely impact the utility rate payers of Wyoming and the Pacific Northwest.

S10-2 It appears to the Commission that the entire cost of rectifying the salmon problem has been unfairly placed on the electrical utility customers of the region who are partial beneficiaries of generation of hydroelectric power. Those who benefit from the enhancement of the salmon fisheries and the irrigation control have not been asked to share in the cost. This is unfairly discriminatory against utility ratepayers of Wyoming and the Pacific Northwest. It also damages the regional economy through lower power availability and higher power cost.

If you should have any questions regarding this matter, please let me know.

/ab

STATE OF WYOMING, OFFICE OF THE GOVERNOR

(MIKE SULLIVAN, GOVERNOR)

WYOMING
GAME AND FISH DEPARTMENT

Mike Sullivan, Governor — Terry Cook, Director

OCT 28 15:12

October 28, 1992

EIS 6478
U.S. Army Corps of Engineers
Walla Walla District
Draft Supplemental Environmental
Impact Statement
Interim Columbia and Snake
Rivers Flow Improvement Measures
for Salmon
SIN: 91-120
Teton and Lincoln Counties

ROD MILLER
STATE PLANNING COORDINATOR'S OFFICE
HERSCHLER BUILDING, 4TH FLOOR EAST
CHEYENNE, WY 82002

Dear Mr. Miller:

S10-3 The staff of the Wyoming Game and Fish Department has reviewed the draft supplemental environmental impact statement for Interm Columbia and Snake Rivers Flow Improvement Measures for Salmon. Our review of this document indicates that none of the five alternatives would affect any waters within the state of Wyoming. We subsequently perceive no potential negative impacts to fisheries and have no objections to the document.

Thank you for the opportunity to comment.

Sincerely,

JOE WHITE
DEPUTY DIRECTOR

JW:TC:as
cc: Fish Division
USFWS

Headquarters: 5400 Bishop Boulevard, Cheyenne, WY 82006-0001
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THE STATE OF WYOMING

DEC 9 1992

MIKE SULLIVAN
GOVERNOR

GORDON W. FASSETT
STATE ENGINEER

State Engineer's Office

HERSCHLER BUILDING, 4-E
(307) 777-7354

CHEYENNE, WYOMING 82002-0370
FAX (307) 777-5451

December 3, 1992

Mr. Rod Miller
State Planning Coordinator's Office
Herschler Building, 4E
Cheyenne, WY 82002

Re: Interim Columbia and Snake Rivers Flow Improvement for Salmon SPC ID#91-120

Dear Rod:

The above referenced draft supplemental EIS analyzes the impacts of operational changes made on the lower Snake River and Columbia River system for increasing flows during critical times for salmon migration. While there is no direct impact on Wyoming from these flow changes, this issue needs to be carefully followed by the State due to possible operational impacts in the upper Snake River system.

S10-4 I am enclosing a copy of a letter written November 12, 1991 describing the potential impacts to Wyoming due to Snake River operational changes. Most of the concerns raised in that letter are still valid. Wyoming can participate in the Snake River Water Bank by virtue of its contract for Palisades Reservoir storage space. The Bureau of Reclamation and the Committee of Nine in Idaho are under a great deal of pressure to make as much water as possible available from the Water Bank for supplementing salmon flows.

Wyoming should continue to stay abreast of the proposed operational changes in the Columbia River system. If you have any questions concerning Wyoming's contract for Snake River storage, or any other questions, don't hesitate to contact me.

Sincerely,

Sue

Sue Lowry
Interstate Streams Engineer

Encl.
cc: Jeff Fassett
Joe White

STATE OF WYOMING, OFFICE OF THE GOVERNOR
(MIKE SULLIVAN, GOVERNOR)

THE STATE OF WYOMING

MIKE SULLIVAN
GOVERNOR

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STATE ENGINEER

State Engineer's Office

HERSCHLER BUILDING, 4-E
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CHEYENNE, WYOMING 82002-0370
FAX (307) 777-5451

November 12, 1991

Mr. Rod Miller
State Planning Coordinator's Office
Herschler Building, 4E
Cheyenne, WY 82002

RE: Columbia River Flows EIS
SPC ID# 91-120

Dear Rod:

I have reviewed the draft Environmental Impact Statement (EIS) regarding Columbia River Salmon Flow Measures. While the upper Snake River system, including the headwaters in Wyoming, doesn't make a significant contribution to the overall flows of the Columbia, the management of the upper Snake storage facilities is mentioned in the EIS. As Wyoming has now become a space holder in Palisades Reservoir, we could potentially be impacted should the upper Snake Rivers storage systems be managed differently to accommodate increased downstream flows for salmon migration.

The EIS considers several alternatives. The increased contributions being considered from the upper Snake River vary from 100,000 acre feet to 300,000 acre feet above Brownlee Reservoir, which is located in Idaho above Hell's Canyon on the Idaho-Oregon state line. An option being considered includes the purchase of excess water from the irrigation districts who store water in the upper Snake River facilities. Wyoming's contract for storage in Palisades Reservoir does allow for Wyoming to market its excess water through the Idaho Water Bank. This same Water Bank could be approached for making water sales for use in supplying increased salmon flows. On page 5-5 of the EIS, they state that due to the complexities of the water rights and other water issues involved with completing a purchase from the water banks, no purchases would be pursued for the 1992 season. However, this issue will likely not be easily solved and the use of water bank purchases may materialize in the future beyond 1992.

This draft EIS is only reviewing potential changes for the 1992 operating year. Wyoming needs to remain involved as future planning documents are completed for more permanent solutions to the problems surrounding the declining salmon populations. However, as no sales from the Water Bank will be pursued next year, I see no immediate impacts to Wyoming in this EIS.

If you have any further questions regarding the issues covered by this EIS or other Columbia Basin issues, don't hesitate to contact me.

Sincerely,

Sue Lowry

Sue Lowry
Interstate Streams Engineer

cc: Jeff Fassett
Joe White

WASHINGTON STATE DEPARTMENT OF ECOLOGY (INCLUDING WDW AND WDF)

(T.L. ELWELL)

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
Mail Stop PV-11 • Olympia, Washington 98504-8711 • (206) 459-6000

December 10, 1992

District Engineer
Department of the Army
Walla Walla District, Corps of Engineers
ATTN: CENPW-PL-ER
Walla Walla, Washington 99362-9265

Dear Colonel Volz:

On behalf of the State of Washington, we have coordinated the State's review of your Supplemental Environmental Impact Statement - Interim Columbia and Snake River Flow Improvement Measures for Salmon. Attached are comment letters from the State's departments of Fisheries and Wildlife. As you know, Washington State is vitally interested in the Columbia/Snake River salmonid issue and participates in many different venues. Thank you for the opportunity to formally comment on this particular aspect.

Sincerely:

T.L. Elwell,
Environmental Review and
Sediment Management

Enclosures

cc: Washington Department of Fisheries
Washington Department of Wildlife

CURT SMITH
Director

STATE OF WASHINGTON
DEPARTMENT OF WILDLIFE
600 Capitol Way North • Olympia, Washington 98501-1091 • (206) 753-5700

December 7, 1992

Mr. Peter Poolman, EEIS Manager
Department of the Army
Walla Walla District, Corps of Engineers
Walla Walla WA 99362-2265

Dear Mr. Poolman:

The Washington Department of Wildlife has reviewed the October 1992 "Interim Columbia and Snake River Flow Improvement Measures for Salmon Draft Supplemental Environmental Impact Statement (SEIS)" and would like to make the following comments on this document.

S11-1 In general, we believe the document did not present a broad enough range of alternatives for consideration. The "No Action Alternative" is a reversion to system operations as they were during the "base" period of 1984-1990. The other four alternatives are merely variations on 1992 operations with few, if any, real differences. We appreciate the difficulty of instituting major changes in a system as complex as the Federal Columbia River power system, but such changes must at least be considered as alternatives in the NEPA process.

S11-2 We also are concerned over the implication that this document will serve to guide actions beyond 1993 "until the plan of action can be modified as a result of long-term studies currently underway". This document should be limited to 1993 operations only.

Our comments by section:

2.0 DESCRIPTION OF EXISTING ENVIRONMENT

2.2.4 Activities Related to Fish

S11-3 Juvenile Bypass Program: Although the ice and trash sluiceways have served as one means of bypassing fish at Ice Harbor and The Dalles dams, spill is also an important means of juvenile salmonid passage.

S11-4 Transport: There is no agreement on the actual use of transportation at Lower Monumental Dam. It should be explained that the returns of adults in the existing transportation experiments have been measured at Little Goose Dam and not at the point of origin of the juveniles (hatchery or natal stream). Also, we question the use of the term "meaningless" to describe the results of transportation tests *where* there were either poor returns for tranport and control groups or no returns of either. This *shows* that there are a *number* of variables outside of transportation acting on the survival of Snake River salmonids.

WASHINGTON STATE DEPARTMENT OF ECOLOGY (INCLUDING WDW AND WDF)

(T.L. ELWELL)

S11-5 Adult Passage: There is no discussion of the incidence or significance of adult fallback at the various projects.

2.2.6 River Management Actions in 1992

S11-6 Flow Augmentation and Temperature Control: It should be explained that the flow augmentation releases from Brownlee in July and the temperature control releases from Dworshak and Brownlee in July and September were not passed through when they reached the Columbia, but were stored by Bonneville Power Administration on the premise that flow augmentation for Snake River stocks was limited to the Snake itself and did not have to be passed through once those stocks had reached the Columbia. This is also viewed as a defect in the modeling, as will be covered below.

2.5.3 Candidate and Sensitive Species

S11-7 Bull Trout: The U.S. Fish and Wildlife Service (Service) has received a petition to list the bull trout throughout its range. The Service will have made its decision on acceptance of the petition by mid-December, so this section should be updated to reflect the latest status of bull trout.

3.0 PROPOSED ACTIONS AND ALTERNATIVES:

S11-8 As stated above, we do not believe the proposed alternatives represent any serious change from the 1992 operations and do not cover a reasonable range of possible alternatives. Also, it appears that the alternatives being considered are limited by decisions made well in advance of the SEIS through the Pacific Northwest Coordination Agreement and the resulting power planning for 1993, which was actually completed in early 1992. This severely prejudices any flexibility in looking at alternatives to existing operations as well as any in-season flexibility in modifying operations to respond to worse-than-expected conditions.

4.0 ENVIRONMENTAL EFFECTS OF ALTERNATIVES:

We have a number of concerns about the way the various models have been used in the analysis. These concerns are:

S11-9 a. Beneficial effects have been ascribed to squawfish control, adult passage improvements, and transportation of juveniles that are very optimistic, or at least open to debate. It would be useful to see the modeled benefits for each parameter in order to evaluate the sensitivity of the various models to specific assumptions.

S11-10 b. The modeling did not accurately predict actual 1992 flows. This raises the question of how well the modeling can predict flows in

S11-10 (cont.) any year where runoff patterns are unusual or where modeling assumptions were not met (see below). This also opens to question the heavy reliance of this analysis on modeling results where those results do not accurately reflect what actually happened in 1992.

S11-11 c. Several actions were included in the modeling that did not actually occur in 1992, or if they did occur, were not accurately characterized. These include the late summer releases into the Snake from Brownlee and Dworshak reservoirs. It appears the modeling assumed that these flows were passed through the Columbia once they reached Lake Wallula, when in fact they were not. Also, there was no release of 100,000 acre feet from Brownlee in September, although it is included in the Northwest Power Planning Council's Fish and Wildlife Program and was thus included in the modeling.

4.4.15 Mitigation

S11-12 We concur with the need for additional monitoring and research to assess the impacts of future actions on shallow-water habitat, wetlands, embayments, riparian areas and habitat management units.

This concludes our comments. If you have any questions or require further information, please contact Mr. Jim Nielsen at (206) 753-1699.

Sincerely,

Jerry Neal, Administrator
Columbia River Program

JN:rm

cc: Bruce Crawford
Chris Drivdahl

WASHINGTON STATE DEPARTMENT OF ECOLOGY (INCLUDING WDW AND WDF)
(T.L. ELWELL)

STATE OF WASHINGTON
DEPARTMENT OF FISHERIES
115 General Administration Building • Olympia, Washington 98504 • (206) 753-6600 • (SCAN) 234-6600

December 8, 1992

Walla Walla District
Corps of Engineers
CENWWDL-ER
Walla Walla, Washington 99362-9265

Gentlemen:

We are providing comment on your Supplemental Environmental Impact Statement (SEIS) for the Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon.

General Comments

S11-13 We have a serious concern that despite the fact that the various modeling exercises displayed and discussed in Section 4.0 of your SEIS clearly indicate that low flow conditions dramatically reduce juvenile passage survival you have not specifically discussed or analysed the effects of the 1991 and 1992 flow years on the status of Snake River salmon stocks. The extreme low flow conditions which the juvenile salmon migrants experienced in 1991 and 1992 should be anticipated to contribute to a substantial reduction in abundance for the brood year classes which emigrated in 1991 and 1992.

S11-14 You clearly indicate in your Executive Summary that you are anticipating implementation of the preferred alternative for 1993 and the foreseeable future, while a long-term plan of action is being developed. We request that you give serious consideration to more aggressive augmentation measures when the brood year classes which emigrated in 1991 and 1992 return to the Columbia and Snake Rivers. Now, while you have the substantial planning and evaluation effort mobilized, is the time to explore contingencies to deal with the exceptionally weak future broods which we anticipate as a result of the 1991 and 1992 draught conditions.

S11-15 Although we would have preferred a greater degree of flow augmentation as part of the range of alternatives considered, we concur that your preferred alternative (Alternative 4) is the best alternative presented for consideration in your assessment.

Specific Comments

S11-16 It is apparent from the presentations of modeling results in Section 4.0 that the "significant additional survival improvements" expected in the period 1993 through 1998 are the result of actions other than flow improvement. It is also clear that even though you expect survival improvement in low flow years relative to the 1990 baseline. The juvenile migrant survival in low flow years will still be

S11-16 (cont.) dramatically reduced relative to the 1990 baseline with average flow conditions. This situation indicates to us that a more aggressive effort is needed to explore alternatives which provide greater flow augmentation and/or greater improvement in juvenile migrant travel time.

S11-17 In addition the modeling exercises presented in Section 4.0 are relaying on fairly optimistic assumptions regarding future performance of predator control efforts, transportation improvements and adult passage improvements. The modeling has included some sensitivity assessment, which is appropriate and which helps to demonstrate how tenuous the Snake River salmon recovery process maybe. We are concerned that past reliance on overly optimistic assumptions/ projections of performance, particularly for juvenile migrant transportation, has contributed to serious delay in consideration of and development of other otentially viable alternatives. It is appropriate to make more conservative assumptions regarding the performance of alternatives to flow/travel time enhancement and seek alternatives which would accomplish recovery in light of these conservative assumptions.

Implementation of this approach would accommodate an accelerated salmon stock recovery if the more optimistic assumptions proved to be accurate. We do not have specific alternative assumptions to recommend at this time. However, we are available to work with your technical staffs regarding this in future iterations of the modeling and planning process.

S11-18 As we solidify long-term operating alternatives the critical model assumptions should be evaluated, to the extent practicable, to validate expected system performance.

S11-19 There is potential for loss of critical shallow water rearing habitat for juvenile fall chinook associated with operation of reservoirs at reduced pool elevations. This situation should be evaluated and the amount, if any, of lost productivity quantified.

We appreciate the opportunity to p ovide input to your planning process and look forward to continued involvement as this critical regional issue is addressed in the future.

Sincerely,

Rodney McDowell for

Bill Koss
Assistant Director
Salmon Program

BK:RW:lt

IDAHO STATE HISTORICAL SOCIETY
(KENNETH J. SWANSON)

IDAHO STATE HISTORICAL SOCIETY

CECIL D. ANDRUS, Governor

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Genealogical Library
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Historic Preservation
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December 10, 1992

Department of the Army
Walla Walla District, Corps of Engineers
ATTN CENPW-PL-ER
Walla Walla, Washington 99362-9265

RE: Draft Supplemental Environmental Impact Statement
Interim Columbia and Snake Rivers Flow Improvement
Measures for Salmon

Our office has received the Draft Supplemental Environmental Impact Statement (SEIS), Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon. The SEIS identifies Alternative 4 as the preferred plan of action for interim system operation. Components of Alternative 4 include operating the Lower Snake River reservoirs near the Minimum Operating Pool level and increasing the flow from Dworshak and Brownlee. Since these actions will lower the reservoir pools, Alternative 4 will have an adverse effect on historic properties. S12-1

We agree that appropriate mitigation will vary depending upon the context and nature of recorded sites within each study area. Before mitigation proposals can be developed, however, additional inventories will be necessary to identify historic properties on reservoirs within Idaho. It is our understanding that one of these inventories, Dworshak Reservoir, will be continued this year. We are pleased that the Waterways Experiment Station is also involved at Dworshak by providing technical assistance in assessing the effects of the proposed actions on specific sites around the reservoir. S12-2

Additionally, we look forward to receiving a monitoring report documenting the effects of the March 1992 Test Drawdown of Lower Granite on archaeological sites in Idaho.

If you have any questions, feel free to contact Suzi Neitzel at 208-334-3847.

Sincerely,

Kenneth J. Swanson
State Historic
Preservation Officer

cc: John Leier, USACE, Walla Walla
Lynda Walker, USACE, Portland

The Idaho State Historical Society is an Equal Opportunity Employer

UPPER COLUMBIA UNITED TRIBES FISHERIES RESEARCH CENTER
(ALLAN T. SCHOLZ)

UPPER COLUMBIA UNITED TRIBES FISHERIES RESEARCH CENTER

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RESEARCH OFFICE
Department of Biology
Eastern Washington University
Cheney, Wa. 99004
509-359-6397

October 24, 1992

Lt. Col. Robert D. Volz, District Engineer
U.S. Department of the Army, Corps of Engineers
Walla Walla, WA 99362-9265

Dear Lt. Col. Volz:

Enclosed are the comments of the Upper Columbia United Tribes (Spokane, Kalispel, Kootenai and Coeur d'alene) on you Draft Supplemental Environmental Impact Statement (DSEIS) on Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon (dated October 1992).

After examination of the five alternatives (pp 3.6 and 3.7), it appears that operation at Libby Reservoir and Hungry Horse Reservoir are not affected by any of the alternatives. Also, all alternatives, except for the no action alternative, would involve a flood control shift from Dworshak and Brownlee to Grand Coulee Reservoir, subjecting Grand Coulee to above normal drafts. We believe that such drafts coupled with the release of water budget water (3.45 MAF water budget, plus up to 3.0 MAF additional flow augmentation up to 3.0 MAF) from Lake Roosevelt to protect anadromous salmonids, will decimate the resident fisheries in Grand Coulee Reservoir. Water retention time will be reduced, nutrients will be flushed from the system at a faster rate (resulting in poor phytoplankton and zooplankton production which means less food, poorer growth and reduced survival for the resident fish). Also, short water retention times tend to flush fish out of Lake Roosevelt. (See BPA reports by Peone et al. 1991 and Griffith and Scholz 1991). We believe that the BPA ratepayer investment in two kokanee hatcheries at Lake Roosevelt will be wasted if any of the alternatives are adopted. Page 4-39 of the DSEIS indicates that if the preferred alternatives (ALT 4) is adopted, we are writing off resident fish in Lake Roosevelt. It is unfair for the region

R1-1

R1-2 to shift most of the environmental harm and economic cost for protecting anadromous fish to the Tribes and non-Indian residents of Northeastern Washington. The residents of this area have already had their anadromous fish resources destroyed by the block at Grand Coulee. At least residents at Dworshak and on the Snake River will have the benefit of protecting their anadromous fish. Clearly, the SDEIS needs to be revised again, this time with some real alternatives that lessen the impact at Grand Coulee. Such alternatives could consist of primalrly non-flow related activities such as improving transportation, improving bypass system, and increasing hatchery production.

R1-3 We believe that altering system operation at this time to further protect anadromous fish would be folly because there is a high potential that your alterntaives will negatively impact entire ecosystems on the Snake and Upper Columbia. At the same time there is no hard scientific proof that these actions will benefit anadromous fish. Therefore, we believe that the only prudent course is to defer action until a thorough analysis is completed through the ongoing System Operation Review process.

R1-4 We are also concerned that, no mitigation plan is provided for Lake Roosevelt in the event that the preferred alternative is adopted. Therefore, this is an incomplete DSEIS. The DSEIS needs to be revised again to describe the mitigation that will occur at Grand Coulee to reduce environmental impact to fish stocks and to reduce economic impact to the Tribes, who depend on Lake Roosevelt for subsistence. Also, small communities and businesses surrounding the Lake will need to be mitigated for their economic losses. An EIS is not complete unless it contains mitigation measures.

Thank you for this opportunity to comment.

Sincerely,

Allan T. Scholz

Allan T. Scholz

cc: L. Goodrow
Tom Trulove, NPPC
Rep. Tom Foley
Sen. Brock Adams
Sen. Slade Gorton
Gov. Booth Gardner
Kelly Cash, NPS
J. Hisata, WDW
Lake Roosevelt Forum (Louise Watson)
Janet Kilpatrick

THE CONFEDERATED SALISH AND KOOTENAI TRIBES OF THE FLATHEAD NATION
(MICHAEL T. PABLO, CHAIRMAN TRIBAL COUNCIL)

THE CONFEDERATED SALISH AND KOOTENAI TRIBES
OF THE FLATHEAD NATION
P.O. Box 278
Pablo, Montana 59855
(406) 675-2700
FAX (406) 675-2806

Joseph E. Dupuis - Executive Secretary
Vern L. Clairmont - Executive Treasurer
Bernice Howardcorn - Sergeant-at-Arms

November 5, 1992

TRIBAL COUNCIL MEMBERS:
Michael T. "Mickey" Pablo - Chairman
Lawrence Kennedy - Vice Chairman
Elmer "Sonny" Morigeau, Jr. - Secretary
Antoine "Tony" Incashola - Treasurer
Louis Adams
Lloyd Irvine
Patrick Lefthand
Harry "Hank" Saylor
John "Chris" Lozeau
D. Fred Matt

Department of the Army
Walla Walla District, Corps of Engineers
ATTN: CENPW-PL-ER
Walla Walla, Washington 99362-9265

Dear Sirs,

Thank for the opportunity to review and comment on the Draft Supplemental Environmental Impact Statement (SEIS), Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon.

R2-1 We were pleased that Hungry Horse and Libby Dams were finally addresses within this draft SEIS, however we still find the document lacking in several areas.

At your public meeting on November 5, 1992 in Kalispell, Montana, Mr. Joe DosSantos, Tribal Fisheries Program Manager will be making oral comments on several deficiencies that are apparent. We will be following up Mr. DosSantos's comments in another letter to you before the close of your comment period on December 7, 1992.

Once again, thank you for the opportunity to comment on this important issue.

Confederated Salish & Kootenai Tribes

Michael T. Pablo, Chairman
Tribal Council

THE CONFEDERATED SALISH AND KOOTENAI TRIBES OF THE FLATHEAD NATION

(MICHAEL T. PABLO, CHAIRMAN TRIBAL COUNCIL)

THE CONFEDERATED SALISH AND KOOTENAI TRIBES
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Joseph E. Dupuis - Executive Secretary
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Bernice Howardsum - Sergeant-at-Arms

December 7, 1992

TRIBAL COUNCIL MEMBERS:
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Elmer "Sonny" Morigeau, Jr. - Secretary
Antoine "Tony" Incashola - Treasurer
Louis Adams
Lloyd Irvine
Patrick Lefthand
Henry "Hank" Saylor
John "Chief" Lozeau
D. Fred Matt

Department of the Army
Walla Walla District, Corps of Engineers
ATTN: CENPW-PL-ER
Walla Walla, Washington 99362-9265

Dear Sirs,

Thank for the opportunity to review and comment on the Draft Supplemental Environmental Impact Statement (SEIS), Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon.

We were pleased that Hungry Horse and Libby Dams were finally addresses within this draft SEIS, however we still find the document lacking in several areas.

At your public meeting on November 5, 1992 in Kalispell, Montana, Mr. Joe DosSantos, Tribal Fisheries Program Manager made oral comments on several deficiencies that were apparent. We would now like to add the following comments in addition to those of Mr. DosSantos.

R3-1 On October 28, 1992, several Montana based resource groups petitioned the U.S. Fish and Wildlife Service (Service) to formally consider the bull trout as a threatened and/or endangered species under the 1973 Endangered Species Act (ESA). Section 402.10 of the 1973 Endangered Species Act is clear as to the Corps's responsibility now that bull trout have been formally petitioned: "(a) Each Federal agency shall confer with the Service on any action which is likely to jeopardize the continued existence of any proposed species...". The reservoir operations and resultant flow releases proposed within the SEIS certainly could jeopardize the continued existence of bull trout. Therefore, we request that the Corps confer with the Service on the SEIS.

R3-2 Further drawdowns in Libby and Hungry Horse Reservoirs will result in increased exposure of Indian archaeological and cultural resources due to low pool elevations. Hundreds of these sites are already threatened by the current low pool elevations and pool fluctuations at these reservoirs. It has extremely difficult for the Forest Service and the Corps of Engineers to provide adequate monitoring of these sites that have already been exposed. The Tribes are very concerned that the proposed

R3-2 (cont.) actions would severely and adversely affect these Treaty protected cultural resources, and may be contrary to the federal governments obligation to protect these resources pursuant to the National Historic Preservation Act and the Archaeological Resources Protection Act.

Once again, thank you for the opportunity to comment on this important issue.

Confederated Salish & Kootenai Tribes

Lawrence Kennedy
Michael T. Pablo, Chairman
Tribal Council

cc: Tribal Legal Department
Joe DosSantos, Tribal Fisheries Program Manager

ref: JD.120792.LET

COLVILLE CONFEDERATED TRIBES
(PATTI STONE, ACTING DIRECTOR)



Colville Confederated Tribes

P.O. Box 150 · Nespelem, WA 99155 (509) 634-4711

December 1, 1992

Department of the Army
Walla Walla District, Corps of Engineers
Building 602, City-County Airport
Walla Walla, WA 99362-6619

Dear Sirs;

The Colville Confederated Tribes have been involved with the Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon Draft Supplemental EIS. We appreciate the opportunity to comment on the most recent draft. Our comments will be limited to Alternative 4, since that was cited as the preferred alternative.

R4-1 Section 3.2.5 - Alternative 4 details flood control shift from both Dworshak and Brownlee when run-off forecast is 3.0 MAF or less, however the volume of the shift from each location is not detailed. How can one evaluate the effect of the flood control shift without this information?

R4-2 Table 3.5.7 - The end of the month elevations for the No Action Alternative look suspiciously like the minimum target values for base operation and not the actual end of month elevations for the fifty years operation. Please confirm the source of the No Action Alternatives for the fifty year period, End of Month Elevations.

R4-3 Section 4.3 - Modified 1992 operations potential impacts should include delayed/decreased zooplankton availibilility.

R4-4 Section 4.3.6 - Release of nutrient load during consecutive low water periods could have significant cumulative impacts to resident fish as stated, however good water years are not any better for resident fish in Coulee because of deep drafts for flood control and power production. It appears that implementation of Alternative 4 will result in poor rearing conditions during consecutive low water periods and normal operation results in poor rearing conditions during high water years. With this operation all years appear to have potential negative cumulative impacts to resident fish, especially years when the upper Columbia has a good water year and the Snake has a poor water year.

R4-5 Finally I offer these general comments: i) Nowhere in this docu[illegible] is there any indication of provisions for mitigative measures to deal with adverse effects to resident fish due to alternative operations. 2) The implemenation of Alternative 4 is

R4-5 (cont.)

R4-6 based on projections of 3.0 MAF (for flood control) for Dworshak's April forecast. Past years have proven that current technology does not allow very reliable forecasting, this is no ones fault but is a very real problem when one bases operational changes on these forecasting abilities.

Thank you for giving the Confederated Tribes of the Colville Reservation the opportunity to comment on the proposed flow improvement measure for salmon.

Sincerely,

Patti Stone

Patti Stone, Acting Director
Fish and Wildlife Department
Colville Confederated Tribes

cc: Business Council
John Smith

NEZ PERCE TRIBAL EXECUTIVE COMMITTEE
(SAMUEL N. PENNEY, CHAIRMAN)

Nez Perce
TRIBAL EXECUTIVE COMMITTEE
P.O. BOX 305 • LAPWAI, IDAHO 83540 • (208) 843-2253

December 2, 1992

Peter Poolman
SEIS Manager
Department of the Army
Walla Walla District, Corps of Engineers
Walla Walla, WA 99362-2965

RE: Interim Columbia and Snake River Flow Improvement Measures for Salmon Draft Supplemental Environmental Impact Statement (SEIS).

Dear Poolman:

The Nez Perce Tribe submits the following comments in response to the proposed 1993 Salmon DEIS.

R5-1 The Nez Perce Indian Tribe is a federally recognized Tribe by virtue of treaties with the United States Government in 1855, 1863 and 1868. Today, the Nez Perce Reservation, located in North Central Idaho, encompasses approximately 750,000 acres, including portions of Idaho that will be affected by this drawdown. The Nez Perce Tribe retains treaty rights within a large portion of areas affected by this DEIS as recognized by the United States Government. The Tribe maintains a policy through self determination to exercise control and provide input into projects that affect tribal resources.

The Tribe considers cultural resources to be of high priority. Evidence of the continual deterioration and desecration of these valuable resources causes deep concern and has prompted the Tribe to develop management practices aimed at protecting these resources. The Tribe believes that this DEIS report does not provide assurances for adequate protection or preservation of existing and additional unknown cultural resources and that alternative management plans should be adopted.

The most recent DEIS report for the Columbia and Snake Rivers indicates the preference on behalf of the Corps of Engineers (COE) for Alternative 4, which includes the summer 1993 drawdown of the Dworshak Reservoir. The following points of concern regarding the impact of a drawdown on cultural resources are inadequately addressed in the DEIS:

R5-2 (1) In section 4.12.7, the COE states that a monitoring program will be developed to assess the impact of the drawdown on all identified culture resource sites. However, the only survey conducted to identify cultural resources in the Dworshak area is incomplete. In the 1989 survey report conducted by John A. Draper, Center for Northwest Anthropology, Washington State University, only 34 of the 55 miles of reservoir shoreline was examined. Within those 34 miles, the survey crew recorded 170 sites, demonstrating the high density of cultural resources in this area. Thus, 21 shoreline miles remain which have yet to be surveyed. The numerous sites identified by the 1989 survey indicate a high probability for additional sites within the remaining 21 miles. Draper estimates the potential for 40-50 additional sites.

The scope of the 1989 survey was to include an area from the 1450 - 1600 ft. contour level. However, the reservoir was raised to the 1500 ft. level to accommodate run-off from rain and snow-melt. Therefore, cultural resources existing between the 1450 - 1500 ft. level have not been determined and must be considered if the proposed drawdown will drop water levels below 1500 ft. In view of this information, the DEIS must provide a full assessment of the existence of cultural resources within the remaining 21 miles of unsurveyed shoreline, and within the entire 55 miles below the 1500 ft. level if this area is to be exposed.

R5-3 (2) Section 4.12.3 of the DEIS states that all sites in the Dworshak area will continue to be adversely affected by natural activities, including erosion, scouring, wet/dry cycles, slumping, etc.. Draper in his 1989 survey report emphasizes the "alarming rate" at which cultural deposits are being destroyed, citing that several sites recorded in 1986 have eroded to such an extent that little material remains.

Section 4.12.3 also states the sites will continue to be adversely affected by human activities, including vandalism, recreation, vehicles, etc.. Draper observed many footprints and vehicle tracks while conducting the 1989 survey. He also found evidence of unauthorized excavating in some areas, which is not surprising considering that most of the drawdown area is easily accessible by foot or boat. Therefore, there is a great concern for the protection of exposed cultural resources from natural and human processes, which have proven extremely detrimental in the past. The Tribe suggests that the final EIS assess these adverse affects and provide for adequate protection and mitigation measures before any action is taken.

R5-4 (3) It is the position of the Tribe that federal agencies must involve the Tribe in all aspects of cultural resource management regarding areas within the Reservation and ceded territory. Tribal consultation must be sought during preliminary planning stages, prior to any archaeological assessments. In addition, the Tribe has qualified personnel for active participation in archaeological projects. Unfortunately, the Tribe was not consulted or involved directly in the 1989 Dworshak survey. Hopefully this oversight will not occur in the future.

R5-5 Before any management plans can be suggested or initiated, a complete assessment of cultural resources within the reservoir must be completed. Management of presently identified cultural resources is inadequate and the potential is extremely high for additional resources in the areas not surveyed. The protection of numerous sites from natural and human activities is difficult within a large recreational area such as the Dworshak Reservoir. These issues are important and are not addressed to any satisfactory extent in the most recent DEIS report.

In conclusion, the Corps of Engineers has not provided for adequate assessment or protection of cultural resources within the Dworshak area in conjunction with the proposed summer 1993 drawdown. If the final EIS does not remedy these inadequacies, the Tribe will oppose the project based on information (or lack of) provided in the EIS. We await further information and contact from your office.

Sincerely,

Samuel N. Penney

Samuel N. Penney, Chairman
Nez Perce Tribal Executive Committee

cc: NPTEC Read File
Legal Counsel
Cultural Resources
Bob Ringo, CRITFC

COLUMBIA RIVER INTER-TRIBAL FISH COMMISSION
(TED STRONG, EXECUTIVE DIRECTOR)

COLUMBIA RIVER INTER-TRIBAL FISH COMMISSION
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Telephone (503) 238-0667
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December 7, 1992

Lt. Colonel Volz
Department of the Army
Walla Walla District
Corps of Engineers
Building 602
City-County Airport
Walla Walla, WA 99362-2965

Dear Colonel Volz:

The Columbia River Inter-Tribal Fish Commission (CRITFC), a fisheries service organization for the Nez Perce Tribe, the Confederated Tribes of the Umatilla Reservation, the Confederated Tribes of the Warm Springs Indian Reservation and the Yakima Indian Nation has reviewed the Draft Supplemental Environmental Impact Statement (SEIS) on Interim Columbia and Snake River Flow Improvement Measures for Salmon. These comments are submitted at the direction of the Commission's member tribes.

Adequate flows to aid salmon survival are critical to the restoration of the anadromous fishery resources upon which the exercise of treaty Indian fishing rights depends. As such, the proposed actions address a subject matter that is of extreme importance to the Commission's member tribes. Unfortunately, CRITFC's previous comments on the OAD/DEIS have yet to be fully addressed by the Corps. Continued disregard for the tribes' concerns, including the tribes' fishing rights and cultural resources, would be inconsistent with the Corps' and the cooperating federal agencies' legal responsibilities.

The following comments address the tribes' interest in salmon rebuilding, the results of modeling analyses of SEIS alternatives, the scope of the SEIS, and specific project operations for 1993.

R6-1

RECOGNITION OF TRIBAL INTERESTS

The SEIS contains an extremely limited and inadequate discussion of treaty Indian fisheries (pgs. 2-49, 4-92). Apart from three general statements on Indian culture, fishing techniques, and fishing access sites, the SEIS provides no information on the significance of tribal interests at stake. The document does not list the four tribes' 1855 treaties with the United States that guarantee the right to take fish and the preservation of the resource.[1] Above all, the SEIS provides no discussion of how treaty Indian fishing rights might be impacted through the modification of mainstem river flows.

Federal agencies as well as the states must recognize that Indian treaties made under the authority of the United States "shall be the supreme Law of the Land; and Judges in every State shall be bound thereby...." U.S. Const. art. VI, cl.2 construed in United States v. Washington, 384 F. Supp. 312, 330 (W.D.Wash. 1974). The courts have recognized that the treaty Indian fishing right has two discrete aspects, a geographical component and the guarantee of an equitable share of fish. Washington v. Washington State Commercial Passenger Fishing Vessel Ass'n, 443 U.S. 658 (1979). All federal agencies, including the Corps, have an obligation to protect treaty fishing rights. Two cases serve to highlight this point. Each case involved one of the Commission's member tribes suing the Corps to protect the tribe's treaty fishing rights.

In Confederated Tribes of the Umatilla Indian Reservation v. Alexander, 440 F. Supp. 553, (D.Or. 1977, the court halted the construction of a Corps dam that would have flooded and destroyed Indian usual and accustomed fishing stations. It made no difference in the court's analysis that there remained fishing

[1] For instance, Article III of the Yakima Treaty provides:

> The exclusive right of taking fish in all of the streams, where running through or bordering said reservation, is further secured to said confederated tribes and bands of Indians, as also the right of taking fish at all usual and accustomed places, in common with the citizens of the Territory, and of erecting temporary buildings for curing them; together with the privilege of hunting, gathering roots and berries, and pasturing their horses and cattle upon open and unclaimed land.

COLUMBIA RIVER INTER-TRIBAL FISH COMMISSION
(TED STRONG, EXECUTIVE DIRECTOR)

R6-1 (cont.) stations available to the Indians elsewhere or that the Corps proposed a mitigation plan. In Confederated Tribes of the Umatilla Indian Reservation v. Callaway, No. 72-211 (D.Or. August 17, 1973), the court ordered federal water managers not to manipulate the Federal Columbia River Power system (FCRPS) so as to inundate tribal in-lieu fishing sites above the Bonneville Dam. The court also ordered the BPA and the Army Corps of Engineers to manage and operate the FCRPS's peak power system in a manner that did not "impair or destroy" the tribe's treaty fishing rights.

R6-2 The most obvious implication of the SEIS to the tribes' fishing interests is the extent to which the flow improvement measures will rebuild salmon runs that can be harvested by the tribes. The actions proposed in the SEIS are not favorable to rebuilding salmon runs. Model studies that have attempted to estimate rebuilding indicate that the flow measures contained in the SEIS are not adequate to rebuild salmon runs and may jeopardize the existence of Snake River stocks. The loss of harvestable fish to the treaty fisheries due to inadequate flows is a severe impact to the tribes. The tribes have already borne the brunt of the conservation through impacts to their harvest of salmon.[2]

R6-3 Indian fishing also may be impacted through modification of river flow patterns eliminating the effectiveness of a fishing site. If mitigation measures are necessary to insure access and fishing opportunity (extension of boat ramps, location of alternate access sites, compensation for increased commercial barge traffic that impacts fishing opportunity, etc.) then the federal agencies have an obligation to work closely with the tribes to reach acceptable solutions within the framework of their treaty rights.

[2] In 1964, the Commission's member tribes closed their commercial summer chinook fishing, losing a salmon resource second in value only to the spring chinook. In 1977, the tribes discontinued commercial fisheries for spring chinook. Spring chinook salmon were and remain the tribes most precious cultural and economic resource. In spite of 20 years of tribal and non-Indian fishing closures, summer and spring chinook stocks are in serious jeopardy, with the Snake River stocks now listed as threatened species. Harvest is not the factor constraining salmon rebuilding. Imposition of further constraints on rebuilding through continuation of inadequate flow regimes is inconsistent with the tribes' interests.

R6-4 The Corps and the cooperating agencies must work with the tribes to address impacts to cultural resources during reservoir drawdown. The Confederated Tribes of the Umatilla Indian Reservation provided the Corps with recommendations for developing immediate mitigation that included proper tribal consultation on a government-to-government basis, tribal funding for participation in monitoring and evaluation, site protection, repatriation of human remains and associated artifacts and possibly enforcement activities. Similar concerns are expressed by the Nez Perce Tribe with emphasis on Dworshak Reservoir. (Appendix A) The development of a long term plan for cultural resource protection was requested by the tribe.

MODELING ANALYSES DO NOT SHOW REBUILDING

R6-5 The modeling analyses contained in the SEIS indicate the need for additional alternatives that will promote the recovery of the affected salmon stocks. Figures 4.2-5 and 4.2-6 (Appendix B) developed by the Northwest Power Planning Council (NPPC) indicate that continuing declines of spring and summer chinook stocks will occur with implementation of the proposed 1992/93 operations. TECH committee analyses essentially concur in the results of the NPPC spring and summer chinook model analyses; "assessing the 1992 actions show[s] the escapement[s] are not exhibiting significant increasing trends." (Appendix C, p. 9) For fall chinook, the TECH committee also noted that continuation of "the 1993 actions would not stop this stock from a continued decline." (Appendix D, p. 7) In short, two separate technical analyses indicate that the proposed operations will not reverse the population declines, which is the admitted purpose of the SEIS.

R6-6 The discrepency between the results of the BPA modeling and others' modeling is attributable to BPA's assumptions regarding improved survival as a result of predator control, smolt transportation, and improved adult passage programs. Sensitivity analyses performed by the TECH committee indicates that flow improvements for juvenile migration are likely to provide greater benefits to salmon than predation, transport, and adult passage measures favored in BPA's analysis.

The supporting evidence for the benefits derived from predator control and adult passage actions is limited, due, in part, to the recent initiation of these programs. In addition, many significant questions remain regarding the data and conclusions associated with smolt transportation. One thing is clear; smolt tranpsortation was not effective to prevent continuing declines in Snake salmon

R6-6 (cont.) populations. The quality scientific information to support these measures is not as good as the quality of information indicating that salmon smolts require adequate flows for their seaward migration.

R6-7 The importance of flow in relation to juvenile salmon migration is well documented. Reduced river flow during the spring smolt migration and the greater cross-sectional area of the river due to reservoir storage slow the juvenile fish as they migrate (Sims and Ossiander 1981). This exposes them to increased predation and has an impact on their ability to make the transition from freshwater to saltwater as a result of delayed travel time (Chrisp and Bjornn 1978, Adams et al. 1975, Maule et al. 1988, Schreck et al. 1984, and Gould et al. 1985).

A recent summary of migration and flow information by the Fish Passage Center (1992) for the ESA Recovery Team indicates that prior to 1958 water travel time remained fairly stable in spite of the large annual variations in flow. Water travel time began to change with the extensive development of the Snake River. After construction of Lower Monumental (1969) Little Goose (1970) Lower Granite (1975) and with the addition of John Day Dam (1968) major changes in water travel time occurred (Figure 1). Supporting evidence is provided by comparative changes in the wild spring chinook stocks from Marsh Creek and the Deschutes River that were self-sustaining during 1958-1968. Since that time the Marsh Creek stock has declined dramatically in comparsion to the Deschutes stock (Petrosky and Schaller, 1992). Further, Bergren and Filardo (1991), demonstrated the similarity of juvenile salmon response in relation to water particle travel time. This similarity supported a causative, rather than a simple correlative relationship between smolt travel time and flow (Petrosky, 1991). In this light, the SEIS should contain a more robust treatment of flow alternatives.

R6-8 **THE SCOPE OF ALTERNATIVES IS INADEQUATE**

The SEIS does not provide a thorough review of options that could be undertaken to improve the migration and survival conditions. The SEIS addresses only very limited changes within the basic context of the hydropower, flood control and irrigation operations that have been in existence for years in the Columbia Basin. Viewed from a more recent perspective, the SEIS considers only variations of those migration survival measures implemented in 1992. The SEIS does not consider commitments of additional water volumes for flow augmentation beyond those volumes

R6-8 (cont.) implemented in 1992.[3]

By limiting the alternatives to a narrow range, which represents hydrosystem operations previously established for 1992, the SEIS does not accommodate adequate fish flow measures for salmon rebuilding. Nor does the SEIS fulfill NEPA requirements. California v. Block, 690 F.2d 753 (9th Cir. 1982) provides a useful analogy. There, the U.S. Forest Service had presented a range of eight alternatives for public consideration, which for all practical purposes represented variations of the same basic (34%-40%) commitment of lands to wilderness designation. The reviewing court determined these alternatives were not sufficient to permit a reasoned choice and informed public participation. The court rejected the Forest Service's requests that the court view its decision criteria separate from the substance of the alternatives. Noting that the Forest Service had "shrouded the issue from public scrutiny," the court concluded that it was unreasonable for the Forest Service to overlook other alternatives.

Aside from the no action alternative, the SEIS truly considers only one alternative, implementing the 1992 flow commitments without a test drawdown. Granted the SEIS presents variations on mechanisms for implementation, it does not address the core issue: What "changes to the previous operation of the Columbia-Snake River System are needed to reverse the population decline and to contribute to the recovery of these salmon stocks." SEIS at ES-1. NEPA requires a reasonable range of alternatives be included in the SEIS.

It is particularly troubling that the scope of the SEIS is so constrained. Below, we have summarized three additional alternatives that should be addressed in the SEIS.[4]

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[3] The only exception is the consideration of increasing the frequency of flood control shifts from Dworshak to Grand Coulee, which has the effect of extending the commitment of increased water supplies to additional water-years.

[4] These alternatives are not intended to be exclusive of other reasonable alternatives, including increased flow commitments from the upper Columbia Basin for spring and summer migrating juvenile salmon.

COLUMBIA RIVER INTER-TRIBAL FISH COMMISSION
(TED STRONG, EXECUTIVE DIRECTOR)

Upper Snake River Basin Water Commitments

R6-9 There are 31 major water storage projects in the upper Snake River Basin above Brownlee Dam that account for an active storage capacity of 8,054,000 acre-feet (AF). As of 1986, there was approximately 735,000 AF of uncontracted water in five middle and upper basin reservoirs (Tolisano, 1989). This storage represents only nine percent of the total storage in the upper Snake and could be a significant component in efforts to improve conditions for smolt migration. Yet, the SEIS considers only one option for implementation in 1993: "contributions from... unspecified sources in the upper Snake River Basin (0 to 190 kaf)." SEIS at 3-11. The commitment of 190,000 AF (190 kaf) is only 2.4 percent of the upstream storage and even that amount is not guaranteed.[5]

We request that the final SEIS contain an alternative with substantially increased water availability for salmon from the upper Snake River. We offer the following alternative for your consideration.[6] The alternative draws from reports by Tolisano (1989) and Brendecke (1991) and highlights the magnitude and timing of additional water that might be made available through a change in upper Snake River Basin water resources management.

Modification of flood control and hydropower operations, improvements in water conservation, water purchase or lease and reprogramming of uncontracted storage within the Bureau's irrigation system could result in annual increases in the water supply for fish in a low runoff year that range between 500,000 AF to 1,400,000 AF.[7] The water sources considered are as follows:

R6-10 Uncontracted Irrigation Storage: As of 1986, there was more than 700,000 acre-feet (AF) of uncontracted irrigation space in five Bureau of Reclamation projects in the upper Snake River Basin (Tolisano, 1989). The amount available ranges from about 52,000 AF in Palisades (Snake River) to more than 380,000 AF in Cascade (Payette River). This alternative assumes a conservative amount of 400,000 AF allocated to fish by 1998.

Water Purchase or Lease: From Brendecke and Mann 1991 (Chapter 5), it appears that the combination of purchase and transfer of natural flow irrigation water rights and leasing from irrigation water banks could eventually provide at least 200,000 AF of additional water during any year.

Water Conservation: More efficient use of water diverted for irrigation, including reduction in water consumed as well as reduction in transmission losses, could result in at least 300,000 AF more water being left in the streams during the irrigation season. This is only about 2.5% of present annual irrigation diversions.

R6-11 Modified Flood Control and Power Operations: The combination of reducing winter power generation at Dworshak and Brownlee by replacement with energy from other sources, and reducing flood control evacuations in Dworshak and Brownlee reservoirs and in reservoirs in the Payette and Boise systems could result in at least 500,000 AF of increased reservoir yield during fish migration periods.

R6-12 Figure 2 illustrates the combined effect of additional volumes from the four sources considered on a sliding scale from 1993 through 1998. These are stacked on top of each other to illustrate the additive effect of combining available water from several sources. A straight-line increase over the years is used to illustrate increased commitments over time. This sliding scale scenario, assuming that it can be pursued successfully, calls for immediate commitment of 500,000 AF (0.5 MAF) of additional water,

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[5] Diversions of water in this region of the Snake River basin total more than 18 million AF (MAF) (Brendecke, 1991). A commitment of 190,000 AF represents approximately one percent of the total amount of water diverted from the upper Snake.

[6] This alternative considers water sources that are immediately available. It is not intended to reflect an amount of water necessary to fulfil Indian treaty obligations.

[7] The timing and magnitude for the use of this additional water that is derived from a variety of sources present a major and complex water routing challenge. For example, water from storage reservoirs is shapable but takes different times to reach the lower Snake River depending upon each reservoir's location. On the other hand, the water volume accruing from reduced irrigation diversions or water conservation are not shapable and, in effect, represent uncontrolled increases in runoff during the irrigation season. Keeping those waters in the streams for the intended purpose presents a difficult monitoring and control problem. Arrangements with Idaho Power Company will be a key factor in maximizing benefits from use of upper Snake waters because of the strategic location of Brownlee Reservoir with its control over lower Snake flows.

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R6-12 (cont.) increasing to 1,400,000 AF by 1998 from the four sources.

Snake River Drawdown

R6-13 The SEIS does not consider a drawdown strategy below minimum operating pool (MOP) for implementation in 1993. Potential benefits might be obtained from implementation of a drawdown strategy in 1993. At a minimum, the SEIS should consider drawdown among its alternatives to provide for informed decision-making and the opportunity for public comment. We recommend that the following drawdown strategy be analyzed in the SEIS.

Maintain a free-flow discharge over the spillway within a flow range of 20,000 to 200,000 cfs, beginning 15 April by drafting Lower Granite Reservoir to near-spillway crest. Actual drafting would begin 1 April. Extend the adult ladder exit at Lower Granite Dam to accommodate the lowered pool elevation below 710 fmsl. Refill Lower Granite to MOP immediately after 15 June, using storage in Dworshak and/or Brownlee reservoirs.

For the period of lowered reservoir elevation, manage flow between the powerhouse and spillway to meet the following objectives:

- Maintain a safe inriver migration environment for both juveniles and adults (no collection, no transport).
- Pass the maximum number of juveniles over the spillway as possible by optimizing the spill.
- For those juveniles trapped in the gatewells, develop methods for dipping and removing.
- Dissolved gas levels below the project should not exceed 130% saturation for an extended period (gas levels ranging between 120 to 130% should be acceptable if juveniles are allowed to sound to depth with no collection holding or transport).

Adjust powerhouse discharge and spill rates at Lower Granite Dam to meet the inriver needs of migrating salmonids. Experiment with discharge, balancing between the spillway and powerhouse as it relates to temporal (seasonal, weekly, daily, diel) movement of both juveniles and adults.

R6-13 (cont.) An intensive monitoring program will be required to make in-season adjustments in project operations relating to arrival timing of juveniles and adults at the project. If conditions are deemed unsafe for either juveniles or adults, the river would be returned to normal operations at MOP.

Improved Project Operations

R6-14 Implementation of improved passage conditions at Corps of Engineers' mainstem hydroelectric projects was not considered in the 1992 OAD/EIS, nor are they considered in the SEIS. Appendix E is a memorandum summarizing the recommended changes in project operating conditions for 1993. These changes include increased spill to pass juvenile salmon, operation of turbines at peak efficiency, improved transportation releases, increased attraction flows at adult fishways, and bypass system requirements.

The foregoing alternatives highlight the need for additional alternatives to be included in the SEIS. In the absence of these alternatives, the reviewing public and decision-makers will not be fully informed.

CONCLUSION

Thank you for the opportunity to comment. The SEIS addresses issues of vital importance to the Commission's member tribes. Unfortunately, the range of alternatives presented in the document does not allow for our adequate input. Analyses of a reasonable range of alternatives would enable a more thorough and meaningful review. In the absence of such alternatives, we have recommended alternatives for inclusion in the SEIS.

Sincerely,

Ted Strong
Executive Director

appendices

cc: Gary Smith, NMFS
Roy Fox, BPA
Witt Anderson, Corps-NPD

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COLUMBIA RIVER INTER-TRIBAL FISH COMMISSION
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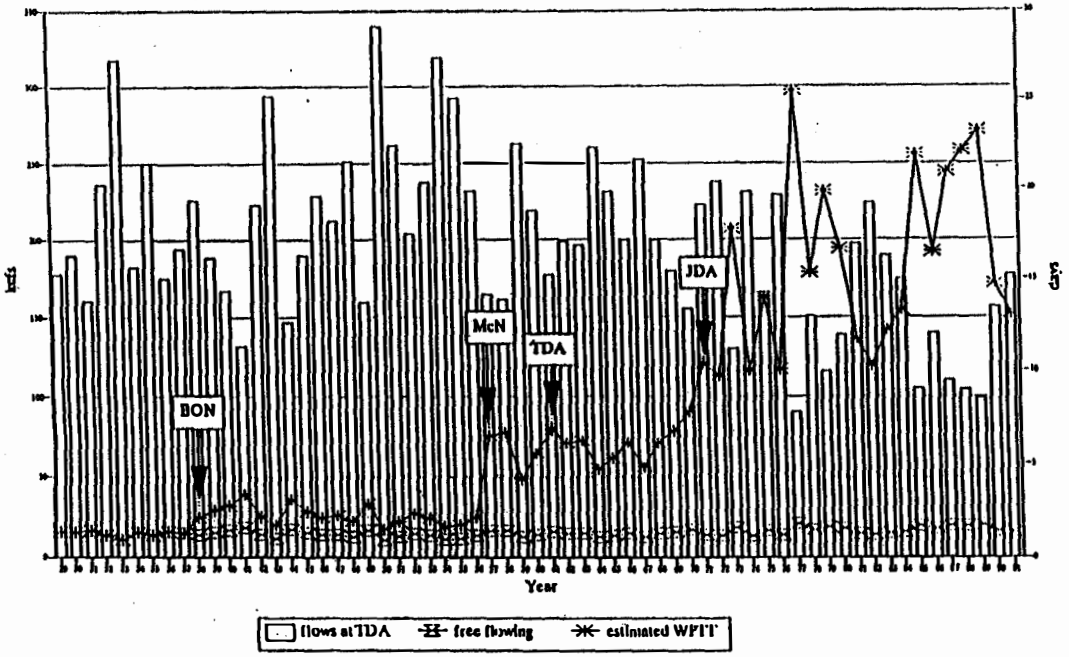
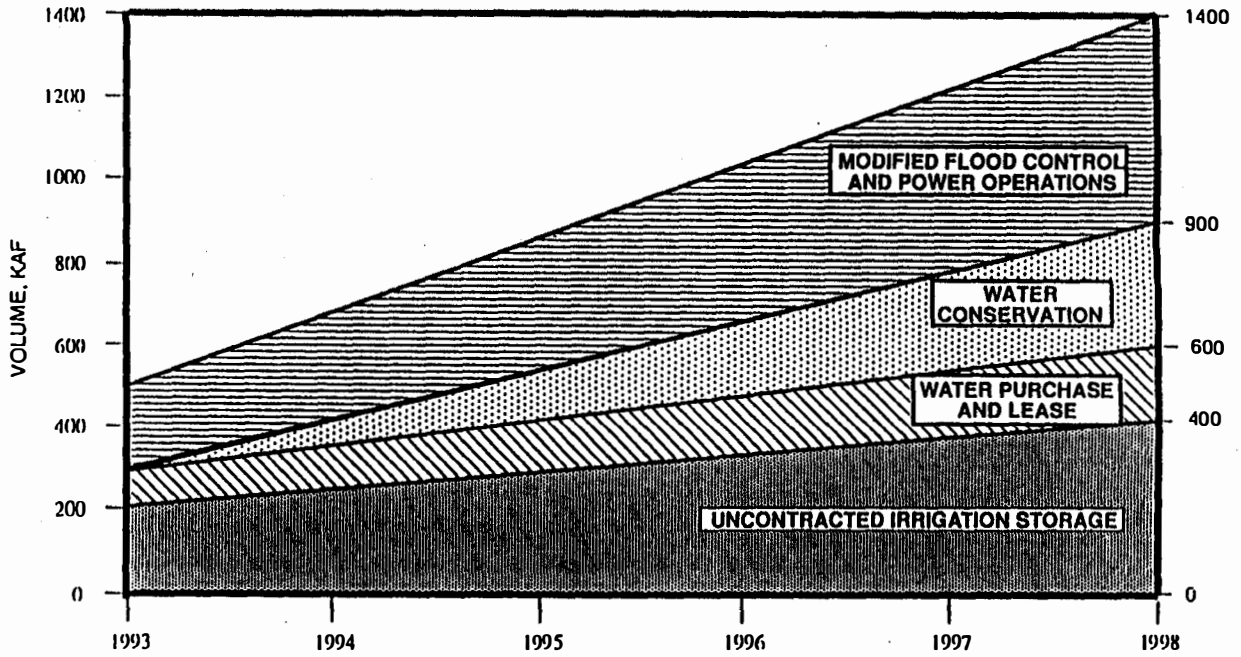


Figure 1. Flows and estimated WPTT: lower Columbia River - Summer
(Fish Passage Center, 1992)

COLUMBIA RIVER INTER-TRIBAL FISH COMMISSION
(TED STRONG, EXECUTIVE DIRECTOR)

Figure 2

UPPER SNAKE RIVER
INCREASED WATER SUPPLY FOR FISH
LOW RUNOFF YEAR



11/20/92 MIIK

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December 10, 1992

Lieutenant Colonel Robert D. Volz
District Engineer
Walla Walla District, Corps of Engineers
Attention: CENPW-PL-ER
Walla Walla, Washington 99362-2965

Dear Colonel Volz:

The Northwest Power Planning Council has reviewed the Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon -- Draft Supplemental Environmental Impact Statement (SEIS) dated October 1992 and offers the following comments for your consideration in preparation of the final SEIS. We appreciate the efforts of the Bonneville Power Administration, the Bureau of Reclamation, the Corps of Engineers and the National Marine Fisheries Service to complete this enormous task in a timely manner and the commitment of a substantial amount of staff time and attention to the preparation of the document. Similar to 1992, these efforts were necessary so that the region would be able to implement the various salmon passage measures during the 1993 passage season.

R7-1 In general, the SEIS provides a solid analytical foundation for the evaluation of benefits and impacts of proposed alternatives to the 1993 hydroelectric system operation. Results pertaining to reservoir elevations, river flows and power system costs are reasonable and are, for the most part, in agreement with the Council's estimates. The Council, however, cautions against only using results for average conditions to represent the potential cost for 1993. Since water conditions for 1993 are as yet unknown, the Council recommends presenting costs over low and high water conditions as well as over a 50-year average. This approach was taken in presenting results for reservoir elevations and flows but it appears not to have been used to reflect power system costs.

R7-2 Much of the assessment of potential impacts to salmon populations is properly based on model simulations and reflects the great amount of analytical work provided by several groups in the region, including the Council. The Council applauds this approach as a means of bringing together a large amount of information and comparing potential impacts under different scenarios. The Council, however, cautions against focusing too much attention on relatively minor differences in the rate of rebuilding portrayed by any of the analyses. Again, because water conditions for 1993 are unknown, the Council recommends that impacts be provided for a range of possible conditions including a worst case, rather than confining the comparisons to average conditions. The rate of rebuilding is very sensitive to several key factors and can show appreciable variation within a plausible range of assumptions. Instead, we suggest that the focus should be on comparing alternatives in light of biological and environmental uncertainties.

R7-3 The Council also recommends that the SEIS should approach the analysis of 1993 operations from an ecosystem perspective. This should include a discussion of potential impacts to resident fish and wildlife from operations to aid anadromous fish. For example, shifting system flood control space from Dworshak and Brownlee to Grand Coulee can increase storage and flows in the Snake River in some years. However, it could also shorten water retention time in Grand Coulee reservoir and so reduce productivity for resident fish populations.

Additional comments and concerns are provided in the attachment.

The Council is hoping to work cooperatively with each of the federal agencies to address these concerns in a constructive manner. Again, we want to express our appreciation for the substantial amount of work the agencies have performed in preparing this document. The Council looks forward to working with you to provide improved migration conditions this year for salmonids.

Thank you for the opportunity to comment.

Sincerely,

Ted Bottiger
Vice Chairman

Attachment

NORTHWEST POWER PLANNING COUNCIL
(TED BOTTIGER)

Attachment

Additional Council Comments
on the
1993 Draft Supplemental Environmental Impact Statement

Use of Brownlee to Shape Water in the Spring

R7-4 The SEIS assumes (page 3-20) that Brownlee will shape 190 KAF of Snake River Basin water in the spring. That is, Brownlee will release water from its reservoir in the spring and then be refilled later in the year when uncontracted water from the upper basin is available. Idaho Power Company has assured the Council that it will put forth its best effort to shape as much water as possible in the spring. However, under the operation specified in their "Fall Chinook Interim Recovery Plan and Study," Idaho Power Company has stated that Brownlee would not be drafted below 2069 feet for a flow augmentation operation in the spring. Unfortunately, this severely limits Brownlee's ability to shape spring water.

Flow Augmentation at Dworshak for Moderate Water Conditions

R7-5 In years when the forecast runoff volume at Lower Granite is greater than 16 MAF but less than 29 MAF, the Council's program calls for Dworshak to provide all available water while still maintaining a 70 percent refill probability. For some of these moderate years, the Council's actions would provide less than 900 KAF for flow augmentation. The SEIS differs from the Council's program in that it calls for a minimum of 900 KAF for these moderate years, unless the flow at Lower Granite exceeds 100,000 cfs. The Council commends the federal agencies for proposing to provide up to 900 KAF of Dworshak water in these below average to moderate water years, but is concerned with the proposal to limit flow augmentation efforts to a maximum of 100,000 cfs.

Assessment of Biological Impacts

R7-6 Much of the assessment of potential impacts to salmon populations is properly based on model simulations. The Council, however, cautions against focusing too much attention on relatively minor differences in the rate of rebuilding portrayed by any of the analyses. The rate of rebuilding in the simulations is highly dependent on the initial assumed conditions and the calibration of each model. It is possible to achieve a positive or negative slope for the same scenario with equally plausible assumptions. This inability to distinguish accurately small changes in the rate of rebuilding between scenarios reflects 1) the sensitivity of the models (and, hopefully the populations) to certain assumptions or conditions, and 2) the present inadequacies of our knowledge on such things as stock

R7-6 (cont.) productivity, the effects of flow, and the benefits of smolt transportation, among others.

Within these limitations, we feel that analysis of the type portrayed in the draft SEIS has significant value to decision makers. In particular, decision makers need to be aware of the limitations in knowledge and the relative vulnerability of different options to uncertainties. Analysis and modeling can be fruitfully used to provide a range of possible outcomes given alternative, plausible assumptions. It has been our experience that some options are highly dependent on speculative assumptions whereas other options are relatively robust to these same uncertainties. Decision makers can use this information to judge the relative risks of options compared to the potential gains.

R7-7 It is difficult to determine our ability to assess the risk of 1993 operations given the uncertainty regarding environmental conditions during the 1993 migration period. At this point in time, it is impossible to predict runoff and flow conditions in the upcoming spring. For this reason, our ability to predict changes in downstream passage survival, for example, is limited to statements of probability based on an historical runoff record. We provided an example of such an analysis in our preliminary report to the Corps (SEIS, Appendix F). Given the flow conditions that we have experienced in the last several years, it is important that, at a minimum, the potential biological impacts using recent flows or a worst case scenario be included. The presence of threatened and endangered stocks and the depressed nature of many stocks in general also argues for inclusion of low flow or worst case conditions in the analysis. This should also be kept in mind when viewing any of the rebuilding projections shown in the SEIS. These represent the results of multiple runs (up to 500) randomly picking flow and survival conditions. Comparisons of the median rebuilding, for example,. may give unrealistically optimistic expectations if recent drought conditions continue.

R7-8 **Page ES-5, 2.2 Alternative 2, First Bullet under Reservoir Operation**

We suggest adding item number 3 to point out that the operation at Libby and Hungry Horse reservoirs was "fixed" so that they would not make up for lost power due to Snake River actions.

R7-9 **Page ES-5, 2.2 Alternative 2, First Bullet under Flow Augmentation**

We suggest replacing "900 KAF" with "900 KAF plus any water stored in shifted flood control space..."

R7-10 **Page ES-6, 2.4 Alternative 4**

The first sentence may be misread. It states, "This includes those actions actually occurring in the 1992 operating year... plus enhancement of summer flow

NORTHWEST POWER PLANNING COUNCIL
(TED BOTTIGER)

R7-10 (cont.) augmentation from Dworshak, and flow augmentation from the upper Snake and Brownlee." It could imply that additional summer flow augmentation is provided by upper Snake projects and Brownlee.

R7-11 **Page ES-9, 3.2, Second Bullet**

This sentence could be made a little more clear.

R7-12 **Page ES-9, 3.2, Fifth Bullet**

The range of power costs appears to represent the cost over average water conditions. We suggest also providing costs for a worst case scenario.

R7-13 **Page 2.18, 2.2.6, First Bullet under Flow Augmentation**

Releasing 6.45 MAF of water over 61 days (May and June) produces a flow of about 53,300 cubic feet per second, not 60,000.

R7-14 **Page 2.18, 2.2.6, Second Bullet under Flow Augmentation**

Perhaps it should be mentioned that the 90 KAF of uncontracted storage from the Water District No. 65 Rental Pool has not yet been released this year.

R7-15 **Page 2.19, Temperature Control**

This paragraph implies that NMFS called for a combined release of 400 KAF from Dworshak (270 KAF) and Brownlee (130 KAF). In fact, Idaho Power Company had already planned to release up to 137 KAF from the Brownlee reservoir in July as a part of their operating plan under the "Fall Chinook Interim Recovery Plan and Study." In addition, the last sentence leaves the impression that the September releases for temperature control operations for adult fish passage were fully implemented. For example, although 200 KAF from Dworshak was provided in September 1992 for temperature control operations, Idaho Power did not draft 100 KAF from Brownlee in September for temperature control due to the project's low refill probability.

R7-16 **Page 3-6, Table 3.2-2, under the No Action Alternative**

It should be noted that Idaho Power Company has provided water for spring flow augmentation in pre-1992 operations. Their commitment was to provide up to 110 KAF in May (no draft below 2069 feet) for flow augmentation, when needed. It should also be noted that the same operation at Brownlee should be assumed for all other alternatives in May.

R7-17 **Page 3-9, Flow Augmentation, Item 1, First Bullet**

It should be noted that the 900 KAF from Dworshak is in addition to any minimum outflow requirements.

R7-18 **Page 3-9, Flow Augmentation, Item 1, Second Bullet**

It is not clear whether the 270 KAF from Dworshak for summer flows is provided under every water condition.

R7-19 **Page 3-9, Flow Augmentation, Item 1, Fourth Bullet**

Other local constraints can also prevent Dworshak from maintaining a 2 kcfs minimum outflow. In particular, flow constraints at Dworshak in October and November may override the 2 kcfs minimum flow target. Have these other constraints been considered in this analysis?

R7-20 **Page 3-9, Flow Augmentation, Item 2**

It appears from page 3-20 that Brownlee will shape 190 KAF of upper Snake water during the spring migration period. If this is so, it should be stated in this section.

R7-21 **Page 3-14, First Paragraph**

It should be stated whether the analysis was performed as a refill study (reservoirs start full at the beginning of each water condition) or as a continuous study (reservoirs start where they left off the year before).

R7-22 **Page 3-14, 3.5.2 Mainstem Flows, Second Paragraph**

The example in this paragraph is hard to understand. Is the important point that, although the monthly average increase in flows does not appear to be large, for a given day in the month the flow increase could be substantially higher than the average? If this is the intent then perhaps a rewording of this paragraph would help clarify this point.

R7-23 **Page 3-20, First Bullet**

This sentence could be more specific in stating that 137 KAF will be provided by Brownlee and the rest (270 KAF) from Dworshak.

NORTHWEST POWER PLANNING COUNCIL
(TED BOTTIGER)

R7-24 **Page 3-20, Second Bullet**

How does this sentence translate into a system operation? Was this modeled or is it just conceptual thinking?

R7-25 **Page 3-20, General Comments**

The preferred alternative (number 4) calls for the use of uncontracted water from Snake River projects above Brownlee Dam. The Council's program also calls for the use of this water. While the availability of water in projects above Brownlee is difficult to assess, the Council strongly supports efforts to secure the full amount of water available for juvenile migration. Excluding Dworshak and Brownlee, the Council's program calls for 427,000 acre-feet (KAF) of water from the Snake River Basin; 190 KAF for spring flow augmentation, 137 KAF in August to replace water drafted out of the Brownlee reservoir in July and 100 KAF in September for temperature control to augment the 100 KAF contribution from Brownlee. It is not clear in the SEIS that the full amount of Snake River Basin water is being considered for the 1993 operation. In addition, the Council recommends that impacts to the entire Snake River Basin be included in the SEIS since these projects play an integral part of the 1993 flow improvement strategy.

R7-26 **Page 3-20, Brownlee, First Paragraph**

The Council's understanding of Idaho Power Company's water budget commitment is that they will attempt to provide up to 110 KAF in May unless their refill probability is adversely affected. We do not understand where the 138 KAF of water budget volume for Brownlee came from.

R7-27 **Page 3-20, Grand Coulee, First Paragraph**

Another limitation at Grand Coulee is the 1,285 foot minimum elevation requirement in June, July and August for recreation. This limit should be active for all of the alternatives.

R7-28 **Page 3-22, Libby, Second Paragraph**

Council analysis has shown that in addition to Libby elevations occasionally being lower under an alternative 2 type of operation, they were also found to be higher in some months. The net impacts to monthly average elevation levels were small and the impacts to refill (elevation by the end of July) were insignificant. The state of Montana has reviewed the Council's analysis and believes that while monthly averages show little impact, daily fluctuations may present larger problems. This issue continues to be an important one that the Council is examining.

R7-29 **Page 3-23, Table 3.5-8**

If the Libby and Hungry Horse operations were "fixed" except for alternative number 3, why is the "No Action" elevation at both these projects different from the other alternatives? Shouldn't alternative 3 be the only different one?

Table 3.5-8 shows the July elevation to be identical for alternatives 2 and 3, yet the refill probability is higher for alternative 3. We do not believe this to be in error since the median elevation could stay the same while the refill probability could change. In this case a duration plot for end of July elevation may illustrate refill impacts in a clearer way.

R7-30 Page 4-15, Harvest Reductions, First Bullet

An important amendment in the Council's Phase 3 Fish and Wildlife addresses a decrease in harvest rates. The Council's program calls for fall chinook harvest rates to be reduced to 55 percent. The Council suggests that the Corps incorporate this harvest rate in their analyses. In addition, your analyses assume a return to 1991 harvest levels in 1996. We believe this may be optimistic.

Harvest is an important facet of any recovery plan and one in which significant increases in the number of returning adults can be observed. The harvest rates included in the Council's Phase 3 plan were incorporated, in part, as a component of a regional solution. This solution, to be maintained, must maintain the concept of regional cost-sharing.

R7-31 **Page 4-67, Capacity Losses**

The cost of capacity losses is non-zero only if the Northwest were not capacity surplus and if markets exist for that surplus. The assumption made is that the lost capacity (after the first 1,000 megawatts) could have been sold. It is possible that there would be no markets for this capacity during this time of year. As a suggestion, the cost of lost capacity can be shown as a range from zero (no markets available) to $ 11 million.

R7-32 **Page 4-67, Non-firm Energy Losses**

It should be noted that the loss of non-firm energy under this listed item is due to the loss of system flexibility, that is, due to the more constrained operation of the four lower Snake projects and John Day. It does not reflect lost non-firm energy due to Columbia River actions.

NORTHWEST POWER PLANNING COUNCIL
(TED BOTTIGER)

R7-33 **Page 4-70, 4.9.3, Last Paragraph**

The Columbia River actions, if included in firm planning, would represent a loss of about 330 megawatts of FELCC. This is true only if the entire hydroelectric system is allowed to flex or make up as much lost power as possible. In its Fish and Wildlife Program Amendments, the Council did not approve a firm planning approach due to the added cost and severe refill impacts to other reservoirs.

R7-34 The use of a spreadsheet model to determine costs for Columbia River actions provides only a rough approximation of the potential cost. The assumption made is that during a year when water is to be stored in the Columbia, all secondary energy would be withheld in storage first. Secondly, if this does not provide the required volume, more water would be withheld and energy purchases would be made from out-of-region utilities to make up the lost generation.

The Council's analysis, using the System Analysis Model (SAM), shows a more detailed series of operations. First of all, if water is to be stored, secondary energy is withheld. If requirements call for more water to be withheld, then SAM will do so and replace the lost generation with the cheapest resource available. Replacement energy could come from idle Pacific Northwest thermal resources, or from surplus B.C. Hydro energy. As a last resort, SAM will purchase energy from California to make up lost generation.

Assuming that all replacement energy (after secondary is curtailed) will come from California utilities may inflate the estimated cost for this operation.

CLEARWATER COUNTY BOARD OF COMMISSIONERS
(DONALD PONOZZO)

BOARD OF COUNTY COMMISSIONERS
CLEARWATER COUNTY
P.O. BOX 000 OROFINO, IDAHO 83544-0586 (208) 476-3816

November 30, 1992

Robert D. Volz, Colonel
U. S. Army Corps of Engineers
Walla Walla District
City/County Airport
Walla Walla, Washington 99362-9265

Re: Lowering of the Dworshak Reservoir

Dear Colonel Volz:

The citizens of Clearwater County as well as the surrounding counties are striving to diversify their economy with tourism due to the decline of the logging industry, and in doing so the Dworshak Lake has become a main center of attraction. For a number of years, the Corps of Engineers and Bonneville Power Company had respected the fact that when the Dworshak Dam was built, recreation was one of the three selling points to the public for its creation. There had been an agreement that the reservoir would be at full pool from Memorial Day in May through Labor Day in September.

L1-1 Now it comes to light that some of the dams in the Pacific Northwest may be hampering the migration of certain species of fish. Were there no "environmental impact statements" required? Is it environmentally sound to cripple the economic tax base that pays the governmental agencies who claim that the fish must prevail and humanity can figure out yet another way to survive. Now that everyone has adjusted themselves to depending on the diversification the dams have brought, in our case, specifically the Dworshak Dam, it has been decided, in an effort to save the "migration habits" of one small fish, all the dams and rivers are to be used for "its" survival. Not the survival of the fish itself, but its migration habits.

L1-2 There is to date no biological evidence that lowering these dams to their maximum level or changing the water flow is doing anything for the fish migration. Therefore, all pools should remain at operational levels.

L1-3 By no means are we in favor of this unproductive and useless experiment at the expense of all taxpayers. We insist the Dworshak Dam is to be used as it was intended.

L1-4 The Board of County Commissioners, Clearwater County, Idaho hereby go on record in objection to any further "drawdowns" of the Dworshak Pool. There has been no biological evidence that this will help the fish. We feel the experiment does not help the fish and causes our citizens to pay a double burden, higher electrical rates, less economic diversification.

Sincerely,

Donald Ponozzo, Chairman
Board of County Commissioners
Clearwater County, Idaho

DP:ah

cc: Cecil Andrus, Governor
Bonneville Power Administration
National Marine Fisheries Society
Larry Craig, Senator
Dirk Kempthorne, Senator
Larry LaRocco, Representative
Michael Crapo, Representative
Marguerite McLaughlin, Senator
Charles Cuddy, Representative






WILDLIFE FOREVER – INC.
8435 S.E. 17th Avenue
Portland, Oregon - 97202
Phone 503-233-4841

November 5, 1992

Dept. of the Army
Walla Walla District
Corps of Engineers Bldg. 602
Walla Walla, Wash. 99362-2965

Subject: "Draft" Supplemental Environmental Impact Statement, dated Oct. 1992.

Comments:

1. The programs detailed in the "Draft" appear to have been researched very well and as to their technical applications this organization has no method of ascertaining their consequences.
2. As a "volunteer group" in the Wildlife in the State of Oregon and Southern Washington we will only comment on impressions from reading the "Draft" and general membership consensus.

A1-1 3. Controlling water flow at dam sites.
A. We have concluded the idea is worth trying. To not try is penny wise and pound foolish.
B. Fry migration, from our layman observation, is that transporting the fry

A1-2 below Bonniville Dam is more pratical, less costly, and less mortality on fry or smolt.
4. What concerns us is rearing of fry in the Snake and Salmon Rivers, then transporting them below Bonniville for their ocean voyage and return.
A. Return, then becomes a question mark of losses to all spicies, mostly man.
B. We are concerned, even upset, over excessive Chinook taking in the Columbia and Ocean entry.
5. This organization works in the Oregon and Washington Salmon and Trout Enhancement Program, therefore, we have a "material" interest in percentage returns. The writer having been involved since 1979 at 2212 SE Lambert, Portland, on Crystal Springs Creek.

A1-3 A. We have over 50 members who also participates in the program of hatching.
B. Consequently we also undertake salmon habitate rehab on streams below Bonniville Dam in both Oregon and Washington.
C. While this has been "State" directed we are "somewhat concerned" your programs are not further transferred to this volunteer force above providing eggs to hatch.
D. We believe these volunteers are better equipped to solve more problems but find little, if any, operational direction from The Corp of Engineers

A1-4 6. Water lowering will be costly in operation and capital cost in electrical cost.
A. Equated against our activities and we would hope other volunteers a savings of capital.
B. In this view, though laymen and women, we cannot get the logical equations to compute on a "capital loss basis".

A1-5 7. Fishing days must be cut at the mouth of the Columbia River. We propose that only Friday, Saturday and Sunday be considered.
A. Limits be cut to one chinook 24 inches and above and one Coho daily, limit of six in those three days per punch card, but only 3 Chinook and 3 Coho.
B. No "gillnetting" until sufficient returns are restored to all streams upriver for at least seven years. After 7 years a review.
(1) The "gillnetting" loss of capital must be bought out and we would support a stipulated dollar amount and paid for with a State and Federal License fee of not more than $25.00 combined earmarked for "gillnetting" buy out

A1-5 (cont.) 8. We believe other users, should be restricted to Treaty designations as agreed, but proportionally reduced with computed "gillnetting take". They must also help.
A. American Indians and Sportsman Fishers must surely agree we have a problem of restoring the Salmon on the Columbia River Systems, therefore, it makes no logical conclusion to limit one and have another "overfish".
B. The last word hereon "overfish" is the main culprit of the destruction of salmon runs in the Columbia River Systems.
Now days with fancy electronic gear a "school of salmon" doesn't have an equal fairness of survival. True the dams, turbines, fish ladders, etc have their toll, but we are addressing that, but not the overfishing.
C. In your "Draft" we find little, if any, addressing this very huge problem.

Concusion:

We have stated our concerns on the "Draft" and sincerly hope logic and sound reasoning will prevail for the Salmon and Steelhead. The word Salmon, we include all Chinook, Coho, Jacks, Pinks, whatever, as all salmon are pointingly endangered.
We, again, as Laymen and Women have stated our position, not from a desk or back room, but those outfront working as volunteers to restore salmon, elk, deer and other wildlife habitate. We believe deeply and sincerly man needs to stop and share the environment with wildlife as it exist today, taking a lesson from Cheif Joseph that mother nature is the preservor of us all, man and wildlife, to this we will not apologize

Respectfully,
Clyde V. Brummell, President
Clyde V. Brummell
By Orders of the Board of Directors.

cc/ Oregon-Washington Game Commission.

NORTHWEST IRRIGATION UTILITIES
(DARRYLL OLSEN, Ph.D.)

NIU
Northwest Irrigation Utilities

(503) 233-5823
Fax (503) 233-3076
825 NE Multnomah, Suite 1015 • Portland, Oregon 97232

TECHNICAL MEMORANDUM

DATE: November 10, 1992

TO: Lt. Col. Robert D. Volz, Walla Walla Dist., Army Corps
Mr. Pete Poolman , Walla Walla Dist., Army Corps

FROM: Darryll Olsen, Ph.D.
Regional Planner/Resource Economist

SUBJECT: Northwest Irrigation Utilities (NIU) Comments on the Draft Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon--Draft Supplemental Environmental Impact Statement (SEIS)

There is much to praise about the SEIS. For example: the general quality of the technical information presented; the use of salmon life-cycle models to estimate system operation impacts (though measure marginal benefit estimates are required); the explicit identification of the "critical assumptions" employed within the Bonneville life-cycle models; and the further development of cost-effectiveness analysis relative to the 1992 Options/Analysis EIS (though further modification to the analysis format is required).

More specifically, NIU submits the following technical comments and recommendations regarding the SEIS to the Corps of Engineers and to the Bonneville Power Administration, the Bureau of Reclamation, and the National Marine Fisheries Service (hereinafter referred to as supporting agencies).

A2-1 *Given the circumstances posed by the Endangered Species Act (ESA) listings, NIU generally supports the decision to make Alternative 4 (modified 1992 operations) the preferred action alternative, for interim system operations. But this support is tempered with considerable reservations about the uncertainty of the marginal smolt survival benefits currently estimated from*

A2-2 *flow augmentation or reservoir drawdown measures.*

With regard to the issue of uncertainty pervading marginal smolt survival estimates related to flow improvements, NIU suggests that some important data analysis omissions are apparent within the SEIS (as well as the 1992 Options/Analysis EIS). First, it is noted that the smolt travel time analysis prepared by the NMFS Northwest Fisheries Science Center, *Quarterly Report* (January-February-March, 1992) has not been discussed within the SEIS. This report, "PIT-Tagged Spring and Summer Chinook Salmon Detection Rates Compared with Snake River Flow at Lower Granite Dam," offered the following findings: *"Our*

A2-2 (cont.) *observations at Lower Granite Dam indicated that prior to 14 May in 1989-1991 (by which time 90-95% of the outmigrants had passed), flow had little effect on the dynamics of the outmigration of hatchery or wild spring/summer chinook salmon populations. There was virtually no difference in fish movement patterns for the 3 years in each of the three groups of chinook salmon."*

Second, neither the SEIS nor the 1992 Options/Analysis EIS noted the PNUCC 1991 report on smolt travel time and flow regime relationships in the John Day Pool. This report, "Yearling Chinook Salmon Travel Time and Flow Regime Relationships in the John Day Pool, 1989 and 1990," indicated that: *"Based on these statistics and corresponding data sets, it cannot be said that flows significantly affect travel time with a high level of confidence [at the 200-300 kcfs range]...Within the technical literature, it is suggested that other variables may play an important role in influencing smolt travel time."*

NIU recommends that both of the above reports--as well as any other pertinent, technically based studies that have been overlooked--be acknowledged and described within the Final SEIS (see enclosures).

A2-3 *NIU strongly supports the use of salmon life-cycle models to assess the biological effectiveness of salmon recovery plan alternatives; the biological objective for life-cycle analysis should focus on returning adult salmon to Idaho waters.*

NIU stridently concurs with the Corps' and supporting agencies' analytical modeling approach that emphasizes a review of a combination of recovery measures, rather than a "narrow focus" on all separate life-stages. This approach is consistent with the development of a weak stock salmon recovery plan that would incorporate multiple alternatives, and for the need to provide a least-cost planning basis for understanding measure optimization--acquiring the highest level of biological benefit for each recovery dollar spent. And it is important that the biological objective is not diminished or disaggregated to a meaningless concept or directed toward a proxy variable.

However, a technically competent cost-effectiveness analysis must be based on a review of the major alternatives' biological effectiveness. This review should assess each alternative not as a "stand alone" measure, but as an integral component to a comprehensive set of recovery measures. This analytical approach is obtained through a marginal benefit assessment, within a cost-effectiveness framework.

The life-cycle analysis should be focused on recovery measures' marginal benefits, in order to estimate explicitly the added biological benefits derived from any given measure.

As noted above, the correct application for the cost-effectiveness framework should embrace a marginal benefit assessment. A set of recovery measures should form the "base case" life-

NORTHWEST IRRIGATION UTILITIES
(DARRYLL OLSEN, Ph.D.)

A2-3 (cont.) cycle modeling run, to estimate returning weak stock salmon back to Idaho waters. From this base case context, each major measure is separately removed from the set, with a new modeling run prepared; one modeling iteration for each measure marginal benefit assessment. The difference in returning adults across different modeling runs, with and without each measure, determines a measure's marginal benefit to the comprehensive recovery plan or new system operations.

The "critical assumptions" section of the SEIS (pages 4-14 to 4-17) for life-cycle modeling clearly stipulates some of the major measures for a comprehensive set of recovery plan measures or interim system operation actions. These key measures include: in-river commercial harvest reduction (note: the SEIS did not identify any harvest reduction costs, but should); habitat improvements; the NPPC flow augmentation option; transportation improvements (the SEIS offered a limited discussion); predator control; and reservoir drawdowns.

It is crucial that the SEIS separate key measures for life-cycle modeling analysis. For example, the biological benefits--the marginal adult fish returns to Idaho--resulting from a drawdown of the John Day Pool to elevation 262.5 should be independently identified within the modeling analysis. Action on the John Day Pool should be treated as a distinct measure.

A technical objective of the Corps and supporting agencies should be to form a cost-effectiveness analysis that is "structurally consistent" with the analysis illustrated by Figure 1 (see page 4 and enclosed report).

A2-4 ***To more fully come to terms with the above comments concerning the cost-effectiveness analysis, the NIU requests that the Corps convene a cost-effectiveness analysis work group, similar to the work group that was formed after the release of the 1992 Options/Analysis EIS. The Options/Analysis EIS economics work group proved to enhance substantially the technical approach used in the Final 1992 EIS. It is likely that the SEIS could benefit from the same type of work group, as well.***

cc: Bruce Lovelin, Exec. Dir., NIU
NIU Board
AWUF Board
Gary Smith, NMFS Seattle
Don Bevan/Jim Crutchfield
NMFS Salmon Recovery Team
Attention: ESA Administrative Record
Salmon Recovery Plan Economics

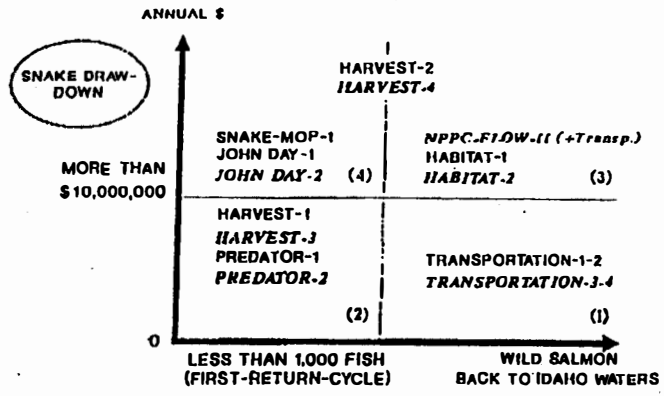
Enclosures: (Only to Volz/Poolman)

THE PATH TOWARD COST-EFFECTIVENESS

A2-4 (cont.) A marginal benefit assessment can be made to review the incremental fish benefits gained--weak stock fish returning to Idaho waters--relative to measure costs. This is accomplished by identifying the incremental benefit provided by a separate recovery measure, when "removed" from a comprehensive set of measures that form a recovery plan.

Figure 1 portrays a "quadrant level" approach to cost-effectiveness analysis (low water actions are designated by *italics*). By using this approach, the range of uncertainty underlying fish benefits or economic costs, for cost effectiveness ranking, can be substantially minimized--an alternative is given a relative ranking defined as greater or less than a certain value for fish benefits or economic costs. This analytical approach further moderates the uncertainty of biological benefit estimates by focusing on an "optimized" first-return-cycle instead of attempting to "forecast" fish returns over multiple life-cycles.

FIGURE 1. COST-EFFECTIVENESS ANALYSIS
RECOVERY MEASURE MARGINAL BENEFITS/COSTS
(QUADRANT RANKS 1,2,3,4)



Within the parameters of this analysis, the most cost-effective salmon recovery alternatives are estimated to be transportation improvements, in-river commercial harvest restrictions, and predator control programs. Reservoir drawdown alternatives would offer the least viable, least cost-effective measures to be included within a salmon recovery plan or interim system operations.

Source: Olsen, D. 1992. "The Path Toward Cost-Effectiveness, A Working Paper Analyzing the Cost-Effectiveness of Major Salmon Recovery Alternatives." Northwest Irrigation Utilities, Portland, Oregon (October 1992).

FLATHEAD WILDLIFE, INC.

(HERBERT JOHNSON)

Flathead Wildlife, Inc.
P.O. Box 4
Kalispell, MT 59903

Dept. of the Army
Walla Walla District
Corps of Engineers
CENPWPL-ER
Walla Walla, WA 99362-9265

November 11, 1992

Gentlemen:

Thank you for the opportunity to comment on the Supplemental Environmental Impact Statement. Being a sportsmens group in western Montana, we have a sincere interest in the welfare of fish and wildlife wherever they occur, however, we also have concerns for the local environment. In that light we respectfully submit the following comments:

A3-1 We feel that Hungry Horse and Libby dams were operated in an abnormal regime in 1992 and thus should not be used as a "normal" base for reference. Also it should be noted that daily fluctuations in discharge at both dams likely impact resident fish

A3-2 populations as severely as annual fluctuations. If resident fish populations are adversely affected by salmon recovery regimes, then mitigation expenses and efforts are wasted.

It should be noted that petitions have been filed with the

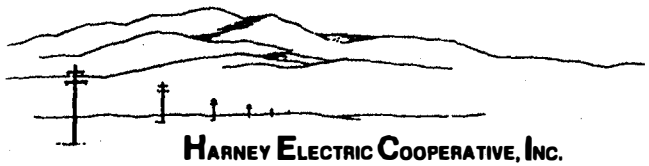
A3-3 U.S. Fish and Wildlife Service for listing under the Endangered Species Act for both white sturgeon in the Kootenai River and for bull trout in the Flathead River. We would hope, perhaps naively, that our endangered species would have as much clout as someone else's.

We, like a lot of other Montanans, fear that changes in the

A3-4 reservoir drawdowns will result in the pools not reaching "full pool elevations in some years and the subsequent drawdown then would have severe consequences for fish populations, recreationists, and the environment. Nowhere in the SEIS did we find a "what if".

Herbert Johnson
Secretary

HARNEY ELECTRIC COOPERATIVE, INC.
(JACK HEASTON)



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FIELDS, OREGON

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November 12, 1992

Lt. Col. Robert D. Volz, District Engineer
Department of the Army
Walla Walla District, Corps of Engineers
ATTN: CENPW-PL-ER
Walla Walla, WA 99362-9265

Re: Draft SEIS - Columbia and Snake Rivers Flow Improvement Measures

Dear Lieutenant Colonel Volz

Thank you for the opportunity to comment on the Draft SEIS.

It would certainly be pretentious for us at Harney Electric, a little electric co-op out in the eastern Oregon desert, to proclaim ourselves experts and sufficiently well acquainted with all aspects of your draft SEIS to offer detailed technical comment. We have neither the expertise, staff nor inclination to read the draft from cover to cover, make eny sense of it et all and come up with substantive conclusions as to its adequacy. However, since this can be nearly universally applied to all other respondents, and it certainly isn't going to slow them down noticeably, we ask that the following comments be included in your deliberations in whatever it is you finally come up with es regards hydro operations end flows.

A4-1 It seems to us that despite the protestations of a few groups long on rhetoric end short on common sense, there is virtually no scientific evidence whatsoevar that flows or drawdowns would likely heve any statistically significant effect on smolt travel times. It sounds good, makes really great speech material, but it just doesn't fly. In fact, there are two studies quoted in Mr. Darryll Olson's November 10, 1992 technical memorandum to you, whose findings clearly state there is no causal relationship between flows and travel time.

Others feel that flows could actually harm the fish we ere trying to help. It's pretty obvious that various flow augmentation schemes end drawdowns have serious impacts to other river-oriented resources. It remains quite surprising to us that flows are even being considered es a viable alternative. In fact, politics and mollifying the shrill screams of the extremists aside, why are you seriously thinking about it?

We view flows or drawdowns or whatever to be just another handy self-serving solution. One of those things that sounds good but doesn't really accomplish anything. We're opposed to those kinds of convenient single issue fixes to complex problems. Therefore, we can't see the value in flows, especially in light of the potential for harm to target species, scientific evidence to the effect they don't decrease travel time (We aren't evan convinced that travel time is ail that big a deal in smolt survival anyway.) and the obvious deleterious effects on other river-oriented resources.

A4-2 Lastly, wa would urge that whatever comas of this ba subjected to a cost effectiveness acrutiny to reduce the likelihood that what we're really buying here is stock in some cleverly-veiled extremist agenda, grants, entitlements and imaginary administrative expense reimbursements, and, mora staff, staff meetings, coffee breaks and PCs for unnecessary agency personnel.

Thank you for considering our views. We don't envy you your task.

Sincerely,

Jack Heaston
general manager

WESTERN MONTANA ELECTRIC GENERATING & TRANSMISSION COOPERATIVE, INC.
(RONALD H. WILKERSON)

WESTERN MONTANA ELECTRIC

GENERATING & TRANSMISSION COOPERATIVE, INC.

1209 Mount Ave.
Missoula, MT 59801-5601

(406) 721-0945
FAX (406) 721-3738



November 12, 1992

Lieutenant Colonel Robert D. Volz
District Engineer
Department of the Army, Walla-Walla District
Corps of Engineers
Attention: CENPW-PL-ER
Walla Walla, WA 99362-9265

Dear Colonel Volz:

The purpose of this letter is to submit comments regarding the draft Supplemental Environmental ImpactStatement, Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon. The members of the Western Montana Electric Generating & Transmission Cooperative, Inc. (Western Montana G&T) as identified at the bottom of this page are each a full requirements customer of the Bonneville Power Administration (BPA). As such, we are concerned about the constraints on power generation and reduced reservoir levels caused by increasing flows to accommodate fish and wildlife.

Our comments follow:

A5-1 | 1. In the Executive Summary, Section 1.4 Scope, paragraph 3; the statement is made *"Based on the assumption that the rate of juvenile salmon travel is directly related to water velocity, it is possible that improved flow conditions in the Lower Snake and Lower Columbia Rivers will increase survival of salmon in the Columbia River Basin."* This is one big assumption! Tremendous amounts of money have been spent, and are in the process of being spent, based upon this assumption. This assumption must be validated before major additional flow enhancement measures are taken. Even if the assumption is correct, we must still examine the cost effectiveness of the alternatives of: 1) increasing the flows, and 2) transporting the juvenile salmon by barge or truck. The lowest cost alternative should be pursued.

A5-2 | 2. In the Executive Summary, Page 5, Section 2.2, Alternative 2: 1992 Operations, second bullet, third subparagraph; it is noted that in the upper Snake River 190,000 acre feet from April 15 to June 15 would be acquired via purchase. Is this purchase funded by BPA ratepayers?

A5-3 | 3. In the Executive Summary, Page 6, Section 2.3, Alternative 3: 1992 Operations With Libby/Hungry Horse Sensitivity, mention is made of running the hydro-regulation models with Libby and Hungry Horse "fixed" in their normal operating patterns. Please be aware there is interest on the part of the Montana Department of Fish, Wildlife & Parks, and others, to modify the "normal" operation of Hungry Horse and Libby to improve conditions for resident fish. It is certainly possible some operational changes will be made in the future.

A5-4 | 4. In the Executive Summary, Page 8, Section 3.1, Juvenile Fish Survival, third paragraph on Page 8; mention is made of the squawfish management program to reduce predator influence on fish survival. In a later paragraph it is mentioned the NPPC SPM lifecycle model includes some recognition of predator control activities. Do any of these models recognize a difference in the level of predator impact as a result of different flow characteristics? Common sense would lead one to believe predator activities could be altered as the flows and the velocities are changed.

Also, this may be an appropriate point to mention that all predators should be examined as to their impact on salmon including mammals at the mouth of the Columbia River. We should insure we aren't working against ourselves by increasing the population of species which naturally prey upon juvenile salmon. For instance, do other game fish consume salmon smolts? And if so, should we increase the harvest of such species in order to decrease the predation on salmon? What influence do shad have on salmon? It is my understanding the population of shad has increased tremendously in the Columbia River in the last ten years. Is it coincidence that during this same period some of the weak stocks have continued to decrease?

A5-5 | 5. Chapter 2, Pages 2-16, under discussion of "Water Budget." The existence of the water budget is mentioned but nothing is said about the benefits of such water budget. The water budget has been in existence for about ten years or more. Has there been a commensurate increase in the juvenile survival during that period? Does the data show that increased flows of the water budget have been helpful? Or, is it coincidence that some of the weak stocks continue to decrease?

A5-6 | 6. Chapter 2, Page 2.29. Activities are continuing with regard to listing of Kootenai River white sturgeon and bull trout as threatened or endangered species. The final EIS should capture the current status as best possible.

A5-7 | 7. Chapter 3, Page 3-8, under Section 3.2.3, second paragraph. Did BPA rent the water from Cascade and Deadwood Reservoirs? If so, please register our concern that here again more money is being spent because of a presumption that increased flows will help solve the salmon problem.

WESTERN MONTANA ELECTRIC GENERATING & TRANSMISSION COOPERATIVE, INC.

(RONALD H. WILKERSON)

A5-8 8. Chapter 4, Page 4-15, under "Harvest Reductions." It should be noted there is a difference between harvest rates and harvest levels. We favor establishing harvest levels or escapement targets rather than harvest rates. Harvest rates simply allow the improvement, if there is some, to be partially offset by increased harvest.

A5-9 I suggest some information contained in appendix A regarding harvest be brought forward into the text on page 4-15. Most readers are probably not aware that according to the NMFS Biological Opinion (1992) harvest accounts for about 6-11% and 31-39% of the human-induced mortality of Snake River spring/summer, and fall chinook, respectively.

A5-10 9. Chapter 4, Page 4-41. The opinion is expressed "One year of deeper drafting of the reservoir (Hungry Horse) would not likely have a major effect on the reservoir's aquatic resources." We agree. Although there may be some impact for a short period, the aquatic resources will quickly recover. As a non-biologist, but with substantial experience of observing fishing in various man-made reservoirs, fish have an amazing ability to adjust rapidly to changing habitat. This is also true with biological adjustments to cope with dynamic changes resulting from introduced species. The Flathead drainage below Hungry Horse is an excellent example. The kokanee, the lake trout, the Lake Superior white fish, and rainbow trout are all introduced species of the Flathead System below Hungry Horse. Recent (mid 1980's) introduction of mysis shrimp in Flathead Lake has caused a rapid change in the populations of the various species, including virtual disappearance of kokanee. Such change is continuing at a relatively fast rate. The existence of and operations at Hungry Horse Dam were virtually non-factors in the "crash" of the kokanee population in Flathead Lake.

We wish to thank you for the opportunity to comment. We are relying upon the Corps of Engineers as the most professional and non-political entity in the Pacific Northwest involved in the fish management activities. We urge you to continue to separate fact from fiction and to ensure your actions are based upon science and good engineering. You have a difficult task -- but someone needs to do it!

Sincerely,

Ronald H. Wilkerson

Ronald H. Wilkerson
Manager

RHW:wsh

cc: Trustees, Alternates
Member System Managers

STANLEY-SAWTOOTH CHAMBER OF COMMERCE

(TOM STUART)

STANLEY-SAWTOOTH CHAMBER OF COMMERCE
Stanley, Idaho 83278

Lt Col Robert D. Volz. District Engineer
US Army Corps of Engineers
Walla Walla. Washington

16 Nov 93

Dear Col Volz.

Attached find my comments and recommendations on the Draft Interim Flow SEIS. I appreciate the meeting in Boise for public input. although I was personally unable to attend.

Note that I have criticized the adequacy of all operating alternatives discussed in the SEIS. and have offered specific additional measures that can be easily engineered and implemented in 1993. 1994. and 1995.

I encourage the Corps to take a leading role in mainstem passage improvements for Salmon. Turn your staff "loose", to develop higher water velocities and shorter migration times for fish.

Regards.

Tom Stuart. Stanley Chamber of Commerce
2301 Hillway Dr
Boise. Idaho 83702

COMMENT SUMMARY FOR Army Corps of Engineers
BOISE, IDAHO, 12 Nov 92

A6-1 CONTEXT: COE and others assisting in interim flow recommendations are not taking sufficient action with regard to Snake River Salmon stocks. Biological needs are being subordinated to the needs of power generation, and to the inertia of "business as usual". Draft SEIS operating alternatives do not offer a broad enough range of options, and the alternatives offered all place Salmon stocks in continued jeopardy. National and regional consensus requires significantly stronger steps.

REFERENCE: Background and context of Draft SEIS, Interim Flow Improvement Measures, October 1992.

A6-2 1. The need for changes to hydrosystem operations is well known, as stated in the draft SEIS, page 1-1:

"In summary, changes to the previous operations of the Columbia-Snake River system are needed to avoid the continued decline and to contribute to the recovery of these Salmon stocks."

We concur. Without order of magnitude improvements in the hydrosystem, stock collapse cannot be reversed in available time.

A6-3 2. The 1992 operation of the Snake/Columbia system was a disaster for Salmon. 1992 interim plan was rationalized in part, and approved by NMFS, by the following flow histories charted in the draft SEIS, chapter 3:

Table 3.5-2. Median monthly flows at Lower Granite by alternative.

Alternative	Flows (kcfs)[a] April 16-30	May	June	July	August 1-15
1. No Action	81.7	95.8	90.9	37.2	22.7
2. 1992 Operations	83.8	100.0	91.3	38.0	27.4
3. 1992 Operations, LIB/HGH Sensitivity	83.8	100.0	91.3	38.0	27.4
4. Modified 1992 Operations	85.3	100.0	91.3	39.7	29.0
5. Modified 1992 Operations, Upper Snake Sensitivity	84.9	99.9	91.3	39.5	24.1

Note that higher flow recommendations of the Fish Passage Center, tribes, and ID, OR, WA fishery agencies were not used in this judgment; all flows estimated above are in fact insufficient to reverse stock collapse.

STANLEY-SAWTOOTH CHAMBER OF COMMERCE

(TOM STUART)

A6-4 3. Actual flows achieved in the Lower Snake during the 92 migration were disastrous, averaging only 48 kcfs under the 1992 operating plan. Plans must be made for variations in individual water years. Hindsight verifies that the NMFS 1992 "no jeopardy" opinion was clearly in error. COE, BPA, et al should not expect to justify incidental take in the 60-90% range for listed species, with these flow regimes.

A6-5 4. NMFS stated in the 1992 opinion that additional measures must be taken in 93 and later years. The SEIS recalls:

"This SEIS is a direct outgrowth of the NMFS consultation on the 1992 operations plan. NMFS indicated its concern that merely continuing to operate the Columbia River Power System under the 1992 plan would not be sufficient to reverse the decline of salmon populations. It indicated that additional steps would likely be needed in 1993 and future years..."

Nothing is offered in the draft SEIS alternatives beyond 1992 protocols. In fact, all options discussed are lethal for Salmon, and will be rejected as "jeopardy" plans. In fact, the net effect in the "preferred alternative" is less than 5% flow increase during the Spring migration over the no-action option. COE, BPA, et al must develop alternatives that achieve significant flow improvements, 120kcfs flow equivalent at LGD, and 250 kcfs in the Lower Columbia, including drawdowns if necessary.

A6-6 5. Real actions to be accomplished in 93, 94, 95 for Salmon are not addressed in the SEIS. These include:

1993:
1. Drawdown Snake Reservoirs as needed to achieve 120kcfs equivalent at LGD. Spill maximum smolts, while balancing spill and generation to minimize dissolved gases.
2. Begin pump mods, marina mods, port mods in Snake pools.
3. Begin prototype modification of LGD to pass juvenile and adult fish with reservoir levels near Spillway crest.
4. Augment Columbia flows to meet 250kcfs minimum.
5. Begin extension of pumps in John Day pool, to accommodate MOP in 1994.

1994:
1. Repeat 93 flow actions in Snake and Columbia.
2. Complete mods in Snake pools of pumps and structures for 4-pool drawdown below MOP.
3. Continue prototype mod of LGD.
4. Complete irrigation pump extensions in John Day pool.

A6-6 (cont.)

1995:
1. Drawdown LGD to near spillway crest during migration.
2. Begin mods of other 3 Snake projects based on prototype experience.
3. Drawdown other 3 Snake projects as needed to maintain 120kcfs equivalent during migration.
4. Operate John Day at MOP.
5. Augment Columbia to meet 100% of CBFWA recommendations.

In summary, this draft SEIS is not sufficient. Necessary program changes have been omitted. Flow alternatives discussed offer insignificant changes, with lethal consequences demonstrated in 1992 flow averages. I urge COE and BPA to take the lead in addressing the real problems with real options. Thanks for the chance to comment.

Tom Stuart
Boise, Idaho

AGRINORTHWEST

(R. THOMAS MACKAY)

AgriNorthwest

P.O. BOX 2308, TRI-CITIES, WA 99302-2308
509-735-6461

November 17, 1992

Department of the Army
Walla Walla District, Corps of Engineers
Attn: CENPW-PL-ER
Walla Walla, Washington 99362-9265

RE: Draft SEIS - Interim Columbia and Snake River Flow Improvement Measures for Salmon.

A7-1 The Corps of Engineers must be commended in general for the quality and content of the SEIS. It appears that the Corps have attempted to use the salmon life-cycle models in determining system operation impacts. The Corps must also continue to include cost-effectiveness analyses as it determines a future system operations plan. The goal of any recovery plan must be to improve the number of adult fish returning to Idaho waters.

A7-2 We generally support the decision to make Alternative 4 (modified 1992 operations) as the preferred system operations action. The smolt survival benefits under each of the components within Alternative 4 should be analyzed independently. The uncertainty of the smolt survival benefits associated with drawdowns and flow augmentation must be weighed before any drawdown scenario is accepted. Each individual component must provide improvements to smolt survival.

A7-3 Recovery measures must be based on both the biological benefits and the cost-effectiveness of the alternatives. We continue to believe that effective transportation provides the quickest and best opportunity for improved salmon survival within the river system.

A7-4 We believe additional study of key additional plan measures is necessary before any plan is adopted. These key measures include: in-river commercial harvest reductions; habitat improvements; NPPC flow augmentation; transportation improvements; predator control and reservoir drawdowns.

We believe the Corps can provide a significant service to the Northwest by studying the alternatives and choosing a best cost-effective approach to the salmon recovery effort.

R. Thomas Mackay
Vice President-Finance

2810 WEST CLEARWATER AVE.
KENNEWICK, WA 99336

AGRINORTHWEST
(J. RODNEY LARSON)

AgriNorthwest
P.O. BOX 2308, TRI-CITIES, WA 99302
509-735-6461

November 18, 1992

Department of the Army
Walla Walla District, Corps of Engineers
Attn: CENPW.PL.ER
Walla Walla, Washington 99362-9265

Re: Draft Seis-Interim Columbia and Snake River Flow Improvement Measures for Salmon.

A8-1 Let me compliment the Corps of Engineers for the quality and content of the SIES. In general the Corp has attempted to use the Salmon life-Cycle model in determining system operation impacts. It is also very important that the Corps continue to utilize cost effectiveness analyses as a future system operation plan is determined.

A8-2 At this time we support using alternative 4 (modified 1992 operation) as the preferred system operation action. Smolt survival benefits need to be analyzed independently for each component within alternative #4 Since it is apperently uncertain that draw down has any benefit to smolt survival. Flow augmentation must be fully evaluated before draw down is accepted, if there is not significant improvement in smolt survival then why do it.

A8-3 Biological benefits and cost effectivness must be the central theme of any recovery measures. It appears that effective transportation continues to provide the quickest and best opportunity for Salmon survival.

There must be additional studies of key plan measures before a recovery plan is adopted.

A8-4 Areas of concern include:

1-Commercial Harveat Reductions
2-Habitat Improvements
3-NPPC Flow Augmentation
4-Transportation Improvements
5-Predator Control
6-Reservior Drawdowns

A further study of these areas would provide for a better cost effective decision to be made.

Once again I would like to take the opportunity to commend the Corp in it's efforts.

Sincerely;

J. Rodney Larson
Area Director/Prior West Farm
JRL/jd

8701 WEST GAGE BLVD.
KENNEWICK, WA 99336

AGRINORTHWEST, INC.

(D. JEFFREY MASON)

November 18, 1992

Department of the Army
Walla Walla District, Corps of Engineers
ATTN: CENPW-PL-ER
Walla Walla, WA 99362-9265

RE: Draft SEIS - Interim Columbia and Snake River
Flow Measures for Salmon

A9-1 The use of the salmon life cycle models by the Corps of Engineers to determine system operations impacts on salmon is a very much needed improvement. The Corp is to be commended for the overall quality of the SEIS. It seems to me that any future system operations plan must continue to include cost-effectiveness analysis. The goal of any recovery is plan not just to get the smolts to the ocean but to improve the numbers of adult fish returning to Idaho tributaries.

A9-2 Alternative 4 (modified 1992 operations) is a very supportable operation action. Any uncertainty about smolt survival benefits associated with drawdowns must be carefully weighed before any drawdown plan is accepted. The survival benefits under each of the components within alternative 4 should be analyzed independently. If each component doesn't provide for improved smolt survival rates then it should not be included in the plan.

A9-3 Drawdown is only one facet of the plan. Additional study needs to be made in such areas as in-river commercial harvest reductions; NPPC flow augmentation; transportation improvements; habitat improvements; and predator control. Biological benefits and cost effectiveness of all of the alternatives must be the basis for any recovery measures.

We appreciate the Corps role in studying the alternatives and believe that the Corps can provide a significant service to this region by choosing a best cost-effective approach to the salmon recovery effort.

D. Jeffrey Mason
Area Director - AgriNorthwest, Inc.

JM:pm

MONTANA WILDLFE FEDERATION

(HERBERT B. JOHNSON)

P.O. Box 1175
Helena, MT 59624

1990 Outstanding State Affiliate of the National Wildlife Federation

Dept. of the Army
Walla Walla District
Corps of Engineers
CENPWPL-ER
Walla Walla, WA 99362-9265

November 18, 1992

Gentlemen:

Thank you for the opportunity to comment on the Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon Supplemental Environmental Impact Statement. The Montana Wildlife Federation is very much interested in the welfare of wildlife and in the recovery of threatened or endangered species.

A10-1 In the draft SEIS options one, two, and four refer to a "no-change" operation for Libby and Hungry Horse dams based on 1992 operation. We believe that the dams were not operated at "normal" in 1992 and would not like to see 1992 operation used as a base for future comparisons.

A10-2 Both Kootenai and Flathead Rivers have extensive lengths of river below the dams with important recreational values - values that are directly affected by the operation of the dams. These values need to be addressed. The SEIS seems to be totally engrossed in pool fluctuations. Daily fluctuations in dam operation was not discussed in the SEIS and may not be within the scope of the assessment, but daily operations impact resident populations as severely as annual operations.

A10-3 In summary, while we endorse the salmon recovery program wholeheartedly and certainly hope for success, the welfare of resident species must be considered also.

Herbert B. Johnson
Director

MERCER RANCH
(RICHARD T. BEIGHTOL)

MERCER RANCH
QUALITY WASHINGTON GROWN VEGETABLES
46 SONOVA ROAD, PROSSER, WASHINGTON 99350 -- 509/894-4773 FAX 509/894-4965

NOVEMBER 11, 1992

LT. COL. ROBERT D. VOLTZ, ARMY CORPS OF ENGINEERS
WALLA WALLA DISTRICT
WALLA SWALLA, WA 99362-9265

RE: COMMENTS ON DRAFT INTERIM COLUHBIA AND SNAKE RIVERS FLOW IMPROVEMENT HEASURES FOR SALHON--DRAFT SUPPLEHENTAL ENVIRONHENTAL IHPACT STATEHENT(SEIS)

DEAR COLONEL VOLTZ

HY NAHE IS RICHARD T. BEIGHTOL. I AH THE VICE PRESIDENT OF OPERATIONS AT HERCER RANCHES INC.

HERCER RANCH IS A FAHILY OWNED FARH IN SOUTH EASTERN WASHINGTON. WE PUHP WATER FROH THE COLUHBIA RIVER(JOHN DAY POOL) AND IRRIGATE 3500 ACRES. WE PRODUCE POTATOES, CARROTS, AND CORN. HERCER RANCH EHPLOYS 50 PEOPLE ON A YEAR ROUND BASIS AND UP TO 200 PEOPLE DURING PEAK HARVEST SEASON.

I SUPPORT THE NATIONAL HARINE FISHERIES SERVICE AND THE REGIONS EFFORTS TO RESTORE THE SALHON RUNS AND PROTECT ENDANGERED SPECIES. I BELIEVE THAT THIS CAN BE DONE WHILE HAINTAINING A STRONG NORTHWEST ECONOHY WHICH IS SO IHPORTANT TO ALL OF US.

I BELIEVE THAT THE CORPS OF ENGINEERS UNDER YOUR LEADERSHIP HAS EXHIBITED EXTREHE COURAGE AND GOOD JUDGHENT IN THE HANAGEHENT AND OPERATION OF OUR RIVER SYSTEH THROUGHOUT THE ENDANGERED SALHON ISSUE. THE CORPS HAS DEHANDED GOOD SCIENTIFIC AND ECONOHIC JUSTIFICATION FOR PROPOSED RIVER HANAGEHENT CHANGES. I COHHEND AND THANK YOU FOR THIS.

I APPRECIATE THE OPPORTUNITY TO PARTICIPATE IN THIS PUBLIC INVOLVEHENT PROCESS.

I AH DEEPLY CONCERNED ABOUT FLOW PROPOSALS RELATING TO THE JOHN DAY POOL.

I HAVE SPECIFIC CONCERNS AND RECOHHENDATIONS THAT I WOULD LIKE TO HAVE INCLUDED IN THE FINAL SUPPLEHENTAL ENVIRONHENTAL IHPACT STATEHENT.(SEIS)

MERCER RANCH
QUALITY WASHINGTON GROWN VEGETABLES
46 SONOVA ROAD, PROSSER, WASHINGTON 99350 -- 509/894-4773 FAX 509/894-4965

DRAW DOWNS

A11-1 ALTERNATIVES 2 THROUGH 5 INCLUDE DRAWING DOWN THE LOWER SNAKE RIVER POOLS AND THE JOHN DAY POOL TO ENHANCE SHOLT SURVIVAL. ARE DRAW DOWNS AN EFFECTIVE HEANS OF ACHIEVING THIS GOAL? RESEARCH WORK DONE BY THE NATIONAL HARINE FISHERIES SERVICE, NORTHWEST FISHERIES SCIENCE CENTER, TITLED PIT-TAGGED SPRING AND SUHHER CHINOOK SALHON DETECTION RATES COHPARED WITH SNAKE RIVER FLOW AT LOWER GRANITE DAH, INDICATES THAT THERE ARE ENVIRONHENTAL AND PHYSIOLOGICAL FACTORS IN ADDITION TO FLOW THAT INFLUENCE HOVEHENT PATTERNS OF FISH. QUOTING FROH THEIR REPORT,"OUR OBSERVATIONS AT LOWER GRANITE DAH INDICATE THAT PRIOR TO HAY 14 IN 1989-91(BY WHICH TIHE 90-95% OF THE OUTHIGRATION HAD PASSED), FLOW HAD LITTLE EFFECT ON THE DYNAHICS OF THE OUTHIGRATION OF HATCHERY OR WILD SPRING/SUHHER CHINOOK SALHON POPULATIONS". THIS DATA CLEARLY SHOWS THAT THE ASSUHPTION THAT SURVIVAL RATES, HIGHT BE BETTER, IF WE COULD, INCREASE RIVER VELOCITIES, IS SERIOUSLY FLAWED. (ENCLOSURE, QUARTERLY REPORT)

I WOULD LIKE TO ENCOURAGE THE CORPS TO CONTINUE SCIENTIFIC EVALUATION OF THE BENEFITS FROH FLOW AUGHENTATION.

ECONOHIC IHPACT

A11-2 THE EXECUTIVE SUHHARY IDENTIFIES THE COST OF ALTERNATIVE NUHBER 4 AT $66 TO $93 HILLION DOLLARS. I BELIEVE THAT THE IHPACT TO THE PRIORITY FIRH POWER RATE SHOULD BE INCLUDED IN THE EXECUTIVE SUHHERY AND IN SECTION 4.9 "ELECTRIC POWER". THIS WOULD GIVE RATE PAYERS THE OPPORTUNITY TO EVALUATE THE IHPACT TO THEIR RESPECTIVE POWER COSTS.

A11-3 ON OUR FARH THE INCREASED PUHPING HEAD (3%) AND THE PROJECTED INCREASE IN POWER COST COULD RAISE PRODUCTION COSTS BY APPROXIHATELY $20,000 DOLLARS ANNUALLY.

A11-4 IS ALTERNATIVE NUHBER 4 THE HOST COST EFFECTIVE HETHOD OF INCREASING SHOLT SURVIVAL? I BELIEVE WE OWE IT TO THE FISH TO AND TO THE RATE PAYERS TO HAXIHIZE THE BIOLOGICAL BENEFIT FOR EVERY DOLLAR SPENT ON RECOVERY. I WOULD ENCOURAGE THE CORPS TO CONTINUE TO USE ECONOHIC ANALYSIS OF ALL PROPOSED RECOVERY HEASURES.

MERCER RANCH
(RICHARD T. BEIGHTOL)

MERCER RANCH
QUALITY WASHINGTON GROWN VEGETABLES
46 SONOVA ROAD, PROSSER, WASHINGTON 99350 — 509/894-4773 FAX 509/894-4355

TRANSPORTATION

A11-5 I SUPPORT THE NATIONAL MARINE FISHERIES SERVICE AND THE CORPS OF ENGINEERS IN THEIR EFFORTS TO INCREASE THE NUMBER OF TRANSPORTED SHOLT. SCIENTIFIC DATA INDICATES THAT TRANSPORTED SHOLT SURVIVAL RATES CAN BE 5 TIHES THAT OF NON TRANSPORTED AND THAT THE BEST RESULTS ARE ACHIEVED WITH WILD FISH. I DO NOT BELIEVE THAT WE SHOULD PUNISH THE FISH BECAUSE A FEW PEOPLE IN THE REGION WOULD LIKE TO LIVE IN THE PAST.

IS TRANSPORTATION THE MOST RELIABLE, COST EFFECTIVE AND BIOLOGICALLY SOUND WAY TO MOVE SMOLTS THROUGH THE RIVER SYSTEM? I BELIEVE THAT IT IS AND I WOULD ENCOURAGE THE CORPS TO AGGRESSIVELY PURSUE INCREASED TRANSPORTATION CAPABILITY AND CONTINUED TRANSPORTATION RESEARCH.

I BELIEVE THAT ON NOVEMBER 3 THE PEOPLE OF THIS COUNTRY GAVE PRESIDENT ELECT CLINTON A CLEAR MANDATE TO RESTORE THE ECONOMY AND THE WORLDWIDE COMPETITIVENESS OF THIS COUNTRY. IT IS PARAMOUNT THAT WE ALL WORK TOGETHER TO ACHIEVE THIS GOAL. OUR STRENGTH LIES IN OUR ABILITY TO MAINTAIN A HEALTHY ECONOMY. IT IS OUR ECONOMIC STRENGTH THAT ALLOWS US THE OPPORTUNITY SAVE THE SALMON.

IF WE WORK TOGETHER WE CAN RESTORE THE SALMON RUNS AND THE ECONOMY.

SINCERELY

RICHARD T. BEIGHTOL, FARMER

ENCLOSURE

FLATHEAD BASIN COMMISSION
(ELNA DARROW)

FLATHEAD BASIN COMMISSION

EXECUTIVE DIRECTOR
OFFICE OF THE GOVERNOR
CAPITOL STATION
HELENA, MT 59620
(406)444-3111

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COMMENTS OF THE FLATHEAD BASIN COMMISSION
on:
Draft Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon Draft Supplemental Environmental Impact Statement

A12-1 The Flathead Basin Commission is pleased that the agencies involved in operating the Columbia River system have heeded the request of the Commission and others to Supplement the EIS [prepared for changes in river operation due to salmon recovery efforts] to reflect the fact that such system changes would affect the operations of Hungry Horse Reservoir. You do allege that the effects are very small.

We have some reservations.

A12-2 You are trying to take good care of anadromous fish; you really short your analysis of effects of operations on bull trout in this ecosystem. The petition for Bull Trout listing is just the most recent effort in the region to protect this fish: existing BPA-funded mitigation plans include efforts to change operations at Hungry Horse to reduce impacts of HH operation on resident fish. The general acceptance of this plan among fisheries scientists and affected groups indicates that present operation is already not good enough–this was a bad year to use as a benchmark–the standard to be used anywhere should recognize current operation as inadequate for resident fish.

A12-3 We urge that the agencies consider developing a long-term marketing strategy for power that would make possible more fall and winter storage of water, with increased sales of power in the spring, when natural river operations could be approximated.

A12-4 Generally, we subscribe to the analysis of the Montana office of the NPPC on this issue and urge agencies to consider that analysis along with our comments in turning the SEIS into a Final EIS.

signed:

Elna Darrow

Elna Darrow, Chair, SOR Committee

IDAHO RIVERS UNITED
(CHARLES RAY)

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Jerry Myers
Salmon
Gerald Sehlke
Idaho Falls
Philip Szuromi
Moscow

Dec. 6, 1992

Lt. Col. Robert Volz
Dept. of the Army
Walla Walla District, COE
ATTN: CENPW-PL-ER
Walla Walla, WA 99362-9265

Re: SEIS, Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon

Lt. Col. Volz,

Thank you for the opportunity to comment on the SEIS. Please accept the following comments.

Idaho Rivers United (IRU) is a private, non-profit conservation organization that represents over 700 individuals and 20 member organizations.

The range of alternatives presented in the SEIS fails to meet the requirements of the National Environmental Policy Act. All action alternatives are virtually identical, only differing in name. A13-1

IRU requests that this SEIS be withdrawn and re-issued for comment after alternatives are developed that actually improve flows, sharply define the issues, and give the decisionmaker a clear basis for choice, as required by NEPA.

IRU requests that at least one alternative that provides the CBFWA flow recommendations be developed and analyzed. IRU requests that a full range of measures, utilizing all available means for improving flows, be developed and analyzed in a revised SEIS. A13-2

Thank you.

Charles Ray

Charles Ray
Idaho Rivers United

VALLEY CONSERVATION DISTRICT
(KEN POSTMA)



Valley Soil Conservation ...rict
P O Box 200
Donnelly, Idaho 83...
Phone: 325-8567

April 30, 1992

Regional Director
Bureau of Reclamation
Attention PN-150
Box 43, 550 West Fort Street
Boise, ID 83724

RE: Comments on Draft EA for Management of the Uncontracted Space in Cascade and Deadwood Reservoirs

The Valley Soil Conservation District (VSCD), in cooperation with the Idaho Soil Conservation Commission, the Idaho Department of Health and Welfare-Division of Environmental Quality, and the USDA-Soil Conservation Service, has entered into the implementation phase of its Agricultural Pollution Abatement Plan for the Cascade Reservoir watershed. The main thrust of this plan is the reduction of nutrients and sedimentation from agricultural lands in Cascade Reservoir watershed, resulting in an improvement in water quality in the reservoir. The VSCD has spent or committed funds through various grants and cost-share programs totaling over one and one-quarter million dollars for the purpose of improving water quality in Cascade Reservoir. Additionally, the District plans to continue working toward improved water quality by implementing further cost-share programs on several of the contributing tributaries. With these water quality issues in mind, the VSCD Board of Supervisors has reviewed the Bureau of Reclamation's Draft Environmental Assessment for Management of the Uncontracted Storage Space in Cascade and Deadwood Reservoirs. We feel that VSCD should be included in the annual evaluation procedure (pg. 13) and submit the following comments:

1. Our combination of Alternatives does not seem to be addressed in the Bureau's Environmental Assessment.
2. Seasonal shifts in reservoir releases under Alternative A and C are projected to have negative impact on reservoir water quality. (page 31, paragraph 1)
3. Seasonal shifts in reservoir releases would also occur under many of the potential uses of the 72,000 acre feet of uncontracted storage under Alternative B and D. (page 32, paragraph 3)
4. We support the sale of 300,000 acre feet of Cascade Reservoir to the State of Idaho to established a permanent conservation pool.
5. We also support the addition of the uncontracted 72,000 acre feet to the conservation pool, whether through sale to the State of Idaho or through a Memorandum of Understanding with the State Water Resource Board, bringing the permanent conservation pool to an elevation of 4813 feet, or 372,000 acre feet.

Thank you for the opportunity to comment on this matter.

Sincerely,

Barry A Holloway

Barry Holloway, Chairman
Valley Soil Conservation District

PACIFIC NORTHWEST WATERWAYS ASSOCIATION
(GLENN VANSELOW, Ph.D.)

PNWA
P.O. Box 61473, Vancouver, Washington 98666-1473
Pacific Northwest Waterways Association FAX: (206) 699-5121 Telephone: (206) 699-4666

December 7, 1992

FAXED TO:

Mr. Peter Poolman
SEIS Manager
Department of the Army
Walla Walla District
Corps of Engineers
Walla Walla, WA 99362-2965

Dear Mr. Poolman:

Comments on Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon, Draft Supplemental Environmental Impact Statement.

A14-1 **PNWA supports the Preferred Alternative with qualifications:**

The Pacific Northwest Waterways Association has, from the beginning of the Salmon Summit, endorsed a comprehensive planning approach to recovering the listed runs of Snake River salmon.

We were pleased to see cost effectiveness identified as one of the key evaluation criteria. Since it seeks the greatest biological benefit at the least cost, we believe that it is the standard that should be used in the selection of the preferred alternative. However, we believe that, for the cost-effectiveness criterion to be appropriately applied, it must be applied across the full range of alternatives available, not just the mainstem flow alternatives. Changes in river operations should not be instituted as long-term recovery measures if other non-river operations measures provide more cost effective solutions.

Therefore, we support the implementation of the preferred alternative as an interim measure until such time as a more comprehensive analysis is completed to address flow measures in the context of other non-river operation measures.

PNWA has Specific Concerns:

A14-2 **Drawdowns below M.O.P.** PNWA continues to oppose reservoir drawdowns (Draft SEIS, p. 3-10) below M.O.P. on the Snake River and below minimum irrigation pool on the John Day reservoir unless they are demonstrated to be biologically effective and the least-cost alternative to achieving Endangered Species Act required rebuilding objectives.

A14-3 **Smolt Transportation.** The alternatives analysis did not sufficiently address transportation improvements as alternatives to flow (Draft SEIS, p. 3-11). Several transportation improvements are being analyzed by the Corps in the System Configuration Study. That analysis should be incorporated into the SEIS, and potentially beneficial alternatives should be incorporated into the preferred alternative. Examples include constructing and testing mobile net pens, reducing fish densities in barges, slowing barge travel to more closely approximate in-river migration, selection of alternative release sites and the use of holding pens for acclimation at release.

NMFS' conclusion that transport is beneficial under all flow conditions and recently released data from the NMFS' evaluation of transportation that show a transportation-benefit ratio greater than 2:1 (Draft SEIS, p. 2-15), justify greater attention to transportation as the most cost-effective measure for improving mainstem survival.

A14-4 **Implementation.** PNWA has appreciated the responsiveness of the Corps of Engineers in implementing the 1992 emergency dredging program to maintain the operational capabilities of ports and river facilities at M.O.P. We request that the Corps exercise the authority granted in the Water Resources Development Act of 1992 to dredge those ports and facilities identified in the draft SEIS which are not fully operational at M.O.P. (Draft SEIS, pp. 4-62, 4-75) during the January-February 1993 Snake River dredge window.

We appreciate the opportunity to comment and would be happy to assist as the Corps completes the final SEIS.

Sincerely,

PACIFIC NORTHWEST WATERWAYS ASSOCIATION

GLENN VANSELOW, Ph.D.
Executive Director

VALLEY CONSERVATION DISTRICT
(KEN POSTMA)

Valley Conservation District
[illegible]
Phone 325 [illegible]

May 20, 1992

TO: Regional Director
Bureau of Reclamation
Box 43, 550 W. Fort Street
Boise, ID 83724

RE: Comments on Draft EA for the Management of the Uncontracted Space in Cascade and Deadwood Reservoirs.

The Interagency Task Force concurrs with the Valley Soil Conservation District's letter of April 30, 1992 with the addition or clarification of the following points:

1. It is the general concensus of the Task Force to support the Annual Review. The Valley SCD, Idaho Division of Environmental Quality, and Idaho Fish and Game should be included in the Annual Review process.
2. The Task Force supports that the 72,000 AF should be added to the conservation pool for water quality.
3. Additional study is needed to determine what minimum pool would be required to maintain the fish population through the summer period. This study also needs to determine the minimum pool necessary to maintain the bald eagle territory and fledgling survival. The 300,000 AF conservation pool was a level determined to provide sufficient oxygen levels to maintain fisheries only through the winter. Recent lower water pools and the reservoir's summer thermoplane may severely effect the ability of the 300,000 AF conservation pool to maintain fisheries.
4. The normal operating procedure on Cascade Reservoir has been to start with a full pool and the level would gradually decline into October. July is not an acceptable time to flush water. An early release of water will degrade water quality and adversely effect the fisheries and the bald eagle population of Cascade Reservoir.

The Interagency Task Force is a technical advisory committee composed of federal, state, and local governmental agencies and citizens organizations. The purpose of the Task Force is to coordinate the activities that effect water quality in Cascade Reservoir. The agencies and organizations include:

Idaho Fish & Game	Idaho Department of Lands
Payette National Forest	Division of Environmental Quality
Valley SCD	US EPA
Boise National Forest	Valley County P&Z
Payette Lakes Sewer & Water	West Central Highlands RC&D
US Fish & Wildlife Service	US Bureau of Reclamation
Central District Health Dept.	Soil Conservation Commission
Soil Conservation Service	Extension Service
Valley County Commissioners	Cascade Reservoir Association
Dept. of Water Resources	

Thank you for the opportunity to comment on this matter.

Sincerely,

Barry Holloway, Chairman
Valley SCD

cc: Representative Larry LaRocco
Representative Richard Stallings
Representative J. L. Whitten (Chairman, Appropriations Committee)
John F. Turner (Director US Fish & Wildlife)
US Department of Interior
Senator Terry Haun
Representative Gayle Wilde
Representative Judi Danielson
Laird Noh (Chairman Resource & Environmental)
Dolores Crow (Chairman Resource & Environment)
Senator Larry Craig
Senator Steve Symms
Senator R. C. Byrd (Chairman of Appropriations Committee)

NORTHWEST RESOURCE INFORMATION CENTER, INC.
(ED CHANEY)

NORTHWEST RESOURCE INFORMATION CENTER, INC.
P.O. Box 427 Eagle, Idaho 83616
Telephone 208-939-0714 -8731
Fax 208-939-7263

Robert D. Volz
District Engineer
Army Corps of Engineers
Walla Walla WA 99367

December 7, 1992

RE: DSEIS - Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon

Colonel Volz:

To reduce duplication, these comments incorporate by reference: 1] comments submitted by the Idaho Department of Fish and Game on the DEIS,[1] 2] the letter and attachments provided NRIC by Doug DeHart of the Oregon Department of Fish and Wildlife,[2] 3] previous comments submitted by NRIC and IDFG on the precursor OA/EIS.

Colonel, this is a real piece of work. I despair for the good people trapped into producing such a piece of propaganda disguised as problem-solving analysis. I despair for our political institutions and the democratic process.

General Comments

The DSEIS:

A15-1 1] Generally perpetuates the errors and ignores the comments provided on the previous OA/EIS to which it is tiered.

A15-2 2] Specifically perpetuates the error of focusing on "interim" measures, which in fact are not "interim," but indefinite. The strategy is nothing if not obvious. It is time for the Corps to stop dodging its responsibility to provide fish passage at and between the main-stem dams as intended by Congress in project authorizations and reaffirmed in the Pacific Northwest Electric Power Planning and Conservation Act of 1980.

A15-3 3] Is embarrasing in its desperation to rationalize and defend the status quo and to seek political absolution for it by spreading the blame. The discussions of collecting and transporting juvenile fish, and of other factors affecting Snake River salmon are particularly disingenuous.

---

[1] Idaho Department of Fish and Game, Comments on Interim Columbia and Snake Rivers Flow Improvment Measures for Salmon, Draft Supplemental Environmental Impact Statement, December 4, 1992.

[2] November 3, 1992 letter and attachments from Doug Dehart, Oregon Department of Fish and Wildlife to Ed Chaney, NRIC; provided under separate cover.

A15-4 4] Presents critical assumptions on squawfish predation, projected improvements in adult passage survival and collection and transportation of juvenile fish that were invented from whole cloth by Bonneville Power Administration.

A15-5 5] Does not include an alternative that will actually help the fish.

A15-6 6] Should include the following altemative which will help the fish pending completion of modifications of the dams and other structures necessary to achieve congressional intent vis-a-vis fish passage.

Every other year:

Draw down four lower Snake River reservoirs to near spillway crest April 15 - May 5; spill juvenile fish past the projects. Block or collect and haul early arriving adults.

Refill reservoirs with natural flow. Reserve water budget for flow augmentation at request of Fish Passage Center.

Every year:

Draw down Lower Granite to lower limit of adult fish passage facilities till September 15; periodically refill to MOP to pass barge convoys.

Spill at all projects till September 15 to Fish Passage Center specifications.

Meet hard constraint of 250 KCFS at The Dalles Dam.

Specific Comments

These comments are broadly represenative of our concerns with this document. To fully accuratize the DSEIS would require a document of equal length.

A15-7 The greatest flaw of the SEIS is that is does not consider a broad range of altematives. The alternatives considered are basically 1992 operations with marginal variations. All are basically no action, and do not substantially improve conditions which are driving Snake River salmon and dependent economies to extinction in contravention of long-standing congressional intent.

The goal of this SEIS (and previous OA/EIS to which it is tiered) is stated to be "to increase the velocity of water in the lower Columbia-Snake rivers in 1993 and future years to assist the migration of juvenile and adult anadromous fish past eight hydropower dams".

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(ED CHANEY)

A15-7 (cont.) The SEIS does not provide an adequate range of alternatives to meet this goal. Alternative 1 represents 1985 through 1990 baseline conditions. This alternative should be excluded from consideration since it has nothing to offer. Alternatives 2 through 5 are all variations of 1992 conditions and provide no significant improvements in flows. The document states "The model analyses indicate no quantifiable difference in juvenile survival results for spring migrants among Alternatives 2 through 5."

A15-8 Current documentation from the Fish Passage Center shows that 1992 operations totally failed to meet even the questionable benefits they were designed to provide. The Alternative 1, no action, and Alternative 2, 1992, DSEIS model predictions do not reflect the actual flows that occurred in 1992; see comments and attachments provided by Doug DeHart which are included as part of these comments.[3] As with the 1992 Biological Opinion, the DSEIS makes critical decision with models that do not reflect actual conditions. Resulting passage conditions could be much worse than projected, as they were in 1992.

A15-9 None of the alternatives meet the stated goal of the document as defined above. In fact conclusions drawn from the NPPC models, which are more clearly presented and incorporate more acceptable assumptions than the BPA models, state that the alternatives presented do not meet the goal of improving the survival of salmon stocks. Regarding Alternative 1, conclusions in Appendix F state, "Given natural variation in survival and production, there is a high likelihood that the run would go extinct. The increase in passage survival rate as a result of 1992-93 operations was insufficient to turn the trend line around and begin to rebuild the runs."

A15-10 In addition, there is no basis for the selection of the preferred alternative, other than "Alternative 4 might have an advantage by providing potential flow benefits for summer migrants." Even though the document states that "Criteria used for evaluation are (1) mainstem juvenile salmon survival rate (2) cost-effectiveness and (3) environmental effects," there is no evidence that any of these criteria clearly pointed to any of these alternatives as being justifiably preferred, let alone meeting the stated goal of improving survival of anadromous stocks.

A15-11 The DSEIS appears to be basically a rationale and justification for hydrosystem operation decisions that were made previously. The DSEIS is "tiered" with the 1992 Biological Assessment and Opinion. The DSEIS tiered or brought forward several portions of the original documents that were flawed and received critical comment without addressing those comments or making any changes in the DSEIS.

A15-12 The title of this DSEIS contains the words "Flow Improvement Measures for Salmon". The issue of flows and travel time [for its intrinsic biological significance and as a surrogate for broader ecological parameters] are critical to this particular NEPA document. Chapter 2, Description of the Existing Environment contains 50 pages, none of which describe existing flow and/or travel time conditions. None of which present a clear statement that the Corps' failure to properly design these projects is driving Snake River salmon and dependent economies to extinction. That the resulting

A15-12 (cont.) social, economic and political trauma has terrorized the region [and undermined the ethical moorings of the federal agencies signatory to this DSEIS.] Even Section 12, the Index, fails to list the words "flow" or "travel time".

A15-13 In Section 2 the DSEIS should state clearly that upstream storage projects in the Snake River Basin except for Dworshak were in place before the lower Snake River projects were built, and that fish migrated without difficulty under all flow conditions.

A15-14 The Section 2 discussion of collection and transportation is Orwellian and disingenuous, among other things. In case the authors hadn't noticed, the fish are going extinct. Killing all the controls may result in a favorable TBR, it does nothing for the fish. Barging is unacceptable because it doesn't work, not because it is "artificial." Don't add insult to injury with this kind of sophomoric misrepresentation.

A15-15 Chapter 3, Proposed Actions and Alternatives, presents only median monthly flow comparisons, which are meaningless. No actual flow comparisons are made. Although conclusions are supposedly based on comparing 1992 flow operations with base conditions (1985-1990), no record of actual conditions is presented or compared--not on flow, not on travel time, not on fish survival.

A15-16 Serious doubts as to the ability to achieve the flow augmentation measures proposed are outlined on pages C-13 to C-17. There are significant political and physical constraints to achieving the flows projected. It is not mentioned anywhere that flow augmentation won't achieve the recommended flow velocities the salmon need to recover--even if the projected augmentation could be achieved.

A15-17 The section on "Flow Effects on Juvenile Salmonids" frankly is anti-science at its worst. Where is acknowlegement of the environmental conditons under which Snake River salmon evolved? We are faced with extinctions for God's sake. What does it take to end the diversionary debating of the studies and get down to basics, i.e., we can't get juvenile fish through the reservoirs while simultaneously passing adults? Giorgi, et al. are getting paid to divert attention from the real problem to arguing over marginally relevant attempts to *describe* the problem. If you are going to cite Giorgi/Kindley, and rely on their bought analyses, you should do the scientific thing, and cite comments of the Fish Passage Center and others indicating that Giorgi/Kindley were wrong.

A15-18 In Section 4 Bonneville's model assumptions are so bizarre, so unsupported by scientific data or common sense, that the modeling results are simply facarical. It is distressing, and telling, that the Corps and other agencies would allow their names to be associated with this kind of deception.

A15-19 The statements in Section 4 about poor condition fish that are transported is of a piece with the anti-scientific, propaganda slant of the DSEIS. The wild salmon are not in poor condition; transportation doesn't work. To imply poor condition fish is the problem with transportation is simply pathetic.

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(ED CHANEY)

A15-20 The final SEIS should include a clear presentation of actual migration conditions in 1992 versus what was projected in the Biological Assessment and Biological Opinion. This discussion should include details on Bonneville and COE operations of Columbia River projects that reduced lower Columbia River flows proportionate to the increase in Snake River flows. Include also, how much water Bonneville stored above the normal rule curve, and the net revenue including that resulting from the additional head and sale of water released for fish.

A15-21 In Section 7, spell out the specific requirements of the Northwest Power Act regarding flows at and between the main-stem dams, and the requirement that the Corps give fish "equitable treatment" with other uses of the hydropower projects of the region. Also, spell out congressional intent in authorizing McNary and the other lower Columbia River projects, the lower Snake River projects, and all the fish passage facilities and hatcheries at and above the dams.

A15-22 One of the best discussions of juvenile fish passage is presented in Appendix A, pages A-15 to A-17. This discussion purports to assign relative risk to various juvenile passage components of the hydroelectric system. However, there are two glaring deficiencies in this section. First of all, no mortality numbers are assigned to the issue of "delayed migration". Secondly, the issue of transportation should be added to the list of significant factors, and mortality assessments, including those associated with stress and disease (even though death may occur later in the ocean) should be addressed.

A15-23 Page A-47, provides a good example of what is wrong with this document and with NMFS. NMFS apparently has no hesitation in assigning an expected increase in survival for increased enforcement against illegal harvest, as 2 to 10 percent for endangered salmon stocks. However, there is no attempt whatsoever to ascribe any benefits to the endangered stocks by the decreased travel time and spill which could be provided by reservoir drawdowns.

A15-24 Page A-49 illustrates the ongoing problem of faulty assumptions being assigned to the fish barging process. It states "While fish transport is controversial, it has been proven to increase survival of fish over those not transported under the current operating conditions....This program is especially important during low-flow years when low flows in the river can not be adequately augmented." No "proof" is documented. Nevertheless, conclusions of the document are based on modeling assumptions incorporating these unproven transportation benefits.

A15-25 The most reliable modeling information, that provided by the fishery agencies and tribes, is not a part of this DSEIS. The report states this information will be included in the final EIS. Alternatives for evaluation and modeling assumptions which have been proposed by citizen advocates of salmon recovery are not included or evaluated in this DSEIS.

A15-26 Finally, I strongly object to the SEIS projections of cost to Bonneville of revenue foregone. Bonneville does not own the Columbia and Snake Rivers. Bonneville does not own a water right. Bonneville has no right to water required to meet congressional intent vis-a-vis fish passage. Therefore, it has no opportunity cost. Bonneville has been stealing the fishes water for decades. Now it

A15-26 (cont.) wants to charge fish for taking a little of it back. This has no basis in law; Bonneville is not entitled to payment nor to claim opportunity cost foregone for something it does not own.

A15-27 The SEIS should estimate the cost to date and into the future of fish lost because the Corps failed to properly design the main-stem dams to meet congressional intent vis-a-vis fish passage.

Sincerely,



Ed Chaney

P.S. This letter is being faxed to arrive December 7. Cited attachments have been mailed under separate cover.

cc: CENPW-PL-ER

IDAHO STEELHEAD & SALMON UNLIMITED
(ISSU BOARD OF DIRECTORS)

IDAHO STEELHEAD & SALMON UNLIMITED

Committed to Recovering Idaho's Anadromous Fish Runs.

November 30, 1992

Peter Poolman
SEIS Manager
Department of the Army
Walla Walla District, Corps of Engineers
Walla Walla, WA 99362-2965

Public comment from Idaho Steelhead and Salmon Unlimited
on
Interim Columbia and Snake River flow improvement measures
for salmon --
Draft Supplemental Environmental Impact Statement (DSEIS)

A16-1 ISSU appreciates receiving a copy of the DSEIS. However, after a complete analysis of the document we are like the little old lady in the hamburger commercial who asks "Where's the beef?" Where's the alternatives? The range of alternatives presented are simply 1992 operations and 1992 operations with added protection for the federal hydropower system and its users.

ISSU strongly objects to the current list of alternatives and especially to the preferred alternative, which is frankly nothing more than 1992 operations with modified Dworshak operations. The list of alternatives must be substantially broadened in order to even meet existing law, i.e., Northwest Power Act NEPA and original project authorizations.

A16-2 Alternatives that require long term actions must have short term and interim components including, keeping Lower Granite at lowest level where adult fish facilities will work until June 15. Set flow targets and require all available means to meet these targets. Set aside more storage in the Columbia beyond the three million acre feet to meet lower river flows of 250-300 kcfs.

BPA and COE have proven they can not be trusted to pass through Snake River flows. Therefore lower river flows must be a hard constraint.

A16-3 ISSU QUESTIONS THE ACCURACY OF THE MODELING USED IN THE DSEIS. The models used in the DSEIS are not the ones that the fishery agencies and tribes support. The DSEIS models show increases in survival coming from predator control, transportation improvements, and improved

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A16-3 (cont.) adult passage. These are pure speculation! No basis for these improvements is presented in the DSEIS. For example, using very similar modeling, NMFS predicted flows of 64 kcfs at Lower Granite and 178 at The Dalles. However the actual flows last year turned out to be only 48 kcfs at Lower Granite and 178 at The Dalles. Needless to say, we have very little confidence that the modeling used in the DSEIS reflects actual flows and adult returns. Where information is this uncertain, ISSU recommends use of a worst-case scenario.

A16-4 THE DSEIS COVERS 1993 AND "FUTURE YEARS," BUT PROVIDES NO STANDARDS OR STRATEGIES FOR LONG-TERM RECOVERY OF SNAKE RIVER SALMON.

This is a limited status-quo EIS and cannot support agency actions for more than one year. A comprehensive EIS that sets long-term objectives and step-by-step action to implement those measures should be prepared. ISSU has been told that this EIS is not a proper use of "tiering" under NEPA regulations.

NMFS IS A COOPERATING AGENCY FOR THE DSEIS.

A16-5 ISSU questions the legality and ethical behavior of NMFS's role in the preparation of the DSEIS. Under the ESA, BPA/COE/BR must prepare a biological assessment and NMFS must issue a biological opinion. ISSU believes that NMFS' concurrence in the DSEIS undercuts its regulatory role and independence and requests NMFS withdraw as a cooperating agency for the DSEIS, and re-establish itself as the regulatory agency for the ESA and subsequently Idaho's threatened and endangered salmon.

Idaho Steelhead and Salmon Unlimited was formed in 1985 by a diverse group of businessmen, guides, conservationists, sport fishermen and concerned citizens to help protect, preserve and restore Idaho's once valuable anadromous resources. ISSU is an informational, educational and scientific charitable organization formed under the laws of the state of Idaho. ISSU represents over 2000 regular members and 3000 associate members in thirty-one states.

Thank you for the opportunity to comment.

ISSU BOARD OF DIRECTORS

cc: Rollie Schmitten, NMFS
Ted Hallock - NWPPC

AMERICAN RIVERS

(F. LORRAINE BODI)



December 4, 1992

U.S. Army Corps of Engineers
Walla Walla District
City/County Airport, Building 602
Walla Walla, Washington 99362-6619

RE: Interim Flow Draft Supplemental Environmental Impact Statement

Dear Sirs:

American Rivers is the only national conservation group dedicated to the preservation of rivers and river values. In the Northwest, we are actively involved in the protection and restoration of salmon, including Snake River salmon listed under the Endangered Species Act. We have the following comments on the draft Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon Supplemental Environmental Impact Statement (DEIS):

A17-1 THE PURPOSE OF THE PROPOSED ACTION IS UNDULY LIMITED. The need for interim flow improvements in the Columbia Basin is not simply the result of listing Snake River salmon under the Endangered Species Act. The DEIS should describe the mandate of federal dam operators under the Pacific Northwest Electric Power Planning and Conservation Act to protect, mitigate, and enhance salmon and their habitat in a manner that provides the equitable treatment.[1]

Key priorities under the Act, not yet achieved, are:

* flows of sufficient quantity and quality between federal dams to improve production, migration and survival of salmon;

* improved survival of fish at the dams;

[1] 18 U.S.C. 839b(4)(h)(11)(A)(i).

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A17-1 (cont.)

* consistency with the rights of affected Indian tribes; and

* deference to the recommendations of fish and wildlife agencies and Indian tribes.[2]

The DEIS should reflect these priorities in the form of fish travel time objectives based on the Columbia Basin Fish and Wildlife Authority Flow Proposal.

A17-2 THE BASELINE/NO ACTION ALTERNATIVE IS UNJUSTIFIED. The DEIS uses a 1985-90 baseline/no action alternative, with little explanation. If a historical baseline is used, it should cover the period from 1984 through 1992, the full time period when salmon flow measures have been implemented. No reasonable basis exists for excluding the flow conditions which occurred in 1984, 1991, and 1992. Moreover, 1992 conditions, the measures most recently implemented, should be considered the "no-action" alternative.

A17-3 Last years' experience brought to light substantial discrepancies between flow conditions projected in environmental documents, biological assessments, and biological opinions, compared with actual flow conditions. This risk factor should be discussed, along with an explanation of how lower than anticipated flows will be addressed. Last year, no actions were taken to update environmental reviews or salmon flow measures based on the failure of flow assumptions, a situation that should not be allowed to continue. Salmon require more water in the river, not simply on paper.

A17-4 IMPORTANT ALTERNATIVES HAVE BEEN IGNORED. Under regulations implementing the National Environmental Policy Act, the EIS must "[r]igorously explore and objectively evaluate all reasonable alternatives, and for alternatives which were eliminated from the detailed study, briefly discuss the reasons for their having been eliminated."[3] The remarkably narrow range of alternatives presented in the DEIS fails to meet this requirement. It includes only the measures implemented in 1992 and minor variations on those measures. As a result, the EIS fails to present a reasonable range of interim measures that could be implemented to protect and restore Columbia Basin salmon.

A17-5 American Rivers recommends full analysis of the following combination of alternatives:

[2] 16 U.S.C. 839b(40(h)(6).

[3] 40 C.F.R. 1502.14(a).

AMERICAN RIVERS
(F. LORRAINE BODI)

A17-5 (cont.)

* Use all available means to meet the flows recommended for the Snake, Mid-Columbia, and Lower Columbia Rivers in the Columbia Basin Fish and Wildlife Authority Flow Proposal. As a variation on this alternative, use all available means to meet flow targets of 100 to 140 kcfs in the Snake and 220 to 300 kcfs in the lower Columbia, depending on water conditions.

* Available means should include, but not be limited to, increased use of reservoir storage, advance purchase of power, power exchange agreements, and water leasing. Measures that will improve the effectiveness of these techniques should also be examined, e.g. setting annual targets for water leasing, eliminating federal price caps for water leasing, reduction of FELCC during low flow years, requirements that paybacks for advance drafting and FELCC shift be in the form of water rather than power, etc.

* Increase spill to maximum biological benefit at all projects, according to spill plans developed for each project.

* Operate Lower Granite reservoir at elevation 710, and consider operation at lower elevations at night.

* Release 400,000 acre feet from Dworshak reservoir for summer flow augmentation, in addition to available storage from the upper Snake River.

* Prohibit decreases in Mid-Columbia flows related to Snake River flow augmentation.

* Achieve greater use of Brownlee reservoir for flow augmentation.

A17-6 ALTERNATIVES WERE IMPROPERLY LIMITED BASED ON EXISTING HYDROPOWER PLANS. The DEIS states that the alternatives considered were limited by "the structural configuration of the system and the total amount of storage available."[4] We remain concerned that a major impediment to flow augmentation for fish is the annual planning that occurs under the Pacific Northwest Coordination Agreement and other contracts between the region's utilities and customers.

For example, under the Coordination Agreement, federal dam operators submitted their plans for 1993 operations almost a year ago, in February 1992, and a final operating plan was established in March 1992. The federal dam operators will now either have to obtain the agreement of all parties or pay a financial penalty for deviations from the plan. This process provides a hidden but

[4]DEIS, p. ES-4.

A17-6 (cont.) powerful disincentive to change, a disincentive seen in the narrow range of alternatives presented in the DEIS. In addition, the timing of this DEIS in relation to these existing plans raises questions of NEPA compliance, since the applicable regulations require that an EIS be prepared "early enough so that it can serve practically as an important contribution to the decisionmaking process and will not be used to rationalize or justify decisions already made."[5]

We request a full discussion of the provisions of the existing operations plans, the provisions of future plans as now anticipated, and how NEPA requirements will be satisfied for those plans.

A17-7 THE DEIS ANALYSES USES UNRELIABLE PROJECTIONS OF FLOW. The analyses of impacts and alternatives presented in the DEIS are the output of several theoretical models. As noted previously, the models contain projected flows that are highly unreliable. For example, as shown in our Attachment 1, the baseline flows used in the DEIS do not reflect the actual flows experienced during the 1985-90 time period. The DEIS model also assumes, incorrectly, that Snake River flow augmentation results in increased summer flows in the lower Columbia, a result which has not occurred in actual operations.

A17-8 Model flow projections for 1992 operations are more generous than actual flows in 1992. NMFS' biological opinion for 1992 hydropower operations used similar flow projections, relying on a 1984-90 flow baseline of 60 kcfs at Lower Granite and 209 kcfs at The Dalles, and projecting flows with 1992 operations of 64 kcfs and 228 kcfs, respectively. In contrast, actual flows were about 48 kcfs at Lower Granite and 179 kcfs at The Dalles, a significant difference. Last years' models also assumed full Idaho Power cooperation in 1992 flow operations, which simply did not occur.

The models used in the DEIS should, at the very least, be revised to use actual flows for the analyses that rely on historical operations, including 1992. This change is particularly important in light of NMFS' refusal to re-open hydropower operations for the benefit of fish when it became clear that 1992 flows were substantially less than its models had projected.

The use of actual flows is quite revealing. Attachments 2 and 3 show that actual 1992 flows were lower than the DEIS 1985-90 baseline flows. This is yet another indication that the range of measures considered in the DEIS is completely inadequate.

[5]40 C.F.R. 1502.5.

AMERICAN RIVERS
(F. LORRAINE BODI)

A17-9 THE DEIS ANALYSES RELY ON QUESTIONABLE ASSUMPTIONS. We are pleased to see a new commitment from the dam operators to use a variety of models rather than simply using BPA and Corps models. The models currently being developed by the fishery agencies and tribes should also be included in the DEIS to present a reliable range of results. We note that none of the models used in the DEIS have been tested and verified.

Perhaps as a result of this lack of verification, highly questionable assumptions plague all of the modeling results. The models show increases in survival coming primarily from predator control, transportation improvements, and improved adult passage. In all three areas, the DEIS assumptions are highly speculative.

A17-10 First, the benefits of predator controls, if any, are questionable. Although benefits are possible, these may well be cancelled out by compensatory responses and fish community changes. Fish and Wildlife Service research indicates that predation is not limited to squawfish, is not a problem in all reservoirs, and does not occur uniformly throughout a reservoir. This casts doubt on key assumptions: the assumed juvenile mortality rate of 2.56 per day of travel time, the assumption that reduced pool area could increase predation, and, most significant, assumed mortality reductions of 7.5% and 25%. Reservoir mortality estimates should be revised, and assumed mortalities from predator control should be deleted.

A17-11 Second, transportation assumptions are the subject of wide-ranging biological opinion. What we do know, and what Attachment 4 shows, is that increased transportation of fish has paralleled decreasing adult returns. Moreover, even positive transport benefit ratios at dams seem to change to negative transport ratios by the time fish reach their spawning areas, raising the prospect of additional complications tied to the transportation program. Transportation assumptions should be revised to reflect the questionable benefits of transportation in terms of adult returns to spawning grounds.

A17-12 Finally, the models assume a 6% increase in adult survival. This figure is completely unsupported and should be eliminated.

A17-13 STANDARDS AND STRATEGIES FOR LONG-TERM SALMON RECOVERY ARE LACKING. This is a limited, status-quo DEIS, but one which purports to cover hydropower operations for a series of indefinite years. The DEIS should be expanded to set long-term objectives and present step-by-step actions to implement those objectives.

As noted above, the DEIS should incorporate as its long-term goal the fish travel time objectives derived from the Columbia Basin Fish and Wildlife Authority Flow Proposal. In addition, the alternatives analysis in the DEIS should identify and evaluate

A17-13 (cont.) steps toward prompt investigation and implementation of reservoir drawdowns and, in tandem, the termination of fish barging. One key element of this schedule should be the full drawdown, modification, and study of Lower Granite Dam.

A17-14 NMFS SHOULD NOT BE A COOPERATING AGENCY. We seriously question NMFS' role as a cooperating agency in the DEIS. Under the ESA, NMFS must develop and issue an independent biological opinion on hydropower operations, following a biological assessment developed by the dam operators. NMFS cooperation in the DEIS undercuts its independent regulatory role and objectivity, creating the impression, if not the existence, of impropriety.

A17-15 A NEW DEIS SHOULD BE PREPARED. The changes we are recommending will necessarily result in major changes in the DEIS analyses. Consequently, we recommend the preparation of a new DEIS for public comment.

Respectfully submitted,

F. Lorraine Bodi

F. Lorraine Bodi

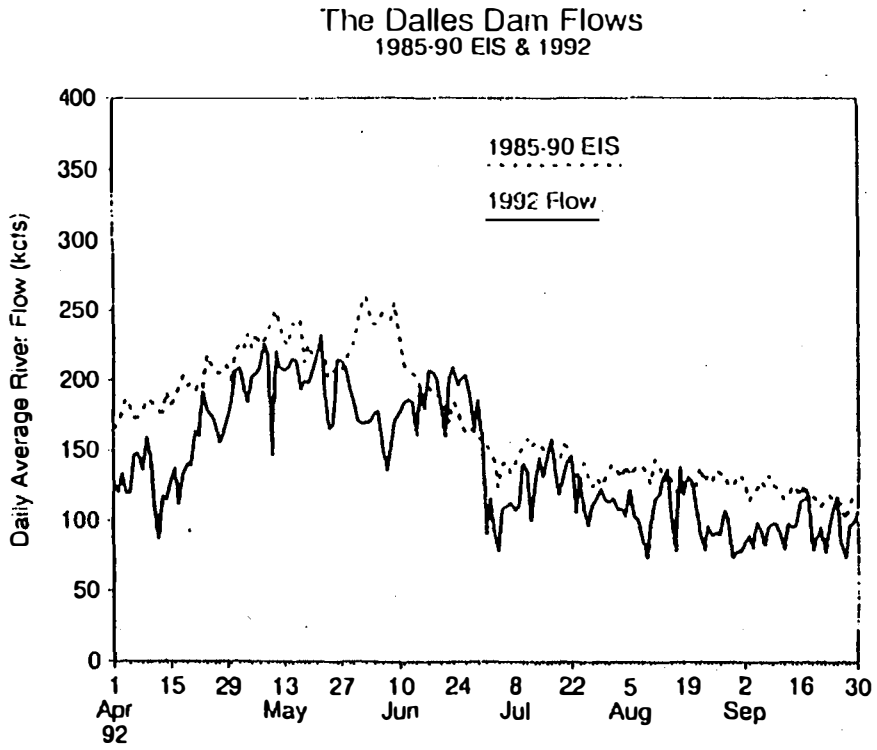
cc: Save Our Wild Salmon
Columbia Basin Fish and Wildlife Authority
Columbia River Inter-Tribal Fish Commission
Northwest Power Planning Council
National Marine Fisheries Service
Bonneville Power Administration

AMERICAN RIVERS
(F. LORRAINE BODI)

Lower Granite Dam					
	Alternative II		Alternative I		
1992 Period	SEIS Projected	1992 Actual	Moderate	Low	Actual 1985-90
Apr 16 - 30	49.0	47.9	81.7	37.8	74.8
May 1 - 31	85.8	60.0	95.8	83.0	81.1
June 1 - 30	53.8	29.8	90.9	49.8	69.7
July 1 - 31	26.5	24.6	37.2	24.7	25.5
Aug 1 - 15	21.9	13.1	22.7	22.7	19.7

The Dalles Dam				
	Alternative II			
1992 Period	SEIS Projected	1992 Actual	Alternative I	Actual 1985-90
Apr 16 - 30	250.3	158.7	208.5	201.4
May 1 - 31	275.0	201.1	275.3	225.8
June 1 - 30	259.3	180.5	259.3	204.6
July 1 - 31	204.9	119.1	204.9	142.1
Aug 1 - 15	147.3	108.5	147.3	135.3

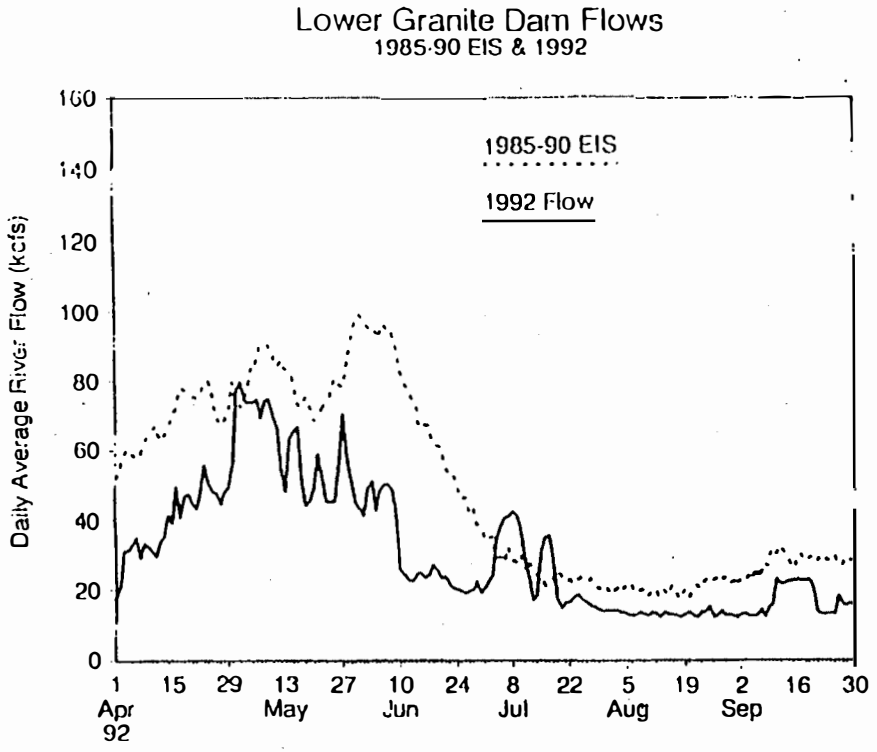
Attachment 1



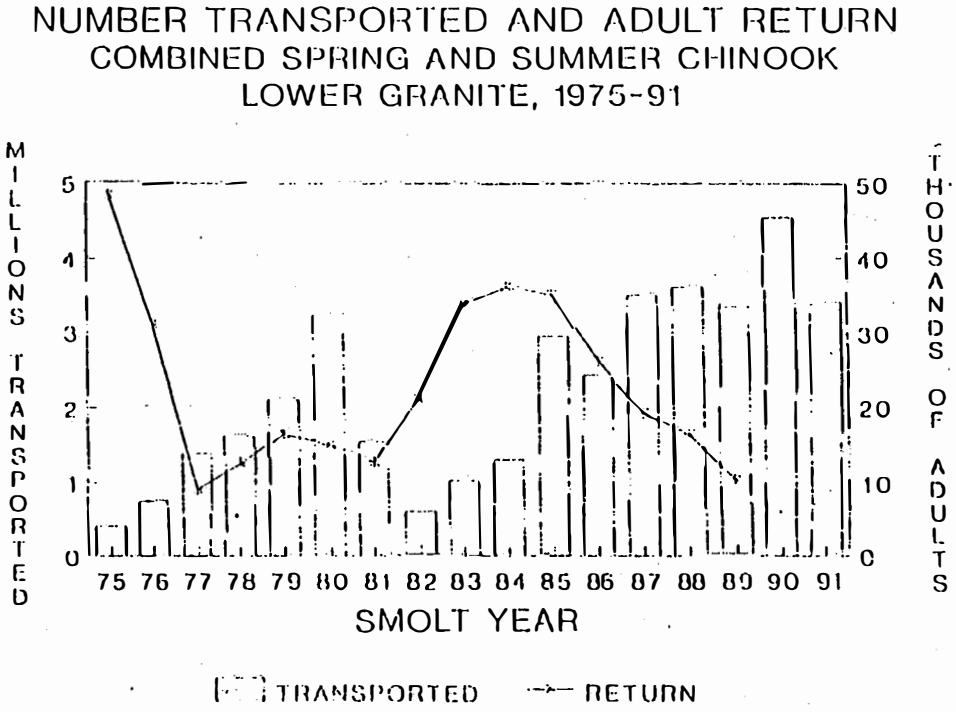
Attachment 2

AMERICAN RIVERS

(F. LORRAINE BODI)



Attachment 3



SOURCE: IDAHO DEPARTMENT OF FISH AND GAME

Attachment 4

PUBLIC POWER COUNCIL
(WILLIAM K. DRUMMOND)

Public Power Council

500 NE Multnomah, Suite 779
Portland, Oregon 97232
(503) 232-2427
FAX (503) 239-5959

VIA FAX

December 7, 1992

Peter Poolman, SEIS Manager
Department of the Army
Walla Walla District, Corps of Engineers
ATTN: CENPW-PL-ER
Building 602, City-County Airport
Walla Walla, Washington 99362-9265

Re: PPC's Comments on Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon Draft Supplemental Environmental Impact Statement (DSEIS)

Dear Mr. Poolman:

The Public Power Council (PPC) submits the following comments on the Draft SEIS.

PPC members and staff have participated with Pacific Northwest Utilities Conference Committee members and staff in developing PNUCC's comments on the DEIS. PPC hereby endorses PNUCC's comments and joins PNUCC in presenting the comments as submitted by Al Wright to you on December 7 (attached).

In addition to endorsing PNUCC's comments, PPC submits the following by section:

A18-1 4.9.4 Effect on Rates

The Draft SEIS states that an increase in BPA's operating expenses during fiscal year (FY) 1993 would "likely" reduce BPA's operating (i.e., financial) reserves, which "might" lead to a rate increase in the FY94-95 period. This conclusion is unnecessarily tentative. BPA, one of the agencies responsible for this Draft SEIS, is negotiating a settlement to the 1993 rate case, which will set rates for the FY94-95 rate period. One critical element in those settlement discussions is the level of financial reserves that BPA projects will be available at the end of FY93. Because BPA's rates are already set for the current fiscal year, if BPA spends $90 million in FY93 for replacement power, financial reserves will be reduced by $90 million. BPA has argued that reductions in financial reserves will require an adjustment in future rates to replenish those reserves. The Final SEIS should explicitly treat part of the increase in wholesale power rates in FY94-95 that results from actions taken to purchase power during FY93. These costs will presumably be recovered from consumers throughout the Northwest, and will lead to reductions in net income and social welfare as a result.

A18-1 (cont.)

A18-2 From another perspective, a decrease in BPA's operating reserves means that funds are being spent that previously reduced household and business income in the Northwest, because the funds were accumulated at BPA instead of being allowed to remain under the control of individuals. BPA built up financial reserves instead of returning these accumulated funds to the consumers, and some of those reserves will be used to buy replacement power in FY93. This reduction in income caused a fall in consumer and producer surplus in the region and elsewhere, which is the most appropriate measure of economic cost. Reductions in consumer and producer surplus can also have detrimental effects on the human environment, and the Draft SEIS has ignored these impacts. (See the literature cited in D.J. Mitchell, "The Deadly Impact of Federal Regulations", *Journal of Regulation and Social Costs*, June 1992.) The Final SEIS should recognize that the expenditure of funds by BPA does in fact reduce welfare and does impose economic costs on individuals. Furthermore, a consistent measure of economic costs should be adopted that allows comparisons across economic sectors, so that the cost-effectiveness analysis can be performed in a straightforward and understandable manner. The Final SEIS should address this issue directly.

A18-3 4.9.5 Mitigation

The Draft SEIS states that "[n]onfirm losses result primarily in revenue losses and would not need to be replaced." Although strictly true from a resource perspective, this conclusion ignores the fact that BPA does not in fact "lose" revenue; rather, because costs do not fall in response to reductions in revenues, BPA shifts the expected and actual sources of funds used to pay its expenses. If BPA expects or actually receives lower revenues from the sale of nonfirm energy, then future wholesale rates to firm power customers will increase to compensate. Funds that previously were received from nonfirm energy customers will now be expected to come from firm power sales. This shift in the expected source of revenue will reduce incomes and welfare in the Northwest and perhaps in other regions. Also, if less nonfirm energy is available to sell outside the region, other, more expensive generating resources will be relied on instead, which will have environmental impacts outside the region (and perhaps inside the region as well, if Northwest coal-fired generation increases). In addition, consumers who previously relied on supplies of Northwest nonfirm energy to reduce their bills will pay higher electricity prices, which will reduce their incomes and consumer surplus. The Final SEIS should incorporate an analysis of environmental impacts associated with additional thermal generation caused by greater spill of hydroelectric energy, as well as an analysis of the economic costs and impacts on the human environment of increased retail energy bills.

PUBLIC POWER COUNCIL
(WILLIAM K. DRUMMOND)

A18-4 §5.2.2 Cost Effectiveness

There are several problems with this section of the Draft SEIS. First, and perhaps most important, the agencies argue that uncertainty about the biological outputs of the alternatives supports a decision to shift the biological goal. Instead of measuring the number of returning adult fish, the agencies propose measuring the relative percentage increase in juvenile survival. Although there is in fact considerable uncertainty about the biological benefits of various river operations, the shift to relative percentage increases in juvenile survival simply substitutes one highly uncertain number for another highly uncertain number, and transforms the purpose of the actions from "saving fish by whatever means" to "saving only juvenile fish, because we do not need to be concerned about what happens after they move downstream". This approach may be appropriate when the purpose of the document is to consider only downstream passage alternatives, but is completely inappropriate and inadequate for any larger analysis of all alternatives for assisting in the survival of the species. If there is no sufficient data with which to establish the biological benefits of the proposed alternatives with reasonable certainty, then the SEIS may be a document that can only support experimentation and data-gathering, not changes in river operations that cost tens of millions of dollars relative to the base case or no action alternative.

A18-5 Furthermore, the percentage increases in juveniles projected for 1993 can easily be recalculated as returning adults over the salmon's life cycle. Any percentage increase in juvenile survival can be translated into an absolute number of juveniles assumed or projected to survive downstream passage. Simple arithmetic can then transform those higher numbers of surviving juveniles into higher numbers of surviving adults, based on various assumptions about factors that affect the remaining stages of the salmon life cycle. More surviving adults can then be projected, and we are then left with a target expressed in returning adults, not as a percent of surviving juveniles.

A18-6 The agencies offer another argument in support of the percentage approach: it prevents the calculation of benefits to the fish. The agencies appear to believe that a strict National Economic Development (NED) approach requires the calculation of economic benefits to the fish. This argument fails on its surface, because the NED approach focuses on economic costs; human beings, not fish, pay NED costs. (Fish may be argued to "pay" an environmental cost, but this line of argument quickly leads to interspecies comparisons of economic costs, which is the province neither of NED accounting nor of the National Environmental Policy Act). An accurate and complete calculation of the economic costs of the alternatives can proceed without making any assumptions about the economic benefits (or costs) to the fish per se. Rather, the goal of increasing numbers of surviving adults can be adopted, and then economic costs can be analyzed with the goal of minimizing the cost of achieving a specific increase in surviving adults. There is no need to abandon the numerical target with respect to

A18-6 (cont.) adults just because of the need to calculate economic costs.

A18-7 The practical result of shifting the target in this case may be nil, because all the alternatives have exactly the same biological impact: an increase in juvenile survival ranging from one to 19 percent. (See Table 5.2-1, p. 5-5.) The low end of this spectrum captures what might politely be called "noise" in the computer models, an improvement for which the SEIS estimates we will pay between $52 million and $93 million. The fact that all the alternatives have the same highly uncertainty benefit supports the conclusion that the shift in target is unnecessary, especially because is confounds attempts to compare the results of this Draft SEIS with other work. The agencies should reconsider the method of calculating benefits, to ensure that there is reasonable continuity across the environmental and economic analysis of fish mitigation efforts.

Thank you for this opportunity to comment.

Sincerely,

for William K. Drummond
Manager

Attachment
Original by mail

cc: Randy Hardy, Bonneville Power Administration
John Keys, Bureau of Reclamation
Rolland Schmitten, National Marine Fisheries Service
Major General Ernest J. Harrell, Corps of Engineers

PACIFIC NORTHWEST UTILITIES CONFERENCE COMMITTEE
(AL WRIGHT)

PNUCC

PACIFIC NORTHWEST UTILITIES CONFERENCE COMMITTEE

December 7, 1992

Peter Poolman
SEIS Manager
Walla Walla District, Corps of Engineers
Building 602, City-County Airport
Walla Walla, Washington 99362-9619

Re: PNUCC's comments on the Draft Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon Draft Supplemental Environmental Impact Statement (Draft SEIS)

Dear Mr. Poolman:

The Pacific Northwest Utilities Conference Committee (PNUCC) offers the following comments on the Draft SEIS. The attached items describe our major points and are separated into five areas of concern.

A19-1 The majority of PNUCCs comments are of a technical nature and are not discussed in priority order. However, there are two points we wish to highlight. First, the SEIS is limited in scope and only focuses on changing flows in the river to protect endangered salmon. The SEIS should clearly state its narrow focus. It should also note that the federal agencies must evaluate actions in other areas such as other river operations, hatcheries, harvest, and habitat subsequent to issuance of a biological opinion by National Marine Fisheries Service.

A19-2 Second, PNUCC believes that river operations in 1992 were adequate to protect the listed species of salmon. We strongly object to the selected preferred alternative as it calls for additional flow augmentation during the summer to assist juvenile fall chinook migration in the Snake River. The biological evidence to support the alleged biological benefits of summer flows in the Snake River is highly questionable.

Thank you for this opportunity to comment.

Sincerely,

Al Wright
Executive Director

Attachment

cc: Randy Hardy, Bonneville Power Administration
John Keys, Bureau of Reclamation
Rolland Schmitten, National Marine Fisheries Service
General Harrell, North Pacific Division, Corps of Engineers

SM108

PNUCC [redacted] AIN PLACE · 101 SW MAIN STREET, SUITE 810 · PORTLAND, OR 97204-3216 · (503) 223-9343 · FAX (503) 294-12[redacted]

PNUCC Comments For the Corps SEIS

General

A19-3 1. The 1992 OA/EIS should be incorporated by reference in its entirety except for those portions specifically excluded. For example, a 1992 drawdown test should be specifically identified as not being included in the SEIS. PNUCC recommends these statements be added at the beginning of the document and at the start of each chapter.

A19-4 2. The final SEIS should state that it is adopting the conclusion of the 1992 OA/EIS, and that the preferred alternative has been adopted based upon the additional analysis contained in the SEIS.

A19-5 3. The Draft SEIS uses three criteria -- juvenile salmon survival rates, cost effectiveness, and environmental effects -- for selecting the preferred alternative. PNUCC supports the use of these criteria with the exception of the juvenile salmon survival rate. The criterion should be the survival rate of returning adults to Lower Granite Dam.

A19-6 4. PNUCC strongly objects to the selected preferred alternative. The preferred alternative in the Draft SEIS calls for additional flow augmentation during the summer to assist juvenile fall chinook migration in the Snake River. No credible evidence exists to support the conclusion that fall chinook benefit from additional flow augmentation. Therefore, there is no biological justification to provide flow augmentation in the Snake River for juvenile fall chinook.

A19-7 5. Of the alternatives presented, alternative 2 (1992 Operations) is the least offensive to PNUCC. We believe that river operations in 1992 were adequate to protect the listed species of salmon.

A19-8 6. PNUCC supports the choice of operations from 1985 to 1990 as the "No Action" alternative.

A19-9 7. Benefits shown in Table 4.2-1 are only shown for alternative 4. To comply with NEPA and CEQ regulations, benefits from Alternatives 2, 3, and 5 must be reported. Decisionmakers must be able to make comparisons between alternatives. Substantial treatment of each alternative must be provided in sufficient detail so that reviewers may evaluate the alternatives' own comparative merits. 42 U.S.C. § 4332(2)(C) and § 4332(2)(E). Also, 40 CFR § 1502.14 calls for a detailed statement of alternatives.

A19-10 8. In the description of the alternatives, Tables 3.5-2 through 3.5-5 present expected flows at several points in the Snake and Columbia rivers. The magnitude of these flows is questionable. If the information can not be corrected, remove these tables. If these tables are changed, PNUCC believes that flows related to low water conditions would be more informative to the decision makers. The actions being taken are directed at low water conditions.

Cost-Effectiveness Analysis

A19-11 9. PNUCC supports using cost effectiveness as a decision criterion. It makes sense to choose an alternative that gives the most benefit for the least dollars -- so long as there are biological data to support the estimates of the benefits (effectiveness).

PACIFIC NORTHWEST UTILITIES CONFERENCE COMMITTEE
(AL WRIGHT)

A19-12 | 10. Benefits should be expressed as the total number of returning adults to Lower Granite pool or smolt to adult ratios (SARs). The Draft SEIS uses relative percent increase in survival as the measure of benefits. This results in ranges of cost effectiveness for each alternative which are too wide.

A19-13 | 11. To do a proper cost-effective analysis the costs and benefits used in the analysis must be comparable and treated consistently. Total benefits should be compared to total costs. Benefits to individual species should be compared to costs associated with improvements to that species.

Fish Survival Analysis

A19-14 | 12. The Final SEIS should thoroughly acknowledge the uncertainty surrounding the biological information supporting the theory that increased flows benefit juvenile salmon. Those parties who have participated in fish issues over the last decade, particularly those involved since the listing of the Snake River salmon species, are well aware of the uncertainties regarding the alleged benefits of increased flows for the listed species. These uncertainties underlie and are implicit in the discussion of flows in the SEIS; however, they need to be addressed directly (and repeatedly) for the uninitiated. As stated above, all references to the alleged "benefits" from flow measures must be qualified. 40 CFR § 1502.22.

A19-15 | 13. PNUCC objects to study results in which benefits for fall chinook are estimated based on the Fish Passage Center (DeHart/Berggren and Filardo) analyses alone. This information assumes that a flow/travel time/survival relationship exists for fall chinook. However,

a. A fair amount of literature exists that indicates that there is no flow/travel time/survival relationship. In fact, some researchers believe that subyearling chinook must rear prior to migration.

b. The flow/travel time/survival relationships used to determine the alleged biological benefits for fall chinook are highly questionable and have not undergone regional review.

At the very least, the Final SEIS should also include analysis based on data that assumes no flow/travel time/survival relationship for fall chinook. The data are found in the NMFS reports prepared by Simms and Miller, 1982 - 1984.

A19-16 | 14. The Draft SEIS includes information from the Fish Passage Center that indicates flow affects the migration of juvenile sockeye. This information for Snake River sockeye is flawed. This work was based on a small sample data set that provided misleading results. Any analysis based on this data should be eliminated.

A19-17 | 15. The Draft SEIS states that new biological modeling (FLUSH3 and ELCM) done by the Oregon Department of Fish and Wildlife and Inter-Tribe will be included in the Final SEIS. This information should not be included for the following reasons:

a. This is potentially significant new information, and there will be no opportunity for formal public review of the analyses based on this new methodology;

b. The ELCM and FLUSH3 models have not received regional review;

A19-17 (cont.) | c. Results from these analyses could significantly impact the conclusions of the SEIS. If new information is relevant to environmental concerns and will have a bearing on the proposed action or its impacts, then an agency shall prepare a supplement to either a draft or final EIS. 40 CFR § 1502.9(c)(1)(ii).

A19-18 | 16. The Draft SEIS proclaims that Kootenai River white sturgeon spawning success is correlated to flows. This position is not based on reliable scientific information. Statements indicating that spawning success is dependent on high spring flows should be omitted from the Draft SEIS. Currently the status of these sturgeon is being studied. Also the relationship between flows and successful spawning of these sturgeon is being analyzed. Any conclusions should be held until study results are available.

Existing System Assumptions

A19-19 | 17. The harvest rates for fall chinook should be lower than 55 percent. The Draft SEIS states that the source for the harvest rate of fall chinook is the Northwest Power Planning Council's Phase II amendments. The value in the amendments is 55 percent. However, the value used in the Draft SEIS is 65 percent. Although PNUCC believes that the Council's 55 percent should be lower, the SEIS should, at minimum, reflect the Council's value.

A19-20 | 18. The SEIS harvest levels are based on ELCM model runs. ELCM has never been released to the public and is currently not available for public review. CEQ regulations prohibit the inclusion of information not available to the public if such information has a significant impact on the analysis and conclusions. 40 CFR § 1502.21. This harvest information could have a significant impact. Therefore, all references to ELCM and its results should be excluded from the SEIS.

A19-21 | 19. Table 3.2-1 indicates that Lower Monumental will not have any planned spill in 1993, but Table 4.1-1 indicates that spill will continue at Lower Monumental for 1993. This operation should be clearly described in the SEIS.

Power Costs

A19-22 | 20. PNUCC believes that in the long term the costs are greater than represented here. These losses will eventually be part of firm planning and consequently they will be replaced with new firm resources. The Draft SEIS should include estimates of long term costs based on firm resource replacement.

A19-23 | 21. The cost of lost opportunities for capacity sales due to the operations at Dworshak should be included. Dworshak operation allows for peaking in emergency situations. However, the new proposed operation of Dworshak will restrict BPA from marketing capacity. The cost of this loss should be added to the total cost of each alternative.

VALLEY CONSERVATION DISTRICT

(KEN POSTMA)

Valley Soil Conservation District
P.O. Box 209
Donnelly, Idaho 83615
Phone: 325-8567

December 3, 1992

TO: Department of the Army Corps of Engineers
Building 602, City-County Airport
Walla Walla, WA 99362-2965

RE: Draft SEIS Columbia and Snake River Flows

A20-1 The Valley Soil Conservation District Board has reviewed the draft SEIS Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon and has the following concerns. The draft SEIS only addresses the effects on the water quality and fisheries of the Brownlee Reservoir, with no concern for upstream water, including Cascade and Deadwood reservoirs which will be severely impacted. Our SCD has entered into grants and cost-share agreements to help improve the water quality in the Cascade Reservoir. We are very concerned about any changes in operating procedure which may increase phosphorus loading or reduce water quality in any way to these water bodies. We feel that any reduction in water from these reservoirs will impact water quality in many different ways and that your SEIS must address these impacts so that we will have the best information upon which to base our future water quality decisions.

The Valley Soil Conservation District's (VSCD) concerns on this SEIS draft are basically the same as were expressed in the enclosed VSCD April 30, 1992 letter on uncontracted space in the Cascade and Deadwood Reservoirs and also in the May 20, 1992 Cascade Reservoir Interagency Task Force letter.

A20-2 The normal operating procedure on Cascade Reservoir has been to start with a full pool with the water level gradually declining until October for irrigation purposes. This process is used to maintain a 300,000 acre foot conservation pool which maintains the resident fisheries. This resident fisheries in turn maintains our endangered species, the bald eagle. Any change in the normal operation or flushing of water to fill downstream reservoirs will degrade the water quality in Cascade Reservoir and adversely effect the resident fisheries and the bald eagles.

A20-3 For the above reasons, we our opposed to any activity that reduces the water quality of Cascade Reservoir. Thank you for the opportunity to comment on the draft SEIS.

Sincerely,

Ken Postma, Chairman
Valley Soil Conservation District

cc: Larry Koenig, DEQ

OROFINO CHAMBER OF COMMERCE
(H.L. "ROY" CLAY)

OROFINO
Gateway to Idaho's Vast White Pine Country
CHAMBER OF COMMERCE
Phone: 208-476-4335
Box 2221 Orofino, Idaho 83544-2221

December 3, 1992

Lt. Col. Robert Volz
U.S. Army Corps of Engineers
Walla Walla District
Building 602, City County Airport
Walla Walla, Washington 99362

Dear Lt. Col. Volz:

We would like the following comments to be printed in their entirety in the Final Environmental Impact Statement.

A21-1 Since the preferred alternative in this draft EIS is similar to the actions undertaken in 1992, we would like to see an accounting of the specific results achieved by those actions in 1992. They are conspicuously absent from the SEIS. Certain statements in the report; "No recent studies have been

A21-2 conducted to determine the relationship between flow and downstream survival..." (page 4-9); and "the benefits are uncertain and could be less than indicated..." (in the various fish passage models), page 4-10; support the belief that Dworshak flows cannot help to restore salmon runs to any significant degree. We also call your attention to several studies which indicate the limited effectiveness of flow augmentation: "PIT Tagged Spring and Summer Chinook Salmon Detection Rates Compared with Snake River Flow at Lower Granite Dam" - NMFS 1992; "Timing of Passage of Juvenile Salmon at Columbia River Dams: - William J. McNeil, Oregon State University, 1992; and "A Literature Review of Factors Associated with Migration of Juvenile Salmonids" - Karen Young Dreeger and William J. McNeil, Oregon State University, 1992.

A21-3 We did not see any discussion of possible conflicts between the proposed actions and Dworshak enabling legislation which lists recreation as one of the project purposes for which Dworshak dam was constructed. It is our opinion that the intention of this condition is not being met under the proposed operations.

A21-4 On page 4-86 pool elevations under Option 4 are estimated to be 9 feet lower than base case in July and 20 feet lower in August. Since Option 4 allows for the taking of this water as early as July, impacts should be measured against a July drawdown and not an ambiguous July-September scenario. The manner in which this is presented understates the reality of the situation. We also have reason to believe that the extent of the drawdown would be worse than described; our experience has been that Corps estimates of reservoir levels have not been accurate in the past.

A21-5 On page 4-80 recreational visitation is estimated to decrease only 3% under Option 4, when compared to the operating methods of last summer. There are two issues that need to be addressed here:

1. The area has already suffered a loss in 1992 due to that year's operations and you should not use that year as a base for this or any other future comparisons.
2. The 2% estimate of additional losses in visitation greatly understates the reality of the situation. If the September release of 200 KAF was scheduled in July, just prior to the peak recreation season, instead of following it, then the major dropoff in visitation would also occur earlier in the year, during July, a time period which normally has about twice the visitation of August.

A21-6 On pages 4-90/92 you indicate that the "potential displaced value of recreation" under Option 4 would be about $5,000, and that displaced recreation losses under Option 2 would be only $275, based upon a general recreation value of $2 to $6 per day. Regardless of the methods that were used to come up with these figures they are ridiculous and misleading. Many individual businesses and other providers of tourism services in the Orofino area suffered during the 1992 season because of low water levels. Some of their comments are listed below. We want all of these comments to be printed in your final EIS because we believe that supposedly sophisticated economic models often lose sight of on-the-ground reality. The reality is that business in our area suffered greatly because of the 1992 summer drawdown of Dworshak Reservoir, and it will suffer more if Option 4 of your SEIS is adopted. The comments are as follows:

DWORSHAK STATE PARK - Campground revenue during calendar year 1992 was approximately $64,000, a drop of 20% from the $80,000 of the prior year. Overall camping during 1992 was down 25% from 1991, and it was down more than 50% during the peak drawdown month of August. Other nearby Idaho State Parks reported a net increase of about 10% over the previous year, so Dworshak's decline can definitely be attributed to the low water levels. - Mike McElhatton

OROFINO CHAMBER OF COMMERCE

(H.L. "ROY" CLAY)

A21-6 (cont.)

DWORSHAK EXCURSIONS - Revenue was off 22% in 1992. Normally about 10% of all customers make an advance reservation for the following year upon departure, but only one customer made an advance reservation in 1992. Generally about 70% of all reservations for the season are made by February, with reservations beginning to come in November. Reservations for the next year are lagging far behind the average. With the rising costs of marine insurance, advertising and maintenance, it is imperative that mid-summer pool elevations are maintained at high levels. If mid-summer drawdowns are to continue the owner may need to consider liquidation. - Jerry Olin

RIVERSIDE MOTEL - Many anglers indicated they won't return because of the low water levels, and fewer boaters were noticed staying in town. - LeAnn Callear

HELGESON HOTEL - A drop was noticed in the number of guests, especially for events held at the reservoir such as the mini-hydroplane races. There were many negative comments from guests about the appearance of the reservoir and the lack of swimming facilities. - Sandy Medley

ATKINSON DISTRIBUTING - Sells marine gas to the marina. Because there were fewer boats on the reservoir gas sales were down 25%. - Bill Atkinson

CLEARWATER NATIONAL FOREST - Records show that tourist inquiries at the visitor senter were down from 11,600 last year to 8,600 this year, a drop of 3,000 visits or 26%. - Bob Tribble

PONDEROSA RESTAURANT - Noticed that fewer boaters and anglers were eating breakfast at the restaurant this year during the mid-summer drawdown months. - Roy Clay

SNYDER'S SPORTING GOODS - Reported a decrease in retail sales of sporting goods, fishing tackle and swim wear. - Elbert Snyder

WEST'S SPORTING GOODS - The owner reported a definite effect, but found it hard to quantify. - Ronnie West

WHITE PINE MOTEL - The occupancy rate was down this summer. - Gordon Thiessen

CLEARWATER CLEANERS - There was a drop in visitors using the coin laundry this summer. - Sue Atkins

A21-6 (cont.)

HOMESTEAD LOUNGE - Noticed fewer anglers as patrons this summer.

LAKE AND LAWN - Although overall sales were up, marine business was down by 20%.

MARCIA'S FAMILY APPAREL - The lack of tourists had a big effect on sales of T-shirts and tourism-related clothing.

OROFINO CHEVRON - Gas sales, towing and mechanical work were all down 15%. - Jerry Koerling

CLEARWATER VALLEY MARINE - Boat and motor repairs are the greatest part of this business, which was down 25%, or between $25,000 and $30,000. - Joe Rintelen

NORTHWEST VALUE PHARMACY - Sales of suntan products were down $1,000 last summer and sales of swim devices (floats, etc.) were down $500. This does not include the additional costs of carrying leftover inventory over the winter. - Ron Hembree

RIVERSIDE SPORT SHOP - The owner feels he has lost at least $5,000 in sales of items such as tackle and gas. He feels his customers are not returning as often, and some have indicated they will not return. In addition to the problem during the summer months, the summer and fall drawdowns have taken water which was previously released in November and helped to move steelhead in the river. This has resulted in lower catches during one of the traditionally busiest fishing seasons. Stu Kestner

THE BAZAR - Business was down 15% this past August at a time when the tourism-related part of the business normally increases.

COAST TO COAST - August sales of recreational toys were down about $5,000. - Ginny Trapp

HANSON GARAGE - Fewer repairs were noticed for recreational vehicles, but it is hard to put a dollar value on it. Keith Hanson

MICHAEL'S RESTAURANT - About 10-15% fewer tourists were noticed in the restaurant. Many customers indicated that they would not return because of conditions on the reservoir. Mike Morrison

A21-6 (cont.)

VALLEY MOTOR PARTS - There was a dropoff in boat-related items and a slight drop in business from regular out-of-state customers, many of whom said they would not return. Clay Hesson

GLENWOOD IGA - This store tracks sales and trends very carefully. Although they report an increase in sales for the year overall, the summer months were down. July sales were down $22,655 from the previous year and August sales were down $25,109. Customer counts were down 639 in July and 583 in August. An assessment by category shows that the hardest hit items were cold beverages, ice, and take-out deli items, all areas impacted by tourism. They also have checkout personnel keep track of visitor requests and comments, and negative comments about the reservoir were widespread. The store manager believes that the majority of their decreases were due to poor conditions on the reservoir. Doug Donner

SERV-A-BURGER - Lost about $5,000 in sales and reported lots of negative comments from boaters.

MEDLEY'S ON THE LAKE - Prior to the windstorm which destroyed the docks, the marina and restaurant had suffered greatly due to reduced tourism and boating. Several regular customers did not renew their boat slip rentals this season because of anticipated drawdowns. Although the same number of slips were rented as in the prior year, they were generally rented by the month instead of the season. Gary Medley

BARNEY' SCOOPER - Touris sales were down 1-2%. Emmett Bartman

THE REAL ESTATERS - While it is difficult to put a dollar figure on the impact, people are less motivated to purchase property in the area if they have difficulty launching boats and obtaining fuel. Sales of lakeview properties suffer when there is a muddy shoreline. When they do purchase, buyers pay less for the lots. Lee Pippenger

THE PROGRESSIVE MERCHANTS - As an organization that promotes local trade and tourism, it is extremely difficult to attract individuals to our community when the heart of our recreation has been destroyed. The drawdown of Dworshak Reservoir has cost our business community tens of thousands of dollars with recovery no where in sight. Future drawdowns may very well shut the doors of many businesses, which in turn may be the catalyst that ignites total economic collasp. Ron Hembury

OROFINO CHAMBER OF COMMERCE

(H.L. "ROY" CLAY)

Sincerely,

H. L. "Roy" Clay
President

HLC:jes
by fax
cc: Senator Larry Craig
Senator Dirk Kempthorne
Rep. Larry LaRocco
Rep. Mike Crapo
Governor Cecil Andrus
Senator Marguerite McLaughlin
Rep. Chuck Cuddy
Rep. June Judd

VALLEY GRAPHICS
(LARRY SCHLIEPER)

Valley Graphics

Hallmark Cards • Gifts • Office Supplies • Printing

December 4, 1992

Lt. Col. Robert Volz
Department of the Army
Walla Walla District
Corps of Engineers
Building 602
City County Airport
Walla Walla, WA 99362-6619

Lt. Col. Volz:

We are one of the many businesses in Clearwater County and Orofino that have been economically effected by the drawdown of Dworshak Dam. Our summer business is very dependant on tourist trade to at least show a small profit in the summer months.

A22-1 This last summer, particularly July and August, were not slightly off, but a major disaster, in sales of tourist season gifts and souvenirs. In past years our business has grown and souvenir sales have been on the increase... So we bought heavy for last year's tourist season, but sales fell dramatically and we had to store away over $3,000 worth of inventory which translates into about $3,000 lost profits. That loss of store traffic also means lost revenue in other departments of our store which could mean up to $5,000 or $6,000 in lost sales.

We have had tourists that did shop our store complain about the drawdown and state they would not return to Orofino.

All I can say is if this drawdown continues along with all our other economic woes, who knows, next step wil be to close our doors for good, thanks to you or whoever is responsible. If Option 4 of EIS is adopted for 1993, you know "the rest of the story".

Larry Schlieper
Store Owner/Manager

PHONE 208-476-5211 • BOX 467 • 147 JOHNSON AVE. • OROFINO, IDAHO 83544

PACIFIC NORTHWEST GENERATING COOPERATIVE

(DAVE HARPER)

PNGC
Partners in Power Management

December 3, 1992

Colonel Robert D. Volz
Department of the Army
Walla Walla District
Corps of Engineers
Building 602
City - County Airport
Walla Walla, WA 99362-6619

Re: PNGC's Comments to the Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon Draft Supplemental Environmental Impact Statement

Dear Colonel Volz:

Pacific Northwest Generating Cooperative ("PNGC") has the following comments about the Draft "Supplemental Environmental Impact Statement" ("SEIS") of October 1992. PNGC represents 29 electric cooperative utilities, and its members provide electrical service to 750,000 residents of the Pacific Northwest.

A23-1 PNGC concurs with the need to preserve the listed salmon runs in the Columbia River and its tributaries. However, recognition of this need should not be viewed as support for the adoption of costly measures where expedience and a series of unproven assumptions are substituted for a comprehensive, balanced program.

A23-2 I. PURPOSE OF SEIS

The NEPA process begins with a proposal for action. The purpose and need section of an EIS articulates the underlying reasons for the agency's action. 40 CFR § 1502.10(d). There should be a direct and causal relationship between the underlying purpose and need and the agency's action. The scope of alternatives to be considered is a function of how narrowly or broadly one views the objective of an agency's proposed action. City of New York v. United States Department of Transportation, 715 F2d 732 (2d Cir 1983), cert denied, 465 US 1055 (1984).

Pacific Northwest Generating Cooperative
500 N.E. Multnomah
Suite 860
Portland, Oregon 97232-2044
(503) 235-3500
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A23-2 (cont.) The 1992 OA/EIS was stated to apply only to actions considered for implementation in 1992, a one year operating period. The "stated" purpose of the SEIS is to evaluate the impact of several alternatives to the operation of certain dams and reservoirs in the Columbia-Snake River system during 1993 and future years. The "implicit" purpose of the proposed action and, hence, the purpose and need for the SEIS, is to avoid the decline of the listed Snake River salmon species and to contribute to their recovery. Since this is the purpose and need of the SEIS, it should be clearly stated as such.

A23-3 II. SELECTION CRITERIA

The Draft SEIS uses three criteria for selecting the preferred alternative: cost effectiveness, juvenile salmon survival rate, and environmental impacts. PNGC supports use of these criteria, except for juvenile salmon survival rate. That criterion should be the survival rate of the listed salmon throughout their life cycle.

A23-4 III. FISH SURVIVAL ANALYSIS

Those participating in fish issues, particularly since the listing of the Snake River salmon species, are well aware of the uncertainties about the alleged benefits of increased flow for the listed salmon species. These uncertainties underlie and are implicit in the discussion of flows in the SEIS. However, such critical uncertainties regarding the SEIS analyses and its underlying assumptions need to be highlighted. 40 CFR § 1502.22. In particular, there should be no reference to alleged "benefits" from flow regimes without a qualification that the alleged "benefit" is based on unreliable data.

PNGC recognizes that changes in the operation of the river might result in improved passage for juvenile salmon. Yet not one research group has performed a comprehensive analysis demonstrating the alleged effectiveness of increased flows on the fish survival.

A23-5 PNGC opposes the adoption of drawdown measures. Drawdowns are not supported by reliable scientific research and have not been shown to result in enhancement of fish survival or evaluated by comparisons with other less expensive alternatives, such as transportation or harvest reduction.

PACIFIC NORTHWEST GENERATING COOPERATIVE
(DAVE HARPER)

A23-5 (cont.) Due to the life cycle of the salmon, it may be several years before data are available to determine whether augmented flows or drawdowns contribute any material benefit toward attainment of biological objectives. As a result, drawdowns should not be implemented until it is established that such measures are biologically effective and that the biological objections cannot be achieved with less costly alternatives.

A23-6 PNGC objects to study results where benefits for fall chinook are estimated based on the Fish Passage Center (DeHart/Berggren and Filardo) analyses alone. This information assumes that a flow/travel time/survival relationship exists for fall chinook. However, a fair amount of literature exists that indicates that there is no flow/travel time/survival relationship. In fact, some researchers believe that subyearling chinook must rear prior to migration. Moreover, the flow/travel time/survival relationships used to determine biological benefits for fall chinook are highly questionable and have not undergone regional review.

At the very least the Final SEIS should include analysis based on data that assumes no flow/travel time/survival relationship for fall chinook. The data are found in the NMFS' reports by Sims & Miller, 1982-84.

A23-7 The Draft SEIS includes information from the Fish Passage Center that indicates flow affects the migration of juvenile sockeye. This information for Snake River sockeye is flawed. This work was based on a small sample data set that provided misleading results. Any analysis based on this data should be eliminated.

A23-8 The Draft SEIS indicates that new biological modeling (FLUSH 3 and ELCM) done by the Oregon Department of Fish and Wildlife and Inter-Tribe will be included in the Final SEIS. This information should not be included for the following reasons:

a. There will be no opportunity for public review of the analysis based on these models;

b. The ELCM and FLUSH 3 models have not received regional review;

A23-8 (cont.)

c. Results from these analysis could significantly impact the conclusions of the SEIS.

A23-9 The Draft SEIS proclaims that Kootenai River white sturgeon spawning success is correlated to flows. This position is not based on reliable scientific information. Statements indicating that spawning success is dependent on high spring flows should be omitted from the Draft SEIS.

A23-10 The decline of listed salmon stocks has been attributed to a variety of factors, including increased harvest, predation, habitat destruction, pollution, power production, irrigation, river recreation, flood control, river navigation, mining, timber harvest and fishery management practices.

Because the purpose of the proposed action--recovery of the listed salmon--is functionally related to activities in the areas of harvest, habitat and hatcheries in addition to river operations, the SEIS must contain (or incorporate) analyses of measures in each of these areas. This is true whether or not those actions are within the jurisdiction of the participating agencies. 40 CFR § 1502.14(c). In addition, NEPA requires the participating federal agencies to address the cumulative impacts of various actions.

The SEIS will not solve problems with the listed salmon species until and unless the regulating agencies substantively addresses all factors which cause the decline in salmon and steelhead stocks, including over harvesting, hatchery operations and habitat degradation.

A23-11 The harvest rates for fall chinook should be lower than 55 percent. The Draft SEIS states that the source for the harvest rate of fall chinook is the Power Planning Council's Phase II amendments. The value in the amendments is 55 percent. However, the value used in the Draft SEIS is 65 percent and is, therefore, incorrect. PNGC also believes that the Council's 55 percent should be much lower. Continued harvest at current levels is extremely detrimental to the listed salmon species.

A23-12 The SEIS harvest levels are based on ELCM model runs. ELCM has never been released to the public and is currently not available for public review. CEQ regulations prohibit the inclusion of information not available to the public if such information has a significant impact on the analysis and

PACIFIC NORTHWEST GENERATING COOPERATIVE

(DAVE HARPER)

A23-12 (cont.) conclusions. 40 CFR § 1502.21. This harvest information could have a significant impact. Therefore, all references to ELCM and its results should be excluded from the SEIS.

A23-13 Table 3.2-1 indicates that Lower Monumental will not have any planned spill in 1993, but Table 4.1-1 indicates that spill will continue at Lower Monumental for 1993. This operation should be clearly described in the SEIS.

A23-14 Regarding hatchery production, the models should consider the mortality effects on the listed species.

Regarding improvements in habitat quality, the models should consider that increases in habitat quality will increase survival of listed species greater than 10 percent.

IV. COST-EFFECTIVENESS ANALYSIS

A23-15 PNGC supports using cost effectiveness as a decision criteria. It makes sense to choose an alternative that gives the most benefit for the least dollars--as long as there are biological data to support the estimates of the benefits.

A23-16 Benefits should be expressed in total number of returning adults to Lower Granite pool or smolt to adult ratios (SARs). The Draft SEIS uses relative percent increase in survival as the measure of benefits. This results in too wide of ranges of cost effectiveness for each alternative.

A23-17 In a proper cost-effective analysis, the costs and benefits used in the analysis must be comparable and treated consistently. Total benefits should be compared to total costs. Benefits to individual species should be compared to costs associated with improvements to that species.

A23-18 PNGC believes that in the long term the costs are greater than represented in the SEIS. These losses will eventually be part of firm planning and consequently they will be replaced with the new firm resources. The Draft SEIS should include estimates of long term costs based on firm resource replacement.

A23-19 The cost of lost opportunities for capacity sales due to the operations at Dworshak should be included. Dworshak operation allows for peaking in emergency situations. However,

A23-19 (cont.) the new proposed operation of Dworshak will restrict BPA from marketing capacity. The cost of this loss should be added to the total cost of each alternative.

V. ALTERNATIVE ACTIONS

A23-20 The set of stated alternatives fail to include alternatives that consider modifications to factors of decline other than the FCRPS operations. These other factors of decline appear to be held constant. These alternatives are combinations of lower reservoir elevation and flow augmentation. The objective of these measures is to improve the downstream survival rate of juvenile salmon.

The SEIS in effect considers only one alternative to avoid the continued decline and to contribute to the recovery of the listed salmon stocks--flow improvements.

A23-21 Of the stated alternatives, as stated in the SEIS, all achieve similar biological results with similar costs. The COE favors alternative 4 because it allows for flow augmentation to assist wild juvenile fall chinook migrate in late summer or early fall.

A23-22 Benefits shown in Table 4.2-1 are only shown for alternative 4. To comply with NEPA and CEQ regulations benefits from Alternatives 2, 3, and 5 must be reported. Substantial treatment of each alternative must be provided in sufficient detail so that reviewers may evaluate the alternatives' own comparative merits. NEPA § 102(2)(C) and § 102(2)(E). Also CEQ regulation 40 CFR § 1502.14 calls for a detailed statement of the alternatives.

A23-23 In the description of the alternatives, Tables 3.5-2 through 3.5-5 present expected flows at several points in the Snake and Columbia rivers. The magnitude of these flows is questionable. The actions being taken are directed at low water conditions. PNGC believes that average flows across low water conditions would be more informative to the decision makers.

A23-24 PNGC supports the choice of operations from 1985 to 1990 as the "No Action" alternative.

A23-25 PNGC strongly objects to the selected preferred alternative. The preferred alternative in the Draft SEIS calls

A23-25 (cont.) for additional flow augmentation during the summer to assist juvenile fall chinook migration in the Snake River. No credible evidence exists to support the conclusion that fall chinook benefit from additional flow augmentation.

Respectfully submitted,

Dave Harper

Dave Harper
Pacific Northwest Generating
Cooperative

GLENWOOD IGA FOODLINER

(DOUG DONNER)



Glenwood IGA Foodliner

Post Office Box 463 • Orofino, Idaho 83544-0463

December 3, 1992

Lt. Col. Robert Volz
Department of the Army
Walla Walla District
Corps of Engineers
Building 602
City County Airport
Walla Walla, WA 99362-6619

Lt. Col. Volz:

A24-1 Glenwood IGA is one of many businesses in the Orofino area that has suffered during the 1992 summer drawdown of Dworshak. We are an established business of 47 years with 16,000 sq. ft., open 24 hours and 58 employees. We also track the economics of the area very closely. The over all store sales are up for the year, but July's sales were down $22,655.00 and our customer count was down 639. Our August sales were down $25,109.00 with the customer count down 583.

In the proposed 1993 draft EIS it was stated that the potential displaced value of recreation was estimated at a $5,000.00 loss. The primary purpose of this letter is to simply point out that your $5,000.00 figure is grossly under estimated. We alone exceed almost a $48,000.00 loss.

A24-2 We had tourists and customers commenting negatively all summer long on the lack of facilities, the mud they sank in up to their knees, congestion at the narrow end of a long ramp, ramps on the other side of the dam not cleared of "dead head" logs and cable. Many people indicated that they will not come back.

A24-3 The decline in sales and decline in customer count for July and August was most definitely attributed to low water levels at Dworshak. Our business will suffer more if Option 4 of SEIS is adoped for 1993.

Doug Donner
Store Manager

cc legislature

DIRECT SERVICE INDUSTRIES, INC.
(JOHN D. CARR)

Direct Service Industries, Inc.
925 LLOYD CENTER TOWER ◻ 825 N.E. MULTNOMAH STREET ◻ PORTLAND, OREGON 97232-2150 ◻ (503) 233-4445

December 7, 1992

Colonel Volz
Department of the Army
Walla Walla District, Corps of Engineers
ATTN: CENPW-PL-ER
Walla Walla, Washington 99362-9265

Re: DSI Comments on Draft SEIS

Dear Colonel Volz:

Direct Service Industries, Inc, on behalf of its member companies, submits the attached comments on the Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon Draft Supplemental Environmental Impact Statement ("Draft SEIS"). The Draft SEIS, the FSEIS, and all subsequent decision documents should demonstrate that the decision made used the best evaluative techniques and embodied the appropriate principles and guidelines methodology. Specific points to these issues are included in our general comments.

A25-1 In addition to the general comments, we submit a comment by Dr. Graham Gall that specifically address biological and scientific concerns with the document. Dr. Gall's comments include an attachment that addresses the scientific uncertainty regarding juvenile salmon migration and river flow.

We also submit for the record two reports on the relationship between flow and juvenile salmon migration that are referenced in our comments. One report, "Timing of Passage of Juvenile Salmon at Columbia River Dams," by Dr. William J. McNeil, studied the relationship between flow levels and migration timing in the Snake and Columbia Rivers. Dr. McNeil concluded that there was insufficient evidence to support the conclusion that increased flow advanced migration timing. A summary of the document is also included. The other report, by Karen Kreeger and Dr. McNeil is a literature review of reports on flow and salmon migration.

The comments by Dr. Gall and the reports by Dr. McNeil demonstrate that there is a need to review assumptions about flow and salmon migration. The Draft SEIS is premised on the assumption that increased flow increases juvenile salmon survival. The Draft SEIS does not adequately explain the weakness of the evidence in support of this assumption and does not provide studies to evaluate the effects on salmon and the environment should the assumption prove wrong. These uncertainties are critical to the decisions made in the Draft SEIS and have not been adequately explained.

A25-2 The listed salmon species do not need piecemeal efforts, but a comprehensive solution. The Draft SEIS is limited in scope to flow measures. The Draft SEIS does not even address all river operations. The Draft SEIS should have considered a wider range of alternatives, including all river operations measures and additional measures in the area of habitat improvement, hatchery operations and harvest reductions.

A25-3 The DSIs also have particular concerns about the Draft SEIS because the measures in the draft SEIS affect the production of electric power by the Federal Columbia River Power System (FCRPS). The top quartile of the DSI load served by BPA is subject to interruption. A reduction in energy produced by the FCRPS may reduce BPA direct service to the DSIs. If that occurs, the DSIs must either shut down, curtail operation, or buy replacement energy (Industrial Replacement Energy or IRE). IRE is more expensive than energy purchased from BPA, furthermore, if BPA is buying energy as a result of its fishery obligations at the same time the DSIs are buying IRE, the DSIs will be competing with BPA for energy. This competition will raise the price of energy for both the DSIs and for BPA.

We thank you for the opportunity to comment and hope that our comments assist the Corps in preparing the final document.

Very truly yours,

John D. Carr
Executive Director

JDC:jr
Attachments

cc: General Harrell -- COE Portland
Randy Hardy -- BPA
Rollie Schmitten -- NMFS
John Keyes -- BOR

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DIRECT SERVICE INDUSTRIES, INC.

(JOHN D. CARR)

December 7, 1992

COMMENTS OF THE DIRECT SERVICE INDUSTRIES ON THE
INTERIM COLUMBIA AND SNAKE RIVERS
FLOW IMPROVEMENT MEASURES FOR SALMON
DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

I. EXECUTIVE SUMMARY

A25-4 The "Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon Draft Supplemental Environmental Impact Statement" (the "Draft SEIS") presents five alternatives for operating the Federal Columbia River Power System ("FCRPS") in 1993 (and possibly additional future years). The Direct Service Industrial Customers ("DSIs") cannot support the selection of Alternative 4 as the preferred alternative. (See Draft SEIS 3-10, 5-7.)

A25-5 The Draft SEIS is not clearly written as a supplement. It combines elements of a supplemental EIS with elements of a stand-alone EIS. As a result the document is frequently confusing. The final document should be revised to clearly be either a supplement or a new EIS. The Draft SEIS is subject to criticism as a stand-alone EIS because of the limited scope of alternatives considered. Therefore, the DSIs suggest that the final document be made more clearly a supplement to the 1992 OA/EIS. The final SEIS should explicitly affirm the 1992 decision, as modified in the SEIS.

A25-6 Alternative 4 of the Draft SEIS, selected as the preferred alternative, provides that the FCRPS will be operated as it was in 1992, but with the flexibility to transfer 200 KAF of releases from Dworshak from September to July or August, and with some change in the criterion for flood control transfer from Dworshak to Grand Coulee. (Draft SEIS 3-9 - 3-10.) The analyses in the Draft SEIS do not show greater benefits to anadromous fish for Alternative 4 as compared to Alternative 2, but Alternative 4 is projected to be more costly. Selection of a more costly alternative that provides no greater benefits seems contrary to the cost-effectiveness criterion purported to be relied upon the Draft SEIS. (Draft SEIS 5-3 - 5-8.)

Shifting 200 KAF of Dworshak flows from September to July or August is intended to improve survival of juvenile fall chinook, and possibly returning adults. (Draft SEIS 5-3.) There is no reliable scientific evidence to support the conclusion that juvenile fall chinook benefit from additional flows. However, the DSIs understand that Alternative 4 gives the operating agencies "the flexibility to shift the timing of flow augmentation in the period of August through September." (Draft SEIS 5-7.) The river operating agencies should have flexibility to decide when to provide releases and should not be bound to specific schedules.

A25-6 (cont.) Use of flow from Dworshak may[1] provide some benefit to adult migration by lowering river temperatures, but the provision of releases for temperature control should be regarded as an experiment.

A25-7 The Draft SEIS addresses "alternative" measures to benefit salmon, in particular those salmon populations that have been listed as threatened or endangered under the Endangered Species Act. Thus, the justification for changes from the "no action" baseline must be that the changes will benefit salmon, in particular the listed species. The Draft SEIS does not sufficiently explain that most, if not all, of the changes being made to FCRPS operations are based on questionable evidence. The final document should identify all areas in which scientific data is lacking or uncertain. 40 CFR § 1502.22.

A25-8 Changes in operations to increase flows are based on the premise that increased flows will improve juvenile salmon migration. (See Draft SEIS 3-1 - 3-2.)[2] The Draft SEIS uncritically accepts this premise as the basis for many of the changes proposed for the system. The Draft SEIS mistakenly states: "Much migration research indicates that survival of juvenile salmonids . . . might be related to water flow or velocity." (Draft SEIS at 3-1.) In fact, only a limited amount of research has been done in this area and the results are equivocal. (See Kreeger and McNeil 1992, McNeil 1992.) There is absolutely no evidence to support the assumption that juvenile Snake River fall chinook benefit from increased flow, yet the decision to choose Alternative 4 over Alternative 2 is largely based on this unsupported assumption.

A25-9 The scope of the Draft SEIS is unnecessarily limited. The Draft SEIS addresses transportation of salmonid juveniles in only a limited way and does not suggest any changes to the transportation system. The transportation system is an integral part of the system -- most smolts from upper reaches of the Columbia and Snake Rivers are transported. The main concern of the Draft SEIS is to improve the system to increase juvenile migration

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[1] The benefits, if any, to adult migrants would likely be limited to a rare combination of low flows and a high temperature differential between Dworshak Reservoir and the mainstem Snake River. Increased flow in medium to high flow years would likely slow adult migration.

[2] Certain federal, tribal and state agencies have jumped on the "flow" bandwagon as a way of blaming the hydropower system for all problems faced by salmon in the Pacific Northwest and as an excuse not to take the measures necessary to reduce harvest, to change harvest practices, to modify the failed hatchery system and to protect or restore salmon habitat.

A25-9 (cont.) survival, yet does not deal sufficiently with possible ways of increasing survival by improving the transportation system.

A25-10 The Draft SEIS is too narrow in scope in other ways. Environmental impact statements should consider alternatives not within the jurisdiction of the lead agency. 40 CFR § 1502.14(c). Neither the Draft SEIS nor the 1992 OA/EIS considered alternatives other than river operations measures. By limiting the scope of the Draft SEIS to flow measures, the agencies have failed to properly consider all cumulative actions. 40 C.F.R. § 1508.25. Reduced harvest, improved hatchery practices and better habitat management should have been considered, either as separate alternatives or incorporated into one or more river operations alternatives.

A25-11 The Draft SEIS relies on models to support its conclusions. The drafting agencies appropriately provided considerable information on the assumptions and parameters for the CRISP, SLCM, PAM and SPM models. However, the Draft SEIS stated that the agencies would also use the FLUSH and ELCM models in the final decision. These models have not yet been reviewed and their results should not be relied on in decision making until after considerable review.

A25-12 The impacts of other actions should be taken into account in an EIS. 40 CFR § 1508.25(a)(2). Hydropower operations, harvest, hatchery practices and habitat management all have cumulative effects on the listed salmon species. The cumulative effects of these measures cannot be adequately evaluated unless appropriate sensitivity studies are performed to determine how the different factors interact. Additional modeling is needed to develop a better understanding of the cumulative effects of human activities that affect salmon.

A25-13 The assumption of a 65 percent harvest rate for fall chinook in the models was improper. (Draft SEIS, App. E at 3). Although it may be appropriate to use a 65 percent harvest rate as part of a sensitivity analysis, the models should have assumed a range of rates, including the 55 percent harvest rate recommended by the Northwest Power Planning Council, and zero U.S. harvest, as required by the Endangered Species Act. At a minimum, the agencies authoring the report must make it clear that a 65% harvest rate of any listed species is unacceptable. If the agencies that r late harvest are aware that the river operations are compensating for the effects of harvest, those agencies will not act to reduce harvest. As a result, mitigation for the adverse effects of harvest will come from changes in river operations, not changes in harvest. The hydropower system and BPA's ratepayers should not have to pay hundreds of millions of dollars to allow harvesters to continue to take listed species in violation of the ESA.

A25-14 The Draft SEIS is written as if the flow measures will benefit juvenile migration of the endangered Snake River sockeye in 1993.

A25-14 (cont.) No juvenile sockeye migration from Redfish Lake is expected to occur in 1993.[3] There has been no natural spawning of sockeye adults in Redfish Lake since 1989. All progeny from this spawning would have long since migrated, and there will not be any releases from the captive broodstock program in 1993 or 1994. Therefore, there is no need in those years to take measures to assist juvenile sockeye migration from the Snake River.

II. COMMENTS

A. The SEIS Should Be A Supplement, Not A Hybrid Supplement/Stand-Alone EIS

A25-15 The Draft SEIS has many elements of a stand-alone EIS. It analyzes new alternatives and contains lengthy descriptions of the geography, ecology and economy of the area that will be affected. Although there are some general statements that the document is a supplement to the 1992 OA/EIS, much of the discussion and analysis is written as if the 1992 OA/EIS did not exist. The Draft SEIS is neither a satisfactory supplement, because it is not sufficiently integrated and tied to the 1992 OA/EIS, nor a sufficient stand-alone EIS, because the consideration of alternatives was too restricted. The Draft SEIS should be modified so that it is clearly either a supplement or a stand-alone document.

A25-16 The Draft SEIS lays out five alternatives. Alternative 1, the no action alternative, is not a realistic choice because NMFS would surely reject this option and issue a "jeopardy" opinion if the river operating agencies adopted Alternative 1. Alternative 2 is 1992 operations. Alternative 3 is the same as Alternative 2, but with a different analysis, based on different assumptions. Alternative 4 is slightly different from Alternative 2, but the differences are relatively minor. Alternative 5 is the same as Alternative 4, but again with a different analysis based on different assumptions. Thus, there are only three alternative courses of action, one of which is not politically possible but is appropriate for use as the no-action alternative. The differences in the remaining two alternatives are minor.

The heart of an EIS is the discussion and analysis of alternatives. 40 CFR § 1502.14. The EIS should "rigorously explore and objectively evaluate all reasonable alternatives." 40 CFR § 1502.14(a). The alternatives presented in the Draft SEIS would not satisfy the requirements of a stand-alone EIS that all reasonable alternatives be explored and evaluated. However, a wider range of alternatives (several different flow options,

[3] A juvenile migration of O. nerka from Redfish Lake can be expected, but these will be offspring of resident fish. In fact, most, if not all, outmigration from Redfish Lake in the last decade has been of the offspring of resident fish.

A25-16 (cont.) drawdown options and combinations of flow and drawdown measures) was evaluated in the 1992 OA/EIS. The Draft SEIS should explicitly state that it reaffirms the decision made in the 1992 OA/SIS, but that additional alternatives intended to fine-tune its 1992 decision are analyzed.[4]

A25-17 Much of the information contained in the Draft SEIS is duplicative of information contained in the 1992 OA/EIS. Section 2 (Description of Existing Environment), Section 4 (Environmental Effects of Alternatives) and Section 7 (Compliance with Applicable Federal Environmental Statutes and Regulations) in particular contain much repetition of information from the 1992 OA/EIS. To comply with 40 CFR § 1502.20 and 1502.21, these sections should be reduced significantly, with the provisions of the 1992 OA/EIS incorporated by reference. Some of the analysis (Section 4) has changed, but only new or changed information should be included if the document is to act as a supplement.

B. The Final SEIS Should Clarify The Extent To Which The 1992 OA/EIS Is Incorporated By Reference

The Draft SEIS states:

> (R)elevant previous discussions and analyses from the 1992 OA/EIS, if there has been no change, will be summarized and incorporated by reference into the SEIS. Issues and impacts from actions considered in the 1992 OA/EIS that are not incorporated in the current set of alternatives for the interim years are not addressed in the SEIS.

(Draft SEIS ES-1.)

A25-18 The Draft SEIS is a supplement to the 1992 OA/EIS. As such, the Draft SEIS modifies but does not replace the 1992 OA/EIS. Therefore, all discussion and analysis in the 1992 OA/EIS should be considered to be "incorporated by reference" into the Draft SEIS, except to the extent explicitly changed by the Draft SEIS. The discussion of incorporation by reference to the 1992 OA/EIS should read:

> The discussion, analysis and implementation of the drawdown test described in the 1992 OA/EIS is specifically excluded from this SEIS. With that exception, the 1992 OA/EIS is reaffirmed and made applicable to river operations in 1993 and subsequent

[4] This does not mean that the "no-action" alternative should be deleted or changed. River operations in the 1985-1990 period should remain the baseline against which all alternatives are measured.

A25-18 (cont.) years, except as explicitly modified by this SEIS. All discussion and analyses in the 1992 OA/EIS are incorporated herein by reference, except to the extent that those analyses are modified by this SEIS.

A25-19 The Draft SEIS states that preparation of a supplemental EIS is appropriate because there have been substantial changes in the project relevant to environmental concerns, there is significant new information relevant to environmental concerns and the purposes of NEPA will be furthered by doing so. (Draft SEIS 1-1.) There have been no substantial changes in the projects -- the shift in the timing of releases of 200 KAF from one dam, given the entire scope of project operations is not substantial. No significant new information relevant to environmental concerns has been discovered in the last year. However, the Draft SEIS contains new analyses, based on flow/survival relationship rather than flow/water particle travel time relationship. (Draft SEIS 4-10.) Because the purpose of the measures taken is to assist the listed species, analysis based on survival rather than travel time is more appropriate. Therefore, provision of the new analyses is appropriate in the supplement.[5] A supplemental EIS would further the purpose of NEPA by extending the applicability of the 1992 decision for additional years and providing the appropriate environmental analysis for the decision to continue 1992 operations, as modified.

C. The Scope of the Draft SEIS Is Unnecessarily Narrow

A25-20 The Draft SEIS addresses primarily operations of the FCRPS that affect flow in the Snake and Columbia rivers. Although there is some discussion of transportat on of juvenile salmon migrants, (see Draft EIS 3-11 - 3-12), no alternatives that would improve transportation program are considered. Given the number of upriver fish that are transported, improvements in the transportation system have the potential for providing much greater benefits than any conceivable flow measure. The transportation system has become an integral part of the river system and improvement and expansion of the trans ortation system should be considered as part of any analysis of the operations of the FCRPS. Any analysis of the effects of the FCRPS on salmon that does not fully consider transportation is deficient.

The DEIs strongly urge the Corps and other responsible agencies to consider ways of improving the transportation system by reducing density, improving segregation by species, changing release points, varying speed of transportation, experimenting with alternative transportation vessels, including net pen barges,

[5] Nothing in these statements about the ap ropriateness of analyses based on survival should be interpreted as acceptance that there is a relationship between flow and survival or as acceptance of the substance of the analyses.

A25-20 (cont.) increasing the numbers of fish transported and increasing segregation of hatchery and wild fish.

A25-21 The Draft SEIS also does not consider other actions that are an integral part of the river system, including improved screening of irrigation diversions. All river operations should be analyzed.

A25-22 An EIS should consider all reasonable alternatives, even if the alternatives are not within the jurisdiction of the lead agency. 40 CFR § 1502.14(c). The Draft SEIS and the 1991 OA/EIS both fail to consider the wide range of alternatives to assist salmon survival. Reduced harvest levels, improved habitat management and hatchery practices that are more sensitive to the needs of the listed species and other wild fish should all have been incorporated into one or more of the alternatives. Failure to do so results in only a limited approach to the overall problem of salmon survival. The purpose of an EIS is to identify the best alternative, not to identify a partial solution. Continued harvest at present levels may make it impossible for river operations measures ever to be successful.

D. The Assumptions in the Draft SEIS Relating to Flow Levels Are Questionable

A25-23 An EIS should clearly identify areas in which information is incomplete or unavailable. 40 CFR § 1502.22. There is much questionable information in the Draft SEIS, which is not identified as such. The Draft SEIS accepts that, for at least some stocks and under certain conditions, additional flow will increase the survival of juvenile salmonids. (Draft SEIS 4-9.) Although some studies have shown some possible correlation between increased flow and juvenile survival, or between increased flow and reduced travel time, none of these studies show a sufficiently strong relationship with a sufficient degree of reliability to allow the conclusion that increased flow in the mainstem of the Snake and Columbia Rivers will increase the survival of juvenile salmonids during migration. The final document should clearly state that evidence regarding flow and survival is unreliable, and should do so at every mention of the relationship.

A25-24 It is possible that the relationship between flow and travel time are both dependant of date, and that the relationship between the two is not causal. It is also possible that the relationship between flow level and juvenile survival (if any) is primarily (or entirely) the result of improved water conditions in the unregulated portions of spawning tributaries. Although there may be a relationship between flow levels in the regulated portions of the river system and juvenile salmonid survival, that relationship has not been proven. If the Draft SEIS is to choose an option that provides increased flows for juvenile salmon, it should explicitly state that these flows are provided because of possible benefits projected as a result of studies whose reliability has been

A25-24 (cont.) questioned. See 40 CFR § 1502.22. The final SEIS should explicitly provide that the operation of the river may change as additional information is learned concerning the relationship between flow in the regulated portions of the river system and salmon survival.

1. The Draft SEIS Overstates the Results of Scientific Studies Correlating Flow and Survival

A25-25 The Draft SEIS states that flow and travel time relationships have been found to be significant for yearling chinook at low flows in the Snake and Columbia Rivers. (Draft SEIS at 4-9.) While there have been some studies that show an apparent relationship, none of these studies show a significant relationship at any degree of confidence and do not demonstrate that the relationship is causal. It is quite possible that both travel time and flow are related to date. Flows increase later in the yearling chinook migration season. Similarly, later migrating yearling chinook have generally experienced a greater degree of smoltification and thus are more ready to migrate. Furthermore, even if a causal relationship could be assumed, the relationship between travel time and survival remains only an assumption.

Some studies have tended to shed doubt on whether there is any relationship between flow and survival, travel time, or migration timing.[1] The Draft SEIS states that there is "some uncertainty" in the relationship. This is incorrect -- the limited scientific evidence available provides no level of certainty at all. At best, the scientific evidence supports the conclusion that increased flow may benefit juvenile yearling chinook during low flow years. (See Draft SEIS 4-9.)

A25-26 The Draft SEIS estimates that operations under Alternative 4 will cost an additional $66 million to $93 million annually. These costs are attributable to the provision of additional flows over baseline conditions. Most, if not all, of these costs will be borne by BPA's ratepayers. The DSIs expect to pay for approximately one third of these additional costs through their rates. The DSIs' acquiescence in these costly and questionable measures will cease if additional scientific information disproves the flow hypothesis, or provides alternative solutions that provide more certain benefits.

[1] See McNeil, 1992. While migration timing and travel time are not entirely the same concept, Dr. McNeil's migration timing study shows such a uniformity in migration timing over the years, regardless of flow levels, that suggests that travel time may not be a useful concept.

2. Water Particle Travel Time and Juvenile Salmonid Migration Time Should Not Be Confused

A25-27 Much of the literature supporting the hypothesis that increased flows will benefit salmon is based on the assumption that there is a 1:1 correlation between water particle travel time and smolt travel time. The limited studies available do not support this conclusion, even for yearling chinook. It is very clear that subyearling chinook do not migrate at the same speed as the river current, but migrate at slow speeds to enable them to feed and develop during migration. The Draft SEIS is an improvement on the 1992 OA/EIS in that it attempts to analyze the effects on survival rather than on travel time. (Draft SEIS 4-1.) The relationship between flow and survival is questionable; but it at least attempts to measure the right thing -- salmon survival, not water speed.

3. There Is No Evidence To Support The Conclusion That Snake River Fall Chinook Juveniles Would Benefit From Increased Flows

A25-28 As scanty as the information is generally relating flow and juvenile migration survival generally, there is even less information establishing a relationship between juvenile fall chinook (subyearling)[7] migration and survival. One study showed a weak correlation for subyearling chinook, (See Draft SEIS at 4-9) but other studies have found no correlation. Despite the lack of reliable evidence that additional flow increases fall chinook juvenile migration survival, the Draft SEIS chose Alternative 4 as the preferred alternative, partly because Alternative 4 provides flows for Snake River fall chinook juvenile migration. (See Draft SEIS 3-10.)

The DSIs cannot support a decision based on such flimsy evidence, especially in the face of stronger evidence to the contrary. The final SEIS should state that the evidence on the flow/survival relationship for fall chinook is does not support the provision of additional flows for fall chinook juvenile migration.

A2 -29 There is some possibility that drafting 200 KAF from Dworshak during the late summer may assist the migration of adult chinook and sockeye returning to spawn under certain conditions (low flow[8]

[7] Most Snake River fall chinook migrate as subyearlings and most Snake River spring/summer chinook migrate as yearlings. The studies that have been performed distinguish between subyearling and yearling migrants. The conclusions reached as to subyearlings are generally considered to be applicable to Snake River fall chinook.

[8] In years of medium to high flow, the increased flow would likely slow adult migration.

A25-29 (cont.) and high temperature differential between Dworshak and the mainstem Snake River). Providing these flows from Dworshak may help to reduce the temperature in the Snake River and prevent a "temperature block." However, the number of years in which there are both low flows and a high temperature differential are likely to be few. There tends to be a smaller temperature differential in low flow years.

Although the change in flows from Dworshak to an earlier period cannot be justified as benefitting fall chinook juvenile migration, allowing the agencies the flexibility to shift the releases earlier in the years if a temperature block develops may benefit adult migration. A better analysis of both the effects on adult migration and on refill capability would be useful to evaluate this measure. The reasons given for the decision in the Draft SEIS do not provide an adequate basis for the choice of Alternative 4.[9]

E. The Assumptions Concerning Harvest Levels May Assist Other Agencies To Set Unacceptably High Harvest Levels

A25-30 An EIS should consider the impacts of all cumulative actions that affect the fish. See 40 CFR § 1508.25. Harvest, habitat management and hatchery practices are all actions that affect salmon, including the listed species. Harvest levels, habitat protection and hatchery practices are all changing or can be expected to change as a result of the listing of Snake River salmon under the ESA. The Draft SEIS does not consider how these changes may affect the listed species, but merely assumes "business as usual" in these areas. This does not give a true picture of the impacts on the listed species, nor does it allow a proper evaluation of all alternative measures.

The Draft SEIS, and the modeling performed to assess the impacts of the Alternatives, assume a harvest rate of 59 percent in the years 1993-95 and 65 percent in 1996 and beyond for Snake River fall chinook. (Draft SEIS, App. E at J.) These harvest rates are unacceptable and the agencies authoring the report should not have assumed these as the only harvest rates in designing the modeling. Rather, the agencies should have run the models with different assumptions as to harvest rates. This would serve two purposes. First, it would function as a sensitivity analysis to show the effects of different harvest rates. Second, it would allow the river operators to more accurately assess the needs for additional

[9] The DSIs note that the environmental benefits of Alternative 4 are calculated to be similar to those of Alternative 2. (Draft SEIS Table 4.2.) Given that the cost of Alternative 4 is estimated to be higher than Alternative 2, (See Table 5.2-1) the selection of Alternative 4 seems contrary to the cost-effectiveness criteria supposedly used in making the decision.

A25-30 (cont.) adjustments in subsequent years. It would also provide an appropriate evaluation of cumulative effects, which is currently lacking. See 40 CFR § 1508.25.

A major problem with assuming a harvest rate of 59 or 65 percent is that if such these harvest rates are assumed in river operations, the modifications in river operations will provide some level of assurance that harvest at that level can be maintained. If the river operations are successful in compensating for a 65 percent harvest, the harvest regulators will continue to allow this absurdly high harvest level of a listed species to continue. If this happens, the costs of providing remediation measures to compensate for harvest will be borne by BPA's customers, not by the harvesters.

Appendix A to the Draft SEIS clearly demonstrates that harvest was responsible for the original decline from the historic high levels of salmon returning to the Columbia River. Both harvest and river operations have affected salmon, it is fundamentally unfair to impose the entire cost of recovery efforts on the hydro system and leave the harvesters free to continue to take threatened and endangered species.

The final SEIS should contain additional modeling results which use a range of harvest rates. Although a 65 percent harvest level for any listed species should not even be considered by harvest regulators, it may be appropriate to use this figure as a worst case analysis in a modeling run. However, other model runs should assume lower harvest rates, perhaps including the 55 percent harvest rate recommended by the Northwest Power Planning Council,[10] and zero harvest in areas subject to the jurisdiction of the United States (note that this would assume some harvest, including harvest in areas subject to Canadian jurisdiction and high seas harvest).

A25-31 The lack of any sensitivity analysis regarding harvest is part of a larger problem with the Draft SEIS. The Draft SEIS does not analyze the cumulative effects of all actions being taken to assist the listed species, as required by 40 CFR § 1508.25. The modeling runs not only assumed a static harvest rate, but, for the most part, also assumed that there would be no improvements in habitat quality and no reduction of adverse impacts from hatchery operations.[11] Additional modeling runs, based on varying assumptions as to benefits from habitat and hatchery mitigation measures, would have provided a better projection of future populations of the listed species. Again, assuming no benefit from

[10] This rate is also unacceptably high.

[11] Some allowance for habitat improvement was included in certain modeling runs, however, the final documents should provide additional sensitivity analyses.

A25-31 (cont.) these measures is appropriate as one conservative assumption, but additional sensitivity analyses would have provided more information.

F. The Draft SEIS Should Modify Its Analysis of the Impacts on Snake River Sockeye Because It Is Unlikely that Snake River Sockeye Juveniles Will Migrate in 1993

A25-32 The Draft SEIS analyzes the survival of Snake River sockeye juvenile migrants in 1993. (See e.g. Draft SEIS 4-17 - 4-18.) We assume that the Draft SEIS uses the term "Snake River sockeye" as that term is used in listing Snake River sockeye as an endangered species. The listed species of Snake River sockeye includes only fish with anadromous ancestry -- offspring of kokanee are not included within the definition. It is extremely unlikely that any sockeye juveniles will be migrating from Redfish Lake (or anywhere else in the Snake River Basin) in 1993. There will be no releases from the captive broodstock program by the time of the juvenile migration. The last natural spawning of sockeye in Redfish Lake was no later than 1989.[12] Any offspring from the possible spawning in 1989 or any previous year would have already migrated. Therefore, any O. nerka migrating from Redfish Lake in 1993 or 1994 will be the offspring of resident fish. It is extremely doubtful that these fish are "Snake River sockeye" as that term is used to describe the endangered species. Rather, they are members of the abundant Redfish Lake kokanee population that, for one reason or another, were stimulated to migrate.

An EIS should address environmental impacts in proportion to their significance. 40 CFR § 1502(b). There is no reason to analyze in such detail the effects of the alternatives in the Draft SEIS on Redfish Lake kokanee juveniles that exhibit anadromous behavior. Redfish Lake kokanee, like the kokanee in Alturas Lake, Dworshak Reservoir and many other lakes and reservoirs, produce numbers of juveniles that exhibit anadromy. Redfish Lake kokanee are relatively abundant and have not been listed under the ESA. For 1993 and 1994 operations, analysis of the effects on Snake River sockeye should be replaced with a brief summary of the effects on Snake River kokanee. See 40 CFR § 1502.2(b). To the extent that the decision in the Draft SEIS is based on the effects on the survival of "Snake River sockeye" juvenile migrants in 1993 or 1994, the decision should be reexamined. The Draft SEIS will have no impact on Snake River sockeye juvenile migrants because none will be in the river in 1993.

[12] Two adults returned in 1989. It is unknown whether they spawned.

G. The Analysis of The Alternatives Throughout the Document Is Confusing

A25-33 Much of the discussion of the environmental effects of the alternatives (Section 4) is generic. If there are no differences between the effects of Alternatives 2, 3, 4 and 5, the final document should explicitly state so and eliminate redundant comparisons. Many of the tables could be reduced in complexity by deleting separate categories for these four alternatives and combining the four into a single category. Confusion is created because most of the discussion and analysis is of the effects of either Alternative 2 or Alternative 4, but rarely both. The extensive analysis of Alternative 2 is important as additional justification of the basic decision in the 1992 OA/EIS, which is being reaffirmed with slight modifications.

Normally, an EIS should explicitly compare alternatives and the Draft SEIS contains no real comparison between Alternatives 2, 3, 4, and 5. As a supplement however, the document can reaffirm the original choice among alternatives and then consider minor modifications. Unless the document is redrafted along these lines, it fails as either an SEIS or a stand alone EIS.

If the final document is to be a supplement, it should clearly state that its intent is to expand the applicability of the 1992 OA/EIS to 1993 and future operations. The document should state that additional analyses supporting the basic decision in the 1992 OA/EIS have been performed and that minor variations on the basic choice made in 1992 are being evaluated. The document should provide that additional supporting information (i.e. the information describing and analyz g the benefits of Alternative 2) and also provide some basis justifying the selection of Alternative 4 as the preferred alternative.[13] The range of alternatives reviewed in the Draft SEIS is not sufficient for an EIS but may provide an adequate review of minor adjustments to the prior decision.

H. The Criteria Used Should Be Modified and the Selection of Alternatives Should Be In Accord With Those Criteria

A25-34 The stated criteria for evaluating the alternatives are "(1) juvenile salmon survival rate, (2) cost-effectiveness, and (3) environmental effects." (Draft SEIS 5-1.) Juvenile salmon survival rate is not an appropriate criterion. Overall salmon survival must be the criterion to measure the effects on salmon. A measure that improves juvenile salmon survival that has equal or greater impacts on adult salmon survival should be rejected, but is not rejected under the criteria used in the Draft SEIS. Increased flow may adversely affect adult migration; drawdown would create major problems for adult migration. Therefore, the final document should use overall salmon survival (modeled over many years or generations) as the "salmon" criterion.

A25-34 (cont.) None of the comparisons between alternatives show any difference in the effects of Alternatives 2, 3, 4, and 5, except that Alternative 4 is more costly than Alternative 2. Given the cost-effectiveness criterion, the choice of Alternative 4, which is more costly with the same ecological and biological impacts does not follow the criteria. Although the decision states that the agencies believe that Alternative 4 provides the best survival, no basis is given for that belief. The final document should either provide a better rationale for the decision or change the decision.

III. CONCLUSION

A25-35 The Draft SEIS contains a great deal of information. It improves the analysis[14] contained in the 1992 OA/EIS that it supplements. However, the document needs to be restructured to be more clearly a supplement.[15] If restructured as a supplement, the SEIS should be shortened considerably by deleting material that merely duplicates the information in the 1992 OA/EIS. The SEIS should explicitly adopt the decision in the 1992 OA/EIS as modified, provide the additional analysis that the Draft SEIS contains, and discuss any changes from 1992 operations.

A25-36 The decision to adopt Alternative 4 comes as something of a surprise because there is very little information in the document to support the choice. The decision is justified as giving the operating agencies the flexibility to adjust timing. (Draft SEIS 5-7.) More discussion and analysis to support this reasoning is needed earlier in the document. The DSIs can support a decision to give the river operators more flexibility -- the DSIs cannot support a decision to provide summer flows to assist juvenile migration. If Alternative 4 is adopted, the operating agencies must use the added flexibility in ways that will benefit fish, not just appease political interests.

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[13] This justification is totally lacking in the Draft SEIS. Unless some justification for Alternative 4 is provided, Alternative 2 should be the preferred alternative.

[14] The analysis should still be more extensive. The Draft SEIS used three criteria in its analysis: juvenile salmon survival rate, cost-effectiveness, and environmental effects. (Draft SEIS 5-1.) Flows affect adult salmon survival; the effect on adult salmon survival should have been analyzed as well. Even a measure that increases juvenile migration survival by 10 percent cannot be justified if it decreases adult survival by 15 percent.

[15] Alternatively, the Draft SEIS could be made into a stand-alone EIS. A stand-alone EIS would require discussion and analysis of a wider range of alternatives.

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DIRECT SERVICE INDUSTRIES, INC.
(JOHN D. CARR)

December 7, 1992

Comments on the Interim Columbia And Snake River
Flow Improvement Measures for Salmon Draft
Supplemental Environmental Impact Statement

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The Interim Columbia And Snake River Flow Improvement Measures for Salmon Draft Supplemental Environmental Impact Statement (Draft SEIS) presents five alternatives for the operation of the Federal Power System for 1993 and possibly future years. The five alternatives are narrow in scope and consider only minor differences in operation. Alternative 4 is chosen as the preferred alternative.

A25-37 The Draft SEIS is confusing and incomplete. Only limited evidence is presented regarding the selected alternative. Alternative 2, which is to operate the system as it was in 1992, is discussed at length, but information essential to understanding why the other three alternatives, including the base case of no action (Alternative 1), were not chosen is not provided. The terminology used to identify the various alternatives in different sections of the Draft SEIS is inconsistent, so the reader is never sure which alternative is being discussed. As a result it is nearly impossible to assess the true nature of the analyses carried out to evaluate the alternatives. In addition, it appears that not all alternatives were fully analyzed, but rather similarities among alternatives, either assumed or discovered early in the analysis process, resulted in some alternatives not being analyzed completely. In particular, most of the discussions offered in the Draft SEIS pertains to results on analyses of Alternative 2 but a conclusion is reached that Alternative 4 is the preferred alternative.

A25-38 The analyses, as reported in the Draft SEIS, appear to have been highly superficial. No evidence is provided as to the specific biological impacts the drafting agencies considered central to an analysis of river operations. For example, neither survival during various stages of migration of juvenile salmon, nor differential effects on various listed species, is specifically addressed; results of analysis are given only in summary form for some alternatives. In addition, all of the analyses were based on the results of running simple computer models. Consequently, all conclusions presented in the Draft SEIS are dependent solely on the assumptions inherent in the models. No attempt appears to have been made to logically or scientifically assess the deficiencies of the models or the probable effectiveness of the various alternatives if the explicit assumptions failed to agree with reality. One obvious error exist of the kind was the assumption that a harvest rate of 65 percent would be true for 1993 and all future years. Numerous other errors exist in the analysis, such as

A25-38 (cont.) assuming only a single relationship between water flow and survival of juvenile salmon, assuming a single, simple relationship among the factors water flow, timing of migration and juvenile growth and development, and assuming a static effectiveness of transportation.

A25-39 A biologically more prudent approach would be for the drafting agencies to explicitly list all biological and physical elements central to salmon production in the river system, along with the likely impacts of the various alterative modes of river operation on each element. This should be followed by a critical scientific analysis of the likelihood of each impact occurring, positive or negative, under various assumptions regarding the relationships among the effects of river operation ?? the performance of juvenile salmon. For example, one glaring assumption inherent in the analysis presented in the Draft SEIS is that increased flows through reservoirs will improve the survival of Snake River fall chinook according to a specific relationship of flows, travel time and length of fish. There is essentially no scientifically reliable information to support this assumption. It is imperative that the SEIS evaluate the consequences of the assumption being incorrect and, at a minimum, provide an analysis of potential negative impacts of increased flows on fall chinook survival. This example alone illustrates why the results of modeling should be used only as one source of information in the analysis of possible impacts, and should be used primarily to assess the sensitivity of the analysis to changes in assumptions. Computer modeling cannot be used to predict absolute outcomes.

A25-40 In addition to lacking information on the analysis of all five alternatives and a complete discussion of probable impacts, the Draft SEIS does not address potential conflicts of adopting any one of the various alternatives on different species at various stages in the growth and development of juvenile salmon. Thus, the Draft SEIS does not provide a balanced analysis of all five alternatives.

A25-41 The behavior and physiology of juvenile salmon changes constantly during their early growth and development and particularly during their adaption to the complex transition from freshwater to saltwater. Water is the life support system for juvenile salmon so they have evolved behavioral and physiological mechanisms in response to the behavior of water current, the seasonal availability of food, and the limitation of the freshwater habitat for growth and effective reproduction. Artificial modification of water flows potentially can disrupt as well as change normal juvenile behavior. The Draft SEIS addresses these issues only from the standpoint that increased flows are likely to be beneficial under all circumstances; it does not address the possibility of increased flows having negative effects on juvenile behavior and subsequent survival. Consider an example to illustrate the importance of a balanced analysis. Snake River fall chinook migrate from the habitat where they hatched to the ocean within a few months; this is in contrast to Snake River spring

A25-41 (cont.) chinook which remain in freshwater for at least their first full year of life. In order to grow and develop to the body size and physiological state necessary for ocean survival, these fall chinook juveniles must feed during a slow and measured migration down the river system. Thus, a critical issue in the analysis of impacts of flow on fall chinook not addressed by the Draft SEIS is: "What is the likelihood that increased flows will displace Snake River fall chinook downstream before they have had adequate time to grow and develop and what effect will this have on subsequent survival?"

A25-42 A brief document is attached that summarizes the migratory behavior of juvenile salmon. It outlines at least a minimum set of behavioral and physiological changes prior to and during migration that should be considered in an analysis of alternative modes of river operation. To achieve a balanced evaluation of any set of alternatives, the drafting agencies must undertake analysis that follows a reasonable and scientifically logical set of hypotheses of salmon biology and migratory behavior.

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December 7, 1992

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Re: DEIS Columbia and
Snake Rivers Flow Improvement
Measures for Salmon

Dear Mr. Poolman;

Thank you for sending a copy of the DEIS for 1993 Corps operations of the Columbia River system for our comments. After reviewing the DEIS, we have identified five issues for your consideration.

I. The DEIS is not readable within the meaning of NEPA.

II. The range of alternatives presented in the DEIS is inadequate.

III. The DEIS covers 1993 operations but predicts outcomes based on 5-year projections; therefore, the DEIS appears to be outside the scope of operations considered for next year.

IV. There is no long-range plan for salmon recovery.

V. The NEPA process in subsequent years is unclear and must be clarified. Continued "tiering" on the 1992 EIS is not permitted under NEPA.

I. <u>The DEIS is not readable within the plain meaning and intent of the National Environmental Policy Act</u>.

A26-1 First, an EIS must be written so as to be clearly understood by the public.[1] Secondly, the rule has been interpreted as commanding readability despite complex technical and scientific information.[2] Although the problems presented by data, models, studies, and plans on salmon and salmon recovery are complex, it is imperative that individuals and groups understand the differences in scope and effects of the alternatives contemplated by the DEIS. Unfortunately, the discussion of alternatives and environmental effects in the DEIS is quite difficult to comprehend because of generally unclear language and needlessly obtuse sentence construction. For example, the explanation of environmental effects on power in sections 4.9 through 4.9.2 was particularly confusing: "Again, these values are not intended to represent the actual monetary loss to the power system, but should provide an estimate of the relative value of the capacity losses." DEIS 4-68. It is not clear what a monetary "value" represents in subsequent analysis of effects on energy, nonfirm energy, and rates. Unless losses are expressed as real costs, the educated reader has almost no ability to distinguish the harms or benefits of alternatives. Another example: "Assuming BPA's financial goals remained the same, <u>this</u> might lead to a rate increase in the FY 1994-1995 rate period; however, <u>this</u> is difficult to predict (emphasis added). In the preceding sentence, to what does <u>this</u> refer?

A26-1 (cont.) While we appreciate the difficulty of rendering complex technical terms into comprehensible language, the task of writing in plain, readable language so that an EIS can be clearly understood is a requirement to which the Corps must adhere. The Corps must rewrite the Final EIS so that it can be understood.

II. <u>The range of alternatives is inadequate because there is no alternative which substantially decreases the decline in salmon stocks</u>.

A26-2 a) The standard set by the National Marine Fisheries Service in its Biological Opinion for recovery of salmon stocks was "to make progress toward reversing the decline." It is impossible for a reader to determine whether this standard can be met by any of the five alternatives. Because 1992 conditions assumed by NMFS did not take place, the selection of 1992 operations as the standard for 1993 operations gives no assurance that progress towards reversing the decline will be made. Will the comparison for 1993 operations be 1) improvement over 1992 projections by NMFS or 2) improvement over NMFS projections for 1992 which did not occur? There is no way to determine the answer from this DEIS.

A26-3 In addition, the no-action alternative and baseline for computations should be 1992 operations. Alternative 1 could be included an alternative, but the NMFS biological assessment clearly stated that 1992 operations (based on assumed conditions) would not be enough to make progress towards reversing the

[1] Environmental impact statements shall be written in plain language. . . so that decision makers and the public can readily understand them." 40 C.F.R. § 1502.8.

[2] "The more complicated the science underlying those [environmental] consequences is, the more challenging the preparer's task will be to convey the information clearly." <u>Oregon Environmental Council v. Kunzman</u>, 817 F.2d 484 (9th Cir. 1987).

A26-3 (cont.) decline. Finally, it is unclear why 1991 is not included in any calculation of baseline operations.

A26-4 b) The DEIS dismisses consideration of structural changes because of incomplete studies and information. Waiting for the results of the System Configuration Study (assuming the Phase I report is completed by mid-1993) does not preclude taking more aggressive measures within the system on behalf of fish, considering the concern by NMFS that continuing 1992 operations "would not be sufficient to reverse the decline of salmon populations." DEIS 1-7. The alternatives presented include no more aggressive measures than different shaping of flows and release of stored water. Given that 1992 actual flows did not meet those requested by the agencies and tribes[1] and the fact that recovery projects are based on years outside the scope of this EIS (see III following), structural changes affecting passage must be considered within an alternative for 1993 operations.

A26-5 c) The use of 1) "relative percent change in survival" for cost-effectiveness analysis and 2) the "rate of increase of survival" for recovery objectives obscure the need to express fish recovery in numbers of returning fish in 1993. "Costs" of power losses are expressed in relative "value" while the objective for numbers of fish becomes an abstract "percentage" as well. Abstract analysis is more readily understood if quantifiable objectives are expressed in numbers of surviving fish. The use of real numbers for biological goals will aid in analyzing alternatives for 1993 operations as well as in calculating the actual success of the alternative adopted.

A26-6 III. <u>The analysis of alternatives considers actions taken outside the permissible scope of the DEIS</u>.

The percent of survival improvement shown in Alternative 4 does not necessarily alter the downward trend in survival to the point of recovery, admits the DEIS. However, with "actions taken" through 1998, the percentage of improvement rises dramatically. These actions assume "habitat changes and improvements that may be implemented in actions currently planned through 1998".(CRiSP model 5-2). The NPPC model concludes that "[d]ecreasing trends were still apparent in some of their model runs when lower benefits were assumed for some of the possible future actions". Their results "suggest that some of the greatest enhancement to adult returns would be from improving the spawning and rearing habitat. Not until this component was added did the trend in returns begin to increase instead of decrease." DEIS 5-2. However, the preferred alternative makes no mention of improvements to spawning and rearing habitat.

Because the DEIS is restricted to 1993 operations, it is impossible to know whether improvements to spawning and rearing

[1] Memorandum from Michele DeHart to MLG, Aug. 5, 1992, p.7.

A26-6 (cont.) habitat will take place, and, if they do take place, what effectiveness they will have.

In addition, the rates of increase in survival reflect assumed increases in predator control, additional screens, and increased transport through 1998, all actions outside the scope of 1993 operations. Without the additional five years of projected actions, it is doubtful that the change in the downward survival trend will be enough to presume that 1993 operations will lead to "recovery" of salmon.

A26-7 IV. <u>There is no long-range plan for salmon recovery</u>.

The DEIS states that passage problems are a "significant factor" in declining salmon runs. Nevertheless, the DEIS also states that actions resulting from studies addressing "long-term approaches to rebuilding wild salmon runs" will not take place for several years. Notwithstanding scientific uncertainty, the Corps continues an inappropriate ad-hoc approach to salmon recovery by not incorporating 1993 operations into a long-term plan. Such a plan would by necessity be keyed to flexibility, the same rationale underlying the DEIS preferred alternative. By suggesting that actions will be undertaken through 1998, the Corps is stacking yearly operations into what may become a de facto long-term plan with no comprehensive planning.

A26-8 V. <u>The NEPA process in subsequent years is unclear and must be clarified. Continued "tiering" on the 1992 EIS would not be appropriate under NEPA.</u>

The DEIS is described as an interim plan based on 1992 operations which may not reverse the downward trend in salmon survival. Although it may be appropriate to tier the 1993 DEIS on the 1992 EIS, actions in subsequent years should not continue to be implemented as "interim" actions but rather should be considered as part of a long-range plan approved through the NEPA process. Otherwise, ad-hoc and uncoordinated programs may be implemented indefinitely. A date should be set for adoption of a long-range plan.

Sincerely yours,

Joan K. Eltman

Joan K. Eltman

TOBACCO VALLEY ECONOMIC DEVELOPMENT COUNCIL
(JOE GIBBONS)

December 3, 1992

Joe Gibbons, President
Tobacco Valley Economic Development Council
P.O. Box 395
Eureka, MT 59917

Department of the Army
Walla District
Corps of Engineers
CENPWPL-ER
Walla, WA 99362-9265

RE: Public comment on Draft SEIS

To Whom It May Concern,

Incomplete and incorrect data is contained in the Draft Supplemental Environmental Impact Statement (Draft SEIS). Complete and accurate facts should be the basis of any decision that affects the whole Columbia River Ecology System, not on opinions slanted to appease special interest groups or entities, including government agencies.

The Tobacco Valley Economic Development Council realize the complexity of multiple-purpose uses surrounding the operation of the System; however, we also recognize the absence in the Draft SEIS of careful consideration when creating negative impacts affecting the upstream environment.

The following points are data from the Draft SEIS that verify inadequate consideration of the impacts on Lake Koocanusa:

A27-1 3.2 / page ES-9 "Insignificant increases in blowing dust during some periods of the year, particularly near the storage reservoirs."
There is insufficient data supporting this summation. There has not been enough time to determine the degree blowing dust has on Tobacco Valley since the Corps only recently placed a weather monitor at Murray Springs Fish Hatchery. And it won't be until 1994 when the Corps reports its findings on dust data collected near Libby Dam after a full year of monitoring (page 4-60).
This summation is also opposite the Draft statement that "fugitive dust concentrations are likely to be significant and detrimental to local users of the reservoir" (4.6 / page 4-59).

A27-2 2.3.6 / page 2-23 "Sediments in Lake Koocanusa are calcarcous and low in organic matter, have a silty loam or loam texture, and serve as a phosphorus sink."
This sediment discharged annually also settles on the shores and flats which contributes to the dust problem.

A27-3 2.12.2 / page 2-39 to 41 Recreation-Libby/Kootenai River
Statistics used to determine recreation are taken from 1985, eight years ago. Current information and demographics must be used, from private enterprises as well as Corps and Forest Services statistics:

- Mariners Haven, a full-service campground and marina, is neither marked on the recreational map nor described accurately.
- Koocanusa Marina, owned by Bob Cutts and located in British Columbia, is not mentioned; it has over 200 campsites as well as a marina.
- Kootenae River Cruises is described as currently operating, but it has been out of business for several years.
- Kalispell is also 75 miles from Lake Koocanusa, not "140 miles".

A27-4 2.13.6 / page 2-44 Aesthetics-Libby/Kootenai River
Lake Koocanusa extends into British Columbia, not "Alberta."

A27-5 2.15.2 / page 2-48 "All counties in the study area for which unemployment statistics were available experienced a decline in the unemployment rate."
Tobacco Valley's continuing program for a diversified economy in tourism and recreation includes Lake Koocanusa. Negative impacts, pointed out in this letter, will certainly affect these income-providing industries and prove to be catastrophic for Lincoln County, Montana where the unemployment rate is already very high . . . 10.7%.

A27-6 4.5.5 / page 4-57 Geology and Soils-Conclusion
This Draft section confirm that silt continues to be redeposited annually and worsens the dust problem. Lower reservoir level means more miles of sand and dust exposed to winds.

A27-7 4.10 / page4-73 "Additional drafts of up to 20 feet in some months of low-water years, possible constraints on use of facilities."
It is a definite constraint. And using only Forest Service campgrounds as models for low-water effects is not aufficient data to make this conclusion.

A27-8 4.11 / page4-84 "Seasonal drafts up to 20 feet deeper in low-water years, with minor incremental aesthetic effects."
A 120-foot bathtub ring around Lake Koocanusa is not a scenic sight.

A27-9 4.11.1 / page 4.85 "Actions that would draft reservoirs for the longest periods and expose the greatest amont of shoreline and lake bottom would have the greatest potential for increasing dust."
Any drawdown increases negative aesthetics.

A27-10 4.13 / page 4-90 "Value of displaced recreation less than $5,000."
How can this statement be true when private enterprise was not consulted? Private businesses lose more than $5,000 with low water, directly and negatively affecting the socioeconomic fiber of Lincoln County, Montana.

The Tobacco Valley Economic Development Council appreciate the enormity and complexity of the System. And so, we request the Corps to consider the points covered in this letter carefully and to gather complete, accurate facts before deciding on operational changes affecting the whole Columbia River Ecology System.

Thank you very much.

Sincerely,

Joe Gibbons

IDAHO WATER USERS ASSOCIATION, INC.
(LYNN TOMMINAGA)

Idaho Water Users Association, Inc.

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TESTIMONY OF THE
IDAHO WATER USERS ASSOCIATION
ON
INTERIM COLUMBIA AND SNAKE RIVERS FLOW
IMPROVEMENT MEASURES FOR SALMON
ON THE
SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT
BY LYNN TOMINAGA
WATER & PUBLIC POLICY ANALYST
DECEMBER 8, 1992

Gentlemen:

My name is Lynn Tominaga and I am the Water and Public Policy Analyst for the Idaho Water Users Association (IWUA). The Association represents over 180 canal companies and irrigation districts and over 90 agri-businesses and many individuals in the State of Idaho. This testimony on the Supplemental Environmental Impact Statement (SEIS) will address issues of concern to irrigation interests and farmers who rely upon Snake River water for their livelihood.

A28-1 Our first concern is the lack of alternatives other than flow considerations. The federal projects on the Snake and Columbia Rivers are multi-purpose projects that provide a multitude of public benefits. One question is why were there no alternatives for both storage projects and run of river projects? If flow levels and velocity are concerns for the salmon, then more tests of run of river projects should have been included. The alternatives in the SEIS did not provide information on different operating levels for such project.

A28-2 The second concern our association has is regarding the use of Idaho water to increase flow velocity. If water particle travel time (WPTT) is a major factor in moving smolts through the river system then drawing the lower Snake River reservoir levels down should be an alternative more thoroughly explored. An alternative could have been to test one of the run of river projects to get better information on WPTT and the effect of gas supersaturation on smolts and upmigrating adults.

A28-3 Another problem our Association has is that one of the SEIS recommendations may become permanent operating policy for the lower Snake and Columbia River system. IWUA believes an alternate or final plan will never be put into place and the flow recommendations or alternatives under the SEIS will become the permanent operating policy for the river system. If the U.S. Army Corps of Engineers intends these recommendations to be just an interim measures, then a limit of one to three years duration should be established.

A28-4 An additional concern is that if any of the alternatives #2 through #5 become permanent, a minimum stream flow set by a federal agency or agencies will be in place, not one set by state law or compact. In the past, western state legislatures have always had jurisdiction over water quantity. By releasing water for salmon, Idaho reservoirs would effectively come under the jurisdiction of the U.S. Army Corps of Engineers or the Federal Energy Regulatory Commission and Idaho law would have little effect.

IDAHO WATER USERS ASSOCIATION, INC.
(LYNN TOMMINAGA)

A28-4 (cont.) Another concern is that alternatives #2 through #5 would set a permanent minimum stream flow from Idaho at Lewiston. If this occurs, future growth in the state would be inhibited because water would not be available for appropriation.

A28-5 Our Association is also concerned about the emphasis placed on augmentation versus drawdown. It seems that if downstream migration and WPTT are overriding factors in smolt survival, all alternatives must be explored, not just those falling within the philosophical confines of the Corps.

A28-6 Our Association is disturbed with the alternatives being considered in the SEIS because they only look to getting more water from Idaho. The draft SEIS alternatives #1 and #5 will have the least effect on Idaho irrigated agriculture because these alternatives ask the least amount of water from irrigated agriculture. The water users of this state question the proposal to take water from Idaho when studies done by the Corps show that the water gained by these alternatives only increases velocity by 5% to 7% under present operating conditions.

A28-7 The last point we wish to make is the emphasis on flow in the river system. We would like to point out that in July of 1992 200,000 acre/feet of water was release from Dworshak Reservoir at a rate of 10,000 cfs. If flow was an important factor for migrating juvenile smolts and returning adults during this time period, then why was the flow at the confluence of the Columbia and Snake Rivers reduced by 10,000 cubic feet per second for ten days during the same

A28-7 (cont.) time period? The same circumstances occurred in September for a period of ten days where water was released from Dworshak reservoir and for the same ten days flows were decreased at the confluence of the Columbia and Snake River system.

I would like to thank the U. S. Army Corps of Engineers for letting me submit testimony for the official record and for coming to Boise, Idaho, and receiving oral comments on the Supplemental Environmental Impact Statement.

Respectfully submitted,

Lynn Tominaga

Lynn Tominaga
Water and Public Policy Analyst

SLC:kje

IDAHO WILDLIFE FEDERATION
(ROBERT MINTER, JR.)

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December 4, 1992

Robert D. Volz, Lt. Col.
Department of The Army
Walla Walla District, CUE
ATTN: CENPW-PL-ER
Walla Walla, Washington 99362-9265

Re: Idaho Wildlife Federation Comments on DSEIS, Interior Columbia and Snake River's Flow Improvement Measures For Salmon

Dear Mr. Volz:

Thank you for providing Idaho Wildlife Federation with the opportunity to present comments on the DSEIS at your public hearing/workshop in Boise on November 12, 1992. As noted in my testimony at the workshop, IWF has reviewed the DSEIS and is of the opinion that all alternatives presented appear to be structured more for convenience for maintaining the "status quo" of the hydro/reservoir operation system than for near term enhancement or mitigation for salmon losses. In our opinion the DSEIS operating alternatives do not offer a broad enough range of options which would appear to be feasible in the near term to protect Columbia River and Snake River Salmon stocks. The alternatives presented, including that which the study groups recommend (Alternative 4), are limited to 1992 operations and 1992 operations with added protections for the "business as usual" system operations. IWF is very concerned that this approach reflects that the responsible public agencies are not proposing nor studying sufficient actions with regard to improving Snake River Salmon stocks. A29-1

We, therefore, have the following comments and suggestions regarding finalizing the DSEIS.

A29-2 There is significant need to change the hydro system operations in the near term to avoid continued decline of and assist toward the recovery of all salmon stocks.

A29-3 The 1992 operation of the Snake/Columbia system was a disaster for our Salmon stocks. The flows presented in Table 3.5-2 of the DSEIS reflect no real improvement for salmon of the alternatives analyzed. Actual flows in the lower Snake River during 1992 migration period were below those projected.

A29-4 The models used in the DSEIS are not ones which the regions fishery agencies and tribes have proposed or support for flow analysis. We also question how the analysis shows increases in survival coming from predator control, transportation improvements, and improved adult passage when no basis for these results are reflected in the DSEIS.

A29-5 We are concerned with the lack of any detail regarding assumptions for Snake River flows above the Hells Canyon complex. Actual flows on the lower Snake and Lower Columbia were lower than predicted, flows assumed during 1992 by NMFS. This could occur in 1993 and future years also. We suggest using a historical baseline of 1984-1991 for purposes of analysis and request that a full documentation of projected vs actual conditions for 1992 and a no action alternative of 1992 operations be presented in the final DSEIS.

A29-6 The DSEIS covers 1993 and future years, but offers no guidance for long term recovery of Snake River Salmon. The DSEIS should be more comprehensive - setting long term objectives and a well defined process for implementing each activity.

A29-7 We suggest the following activities be incorporated into the alternative analysis for the near term (93-95) system operations.

1993
- Drawdown Snake River reservoirs as necessary to provide 120 K cfs equivalent at Lower Granite Dam.
- Begin modification of facilities in all lower Snake River pool areas, i.e., pump extensions, port and marina modifications, etc.
- Initiate prototype modification of Lower Granite Dam to facilitate juvenile and adult passage with reservoir levels at spillway crest.
- Begin extension of irrigation pumps in John Day pool area to accomodate MOP in 1994.

1994
- Repeat 1993 flow action in lower Snake and Columbia.
- Complete John Day pool irrigation pump modifications.
- Complete Snake pools modification for pumps and structures for below MOP drawdown.
- Continue prototype modifications of Lower Granite Dam.

1995
- Operate John Day at MOP.
- Augment Columbia to meet 100% of CBFWA recommendations.
- Draw other Snake projects as needed to maintain 120 K cfs equivalent flows during migration.
- Drawdown LGD to near spillway crest during Smolt migration.

A29-8 Finally, we are concerned that NMFS is a cooperating entity in developing the DSEIS. As NMFS must issue a biological opinion on the DSEIS biological assessment this will become a component of the f[illegible]SEIS.

A29-8 (cont.) The NMFS concurrence in the DSEIS raises questions in our mind regarding the agency's regulatory role and independence in the overall process.

In summary, IWF feels the DSEIS does not go far enough towards analyzing alternatives which could be feasibly implemented in the near term to enhance and rebuild this regions Salmon runs. We urge the Corps and other study participants to analyze additional operational alternatives which would provide early and real options for rebuilding the regions Salmon stocks.

Again, thank you for this opportunity to comment on the DSEIS.

Sincerely,

Robert Minter Jr

Robert Minter, Jr.
Vice President, Conservation, IWF

cc: Congressman M. Crappo
L. LaRocco
L. Craig
D. Kempthorne

FLATHEAD LAKERS INC.

— A Non-Profit Corporation of Flathead Lake Residents —

P.O. Box 290, Polson, Montana 59860

December 9, 1992

Peter Poolmen
SEIS Manager
Department of the Army
Walla Walla District, Corps of Engineers
Walla Walla, WA 99362-2965

Dear Peter:

This letter is in reference to the Draft Interim Columbia and Snake Rivers Flow Improvement Measures For Salmon Draft Supplemental Environmental Impact Statement (SEIS).

We have reviewed the comments prepared for your office by Mark Reller of the Montana Office of the NPPC and endorse his very thorough analysis of the draft SEIS. Several points need to added and/or emphasized.

For over thirty years the Flathead Lakers, a citizen group, has served in an advocacy role for the protection of Flathead Lake. During these past two years we presented comments at nine different meetings with the Corps and/or the NPPC on the impacts of water flows from the dams in the Flathead Basin. Our position has been consistent:

A30-1 that the economy of this region and the life styles of the people who live here are, and will be, profoundly effected by the water quality of the Flathead Basin and, more specifically, of the Flathead Lake;

that the water quality in the lake is a function of its water flows and this in turn is largely a function of the operation of the dams in the ecosystem, including Hungry Horse and Kerr dams;

that an ecosystem perspective for evaluating dam operations be adopted; and

that the operation of the dams, as one of the many factors effecting water quality, must reflect not only the needs of private industry and of the lower Columbia system but also, and more importantly, the needs and values of the people of Montana who live here in "this last best place".

To repeat again, the Laker Board of Directors continues to urge an ecosystem approach to managing natural resources, including the analysis of dam operations and their impacts on water quality in the Flathead Basin and Flathead Lake. We know that task is difficult and complex; however, that was the basis for our request of an environmental impact study and/or cumulative river impact study in our motion to intervene in the FERC process of re-licensing Kerr Dam and for our argument that the independence of the process related to Kerr Dam mitigtion and the BPA process related to Hungry Horse Dam threatens to compromise an ecosystem-level action in the Flathead Basin. Again, the SEIS does not address the interrelationship between Hunrgy Horse and Kerr dams and their impacts on Flathead Lake.

FLATHEAD LAKERS INC.
(DICK WOLLIN)

A30-2 It should be noted that the Northwest Power Planning Council has approved the following recommendation concerning the Hungry Horse mitigation plan:

> Immediately begin actions to result in installation of a selective withdrawal structure at Hungry Horse Dam to allow for temperature control to benefit resident fish. The Kerr and Hungry Horse dams mitigation programs will be coordinated so that measures taken under these programs are consistent. **Operational features of these programs should be addressed in the System Operations Review.**

Should not these recommendations be recognized in the SEIS?

A30-3 We are concerned that reference is made to the "potential indirect" impacts of drawdowns from Hungry Horse. As Mr. Reller illustrates at several points, the impacts on Montana waters were and are real; they were and are direct; e.g.,

> "p. 2-19 ..... Once again, the document states a fallacy that the Montana reservoirs did not participate in the flow augmentation measures initiated in 1992. Operations in 1992 at both Montana projects deviated from historic norms. Although many officials have argued that power demands drove the operations, it must be noted that power production was reduced on the system as a result of the drawdown experiment, increased spills, and reduced project heads. ....
> Power peaking operations effect river flows and temperatures and influence aquatic resources."

and in reference to 4-41, "One year of deeper drafting of the reservoir would not likely have a major effect on the reservoir's aquatic resources". "This statement is grossly in error. Research on Hungry Horse has shown that single year deep drafts have long lasting consequences. Missing or weakened year classes occur, nutrient flushing issues arise, predator prey densities change, access to spawning tributaries may be curtained or eliminated, and thermal issues in the reservoirs and in the river are of concern."

A30-4 Concern has been expressed throughout the draft statement over anadromous fish and little attention is given to resident fish in the Flathead watershed - namely the bull trout. The recent reports from the Montana Department of Fish, Wildlife and Parks document the demise in the bull trout counts. The Hungry Horse mitigation plans approved by NPPC and the recent petition for bull trout listing only highlight the need for greater attention to be given the status of resident fish.

A30-5 And finally I would repeat comments made in our letter to the SOR Interagency Team (September 24, 1992):

> To repeat comments made to the Council on the proposed amendments -- unless circumspection is exercised by all involved, the stage will be set for a divisive conflict between the states. We consider it an unfortunate oversight that the potential impacts of "Salmon Summit" amendments as they relate to the Flathead and Kootenai drainages of Montana have been ignored. We believe that the failure to consider these impacts on the headwaters of the Columbia violate the spirit of the Northwest Power Planning act, as well as the requirements of the National Environmental Policy Act.

FLATHEAD LAKERS INC.
(DICK WOLLIN)

A30-5 (cont.) in particular, both the Council's Program and the SOR Team must recognize the requirements in NEPA to assess the cumulative environmental effects of proposals affecting the fish and wildlife of the Columbia and its tributaries. Fish and Wildlife Program P1204(b)(1); 40C.F.R. P1508.7; National Wildlife Federation v. FERC, 801 F.2d 1505 (9th Cir. 1986). The complexity of addressing multiple functions of dam operations is acknowledged, but since the Council is making a regulatory decision affecting the flowages from the Flathead and Kootenai River drainages, the Council has an obligation to consider the impacts on all hydroelectric components of each river drainage simultaneously. Id. As regards the Flathead drainage, the Council (and now the Interagency Team) has an obligation to ensure not only that the flowages and reservoir levels at Hungry Horse are analyzed, but just as importantly, that the impacts of the proposed Hungry Horse changes on Flathead Lake and Kerr Dam are fully analyzed. Finally, NEPA requires the development and study of a full range of reasonable alternatives to the proposed action. 40C.F.R. P 2502.14.

We recognize the extremely complex and difficult problems and issues encountered in developing a coordinated river basin management plan, but this very unique and precious resource that is Flathead Lake deserves a process that does indeed balance hydropower development, salmon and steelhead runs and the other downstream interests along with the need to protect and enhance our rivers and lakes - and a decision which truly reflects the public interests of Montana residents.
We believe a cumulative impact study of the waters in the Flathead ecosystem must be a part of the SOR and/or the Salmon Summit recommendations.

The quality of water that flows through Flathead Lake simply must be sustained and protected.

Thank you for the opportunity to comment.

Sincerely yours,

Dick Wollin
President

DWORSHAK EXCURSIONS
(JERRY O. OLIN)

December 3, 1992

Dworshak Excursions
P.O. Box 1640
Orofino, Idaho
83544-1640

Lt. Col. Robert Vols
Department of the Army
Walla District
Corps of Engineers
Building 602 City- County Airport

Lt. Col. Vols:

I would like the following comments to be printed in the final Environmental Impact Statement.

A31-1 For the past (19) nineteen years Dworshak Excursions has provided water tours and pontoon boat rentals on Dworshak Reservoir. Many thousand visitors from all over the United States and Canada have taken advantage of this unique recreational opportunity. Many have returned several times.

Many more have made Dworshak an annual event. Large youth groups from Federal Way, Washington; Portland, Oregon; Vancouver, Washington; Spokane, Washington; and Lewiston, Idaho - to name a few - have come here in August to spend a week or more at the Mini Camps. Some of these groups have as many as 80 youths with them. They bring with them ski boats and set up ski camps.

Several families hold annual reunions on the reservoir. One such family has come here every year for the past 16 years. Publicity concerning the 1992 drawdown cancelled this reunion in 1992 for Labor Day weekend.

Normally 10 percent of all customers make advance reservations for the following year upon departure. Only one customer, a business located in Grangeville, Idaho, that has held its company outing for its employees here for the past eight years, made an advance resevation in 1992.

Generally about 70 percent of all reservations for the season are made by February, with reservations beginning to come in November.

Reservations for next year are lagging far behind the average.

Dworshak Excursions has spent thousands of dollars in advertising fees to promote Dworshak Reservoir as the ultimate recreational experience. With the rising costs of marine leability insurance, advertizing,and maintenance it is imperative that mid-summer pool elevations are maintained at high levels.

Revenue was off 22 percent in 1992 and 1993 could be off 50 percent or more if mid-summer drawdowns are to continue, and the owners may need to consider liquidation.

Sincerely,

Jerry O. Olin

REED BURKHOLDER

October 28, 1992

Colonel Robert D. Volz
U.S. Army Corps of Engineers
Walla Walla District Office
City-County Airport
Walla Walla, Washington 97058

Dear Col. Volz,

There is no doubt that dams on the Lower Snake and Columbia Rivers have hurt the salmon. There is also no doubt that all current efforts to preserve them are failing, and these at great expense- hundreds of millions of dollars.

I1-1 As ridiculous as this sounds, the best solution for restoring salmon runs in Idaho is to remove all eight dams between Lewiston and Portland.

Removal of the dams would eliminate the problems of turbines, gas supersaturation, high water temperatures of slack water, slow migration time for smolts, squawfish predation, and disorientation of both smolts and adults due to lack of current in the reservoirs. It would also restore spawning grounds between Lewiston and Pasco that were flooded by the pondage created by the dams.

A good case can be made that building this many dams on the Lower Snake and Columbia to provide hydro power and a barging channel to Lewiston was a mistake. The cost to the salmon has been very high. Commercial barging does not even come close to paying its own way on the river. If an aluminum company or two fail due to the low world price of aluminum, electricity will be in surplus again.

It is time to challenge the assumption that these dams are permanent and desirable.

The salmon need the river at valley floor; they need their original habitat of freely flowing rivers. We on the other hand are quite capable of thriving without these dams.

Let's remove the first four dams downstream from Lewiston in the Lower Snake River. Let's take out Lower Granite, Little Goose, Lower Monumental, and Ice Harbor Dams. If the salmon runs do not bounce back, then let's take out The Dalles and John Day.

I do not want to be a part of making the salmon extinct. I want a solution and I want it quickly.

Sincerely,

Reed Burkholder

Reed Burkholder
6105 Twin Springs Drive
Boise, Idaho 83709

LYMAN K. SCHWARKOF

P.O.Box 962
Chehalis,Wa.98532
October 29,1992

Department of the Army
Walla Walla District C.E.
CENPWPL-ER
Walla Walla,Washington 99362-9265

To Whom It May Concern:

I have revieved my copy of SEIS, also the following Draft Analysis. We do have a problem with declines in the various kinds of fish- that is well established. However, we have another and far greater problem.

Population is growing apace. Not only here in the West but Nation wide and Worldwide.

I2-1 Even if fish runs remained at last centuries levels, these fish would not adequately feed the present day population. It is time for trade-offs. The food currently produced on irrigated lands in Washington,Oregon and Idaho could never be replaced by even the heaviest fish runs.

If all the foods currently moving by barge were compelled to move by rail or truck, think of the cost!! Think of the traffic congestion!!

So you see, we need maximum food production, we need adequate irrigation, and the power to move this water.

In order to achieve the highest possible level of food production and the means to move it, let us do the following.

Build Ben Franklin Dam, complete with navigation locks.

Install navigation locks on all dams to permit barge traffic to Wenatchee.

Maintain pool levels to permit maximum irrigation and power generation.

Utilize pumped storage in Moses Coulee for peaking power.

Build a rock fill dam across Hoods Canal with reversible turbine power houses on each shore. This dam could support a permanent all weather road, a safeguard in the event of a second bridge failure.

I agree, sport fishing is important to some people but to expect the general public to accept higher food and power costs to gain this end is totally unrealistic. Likewise,commercial fishing, even under the best of circumstances cannot feed an ever growing population. Please, think it over.

cc Sen Slade Gorton
cc Wenatchee Daily World

Sincerely,

Lyman K. Schwarkof

WADE AND CAROL WAUGH

1920 Alder Avenue
Lewiston, ID 83501
November 1, 1992

U.S. Army Corps of Engineers
Walla Walla District
ATTN: CENPW-PL-ER
Walla Walla, WA 99362-9265

Dear Engineers,

Referring to your meeting notice in the newspaper recently, we are unable to attend so must comment in writing.

I3-1 We are strongly opposed to anymore drawdowns of either the Snake or Clearwater Rivers, whether done at points in Idaho or elsewhere by lowering dam levels downstream and the Columbia.

I3-2 The trial run conducted this past spring/summer which essentially "emptied" the waterways around Lewiston/Clarkston had a devastating effect on the local economy, not only in barge traffic and other losses incurred by the ports, but also for recreational use, irrigation and industrial uses. In view of the past six years' drought in the inland Northwest, your plan was definitely not a smart idea.

I3-3 So now too, Idahoans are being asked to pay a small (?) surcharge on electricity usage for the next year to cover the cost of generating power...which would not be necessary had you not sent the quantity of water out into the ocean that your drawdown brought about. It isn't my fault that the dams don't have enough headwater left to generate the needed power, and since we didn't favor the drawdown in the first place, why are Idahoans asked to pay for the losses?? * See enclosed Article #24555

And we certainly don't give a damn about the salmon! And neither do we care about spotted owls, nor do we care about some tiny wren that was discovered of late in the woods. Let's face it: civilization has done much to destroy many of the good things God put on this earth for us...but it's too late for the salmon, etc., and it seems that any thinking person could figure that out.

And I truly resent Mark (or is it Antoinette) who has the audacity to state that Idaho isn't doing its' part? Who is he to say what Idaho isn't doing? He lives West of the Cascades where this past summer has been the first where even a glimmer of a drought has occurred. We lived in Western Washington/Western Oregon for nearly 50 years before moving to Idaho, and we know where Mark Hatfield's political motivation comes from..and it certainly has nothing to do with keeping the Northwest the best place to live...and we seriously doubt his personal concern about the salmon or any other so-called endangered species.

As it is now...the tax-payers and unemployed are more endangered than the fish or birds in the wild. How can the Corps justify another drawdown at all when reviewing the damages of the last? Do you believe people have a money-tree from which to pay for losses incurred? For businesses lost? For facilities destroyed? For roadways and rail-lines undermined?

I3-4 One additional comment that I would like passed along to the Bonneville Power officials has to do with the power rates passed along to utilities and on to the rate-payers has to do with the cost-effectiveness of BPA operations. I worked for BPA some years ago when the Big Eddy project was going on, and can attest to the waste I observed and the un-productive time spent on various particulars of that project. More recently, I've learned that warehouse foremen are taken off the job several times a year to attend conferences in places like Eugene, Reno, Missoula, etc. A closer look at what really goes on in the many departments of BPA might be justified, because "a little waste" here and there in the field offices could be an indicator of even greater waste "closer to the top".

We truly resent paying higher rates for electricity if the extra money collected by the utilities and given over to BPA isn't being wisely spent on necessary power operations, but is frivolously squandered on unnecessary travel, dining/rooming at fancy hotels, etc.

I3-5 The bottom line -- we don't want any more drawdowns -- we don't want any more rate increases on our electric bills -- and as an afterthought, how much tax-payer money is being spent to get all of your meeting participants together for the November 4, 5, 9, 12, 16, 17, 18 and 19th sessions? I'd really like an answer to that final question.

Sincerely,

Wade & Carol Waugh

JIM PRITCHARD

PRITCHARD

APPRAISAL & FARM FINANCIAL CONSULTING

Phone (509) 647-2611 or (509) 754-2931 • Route 1, Box 20-A • Wilbur, WA 99185
Message Phone (509) 647-2222

November 28, 1992

Department of the Army
Walla Walla District, Corps of Engineers
Walla Walla, Washington 99362-9265

ATTN: CENPW-PL-ER

I have reviewed the Draft Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon-Draft Supplemental Environmental Impact Statement (SEIS) and Alternative Actions for Restoring and Maintaining Salmonid Populations of the Columbia River System-Pacific Northwest Extension Publication 407 dated March 1992. I have also followed the issue in the Capitol Press out of Salem, Oregon and the Wenatchee Daily World from Wenatchee.

I4-1 I wish to go on record as favoring Alternative 1. It appears to have the least impact on the resident fish and the economy of the Northwest. I understand your favoring Alternative 4 and am very glad you didn't recommend going below MOP. I believe nothing should be implemented until a comprehensive program is in place that covers all the losses of Salmon population. If we can't get a total program, then we should do nothing. An incomplete program would be a waste of funds.

I4-2 We certainly should not start with such a high cost measure as being proposed in the SEIS. Appendix A of PNW Extension Publication 407 shows drafting the lower Snake river pools as a high cost measure with an unknown likelihood of success. It also has the most negative effects.

I4-3 In the third paragraph of 1.4, words like assumption, presumable, and believed say to me that we don't know enough yet and should not be implementing such costly measures. Add to this 3.3 "full recognition of the uncertainties surrounding the estimates of economic costs and biological effectiveness."

Sincerely,

Jim Pritchard

Jim Pritchard, ARA - Accredited Rural Appraiser
State Certified General Real Estate Appraiser #20-11 PR-IT-CJ-W7470D
The American Society of Farm Managers and Rural Appraisers (ASFMRA) conducts a mandatory program of continuing education [illegible] with the requirements of the program.

F.A. BAYER

November 13, 1992

Department of the Army
Walla Walla District
Corps of Engineers
CENPWPL-ER
Walla Walla, WA 99362-9265

RE: INTERIM COLUMBIA AND SNAKE RIVERS FLOW IMPROVEMENT MEASURES FOR SALMON SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

Dear Sir:

I5-1 I support your proposed alternative number 2 for 1993 and interim years. As a regular visitor to Dworshak Reservoir, I would prefer the alternative which has the greatest chance of protecting the salmon and, at the same time, has the least effect on Dworshak during the summer.

I5-2 I am absolutely opposed to any drawdown. There is no evidence that a drawdown helps either downstream migration or upstream return of salmon. Nor do I believe that the framers of the Environmental Protection Act envisioned wiping out millions, if not billions, of life forms on the off chance that a particular strain of a specie might be saved when the specie is in no way endangered or threatened.

Sincerely,

F. A. Bayer
2952 Riverview Terrace
Lewiston, ID 83501

FAB/vh

LINDA MCLURE

November 13, 1992

Dept. of the Army
Walla District
Corps of Engineers
CENPWPL-ER
Walla, WA. 99362-9265

To Whom it May Concern:

This letter is in response to the Draft Supplemental Environmental Impact Statement, evaluating the effects on Montanas' water flow to assist downstream, endangered, salmon migration.

As a resident of the Tobacco Valley, a person who uses the recreational resources of Lake Koocanusa as well as my employment being dependent on the water level, I feel Montana's environmental, recreational, the areas economic diversification as well as wildlife interests, are not being carefully addressed by the U.S Army Corps of Engineers, Bonneville Power, Bureau of Reclamation and National Marine Fisheries Service through this SEIS.

I6-1 Any possibility of authorizing drawdowns of Lake Koocanusa, to provide flushing water for anadromous fish or white sturgeon, will have a negative impact to our own residential kokanee and trout fisheries as well as negatively effecting our air quality even more than it already is. (We thank the Corps for the installation of the weather monitor they have installed at Murray Springs Fish Hatchery, hopefully it will document our air quality.)

The following impacts need to be examined carefully:

I6-2 1. Air Quality, the increased incidence of respiratory and bronchial illness in our valley. (This has been mentioned in previous correspondence.)

I6-3 2. Effects on residential fisheries are many, such as when lower water levels occur, less food source is available, as well as the increased incidence of turbine fatality and increased water temperatures.

I6-4 3. Water Quality Downstream impacts include vegetation and wildlife disturbance, siltation (light weight dirt residue deposited on receding shore lines which contribute annually to our air quality problem.)

I6-5 4. Loss of economic recreational revenue due to limited full pool.

Currently this SIES says Lake Koocanusa and Hungry Horse will not be operated differently, but, as history has shown us, what the Government Agencies say and do can be two different things.

I6-6 Careful consideration must be given to the impacts created by the decisions the Corps, and the Corp must accept full responsibility for any adverse impacts

Thank You for this opportunity to voice my opinion.

Sincerely, .

Linda McClure

Linda McClure

ROY E. BARKER

November 16, 1992

Subject: Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon - Draft EIS

Dear Sirs,

I7-1 I would like to express my support for the 'no-action' alternative for the subject Draft EIS. My reasons for this position are as follows:

1. The analysis of increased flow effects on juvenile salmonoids does not support any action. There does not appear to be any consistent or repeatable evidence to suggest that increased stream flows will benefit juvenile salmon migration.

2. The economic analysis of this Draft EIS makes the basic assumption that the potential saving of a single anadromous fish is worth destruction of most of Dworshak Resevoir's use as a recreational area, damage to wild life habitat and resident fish and loss of 90 million dollars worth of electric power. This is absurd to the extreme.

The approach being recommended by this Draft EIS boils down to a familiar one of: "If you can't figure out a solution to a problem, throw a lot of money at it!"

I believe the proposed approach is not justifiable and represents an inappropriate taking of resources from the general public to satisy the whims of a few unimformed but vocal pressure groups.

Very Truly Yours

Roy E. Barker
201 S. Fillmore
Kennewick, WA 99336

WARREN H. MASON

November 17, 1992

Department of the Army
Walla Walla District, Corps of Engineers
Attention; Lt. Col. Robert D Volz
Walla Walla, Washington 99362

RE: SEIS for the Interim Columbia and Snake River Flow Improvement Measures for Salmon.

Good afternoon; I do not have any impressive titles, but I do manage a farm in west Walla Walla Co. and we obtain our irrigation water from behind the Ice Harbor pool. Consequently, I have an enormous interest in what becomes of our water supply or our ability to obtain water from the pool behind the dam should several untoward proposals come about.

I8-1 I am amazed at the mass of data, proposals and recovery plans which have been cataloged and which are now up for public comment. It appears that you have been thorough in your discovery processes. Nevertheless, I would ask that you continue your recovery plan development with true cost effectiveness in mind; that we reap the greatest gain for our tax dollars.

I8-2 To the extent that I understand the SEIS, I would generally support Alternative 4. Each element of Alternative 4 should be judged on its own merits with a gain in smolt survival the primary goal. In other words, we must be more than reasonably certain that all efforts will return dividends for the monies and effort expended.

I8-3 With so many special interests involved in the recovery plan I can only believe all interests are best served by a true scientific analysis of the alternatives. I think the transportation options will provide the greatest cost effective means to improve the salmon runs.

I8-4 Again, I farm for my livelihood and find it difficult to fathom why the harvest of endangered species is allowed to continue while we prepare to spend millions on a recovery plan that will pay such small dividends to so few and yet take so much from so many.

Without any real influence, I can only plead my case and hope that our society will have as great of concern for those impacted by the salmon recovery as it does for the salmon.

I8-5 I appreciate the course you have taken in considering the economic and social impacts of a salmon recovery plan. Finally, I support your serious efforts in researching the benefits to be derived from harvest reductions, flow augmentation, habitat improvement, predator control, transportation and even limited reservoir draw downs.

Warren H. Mason
Farm Manager

KENT NIELSON

18 November 1992

Department of the Army
Walla Walla District, Corps of Engineers
Attn: CENPW-PL-CR
Walla Walla, Washington 99362-9265

Subject: Draft SEIS

19-1 Thank you for considering costs in your plans for running the Columbia River system in 1993. The goal of increasing the number of adult fish returning to their spawning grounds is important. The economic well being of the Pacific Northwest is more important. It seems to me that we can increase the number of fish and still keep our economy intact.

In our society it seems there are those who would work against nature to preserve every species on earth. Natural selection enhances some species and eliminates others. Why try to keep some fish species if others are better adapted and provide the same sport or food? Why let anyone harvest a species if we have to try and save it?

I support your plan to use the modified 1992 operation in 1993. I support using scientifically valid data to help make decisions. "Environmentalists" make a lot of noise and I appreciate your sticking to the facts. I commend you for the good job you have done and are doing.

Very Truly Yours

Kent Nielson

Kent Nielson
Manager, McNary Farm

P.O. Box 682.
Plymouth, Wa
99346

FAITH COOKE

Faith Cooke, 1824 Riverside Dr., Richland WA 99352-5262

18 November 1992

I10-1 I. Maturation is one of the most important aspects or life. Children who are denied time to mature through the necessary stages have learning, sociological and adjustment problems. Plants that are forced are usually discarded.

My question deals with the maturation of the young in the Fish Fast Flush in the "Draw-down".

What agency is responsible for this study, which would necessarily need to be continued for at least two or three generations.

I10-2 2. Whatever the water usage: Recreation, power, domestic water, habitat for fish, navigation or irrigation, the rivers need to be filled to capacity with cold, clean, quality water.

Which agency is responsible for assuring this condition, and what measures are being implemented by this agency?

to:

Colonel Robert D. Volz, District Engineer

Corps of Army Engineers

Walla Walla , Washington 99362-9265

attn: CENPW- PL - E R

SIDNEY N. CLOUSTON, JR.

Senator Mark Hatfield
SH-711 Hart Senate Office Building
Washington DC 20510-3701

Sidney N. Clouston, Jr.
6850 SW 168th Place
Beaverton, OR 97007
(503) 642-9037

November 20, 1992

Dear Senator:

I am involved in a project which will be, when completed, greatly supportive of the effort to save an endangered species such as the Salmon. Also, it will be part of the solution to reduce those conflicts regarding the water resource demanded by the Irrigators of Oregon farms. Futhermore, it will help reduce the higher water reservoir levels that at present seem appropriate to the Hydro electric power providers and Irrigators. In addition, there is concern over the level of Carbon Dioxide (CO_2)emissions not only here in Oregon, but the concern extends internationally. It may appear as an alarmist statement, by pointing out that Oregon is in an eight year drought. Greenhouse Gas, a possible cause of weather pattern changes, may be affecting the region, California has over five years of drought and counting, for their present weather pattern.

Within the state of Oregon, I have developed an impression that Photovoltaic technology applications has unjustified conservative treatment within such documents as the Oregon Biennial Energy Plan of 1991,the Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon, Draft Supplemental Environmental Impact Statement and in "Photovoltaics Technology Status and Development Potential in Oregon", which is a staff report dated November 24 1992 to the Public Utility Commission of Oregon.

Because of the above, I am submitting an unsolicited white paper for you and your staff, the U.S.Army Corps of Engineers and the Policy Administrator of the Oregon Department of Energy.

Sincerely,

Sidney N. Clouston, Jr.

Sidney N. Clouston, Jr.

Enclosure.

Department of the Army
Walla Walla District, Corps of Engineers
Attn: LTC Robert D. Volz/CENPW-PL-ER
Walla Walla, Washington 99362-9265

Sidney N. Clouston, Jr.
6850 S.W. 168th Place
Beaverton, OR 97007

November 19, 1992

RE: Draft SEIS

Dear Sir:

I enjoyed the presentation at the GSA auditorium, it was very informative. I looked over the Draft SEIS and I am quite impressed with it in general. However, I believe that even at this late date, it needs some changes.

I am including with this letter, a letter to Senator M. Hatfield and a white paper. I would like for the white paper to be included in the SEIS as my formal comment,in addition to what was recorded at the GSA auditorium.

Please advise me regarding any further assistance or clarification that you may require.

Sincerely,

Sidney N. Clouston, Jr.

Sideny N. Clouston, Jr.

Enclosures.

SIDNEY N. CLOUSTON, JR.

SAVING SALMON: PHOTOVOLTAICS GOES WITH THE FLOW.

by
Sidney N. Clouston, Jr.
A Solar Power Advocate

INTRODUCTION:

The introduction of Photovoltaic (PV) systems can change for the better ongoing efforts regarding demands on the water resource by hydro electric reservoirs, irrigation needs and the need to increase stream flows for Salmon survival. PV systems provide electric power without generating waste material, environmentally benign and is aligned with the effort to reduce greenhouse gases authorized in Title XVI Global Climate Change, of the Energy Policy Act of 1992.

THE PROBLEM:

I11-1 Within the Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon, Draft Supplemental Environmental Impact Statement (SEIS) p.2-36 section 2.8 Air Quality, in the last paragraph states the following. "The system produces enormous electrical generation, so any potential loss of generation could ultimately be replaced by nuclear plants or by burning additional fuels in thermal powerplants in the region." No mention of renewable systems as a viable clean alternative to firm up the hydro electric system in that "Air Quality" section of the SEIS. Why?

I11-2 That SEIS document was developed by the US Army Corps of Engineers, Sonneville Power Administration, the National Marine Fisheries Services and the Bureau of Reclamation. These several organizations need to be updated regarding the Energy Policy Act Of 1992 prior to December 7, 1992 which is their deadline for the solicited comments of the Draft SEIS.

A SOLUTION:

I would like to cite a few additional titles and sections of the Energy Policy Act of 1992, which has, because of the soon to be implemented 1993 plans for the water resources of the regional Columbia and Snake river flow improvement measures for Salmon, direct bearing. First however, I suggest that Irrigators could have available to them additional water for agriculture and various farm and livestock needs, when hydro electric generators become "firmed up" with a supportive alternative power generation source. This scenario includes greater stream flows for fish and does not produce waste that many believe will have long lasting negative effects to our environment. The photovoltaic systems can supplement the hydro systems in a very complimentary way. We perhaps can easily call it "a marriage made in heaven". With PV electric generation of power during periods of sunshine and also during drought periods, the water normally held in reservoirs will be spared. Therefore the spared water can supply Irrigators and the endangered species of Salmon. Hydro electric generators will operate at night and during the rain and snow season when ample post rain/snow melt run off has filled the reservoirs and rivers.

Contained in Subtitle B-Utilities, section 111 (a) Amendment To The Public Utility Regulatory Policies Act-The Public Utility Regulatory Policy Act of 1978 (P.L. 95-617: 92 Stat 3117; 16 U.S.C. 2601 and following is amended by adding the following at the end of section 111 (d):

"(7) Integrated Resource Planning.-Each electric utility shall employ integrated resource planning. All plans or fillings shall employ integrated resource planning. All plans or filings before a State regulatory authority to meet the requirements of this paragraph must be updated on a regular basis, must provide the opportunity for public participation and comment, and contain a requirement that the plan be implemented.

From (d) Definitions-Section 3 of such Act is amended by adding the following new paragraphs the end thereof:

"(19) The term 'integrated resource planning' means, in the case of an electric utility, a planning and selection process for new energy resources that evaluates the full range of alternatives, including new generating capacity, power purchases, energy conservation and efficiency, cogeneration and district heating and cooling applications, and renewable energy in order to provide adequate and

reliable service to its electric customers at the lovest system cost...."(20) The term 'system cost' means all direct and quantifiable net cost for an energy resource over its available life, including the cost of production, distribution, transportation, utilization, waste management, and environmental compliance.

I believe that tne analysis of the waste management aspect will favor hydro electric and solar generation over any other system, far and away. As far as the environmental compliance, hydro and PV systems will most likely comply with least costs involved in best or worst case scenarios of operation.

I11-3 CONCLUSION:

The Draft SEIS document needs to give PV equal consideration and printed space in that document. Other State and Local plans need to reflect the progressive content contained in the Energy Policy Act Of 1992, which is most definitely comprehensive is its scope.

cc. Department of the Army
Walla Walla District, corp of engineers
Attn: LTC Robert D. Volz/ CENPW-PL-ER
Walla Walla, Washington 99362-9265

Oregon Department Of Energy
Attn: John Savage, Policy Administrator
625 Marion Street N.E.
Salem, OR 97310

WILLIAM F. LARSEN

December 7, 1992

Lt. Col. Robert Volz
Department of the Army
Walla Walla District, Corps of Engineers
Building 602
City - County Airport
Walla Walla, Washington 99362-8619

Lt. Col. Volz,

I12-1 I am writing this letter to raise a new issue with respect to the drawdown of Dworshak reservoir. The issue being: How is the Corps addressing the issue of program access (recreation) as it relates to Section 504 of the Rehabilitation Act of 1974 and to a limited extent the Americans With Disabilities Act of 1990?

It is my understanding that the Corps has an obligation to provide an equal opportunity for the disabled community to participate in the recreation activities offered by the Dworshak reservoir during the "season of use". In line with this obligation, it is my opinion, the Corps must therefore, consider the effect of the drawdown of Dworshak upon "program access" for the disabled community. Since the drawdown of Dworshak reservoir could conceivably be in effect from July through September, this could effect a major term of the "season of use".

Under normal conditions, it is very questionable the degree of program access afforded to the disabled community. Given the conditions of the shoreline and boat launching areas during the drawdown phase, there is a need to address program access for the disabled. As a resident of Orofino, Idaho, the Vice President for the Idaho Taskforce on the ADA, a disabled individual and a leader in the disabled community, I have a vested interest to ensure equal access for the disabled to all recreation activities of the Dworshak reservoir.

I strongly urge the Corps to consider the needs of the disabled community and your legal obligations as it relates to providing program access to the recreation facilities of the Dworshak reservoir during the "season of use". I would also like to offer my services to assist in program planning activities.

Sincerely,

William F. Larsen
P.O. Box 1138
Orofino, Idaho 83544

cc: Jack Ardner
Director of Outdoor Recreation
North Pacific Division
Corps of Engineers
P.O. Box 2870
Portland, Oregon 97208-2870

THOMAS A. TOWNSEND

THOMAS A. TOWNSEND
447 EAST EIGHTH STREET
MOSCOW, IDAHO 83843

6 December 1992

Department of the Army
Walla Walla District, Corps of Engineers
Building 602, City/County Airport
Walla Walla, Washington 99362-6619

RE: COMMENTS DRAFTSEIS (NACOE/10-8-92/03258A)

Having read the draft supplemental EIS and considered the proposed actions ad alternatives I found it to be informative and well balanced as far as it went.

I13-1 What I don't understad is how one can make a choice between the alternative actions when the Corps has not published the System Configuration Study that would designate in detail the modifications needed on the project to benefit anadromous fish.

It is one thing to discuss options and alternatives in general terms and outcomes; however, at some point in time some design criteria and considerations must be developed and some anticipated project cost estimates provided.

I13-2 At this point in lacking this material I cannot develop an alternative that I would support

Submitted,
Thom A. Townsend

cc: Mr. Robert Saxvik, NWPPC, Idaho

THAYNE CHAUMELL

12.3.92

Department of the Army
Walla Walla District, Corps of Engineers
ATTN: CENPW-PL-ER
Walla Walla, WA 99362-9265

Dear Sir or Madam:

Overall I thought the Draft Supplemental Environmental Impact Statement (DSEIS), Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon was informative, well thought out, and offered some viable alternatives for Flow Improvement. There are some areas of the document I thought could be improved upon, or I had questions about, and as a resident of the Northwest I appreciate the opportunity to comment on the document.

I14-1 I think the operative word in the document title is 'Interim'. Based on this assumption the document lacks a sense of urgency. The lack of time frame for permanent measures leads one to believe that 'Interim' should be replaced with 'Indefinite'. Directly related to the lack of urgency I found no mention that the Snake River Coho has already been declared extinct a fact that gives all the more reason to expedite this process, for where the Coho went, so will the Sockeye and Chinook follow.

I14-2 The sections detailing the impact of the various alternatives and of the test drawdown effect on resident fish was informative--even if not complete. However, there should be a distinction made between resident indigenous fish, such as kokanee and sturgeon, and resident non-indigenous species, such as crappie, perch, carp etc. These non-native species should be given little to no weight in the impact statement since they are not native, and are only there because of the reservoirs, the same reservoirs which are a major factor in the decline of the native anadromous fisheries.

I14-3 Questions I have regarding the DSEIS are: Why are no river flow velocities targeted in the alternatives? Why weren't more models used, such as models that are preferred by other agencies with experience and expertise in anadromous fish runs? How long will it be until a long-term plan that includes structural changes to dams is implemented? Lastly, why weren't studies that indicated that barging (and trucking) is an inefficient and ineffective means of short and long-term salmon fishery problems given more weight?

I14-4 Related to the last question I would like to comment on barging. It is my unfounded belief, and something I wish an agency would look into, that barging does not work for one primary reason: The homing mechanism in anadromous fish needs reference, or data points for guidance. By removing salmon in the Snake and placing them essentially in the estuary of the Columbia one has short circuited the homing mechanism. The Snake and the Columbia are vastly different rivers, especially at Lower Granite versus Bonneville. To expect a fish to return with such limited data is to expect too much. A crude analogy is to take someone to a foreign city, show them an intersection, blindfold them and take them 10 miles away, then remove the blindfold and expect them to find their way back to the original intersection. It will not work! The solution is to let the smolts congregate at McNary dam, where the waters of the Snake and Columbia mingle, before they are barged to Bonneville for release. This would ensure the fish get a 'feeling' for both rivers, making sure they have another reference point for their homing mechanism.

Although the DSEIS is a start in the right direction of solving the very complex problem of returning viable salmon runs to the Columbia/Snake I have specific concerns related to the document. I think that it lacks urgency--a time frame for long-term solutions, it is not specific enough with regards to alternative goals, and it may be placing to much emphasis on some factors i.e. non-native fish, and barging. As a concerned citizen I am pleased to have the opportunity to comment on this very important document. I would appreciate receiving any further documentation generated from this important process.

Very truly yours,

Thayne Chaumell

1527 N. Anderson
Tacoma, WA 98406
(206) 756-0964

FRANK GUNDERSON

December 4, 1992

Dept. of the Army
Walla Walla District
Corps of Engineers
CENPWPL - ER
Walla Walla, WA 99362-9765

Re: Interim Columbia and Snake Rivers Flow
Improvement Measures for Salmon Draft
Supplemental Environmental Impact Statement

The undersigned objects to the referenced Environmental Impact Statement in the following particulars:

I15-1 1. No consideration is given to adverse effects of the proposed drawdowns on existing fish populations, specifically various species of trout, including steelhead, including but not limited to:

a. Possible increased silting of water and spawning beds caused by unseasonably high water;

b. The possible adverse effects on the food chain of existing fish populations occasioned by possible increased silting and water velocity;

c. The loss of habitat for existing fish populations and their food chain in present impoundments; and

d. The effects of drawdowns on dissolved oxygen levels in existing impoundments after such drawdowns.

I15-2 2. No consideration is given to possible losses to birds and other wildlife which may be inhabiting riparian areas suddenly inundated by abnormally high water depth and velocity during what would be, sans drawdown, low water periods.

I15-3 3. No consideration is given to possible alternative methods of increasing fish survivability at sea, including but not limited to:

a. Cessation of riverine predation of anadromous fish by Native Americans beyond that allowed other Americans;

b. Cessation of predation in U.S. waters of the North Pacific Ocean by factory trawlers defacto owned and/or operation by foreign interests; and

I15-3 (cont.) c. Cessation of predation of fish in U.S. waters of the North Pacific Ocean by shore based fishing vessels delivering catches to foreign processors, whether on shore or on the high seas.

I15-4 4. No consideration is given to possible alternative methods of increasing survivability of riverine fish by construction of permanent and continuously flowing psuedo natural streams to bypass dams and their ancillary structures.

I15-5 5. No consideration is given to removal of dams, or to their replacement by a series of low head structures which may be easier for fish to pass and which might decrease populations of squawfish and/or other predators. Further, no consideration is given to replacement of lower Columbia power production dams with alternative power sources.

I15-6 6. No hard data exists to support the contention that the proposed drawdowns will increase anadromous fish populations, the entire premise being based upon "professional judgments" by persons or firms admittedly having no prior experience with the effects of such drawdowns on fish.

I15-7 7. While the Corps candidly acknowledges that more dams might be needed to support the proposed drawdowns, no consideration is given to where such dams might be located, nor to the environmental impacts of such dams.

I15-8 8. No consideration is given to equitable apportionment of the environmental and economic effects of the proposed drawdowns among those hopefully to be benefitted thereby; e.g., coastal commercial and sport fishermen, Native American fishermen, riverine fishermen of Oregon and Washington, Oregon and Washington irrigators, and Oregon and Washington power producers.

I15-9 9. No consideration is given to remediation of the obstacles to anadromous fish by those entities responsible for such obstacles in violation of law; i.e., enabling legislation by Congress which conditioned such obstacles upon "no adverse effects" upon anadromous fish populations.

It is sincerely hoped that the Corps and its partners in the proposal to "drawdown" Snake/Clearwater reservoirs in an untried attempt to "flush" juvenile salmon to sea will address the above concerns in its final environmental impact statement. Please add the undersigned to the list of those to whom such final impact statement is circulated at the following address:

Frank Gunderson
10049 Barnsdale Dr.
Boise, ID 83704

I would also like to receive the environmental impact statement to which the referenced EIS is a supplement.

Thank you for your courtesy and cooperation.

Yours truly,

Frank Gunderson

Appendix I

Fish and Wildlife Coordination Activities

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
3704 Griffin Lane SE, Suite 102
Olympia, Washington 98501-2192
(206) 753-9440 FAX: (206) 753-9008

January 27, 1993

Lt. Colonel Robert D. Volz
Department of the Army
Walla Walla District, U.S. Army Corps of Engineers
Walla Walla, Washington 99362-9265

Dear Lt. Colonel Volz:

Enclosed are two copies of the Draft Coordination Act Report (DCAR) provided by the U.S. Fish and Wildlife Service (Service) for the Walla Walla District, U.S. Army Corps of Engineers (Corps) for Interim Columbia And Snake Rivers - Flow Improvement Measures for Salmon. This DCAR has been prepared under the authority of and in accordance with the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 *et seq.*).

Throughout the review and comment period for the Supplemental Environmental Impact Statement, agencies have voiced concern about the narrow range of alternatives presented. These comments also indicated that we would provide a detailed alternative which significantly improves mainstem Columbia and Snake River migration conditions. This alternative is being provided at this time, and we would expect consideration be given to this alternative.

Because of the late date at which we were contacted by the Corps to prepare this CAR, our ability to gather information, coordinate the report with other agencies and prepare our recommendations in a timely manner was constrained. We therefore retain the right to modify our recommendations should new information become available. The exception to this would be the information on anadromous fish and justification for our recommended alternative. This information was developed, for the most part, prior to the CAR and should be considered complete.

Please provide comments to us by February 19, 1993, for incorporation into the final CAR. This report is also being circulated to the fish and wildlife agencies and tribes for comment. If you have any questions, please contact John Grettenberger of my staff at the letterhead phone/address concerning the

CAR, Craig Tuss of the Columbia River Coordinators Office, 9317 Highway 99, Suite A, Vancouver, WA 98665, (206) 422-7888, regarding anadromous fish issues, and the Service's Ecological Services office in the appropriate state regarding resident fish/wildlife issues.

Sincerely,

David C. Frederick
State Supervisor

jg/kr
Enclosure
c: NMFS, Portland
USFWS, Portland
USFWS, Boise
USFWS, Columbia River Coordinator
IDFG, Boise
ODFW, Portland
WDW, Olympia
WDF, Olympia
CRITFC
CBFWA

INTERIM COLUMBIA AND SNAKE RIVERS FLOW IMPROVEMENT MEASURES FOR SALMON

FISH AND WILDLIFE COORDINATION ACT REPORT (DRAFT)

For

U.S. Army Corps of Engineers
Walla Walla District
Walla Walla, Washington

By

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INTRODUCTION

This draft Fish and Wildlife Coordination Act report (CAR) reviews the biological effects of the proposed 1993 Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon (93 Flows). These flow measures in the Columbia River system are to be implemented in 1993, and have been proposed in response to the federal listings of the Snake River sockeye salmon as a endangered species and the Snake River fall and spring/summer chinook as threatened species. Most importantly from the U.S. Fish and Wildlife Service's (Service) standpoint, we are providing an alternative in this CAR that is a significant departure from the Corps of Engineers alternatives. The Service believes that this alternative is implementable in 1993 and will provide more favorable migration conditions for outmigrating anadromous fish than the alternatives being considered in the Draft Environmental Impact Statement (DEIS). More favorable conditions will be created by increasing water velocities during outmigration through flow augmentation and drawdown, and by minimizing the use of transportation when in-river migration conditions are favorable. This CAR has been prepared under the authority of and in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 *et seq.*)

Because of the short time available to prepare the CAR, background information will be provided for anadromous fish only. We have provided detailed information in this subject area, however, to support our recommendation for an alternative proposal for 1993 operations. Project descriptions will be brief. Project effects will be described and discussed in detail primarily where they have not already been covered in the draft Environmental Impact Statement (DEIS) (USACE 1992). In summary, the CAR will focus on reviewing pertinent aspects of anadromous fish biology, a review of past and ongoing monitoring efforts, identification of short and long-term monitoring needs, mitigation recommendations and an alternative proposal for 1993 operations.

PROJECT DESCRIPTION

The general objective of this action is to improve water velocity in the Snake and Columbia Rivers with the objective of reducing migration time for outmigrating juvenile salmonids. Increases in water velocity are being accomplished by reducing the reservoir cross-section area with lower pool elevations and by augmenting flows with releases from storage dams.

The following alternatives are evaluated in the DEIS:

Alternative 1 - Without-Project Conditions (No Action)

Project operations would continue to operate the projects as they were operated from about 1985 to 1990. Run-of-the-river projects would be allowed to fluctuate 1-2 feet within a 3-5 foot range to meet short-term changes in electrical power demand. The four lower Snake River projects and four lower Columbia River projects would be operated in the upper portion of the rule

curve. Storage reservoirs would be operated according to normal rule curves. Flow augmentations for anadromous fish, or the Water Budget, would continue.

Alternative 2 - 1992 Operations

This duplicates operations during 1992. This alternative provides for flow augmentation from additional water from Dworshak, Brownlee, the upper Snake River, and Grand Coulee and Arrow on the Columbia River. The components of the alternative are described below.

1. Reservoir Operation

a) Lower Columbia Reservoirs would be operated near full, except that John Day would be lowered to minimum irrigation pool (approximately 262.5 to 263.5 MSL) from May 1 to August 31. This pool would be maintained as long as possible without adversely affecting irrigators.

b) Lower Snake River reservoirs will be operated near Minimum Operating Pool (MOP), with pulsing from April 1 to July 31.

2. Flow Augmentation

a) Dworshak supplemental releases would be scheduled as follows:

1. 900 KAF from April 15 to June 15, the exact flow depending on runoff forecasts and flows at Lower Granite.
2. 270 KAF above 1,200 cfs minimum discharge June 16 to August 31.
3. To enhance probability of being on the flood control curve by April, maintain 2 kcfs discharge from October through April unless higher discharges are required to stay on the flood control rule curve or for short-term power emergencies.
d. Up to 200 KAF in September, with option to shift to August.
e. Be at 1,558-feet maximum elevation on December 15 (winter flood draft maximum elevation).

b) Brownlee operation would reflect historical releases plus Northwest Power Planning Council requests, as follows:

1. 137 KAF in July
2. 100 KAF in September

c) Upper Snake River

1. 190 KAF April 15 to June 15 (via purchase)

d) Grand Coulee and Arrow

1. 3.45 MAF Water Budget plus 3.0 MAF additional flow augmentation May 1 to June 30. The additional 3 MAF will be obtained, if required, through power purchase and exchange activities, with associated storage carried out by BPA.

Greatest drafts usually occur in April, with the highest reservoir elevations normally occurring from July through December. Spring draft typically reduces reservoir storage by 55%. A hard constraint requires a lower elevation of 1,220.2 feet MSL at all times, and 1240 feet by May 31 to meet pumping requirements for irrigators.

For Alternatives 2 through 4, water from Grand Coulee and Arrow would be released to augment lower Columbia River flows from May 1 - June 30. If the forecasted January through July runoff measured at the Dalles is estimated to be 80 MAF or less, up to 6.4 MAF would be available for release. If the forecasted runoff is between 80 and 90 MAF, the amount of water would vary from 6.4 to 3.4, respectively. If the forecasted runoff is 90 MAF or more, 3.4 MAF is available for release.

3. Flood Control Transfer

a) Dworshak system flood control requirements would be shifted to Grand Coulee, if the April forecast predicts runoff to Dworshak of 2.6 MAF or less, subject to the availability of space at Grand Coulee. The effect is to draft Lake Roosevelt more than if it were drafted only for Grand Coulee's share of system flood control. In low to moderate water years, the maximum draft is controlled by power generation, and seldom does the flood control shift exceed the power draft.

Alternative 3 - 1992 Operations with Libby/Hungry Horse Sensitivity

This alternative is being analyzed as a sensitivity test only to determine the effects of 1992 operations on Libby and Hungry Horse projects. The objective is to determine whether Libby and Hungry Horse would be indirectly affected by flow improvement measures elsewhere in the system. For this analysis, constraints on the operation of Libby and Hungry Horse have been removed from the hydroregulation model. This would allow the full range of effects to be identified.

Alternative 4 - Modified 1992 Operations

This alternative is basically the same as 1992 operations (without the March drawdown test). Two elements of the flow augmentation differ however. The 200 KAF programmed for September release in Alternative 2 would be released in July and/or August to benefit summer juvenile migrants. The runoff forecast trigger for the flood control transfer from Dworshak to Grand Coulee would be increased from 2.6 MAF to 3.0 MAF, which would increase the potential for a flood control transfer. During moderate water years, this draft may exceed the power draft in March and early April.

Alternative 5 - Modified 1992 Operations with Upper Snake Sensitivity

Alternative 5 is being run as a sensitivity model to evaluate the effect of a lack of water due to drought in the Upper Snake River on the proposed actions in Alternative 4. Purchase of uncontracted water from the Upper Snake River was an objective in 1992. However, because of low flows, water was not available for purchase.

Fish and Wildlife Agency 93 Operation Alternative

This alternative should provide a significant improvement in mainstem flow during critical migration periods and provides significant increases in river velocity for the Snake and Columbia rivers. Our alternative addresses the Northwest Power Planning Council (NPPC) program objective of increasing river velocities to reduce travel time for anadromous fish (Section 3.3-3.6). This alternative is supported by the Oregon Department of Fish and Wildlife, Idaho Department of Fish and Game and the Columbia River Inter-Tribal Fish Commission.

System flexibility, marketing strategies, energy exchanges, and storage and reservoir operations will be required to achieve water velocity equivalents of the 1990 Columbia Basin Fish and Wildlife flow recommendation. The specific recommendations of the alternative are:

1. Provide a velocity equivalent of 300 kcfs at full pool at The Dalles Dam from April 16 to June 15.

2. Provide 1.5 MAF from Dworshak reservoir between April 15 and June 30 to augment Snake River flows.

3. Find and provide up to 500,000 acre feet as an interim measure in 1993 using mechanisms such as those identified in measure 3.6c of the NPPC Program. This additional water is included in this alternative as an interim measure because a four-pool drawdown plan will not be implemented in 1993. This additional volume should be made available between April 15 and September 30. Flow augmentation from the upper Snake River will require consultation with the U.S. Fish and Wildlife Service under Section 7 of the Endangered Species Act due to the listed molluscs on the Snake River.

4. Achieve drawdown of Lower Granite reservoir to elevation 710 feet above mean sea level (FMSL) from April 15 to June 15. Maintain all other lower Snake River projects at or near MOP with the following specific attributes:

-Provide spill at Lower Granite Dam to attain a minimum standard of 80% FPE (Fish Passage Efficiency), no fish collection or transport. Include monitoring programs and contingency plans to quantify and address concerns about adult passage, gas supersaturation and gatewell dipping;

-Provide spill at Little Goose Dam to attain a minimum standard of 80% FPE. The intent of this action is to refrain from collection and

transport of spring migrating chinook salmon as long as adequate in-river migration conditions are maintained.

-Provide spill at Lower Monumental Dam to attain a minimum standard of 80% FPE, no fish collection or transport.

-Provide spill at Ice Harbor Dam to attain a minimum standard of 80% FPE.

5. Provide spill at McNary Dam to attain a minimum standard of 80% FPE, no collection or transport from April 15-June 15.

6. From June 16 to September 30 maintain all lower Snake River projects at or near MOP with the following specific attributes:

-Between June 16 to September 30, the decision to collect and transport at Lower Granite, Little Goose, and Lower Monumental Dams will be based on close examination of the river conditions, and in-season monitoring and evaluation of bypass facilities. The basic premise of this alternative is that good in-river migration and project passage conditions will be provided for fish migrating in-river through the mainstem Snake and Columbia rivers. If spill is decided on as the mode of passage, spill to attain a minimum standard of 70% FPE will be provided. Include monitoring programs and contingency plans to quantify and address concerns about juvenile and adult passage, migration timing and gas supersaturation.

-provide spill to attain a minimum standard of 70% FPE at Ice Harbor between June 16 and August 31.

7. Between June 16 and September 30, the decision to collect and transport at McNary Dam will be based on close evaluation of bypass facilities. The basic premise of this alternative is that good in-river migration and project passage conditions will be provided for fish migrating in-river through the mainstem Snake and Columbia rivers. If spill is decided on as the mode of passage, spill to attain a minimum standard of 70% FPE will be provided.

8. Provide 400 KAF from Dworshak reservoir during July and August to augment Snake River flow levels. The benefit of this augmentation should be allowed to continue through the Columbia River below the confluence with the Snake River.

9. Provide velocity equivalents at The Dalles Dam from June 16 to September 30 to maintain average water particle travel time through the McNary-Bonneville reach equivalent to the Columbia Basin Fish and Wildlife Authority flow recommendations.

10. We concur with the proposed operation of the John Day reservoir elevation near 262.5 (minimum irrigation pool) in 1993.

11. Allow the firm energy load carrying capability to be impacted in low water years to achieve flow targets in the lower Columbia River.

The decision to transport from these facilities should be based on close examination of the river conditions and in-season monitoring. The basic premise of this alternative is that good in-river migration and project passage conditions will be provided for fish migrating in-river through the mainstem Snake and Columbia rivers.

EXISTING RESOURCES-ANADROMOUS FISH

Several species of anadromous fish occur in the Columbia and Snake River basin. These include six species of Pacific salmon (*genus Oncorhynchus*): 1) chinook (*O. tshawytscha*), 2) coho (*O. kisutch*), 3) sockeye (*O. nerka*), 4) chum (*O. keta*), 5) pink (*O. gorbuscha*) and 6) steelhead (*O. mykiss*); white sturgeon (*Acipenser transmontanous*) and Pacific lamprey (*Lampetra tridentata*). All but two of the salmon species, chum and pink, occur in significant numbers above Bonneville Dam. White sturgeon populations above Bonneville Dam have become landlocked as a result of hydropower development.

WHITE STURGEON

The sturgeon resource above Bonneville Dam is usually considered to be composed of discreet, closed populations within each reservoir. Some exchange of individual fish probably does occur by means of the fish ladders and through the navigation locks. In addition, displacement of eggs and larvae to downstream pools may occur (TAC 1991). While information concerning white sturgeon is sketchy, overharvest and hydropower development seem to be the major threats to these populations. With the loss of access to the marine environment, these fish lost a forage base and a refuge from fishing pressure. These two factors make the populations above Bonneville Dam more susceptible to harvest pressure than the populations below Bonneville Dam. Recent research by the Service suggests that water velocity in the tailrace of the dams may be tied to spawning success. It is hypothesized that a threshold water velocity is required to bring on reproductive activity.

ANADROMOUS SALMON-LIFE HISTORY AND HABITAT REQUIREMENTS

Pacific salmon species spawn in freshwater in gravel beds (redds) in the rivers, and in tributary streams and lakes. After rearing in freshwater from a few days up to three years, they migrate to sea where they spend from one to five years feeding. Some of the stocks migrate extensive distances during their ocean residence. They have a strong tendency to return to their river of origin and to utilize a wide variety of freshwater habitats, which has resulted in the development of a wide range of adaptations and many reproductively isolated populations or stocks.

The native stocks of salmon and steelhead evolved over thousands of years within the natural ecosystem of the Columbia River basin. The timing of their seaward migration as juveniles coincided with the period of high runoff (Mains

and Smith 1964). The large volume of runoff, high water velocities, and high turbidity helped the juvenile migrants to move rapidly downstream with a minimum of energy expenditure and protection from predators. High flows also provided favorable conditions for adult salmon and steelhead migrating upstream.

While the basic migration mechanisms and needs and other biological requirements of salmon and steelhead have remained unchanged over time, the migration corridor in the Columbia River basin has changed dramatically. Today the river is a series of reservoirs with large cross-sectional areas and lower water velocities, and upstream storage impoundments that have shifted spring and summer flows into the fall and winter. The changes in the migration corridor and runoff management, in combination with other factors such as habitat degradation and over-fishing, have led to the extinction of some stocks in the Columbia River basin and the recent listing of Snake River sockeye salmon as endangered and Snake River spring/summer and fall chinook as threatened under the Endangered Species Act.

Adult migration and spawning

Adult salmon and steelhead enter the Columbia River and begin their upstream migration virtually every month of the year. The timing of many runs of anadromous salmonids corresponds with peak flow (Collins 1892; Pritchard 1936; Cramer and Hammock 1952; Andrew and Geen 1960; reviews in Major and Mighell 1966, and Banks 1969; and Baker 1978), which probably provide a favorable migrating condition for adult salmonids. Summer chinook salmon migration in the Columbia River historically coincided with the time of highest river discharge (Thompson 1951). The timing of upstream migration of historical runs of sockeye salmon in the Columbia River were initiated with the rising waters of spring (Collins 1892).

Salmon usually cease feeding after entering freshwater and depend on their energy stores for migration, gonadal development, and spawning. Adult salmon exhaust virtually all energy reserves prior to spawning and death (Idler and Clemens 1959; Gilhousen, 1980). Extreme flows (both high and low) and high water temperatures can cause delays in the spawning migrations of some salmonid stocks in the Columbia, Snake, and other rivers (Thompson 1945; Fish and Hanavan 1948; Cramer and Hammack 1952; Major and Mighell 1966; ODFW 1977; Johnson *et al.* 1982; Liscom *et al.* 1985; Shew *et al.* 1985). High temperatures, in addition to blocking migration, can increase the rate at which limited energy is consumed for standard metabolism (Fry 1971). Females are more susceptible to delay (Godfrey *et al.* 1954), perhaps because they have less surplus energy than males (Gilhousen 1980). There are also differences among runs, and between early and late components of runs, with respect to energy reserves and swimming ability (Gauley 1960; Gauley and Thompson 1963; Gilhousen 1980). Delays caused by an unfavorable migratory environment can contribute to reproductive failure of salmonids.

Salmon stocks in the Columbia River have evolved discrete populations that home to particular areas, allowing them to utilize a wide variety of habitat in the basin. Different temperature regimes that regulate maturation, incubation, and fry emergence have a major effect on run timing. As water

temperatures decrease from upstream to downstream reaches in the fall, time windows for egg laying at specific sites determine the spawning sequence. For example, mid-Columbia River spring chinook spawn in cooler headwater tributaries from July until mid-September, while summer chinook spawn in warmer downstream areas during October, and fall chinook spawn in the mainstem during late October and November (Meekin 1963). Royal (1953) hypothesized that the sharp peaks or modes in the timing of migration and spawning indicate that sockeye salmon encounter advantageous conditions for survival that extend over a relatively short time period. The chronological order of migration and spawning of individual races of sockeye salmon in the Fraser River shows remarkable consistency (Killick 1955).

Water velocities are an important factor in redd site selection and construction (Chambers 1956, 1960; Meekin 1967a; McCart 1969), and as a result adults often locate their nests at the head of a riffle in the tailout of a pool. Flows are necessary to prevent dewatering and keep redds clean of sediment and well aerated. A shortage of oxygen caused by the lack of adequate flow through the gravel beds jeopardizes egg and larvae survival (Royce 1959). The most important factor in egg and larvae survival is the quality of the water circulating in the spawning gravel (Chambers 1956). This flowing water must circulate adequate oxygen, be a suitable temperature, and be free of any toxic chemicals.

Seasonally high flows can play an important role in flushing harmful fine material from spawning gravel (Reiser *et al.* 1985). The amount of water circulating through the gravel increases with the seasonal increase of water flow during spring runoff. The lack of seasonally high flows has led to a compaction of gravel in some areas and an accumulation of fine material in the gravel (Chapman *et al.* 1986). The subsequent lack of intragravel water flow results in low survival in salmonid eggs and larvae (Shapovalov and Taft 1954). Gravel can become sedimented except where spawning is concentrated each year. The tendency of spawners to concentrate in high-use spawning areas in the Hanford Reach (Dauble and Watson 1990) may reflect the relatively high suitability of gravel that has been cleansed of fines by redd construction in prior years. High flows during spawning can provide a greater wetted area for spawning when space is limiting, but of equal or greater importance is the maintenance, until fry have emerged, of flow levels close to those that prevailed during spawning (Thompson 1974; Graham *et al.* 1980; Chapman *et al.* 1986).

Chinook salmon - Based on run timing, the chinook salmon in the Columbia River basin are divided into spring, summer and fall runs. The spring chinook salmon enter the river during March, April and May, and pass Bonneville Dam from mid-March through the end of May. The summer chinook salmon begin their upstream migration during late May, June and July, and pass Bonneville Dam in June and July. Fall chinook salmon enter the river beginning in late July and August and pass Bonneville Dam during August, September and October. The three runs are comprised of many separate stocks that maintain genetic integrity by spatial or temporal separation during spawning.

Spring chinook journey to the headwaters of the Columbia during high water flows and primarily utilize higher elevation streams for spawning. Summer

chinook historically dominated upper Columbia River spawning grounds in lower elevation streams. In the Snake River basin, summer chinook use small high elevation tributaries more typical of spring chinook (Mathews and Waples 1991).

Snake River spring and summer chinook now spawn in five major subbasins in the Snake River: Tucannon, Imnaha, Clearwater, Grande Ronde, and Salmon rivers. Elevation is a key factor in timing of migration and spawning. In streams where both spring and summer chinook are present, the spring chinook tend to spawn earlier and at higher elevations than the summer chinook (Mathews and Waples 1991).

Wild spring chinook salmon in the Deschutes River spawn primarily in September (Cates 1981) and in the Tucannon River in September (Howell *et al.* 1985). In the Yakima River, spring chinook spawning is earliest in the colder water areas and later in the warmer water areas (Howell *et al.* 1985). Spring chinook spawn in the Salmon River in August and early September (Bjornn 1960).

Peak spawning for summer chinook occurs in the Methow, Okanogan and Similkameen rivers between October 20 and October 30 (Meekin *et al.*1966; Meekin 1967b). In the Upper South Fork Salmon River, peak spawning of summer chinook occurred between late August and mid-September (Ortman and Richards 1964).

The fall chinook salmon in the Columbia River are comprised of two distinct types: "tules" and "upriver brights". Tules are generally confined to tributaries in the lower river from Bonneville pool downstream and spawn from late September to about mid-October. Upriver brights are destined to spawn in upriver areas and retain a silvery ocean phase coloration because they spawn much later than the tules. Upriver bright fall chinook spawn in the Hanford Reach of the Columbia River usually from mid-October to the third week in November (Dauble and Watson 1990). About 70 percent of upper river fall chinook spawning occurs within the Hanford Reach (Carlson and Dell 1990). Most spawning in the Hanford Reach occurs in the upper 15 miles, primarily in the Vernita Bar area (Bauersfeld 1978). Upriver bright fall chinook also spawn in the lower Yakima and Deschutes rivers. Spawning of fall chinook in the Snake River occurs in October and November from the upper extent of Lower Granite Dam pool to Hells Canyon Dam in the mainstem, and in the lower reaches of major tributaries (Waples *et al.* 1991).

Sockeye salmon - Adult sockeye salmon enter the Columbia River beginning in late May. The migration period over Bonneville Dam occurs from May through August with the peak of migration ranging from late June to mid-July. The Wenatchee stock generally migrates earlier than the Okanogan stock. Specific information on the timing of Snake River sockeye salmon at Bonneville Dam is not available. Sockeye migrate past Priest Rapids Dam about two weeks after passing Bonneville Dam (Howell *et al.* 1985).

In the mid-Columbia River, sockeye salmon enter the Okanogan and Wenatchee rivers and reach Lake Osoyoos and Lake Wenatchee, respectively, between mid-July and August (Mullan 1986). In some years, water temperatures of 20-21 C and greater in the Okanogan River inhibit passage (Major and Mighell 1966)

with documented delays in passage of up to a month (Allen and Meekin 1980). The adult fish remain in Lake Osoyoos up to a month and then continue their migration in mid-September to the spawning grounds in Canada when river temperatures begin to cool (Major and Mighell 1966).

In the Okanogan River system sockeye salmon spawn in September and October with most spawning occurring between October 10-20 (Allen and Meekin 1980). Most of the spawning occurs in the Okanogan River between McIntyre Dam and Oliver, B.C. Limited spawning occurs along the shoreline of Lake Osoyoos (Allen and Meekin 1980). Spawning activity peaks in the Wenatchee River about one month earlier than in the Okanogan River. Most spawning occurs in the lower reaches of the Little Wenatchee River and the White River (Howell *et al.* 1985). Mullan (1986) concluded that spawning habitat has not been a limiting factor at recent levels of abundance for sockeye salmon in the Okanogan and Wenatchee rivers.

In the Snake River basin, sockeye salmon returning to Redfish Lake travel about 900 miles from the Pacific Ocean. Peak migration of adult sockeye salmon at Lower Granite Dam ranges from early to mid-July. Arrival of sockeye salmon at Redfish Lake peaks in August and peak spawning occurs in mid-October (Bjornn *et al.* 1968). Bowler (1990) reported that sockeye only spawn along the shoreline of the lake. In the 1950-60's, Bjornn *et al.* (1968) found that spawning occurred in shoreline areas of Redfish Lake and in Fishhook Creek.

Steelhead - There are two distinct types of steelhead in the Columbia River. Winter-run steelhead, or "winter steelhead", enter the Columbia River from November through April and spawn the same year from December to June. Summer-run steelhead, or "summer steelhead", enter the Columbia River and migrate upstream in the spring and summer, but do not mature and spawn until the following spring (Bley and Moring 1988).

Winter steelhead are produced primarily in tributaries of the Columbia River below Bonneville Dam. They are found in some drainages above Bonneville Dam such as Eagle, Herman, Rock and Fifteenmile Creeks and the Hood River in Oregon, and Collins, Catherine and Major Creeks and the Wind and Klickitat Rivers in Washington. The upstream limit of their distribution is Fifteenmile Creek, an Oregon tributary of Bonneville pool (RM 191)(TAC 1991). This is the farthest inland migration of winter steelhead in the Pacific Northwest. Steelhead passing Bonneville Dam between November 1 and March 31 are winter steelhead, but fish counting has not been conducted during this time period at Bonneville Dam since 1950.

Upriver summer steelhead are divided into two segments: the Group A and B populations. Group B steelhead are produced only in the Clearwater and Salmon rivers in the Snake River basin. Group A steelhead are found in almost all of the subbasins above Bonneville Dam including the Clearwater and Salmon rivers (CBFWA 1991). Group A steelhead mainly enter the Columbia River from June to early August and Group B fish from late August into October. Both groups spawn from April into June almost one year after entering the Columbia River (CBFWA 1991). Group B steelhead spend more time on the average rearing in the ocean, and are significantly larger than Group A steelhead. Summer steelhead

also spawn in the Hanford Reach of the mainstem Columbia River from February through May (Fulton 1970; Watson 1973).

Coho salmon - Coho salmon in the Columbia River have a wide range of run timing. They enter the Columbia River from August through December (CBFWA 1991). Current returns of coho salmon above Bonneville Dam are supported almost entirely by hatchery production. The only native upriver stock of coho salmon occurs in the Hood River, an Oregon tributary to Bonneville Pool, and production is very low (CBFWA 1991). Peak migration of coho salmon at Powerdale Dam on the Hood River occurred in September and October, and spawning occurs during October and November (Howell *et al.* 1985).

Below Bonneville Dam, a natural coho salmon run in the North Fork of the Clackamas River returns from November through March (Cramer 1991). Coho salmon of apparent wild origin have been observed in Gnat Creek from mid-September to mid-February (Hirose 1983). Small numbers of coho salmon spawn naturally in other tributaries of the lower Columbia River but most are considered to be feral hatchery fish and only a few of non-hatchery origin (Johnson *et al.* 1991).

Coho salmon in the Columbia River in recent times have been managed primarily for hatchery fish which are divided into early-run and late-run types. The early-run or Type S group has a southerly marine distribution from the mouth of the Columbia River and returns to the river in August and September (Johnson *et al.* 1991). The late-run or Type N group has a northerly marine distribution and returns to the Columbia River in October and November. The early-run (Type S) coho salmon migration past Bonneville Dam peaks in early September and they spawn in October and early November (CBFWA 1991). The late-run (Type N) coho salmon migration over Bonneville Dam peaks in mid-October and they spawn in November and December (CBFWA 1991).

Juvenile rearing

The timing of hatching and fry emergence of salmon and steelhead varies among the different stocks because of differences in incubation temperatures at different locations and because of stock differences in the number of temperature units required for hatching and development. After hatching, salmon alevins (yolk-sac larvae) remain in the gravel interstices for an extended period. Alevins are negatively phototactic which encourages further submergence in the gravel and prevents premature emergence (Godin 1982). As the yolk sac is absorbed, alevins develop positive rheotactic and phototactic responses and begin an upward migration in the gravel (Dill 1969).

Salmon fry emerge primarily at night and disperse into a wide variety of freshwater habitats. The different species select different rearing habitats, which reduces competition for space and food. Flow, water velocity, and water depth determine the amount of suitable habitat available for rearing fish. The amount, type, and location of cover is important during rearing in streams because cover provides food, shade, temperature stability, protection from predators, and overwintering habitat. Substrate composition is also important for rearing because the highest production of invertebrates is in habitats

with gravel- and rubble-sized materials and production decreases as the size of the substrate particles decrease (Reiser and Bjornn 1979).

The primary foods of juvenile salmon in rivers are larval and adult insects of both terrestrial and stream origin. Juvenile salmon, depending on the species, spend from a few days up to three years feeding in freshwater before migrating to the sea.

Chinook salmon - Spring chinook in the Salmon River usually hatch in December and emerge from the gravel in February or March (Bjornn 1960). Spring chinook fry emergence in the John Day River occurs from late February to mid-June (Knox *et al.* 1984). Upper Columbia River summer chinook fry in the Wells spawning channel emerged from January through April (Allen *et al.* 1968, 1969, 1971). Fry emergence of fall chinook occurs from late March through June in the Snake River. The estimated date of peak emergence of fall chinook salmon fry from their redds in the Snake River in 1991 was about May 25. Estimated peak emergence of fry in 1992 occurred about May 1 or about three weeks earlier than 1991 (Dennis Rondorf, USFWS, personal communication).

Movement of fry downstream immediately after emergence is typical of most chinook populations (Bjornn 1971, Reimers 1971, Healy 1980; Kjelson *et al.* 1982). Movement of chinook fry occurs mainly at night (Reimers 1971, Lister *et al.* 1971, Mains and Smith 1964). River discharge plays a role in stimulating movement of chinook fry downstream (Kjelson *et al.* 1981, Healy 1980) and may be a key dispersal mechanism. Other factors such as inter- and intra-specific competition may also play a role in dispersal.

Chinook fry in streams change habitats as they grow older. After an initial hiding period associated with bank cover and shorelines, they move progressively into deeper, high water velocity areas, and rockier habitats (Lister and Genoe 1970; Everest and Chapman 1972). Juvenile fall chinook salmon in the free-flowing section of the Snake River show a fairly high fidelity to rearing areas near shore in low velocity habitats. Preliminary analysis of Passive Integrated Transponder (PIT)-tagged salmon in 1991 suggest fish started migration when they attained a threshold size of about 85 mm (Dennis Rondorf, USFWS, personal communication). Seine catches of subyearling chinook salmon in rearing areas of the free-flowing Snake River declined as water temperatures reached 15-17°C. In 1991, no subyearling chinook were captured by seining after the third week of July when water temperatures reached 20°C. Spring chinook juveniles hide under large rocks and debris during overwintering (Chapman and Bjornn 1969). Recently emerged chinook fry historically reared in the Columbia River estuary, arriving as early as December, and they were abundant in the estuary in March and April (Rich 1920).

The primary foods of chinook rearing in freshwater are larval and adult insects. Crustacean zooplankton, primarily Cladocera, are important in the diet of chinook in the lower Columbia River in July and August but insects are the predominant food item during other times of the year (Craddock *et al.* 1976).

Sockeye salmon - Sockeye salmon fry emerge in March and April in the Okanogan system (Allen and Meekin 1980) and in April in the Little Wenatchee and White rivers (Allen and Meekin 1973). Fry move out of the spawning tributaries soon after emergence and migrate to the nursery lakes where juveniles feed on pelagic zooplankton from one to three years before migrating to the ocean. The percentages of one and two year smolts in the migration from Redfish Lake varied from 2 to 98 percent from 1955-66 (Bjornn *et al.* 1968).

Steelhead - No information is available on time of fry emergence for wild winter steelhead in the Columbia River basin. Summer steelhead fry in the Columbia River generally emerge from July through September (West *et al.* 1965; Mullarkey 1971; Thurow 1985). Juvenile steelhead tend to occupy the shallow riffle areas, particularly during the first year of life (Hartman 1965) and are more closely associated with the bottom of streams than coho or chinook (Hartman 1965; Edmundson *et al.* 1968). The highest densities of juvenile steelhead occur in areas containing instream cover (Johnson 1985). They may migrate to lower stream reaches to avoid freezing conditions in upper tributaries (Howell *et al.* 1985). Juvenile steelhead spend from one to three years in fresh water feeding on aquatic insects, amphipods, aquatic worms and fish eggs, and will occasionally eat small fish (Wydoski and Whitney 1979).

Coho salmon - No information is available on the time of emergence of wild coho in the Columbia River basin. After emergence from the gravel, coho fry initially congregate in schools in areas with cover such as side channels (Sandercock 1991). As they become older, coho salmon juveniles establish territories in both pool and riffle areas, and are best adapted to holding in pools (Hartman 1965). Their abundance in streams is limited by the number of suitable territories available (Larkin 1977) and they are generally displaced downstream if they are unable to defend a territory. Coho primarily feed on drifting stream and terrestrial insects (Mundie 1969). They usually spend about 18 months in freshwater (Mullan 1984).

Juvenile migration

Before impoundment, the Columbia and Snake rivers consisted primarily of pools and riffles of fairly high velocity. Historically, chinook salmon smolts began their seaward migration just before the peak of river flow, and steelhead migration coincided with the peak of river flows (Raymond 1979). Freshets allowed smolts to quickly move through the river with a minimum of energy expended and with protection from predation afforded by the high volume of runoff, high river velocities, and high turbidity. The physiological, morphological, and behavioral changes which occur during the smoltification process prior to and during migration evolved under these conditions when seasonal increase in runoff provided for rapid migration. Raymond (1979) estimated the rate of migration in the free flowing river was 24 to 54 km/day under high to low flow conditions. When the Columbia and Snake rivers were freeflowing, it took smolts only 22 days to migrate from the Salmon River to the lower Columbia River below Bonneville Dam (Ebel 1977).

Migration mechanisms - The onset of migratory behavior is closely associated with the smoltification process in juvenile salmonids.

Smoltification includes changes in both morphology and physiology, resulting in migratory behavior and the ability to live in seawater (Bern 1978; Folmar and Dickhoff 1980). Numerous morphological changes such as the weight to length ratio, coloration, change in caudal peduncle shape, fin shape and coloration, and development of recurve teeth in the mouth result in a smolt profoundly changed from the freshwater parr (Vanstone and Market 1968; Gorbman *et al.* 1982; Winans and Nishioka 1987). Many physiological changes are related to each of these general changes and collectively typify smoltification (Folmar and Dickhoff 1980; Wedemeyer *et al.* 1980; Hoar 1988). Behavioral changes associated with smoltification include restlessness, elimination of territoriality, onset of schooling behavior, and becoming semi-pelagic (Hoar 1965, McKeown 1984). The cumulative effect of the above changes is that smolts are no longer adapted to remain in freshwater habitats, but are well adapted for saltwater entry.

The migration of juvenile salmonids from their freshwater habitats to the ocean must be by active swimming, passive transport by the current, or both. In considering these modes, Thorpe *et al.* (1981) stated "It would be energetically inefficient and ecologically imprudent for smolts to swim actively downstream when a river could transport them passively over the same route. Pressure to evolve such active behavior would only arise if the passive transport system was too slow, or resulted in the delivery of smolts into the sea at an inappropriate season". Smith (1982) postulated that smolts actively swim upstream, but because of their reduced swimming performance are swept downstream. In fact, the only active migration of smolts that occurs routinely appears to be sockeye migration through lakes (Johnson and Groote 1963; Groote 1965) and the movement of fish out of backwaters.

A mostly passive mode of migration, taking advantage of downstream displacement by water currents, is made possible by several mechanisms: development of negative rheotaxis (the movement of an organism in response to a current); a decrease in swimming proficiency; and, a decline in swimming stamina in smolts when compared to parr (Folmar and Dickhoff 1980; McCormick and Saunders 1987). Annual rhythms in rheotaxis have been observed in Atlantic salmon (*Salmo salar*) with strong negative rheotaxis in smolting juveniles (Lundquist and Eriksson 1985). A reduction in swimming stamina among smolts compared to parr has also been observed (Folmar and Dickhoff 1980). The swimming ability for coho salmon parr is 3.5-7.3 body lengths per second (BLs^{-1}) and is about 2-5.5 BLs^{-1} for coho salmon smolts (Glova and McInerney 1977; Smith 1982). A similar decline for Atlantic salmon from up to 7 BLs^{-1} for parr to about 2.0-2.5 BLs^{-1} for smolts indicates that this is not unique to coho salmon, but may be common among all salmonid smolts (McCleave and Stred 1975; Thorpe and Morgan 1978). These changes in swimming behavior provide a mechanism for downstream displacement by flow and a resulting migration that is largely passive, depending mostly on water flow to determine migration speed and direction.

Early observations on chinook salmon support the hypothesis of a mostly passive migration. In a study conducted on the Sacramento River from 1896 to 1901, Rutter (1904) stated "there is no doubt that in migrating the fry drift downstream tail first, keeping the head upstream for ease in breathing as well as for convenience in catching food floating in the water" (his reference to

fry is somewhat misleading in that the fish were about 5 cm in length). The hypothesis of passive migration is also supported by numerous observations on Atlantic salmon. Studies on Atlantic salmon by Thorpe and Morgan (1978), Tytler *et al.* (1978), and Thorpe *et al.* (1981) in Scottish rivers, lochs and estuaries and by Fried *et al.* (1978) in the Penobscot River estuary suggest the migratory behavior is mostly passive. In each study juveniles drifted with the current at night for 6 to 9 hours. Although random movements occurred for various lengths of time during the night, the overall displacement was downstream at a speed consistent with the current velocity.

The close relationship between observed migration rates of chinook salmon and steelhead and flow also supports the passive mode of migration. Raymond (1979) concluded from studies of smolt migration from the Snake River from 1966 to 1975 that the rate of fish migration increased the higher the water velocity. Sims and Ossiander (1931) concurred with and expounded upon the conclusions reached by Raymond. They gathered smolt migration data from 1973 to 1979, plotting average travel time per project during each year against average flows occurring at Ice Harbor Dam during the peak of migration, plus or minus seven days. Sims and Ossiander (1981) confirmed travel time was related to river flow, noting faster migrations in years of higher flow and slower migrations in years of lower flow. Travel time in 1977, a drought year, was twice that of other years. Sims and Ossiander (1981) concluded that travel time differences were more pronounced in periods of low flow than in periods of high flows.

The Fish Passage Center's Smolt Monitoring Program (SMP) has continued to document the relationship between river flow and travel time, and has done so since the program was initiated in 1984. From the data collected by SMP, further study of travel time/water flow correlations have been possible. Berggren and Filardo (In press) noted smolt travel time was inversely related to average river flows for Snake River subyearlings and yearling chinook, as well as Columbia and Snake River steelhead. Average river flow made the largest contribution to explaining the variation in travel time. Berggren and Filardo (In press) showed evidence of a curvilinear relation between travel time and river flow, with a decreased rate of change in transit time at higher flows.

A recent summary of juvenile migration and flow information by the Fish Passage Center (FPC 1992a) indicates that prior to 1958, water travel time remained fairly stable in spite of large annual variations in flow. Water travel time began to change with the expansion of hydro development in the lower Columbia and Snake rivers. With construction of Lower Monumental in 1969, Little Goose in 1970, Lower Granite in 1975 and John Day Dam in 1968 major changes in water travel time occurred. Petrosky and Schaller (1992) provide supporting evidence in comparative changes in wild spring chinook stocks from Marsh Creek, Idaho and Deschutes River, Oregon. During the period 1958-1968 these stocks were self-sustaining. Since 1968, the Marsh Creek stock has declined in comparison to the Deschutes stock. In addition, Berggren and Filardo (In Press) demonstrated the similarity of juvenile salmon response in relation to water particle travel time. This similarity supports a causative relationship, rather than a simply correlative one, between smolt travel time and flow (Petrosky 1991).

Other factors influence smolt travel time. An increased level of stress in migrating smolts increases their travel time and alters their behavior. The prevalence of bacterial kidney disease (BKD) influences travel time by affecting their speed. Estimated travel time data is also skewed as a result of predation losses. The level of smoltification has an impact on smolt travel time, as well. Fish which exhibit elevated levels of gill Na+-K+ adenosine triphosphate activity (ATPase) and plasma thyroxine concentrations (and therefore are further along in the smoltification process) travel faster than fish with lower ATPase and thyroxine levels (Beeman *et al.* 1990). The more advanced in smoltification, the stronger a smolt's reaction to flow.

There is general agreement in the literature that juvenile smolt migration occurs primarily at night except when the water is turbid, during the peak of migration, or in extreme northern latitudes (Jonsson 1991).

Control of Migratory Behavior - Migratory behavior is controlled by genetic and environmental factors (Randall *et al.* 1987). Genetic selection favors genotypes controlling behavior patterns that improve the survival of their carriers (Smith 1985). As early as the 1920's, the migration patterns of juvenile chinook salmon were considered to be inherited by subsequent generations in the Columbia River (Rich and Holmes 1929). In a review, Randall *et al.* (1987) pointed out that the genetic influences on the age of smolting within species have been underestimated in the past. Recent findings indicate chinook in the Nanaimo River, British Columbia, which are characterized by a specific age and size at seaward migration, can be associated with significantly different frequency of allozymes and are seemingly a genetically distinct sub-population (Carl and Healey 1984). At the turn of the century, a wide variety of migratory traits apparently existed, as Rich (1920) observed juvenile chinook salmon in the Columbia River estuary throughout the year. Current knowledge suggests that the wide variety of migration patterns among hatchery and wild stocks has a genetic basis.

Environmental cues serve to synchronize the initiation of migratory behavior and the more general endogenous rhythmicity associated with smoltification. The mechanisms controlling smoltification are mediated through endocrine control at two levels: the first interfaces environmental inputs with the pituitary and the second involves the function of hormones in the endocrine system (Groote 1981; Schreck 1981; Barron 1986). Important environmental factors involved with the development of a disposition to migrate are photoperiod, water temperature and stream discharge. When fish are in a proper state of migratory readiness, a proximal stimulus, such as lunar phase or stream flooding, initiates migration (Hoar 1988).

Photoperiod is a key environmental cue influencing the timing of downstream migration in juvenile steelhead (Wagner 1974). The role of photoperiod cues apparently result from the direction and rate of change of day length (Wedemeyer *et al.* 1980). Baggerman (1960) and Wagner (1974) emphasize that, while photoperiod-controlled changes may bring the animal into a state of preparedness, priming it for migration, other released stimuli initiate and maintain migration. Consequently, McKeown (1984) concluded there is

relatively little evidence supporting photoperiod as an important cue in the actual initiation of migration.

Temperature influences smoltification by controlling the rate of the physiological response to photoperiod, such that effects are apparent sooner at elevated temperatures (Wedemeyer *et al.* 1980; Hoar 1988). The migratory movements of Atlantic salmon smolts are closely correlated with water temperature with only small numbers moving below a threshold temperature (Solomon 1978). Similarly, water temperature explained 89 to 95 percent of the yearly variation in the date of cumulative smolt migration by Atlantic salmon through a combination of temperature increase and ambient river temperature during spring (Jonsson and Hansen 1985). Average stream temperature explained 60 percent of the variation in the median date of emigration of coho salmon smolts from Carnation Creek, British Columbia (Holtby *et al.* 1989). In contrast to these findings, Bjornn (1971) could not establish a causal relationship between stream temperature and the seaward migration of salmon smolts. Although the smolt migrations coincided with increasing stream temperatures in the spring, the increasing temperatures seemed coincidental since steelhead reared in a spring-fed pond migrated from the relatively constant temperature pond at the usual time.

Mains and Smith (1964) found that seaward migration of chinook salmon in the Snake River during 1954 and 1955 was predominantly in the spring. This migration coincided with the spring runoff. They stated that, "While temperatures may play an important role in initiating the downstream migration of chinook salmon, the occurrence of the first spring freshet was the primary factor responsible for stimulating this phenomenon. In both years during which this study was made, the discharge required in the Snake River before migration commenced was approximately 70,000 cfs".

Physiological Development - Physiological changes in juvenile salmon encourage migration and prepare them for residence in seawater. The behavioral motivation for migration has long been recognized as having an endocrinological basis (Hoar 1958). The thyroid hormones have been implicated in behavioral changes associated with migration, but the relations have not been completely elucidated (Leatherland 1982; Eales 1985; Dickhoff and Sullivan 1987; Grau 1988). Godin *et al.* (1974) injected juvenile Atlantic salmon with thyroid hormones and observed that swimming activity, aggressive behavior, and upstream orientation were significantly reduced. They concluded that the hormones initiated the migratory tendencies. Similarly, others have concluded that increased plasma thyroxine permits smolting Atlantic salmon to resist displacement in high flows and orientate head-downstream in moderate flows, thereby elevating ground speed at no extra metabolic cost (Youngson *et al.* 1985; Thorpe 1989). The thyroid hormones do have an endocrine role in controlling migration behavior, but as Hoar (1988) concluded, they do not regulate behavior *per se*.

The migratory behavior of smolts has also been related to the physiological changes associated with the development of osmoregulatory capacity, particularly the level of gill sodium potassium adenosine tri-phosphatase (gill ATPase) activity. (Zaugg and Wagner 1973; Wagner 1974; Zaugg *et al.* 1985; Rodgers *et al.* 1987). The coincidence of an increased percentage of

juvenile steelhead migrating from experimental releases and the seasonal rise in gill ATPase has been demonstrated for winter steelhead from the Alsea River, and for summer steelhead at Dworshak National Fish Hatchery, Idaho (Wagner 1974; Zaugg 1981a; Zaugg 1981b). The same general relationship has been observed in yearling spring chinook salmon from the Deschutes River, Oregon that were allowed to migrate in an artificial stream (Hart 1981).

Many of the observed relations between migratory behavior and gill ATPase activity in smolts are derived from juvenile salmon held in the captive environments of the laboratory or hatchery. We know that smolts released to migrate freely usually exhibit remarkable smolt development indicated by rapid increase in ATPase activity (Ewing *et al.* 1980; Zaugg 1981a; Zaugg 1981b; Zaugg *et al.* 1985). In contrast, the smolt development, including gill ATPase and plasma thyroxine responses, of fish held in the captive environment is often suppressed (Zaugg *et al.* 1985; Nishioka *et al.* 1985; Patino *et al.* 1986; Rodgers *et al.* 1987; Maule *et al.* 1988).

The duration of the elevated gill ATPase levels among migrants is of interest because a decline may indicate a reversion to a parr status accompanied by a loss of migratory behavior. Zaugg (1981b) found that yearling coho held at hatcheries beyond normal May releases showed a decline in ATPase levels and a reversion to the parr appearance. Despite this reversion, fish released in June and July rapidly migrated seaward and experienced renewed high ATPase levels. Although it is apparent that coho, at least, can regenerate high ATPase levels, it is not known how long high levels are normally sustained in migrants. Although the migration experience is stimulatory, ATPase activity collected from migrating smolts of hatchery and wild origin suggest an early June decline similar to the seasonal rhythmicity observed in captive environments.

Salinity Preference and Tolerance - The development of osmoregulatory capabilities is concurrent with a change in behavior that results in a strong salinity preference (Baggerman 1960; Otto and McInerney 1970). Salinity preference has been proposed as an orientation mechanism for migration, particularly in the estuary (McInerney 1964). The salinity preference is a behavioral attribute of smolts that is restricted to a limited time (Baggerman 1960; McInerney 1964). Experimental results show a preference for salinity at the time of migration and a reversion to freshwater preference if the migrants continue their freshwater residency.

The migratory disposition in juvenile steelhead and coho salmon has been found to be preceded by the development of salinity tolerance from as much as several weeks to six months (Conte and Wagner 1965; Conte *et al.* 1966). The development of some salinity tolerance among juvenile salmonids in a wide range of sizes and physiological conditions independent of migratory behavior is not surprising, but the high salinity tolerance and subsequent rapid seawater growth without stunting is an attribute of smolts (Kepshire and McNeil 1972; Woo *et al.* 1978; McCormick and Saunders 1987). Continued freshwater residency is associated with reversion to a parr-like fish with a lower salinity tolerance in steelhead, coho, and chinook salmon (Conte and Wagner 1965; Wagner 1974; Woo *et al.* 1978). Chrisp and Bjornn (1978) concluded that hatchery and wild steelhead could not tolerate saltwater at a

concentration equal to 30 parts per thousand in a 10 day challenge by the time the migration from the upriver areas terminated in early June. Similarly, Adams *et al.* (1975) concluded that saltwater survival of steelhead transferred directly to saltwater at 10 to 11.3 C was low in early March, near 100 percent in mid-April, and declining by early May. Fall chinook differ from other salmonids since their seawater adaptability increases in early May and remains high well into July (Clark and Blackburn 1978; Clarke and Shelbourn 1982). In early August, the latter part of the subyearling chinook migration at McNary Dam exhibited a reduced osmoregulatory ability (Maule *et al.* 1988; Schreck *et al.* 1984). Similarly, fall chinook from Spring Creek National Fish Hatchery, on the lower Columbia river, exhibited a sharp decline in ability to withstand direct exposure to sea water in the laboratory (Gould *et al.* 1985).

"Windows" of Biological Timeliness and Their Management Implications - Numerous investigators have concluded that salmonid smolts have "biological windows" to successfully enter the estuary and ocean (Walters *et al.* 1978; Bilton *et al.* 1982; Boeuf and Harache 1982; Holtby *et al.* 1989). The concept of temporal-spatial windows has been developed primarily to explain the timing of smolts relative to coastal predators, marine productivity, and oceanographic conditions that are likely determinants of early marine survival. However, the smolt migration can also be considered to have windows limited by photoperiod, temperature, and other factors controlling the behavior and the physiology of smolts. The duration of such windows is delineated by the onset and decline of migratory behavior, seawater preference, seawater tolerance, and selected physiological attributes such as gill ATPase. Flow not only determines the time required by smolts to reach the ocean, but it ensures that smolts are at the appropriate location and time and in an acceptable condition.

Delay in migration can expose smolts to seasonally rising water temperatures. Since gill ATPase activity and migratory disposition are sensitive to elevated temperatures, exposure to such temperatures during migration may have deleterious effects. The temperature effects on steelhead are of particular concern because steelhead migrate later than yearling chinook and are more temperature sensitive than coho salmon. Based on laboratory experiments, water temperatures of 15 C (59 F) caused a steep decline in the gill ATPase activity of yearling steelhead; the authors suggested an upper limit of 12 C (54 F) (Zaugg *et al.* 1972; Adams *et al.* 1975; Zaugg 1981a).

The effect of temperature on the elevated gill ATPase activity of migrants that have migrated for weeks under seasonally rising water temperatures is of concern. This condition is fundamentally different from increases in gill ATPase activity observed among juvenile steelhead a few days after hatchery release, when they may experience rising water temperatures in the natural environment.

Predation - Historical accounts of the fish populations in the Columbia River are primarily related to the abundance of salmon, steelhead, and sturgeon. The relative historical abundance of important predators of salmonids is unknown. Northern squawfish (*Ptychocheilus oregonensis*) were probably the principal pool dwellers and played an important role as a predator of juvenile salmon and steelhead. Bull trout (*Salvelinus*

confluentus) and Dolly Varden trout (*Salvelinus malma*) may have been a keystone predators which tended to reduce competition at lower trophic levels by holding competitor populations in check (Mullan 1979).

The assemblage of species is very different today as a result of impoundment of the river system and because of the introduction of exotic species. Bull trout are now considered rare in the Columbia River basin and the Service has been petitioned to review their status as potentially threatened or endangered under the Endangered Species Act (ESA). Impoundment converted about all of the mainstem riverine habitat into pool habitat, which is most favorable for northern squawfish. Northern squawfish and three introduced species: walleye (*Stizostedion vitreum*), smallmouth bass (*Micropterus dolomieui*), and channel catfish (*Ictalurus punctatus*), are the major fish predators in John Day reservoir, with northern squawfish accounting for 78 percent of the estimated smolts lost to fish predators (Rieman *et al*. 1991). About 1.7 million smolts, or approximately 11% of the annual outmigration, are lost to predation each year in John Day reservoir (Beamesderfer *et al*. 1990). In comparison, about 2% of the juvenile salmonid population was lost to bird predation at Wanapum Dam (Rugerone 1986). Northern squawfish predation upon juvenile salmonids is influenced by many factors including prey density, prey species, prey condition, predator size, temperature, and time of year (Peterson *et al*. 1990; Poe *et al*. 1991; Vigg *et al*. 1991). Smolt losses caused by northern squawfish and other predators also depend on the amount of time smolts are exposed to predation which is a function of flow. The impact of low flows on predation is probably the result of longer exposure to predators as well as higher predation rates caused by increased temperature during the summer months. Temperature increases about 1 C every 9 days between May and August, and northern squawfish predation has been shown to increase rapidly with temperature (Beyer *et al*. 1988; Vigg 1988). Beamesderfer *et al*. (1990) estimated that 150,000 smolts were lost in John Day reservoir for each 1 C rise in temperature.

Temperature is probably the most important physical variable affecting the consumption rate and growth of predatory fishes (Brett 1979; Kitchell 1983). Consumption rate increases with increasing temperatures to a maximum rate at an optimum temperature. Above the optimum temperature, consumption rate usually declines rapidly, eventually falling to zero near the maximum lethal temperature for the species.

Consumption rate of northern squawfish, as a function of temperature, has been examined in the field and in the laboratory. Average consumption rate was significantly affected by temperature, prey density, and predator weight in analyses of John Day reservoir data (Vigg 1988; Peterson and DeAngelis, In press). Analyses showed that consumption increased rapidly with increasing temperature. Laboratory studies on digestion rates of northern squawfish showed faster digestion and prey evacuation at high temperature (Falter 1969; Steigenberger and Larkin 1974; Beyer *et al*. 1988). Laboratory experiments (Vigg and Burley 1991) demonstrated that maximum consumption of salmonid prey increased from 0.5 smolts/day at 8.3 C to 7 smolts/day at 20.5 C (Vigg and Burley 1991).

Chinook salmon - Juvenile chinook salmon are migrating down the Snake and Columbia rivers or resident in the estuary virtually year-around (Dawley *et al.* 1986). In general, spring chinook migrate fairly quickly to sea as yearling smolts and fall chinook tend to migrate more slowly as subyearlings. Summer chinook salmon in the upper Columbia River migrate as subyearlings, but summer chinook in the Snake River resemble spring chinook and migrate as yearlings.

Information on historical timing of migration of juvenile salmon in the Columbia River is limited. Most of the passage information available was collected after hydropower development and is not representative of pre-development run timing. Raymond (1979) found that yearling chinook salmon passage at Ice harbor Dam, before the construction of the other Snake River dams, usually peaked between April 26 and May 13 and was completed by mid-June. The range of yearling chinook migration past Ice Harbor Dam was from early April to late June. The earliest migration occurred in years with the highest runoff. Migrations were later when runoff was delayed because of cold weather or poor snowpack. Based on timing of marked Snake River chinook salmon in 1991, wild spring chinook passed Lower Granite Dam between early April and mid-July and wild summer chinook from the middle of April to late July. At McNary Dam, passage of wild Snake River spring and summer chinook occurred between early May and early June. No information is available on the timing of passage of wild spring and summer chinook in the mid-Columbia River. Wild spring chinook smolts from the John Day River migrate past John Day Dam between mid-April and early June (Lindsey *et al.* 1986).

Wild Snake River fall chinook tagged in the Snake River above Lower Granite Dam passed Lower Granite between mid-June and early September in 1991. Preliminary analysis of PIT tag data suggest fall chinook start migration when they attain a threshold size of 85 mm (Dennis Rondorf, USFWS, personal communication). In 1991 the median passage date for wild Snake River fall chinook was July 25 (FPC 1992b). This date also matched the peak date of passage for the subyearling chinook run-at-large. Peak dates of passage for the run-at-large in 1982, 1983, 1985, and 1986 occurred between June 29 and July 9 (FPC 1992b).

The outmigration of juvenile fall chinook salmon in the Hanford Reach of the Columbia River was bimodal in 1955 and lasted from March through July (Mains and Smith 1964). The first peak occurred in March and April and consisted entirely of 0-age fry. The second peak occurred in June and July and was largely fingerlings. Wild fall chinook PIT-tagged in the Hanford Reach of the Columbia River passed McNary Dam between the middle of June and late August in 1991. The median date of passage occurred in mid-July (FPC 1992b).

Sockeye salmon - Smolts migrate out of Redfish Lake from late April through May (Bjornn *et al.* 1968). Recoveries at Lower Granite Dam of PIT tagged Redfish Lake sockeye salmon released at the outfall of Redfish Lake in 1991 indicated that passage at Lower Granite Dam occurred between May 23 and June 15. Median travel time from release to Lower Granite Dam, a distance of 462 miles, was 10.3 days (FPC 1992b).

Based on reports of smolt migration past Tumwater Dam, smolt outmigration in the Wenatchee River began in mid-April and continued for about a month (Mullan 1986). The peak of juvenile sockeye salmon abundance at Wells Dam is usually in mid-May (Johnson and Sullivan 1985). Sockeye migration past McNary Dam usually occurs between early May and early June. The historic 10% median passage date at McNary Dam, based on data from 1984-90, is May 1 and the 90% median passage date is June 3 (FPC 1992b). During 1946-1953, the median passage dates for juvenile sockeye salmon at Bonneville Dam were between April 23 and May 13 (Davidson 1965). The average median passage date at Bonneville Dam for 1987-1990 was May 23 (FPC 1992b). Most sockeye smolts move through the estuary during May and early June, with some remaining until late July (Dawley *et al.* 1984).

Steelhead - Most summer steelhead rear in freshwater for two years, with some rearing for three years before migrating to sea (CBFWA 1991). Peak migration of juvenile steelhead at Whitefish on the Salmon River occurred between May 1 and May 19 for the years 1966-75 (Raymond 1979). Steelhead migration past Ice Harbor Dam usually peaked in mid to late May and generally coincided with maximum river discharge (Raymond 1979). In 1991 wild steelhead migration past Lower Granite Dam occurred between mid-April and early July. At McNary Dam, wild steelhead migration occurred between early May and early June.

Coho salmon - Coho salmon usually spend about 18 months in freshwater before migrating to the sea (Mullan 1983). Coho smolt outmigration occurred in Cedar, Gnat and Big creeks in April and May and in the Clackamas River in May and June (Howell *et al.* 1985).

STATUS OF ANADROMOUS SALMONID RUNS

Salmon and steelhead stocks historically used much of the Columbia River and its tributaries. Prior to development, chinook salmon migrated 1,200 miles up the Columbia River to Lake Windemere in Canada and 600 miles from the confluence of the Snake and Columbia rivers to Shoshone Falls near Twin Falls, Idaho (Fulton 1968; Van Hyning 1968). The Columbia and Snake rivers once supported the largest chinook salmon and steelhead populations in the world (Van Hyning 1973). The Northwest Power Planning Council estimated that Columbia River basin salmon and steelhead runs ranged between 10 and 16 million wild fish prior to development. Chapman (1986) estimated predevelopment run size at 7.5-8.9 million salmon and steelhead.

Since 1970, the minimum number of adult salmon and steelhead entering the Columbia River has ranged from 0.9 million fish in 1983 to 2.9 million fish in 1986. In 1990, 1.1 million adult salmon and steelhead entered the Columbia River, which was the smallest run since 1983 (ODFW/WDF 1991). Artificial propagation facilities, built throughout the basin as compensation for the loss of wild runs, now account for about three-quarters of all fish returning to the Columbia River basin (ODFW/WDF 1991).

The decline of wild runs has been so severe that three stocks of salmon in the Columbia River basin are now listed under the ESA: Snake River sockeye salmon

(endangered); Snake River spring/summer chinook salmon (threatened); and Snake River fall chinook salmon (threatened). Lower Columbia River coho salmon also were proposed for listing but the National Marine Fisheries Service (NMFS) determined that a listing was not warranted. Upper Columbia and Snake River coho salmon are now considered extinct.

Spring and Summer Chinook Salmon

Snake River - Historically, spring and summer chinook salmon were produced in numerous tributaries of the Snake River in Oregon and Idaho. During the late 1800's, the Snake River probably produced in excess of 1.5 million spring and summer chinook salmon in some years (Mathews and Waples 1991). Access to tributaries and the mainstem in the upper Snake River was eliminated by the construction of Swan Falls, Brownlee, Oxbow, and Hells Canyon dams.

Wild production in the Snake River basin in the 1960's was returning 50,000-80,000 spring chinook annually to the Columbia River basin (ODFW 1991). Returns of wild spring chinook in the Snake River basin have declined to about 10%-20% of this level and are still declining in spite of near elimination of harvest (ODFW 1991). The estimated average annual escapement of wild spring chinook salmon at Lower Granite Dam was 6,100 from 1987-91. Escapement trends in Oregon streams from 1954-89 show the same trend with relatively stable spring chinook salmon escapements from the mid-1950's to early 1970's and then a sharp decline soon after the completion of the four additional lower Snake River dams (ODFW 1991). The estimated average escapement of hatchery spring chinook over Lower Granite Dam during the same time period was 12,900 (USFWS 1992).

The Snake River wild summer chinook run has declined substantially from an average run at Ice Harbor Dam in the 1960's of 22,000 fish to an average estimated run of 3,100 fish in the 1980's (ODFW 1991). Hatchery production of summer chinook began in the 1980's. The estimated hatchery summer chinook run at Lower Granite Dam has ranged from 671 in 1982 to 3,883 in 1988 (ODFW 1991).

In April, 1992, the NMFS designated the combined Snake River spring and summer chinook run as a threatened species. They concluded that Snake River spring and summer chinook should not be treated as independent evolutionary lineages under the Endangered Species Act because of the possibility of substantial gene flow between the two forms in streams where they co-occur (Mathews and Waples 1991).

Upper Columbia River - The summer chinook salmon historically was the dominant run into the upper Columbia River (Mullan 1987). Very little information is available on the historical abundance of spring chinook salmon in the upper Columbia River but Bell (1937) concluded that only 4% of the spring chinook salmon that entered the Columbia River originated above Rock Island Dam. Based on geographic distribution of habitat, 500,000 chinook historically may have been produced in the upper Columbia River (Haas 1975).

As a result of overfishing and habitat degradation spring chinook runs to the upper Columbia River had declined substantially by the 1930's. Rock Island

Dam counts of spring chinook salmon ranged from 180 to 4,256 from 1935-42. The construction of Grand Coulee Dam blocked anadromous salmonids from access to the upper Columbia River in 1939. Salmon and steelhead returning to the upper Columbia River were trapped downstream at Rock Island Dam and were released above temporary weirs in the Wenatchee and Entiat rivers or were used for hatchery production at Leavenworth, Entiat, and Winthrop National Fish Hatcheries (Mullan 1987).

In the upper Columbia River redd counts for spring chinook have shown little long term change while fish counts at Priest Rapids Dam show a substantial increase since the mid-1970's (ODFW 1991). The average annual count of spring chinook at Priest Rapids Dam was 7,600 in the 1960's and increased to 14,300 in the 1980's (ODFW 1991). The increase in spring chinook salmon returns above Priest Rapids Dam is due primarily to increased hatchery production. The hatchery and natural/wild components of the spring and summer chinook salmon runs above Priest Rapids have not been estimated.

The summer chinook run in the upper Columbia River has been relatively stable over the past thirty years. Redd counts in the mid-Columbia River tributaries averaged 1,775 in the 1960's and 1,927 in the 1980's. Counts of summer chinook also show little change with an average annual count at Priest Rapids Dam of 15,200 in the 1960's and 14,040 in the 1980's (ODFW 1991).

Fall chinook salmon

Snake River - Historically fall chinook salmon were very abundant and spawned in the mainstem of the Snake River from the confluence with the Columbia River upstream to Shoshone Falls, and in many of its major tributaries (Waples *et al.* 1991). Dams constructed on the mainstem of the Snake River reduced the abundance and distribution of Snake River fall chinook salmon. The mean number of fall chinook salmon returning to the Snake River declined from 72,000 from 1938-49 to 29,000 in the 1950's (Irving and Bjornn 1981). Even after this decline the Snake River remained the most important area for natural production of fall chinook salmon in the Columbia River through the 1950's (Fulton 1968).

Counts of fall chinook at the uppermost Snake River dams declined from an average of 12,720 fish from 1964-68 to 610 from 1975-80 (Waples *et al.* 1991). This decline coincided with the construction of the four lower Snake River dams (1961-75) which eliminated spawning in the lower 146 miles of the Snake River. Estimated escapement of wild fall chinook at Lower Granite Dam from 1981-90 ranged from 720 in 1982 to only 78 fish in 1990 (Waples *et al.* 1991). Fall chinook spawning may also occur in limited areas in the Snake River and in tributaries below Lower Granite Dam. Fall-spawning chinook have been observed in the lower Tucannon River (Bugert 1991) and may spawn in the tailraces of lower Snake River dams but no evidence of spawning near the dams has been documented (Waples *et al.* 1991).

The NMFS, in their status review of Snake River fall chinook salmon, concluded that Snake River fall chinook is a distinct population for ESA purposes that differs genetically and ecologically from upper Columbia River fall chinook (Waples *et al.* 1991). NMFS concluded that Snake River fall chinook salmon

face a substantial risk of extinction and listed it in April 1992 as a threatened species.

Upper Columbia River - Fall chinook historically spawned throughout much of the mainstem of the upper Columbia River. Based on geographic distribution of habitat, 500,000 chinook historically may have been produced in the upper Columbia River (Haas 1975). The fall chinook run destined for the upper river was substantially depressed from historical levels before the construction of Grand Coulee Dam blocked access in 1939. Counts at Rock Island Dam of fall chinook salmon from 1933-1942 ranged from only 165 to 3,287 fish (Mullan 1987). The construction of the mainstem dams in the Columbia River below Grand Coulee Dam eliminated most of the remaining important fall chinook spawning habitat.

The number of fall chinook that spawn in the Hanford Reach of the Columbia River, the last major fall chinook spawning habitat remaining in the mainstem, increased substantially in the 1960's after construction of downriver dams and inundation of spawning habitat caused an upstream translocation (Mullan 1987). Redd counts in the Hanford Reach increased from an average of 1,100 from 1960-64 to 3,300 from 1965-69 (ODFW/WDF 1991). Since 1964 returns of adult upriver bright fall chinook salmon have ranged from 66,600 to 419,400 with the lowest returns occurring in 1980 and 1981. Returns have declined each year from the peak of 419,400 in 1987 to only 102,200 in 1991 (ODFW 1991).

Hatchery releases, primarily from Priest Rapids, Little White Salmon, Lyons Ferry, Bonneville and Irrigon hatcheries, also contribute to the upriver bright fall chinook runs. Hatchery upriver bright fall chinook above McNary Dam from 1986-90 ranged from 4,700 to 24,800 adult returns. Returns of hatchery bright fall chinook released below McNary Dam ranged from 17,000 to 93,000 adults from 1986-90 (ODFW 1991).

Returns of Bonneville Pool hatchery fall chinook (tules) were fairly stable from 1964-1982 and then declined dramatically. The average annual return, which was 108,000 for 1978-82, declined to only 19,700 for the period from 1986-90 (ODFW 1991). Natural spawning of Bonneville Pool hatchery fall chinook also occurs in the lower reaches of the Wind, Big White Salmon and Klickitat rivers. Natural spawning escapement in these areas ranged from 900 to 2,650 adults from 1986-90 (ODFW 1991).

Sockeye salmon

Snake River - Historically, sockeye salmon were abundant in several lake systems in Oregon and Idaho. The only remaining population resides in Redfish Lake in the Stanley Basin of Idaho, which currently supports the southernmost sockeye salmon population in the world (Waples *et al.* 1991). The commercial harvest of sockeye salmon in the Columbia River in some years exceeded 4.5 million pounds in the 1890's and early 1900's (ODFW 1991). The existence of commercial canneries in the Snake River basin, such as the one near Wallowa Lake, is an indication that sockeye salmon historically were abundant (ODFW/WDF 1990).

Declines in the Snake River sockeye salmon run in the early 1900's are attributed to over-harvest and construction of hydroelectric and irrigation diversion dams in Snake River tributaries (ODFW 1991). Sunbeam Dam, built in 1910 about 20 miles downstream from Redfish Lake on the main Salmon River, was not passable until 1912, and possibly not until as late as 1920 when a concrete ladder was completed (Waples *et al.* 1991). The dam was partially removed in 1934, allowing unobstructed passage. Sockeye salmon were observed spawning in Redfish Lake in the late 1920's, 1930's, and early 1940's and were abundant in the 1950's (Waples *et al.* 1991).

In the 1960's some of the lakes in Idaho that were accessible to sockeye salmon were blocked and chemically treated to convert them to resident fish management (ODFW 1991). Alturas and Redfish lakes (2,300 acres) remained accessible (ODFW 1991).

The Snake River sockeye salmon run at the uppermost dam on the Snake River averaged 720 fish from 1965-69. From 1985-89 the average annual run had declined to 20 fish. No sockeye were documented in Redfish Lake in 1990, four were counted in 1991, and one male returned in 1992.

The NMFS determined that the recent sockeye salmon in Redfish Lake are descended from the original sockeye salmon gene pool and should be considered separately from the non-anadromous kokanee which also reside in the lake and other sockeye salmon populations (Waples *et al.* 1991). NMFS listed the Snake River sockeye salmon as an endangered species in November 1991.

Upper Columbia River - Historically, sockeye salmon in the upper Columbia River had access to nursery lakes with a surface area of about 216,000 acres (Mullan 1986). Annual catches of sockeye salmon in the Columbia River ranged from 250,000 to 1.3 million fish before 1900 (Mullan 1986). Habitat loss due to blockage by dams on tributary streams was the major cause of the early post-1900 decline (Mullan 1986).

Grand Coulee Dam construction blocked access in 1939 to most of the historical spawning areas. Wenatchee and Osoyoos Lakes (8,174 acres) were the only remaining lakes accessible to sockeye salmon with a surface area of only four percent of the original area. From 1939 to 1943 sockeye salmon were trapped at Rock Island Dam and relocated to Lake Osoyoos and Lake Wenatchee and to Leavenworth, Entiat, and Winthrop National Fish Hatcheries. From 1938-1959 run sizes at Bonneville Dam ranged from a low of 10,900 sockeye in 1945 to a high of 335,300 in 1947. The 1950's was a period of relatively stable run sizes which sustained an average annual harvest of 95,900 sockeye (ODFW 1991). Hydroelectric dams on the mainstem Columbia River constructed in the 1950's and 1960's account for the most recent general decline (Mullan 1986).

At Priest Rapids Dam escapement between 1960 and 1990 has varied widely from a low of 14,900 in 1978 to a high of 170,100 in 1966. The escapement at Priest Rapids Dam has averaged 52,500 from 1986-90 (TAC 1991). Approximately equal numbers of spawners returned to Lake Osoyoos and Lake Wenatchee during this time period (TAC 1991).

Summer steelhead

Limited information is available on the historical size of summer steelhead runs in the Columbia River basin. Counts began at Bonneville Dam in 1938 and no distinction was made between Group A and Group B upriver summer steelhead until after 1968. The largest run of upriver summer steelhead of record was 423,000 fish in 1940. The combined upriver summer steelhead run remained relatively high until the 1950's and then gradually declined hitting a low during the latter half of the 1970's. The combined upriver summer steelhead run at Bonneville Dam ranged between 84,000 and 195,000 fish between 1975 and 1979 (CBFWA 1991). Transportation of juvenile steelhead and increased hatchery production resulted in larger returns of upriver steelhead in the 1980's. From 1984 to 1989 the upriver steelhead run ranged between 285,000 and 384,000 fish. Hatchery fish usually exceed 65 percent of the Group A run and at least 80 percent of the Group B run (CBFWA 1991). Wild/natural runs are a different story. Since 1986 no progress towards rebuilding wild/natural steelhead runs has been evident. Abundance indices indicate declining trends in wild/natural steelhead abundance throughout the upper Columbia River (ODFW 1991).

Snake River - The interim escapement goal of wild/natural Group A steelhead at Lower Granite Dam is 20,000 fish. Escapements of wild/natural Group A steelhead at Lower Granite Dam have ranged from a low of 7,400 fish in 1974 to a high of nearly 20,000 fish in 1986. Escapements have declined since 1986 (ODFW 1991).

Estimated Group B steelhead escapement at Lower Granite Dam was 2,900 fish in 1974 and increased to 7,000 fish in 1982. The escapements since 1982 have been variable, ranging from 5,100 to 8,900 fish (ODFW 1991). The interim escapement goal is 10,000 wild/natural Group B steelhead at Lower Granite Dam. All Group A and Group B wild/natural spawning areas surveyed in Idaho to determine percent carrying capacity indicate that all areas are underseeded (ODFW 1991).

Upper Columbia River - Wild steelhead escapements to the Wenatchee and Methow rivers have remained steady or increased in recent years while escapements in the Yakima and Wind rivers have decreased in recent years. Estimated escapement of wild steelhead above Priest Rapids Dam was 2,300 in 1986, 3,700 in 1987, 2,200 in 1988, 2,660 in 1989, and 1,380 in 1990 (ODFW 1991). The escapement goal at Priest Rapids Dam is 5,250 adults.

Coho salmon

Snake and Upper Columbia Rivers - Coho salmon historically were abundant in many of the tributaries of the Columbia River above Bonneville Dam. The longest distance coho salmon are known to have migrated in the Columbia River was 700 miles from the ocean to the Spokane River (Fulton 1970). About 300,000 to 400,000 coho salmon were landed annually in the lower Columbia River between 1866 and 1919 (Mullan 1984). Mullan (1984) suggested that between 120,000 and 166,500 coho salmon originated from the mid and upper Columbia River. However, as a result of over-fishing, dam construction, and habitat destruction, from 1933-1940 only 10 to 183 coho salmon were recorded annually passing Rock Island Dam.

In the Snake River basin, the Grande Ronde River was an important coho salmon producer. As recently as 1968 over 6,000 coho salmon were counted at Ice Harbor Dam destined primarily for the Grand Ronde River. From 1973 to 1985, after the construction of the additional Lower Snake River dams, dam counts declined from 1,300 to 8 fish. No coho salmon have been counted over Ice Harbor Dam since 1985 (ODFW 1991).

Wild coho salmon now are considered to be extinct in the Snake and upper Columbia River subbasins (CBFWA 1991). The only remaining native upriver coho salmon stock is in the Hood River, an Oregon tributary to the Bonneville reservoir. There are no current run size estimates, but between 100-300 fish were counted each year from 1963-1971 (CBFWA 1991). Current runs of early and late-stock coho salmon above Bonneville Dam are almost exclusively supported by hatchery releases. In the 1960's the success of hatchery production quickly increased the coho salmon hatchery returns. By the latter half of the 1960's coho salmon counts at Bonneville Dam ranged from 49,000 to 96,000 fish. In the 1980's the counts at Bonneville Dam ranged from a low of 15,000 coho salmon in 1983 to a high of 131,000 in 1986 (CBFWA 1991).

PROJECT EFFECTS

The draft EIS provides a comprehensive, and largely adequate, summary of potential project effects on biological resources. The EIS on the 1992 flow options provided the first opportunity to identify effects, and the experience gained in 1992 permitted this analysis to be refined. A brief summary of those impacts that we perceive to be of significance, as well as any additional impacts that we have identified, is provided here.

Because a new alternative is being proposed by the Service, effects of this new alternative should also be considered. While these effects would be significant, most were addressed in the 1992 Columbia River Salmon Flow Measures EIS, and we do not believe it would require a major new effort to address these effects.

Anadromous fish are discussed below on a system-wide basis. Other resources are evaluated on a project by project basis.

ANADROMOUS FISH

The modeling analyses conducted by the Northwest Power Planning Council for all alternatives of the EIS indicate very little recovery or rebuilding of the affected salmon stocks under the alternatives proposed in the EIS. More to the point, the analyses indicate that the proposed actions will not stop or reverse the decline, although this is the stated purpose of the alternatives proposed in the Supplemental Environmental Impact Statement. More significant benefits are attributed to the proposed alternatives by the Bonneville Power Administration (BPA) model. The discrepancy in results between the Bonneville Power Administration (BPA) modeling analyses, using CRiSP and SLCM, and the Northwest Power Planning Council, using SPM and PAM, is due to the assumptions used by the BPA models.

The increased survival of anadromous fish that is attributed to the proposed alternatives from the BPA model result from predator control, downstream migrant transportation and improved adult passage conditions. The Service is of the opinion, however, that even these relatively small, theoretical benefits may be less than projected, because the assumptions on which the modeling is based are not well supported. Our opinion is based on analyses conducted by the State and tribal fishery agencies TECH work group that indicate that flow improvements for juvenile migration are likely to provide greater benefits than the assumed benefits from predator control, transportation and adult passage improvements (TECH 1992). A brief discussion of these theoretical benefits is provided below.

Predator Control

The theoretical benefits derived from predator control are based on optimistic results from a still experimental program. Research by the Service and Oregon Department of Fish and Wildlife into predator indexing suggests that predation from northern squawfish is not a significant problem in all reservoirs, and predation rates may be lower in mid-reservoir areas than previously estimated. This same research estimates that predation losses are considerably lower in the lower Snake River reservoirs than in the lower Columbia. Smallmouth bass may also be as important a predator on wild juvenile salmon as squawfish (Tabor *et al* In press; D. Bennett, Pers. Comm.).

It is also questionable whether reservoir drawdown would result in greater effective predator densities, as is suggested in the DEIS. If predators were randomly distributed throughout the entire reservoir volume, drawdown would certainly increase predator densities. However, northern squawfish occur primarily in shallow-water (Nigro *et al* 1985; Ward *et al* 1991), so reduced reservoir volumes during drawdown may not change their density. What the response of northern squawfish or any other salmonid predator to reservoir drawdown might be is pure speculation at this time.

The mortality rate per day of travel time (2.26 percent per day) derived from the Columbia River Ecosystem Model is possibly 3-5 times too high. This is based on recent Service research and revision of the John Day mid reservoir area conducted by Service researchers. (This information was recently provided to the modelers but was not available for the analyses). In addition, several other effects of the predator removal program are not addressed. These include: 1) compensatory responses in populations of other resident predator species such as walleye, smallmouth bass and channel catfish, 2) population changes of other prey species following removal of northern squawfish, and 3) changes in the predation rates on smolts by walleye, smallmouth bass, catfish and other resident predators due to reduced competition and changes in smolt (prey) density.

Transportation

Transportation benefits are expressed in terms of a ratio of surviving transported fish/surviving control (in-river migrating) smolts. In most cases these control groups were subject to different holding and release strategies than the transport groups. These differences may have confounded the transport benefit and survival results of these studies. Transport groups were released below Bonneville Dam concomitantly with other transported fish,

whereas control groups were released without additional non-transported fish.

Control fish are usually held for several hours (about 4-7) before release. In the case of transported groups, the trip downriver in the truck or barge takes about 36 hours. The controls have a very short recovery period, while the transported fish have much longer to recover from the stress of collection. Due to these holding and recovery strategies, there may be differences in the stress levels between controls and transports (TRG 1992). Congleton *et al.* (1985) found that chinook with higher plasma cortisol levels were captured by predators at a higher rate than fish with lower levels. Matthews *et al.* (1987) measured plasma cortisol levels of fish at Lower Granite after their capture from the raceways, after marking, and after transport to Little Goose Dam and compared cortisol levels to a control groups. The data showed that plasma cortisol levels returned to pre-marking levels when fish arrived at Little Goose Dam. There were, however, considerable variations in values for individual fish. The test was conducted between April 13 and April 21. This time period is in the early migration period, which limits the applicability of the results of the test (TRG 1992).

Transport studies at Lower Granite Dam in 1986 and 1989 with spring/summer chinook are weighted to the earlier migrating hatchery fish. Therefore, transport benefit ratios at Lower Granite Dam primarily reflect the response of hatchery, and not wild, fish to transportation (TRG 1992).

The tranportation studies at McNary Dam depend on recovery of adults at several sites within the basin, rather than returns to the project, as occurred in the Lower Granite study. A 100% sampling strategy was not implemented at several of these sampling sites, as was implemented at Lower Granite Dam. Recoveries of spring chinook from the McNary Dam studies also appear to be weighted to hatchery returns.

Transport benefit ratios are based on the percentage of observed adult returns to various sample locations. These percent observed-return values are based on small numbers of observations in some cases. While the calculated transport benefit is high (1.6 or 2.5, for example), the actual returns may be very low. As a result, transport benefit ratios are a poor indicator of fish survival and do not provide the entire picture of survival (TRG 1992).

Adult Passage Improvements

Adult passage improvements are estimated to increase adult survival by 6%. These are optimistic estimates and are not supported by any evidence.

Service Alternative

The proposed Service alternative would provide the improved in-water migration conditions that we believe result in the greatest survival of juvenile migrants. The drawdown at Lower Granite to 710 would provide increased flows and more effective spill. Research conducted by NMFS (Giorgi *et al.* 1988) at Lower Granite to evaluate the effectiveness of spill for passing juvenile migrants showed the percentage of spilled juvenile salmon to be 1.5 to 2 times greater than the percentage of flow spilled, i.e (40% of the juveniles spilled at 20% spill levels, 60% of the juveniles spilled at 40% spill).

This alternative will also provide an opportunity for monitoring and evaluating biological effects, both positive and negative, of a drawdown. Ongoing research, such as the Snake River adult passage evaluation study and the smolt monitoring program, will provide monitoring of adult and juvenile passage conditions during 1993. The biological effects of gas supersaturation is an integral part of the smolt monitoring program through the mainstem Snake and Columbia rivers in 1993. This monitoring effort, along with an expansion of the gatewell dipping ability at the Lower Granite project, should allow for real time monitoring and evaluation of juvenile and adult fish passage conditions in 1993. Contingency plans will also be in place to modify drawdown operation should monitoring efforts show impacts which have not been addressed.

Some negative effects due to drawdown of Lower Granite pool to 710 MSL and associated spill operations may occur. Drawdown to 710 MSL at Lower Granite could impact adult passage by degrading conditions in the tailrace near the existing adult fish passage facilities. This impact could result from spill operations which erode tailrace and fish entrance conditions and elevate gas supersaturation levels.

Impacts to juvenile fish from the drawdown and spill operation include biological effects of gas supersaturation, a change in fish passage efficiency and possible delay in the forebay due to decreased water velocities through the turbine intakes. Loss of juvenile rearing habitat from April 1 through June 15 would occur, but may be mitigated by increased migration rates through the reservoir.

The adult fishway entrances at Lower Granite were placed where fish could locate them under spill conditions approaching 100,000 cfs, and an operating powerhouse of 30,0000 cfs. Turner *et al* (1983) found that adult fish were delayed when spill exceeded 40,000 cfs. Current research (Bjornn *et al* 1992) has shown average adult migration times of 30 hours in each of the lower Snake River reservoirs and 30 hours to pass each project. This indicates that under current river conditions and project operations, there is a significant problem of adult passage delay at the lower Snake River projects. Given the current passage problems, it is not clear whether the drawdown to 710 MSL will improve or significantly worsen adult passage at the project.

OTHER RESOURCES

Dworshak

Resident Fish - The preferred alternative (Alternative 4) in the DEIS operates Dworshak Reservoir primarily for the benefit of anadromous fish, and so may impact resident fish. Resident fish in the reservoir would derive the greatest benefits from operations which would maintain water surface elevations as constant as possible. High reservoir water volumes which would maximize water retention time and minimize entrainment of kokanee salmon, zooplankton and phytoplankton would also be beneficial. The preferred alternative will actually increase water surface elevation fluctuations by 15-20 feet beyond what occurs presently, and in average years would increase the flow rate of water through the reservoir in spring and summer. Although generalized conclusions about potential impacts from the preferred alternative can be made, the Corps document does not disclose with sufficient precision

how flows will be released in spring and summer from Dworshak. Therefore, it is very difficult to evaluate specific impacts to resident fish and wildlife resources.

In spring 1992, the reservoir water levels were high enough to inundate areas of the shoreline, where annual forbs and grasses had colonized the exposed banks of the reservoir. Resident fish may have benefited from the increased benthic and terrestrial insect production associated with the flooding of the shoreline vegetation. This, however, was a short term benefit of the change in reservoir pool operations under the 1992 flow alternative (and alternatives 2 through 5 for 1993). Currently, fishery production in Dworshak Reservoir may be decreasing; over the last two years, average size of kokanee appears to be declining independent of density. This may be attributable to zooplankton entrainment through the dam, or a general decline in reservoir productivity commonly observed in reservoirs as they age (M. Maiole, Pers. Comm., Idaho Dept. Fish and Game).

Potential impacts to smallmouth bass spawning habitat also exist. Smallmouth bass spawn in the springtime along shorelines. The faster and earlier in the year reservoir drawdown occurs, the greater the likelihood of impacts to spawning. Also, access to spawning streams by fall spawning fish, including kokanee and bull trout, may be inhibited by large drawdowns in water surface elevation. Large drawdowns may cause streams flowing into the reservoir to flow over broad, coarse alluvial deposits, leaving a braided, shallow channel with difficult access for fish.

Resident Wildlife - Dworshak Reservoir is typically drafted up to 100 feet in fall and winter and refilled in early spring and summer. Consequently, little riparian and wetland vegetation has developed along the reservoir. Because the operating range of the reservoir pool would not change with the five flow alternatives, they are expected to have little impact (positive or negative) on riparian and wetland vegetation, and shallow water habitats in the reservoir. The reservoir receives little use by waterfowl except as a resting area during migration. Dworshak Reservoir also is infrequently used by aquatic furbearers because of the wide fluctuations in pool level and corresponding lack of shoreline cover.

While the total range over which the reservoir pool is operated will not change, on average under alternatives 2 through 5, the reservoir pool will be 4-9 feet higher in the spring and an average of 10 feet lower in the summer in comparison with past operations. These changes in reservoir levels could reduce resident fish populations (see Resident Fish section) and thus negatively impact the food base for bald eagles (*Haliaeetus leucocephalus*) and ospreys (*Pandion haliaetus*). The proposed changes in pool elevations may also concentrate fish in the smaller reservoir pool, and possibly increase foraging opportunities for eagles and ospreys on a short term basis.

In many winters, ice forms on upper Dworshak Reservoir extending down to Dent Bridge. In cold winters, the entire reservoir can freeze over. When the reservoir level is lowered in the winter, the ice on the reservoir edges is weakened or forms huge, slanted blocks of ice along the steep sides of the reservoir. These areas of ice often entrap and kill white-tailed deer (*Odocoileus virginianus*) (Meuleman *et al.* 1989). Flow alternatives which change the reservoir level fluctuation patterns could alleviate or make this situation worse.

Clearwater River

Resident Fish- Discussion in the DEIS of resident fish resources in the Clearwater River below Dworshak Dam is extremely limited. Although resident fish resources are not abundant in this area compared to those in Dworshak Reservoir, resident rainbow trout (*Salmo gairdneri*), mountain whitefish (*Prosopium williamsoni*), northern squawfish, and sucker (*Catastomus* spp.) species do occur. These species may provide limited recreational opportunities for anglers, and may be important to other fish and wildlife species which use the area, including wintering bald eagles.

Any alteration of the natural hydrograph would likely affect native fish species compared to pre-impoundment conditions. However, in some respects, the selected alternative may benefit native resident fishes by providing more natural flow conditions than in recent years, with increased flows in the spring and summer.

Resident Wildlife - Average monthly flows and seasonal peak flows in the Clearwater River below the dam have been altered by the Dworshak project. The average spring peak flow has been delayed one month from May to June and the magnitude of the flow has been reduced from 51,600 cfs to 40,300 cfs (Kronemann and Lawrence 1988). The supplemental flow releases from Dworshak for salmon of 900 KAF between April 15 and June 15, and 270 KAF above a 1,200 cfs minimum discharge from June 16 to August 30, could be used to shift the flows in the Clearwater River toward the natural hydrograph for the river.

Flows released out of Dworshak for salmon thus have the potential to improve conditions for resident wildlife native to the Clearwater River drainage. Any changes in the hydrograph which more closely approximate the natural hydrograph and benefit aquatic resources on the Clearwater River should theoretically improve conditions for species dependant on the river. Species which may benefit include river otters (*Lutra canadensis*), bald eagles, nesting Canada geese (*Branta canadensis*), and migratory birds that utilize the riparian vegetation along the river (Kronemann and Lawrence 1988).

Lower Snake River Projects

Aquatic Resources - The operation at MOP would limit fish spawning in the operational zone, which would reduce the likelihood of dewatering of eggs. This is likely to have some positive effects on resident fish spawning success, which would be negated to an unknown degree by the loss of shallow water rearing habitat from operation at MOP. Some subimpoundments may also be isolated from the main river at MOP. Many of these subimpoundments are fairly large and deep and can support fish throughout the summer. However, there may be a limited number where water quality may deteriorate over the summer and result in mortality of resident and anadromous fish trapped in the subimpoundment.

Benthic community production should not be affected by operation at MOP, because current pool fluctuations limit benthic community development within the operational zone. Molluscs may be affected, although there is a general lack of knowledge about these species on which an analysis can be based. Freshwater mussels such as *Anodonta* spp. are mobile and could move into the

operational zone, where they would be affected by the MOP drawdown. Species requiring an intermediate host for larval forms could potentially be affected if the proposed alternatives altered host distribution or numbers.

Operation at 710 MSL at Lower Granite would have more severe impacts on aquatic resources. Spawning of resident fish species such as smallmouth and largemouth bass (*Micropterus salmoides*), crappie (*Pomoxis* spp.), yellow perch (*Perca flavescens*) and bluegills (*Lepomis macrochirus*) would be greatly affected, as the shallow backwaters preferred for spawning would be dewatered during a portion of the spawning season. Early spawners, such as yellow perch, would be most affected. Rearing habitat for fish would also be affected by dewatering for a period of time. However, the species that would be most affected are exotic species, and therefore of a lower priority than native species, although their recreational value is recognized. Smallmouth bass in particular are also recognized as a significant predator on juvenile salmonids, and a reduction in their numbers may be beneficial to anadromous fish.

Benthic production in the drawdown zone will be greatly reduced by operation at 710 MSL, and it is likely that the increased water velocities will limit zooplankton production. This will affect resident fish growth and production. There will also be an affect on molluscs, although the test drawdown in 1992 has probably already eliminated molluscs within the proposed drawdown zone.

Aquatic plant beds would be eliminated by the drawdown, although aquatic plants beds are not particularly widespread on Lower Granite. They were probably also already affected by last years test drawdown.

Increased flows through the reservoirs will result from Alternatives 2-5. Water retention times would be decreased to a small extent, which may reduce zooplankton production to some unknown degree, although the effect should be insignificant. The modified 1992 operations (Alternative 4) may have a slightly different effect on zooplankton production because of the differences in the timing of water releases.

Wetlands/Riparian - In general, wetland and riparian vegetation can be expected to temporarily colonize suitable substrates in exposed areas. The long term prospect for survival of colonizing perennial vegetation is unknown in the operating zone, but the 2 month drawdown to 710 will not permit its establishment below MOP. Annual plant species are likely to proliferate on silt and mud substrates, although they are not likely to mature below the eleveation of MOP. Existing riparian and wetland vegetation that is de-watered for a prolonged period of time is likely to experience some stress, and potentially some mortality. A reduction in regeneration in existing riparian vegetation may also occur.

Waterfowl - Waterfowl nesting islands may be exposed to increased predation at MOP operation. During 1992, two islands, Fishhook in Ice Harbor /ool and Swift Island in Lower Granite pool, failed to produce any Canada geese. Both islands had a long history of goose production. Swift Island was specifically affected by the test drawdown, as it was landbridged during late March when nesting is initiated. Landbridging is not necessary, however, for predators to access islands as coyotes may swim to islands if flows, water depth, and width of the channel are not excessive. The drawdown to 710 MSL

will preclude Canada geese nesting on islands on Lower Granite, although nesting may still occur on cliffs.

There will be positive and negative effects to food resources for waterfowl and other aquatic birds from the proposed alternatives. During spring/summer, the amount of shallow water and backwater habitat available for foraging waterfowl will decrease, although stable water conditions may favor the development of aquatic plant beds below MOP. Aquatic foraging areas for waterfowl will be practically eliminated during the drawdown to 710 MSL. However, pioneering annual and emergent hydrophytic plants, when they are inundated during the fall and winter, will provide a food source for waterfowl.

The distance to escape cover for Canada goose broods from foraging areas may be increased at some locations by MOP. It is expected, however, that broods would shift their feeding to shorelines where vegetation is colonizing the shoreline and is immediately adjacent to the water. With a drawdown to 710 ft. MSL, access to foraging areas for broods will be very difficult, and predation would probably be significant.

Furbearers - Exposure of beaver (*Castor canadensis*) and muskrat (*Ondatra zibethica*) lodges and river otter dens during spring and summer has been identified as an impact. As kits typically are born in April when the proposed alternatives would be implemented, this would be a significant impact, particularly at 710 ft. MSL. Another impact with operation at MOP, would be that as lodges are exposed, other lodges would be built at MOP elevation. These lodges would be reflooded when the pools are raised in late summer, which would also affect beaver populations. Food availability would be significantly affected at 710 MSL, as the distance between the water's edge and riparian vegetation would be great, and beavers and muskrats would be exposed to increased predation while traversing the drawdown zone. Molluscs and crayfish populations, which are important prey species for otters, would be also be drastically affected. One benefit of a reduced beaver population, however, is that increased development of riparian vegetation may occur.

Other Wildlife - Other species that would most likely be affected by operation at MOP or 701 MSL would be those species which rely on emergent vegetation. Species such as rails, marsh wrens (*Cistothorus palustris*) and red-winged blackbirds (*Agelaius phoeniceus*) would be unlikely to nest in emergent vegetation if it is dewatered. Breeding killdeer (*Charadrius vociferus*) and spotted sandpipers (*Actitis macularia*), as well as migrating shorebirds, would be likely to benefit, however, from the exposed shorelines and mudflats.

Grand Coulee

Aquatic Resources - Effects on fish and wildlife resources are largely limited to those affected by changes in water retention time or drawdown timing. Water retention times affect the primary productivity of the reservoir, and water retention times of 30 to 35 days have been identified as being necessary to provide an adequate forage base for resident fish. Alternatives 2-4 would tend to increase flows through the reservoir, lowering primary productivity and subsequent resident fish production.

Entrainment of fish, rainbow trout and kokanee in particular, is known to occur, and could be significant under these alternatives, particularly in good water years. Juvenile white sturgeon entrainment may also be of concern. Effects to resident fish from entrainment and lowered primary productivity would be greatest with Alternative 4, and would be greater in good water years than in poor water years. Effects would be compounded when relatively good water years in the upper Columbia require drafting of Coulee for flood control, and poor water conditions on the Snake required increased flows for anadromous fish.

Median water elevations are virtually identical for all alternatives from May-December. The shift of flood control from Dworshak to Grand Coulee in Alternative 4, however, would require deeper drafting of Lake Roosevelt in excess of the power draft from March - early April in moderate water years, and therefore would potentially have the greatest effect on fish populations. The drawdown during the winter affects kokanee spawning, which spawn at high water levels in the fall and early winter. The winter drawdown dewaters redds, with deep drafts having the most severe effects, and would entrain fish, particularly during certain moderate-water years.

Wildlife - Few impacts to wildlife would be expected, with the exception of those species that feed on fish. Of the greatest significance is the bald eagle. A number of eagle nests, as well as several hundred wintering eagles, are found on Lake Roosevelt. A reduction in fish populations may affect reproductive success and the carrying capacity of Grand Coulee for both wintering and breeding eagles.

Hanford Reach

Effects to the Hanford Reach were not discussed in the EIS. Little difference in median flows is projected out of Priest Rapids by alternatives 2-5. Alternative 1 differs in having lower flows from April 16-30 and during August 1-15.

Aquatic Resources - Flow fluctuations continue to strand fish in backwaters and side channels along the Hanford Reach. It is not uncommon in the spring to have 3-4 foot hourly drops and 10 foot daily changes in tailwater elevations at Priest Rapids. Effects are most dramatic in the tailwaters of Priest Rapids and become less severe downstream. Fish that spawn and rear in backwaters and side channels are very vulnerable to this type of fluctuation, and recruitment has been severely affected in the past.

Wildlife - The projected median flow data from Priest Rapids indicates there would be no major changes in effects to wildlife from existing conditions. However, there are continuing effects from Grand Coulee flow releases and the interactions of these flows with the mid-Columbia project operations. The most significant effects are from short-term flow surges from water releases, and the timing of the initiation of a higher flow regime at the start of May. Birds, particularly Forster's terns (*Sterna forsteri*), initiate nesting at low elevations during low flows at the end of April and start of May, and are subsequently flooded out by peak daily flows during the higher flows in May.

John Day Project

Aquatic Resources - Operation at minimum irrigation pool from May 1 through August 31 would have overall adverse impacts to aquatic resources. Compared to existing conditions, John Day would be from 1 to 2.5 feet lower during May and June and 4 to 5.5 feet lower during July and August under the preferred alternative (no.4). This lower pool level would result in considerably less wetted area and a loss of available backwater adult spawning and juvenile rearing habitat for warmwater species such as smallmouth bass, largemouth bass, crappie and bluegill. In addition, eggs laid in the shallower waters by earlier spawners, like yellow perch , would be dewatered before hatching as the reservoir drops.

Fish access to backwaters connected by culverts to the Columbia River would be completely eliminated at elevations greater than the reduced pool level. Fish and other aquatic life remaining in theses cut-off backwaters would likely die or be severely stressed during the low water summer period. The four-month dewatering of shallow areas would eliminate a portion of the aquatic invertebrate population. This would adversely impact resident fish which depend on invertebrates as a significant food source. Losses of aquatic vegetation would occur as water levels receded. This would result in a reduction in essential cover habitat for resident fish.

The shallow backwater areas contain important food organisms and other nutrients which play a role in the overall food chain of the Columbia River. Dewatering the upper portion of these areas will eliminate their contribution to the Columbia River ecosystem.

A reduction in angling opportunities and success is also expected. Some of the popular shoreline angling areas in the backwaters would be dewatered and fishermen would have to seek new areas, probably along a barren shoreline. Angling in areas such as the John Day River arm, which supports a significant smallmouth bass and channel catfish fishery, could be severely impacted. It is expected that anglers may find it difficult to use some of the popular boat ramps, especially during the July and August. Some of the ramps which may be affected include Sundale, Threemile Island, Paterson Ferry Road, and Umatilla River. Other less developed ramps in the reservoir area could also be affected. Use of the boat dock on the lower John Day River at Phillipi Park could also be impaired by the low water.

Wildlife Resources - Adverse impacts to wildlife are anticipated because the reduced reservoir level affects major wetland and riparian habitats. Some of the areas where effects to wildlife are of primary concern are McCormack Slough, Paterson Slough, Willow Creek, Glade Creek, Whitcomb Island Slough, and Crow Butte Slough.

Significantly lower pool levels during June, July, and August are of particular concern because this is the period of greatest growth and productivity for aquatic plant species such as sago pondweed, a major waterfowl food. Large productive beds of sago and other aquatics would not tolerate exposure caused by the drawdown and would likely die. Emergent beds of bulrush and cattail are less vulnerable to exposure than submergent species, but would likely undergo severe stress because of the length and timing of the drawdown. Many of these species may be lost over time.

The loss of benthic and aquatic plant communities would create significant food shortages during a critical period for waterfowl during their migration stopover each fall. In addition, spring and summer waterfowl nesting and rearing activity would be eliminated in most of the dewatered backwater area.

The riparian habitat loss resulting from the extended drawdown would adversely affect aquatic furbearers. Animals such as beaver, muskrat, mink, and river otter would be forced to seek new habitat as the water level receded. Many furbearers would not survive the shoreline change because cover would be inadequate along the new waters edge. The new shoreline would not be expected to develop adequate cover because it would re-flood in September. Wildlife losses are also expected in many of the habitats not directly connected to the Columbia River. These wetlands and ponds, like those in the Irrigon Wildlife Management Area, respond to water level changes in the Columbia River. Many of them dewater almost immediately when the reservoir drops. These areas provide important habitat to many types of wildlife including waterfowl, shorebirds, nongame birds, and furbearers. The painted turtle, listed as a sensitive species by the State of Oregon, would be significantly impacted by the loss of these ponds.

CURRENT AND PAST MONITORING

A variety of monitoring actions were implemented on the Columbia and Snake rivers in conjunction with the 1992 test drawdown of Lower Granite Reservoir and 1992 operation of John Day and the Lower Snake Projects. Some of these monitoring activities provide data that are useful for evaluating alternatives for 93 Flows, or are activities which would be useful to continue to monitor long-term effects. Other monitoring, however, was relevant only to the Lower Granite test drawdown. A brief description of pertinent monitoring activities relevant to 93 Flows is provided.

ANADROMOUS FISH

Current monitoring programs include the Annual Smolt Monitoring Program and the Gas Supersaturation Monitoring Program. These are established, ongoing monitoring programs.

LOWER SNAKE PROJECTS

Shoreline Habitat

The monitoring study of shoreline vegetation (Phillips 1992) had two facets. The shoreline planting evaluated survival of five wetland plant species planted in the operational zone (between the minimum and maximum operating pool elevations) at sites on Lower Granite and Little Goose. Plant species diversity and condition of pioneering vegetation within the operational zone and established riparian vegetation above ordinary high water were evaluated at all Lower Snake projects.

The shoreline planting evaluation demonstrated that *Carex obnupta* had the highest survival rates, largely because they were not grazed by Canada geese. Survival rates for *Deschampsia caespitosa* was intermediate while survival of

Scirpus validus, *Carex aperta* and *Eleocharis palustris* were most severely affected by water level and goose grazing.

The significance of these findings is that *Carex obnupta* may be the best species to use for planting where geese are present, if the desired result is establishment of vegetation for covering a shoreline. Where forage production for geese is desired, preferred species for geese should be planted, recognizing that little vegetational structure will develop. However, most significantly, there may be little need to replant the shoreline where pioneering vegetation is present. Even if planted vegetation becomes established, its biological functions would be insignificant in relationship to naturally regenerating vegetation.

The report fails to adequately describe the interrelationship between substrate, adjacent vegetation and vegetation invading the zone between OHWL and MOP. Personal observation indicates that there may be significant variability between sites and this may influence what areas might need revegetation. The report is also overly optimistic in attributing functions such as buffering and filtering of sediments and particulate matter from agricultural fields to this regenerating vegetation.

Soil Sampling

Data were collected on soils characteristics within the drawdown zone on Lower Granite and Little Goose and basic information gathered on pH, nutrient levels and organic content. This information has been tabulated, but the suitability of these soils for vegetation establishment has not been evaluated. The sites were not identified as to whether they were depositional sites or eroding shoreline sites.

Molluscs

The effects of the Lower Granite drawdown were independently evaluated by Frest and Johannes (1992), who provide a basic description of the mollusc fauna of Lower Granite Reservoir. Logistic and funding limitations prevented a comprehensive study, but useful data were obtained.

The Asian clam (*Corbicula fluminea*) is the most abundant species in Lower Granite, and suffered high mortality, although many of the specimens were already long dead. Two mollusc species, which are candidate species under the Endangered Species Act, the shortface lanx (*Fisherola nuttallii*) and the California floater (*Anodonta californiensis*), were found during drawdown. The California floater was found to have been significantly affected, and the shortface lanx was potentially affected to a minor extent.

This brief survey of Lower Granite highlighted the need for a more comprehensive study of the mollusc fauna within those areas which would be affected by the proposed 93 Flows. Although the mollusc fauna in Lower Granite has been greatly reduced in diversity and numbers by impoundment and possibly water quality factors, they still constitute an important food resource for fish and wildlife, and a few rare species still persist. Conditions for molluscs downstream, particularly in the Columbia River, are more favorable, and greater species diversity and numbers may be present, although few surveys have been done.

Benthic Invertebrates

A draft report on benthic sampling (Pacific Northwest Laboratory 1993) became available just prior to completion of this report, and had not yet been reviewed by the Corps. The report tentatively concluded that the drawdown did not have significant adverse impacts on benthic organisms on soft bottoms in Little Goose, but did not draw conclusions on the Lower Granite drawdown because of the lack of pre-drawdown data. The authors were cautious in attributing observed increases between March and June in *chironomids* and *oligochaetes* numbers to the drawdown, because of a lack of baseline data. Riprap and hyporheic benthos such as molluscs, crayfish, *amphipods*, *Trichoptera* and tube-dwelling *chironomids* sustained heavy losses, and the author concluded that it shouldn't take too long for populations to replenish, although there are no data to support this conclusion for molluscs and crayfish.

We concur with the author's caution in interpreting the data without adequate controls or knowledge of the population cycles of the benthic organisms, and the recommendation that adequate baseline information be obtained prior to another drawdown.

Waterfowl

The monitoring for waterfowl focused on the March time period, and specifically on Lower Granite Reservoir. Aerial surveys of wintering waterfowl and nesting surveys of Canada geese were conducted. No significant effects resulting from operating at MOP were described, although land bridging of Swift Island and goose nesting structures during the test drawdown occurred (Lonnie Mettler, USACE, Pers. Comm). Consequently, no goose nesting took place.

Helicopter surveys of cliff nesting geese was also carried out. This provided data on the number of geese nesting on cliffs with the test drawdown. A report on the cliff surveys was not prepared, but the number of nests counted is comparable to 1988, the last year cliff surveys were done (Boe 1988).

Furbearers

Furbearer monitoring was limited to the actual drawdown period at Lower Granite, and few impacts were described in the limited qualitative description (USACE 1992a). A number of beaver lodges were observed to have been exposed, but the actual effect of the exposure of these lodges on beaver was not described. Muskrat and mink (*Mustela vison*) were observed, but the impacts of the drawdown on these species were not evaluated.

Resident Fish

The report on the resident fish monitoring associated with Lower Granite drawdown is not yet available, but the data gathered during the monitoring will not be very useful for evaluation of operation at MOP because of the vast difference in the two actions. There were indications from the Lower Granite monitoring that stabilizing the pool at MOP in 1991 provided benefits to resident fish, but these observations were made incidentally to Bennett's studies related to Lower Granite dredging.

Intensive monitoring of stranding was carried out during the Lower Granite drawdown by Washington Department of Wildlife (WDW) (1992) and NMFS (USACE 1992). This survey provided a fairly thorough evaluation of the stranding occurring during a deep drawdown in Lower Granite. However, it did not provide the detail necessary to evaluate whether stranding or isolation of backwaters/subimpoundments occurs with a reduction of the reservoirs to MOP on the Lower Snake River Projects or 263.2 ft. MSL in the case of John Day.

JOHN DAY

Monitoring during the 1992 drawdown period consisted of evaluating the relationship between the Irrigon and Umatilla Hatcheries water supply and the reservoir level. As the reservoir drops, the available well water for the hatcheries also decreases. This correlation is being closely studied.

RECOMMENDED MONITORING

Many questions have been raised concerning impacts of the proposed operation, both positive and negative, to fish and wildlife. An adequate monitoring program is needed to evaluate the effects that may occur and provide the data needed to mitigate effects. All monitoring efforts should be coordinated with the Service and the appropriate state fish and agencies and tribes.

ANADROMOUS FISH

Monitoring programs and contingency plans to quantify and address concerns about adult and juvenile fish passage, migration timing, gas supersaturation and gatewell dipping are needed. Details on these programs would have to be developed based on the alternative selected. Monitoring of Lower Granite at 710 ft. MSL would be particulary valuable in providing biological information during drawdown conditions.

DWORSHAK

Resident Fish

Populations of kokanee salmon, smallmouth bass and bull trout should be monitored to evaluate potential impacts from implementation of the selected alternative. Entrainment of kokanee through the dam should be monitored as well to determine effects of reservoir volume and drawdown rate on these populations. Also, entrainment of zooplankton and/or zooplankton production in the reservoir should be monitored to identify potential impacts to resident fish forage in the reservoir. Spawning streams for fall spawning kokanee salmon and bull trout should be monitored to ensure that passage of adults into spawning streams is not inhibited. Spawning success of smallmouth bass should be monitored to evaluate potential impacts from reservoir water surface elevation fluctuations in late spring and early summer.

Resident Wildlife

In conjunction with monitoring of the impacts of the flow alternatives on resident fish, the effect of the change in the fish populations on osprey and

bald eagles should be monitored. Changes in the operation of the reservoir could negatively impact these fish-eating raptors by reducing the size of their prey populations. Alternatively, the lowering of the reservoir could result in fish being more available to osprey and eagles if they are concentrated in the smaller reservoir pool.

Entrapment of white-tailed deer by reservoir ice should be monitored. This is another situation where impacts of reservoir drafting could be lessened or increased depending on how the reservoir operations are changed under alternatives 2 through 5.

CLEARWATER RIVER

Resident Fish

Monitoring of rainbow trout and mountain whitefish abundance may be appropriate, since these are two resident fish species which could be affected by the preferred alternative, and they may be used by anglers and by other fish and wildlife species including bald eagles.

Resident Wildlife

Nesting success of Canada geese on islands, river otter use of the Clearwater River, and trends in riparian vegetation establishment and survival should be monitored. The Nez Perce Tribe is currently studying river otter use of the river. This study could be continued or expanded to examine the impacts of the flow alternatives with little additional cost (see also Lower Snake River Project). The flows are likely to benefit resident wildlife and their habitats if they are provided so that the river flow more closely resembles the natural hydrograph of the river prior to the construction of Dworshak Dam.

LOWER SNAKE RIVER PROJECTS

Vegetation

1992 provided a wealth of information on plant invasion of the operational zone. A long term monitoring effort on permanent plots in the operational and existing riparian zone is needed to follow up on these initial studies. Monitoring should:

1. Characterize successional changes and describe, at least in a qualitative sense, the factors that affect vegetation successional patterns.

2. Determine survival rates and growth of individuals of woody species in the operational zone, with the objective of determining the possibility of developing permanent woody riparian vegetation.

3. Monitor tree and shrub growth and long-term survival in the riparian zone. The 1992 monitoring report stated that riparian vegetation above OHWL was not stressed by operation at MOP. This does not, however, recognize that there may have been reduced growth, may be delayed mortality or that the pools occasionally fluctuated up to OHWL in 1992,

which would have rewatered the riparian zone. These fluctuations were not consistent with the planned operation of the reservoirs for juvenile salmon, although they were undoubtedly beneficial to riparian vegetation.

4. Monitor noxious weed growth and dispersal in the operational zone.

Molluscs

The paucity of synthesized data on mollusc populations for the Columbia and Snake River reservoirs limits the possibilities of effectively evaluating impacts of different operational scenarios on mollusc communities, particularly rare species. Systematic sampling of nearshore areas in the Lower Snake River projects is needed, and the mollusc community should be described in terms of species occurrence and densities relative to water depth and velocity, and substrates. This information would be valuable for the System Operation Review and the System Configuration Study also.

Waterfowl

Monitoring of nesting attempts and nesting success of Canada geese should continue on islands that may dewatered at 710 ft. MSL or be otherwise vulnerable to predators under the MOP operation. The change in operations might result in accelerated sediment deposition, which will reduce water depths between islands and the mainland.

A potential benefit which may be derived from operation at MOP is the growth of moist soil plants such as smartweed, which are utilized by waterfowl. These plants would become available to waterfowl when the pool is raised in late summer. Whether this food source is used by waterfowl could have management implications for future operations. We therefore recommend that areas with significant moist soil annuals be mapped (great detail is not necessary) and their use by waterfowl monitored.

Furbearers

The Nez Perce tribe is conducting a telemetry study on otters on the Clearwater River. Extension of this study into the Snake River would provide useful information on otter habitat use, particularly denning habitat. This would permit a better analysis of the effect of alternatives on otters.

Beaver lodges established at MOP operational levels should be located and their occupancy status evaluated after the pool is raised in late summer.

Resident Fish

If possible, Bennett's studies in Lower Granite should be designed to incorporate sampling which would permit an evaluation of the effects of MOP or 710 ft. MSL operation on resident fish. Expansion of the study to a pool not affected by the test drawdown would provide more valid information.

A late summer survey of subimpoundments should be conducted to identify any having water quality problems affecting fisheries.

GRAND COULEE

Bald Eagles

The numbers of nesting and wintering bald eagles on Lake Roosevelt are significant. These numbers have built up based on a food resource that has developed under past operations. The 1992 and 1993 operations, however, propose continuing shifts of flood control to Grand Coulee, with a resulting potential decline in fish populations from entrainment and reduced productivity. How this may affect bald eagles is largely unknown, as data on bald eagle food habits on Lake Roosevelt are not available. Baseline data on bald eagle food habits should therefore be gathered.

Resident Fish

Impacts to Grand Coulee fish populations are a major issue. The Service supports proposals which require flood control shifts to Grand Coulee and the increased drafting to provide adequate flows for anadromous fish. However, we also recognize the significance of the resident fish population, and are of the opinion that a hydroacoustical study to evaluate resident fish entrainment is needed. This would permit an evaluation of the factors related to entrainment, such as the seasonal timing of entrainment and flow levels, patterns and duration at which entrainment occurs. This would assist in developing operation criteria which would reduce entrainment.

Benthics

Very little is known about benthic organisms in Grand Coulee and the effect of drafting on their populations. Monitoring of benthic invertebrates prior to drafting, after drafting and after refill is needed.

HANFORD REACH

The exact relationship between flows out of Grand Coulee and Priest Rapids and impacts to wildlife using islands on Hanford Reach islands has not been adequately described. Actual monitoring of islands, or modeling of flows to predict elevations at islands across a range of flows is needed at key nesting islands.

JOHN DAY

The correlation between reservoir level changes and fish and wildlife habitat impacts requires detailed monitoring to develop an accurate quantified assessment. A brief description of monitoring needs for the John Day Reservoir follows.

Backwater Habitats

This would include monitoring the relationship between the reservoir level, water levels in the backwaters, and impacts on aquatic and riparian vegetation in these backwaters. Changes in wildlife use of the backwaters should also be

monitored. This would include changes during the drawdown period, as well as any possible changes that occur during fall and winter months because of reduced food supply and/or vegetative cover.

Wetlands not directly connected to Columbia River

This includes ponds and wetlands like those in the Irrigon Wildlife Management Area. Monitoring needs are basically the same as in item No.1 above. Impacts to the painted turtle should also be evaluated

Riparian habitat

The response of riparian vegetation along the Columbia River to the extended drawdown period should be evaluated. Monitoring of effects should concentrate on the riparian vegetation primarily in the upper reservoir above the Whitcomb Island-Boardman area. Vegetation on islands, such as Longwalk Island, should also be evaluated for drawdown impacts. Wildlife use of these shoreline areas should be noted.

Resident Fish

Fish in backwater or culverted areas which would be exposed during extended drawdown conditions may become stranded and subject to stress or mortality. Areas that can be identified where this is likely to occur should also be monitored.

Spawning locations and timing for warmwater species should be identified. As the reservoir level drops, these areas would be monitored to determine drawdown impacts.

Hatcheries Water Supply

Monitoring of the relationship of the reservoir level to the available water supply at the Umatilla and Irrigon Hatcheries should continue.

Molluscs

Available data on mollusc populations in John Day Reservoir is extremely limited. Two mollusc species, which are listed as candidates under the Endangered Species Act, are found in the reservoir. These are the shortface lanx (*Fisherola nuttallii*) and the California floater (*Anodonta californiensis*). Nearshore areas in the reservoir should be sampled to determine mollusc habitat location and potential impacts from drawdown.

MITIGATION

JOHN DAY

Fish and wildlife losses are expected in backwaters, wetlands, riparian zones, and possibly island habitats during the drawdown period. Efforts to prevent these losses should be incorporated into project plans. Diking and pumping water into the upper portions of sloughs such as Paterson, McCormack, Willow Creek should be studied as one means of reducing losses. Water used from the Columbia River would not be considered a new water withdrawal as these

backwaters are normally flooded with Columbia River water. Plans should also be developed to irrigate key riparian and wetland areas which would be dewatered by the drawdown.

Replacement of water supply losses at the Irrigon and Umatilla Hatcheries would likely be necessary. Efforts should be directed toward determining the extent of the loss and the best means of providing water to compensate that loss.

Some of the project-caused riparian wildlife habitat losses may be offset by improving conditions on existing islands. Important island habitat, which was once plentiful in this part of the Columbia River, is now very limited. If properly designed, island restoration could provide both riparian and island habitat benefits for wildlife. Further investigation should be conducted to identify specific island areas for this potential as well as shoreline areas where riparian habitat could be improved.

CLEARWATER RIVER

Resident Fish

A justification and re-evaluation of flood control rule curves for both local flood control and system flood control should be completed to ensure that present flood control efforts which cause large pool elevation fluctuations are appropriate, and are not impacting fish and wildlife resources unnecessarily. The preferred alternative will actually approximate the natural hydrograph more than past operations, but will do so with an increase in pool elevation fluctuations behind Dworshak Dam. Similar flows may be achievable with less drastic water surface elevation fluctuations, which would likely cause fewer impacts to resident fishes in Dworshak Reservoir.

A discussion of the trade-offs between impacts to resources associated with large water surface elevation fluctuations in Dworshak Reservoir and impacts associated with providing less stringent flood control at Dworshak should be considered. In general, as more flood control is provided, more floodplain development will take place in areas downstream from the flood control facility, which means that costs of impacts associated with a given level of flooding will likely increase over time. These flood control costs should be quantified now for comparison to costs incurred by fish and wildlife resources, and this information should be disclosed in the EIS. Then, efforts should be made to allow close to natural levels of spring flooding to occur with a minimum fluctuation of water surface elevation in the Dworshak impoundment. We understand the present proposal in the DEIS is to transfer system flood control to Grand Coulee Dam. This proposed solution does not provide more room for compromise in managing flows for fish and wildlife resources, hydropower, and flood control in the Columbia Basin, but simply transfers the problem from one place to another.

Resident Wildlife

As discussed previously, the supplemental flows released out of Dworshak Reservoir for salmon have a great potential to shift the hydrograph of the river below Dworshak Dam back more closely to the natural flows in the river prior to the construction of the dam. These flows could then be used to

mitigate impacts elsewhere on reservoirs in the Snake and Columbia Rivers resulting from the flow alternatives. Some of the benefits of shifting flows in the Clearwater to higher and earlier spring flows more typical of the natural hydrograph include higher island isolation from predators for nesting Canada Geese, and providing annual variations in river flows to help maintain high quality riparian vegetation on the river for use by migratory birds and river otters. To mitigate the impacts of the flow alternatives, the releases from Dworshak should be designed to resemble as much as possible the natural hydrograph of the river while maintaining as stable reservoir elevations as possible.

THREATENED AND ENDANGERED SPECIES

A Biological Assessment (BA) evaluating effects to threatened and endangered species was prepared by the Corps and included in the Draft EIS. The Service's response to the BA was provided in the Department of the Interior's comments, dated December 21, 1992, on the draft EIS (FWS Ref. # 1-3-93-I-098). Based on the information provided, we did not concur with the assessment for effect to bald eagles on Lake Roosevelt. We requested a evaluation of bald eagle food habits and effects to the prey base resulting from the proposed alternatives. This has not yet been received. We concurred with the remainder of the determination.

RECOMMENDATIONS

The various modeling results indicate that the Corps' preferred alternative will only result in a small improvement in survival of juvenile outmigrants. Even these benefits are based on the questionable assumptions of improvements resulting from transportation, predation control and adult passage conditions. The Service therefore recommends the implementation of the alternative proposal previously described and recommends its evaluation in the Supplemental Environmental Impact Statement. This alternative will provide significantly better flow conditions, and will eliminate transportation during that period of outmigration when in-river conditions are more favorable. Our position is that the most favorable downstream migration conditions possible should be provided, and that downstream migrants be kept in the river during the early portion of the juvenile outmigration. The flow target is the 1990 Columbia Basin Fish and Wildlife flow recommendation. Our rationale for our recommendation is as follows:

In-water Migration of Fish

The recent analysis of transportation of juvenile salmonids raises considerable doubts as to the effectiveness of the program. The fish are exposed to considerable stress, and chinook stocks have continued to decline despite transportation. In light of the recent analysis of predation, which indicates that predation is probably not as high as previously thought, it is preferable to keep downstream migrants in the river as long as favorable in-river conditions and FPE can be provided. During the latter part of the outmigration, it may be more difficult to maintain adequate migration conditions, and the benefits from transportation may outweigh its negative effects for some species.

Flow Augmentation/Lower Granite Drawdown

We believe that additional water from the Upper Snake River, Dworshak and Upper Columbia River should be made available for flow augmentation. Additional water from the Upper Snake River is particularly important. The Corps has only proposed one alternative which provides water from the upper Snake River. The option commits 190 KAF from unspecified storage projects. This commitment, while not guaranteed, represents only 1 percent of the more than 18 MAF diverted in the upper Snake River (Brendecke and Mann 1991). Tolisano and McDowell (1989) found more than 700 KAF of uncontracted water in five middle and upper Snake basin reservoirs as of 1986. We propose that more water should be made available for flow augmentation purposes.

Drawdown of Lower Granite to 710 ft. MSL will enhance flow conditions on that reach of the river with minimal negative effects to anadromous fish. It would also provide an opportunity for the evaluation of biological effects of a drawdown. There would be negative effects to other biological resources, but we believe that these are outweighed by the benefits to anadromous fish.

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Appendix J
Salmon Biological Assessment

BIOLOGICAL ASSESSMENT

1993 OPERATION OF THE FEDERAL COLUMBIA RIVER POWER SYSTEM

Submitted to the National Marine Fisheries Service
by
Bonneville Power Administration
Bureau of Reclamation
US Army Corps of Engineers

February 1993

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1.0 Introduction

This document addresses potential impacts of the proposed 1993 coordinated Columbia River hydropower system operation on the continued existence of the following listed species: Snake River sockeye salmon (*Oncorhynchus nerka*) and spring, summer, and fall chinook salmon (*Oncorhynchus tshawytscha*).

This biological assessment (BA) represents a coordinated effort by the Bonneville Power Administration (BPA), the Army Corps of Engineers (Corps), and the Bureau of Reclamation (BoR) as the operating agencies responsible for the operation of the federal hydroelectric projects and the transmission system in the Pacific Northwest and coordination under the U.S.-Canadian Treaty and the Pacific Northwest Coordinating Agreement. This BA builds on the 1992 BAs to evaluate interim flow improvement measures in 1993. The two BAs prepared in 1992 are: the Biological Assessment 1992 Operation of the Federal Columbia River Power System (BPA, January 1992) and Salmon Biological Assessment (Corps, BoR, BPA, January 1992).

The flow improvement measures considered in this BA involve some combination of measures similar to those selected in the 1992 BAs and implemented for 1992 through consultation with National Marine Fisheries Service (NMFS).

Specifically, this BA presents four lowered pool operation/augmentation combinations, in addition to the no action alternative. The alternatives are addressed in detail in the 1993 Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon Supplemental Environmental Impact Statement (SEIS) (Corps, BoR, BPA, February 1993). The alternatives are:

1. Without-project conditions, or the no action alternative, which would involve continued operation under the water management rules in place from about 1985 through 1990.

2. The 1992 operation alternative, excluding the March drawdown test of Lower Granite and Little Goose.

3. The 1992 operation alternatives (without the March test drawdown) modeled to display potential impacts to Libby and Hungry Horse.

4. The 1992 operational alternatives (without the March test drawdown), plus adjustments to salmon flows from Dworshak.

5. The 1992 operational alternatives (without the March test drawdown), plus adjustments to salmon flows from Dworshak, and modeled to show no water from the upper Snake.

The preferred alternative is Alternative 4.

A number of nonflow measures are also included in this Assessment. They are part of the proposed action.

1.0.1 Project Action Area

The "action area" covered by the 1993 BA must include "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." (50 CFR. & 402.02). The listed species migrate from the Snake River through the Columbia River and into the Pacific Ocean. From the ocean, they return to spawning grounds in Snake and Columbia River tributaries. The action area thus encompasses the Columbia River Basin, extending from the Snake River Basin to the Pacific Ocean.

The immediate area of this Assessment is the Columbia River Basin: from the estuary at the mouth of the Columbia River (at the Pacific Ocean) up to and including Dworshak Reservoir (on the North Fork of the Clearwater River in Idaho), and upstream to Libby Dam in Montana.

The Hells Canyon Complex projects also influence the hydrology and ecology of the Lower Snake River. These projects are owned and operated by Idaho Power Company (IPC); operation may be substantially independent of Federal and Canadian project operations. This assessment considers the influence of the Hells Canyon Complex projects upon Federal river operations and their resulting impacts on listed species.

The principal subjects of this Assessment are the Federal projects whose operation affects Snake River sockeye salmon, spring/summer chinook salmon and fall chinook salmon. This includes storage projects in the upper Columbia River Basin and the eight run-of-river projects in the lower Snake and Columbia Rivers.

The storage projects of interest are:

- Dworshak and Libby, operated by the Corps;
- Grand Coulee and Hungry Horse, operated by the BoR; and
- Arrow and Mica in Canada, operated by B.C. Hydro.

All run-of-river projects are operated by the Corps. These are:

- Lower Granite
- Little Goose
- Lower Monumental
- Ice Harbor
- McNary
- John Day
- The Dalles
- Bonneville.

Detailed information about these projects is available in the 1993 SEIS (Corps, BoR, BPA, February 1993), and The Columbia River System: The Inside Story (BPA, Corps and BoR, 1991).

1.1 Operations

1.1.1 Summary of 1992 Operations

BPA, the Corps, and the BoR coordinate operation of 14 large scale Federal hydroelectric projects in the Columbia River basin, other Federal projects, and water released from Canadian projects. The Corps operates twelve projects, and the BoR operates two. Within operating requirements developed by the Corps and BoR, BPA schedules and dispatches power produced by these projects through the Federal transmission system. For a general description of the coordinated system, see the contents of the 1993 SEIS (Corps, BPA, BoR, February 1993) and The Columbia River: The Inside Story (BoR, Corps, BPA September 1991).

1.1.2 Flow Augmentation Measures

The following table summarizes actual 1992 water releases for spring and summer migrants and adult passage coordinated by the operating agencies. Available water was released within flood control and other operating requirements based on real-time monitoring.

Table 1.1-1. COMPARISON OF PROPOSED 1992 BIOLOGICAL OPINION (B.O.), 1992 ACTUAL, AND 1993 PROPOSED FLOW AUGMENTATION MEASURES[1]

Proposed 1992 Operations	1992 Actual Operations	1993 Proposed Operations
May 1-June 30: **Spring/Summer Juvenile Migrants** 3.45 MAF of Water Budget released from Upper Columbia.	May 1-June 30: Released 3.45 MAF of Water Budget from upper Columbia.	May 1-June 30: Same as 1992 operations.

[1] BRN = Brownlee
CDN = Canadian projects
DWR = Dworshak
JDA = John Day
GCL = Grand Coulee
LSN = Lower Snake projects
PRD = Priest Rapids

May 1-June 30: **Spring/Summer Migrants** Release up to 3.0 MAF additional storage from upper Columbia based on runoff volume forecast.	May 1-June 30: Released 2.75 MAF additional water from GCL and CDN. July 13-23: Released 0.25 MAF of additional water from GCL and CDN.	May 1-June 30: Release up to 3.0 MAF of additional storage from upper Columbia based on runoff volume forecast.
April 15-April 30: Release flood control volume from DWR shifted to GCL.	No flood control volume required at DWR. No shift from DWR to GCL in 1992.	April 15-April 30: Release flood control volume from DWR shifted to GCL.
No proposed flood control shift from BRN.	No flood control volume available to shift from BRN to GCL in 1992.	April 15-April 30: Release flood control volume from BRN shifted to GCL.

Proposed 1992 Operations	1992 Actual Operations	1993 Proposed Operations
April 15-June 15: **Spring/Summer Migrants** Release up to 1142 kaf based on runoff volume forecast: 900 kaf Water Budget plus min. outflow of 2 kcfs from DWR.	April 15-June 15: Implemented proposed operations.	April 15-June 15: Release up to 1148 kaf based on runoff volume forecast: 1000 kaf Water Budget plus min. outflow of 1.2 kcfs from DWR.
April 15-May 30: **Spring Migrants** Release up to 110 kaf Water Budget from BRN.	May 1-7: Implemented proposed operations.	April 15-May 30: Release up to 110 kaf Water Budget from BRN.
April 15-June 15: **Spring Migrants** Release up to 190 kaf from upper Snake River.	No water available.	April 15-June 15: Release up to 190 kaf from upper Snake River.
June 16-August 31: **Summer/Fall Migrants** Release 400 kaf from DWR/upper Snake River above min. outflow of 1.2 kcfs from DWR.	July 4-12 & 14-19: Released 267.2 kaf from DWR. July 2-11: Released 139.2 kaf from BRN/upper Snake River.	June 16-Sept 30: Release up to 470 kaf from DWR above 1.2 kcfs min. outflow. July 1-31: Release 137 kaf from BRN/upper Snake River.
September 1-30: **Temperature Benefits for Adults** Release 200 kaf from DWR for temperature control study.	September 7-17: Released 200 kaf of storage from DWR for adult flow augmentation.	June 16-Sept. 30 Release 470 kaf from DWR above 1.2 kcfs min. outflow.

Proposed B.O. Operations	1992 Actual Operations	1993 Proposed Operations
Fall Adults No proposed release from BRN.	No water released from BRN.	September 1-30: Release up to 100 kaf from BRN. September 1-30: Release up to 100 kaf from upper Snake.
April 1-July 31: **Spring/Summer/ Fall Migrants** Operate the four LSN projects within 1 ft. of MOP.	April 1-October 31: Implemented proposed operations.	April 1-July 31: Same as 1992 operations.
May 1-August 31: **Spring/Summer/ Fall Migrants** Operate JDA at min. irrigation pool.	May 1-August 31: Implemented proposed operations.	May 1-August 31: Same as 1992 operations.

The following is a detailed narrative explaining the water releases displayed in the preceding chart.

1992 FLOW AUGMENTATION

Grand Coulee and Canadian Projects

During the May 1-June 30 period, the operating agencies provided 3.45 MAF Water Budget.

During the May 1-June 30 period, the operating agencies released an additional 2.75 MAF from Grand Coulee and Canadian projects. Water was accumulated in Lake Roosevelt (above Grand Coulee Dam), which is operated by BoR, and in Arrow Reservoir, which is operated by the British Columbia Hydro and Power Authority. The remaining 0.25 MAF was released during the period of July 13-23.

No flood control volume was available to shift from Dworshak or Brownlee to Grand Coulee.

Lower Snake River

Between April 1 and October 31, the four lower Snake River reservoirs (Lower Granite, Little Goose, Lower Monumental and Ice Harbor) were operated within one foot of minimum operating pool.

Lower Columbia River

Bonneville, The Dalles, and McNary Reservoirs were operated in the normal operating range. John Day Reservoir was operated between 262.8 and 264 during May. Between June 1 and August 31, John Day Reservoir was operated near elevation 264 to 265 to retain irrigators' pumping capability.

Dworshak Reservoir

From April 21 to June 9, 1142 kaf was released from Dworshak which included 900 kaf of water budget and a minimum discharge of 2 kcfs (242 kaf).

From July 4-12 and July 14-19, up to 267.2 kaf was released from Dworshak in addition to minimum outflow of 1.2 kcfs for a summer flow augmentation.

Between September 7 and September 17, 200 kaf was released from Dworshak in addition to minimum outflow of 1.2 kcfs provided for adult migration.

Brownlee and Upper Snake River Basin

From May 1-7, Brownlee Reservoir released 110 kaf. Storage water was not available from the BoR projects and upper Snake River water banks.

Between July 2-11, Brownlee Reservoir was drafted 139.2 kaf for summer flow augmentation. BPA, BoR, and IPC arranged for 90 kaf of Snake River basin uncontracted storage to refill this draft after October 1992.

SUMMARY OF PROPOSED ACTIONS FOR 1993

1993 Flow Augmentation Measures

A more complete discussion of proposed 1993 flow measures can be found in the 1993 SEIS (Corps, BoR, BPA, February 1993). During the periods of the year other than those described below, the projects will be operated in a manner consistent with providing the flow augmentation.

Grand Coulee and Libby and/or Canadian Projects

During the May 1 - June 30 period, the operating agencies will release 3.45 MAF Water Budget for Columbia River flow augmentation.

During the May 1 - June 30 period, the operating agencies will release up to 3.0 MAF of additional flow augmentation from Grand Coulee, Libby and/or Canadian projects if the adjusted April final forecast of the January - July runoff volume at The Dalles Dam is 90 MAF or less. If the adjusted forecast runoff at The Dalles Dam is 90 MAF or more, only the existing Water Budget volume of 3.45 MAF will be used for flow augmentation from May 1 to June 30. Between April 15 to April 30, the operating agencies will arrange to shift flood control volumes, if available, from Dworshak and Brownlee to Grand Coulee.

Lower Snake River

Between April 1 and July 31, the four lower Snake River reservoirs (Lower Granite, Little Goose, Lower Monumental and Ice Harbor) will be operated within one foot of minimum operating pool.

Lower Columbia River

Bonneville, The Dalles, and McNary Reservoirs will operate in the normal operating range. John Day Reservoir will be drafted to near 262.5 ft. starting May 1 and ending August 31, 1993, except when a higher reservoir level is needed to retain irrigators' pumping capability.

Dworshak Reservoir

When the official April forecast for the April-July volume runoff at Lower Granite Dam is 16 MAF or less, Dworshak Reservoir will provide, in addition to minimum release requirements of 1.2 kcfs, 1000 kaf of water to augment Snake River flows between April 15 and June 15 for a total release of 1148 kaf. If the runoff forecasts is greater than 16 MAF, Dworshak Reservoir will provide 900 kaf subject to the following conditions: (a) to the extent that natural flows at Lower Granite Dam exceed 100 kcfs, the volume of water from Dworshak Reservoir will be reduced, and (b) additional water from Dworshak Reservoir (above 900 kaf) will be released such that the confidence of refill equals 70 percent.

The operating agencies will arrange for the release of up to 470 kaf from Dworshak, above minimum outflow of 1.2 kcfs, from June 16 to September 30. This will allow the flexibility to use the water most effectively based on actual conditions. One potential use may be to provide temperature control for adults. However this water is used, it is important to base the specific timing of the release on real-time data, such as timing predictions from the USFWS life history research, in-season discussions with NMFS, and run timing. Dworshak system flood control requirements will be shifted to Grand Coulee if the April forecast predicts runoff to Dworshak of 3.0 MAF or less.

Brownlee and Upper Snake River Basin

For the April 15 - May 30 period, up to 110 kaf Water Budget from Brownlee Reservoir will be released. For the April 15 - June 15 period, the BoR and BPA will arrange to release up to 190 kaf from BoR projects and upper Snake River water banks that can be made available for water rental. This release is dependent upon availability of water surplus to irrigation demands. System flood control requirements for Brownlee, if available, will be transferred to Grand Coulee.

BoR, BPA and IPC will arrange for the release of up to 137 kaf of storage from Brownlee Reservoir in July. This release is dependent upon the replacement from uncontracted storage within BoR projects and surplus irrigation water made available for flow augmentation from Idaho water banks.

Between September 1 - 30, BPA and BoR will arrange for the release of up to 100 kaf from the upper Snake for temperature control. This release may be dependent upon availability of surplus irrigation water in the upper Snake River basin. For the September 1 - 30 period, up to 100 kaf from Brownlee Reservoir will be released by IPC for temperature control.

The action proposed by the action agencies includes many measures benefiting juveniles. However, improvements now to conditions for juveniles will not result in increased adult populations until approximately four years later, when the matured juveniles return to spawn.

Nonflow Measures

The action agencies propose to implement various non-flow measures that provide benefits to the listed species. These include measures such as:

- Screens, bypass improvements,
- law enforcement,
- transportation,
- upstream passage improvements,
- predator control, and
- lease-back.

For more information regarding these measures, and all other measures included in this assessment, see Appendix A of this document, the SEIS, the Draft 1993 Fish Passage Plan (FPP), and the Corps' Project Improvements for Endangered Species (PIES) Program.

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1.2 1992 CURRENT STATUS OF LISTED SPECIES

1.2.1 Snake River Sockeye Salmon

Species and Habitat

The historical run size of sockeye salmon (*O. nerka*) from the Snake River was estimated to be 150,000 fish (Northwest Power Planning Council 1986). Most of the original rearing habitat for Snake River sockeye salmon has been blocked by irrigation and hydroelectric dams, such as on the Payette and Wallowa rivers. Potential production under existing conditions is greatly reduced.

Today, the only natural spawning and rearing of Snake River sockeye salmon occurs in Redfish Lake, located in the Stanley Basin, Idaho. Potential production of Redfish Lake has been estimated at 1,500 spawning adults (Chapman et al. 1990). If access were provided, four additional lakes in the upper Salmon River Basin could support and expand this sockeye salmon population. The Columbia Basin Fish and Wildlife Authority (CBFWA) estimates escapement potential for this region to be 6,000 per year (CBFWA 1991). This estimate does not include the possible reintroduction of sockeye salmon into the Payette and Wallowa ecosystems.

A total of 4,361 sockeye salmon returned to Redfish Lake in 1955, but this number has been less than 500 fish since 1958, and less than 100 since 1981 (Bjornn et al. 1968, Chapman et al. 1990). Based on counts past Ice Harbor Dam, escapement averaged less than 20 fish from 1985 to 1988. Only two fish returned to Redfish Lake in 1989; none were observed in 1990. In 1991, however, eight sockeye salmon passed Lower Granite Dam and four were captured as they returned to Redfish Lake. In 1992, 15 sockeye salmon passed Lower Granite Dam, and one male was captured at Redfish Lake on September 25, 1992.

Adult sockeye salmon begin entering the Columbia River in April and continue to pass the dams until as late as October. After three winters in the ocean, most adults migrate upstream from June to early August. These fish typically arrive at Redfish Lake from mid-July through August to spawn in beach gravel during October (Bjornn et al. 1968). Juveniles rear in the lake (1+ to 2+ years) before migrating seaward in spring. In recent years, most juveniles passed Lower Granite Dam by mid-June (Chapman et al. 1990).

Because Snake River sockeye salmon are not known to rear in mainstem Snake or Lower Columbia River reservoirs, the presence of this stock in the project area is limited to periods of upriver adult migrations (summer) and downstream smolt migration (primarily spring).

Because of the Snake River sockeye salmon decline, it was deemed appropriate to take extraordinary measures to ensure survival of this species. This led to the creation of a captive broodstock program in 1991. The four sockeye salmon that returned to Redfish Lake in 1991 were artificially spawned; eggs were distributed to two different hatcheries to reduce the risk of accidental loss. Approximately 1,850 juveniles hatched. In addition, about 750 outmigrants were captured leaving Redfish Lake in the spring of 1991. These fish are being reared in a hatchery. When mature, they will be spawned artificially. Offspring will be reared in a hatchery during their early life history, then transferred to net pens in one or more of the Stanley Basin nursery lakes in spring or fall for release in the fall of the same year. The offspring are expected to overwinter in the lake(s) and migrate to the ocean the following spring.

Trapping of adult sockeye salmon returning to Redfish Lake continued in 1992. On September 25, 1992, one adult male was captured at the Redfish Lake Creek weir. A total of 63 ml of milt was cryopreserved for use in the future.

Trapping of some of the juvenile *O. nerka* outmigrants from Redfish Lake also continued in the spring of 1992, when 79 outmigrating smolts were trapped for the captive broodstock program. Based on a trapping efficiency of 13%, estimated total run size was 1,234 outmigrants (IDFG unpublished data). The captured outmigrants are also being reared at a hatchery.

The current plan is to begin releasing juveniles into net pens in Redfish Lake or other nursery lakes in spring or fall 1994. The first adult returns from the captive broodstock program are expected in 1997. There is no plan to make the captive broodstock program permanent. Capture of adults for the adult broodstock program will continue for one or possibly two generations (latter recommended by Bevan et al., 1992). Trapping of adults and smolts for monitoring and evaluation is expected to continue for a much longer period.

The captive outmigrants may be offspring of one or more of the three forms of Redfish Lake *O. nerka*, residual sockeye salmon, kokanee or anadromous sockeye salmon. At present, there is no non-lethal method for distinguishing kokanee outmigrants from anadromous and residual sockeye salmon outmigrants. BPA is funding research to develop a non-lethal genetic test to differentiate among the three forms; the test will help ensure that sockeye salmon are spawned with other sockeye salmon rather than with kokanee.

Although the rehabilitation emphasis for Snake River sockeye salmon is on the captive broodstock program, some smolts may outmigrate from Redfish Lake to the ocean and possibly return as adults. However, it is expected that any outmigrants in the system this year would be progeny of residual sockeye. These sockeye would likely benefit from the 1993 operations proposed for migrating spring/summer chinook.

1.2.2 Snake River Spring/Summer Chinook Salmon

Current Status of Species and Habitat

Historical runs of Columbia River spring and summer chinook salmon (*O. tshawytscha*) are estimated at 2.5 to 3.0 million adults for the years 1881 to 1895 (Chapman 1986). Of these, CBFWA (1991) estimates 39% and 45% were Snake River spring and summer chinook salmon, respectively. Based on the estimates of Chapman (1986), CBFWA (1991), and Fulton (1968), NMFS estimated the total Snake River production was probably in excess of 1.5 million spring chinook salmon at times during the late 1800s (Matthews and Waples 1991). NMFS' review found that adult returns during the 1950s and 1960s was about 100,000 spring and summer chinook salmon. Counts at Ice Harbor declined from about 60,000 during 1962-1970 to about 12,000 in 1979; then increased to about 42,000 in 1988. Subsequently the runs declined sharply to about 25,000 in 1988-1989; however these runs are both hatchery and wild (Matthews and Waples 1991).

Adult Passage

Adult spring chinook salmon passage increased at lower Columbia and Snake river dams during 1992 compared to 1991 and the 10-year average (Table 1.2-1). The 1992 count of Snake River spring chinook salmon at Lower Granite Dam was 21,483 fish, about three times the 1991 level and slightly greater than the 1981-1990 average. Summer chinook salmon counts at all dams were lower in 1992 than previous years. The summer chinook salmon count at Lower Granite Dam was 3,008 fish in 1992 (62% of the 10-year average), and the jack count was 301 (34% of the 10-year average).

The cutoff date for spring versus summer chinook salmon is June 12 at Ice Harbor Dam and June 18 at Lower Granite Dam. In 1991, the timing criteria approximated the low point in the chinook salmon counts at the dams. Bjornn et al. (1992) considered the fish that were tagged and released below Ice Harbor Dam during April and May as spring chinook salmon and those tagged in June and July as summer chinook salmon. In 1992, however, the June 18th timing criterion at Lower Granite Dam (and corresponding dates at downriver dams) did not correspond to the actual timing of spawners into specific tributaries. Therefore, the dam passage counts must be evaluated and

interpreted with caution. For example, fish that should have been reported as "summer" chinook salmon according to their life history patterns and accustomed spawning areas entered the Salmon River in 1992 during the time period corresponding to the spring run (Figure 1.2-1).

Table 1.2-1. Counts of adult spring-summer chinook salmon at Bonneville, McNary, and Lower Granite Dams during 1992 versus 1991 and the 10-year mean.

Bonneville Dam:

Time Period	Spring Chinook		Summer Chinook	
	Adults	Jacks	Adults	Jacks
1992	88,425	2,157	15,163	4,165
1991	57,346	3,889	18,897	3,056
1981-1990 Mean	79,500	4,448	24,711	4,846

McNary Dam:

Time Period	Spring Chinook		Summer Chinook	
	Adults	Jacks	Adults	Jacks
1992	48,383	1,940	11,903	2,510
1991	20,187	2,340	15,170	2,418
1981-1990 Mean	41,045	2,980	18,712	2,770

Lower Granite Dam:

Time Period	Spring Chinook		Summer Chinook	
	Adults	Jacks	Adults	Jacks
1992	21,483	538	3,008	301
1991	6,623	980	3,809	1,179
1981-1990 Mean	18,040	1,078	4,873	895

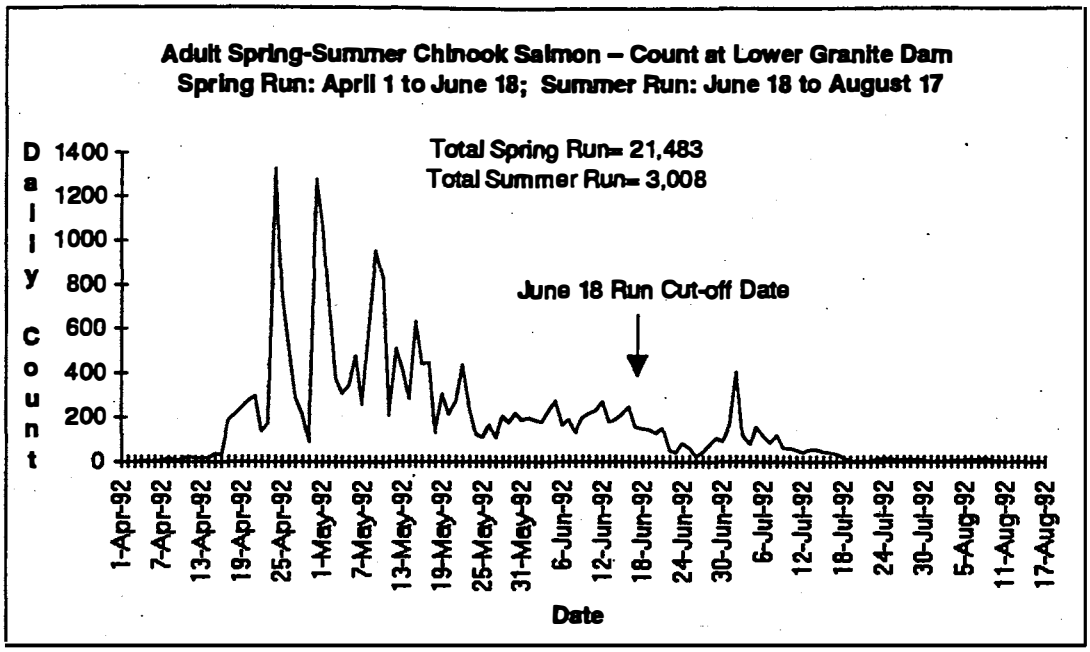


Figure 1.2-1. Counts of adult Snake River spring and summer chinook salmon at Lower Granite Dam, 1992 (Corps, in preparation).

Dam and reservoir passage generally does not cause high mortality for spring and summer chinook salmon adults in the Snake River, under present or past conditions. Chapman et al. (1991) estimated an inter-dam loss of about 5%. Similarly, from 1991 experiments, Bjornn et al. (1992) estimated 87% survival (435/501) of adult radio-tagged spring/summer chinook salmon between Ice Harbor tailrace and Lower Granite forebay. This corresponds to an estimated inter-dam loss of about 3.5%. A preliminary analysis of 1992 dam count and turnoff data for adult spring chinook salmon passage from Ice Harbor to Lower Granite dams indicated a survival rate of 85.9% compared to a 1977-1992 average of 84.4% (Columbia River Compact, Technical Advisory Committee, January 12, 1993). Bjornn (1990) estimated that 45-55% of the wild chinook salmon passing Ice Harbor Dam survived to the spawning grounds during 1962-1989; likewise in 1991, Bjornn et al. (1992) estimated that about 55% of the radio-tagged fish successfully reached spawning grounds or hatcheries.

Returns of spring/summer chinook salmon to the Snake River hatcheries have increased since 1977. Hatchery returns totaled 7,300 in 1992 (24%; Columbia River Compact, TAC Report December 12, 1992).

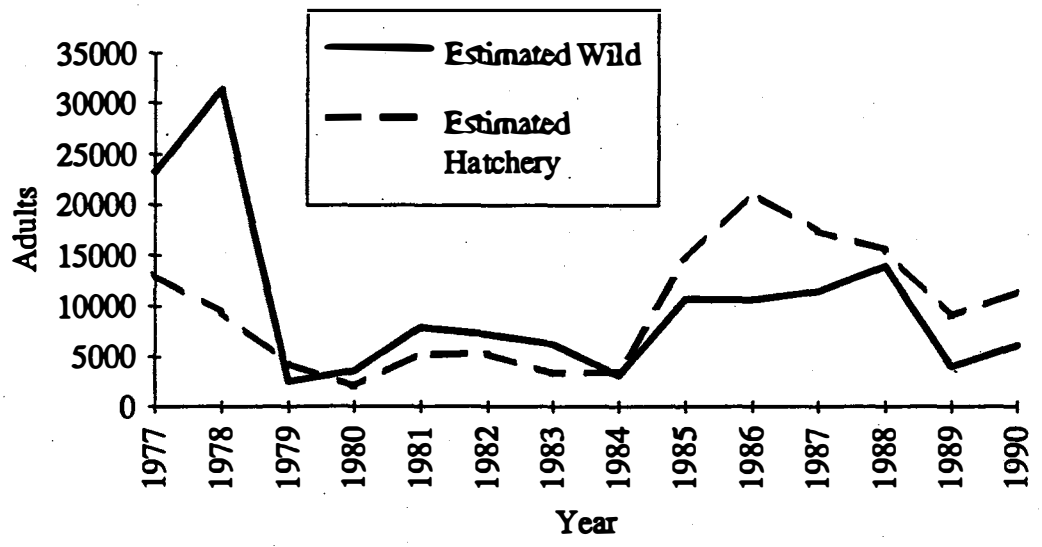


Figure 1.2-2. Estimated wild and hatchery adult spring chinook salmon passing Lower Granite Dam (PSC Chinook TAC 1991).

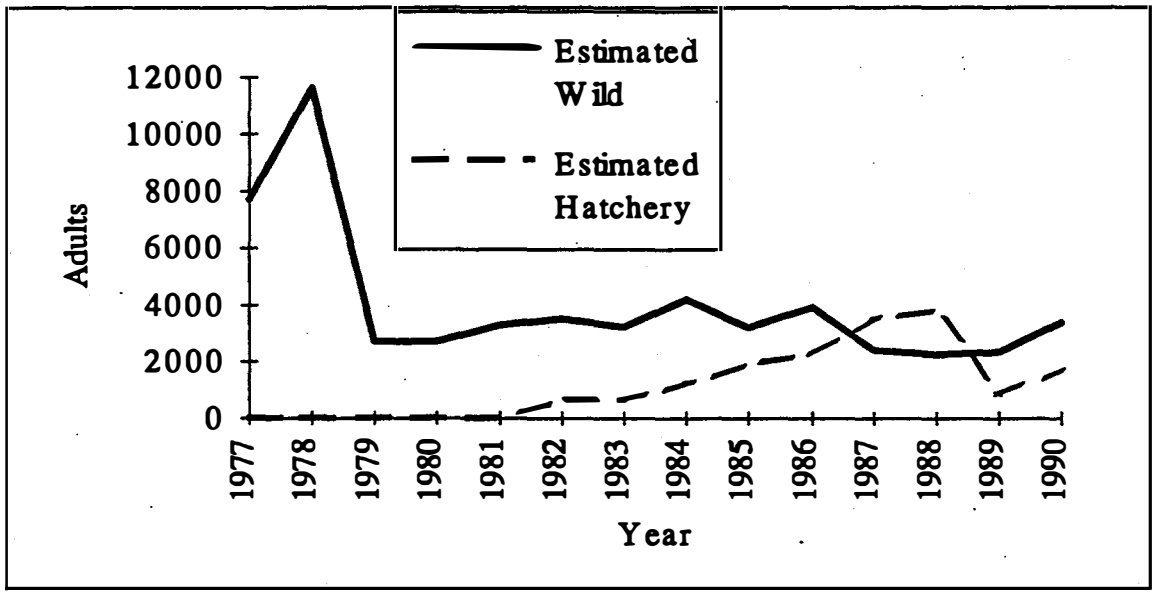


Figure 1.2-3. Estimated wild and hatchery adult summer chinook salmon passing Lower Granite Dam (PSC Chinook TAC 1991).

Table 1.2-2. Estimated total and wild spring and summer chinook salmon passing Lower Granite Dam and percent wild adults (PSC Chinook TAC 1991).

Year	Lower Granite Dam Count		Wild Spawner Estimate		Percent Wild Fish	
	Spring	Summer	Spring	Summer	Spring	Summer chinook
1977	36,200	7,700	23,175	7,700	64%	100%
1978	40,700	11,600	31,375	11,600	77%	100%
1979	6,800	2,714	4,828	2,714	71%	100%
1980	5,500	2,700	2,200	2,700	40%	100%
1981	13,100	3,300	5,371	3,300	41%	100%
1982	12,400	4,200	6,448	3,529	52%	84%
1983	9,500	3,900	6,175	3,233	65%	83%
1984	6,500	5,400	3,250	4,200	50%	78%
1985	25,207	5,100	6,048	3,196	24%	63%
1986	31,722	6,200	7,925	3,934	25%	63%
1987	28,835	5,900	8,928	2,414	31%	41%
1988	29,495	6,100	10,915	2,263	37%	37%
1989	12,955	3,200	3,900	2,350	30%	73%
1990	17,315	5,093	4,152	3,378	24%	66%
1991	6623	3809	2706	2814	41%	74%
1992	21391	3008	8196	1148	38%	38%
1977-1980 Average	22,300	6,179	15,395	6,179	63%	100%
1981-1984 Average	10,375	4,200	5,311	3,566	52%	86%
1985-1988 Average	28,815	5,825	8,454	2,952	29%	51%
1989-1992 Average	14,571	3,778	4,739	2,423	33%	63%

Adult Spawning Escapement and Redd Counts

A total of 17,315 spring and 5,093 summer chinook salmon passed Lower Granite Dam in 1990 (wild and hatchery). Using redd count data to adjust adult dam passage counts, NMFS estimated that an average of about 10,000 wild spring and summer chinook salmon passed Lower Granite Dam from 1980-1990. The lowest estimate of adult run size, about 4,900 fish, occurred in 1980 (Figures 1.2-2 and 1.2-3; Table 1.2-2).

Estimates of wild escapement in various spawning tributaries for spring and summer chinook salmon are not currently available for 1992. These data are needed to evaluate recent trends and current status of naturally-spawning spring/summer chinook salmon populations and the impacts of artificial production on ESA species. Prior to 1968, spring/summer chinook salmon escapement into tributaries was entirely wild fish. In recent years, an increasing number of adults of hatchery origin are straying into natural production areas, such as the Grande Ronde and Imnaha rivers (Table 1.2-3).

Table 1.2-3. Estimates of spring/summer chinook salmon escapement and of percent hatchery strays into the Grande Ronde and Imnaha rivers (ODFW 1991).

Year	Grande Ronde		Imnaha	
	Escapement	% Hatchery	Escapement	% Hatchery
1964-1978	mean = 2371	0	mean= 880	0
1979-1983	mean= 563	0	mean= 279	0
1984	684	1	407	0
1985	560	3	487	0
1986	1,114	5	376	4
1987	957	28	328	2
1988	1,250	37	422	1
1989	1,199	29	116	33
1990	240	34	78	40

Table 1.2-4. Five-year average redd counts of Snake River spring/ summer chinook salmon summarized by subbasin.

Years	Tucannon	Grande Ronde	Imnaha	Salmon	Middle Fk. Salmon	South Fk. Salmon	Total
1960-1964	56	549	245	3797	1805	2015	8466
1965-1969	47	896	299	2803	1480	1035	6560
1970-1974	27	817	394	2211	933	713	5096
1968-1972	39	943	351	2427	1127	800	5688
1973-1977	22	462	272	1668	643	451	3518
1978-1982	56	238	167	1229	265	245	2199
1983-1987	136	310	129	463	301	491	1831
1988-1992	19	289	94	342	336	644	1723

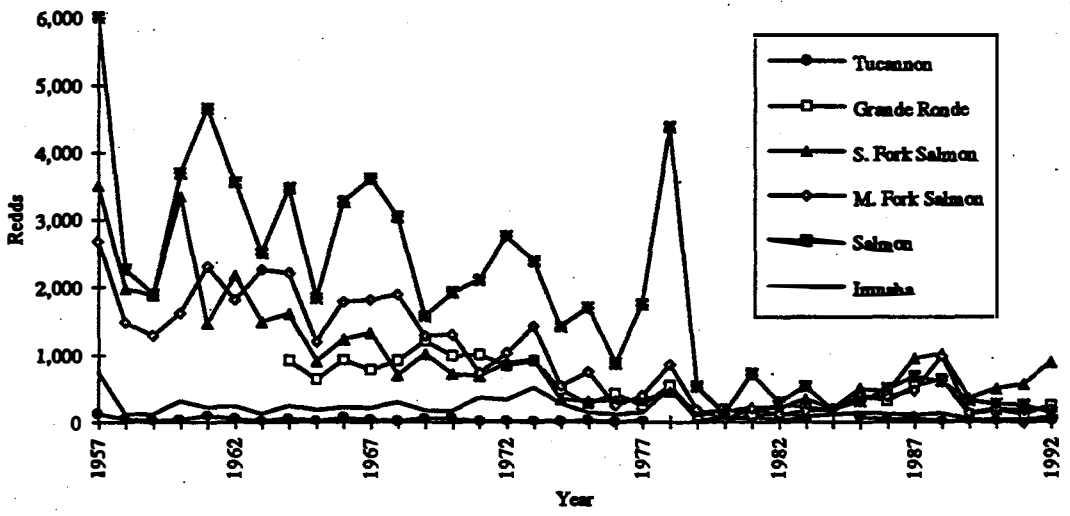


Figure 1.2-4. Spring and summer chinook salmon redd counts for index areas in the Snake River, 1957-1992.[1]

Spring/summer chinook salmon redd counts in the Salmon River have declined for five consecutive years and were the lowest on record in 1992. The spring /summer chinook salmon redd counts at primary index sites in the Tucannon River were low in 1988 - 1992 compared to the previous five-year averages (Table 1.2-4 and Figure 1.2.4).

[1]Matthews and Waples 1991; R. Carmichael, ODFW, pers. comm. 1992; D. Milks, WDF, 1993; and P. Hassmer, IDFG, 1992.

Juveniles

Index redd counts in specific tributaries have been very low in recent years, e.g., in the range of 24 to 500 per site (Matthews and Waples, 1991, p. 53). The redd counts of spring chinook in the Salmon and Clearwater drainages slightly decreased in 1991 compared to 1990 and previous years (IDFG 1992). The redd counts of summer chinook in the Salmon River drainage slightly increased from 1989 to 1990 (IDFG 1992). In 1992, redd counts in index tributaries have generally increased compared to the previous year.

In order to interpret trends in the passage indices for status of the spring/summer chinook salmon ESU, an annual estimate of the proportion of hatchery fish would be necessary. Beginning in 1993, all Snake River hatchery smolts will be marked in order to distinguish them from naturally produced chinook salmon smolts.

1.2.3 SNAKE RIVER FALL CHINOOK SALMON

Current Status of Species and Habitat

Species and Habitat

Adult chinook salmon in the Snake River are considered to be fall chinook salmon (*O. tshawytscha*) if they pass Lower Granite Dam after August 17. As of December 3, 1992, the Lower Granite Dam fall chinook salmon count was 848 adults and 163 jacks (CRITFC video count)[2]. The Washington Department of Wildlife (WDW) has counted 855 adults and 101 jacks passing Lower Granite Dam through December 9, 1992 (visual count); these counts are more comparable to historical dam counts (Table 1.2-5).

The fall chinook salmon reaching Lower Granite Dam are a mixture of wild fish and hatchery strays from both Snake and Columbia river origin (Table 1.2-5). In 1992, 175 known Lyons Ferry brood were trapped at Lower Granite Dam and transported to the hatchery. The preliminary 1992 estimate of total escapement past Lower Granite Dam was 147 hatchery strays and 533 wild spawners (L. LaVoy, Wahington Department of Fisheries (WDF), pers. comm.). To estimate the hatchery and wild stock composition, counts of known coded wire tagged (CWT) adults observed at the dam are expanded by their respective juvenile mark rates and with the marked to unmarked adult ratio. Samples of marked fish are taken to Lyon's Ferry Hatchery for spawning and CWT readings. In addition, spawning ground surveys and carcass collections above the dam are performed and appropriate biological samples are taken for additional stock identification (CWT, scale and otolith analysis, and genetic stock identification (GSI)). Some uncertainty is associated with these methods since not all hatchery fish are marked, and the proportion of marked fish varies among hatcheries. Also, estimates of the wild component prior to 1990 are less accurate since CWT fish were not screened at Lower Granite Dam before then.

[2]These are counts from Columbia River Inter-Tribal Fish Commission's (CRITFC) 24 hour video recording of fish passage at the dam. Visual counts made by WDW are expanded from counts made between 0500 to 2100 hours, for 50 minutes out of each hour.

Table 1.2-5. Fall chinook salmon dam counts at Lower Granite dam, estimated wild adults, and percent wild adults (PSC Chinook TAC 1991).

Year	Lower Granite Dam Count	Wild Spawner Estimate	Percent Wild Fish
1975	1,000	1,000	100%
1976	470	470	100%
1977	600	600	100%
1978	640	640	100%
1979	500	500	100%
1980	450	450	100%
1981	340	340	100%
1982	720	720	100%
1983	540	428	79%
1984	640	324	51%
1985	691	438	63%
1986	784	449	57%
1987	951	252	26%
1988	627	368	59%
1989	706	295	42%
1990	367	78	21%
1991	634	318	50%
1992	855	533	62%
1977-1980 Average	548	548	100%
1981-1984 Average	560	453	82%
1985-1988 Average	763	377	51%
1989-1992 Average	641	306	44%

The total index redd count above Lower Granite Dam in 1991 was 32, resulting in a ratio of about 10 wild adults estimated at Lower Granite per observed redd (memorandum from WDF, February 25, 1992). This high ratio could be due to several factors, including error in dam and redd counts, adult fallback, pre-spawning mortality, and unreported harvest. In addition to the 1991 index count an additional five redds were found by diving in the Hells Canyon Reach. Finalized data for 1992 redd counts and adult-to-redd ratios based on index counts probably will be available in February 1993. Preliminary index redd counts indicate that the 1992 count will be similar to 1991. Other redd surveys conducted in 1992 include dive surveys below the four lower Snake dams and on the Clearwater and Salmon Rivers.

Intensive monitoring of returning Snake River fall chinook salmon over the last several years has shown that about 50% of the adults cannot be accounted for between Ice Harbor and Lower Granite dams (L. Blankenship, WDF, Olympia, WA, pers. comm., BPA project 92-046, 1992). Potential reasons for this discrepancy in addition to mortality include fallback at dams, spawning below dams and in tributary mouths in the lower Snake River, or illegal fishing.

Historically, fall chinook salmon were widely distributed throughout the Snake River and many of its major tributaries, from its confluence with the Columbia River upstream 990 km to Shoshone Falls, Idaho (Waples et al. 1991b). Construction of the Hells Canyon complex of dams eliminated the primary production areas of Snake River fall chinook salmon, and additional habitat loss occurred with the construction of the four lower Snake River dams (Ice Harbor, Lower Monumental, Little Goose and Lower Granite).

Mainstem spawning above Lower Granite Dam is now restricted to the area between the upper limit of the Lower Granite Reservoir and Hells Canyon Dam. Fourteen out of 32 redds observed in the Snake River in 1991 index counts were found at River Mile 162.4, near Captain John Creek. Lower reaches of the Imnaha, Grande Ronde, Clearwater and Tucannon rivers are also be used by spawning fall chinook salmon. There has also been some evidence that spawning may occur below the lower Snake River dams since eggs were found during dredging operations below Lower Monumental Dam in February, 1992, and fry have been found in Little Goose pool.

Relatively little is known about Snake River fall chinook salmon juvenile habitat requirements. Chapman et al. (1991) state that these fish appear to have biological characteristics like that of mid-Columbia River fall chinook that spawn from Richland upstream to Chief Joseph Dam. The U.S. Fish and Wildlife Service (USFWS) is conducting research with BPA funding to study the habitat requirements of fall chinook salmon in the Columbia River Basin (BPA project 92-029). Preliminary information on Snake River fall chinook salmon subyearlings shows that these juveniles tend to remain in nearshore rearing areas prior to downstream migration that occurs at a threshold size of about 85 mm. More information will be available soon when USFWS completes their annual report for this study.

2.0 Biological Analysis of Proposed Actions

Determinations of whether proposed actions are likely to jeopardize the continued existence of the listed species, as well as the consultation between the action agencies and NMFS and analysis by these agencies, must be based on the best available scientific information. ESA 7(A)(2), 50 C.F.R. 402.14(d), 402.14(g)(8). Although information is available from multiple sources, definitive information about the particular listed species is incomplete, and scientific opinion is not uniform. Given the uncertainties, contributors to this BA have obtained information that is currently available and exercised their best professional judgment to apply such information to an analysis of impacts on the listed species.

In order to reduce uncertainties, the action agencies recommend substantial monitoring and evaluation of actions as well as additional research. The action agencies include such studies in their proposed actions for 1993.

In order to consider all available information, the action agencies have used two approaches to analyze the impacts of their river operations actions, as well as the actions of others on the listed species. The effect of the proposed actions on Snake River spring, summer, and fall chinook salmon are analyzed with empirical and biological modeling. The empirical data analysis projects the expected adult chinook salmon population levels in 1993 and reflects the current status of the populations as affected by conditions in the last few years prior to their ESA listings. The biological modeling analysis provides projections of the effects of the 1993 proposed actions on juvenile survival in 1993 and future years, and the effects these actions will have on spawning escapement trends. In addition to the proposed water management actions, the modeling analysis reflects other non-operational mitigation actions that are planned for implementation in 1993 and future years.

2.0.1 Critical Habitat

To assist decision making, the action agencies treat the proposed designation of critical habitat as though it were final. BPA, Corps, and BoR actions affect the river system habitat of listed species. The regulatory definition of destruction or adverse modification of critical habitat is similar to that of jeopardy. Consequently, this assessment of impacts on the listed species encompasses analysis of impacts on critical habitat.

2.1. Analysis of Snake River Sockeye Salmon

Snake River sockeye salmon were not modeled because no Snake River sockeye salmon juveniles belonging to the evolutionarily significant unit (ESU) are expected to outmigrate from Redfish Lake and enter the hydrosystem in 1993. The current definition of the Snake River sockeye salmon ESU includes only the anadromous Redfish Lake beach-spawning sockeye (Brannon 1992; Waples et al. 1991a).

Adult ESU sockeye salmon last spawned in Redfish Lake in 1989. Any progeny of these spawners would have outmigrated by spring 1992. No ESU adults were observed in 1990; all those returning in 1991 and 1992 were captured for the captive broodstock program and were not allowed to enter the lake. Thus, there are currently no juvenile ESU sockeye salmon believed to be in Redfish Lake. ESU juveniles from the captive broodstock program could be released into Redfish Lake in 1994 at the earliest.

Trapping adults for the captive broodstock program is expected to continue through at least 1995, encompassing one four-year sockeye salmon life cycle. (The NMFS Section 10 permit issued to IDFG allows for trapping of up to 20 adults per year through 1997.) Some or all of the progeny of the trapped adults will be reared to maturity in a hatchery as captive broodstock. The progeny of adults captured in 1991 are expected to be spawned artificially in the fall of 1995; possible release of juveniles into Redfish Lake could occur as early as 1997 with volitional outmigration of the age 1+ smolts expected in the spring of 1996.

The outmigrants of uncertain origin captured in 1991 are expected to mature in the fall of 1993. Progeny of these fish would be released into Redfish Lake in 1994 at the earliest; outmigration of age 1+ smolts would be expected in the spring of 1995.

In November 1992, a resident form of *O. nerka* was observed spawning in Redfish Lake at the historical anadromous sockeye spawning beach, during the historical sockeye salmon spawning period. These Redfish Lake "residual" sockeye salmon may have produced brood year 1991 or 1992 offspring that could enter the hydrosystem in the spring of 1993. These recently discovered "residual" sockeye salmon are not included in the Snake River sockeye ESU; their offspring are not currently protected under the ESA.

The 1993 operational measures intended to benefit the Snake River chinook salmon may also benefit the progeny of the Redfish Lake residual sockeye salmon, which would be in the Snake/Columbia system at the same time.

Sockeye salmon smolts typically begin leaving Redfish Lake in mid-April and continue outmigrating through mid-June. During 1992, the average travel time for PIT-tagged outmigrants (n=8) from Redfish Lake to Lower Granite Dam was 16.9 days; average travel time for outmigrants (n=2) from Redfish Lake to McNary Dam was 29.5 days (PTAGIS). About 1,000-3,000 outmigrants per year might be expected from the residual population in Redfish Lake (Schiewe 1993). In 1993, BPA will continue to fund trapping and PIT-tagging of outmigrants leaving Redfish Lake to monitor outmigrant run size and timing, and to estimate travel time in the Snake/Columbia system.

2.2 Empirical Data Analysis of Snake River Chinook Salmon

2.2.1 Spring and Summer Chinook Salmon in 1993

Adult passage counts and redd index counts were evaluated to predict the 1993 spring/summer chinook salmon run. In evaluating these data sets, there are some uncertainties to be considered. For instance, it is difficult to estimate the number of adults that successfully spawn.

Bjornn et al. (1991), initiated a study on adult spring/summer chinook salmon passage through the lower Snake River to spawning areas and hatcheries. This study provides some estimate of unexplained losses that occur after these fish pass above Lower Granite Dam. Of 508 tagged fish believed to be Snake River spring/summer chinook salmon , 26% were not accounted for after passing the four Snake River dams. Based on this information, caution should be taken in extrapolating dam passage counts to spawning success.

Another confounding factor could be inaccurate dam counts. At Lower Granite Dam, the 1991 fallback and reascension rate was 4.9% (Bjornn et al., 1992); rates at other dams are still being analyzed. This rate could be higher in high flow years.

Although the spring and summer chinook salmon are considered to be the same ESU, data for the two runs have been examined separately. The summer component is harvested at a different rate and migrates earlier as smolts. As pointed out earlier, the spring run in 1992 was greater than the 1981-1990 average, but the summer run was 62% of the 10-year average. The adult migration at Lower Granite Dam is comprised of an estimated 30 to 40 percent hatchery fish (PSC Chinook TAC, 1991).

The fishery management agencies have forecast the 1993 McNary Dam escapement of upriver spring chinook salmon as 76,200 which is less than the 89,800 escapement in 1992 (Columbia River Compact TAC Joint Staff Report January, 1993).

Redd counts provide an index of current spawning levels and indicate reproductive potential. Natural spawning for the period 1989 to 1992, as indicated by redd counts in tributary streams, is generally stable compared to 1981-1984 and 1985-1988. Index redd count data should be interpreted carefully as an indicator of population trends because of changes in methodology (e.g., index areas, water clarity, personnel, protocol, time of survey relative to the peak run, and effort), and because of the biological dynamics of run timing and straying among tributaries (depending on environmental conditions). Based on the redd count information presented in Section 1.2.3.A, the overall production of spring and summer chinook salmon in 1992 was similar to the recent past and, therefore, does not indicate substantial improvements in near future run size.

Summary of Empirical Data

The 1993 run forecast of upriver spring chinook salmon is about 15% less than the actual 1992 run. Dam counts of adult spring versus summer chinook salmon at Snake River dams are inconclusive due to problems with the arbitrary time cuttoff versus the timing of spawning runs in tributary streams. We conclude, primarily based on redd count data, that the near term prognosis is for generally stable to slightly decreasing escapement trends compared to 1989-1992. There is a need to reevaluate wild spring and summer spawning escapement into all tributaries and natural production areas, and to evaluate the impacts of artificial production on the ESU.

2.2.2 Fall Chinook Salmon in 1993

Empirical data used to evaluate potential fall chinook salmon escapement levels in 1993 include adult passage counts, redd index counts, and jack counts.

Estimates of adult wild fall chinook salmon passing Lower Granite Dam have increased since the low of 78 fish in 1990, i.e., an estimated 318 in 1991 and 533 in 1992 (Waples et al. 1991; L. LaVoy, WDF, pers. comm.). Dam count data for fall chinook salmon in the Snake River must be interpreted cautiously due to straying and fallback. Preliminary data from 1991 show fallback may be higher than previously believed, and some fall chinook salmon tagged at Ice Harbor migrated to the Yakima or mid-Columbia river systems. Analysis of data from radio-tagged fall chinook during 1991 showed that five of seven fish tagged at Ice Harbor Dam and three of eight fish tagged at Lower Granite Dam fell back at Lower Granite Dam (Mendell et al. 1992). Nine of seventeen tagged fish trapped at Lower Granite Dam were of hatchery origin. Mendel et al (1992) expressed concern about the possibility that the tagging and release activities affected the behavior of tagged salmon near Ice Harbor Dam.

The preliminary pre-season fishery management forecast is for another low upriver bright fall chinook salmon run (catch plus escapement) in 1993 (Columbia River Compact, Technical Advisory Committee, December 9, 1992). The upriver bright run size has been estimated at 74,000 for 1993, compared to a run of about 83,000 in 1992.

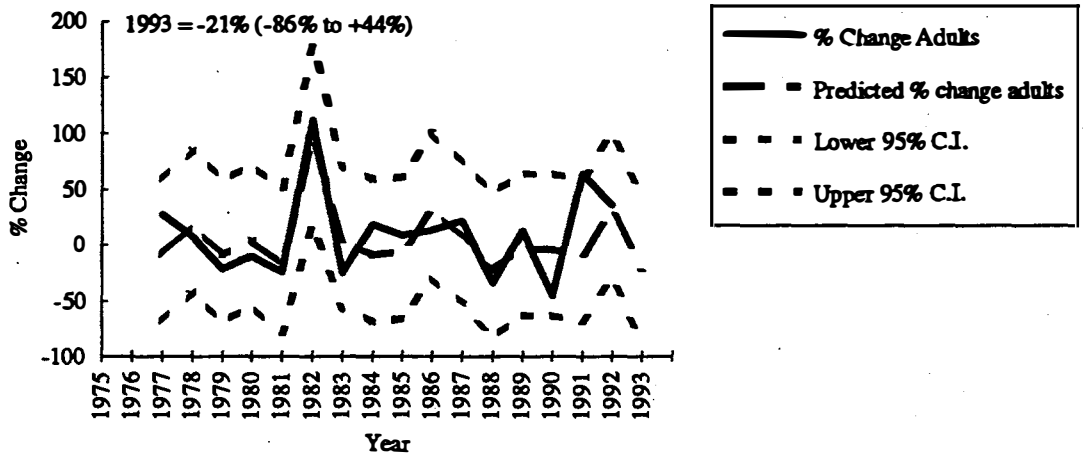
The effect of harvest rates on the actual 1993 adult fall chinook salmon return will be determined in a separate consultation with the management agencies responsible for setting these rates. This is important because the harvest rate on Snake River fall chinook salmon is currently determined by the harvest rate on the mixed-stock fisheries in the ocean and in the lower Columbia River. A constant mixed-stock harvest escapement level can cause proportionately higher in-river harvest rates on the Snake River stock, such as occurred in 1992. This has the potential for occurring again in 1993 and future years unless harvest is managed for the weaker stock of Snake River fall chinook salmon.

Index data on fall chinook salmon redds in the mainstem Snake River provide limited information on natural spawning trends. Redd counts ranged from 57-66 during 1987-1989, and decreased to 37 in 1990 and to the mid-40s in 1991 and 1992 (B. Arnsberg, Nez Perce Tribe, pers. comm., 1993) although the adult fall chinook salmon counts at Lower Granite Dam increased in 1992 (533 wild fish; not corrected for fallback). This information shows the actual number of wild adult Snake River fall chinook salmon reaching the spawning grounds was low and may have been relatively stable during 1990 to 1992. Index redd count data should be interpreted carefully as an indicator of population trends because of changes in methodology (e.g., index areas, water clarity, personnel, protocol, time of survey relative to the peak run, and effort), and because of the biological dynamics of run timing and straying (depending on environmental conditions).

The cumulative index count for subyearling fall chinook in 1991 at Lower Granite Dam was 15,832 and decreased to 5,929 in 1992. Juvenile subyearling chinook migration index numbers at Lower Granite Dam may provide a partial and limited basis for monitoring wild Snake River fall chinook salmon production. Summing the daily passage indices for a given species over the migration period produces an annual passage index for tat site, although caution must be used in making a comparison with previous years for the same species. This is because the counts include fish of unknown origin that may not be wild fall chinook salmon (i.e. subyearling spring/summer chinook salmon). Criteria for classifying subyearling chinook salmon has changed over the years, fish guidance efficiency changes between years and for several years no reporting of fall chinook salmon was attempted because of the recognized uncertainties in the data. Between-site and between-species comparisons are also not directly comparable (FPC 1992).

Snake River fall chinook jack counts at Lower Granite Dam may provide an indication of adult runs in subsequent years. The relationship of percent change in adults at Lower Granite, as predicted by percent change in jacks, is shown in Figure 2.2-1 ($R^2 = 0.51$; $P < 0.01$). From these data, the 1993 population is projected to decrease slightly relative to 1992.

Figure 2.2-1. Percent change in adults (t) at Lower Granite Dam as predicted by percent change in jacks (t-1).



Summary of Empirical Data

Adult passage information shows a slight increase in escapement in 1991 and 1992, although redd counts and possible increased adult fallback indicate that natural spawning levels of Snake River fall chinook salmon may not have increased appreciably since historical low levels in 1990. Any actual increases in the adult fall chinook salmon run since the proposed ESA listing in June, 1991 or the final listing in April, 1992 may be attributed to pre-existing conditions, improvements in adult mortality factors (e.g., harvest reduction and enhanced adult passage), and ocean conditions. Increased adult returns due to system improvements for juveniles are not expected until 1994.

The prognosis is for continued low adult Snake River fall chinook salmon population levels in the near future based on the following information: (1) the forecast by the fishery management agencies of another low upriver bright fall chinook salmon run for 1993, (2) current harvest management escapement goals, (3) a projection of a decreasing Snake River adult run in 1993 based on jack and subyearling counts in 1992, and (4) low redd counts for the past few years.

2.3 Biological Modeling of Snake River Chinook Salmon

2.3.1 Analytical Methods

This assessment uses computer models and currently available scientific information to evaluate the biological effect of the proposed river operations and other nonflow measures on listed Snake River chinook salmon. Professional judgment has been used in those areas where data is limited or is not available. The Columbia River Salmon Passage Model (CRiSP.0) provides information on juvenile passage survival, and the Stochastic Life Cycle Model (SLCM) provides information on spawning escapement trends. They are required analytical tools for a quantitative, comprehensive evaluation of the many factors that combine to affect juvenile system survival to below Bonneville Dam and the long-term population trends of the ESA salmon stocks. A cumulative effects analysis (relative to a narrower focus on individual actions or life stages) is critical to evaluation of the effects of proposed river operations that would occur in combination with other ongoing mitigation measures.

To evaluate the effects of system operations for 1993 and future years, the assessment analyzes available information and data in two ways. First, the CRiSP.0 model is used to analyze juvenile passage conditions. The model analyzes the alternate flow measures identified in the 1993 Flow Options Supplemental Environmental Impact Statement (SEIS Alternatives 2, 3, 4, and 5) relative to no action (SEIS Alternative 1), to determine if the changes in flow and pool elevations are expected to decrease, effect no change, or increase survival of juveniles (other 1993 nonflow measures remain in place). In addition, juvenile passage survival for the proposed flow measures in combination with 1993 and 1998 levels of nonflow measures have been compared to 1990 baseline survival conditions. Second, the SLCM is used to project the expected spawning escapement trend of each population over the next 40 years if the system operations were continued into the future. Also included in the life cycle analyses are actions that are scheduled to be implemented, or that have a high probability of occurring prior to 1988. These include actions such as installation of additional bypass improvements, improved predator control, extended transportation periods, reductions in harvest, adult upstream passage improvements, and subbasin habitat improvements.

The employment of analytical models is important in estimating the possible eventual fate of a population of anadromous fish because of the temporal and spatial distribution of both the population and the actions that affect fish survival. In any given year fish from four or more brood years are distributed throughout the species' range as rearing juveniles, outmigrants, subadults, or adults. The population trend will be affected by mitigation actions started in 1992 and increasing through 1998 and beyond. While it may be possible to estimate the effects of 1993 proposed actions on the survival of one or more life stages, it is necessary to combine these effects with other recent and future mitigation actions to assess the overall effect on the population trend. Life cycle modeling is a critical tool for assessing the expected effect of management actions on a species.

There is a substantial level of uncertainty and variability inherent in biological systems. In addition, several of the mitigation measures have only limited data on their effectiveness. The analyses attempt to capture much of this uncertainty by the use of a statistically based model and application of ranges for several critical assumptions. The results of the models are estimates of the range of expected future states of the populations and the relative changes in juvenile passage survival or population trends between the 1990 baseline operations and alternative future conditions. It should be noted that the production relationships in the model become more uncertain at critically low population levels where genetics and spatial distributions of the species may become a dominant factor. The uncertainty in the biological data and professional judgments used in the analysis requires that a strong monitoring and evaluation program closely follow the dynamics of the population and provide for corrections in both the management actions and the models. Increased monitoring and evaluation for all salmon enhancement measures is planned and the reliability of critical information should increase in future years.

Columbia River Salmon Passage Model

Juvenile migration survival levels for Snake River spring, summer, and fall chinook salmon are analyzed with the CRiSP.0 Model developed by Richard Hinrichsen et al. (1992) at the Center for Quantitative Science, University of Washington. The CRiSP.0 Model is used to estimate the juvenile survival rate for passage from the tributaries of the Snake River above Lower Granite Dam, through the operational system, to below Bonneville dam (system survival). Input parameters describing fish behavior, survival relationships, system configurations, and hydropower operations are specified for the different years and alternatives under analysis. Flow data used in CRiSP.0 are generated from the HYSSR hydroregulation model using the 50 continuous water year record of 1929 through 1978. The results of CRiSP.0 are used in the SLCM life-cycle model analyzing long-term population trends. For more specific information on the CRiSP.0 Model and input parameters, see "Input Parameters for the Modeling of Snake River Salmon with the CRiSP.0 Model" (Fisher 1992) in Appendix E of the SEIS and Hinrichsen et al. (1992).

Stochastic Life Cycle Model

Changes in spawning escapement trends for spring/summer and fall chinook salmon are analyzed with the SLCM developed by Dr. Danny Lee (Intermountain Research Station, Forestry Sciences Laboratory, Boise, Idaho), and Dr. Jeffery B. Hyman (Quality of the Environment Division, Resources for the Future, Washington, DC). The SLCM is used to project spawning escapement trends over a 40-year simulation period (1992 through 2031). This model was designed for population viability assessments combining advanced modeling techniques with concepts from the field of conservation biology. SLCM is designed to mimic the basic mechanisms regulating populations of Pacific Salmon, while capturing some of the intra-annual and inter-annual variation inherent in these populations. The model incorporates uncertainty in projecting the state of salmon populations resulting from: 1) temporal variation in populations and environmental conditions, 2) intrapopulation variation among individuals, and 3) uncertainty in parameter values. Variation in population numbers is simulated by incorporating stochastic processes (using ranges or distributions instead of averages) at each step in the life cycle. The stochasticity incorporated in the SLCM allows a more realistic presentation of the possible future states of these

populations than would be shown by a deterministic model (one that is based on averages). Spawning escapement trends are developed by simulating 500 separate populations over the 40-year period. Probability distributions of future escapement levels are produced for future sets of conditions.

The SLCM is calibrated and initialized using adult harvest and return data from past years. SLCM input data were developed separately for Snake River fall chinook salmon and the spring and summer components of the spring/summer chinook salmon, as these three groups of fish have different life history traits. Because the summer component are harvested at different rates and migrate earlier as smolts, they were modeled separately from the spring component even though they are considered within the same species under the current ESA listings. Output from the CRiSP.0 Model is used to generate a probability distribution of survival for juvenile passage in the SLCM. The analysis of harvest changes for fall chinook salmon use output from a harvest model developed by the Pacific Salmon Commission and applied to Snake River fall chinook by the Oregon Department of Fish and Wildlife (ODFW). For more specific information on the SLCM and input parameters see "Input Parameters for the Modeling of Upper Snake River Wild Chinook Salmon with the SLCM," (Fisher 1993) in Appendix E of the SEIS, and Lee and Hyman (1992).

Critical Assumptions

In addition to the uncertainty modeled through stochastic processes, the SLCM trend analyses assume three separate levels of effectiveness for mitigation measures having substantial levels of uncertainty or limited data. Low, moderate, and high levels of effectiveness are assumed for these measures. The range of effectiveness applied to these measures in 1993 through 1997 and in 1998 and later years are identified in Table 2.3-1 and discussed briefly below along with critical assumptions for flow augmentation benefits and harvest reductions.

Adult Passage Improvements

- Bypass Screens for Adult Fallback - The extended period of operating juvenile passage facilities at McNary, Little Goose, and Lower Granite is assumed to reduce adult fall chinook salmon turbine mortality by collecting adults that are falling back downstream during passage. Adult passage counts at McNary for 1991 during extended operation of juvenile passage screens showed that 14 percent of the run was guided by the juvenile bypass system after falling back through the collection facility (Wagner and Hillson 1992). No data were identified for adult chinook salmon turbine mortality rates, however adult steelhead turbine mortality has been reported from 22 to 44 percent (Wagner and Ingram 1973). Based on these limited data, the effect of bypass screens is calculated to be 0.8 to 1.1 percent increase in Columbia River reach survival when applied to McNary Dam. Similar data collected during 1991 at Lower Granite Dam also showed 14% of the adult fall chinook salmon being guided during the extended screening period (ongoing study analysis, T. Bjornn, University of Idaho, Moscow, Idaho 1992), which would result in a 6.1 to 12.2 percent increase in Snake River reach survival when applied at Lower Granite and Little Goose (see Appendix E of the SEIS).

  It is assumed that for the mainstem Columbia River dams other than McNary the extended period of screening will not affect a substantial number of adults and therefore no effect is modeled. The extended screening is assumed to affect the entire run of fall chinook salmon only at the two uppermost Snake River dams starting in 1993.

- Fish Ladder Temperature Improvements - It is assumed that high temperatures during low water conditions cause a 1 to 5 percent increase in the summer and fall chinook salmon mortality at Snake River adult fish ladders (ongoing study analysis, T. Bjornn, University of Idaho, Moscow, Idaho 1992). Assuming low water conditions occur approximately one-third of the time, ladder temperature improvement effects a 0.3 to 1.7 percent decrease in total Snake River passage mortality. Improvements in ladder temperatures as a result of ladder improvements are projected to start in 1998 for adult summer and fall chinook salmon. No effect is assumed for earlier migrating spring chinook salmon.

Harvest Reductions

- Harvest Regulations - Reductions in harvest are modeled only for fall chinook salmon. The reductions are based on future harvest rate projections as modeled by ODFW. Harvest rates start in 1991 as a 22 percent decrease in US ocean and a 35 percent decrease in Columbia River fisheries from 1990 levels, decrease an additional 5 percent in the ocean and 24 percent in the river for 1992-1995, and then return to 1984-1990 levels for 1996 and beyond. (Schaller et al. 1992). These projections are intended to reflect levels set by the NPPC. This may conflict with current harvest management practices which set a mixed-stock escapement level at McNary.

- Law Enforcement - Increased law enforcement is assumed to increase the upstream survival through the entire lower Columbia River reach by 0.25 to 5 percent, and through the entire Snake River reach by 0.25 to 5 percent for spring, summer, and fall chinook salmon by the year 1993 (S. Vigg, Fisheries Biologist, BPA).

Habitat Improvements

- Habitat Quality Improvements - It is assumed that increases in habitat quality will increase pre-smolt production by 1 to 10 percent over existing conditions starting in 1998 for spring and summer chinook salmon. This increase does not apply to fall chinook salmon (R. Austin, Fisheries Biologist, BPA 1992).

- Irrigation Diversion Screens - It is assumed that screening irrigation diversions will increase the pre-smolt to smolt survival rate by 2 to 5 percent for spring chinook salmon, and 1 to 2.5 percent for summer chinook salmon. These changes are modeled to take effect in the year 1998 (Schill, 1984; D. Daley and R. Austin, Fisheries Biologists, BPA 1992).

- Hells Canyon Dewatering - It is assumed that changes in the operation of the Hells Canyon Dam by IPC will reduce the number of downstream spawning redds dewatered. The number of productive redds is assumed to increase by 0 to 10 percent by the year 1993 (Conner 1992; D. Daley, Fisheries Biologist, BPA 1992).

Juvenile Passage Improvements

- Flow Augmentation - Changes in Snake and Columbia river flows are based on Corps HYSSR Model analyses of base case and alternative operations using 1929 through 1978 water conditions. The effects of changes in flow conditions for spring and summer chinook salmon are based on river reach survival data for yearling chinook salmon from 1970 and 1972-1980 (Sims and Ossiander, 1981). It should be noted that there is uncertainty surrounding this data and its interpretation. For a discussion of this, see Section 4.2.1 - Flow Effects on Juvenile Salmonids in the SEIS).

  The effects of flow augmentation on fall chinook salmon are based on a combination of travel time relationships and a mortality per day of travel time estimate. The travel time relationship for Lower Granite Pool incorporates fish length and flow rate based on 1991 data (memo from Michele Dehart, FPC, to Merritt Tuttle, NMFS, October 16, 1991). Travel time for all other pools is based on data from John Day Pool

(Berggren and Filardo, 1991). It should be noted that these relationships are based on limited data and weak correlations of travel time and flow. Other researchers have questioned the existence of a direct relationship between travel time and flow for subyearlings (Giorgi, 1991; Kindley, 1991). We thus modeled another option (Option 2) as part of a sensitivity analysis. Option 2 assumes no relationship between flow and travel time for fall chinook salmon smolts. The mortality rate per day of travel time is 2.26 percent per day based on output from the Columbia River Ecosystem Model using data for John Day Pool (modeling by Dr. Sam Bledsoe, Consulting Scientist, University of California-Davis, 1991-92).

- Squawfish Management - Changes in reservoir mortality due to the squawfish management program are based on predation modeling. This modeling projects that a sustained 10 to 20 percent annual harvest of adult squawfish may result in a 50 percent or more reduction in predation mortality within the planning period (Rieman and Beamesderfer, 1990). Program efficacy and proportion of mortality due to predation are unknown; this analysis assumes a reservoir mortality reduction of 7.5 percent in 1993 and 25 percent in the year 1998. A factor of plus and minus 50 percent is applied to these values to arrive at an uncertainty range for squawfish effectiveness of 3.75 to 11.25 percent reduction in reservoir mortality for 1993 through 1997 and 12.5 to 37.5 percent for 1998 and beyond.

- Transportation - The analysis models the extension of transportation operations for fall chinook salmon change from mid-August in the 1990 base line to the end of September in all alternatives. Transportation starts at Lower Monumental in 1993. Additional transportation occurs at transport projects as collection efficiencies improve with bypass improvements.

The analysis models transported fish with a direct mortality of 1 percent for transported fish. A review of transport benefit data comparing the adult return rate of transported juveniles to nontransported (in-river) juveniles suggests either:

1. there is a higher latent mortality rate for transported fish than for nontransported fish after release below Bonneville, which is to be expected, because many of the fish that are transported are in poor condition and are unlikely to survive whether transported or migrating in-river;

2. in-river migration mortality estimates are too high; or

3. an unknown combination of 1 and 2. This analysis assumed an additional post-Bonneville mortality that occurs with transported fish (number 1). Based on an analysis of transportation experiments from 1968 to 1989, a post-Bonneville mortality rate of 32 to 76 percent is applied to transported fish, depending on the species and point of collection. We also modeled another option (Option 2) based on analysis of data from 1986 to 1989 transport experiments. These data reflect more recent transportation program conditions: for option 2, a post-Bonneville mortality rate of 34 to 57 percent was applied to transported fish, depending on species and location (See Appendix E of the SEIS for further discussion of post-Bonneville mortality for transported fish).

- Lowered Pool Levels - Decreases in operating pool levels at the Snake River dams and John Day Dam are modeled by converting the lower reservoir flows to velocity equivalent flow rates at normal pool elevations (see Appendix E of the SEIS).

- Spill - This analysis assumes that 1992 spill rates continue through 1997 except for spill at Lower Monumental which terminates in 1993. Spill terminates at Ice Harbor, The Dalles, John Day, and Bonneville for 1998 future conditions.

- Fish Bypass Systems - The Lower Monumental bypass system, the Little Goose and Lower Granite gate raises, Ice Harbor screens, and improvements at Bonneville Powerhouse II are modeled starting in 1993. Bypass systems at The Dalles, a gate raise at Lower Monumental, long screens at Lower Granite, Little Goose, long screens and a gate raise at McNary are modeled starting in 1998. No improvements in bypass systems are modeled at John Day Dam. The fish guidance efficiencies modeled in the analyses are based on information from the Corps Research Reports and is consultation with NMFS researchers (see Appendix E of the SEIS).

Benefits Not Considered in the Analysis

The following potential fish survival benefits were not included in the analysis due to uncertainty regarding efficacy, implementation timing, or the ability to model appropriately.

- Temperature Control - The analysis assumes no adult survival benefits from use of flow augmentation for water temperature control, due to uncertainties.

- Fish Ladder Flow Improvements - No improvement in adult passage survival is assumed for improved ladder flows, modification of spill patterns, and ladder entrance gate modifications intended to reduce migration delays at dams.

- Bypass Screens for Fallback - There is no benefit assumed for spring, summer, or fall adults for reduced turbine mortality from bypass screens added at Lower Monumental, Ice Harbor, and The Dalles.

- Peak Turbine Efficiency - No reduction in mortality for juveniles passing through turbines or adults falling back through turbines is assumed for operating turbines within 1 percent of peak efficiency due to uncertainty for the effectiveness of this measure.

- License Buy-Back and Lease Back - No reduction in fall chinook salmon harvest rates due to the NPPC's proposed program to buy back or lease back in-river non-Tribal gillnet fishing licenses are modeled. The timing and effect of these actions are uncertain.

- Supplementation - This analysis does not model the effects of existing or future hatchery supplementation programs, nor does it model potential effects of future changes in the management of existing supplementation programs.

- Hatchery Production and Management - This analysis does not model future changes in hatchery production quantity or hatchery fish quality that could affect wild stocks.

- Transportation survival - No decrease in direct or post-Bonneville transportation mortality rates is modeled for special care transportation measures, alternative fish release strategies, for increased fish condition from habitat improvements, or for reduced incidence of disease.

- Future Flow Augmentation - There are no additional future flow augmentation improvements modeled for the Snake River from additional water rental, irrigation curtailments, or water conservation programs.

- Flow Operations - There are no improvements in adult or juvenile survival modeled for increased nighttime flows, increased use of flow block pulsing to stimulate juvenile fish movement, or increased priority of flow augmentation for wild run timing.

Table 2.3-1. The ranges of effectiveness applied to measures having significant levels of uncertainty or data limitations for 1993 through 1997 and for 1998 and later years.

		1993			1998		
Parameter	Stock	Low (%)	Mod. (%)	High (%)	Low (%)	Mod. (%)	High (%)
Juvenile Passage Measures							
Squawfish							
% decrease in reservoir mortality due to implementation of squawfish removal program, based on predation modeling which projects a sustained 10-20% annual squawfish harvest may result in >50% reduction in predation mortality (Rieman and Beamesderfer, 1990).	All	3.8	7.5	11.3	12.5	25	37.5
Pre-smolt Measures							
Habitat							
% increase in production of pre-smolts over existing conditions due to increases in habitat quality (estimate - Robert Austin's review of other biological opinions, Fishery Biologist, BPA)							
	Spring/ Summer	0	0	0	1	5.5	10
Hells Canyon Flow							
% increase in no. of productive redds due to changes in operation of Hells Canyon Dam, which will reduce no. of spawning redds dewatered (Connor 1992; estimate - Dan Daley, Fishery Biologist, BPA)	Fall	0	5	10	0	5	10
Irrigation Diversion Screens							
% increase in pre-smolt to smolt survival rate due to installation of screens (Schill, 1984; estimate - Dan Daley and Robert Austin, Fishery Biologists, BPA)							
	Spring	0	0	0	2	3.5	5
	Summer	0	0	0	1.0	1.8	2.5
Adult Passage Improvements							
Bypass Screens for Adult Fallback							
% decrease in mortality due to extended screening period (Wagner and Hillson, 1992; Wagner and Ingram, 1973; personal communication, T. Barila, Corps, Walla Walla District)							
Columbia projects	Fall	0.1	0.1	0.2	0.6	0.8	1.1
Snake projects	Fall	5.0	7.4	9.9	5.0	7.4	9.9

Table 2.3-1. The ranges of effectiveness applied to measures having significant levels of uncertainty or data limitations for 1993 through 1997 and for 1998 and later years.

		1993			1998		
Parameter	Stock	Low (%)	Mod. (%)	High (%)	Low (%)	Mod. (%)	High (%)
Law Enforcement							
% increase in upstream survival due to increased law enforcement (estimate - Steve Vigg, BPA)							
Snake	All	0.25	2.63	5.0	0.25	2.63	5.0
Columbia	All	0.25	2.63	5.0	0.25	2.63	5.0
Adult Ladder Improvements							
% decrease in mortality due to improvements in ladder temperature at the four Snake projects under low water conditions (based on mortality estimated from ongoing study of T. Bjornn, University of Idaho, and an estimated occurrence of low water/high temp.)							
	Fall	0	0	0	0.08	0.25	0.42
	Summer	0	0	0	0.08	0.25	0.42
	Spring	no effect	no effect	no effect	no effect	no effect	no effect
Combined Effects of Adult Passage Improvements							
% increase in survival calculated through spreadsheet applying combined effects with calibrated adult survivals							
	Fall						
Snake		6.34	11.76	17.18	6.4	11.96	17.53
Columbia		0.33	2.75	5.16	0.81	3.46	6.12
Total		6.69	14.83	23.23	7.26	15.84	24.72
	Spring						
Snake		0.25	2.63	5.0	0.25	2.63	5.0
Columbia		0.25	2.63	5.0	0.25	2.63	5.0
Total		0.50	5.32	10.25	0.5	5.32	10.25
	Summer						
Snake		0.25	2.63	5.0	0.27	2.68	5.09
Columbia		0.25	2.63	5.0	0.25	2.63	5.0
Total		0.50	5.32	10.25	0.52	5.37	10.35

2.3.2 CRiSP.0 and SLCM Model Results

CRiSP.0 Results:

The CRiSP.0 model is used to model the following conditions for spring, summer, and fall juvenile chinook salmon:

1. 1990 Baseline - The 1990 river operating rules with 1990 level of nonflow measures. This baseline is a benchmark of conditions just prior to the ESA listing of Snake River chinook salmon.

2. Alternative 1 / 1993 - The SEIS Alternative 1 with 1993 levels of nonflow mitigation measures. This alternative is equivalent to a no action alternative.

3. Alternatives 2-5 / 1993 - The SEIS Alternatives 2 through 5 with 1993 levels of nonflow mitigation measures.

4. Alternative 4 / 1998 - The SEIS Alternative 4 with 1998 levels of nonflow mitigation measures.

The SEIS Alternative 4 is the preferred alternative and was run with low, moderate, and high levels of effectiveness of squawfish management. The SEIS Alternatives 1, 2, 3, and 5 were only run at the moderate level of squawfish management effectiveness.

Table 2.3-2 shows CRiSP.0 Model results for the 1990 baseline and Alternatives 1 and 4 at the moderate level of squawfish management effectiveness. The table shows the 10th percentile, median, (50th percentile) and 90th percentile system survival rates for Snake River juvenile spring, summer, and fall chinook salmon based on the 50 continuous water years of analysis (1929-1978). Changes in survival for alternative 4 relative to alternative 1 (no action) conditions in 1993 and for alternative 4 in 1993 and 1998 relative to 1990 baseline conditions are also shown in Table 2.3-2. The juvenile survival values represent the survival of juveniles from the head of Lower Granite pool through the system to the tailrace of Bonneville Dam, with an additional post-Bonneville mortality rate of 32 to 74 percent applied to transported fish. The median survival values and relative changes from 1990 baseline conditions at the low, moderate, and high levels of squawfish

management for 1993 and 1998 Future conditions are provided in Table 2.3-3. A change in survival relative to the 1990 baseline is equal to the difference in survival between the alternative condition and the 1990 baseline condition all divided by the baseline condition survival.

Figures 2.3-1 (A, B, and C) show the 10 percentile, median, and 90th percentile juvenile survival levels for the SEIS alternatives 1 through 5 for spring, summer, and fall chinook salmon respectively. These survival levels are at the moderate level of squawfish management effectiveness.

SLCM Results:

The SLCM was run for the following conditions for spring, summer, and fall chinook salmon:

1. 1990 Baseline - This is the estimated escapement trend under future conditions with 1990 river operating rules and 1990 level of nonflow mitigation measures. This is a baseline from which to measure the effects of mitigation measures implemented and planned for implementation since 1991.

2. 1993 and Future - This is the estimated escapement trend under future conditions with 1993 proposed river operations (Alternative 4) with 1993 level of nonflow mitigation measures in effect through 1997, and 1998 level of nonflow mitigation measures.

Figures 2.3-2 through 2.3-5 show SLCM results for the projected spawning escapement trends for wild Snake River spring, summer, and fall chinook salmon for both the baseline conditions and the proposed 1993 and future conditions. The 1993 and future action analysis includes three different levels of effectiveness for the measures implemented for: squawfish management, adult fallback screening, ladder temperature improvements, increased law enforcement, habitat quality improvements, irrigation diversion screening, and reductions in Hells Canyon redd dewatering. These levels are identified as low, moderate, and high effectiveness and correspond to analyses with these measures all set to the low, mid-point, and high levels of effectiveness.

The projected median escapement level shown on each figure is based on 500 stochastic simulations. The 10th and 90th percentile lines on the graphs are

the boundaries surrounding 80 percent of the 500 simulated populations for each of the 40 years. The 10th percentile lines (lowest lines on each figure) show the escapement level above which 90 percent of the spawning escapements were projected to occur for each year.

The results of the SLCM shown in Figure 2.3-6 indicate the percent of the 500 population projections falling below a specified low level of spawning fish in each year. This level was set by the modelers at 1,000 spawners for spring chinook salmon, 500 spawners for summer chinook salmon, and 250 spawners for fall chinook salmon. These levels were set to show changes in population trends based on the magnitude of current run sizes. They are not intended to represent a critical population number.

The probability of the population escapement levels decreasing or increasing over time was analyzed by regressing each of the 500 projected 40 year spawning escapement trends. Each regression trend line was tested for statistically significant increasing or decreasing slopes at the 95 percent confidence level (student's t-test). Table 2.3-4 shows the percent of the escapement projections having a statistically significant negative or positive slope over the entire 40 years, and those having no statistically significant slope.

The three levels of uncertainty were also combined assuming equal probability of occurrence and reported as "All" levels of effectiveness. The figures and tables showing "All Effectiveness" are based on 1500 simulations (Three effectiveness levels with 500 simulations per level).

Spring and Summer Chinook Salmon Survival

CRiSP.0 Results:

In general, the CRiSP.0 model results (Table 2.3-2) show that spring and summer chinook salmon juvenile survival increases slightly with the SEIS flow measures (difference between Alternative 1 and Alternative 4). Substantial survival improvements result from the addition of nonflow measures such as increased transportation, squawfish management, and bypass system additions/improvements (1990 baseline compared to alternative 4 - 1993 and 1998). Mitigation measures provide more benefits in low survival years. For spring and summer chinook salmon, approximately

half of the median survival increase projected in 1993 is a result of flow augmentation and drawdown measures. By 1998, approximately one quarter of the increase in median survival is due to flow measures. The model results shown in Table 2.3-2 and Figures 2.3-1 (A and B) show that the SEIS flow Alternatives 2 through 5 provide minor improvements relative to Alternative 1 (no action), and that there is little differences between the SEIS flow Alternatives 2 through 5.

More specifically, the CRiSP.0 Model results show that for 1993 the Alternative 4 flow measures compared to Alternative 1 (no action) provide a relative increase in the 10th percentile, median, and 90th percentile survivals of Snake River spring/summer juvenile migrants of 5.2, 3.5, and 1.1 percent for the spring component and 3.8, 3.9, and 1.1 percent for the summer component. In addition, the results show that relative to 1990 baseline conditions, the Alternative 4 - 1993 flow and nonflow actions increase the 10th percentile, median, and 90th percentile survivals by 14.3, 6.5, and 2.4 percent for the spring component and 13.4, 8.3, and 3.1 percent for the summer component. The results also show that by 1998 the Alternative 4 flow and nonflow actions provide a relative increase in the 10th percentile, median, and 90th percentile survivals of 25.1, 11.8, and 6.9 percent for the spring component and 26.2, 14.6, and 8.2 percent for the summer component.

SLCM Results:

In general, the SLCM results for the spring and summer chinook salmon components show that if all levels of effectiveness are considered, then the projected median escapement levels increase over time relative to 1990 baseline conditions. The probabilities of escapement projections falling below 1000 spawners for the spring component and 500 spawners for the summer component are increasing with time under baseline conditions and stable or decreasing with time under each of the effectiveness levels. Relative to the baseline conditions, the percent of decreasing escapement projections are substantially reduced under each of the effectiveness levels.

More specifically, the SLCM results for the spring chinook salmon component show that under baseline conditions the median spawning escapement is expected to remain steady over the 40 years at approximately 3,000 adults, with 10th and 90th percentiles at 40 years of approximately 0 and 30,000 (Figure 2.3-2). The considered actions increase the 40-year

median projections for low, moderate, high, and all levels of effectiveness of measures from approximately 3,000 adults to approximately 7,000, 14,000, 27,000, and 13,000 adults respectively (Figures 2.3-2 and 2.3-5(A)). The 10th and 90th percentiles for the proposed actions range from less than 1,000 adults (low effectiveness 10th percentile) to over 100,000 adults (high effectiveness 90th percentile).

Under the baseline conditions for the spring chinook salmon component, the probability of escapement levels falling below 1000 spawning adults increases over time to approximately 28 percent by the 40th year (Figure 2.3-6(A)). The probability of being below 1000 adults is stable under the low effectiveness level at approximately 16 percent and decreases under moderate, high, and all combined levels to 7, 3, and 8 percent by the 40th year (Figures 2.3-6(A) and 2.3-7(A)). The percent of simulations with a decreasing escapement trend changes from 24 percent under baseline conditions to 12, 4, 1, and 6 percent respectively under low, moderate, high, and all combined levels of effectiveness (Table 2.3-4).

Specific SLCM results for summer chinook salmon show that under baseline conditions the median spawning escapement starts in the range of approximately 1,200 adults. Escapement decreases slightly to a 40-year median projected run size of approximately 1000 adults, with 10th and 90th percentiles of approximately 300 and 2,100 adults (Figures 2.3-3). The considered actions increase the 40-year median projections for low, moderate, high, and all levels of effectiveness of measures from approximately 1,200 adults to approximately 2,200, 6,000, 12,000, and 6,000 adults respectively (Figures 2.3-3 and 2.3.5(B)). The 10th and 90th percentiles for the proposed actions range from approximately 1,000 adults (low effectiveness 10th percentile) to over 21,000 adults (high effectiveness 90th percentile).

Under baseline conditions for the summer chinook salmon, the probability of escapement levels falling below 500 spawning adults increases over time to approximately 16 percent by the 40th year (Figure 2.3-6(B)). The probability of being below 500 adults is stable under low effectiveness level at approximately 1 percent and decreases under moderate, high, and all combined levels to less than 1 percent by the 40th year (Figure 2.3-6(B) and 2.3-7(B)). The percent of simulations with a decreasing escapement trend changes from 49 percent under baseline conditions to 4, 0, 0, and 1 percent respectively under low, moderate, high, and all combined levels of effectiveness (Table 2.3-4).

Fall Chinook Salmon Survival

CRiSP.0 Results:

In general, the CRiSP.0 model results (Table 2.3-2) show that fall chinook salmon juvenile survival is relatively insensitive to the SEIS flow measures (difference between Alternative 1 and Alternative 4). More substantial survival improvements occur with the addition of nonflow measures such as increased transportation, squawfish management, and bypass system additions/ improvements (differences between the 1990 baseline and Alternative 4 - 1993 and 1998). The results shown in Table 2.3-2 and Figure 2.3-1(C) show that the SEIS flow alternatives 2 through 5 decrease the median survival level slightly and provide minor improvements in low survival years relative to Alternative 1 (no action). These results also show little differences between the SEIS flow Alternatives 2 through 5.

More specifically, the CRiSP.0 Model results show that compared with Alternative 1 conditions, the Alternative 4 - 1993 conditions provide a relative change in the 10th percentile, median, and 90th percentile survivals of Snake River fall chinook salmon juvenile migrants of 7.6, -1.9, and -2.1 percent. In addition, the results show that relative to 1990 baseline conditions, the Alternative 4 -1993 conditions increase the 10th percentile, median, and 90th percentile survivals by 50.8, 28.7, and 20.1 percent respectively. The results also show that by 1998 the Alternative 4 and other nonflow actions provide a relative increase in the 10th percentile, median, and 90th percentile survivals of 140.9, 78.1, and 52.8 percent respectively.

SLCM Results:

In general, the SLCM results for fall chinook salmon show that if all levels of effectiveness are considered, then the projected median escapement levels increase over time relative to 1990 baseline conditions. The probability of escapement projections falling below 250 spawners increases with time under baseline conditions and decreases with time under each of the effectiveness levels. Relative to the baseline conditions, the percent of decreasing escapement projections is substantially reduced under each effectiveness level.

More specifically, the SLCM results for fall chinook salmon show that under baseline conditions the spawning escapement starts in the range of approximately 300 adults and decreases to a 40-year median projected run size of less than 200 adults, with 10th and 90th percentiles of approximately 0 and 300 adults (Figure 2.3-4). The considered actions increase the 40-year median projections for low, moderate, high, and all levels of effectiveness of measures from approximately 300 adults to approximately 4,000, 5,200, 6,400, and 5,000 adults respectively (Figures 2.3-4 and 2.3-5(C)). The 10th and 90th percentiles for the proposed actions range from approximately 2,400 adults (low effectiveness 10th percentile) to approximately 9,800 adults (high effectiveness 90th percentile).

Under the baseline conditions for fall chinook salmon the probability of escapement levels falling below 250 spawning adults increases over time to approximately 84 percent by the 40th year (2.3-6(C)). There are no projections of 250 adults under any level of effectiveness by the 40th year (Figures 2.3-6(C) and 2.3-7(C)). The probability of a decreasing escapement trend changes from 71 percent under baseline conditions to 0 percent under each level of effectiveness (Table 2.3-4).

Sensitivity Analyses

Sensitivity analyses were performed for post-transportation survival, flow-travel time relationship for fall chinook salmon, and no squawfish management. Alternative assumptions regarding post-transportation survival and the subyearling flow-travel time relationship were used to evaluate the effects of the proposed actions. In addition to the range of uncertainty for squawfish management evaluated in the main analyses, a zero level of squawfish management was modeled.

Sensitivity to Post-transportation Survival

Two options regarding post-transportation survival were modeled. Option 1, which was used in the full-scale analysis, assumes that post-transportation survival is calculated using all available data from the NMFS transportation experiments. Option 2 assumes that post-transportation survival is calculated using only data from the NMFS transportation experiments conducted since 1986 . Option 2 results in higher post-transportation survivals for all species except for fall chinook salmon transported from McNary. (All data from the NMFS transportation experiments may be found in Appendix E of the SEIS.) Both options were modeled under the 1990 Baseline Conditions and 1993 Proposed Actions (Alternative 4; moderate effectiveness) cases. Table 2.3-5 and Figures 2.3-8 A, B, and C show the results of the sensitivity analysis. The smolt survival for all species was higher for Option 2 (higher post-transport survival) than for Option 1. However, the relative increase in smolt survival from the 1990 Baseline Conditions to the 1993 Proposed Actions case had little change for both spring, summer, and fall chinook salmon. Improvements in juvenile survival projected by the CRiSP.0 model, then do not depend on differences in the post-transport survival rate data sets analyzed.

Sensitivity to Fall Chinook Salmon Flow-Travel Time

Two options were modeled for the relationship between flow and travel time for subyearling (fall) chinook salmon smolts. Option 1, which was used in the full-scale analysis, assumes that flow and travel time are related. That is, higher flows result in faster travel times. Option 2, assumes that travel time is constant and thus independent of flow. (Flow-travel time assumptions for the Options 1 and 2 are detailed in Appendix E of the SEIS). Both options were modeled under the 1990 Baseline Conditions and 1993 Proposed Actions (Alternative 4; moderate effectiveness) cases. Table 2.3-5 and Figure 2.3-9 show the results of the sensitivity analysis. The smolt survival for fall chinook salmon was higher for Option 2 than for Option 1. The relative increase in smolt survival from the 1990 Baseline Conditions to the 1993 Proposed Actions case was slightly greater under Option 2. Thus, survival improvements predicted by the CRiSP.0 model would be slightly higher if travel time was assumed to be independent of flow for fall chinook salmon.

Sensitivity to No Squawfish Management

A no squawfish management case was modeled under 1993 Proposed Actions conditions (Alternative 4). Figures 2.3-10 A, B, and C compare the resulting passage survivals for no squawfish management effect and all levels of squawfish management under 1993 Proposed Actions conditions to the 1990 Baseline case. Table 2.3-3 also shows the median survival levels for low, moderate, and high effectiveness levels in 1993 and 1998 (future) and their effects on the increase in survival relative to the 1990 baseline. This analysis shows that the majority of survival improvements for 1993 are from measures other than squawfish management.

In general (for spring and summer chinook salmon), approximately one third of the 1993 increase in median survival is the result of squawfish management under the moderate level of effectiveness. For spring and summer chinook salmon, the low and the high ranges of effectiveness change the 1993 projected increase in median survival by plus and minus approximately 15 to 20 percent. For fall chinook salmon, approximately one quarter of the 1993 increase in median survival is the result of squawfish management under the moderate level of effectiveness. The low and high ranges of effectiveness change the 1993 projected increase in median survival by plus and minus approximately 15 percent.

Table 2.3-2 Smolt hydrosystem estimated survival percentages and relative percent change from the baseline conditions at the moderate level of squawfish management effectiveness.

Condition	CRiSP.0 Survival	Species		
		Spring	Summer	Fall
		Passage Survival (Percent)		
1990 Baseline	10th Percentile	16.8	15.7	6.6
	Median	20.8	19.9	12.4
	90th Percentile	22.6	22.5	17.2
Alt. 1 - 1993 (Static 1992 Option)	10th Percentile	18.2	17.1	9.3
	Median	21.4	20.7	16.2
	90th Percentile	22.9	22.9	21.1
Alt. 4 - 1993	10th Percentile	19.2	17.8	10.0
	Median	22.2	21.5	15.9
	90th Percentile	23.1	23.2	20.6
Alt. 4 - 1998	10th Percentile	21.0	19.8	15.9
	Median	23.3	22.8	22.0
	90th Percentile	24.1	24.3	26.2
		Relative Increase in Passage Survival (Percent)		
Increase Alt. 1 - 1993 to Alt. 4 - 1993	10th Percentile	5.2	4.1	7.5
	Median	3.7	3.9	-1.9
	90th Percentile	0.9	1.3	-2.4
Increase 1990 Baseline to Alt. 4 - 1993	10th Percentile	14.3	13.4	51.5
	Median	6.7	8.0	28.2
	90th Percentile	2.2	3.1	19.8
Increase 1990 Baseline to Alt. 4 - 1998	10th Percentile	25.0	26.1	140.9
	Median	12.0	14.6	77.4
	90th Percentile	6.6	8.0	52.3

Note: Numbers are rounded to the nearest 0.1%. The relative increases were calculated prior to rounding, so some slight differences may appear.

Table 2.3-3 CRiSP.0 median estimated survival and relative changes in survival from the 1990 baseline conditions for all levels of effectiveness of squawfish management.

Condition	Spring	Summer	Fall
	Passage Survival (Percent)		
1990 Baseline	20.8	19.9	12.4
1993 Low	22.0	21.2	15.4
1993 Moderate	22.2	21.5	15.9
1993 High	22.5	21.8	16.4
1998 and Future Low	22.5	21.9	20.1
1998 and Future Moderate	23.3	22.8	22.0
1998 and Future High	24.0	23.5	24.1
	Relative Increase in Survival from 1990 Baseline (Percent)		
1993 Low	5.8	6.5	24.2
1993 Moderate	6.7	8.0	28.2
1993 High	8.2	9.5	32.3
1998 and Future Low	8.2	10.0	62.1
1998 and Future Moderate	12.0	14.6	77.4
1998 and Future High	15.4	18.1	94.4

Note: Numbers are rounded to the nearest 0.1%. The relative increases were calculated prior to rounding, so some slight differences may appear.

Table 2.3-4. Percent of estimated escapement projections with a significantly negative, no change, and positive slope (two-tailed Student's T test; $\alpha = 0.05$).[1/]

Species	Scenario	Trend in Slope of spawners		
		Negative (%)	No Change (%)	Positive (%)
Spring Chinook	Baseline	24	47	29
	Low Future	12	43	45
	Moderate Future	4	33	63
	High Future	1	24	76
	All Future	6	33	61
Summer Chinook	Baseline	49	38	13
	Low Future	4	28	68
	Moderate Future	0	1	99
	High Future	0	0	100
	All Future	1	10	89
Fall chinook	Baseline	71	21	9
	Low Future	0	0	100
	Moderate Future	0	0	100
	High Future	0	0	100
	All Future	0	0	100

[1/] Future runs are 1993 flow with 1993 nonflow actions until 1997, and 1998 nonflow actions beyond 1998.

Table 2.3-5. Percent change in estimated median survival between baseline conditions and the 1993 actions - moderate effectiveness case for the two options for post-transportation survival and fall chinook flow-travel time.

Sensitivity	Species		
	Spring	Summer	Fall
Transport option 1	6.49%	8.31%	28.74%
Transport option 2	6.60%	7.72%	27.12%
Fall flow-travel time option 1	—	—	28.74%
Fall flow-travel time option 2	—	—	32.81%

Note: The fall chinook flow-travel time options have no differential effect on spring and summer smolt survival.

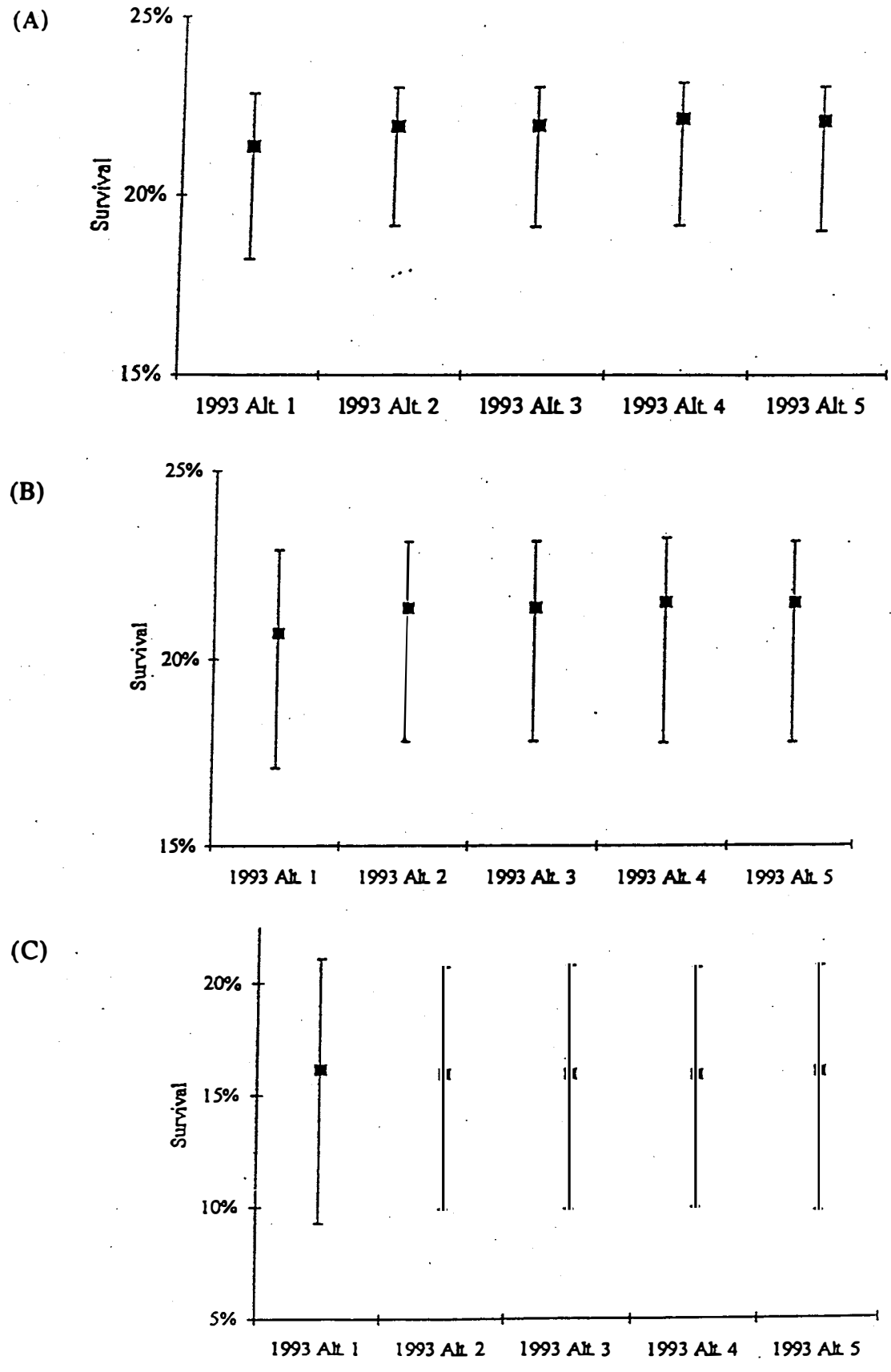


Figure 2.3-1. Spring (A), summer (B), and fall (C) chinook smolt hydrosystem survival percentages (10th percentile, median, and 90th percentile) for the SEIS flow alternatives under moderate effectiveness of squawfish management.

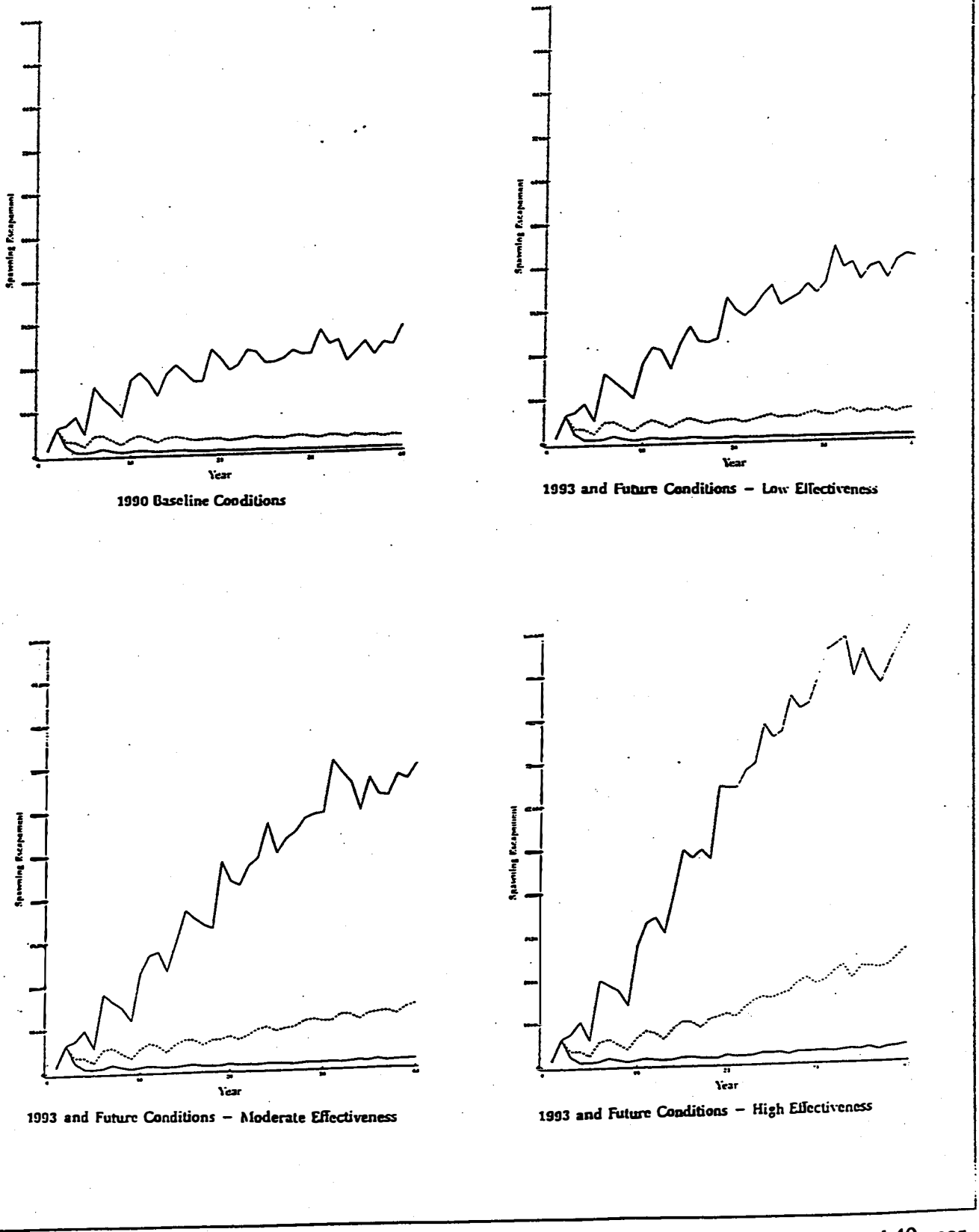


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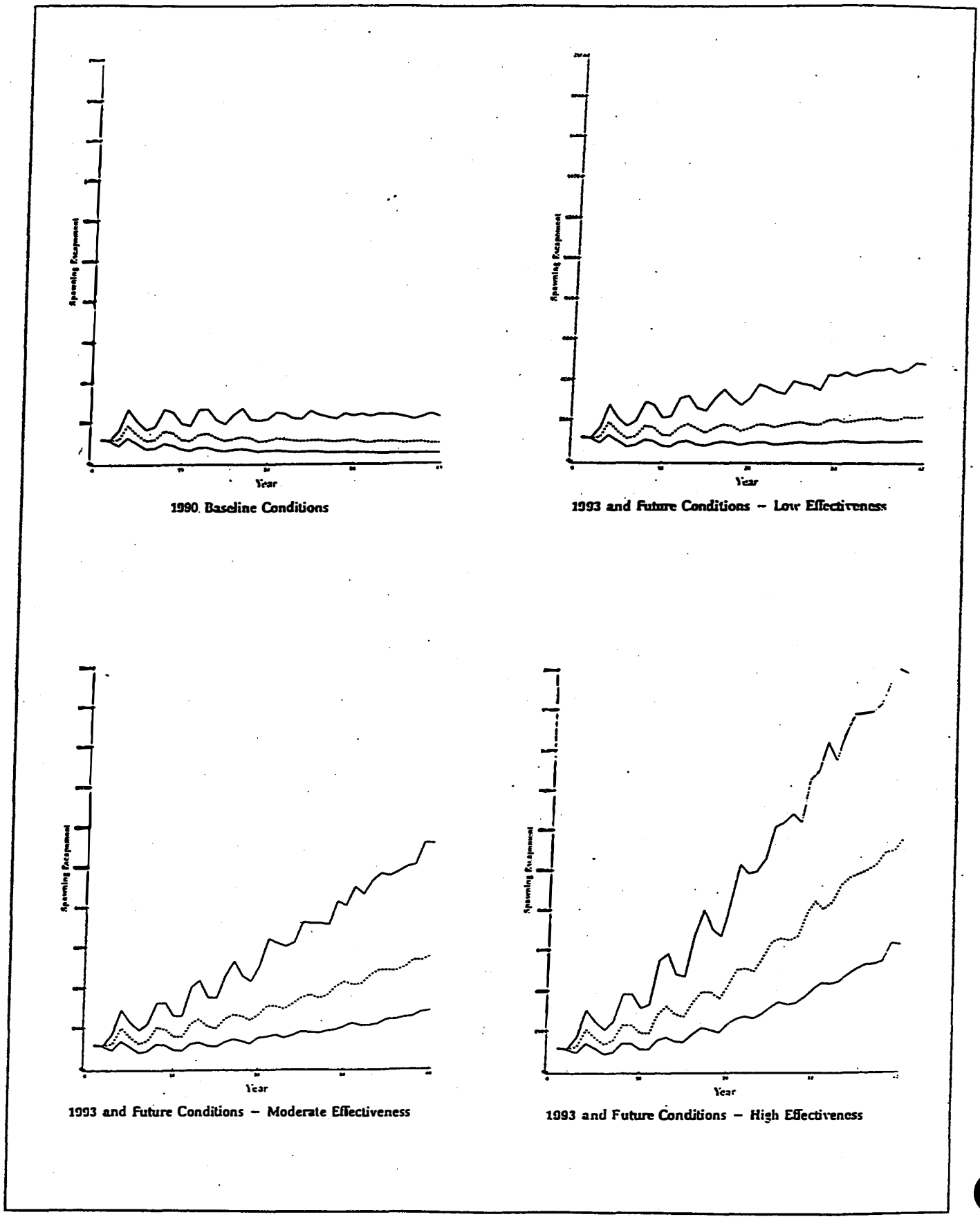


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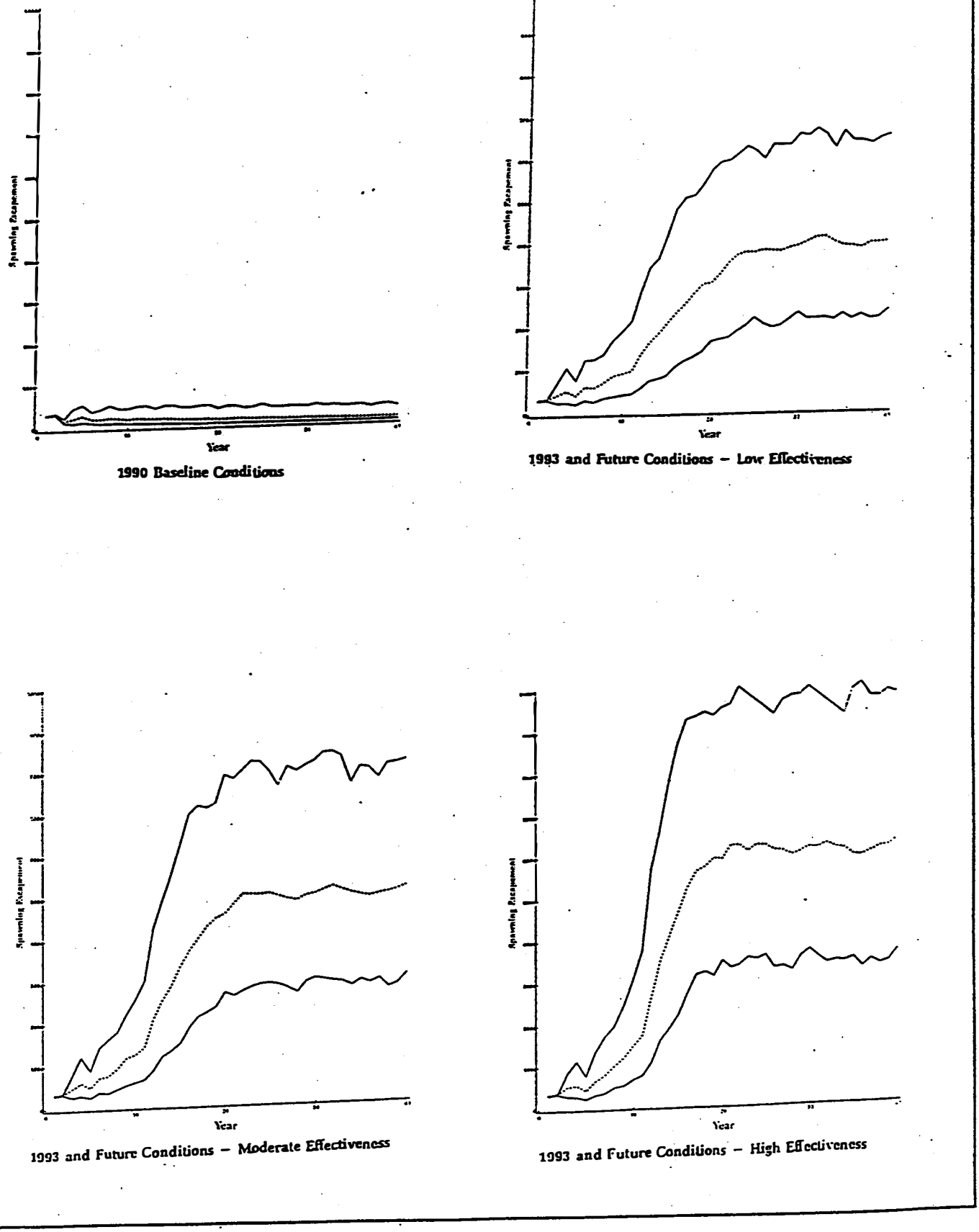


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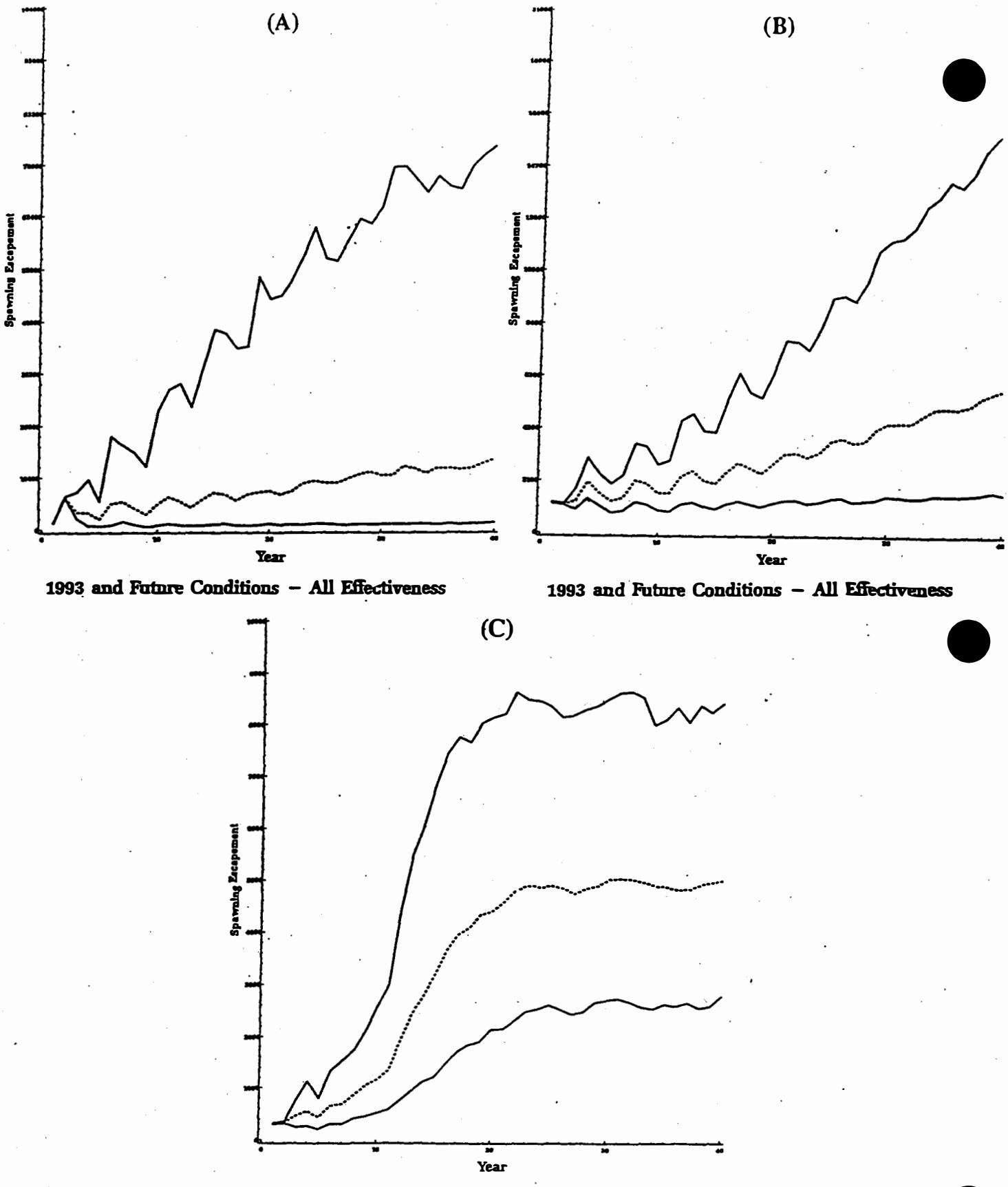


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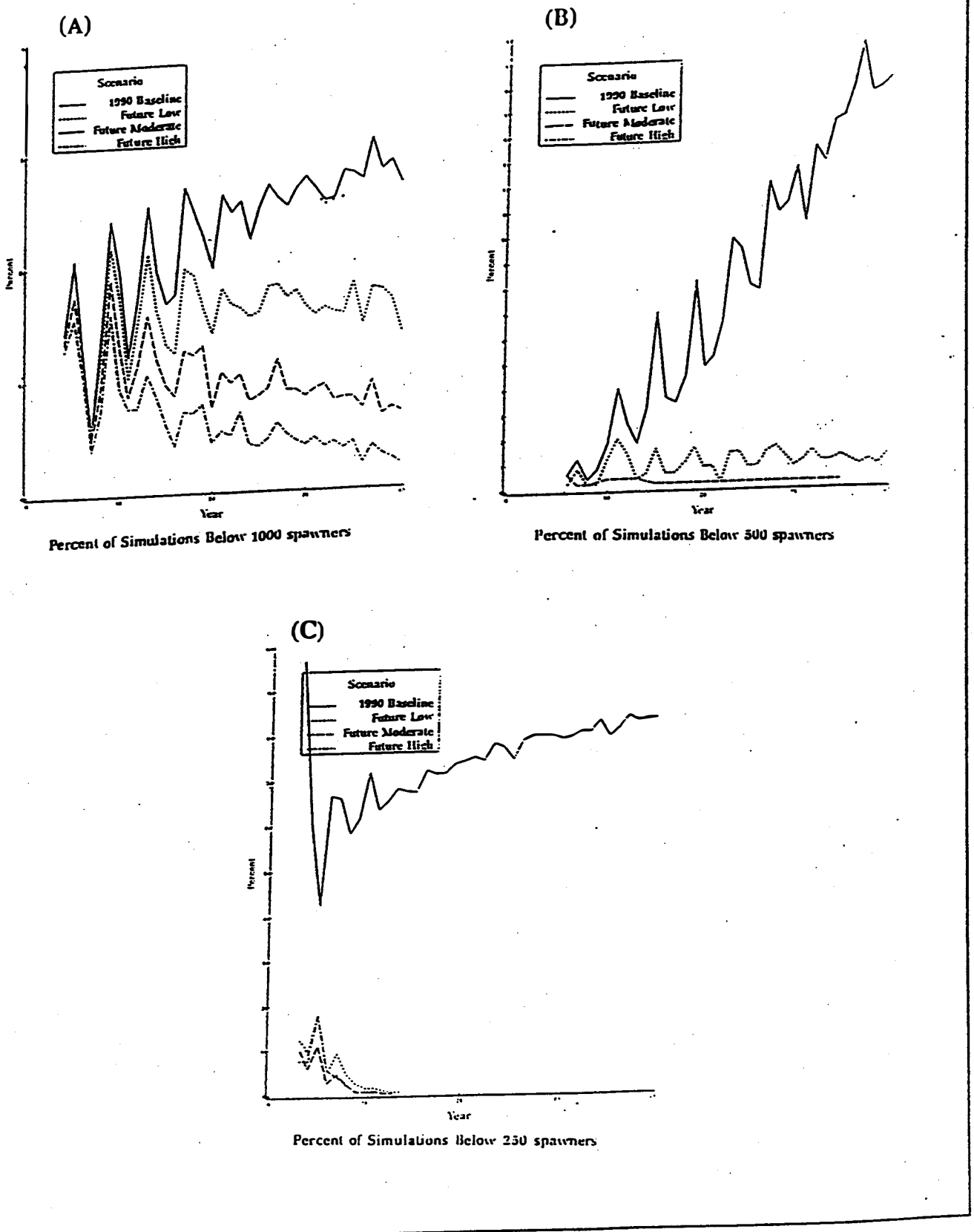
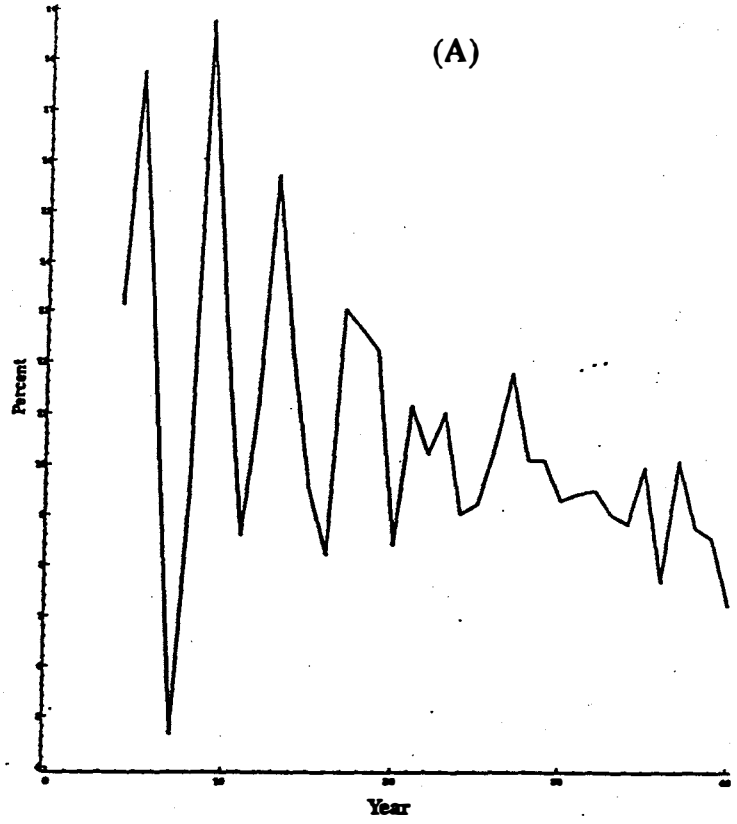
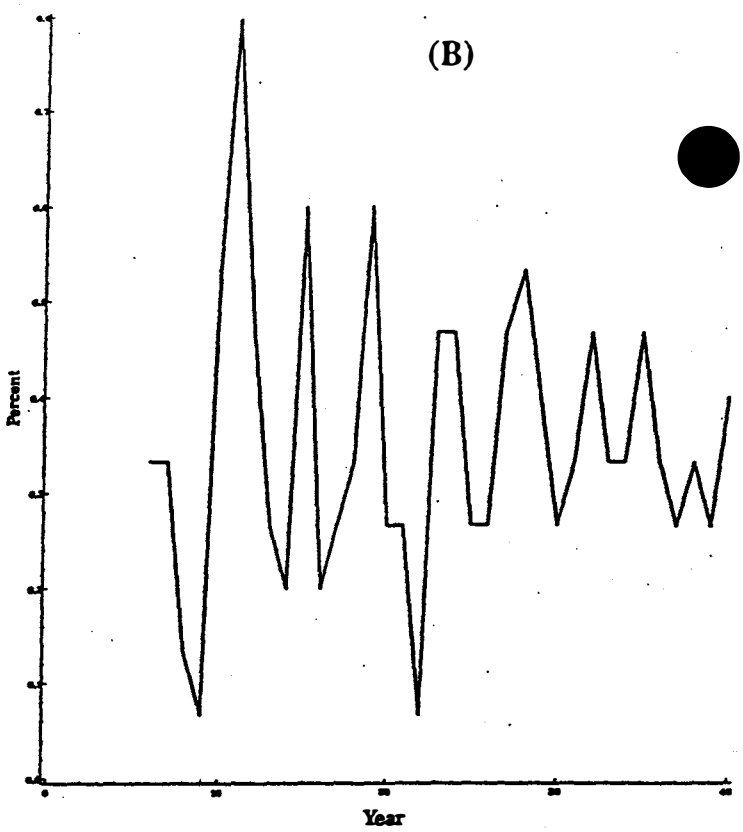


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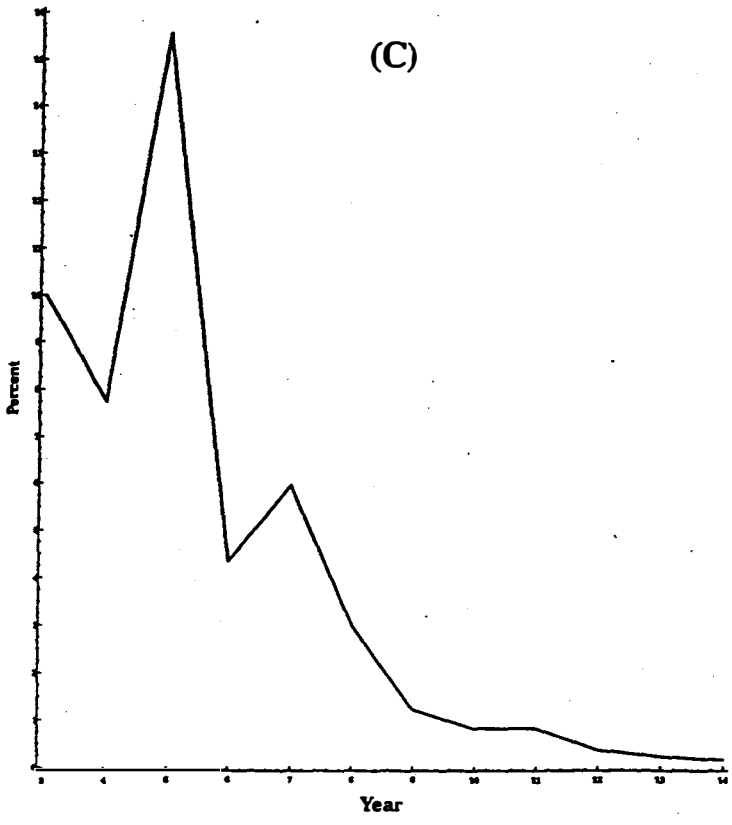


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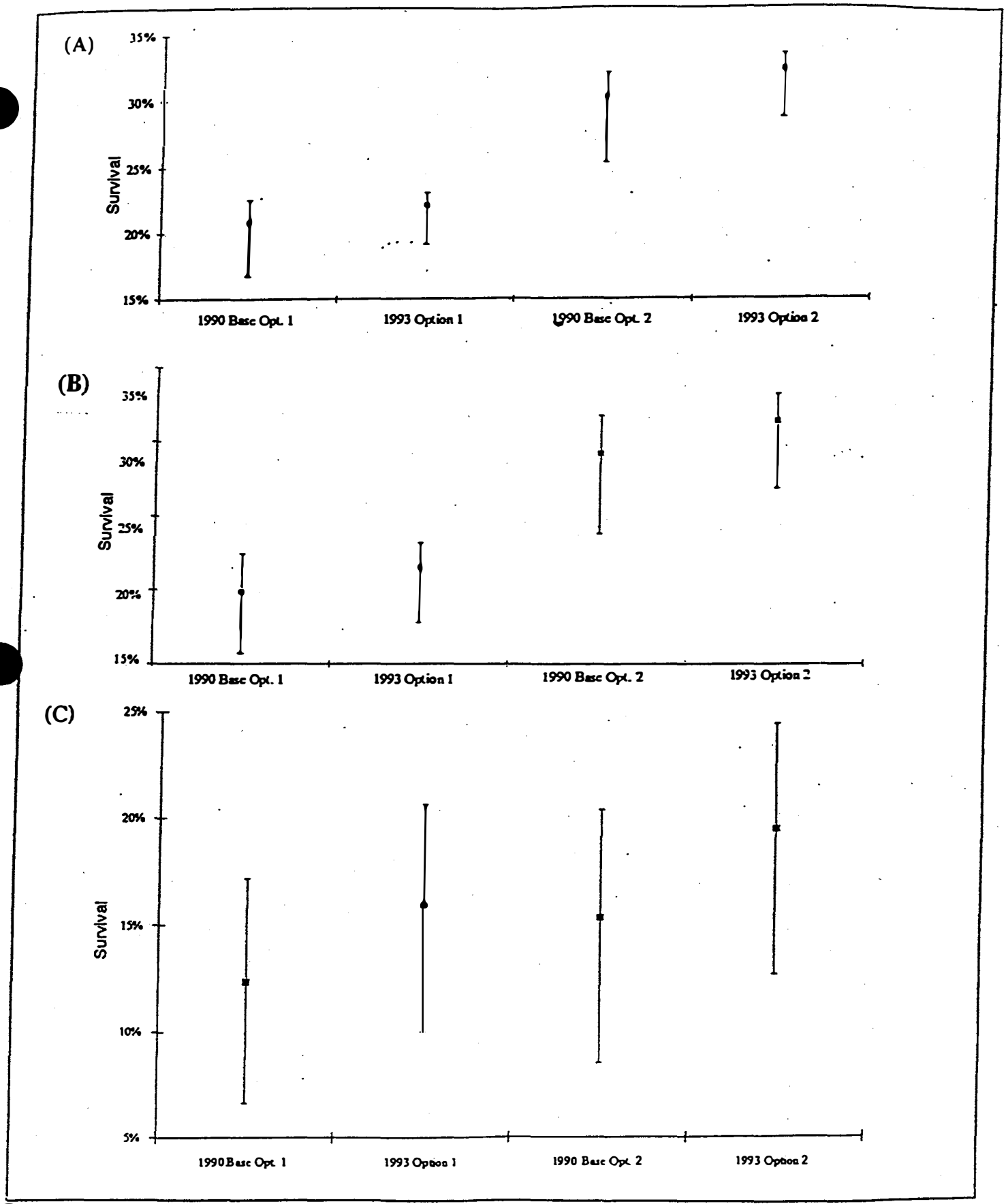


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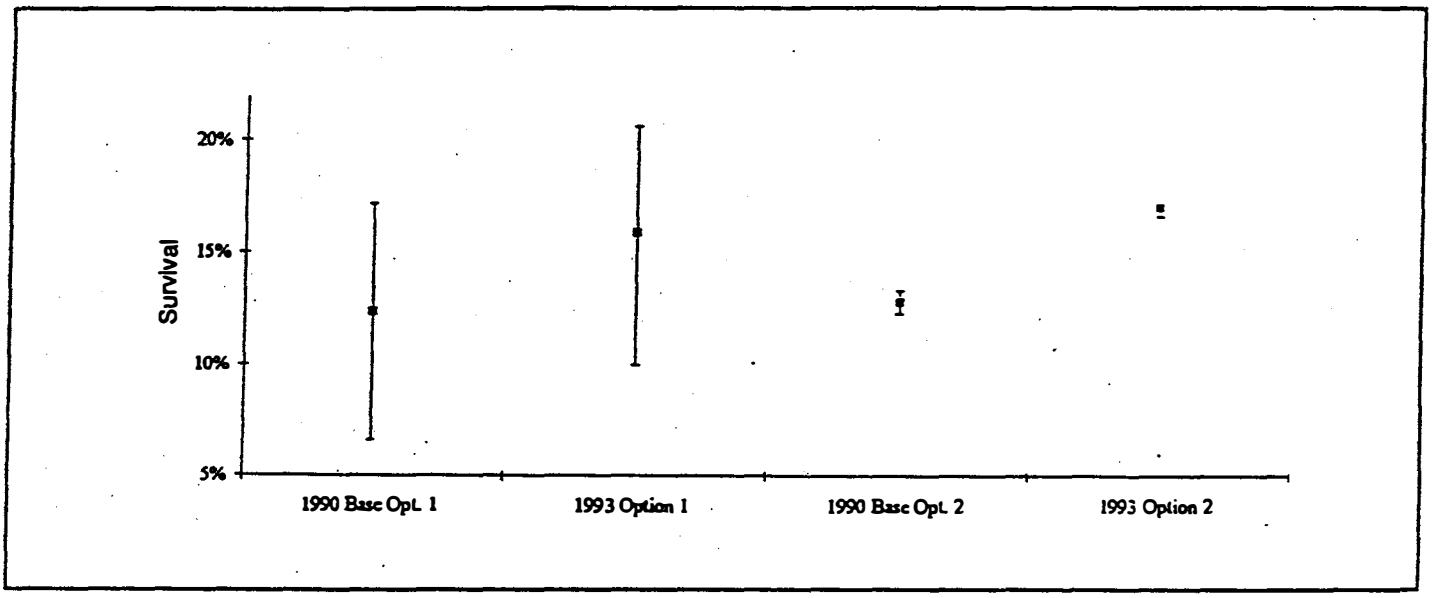


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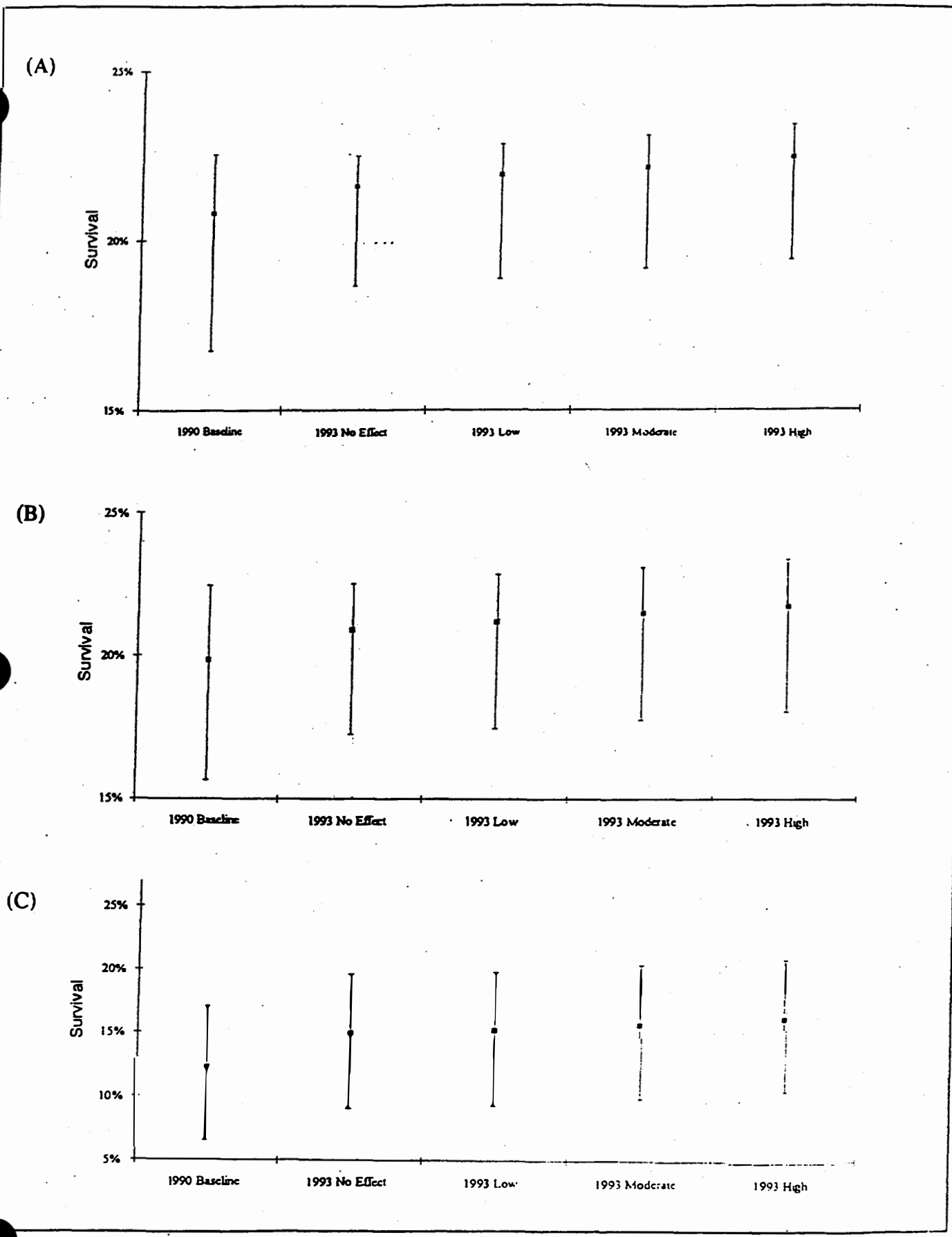


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2.4 Summary of Analytical Findings

2.4.1 Effects on Sockeye Salmon

The actions proposed for 1993 and future years provide conditions that should lead to greater numbers of Snake River sockeye salmon and viability of the population than exists under baseline conditions.

The greatest contribution to the number of adult sockeye salmon in the near term will come from the captive rearing program. This program is expected to greatly increase the number of juvenile sockeye salmon that can be released to migrate to the ocean. The first planned release is in the spring or fall of 1994.

Any sockeye salmon that may migrate in 1993 will benefit from the measures taken to improve conditions for migrating adult juvenile Snake River spring/summer chinook salmon. The projected improvements in survival for migrating juvenile sockeye salmon are estimated to be similar to the projected improvements in survival for migrating juvenile Snake River spring/summer chinook salmon.

The combination of the captive rearing program and improved migration conditions are expected to increase the number and productivity of Snake River sockeye salmon. Consequently, the action agencies conclude that their proposed action for 1993 and future years is not likely to jeopardize the continued existence of this species or result in the destruction or adverse modificaton of their critical habitat.

2.4.2 Effects on Spring/Summer Chinook Salmon

The action agencies believe that their actions are likely to affect the listed species. To assess the extend of the impact on listed species, our proposed action has been evaluated in the context of foreseeable actions by others.

The empirical data indicate that escapement trends over the near term will be generally stable or slightly decreasing compared to 1989-1992. The long-term modeling projections of population trends for spring/summer chinook salmon are positive. Biological modeling projections show improvements in juvenile migration survival in 1993 and future years. Life cycle modeling projections show that the improvements in juvenile passage survival in combination with improvements in other life stages resulting from habitat, harvest, and adult migration measures will lead to a reversal of the current population decline and increased population levels in the future. The increase in spawning population should lead to a corresponding increase in the numbers of redds. The positive population trends over a 40-year period shows that actions at all life stages can enable the species to not only avoid jeopardy but also improve toward recovery. The action agencies conclude, therefore, that their actions are not likely to jeopardize the listed species or result in the destruction or adverse modification of their critical habitat.

The action agencies are aware that the number of spring/summer chinook salmon that may spawn in a given tributary is a subset of the overall escapement for the species. However, due to the larger escapement level for spring/summer chinook salmon in contrast to fall chinook salmon, the action agencies believe that spring/summer chinook salmon are not subject to the same risk of inbreeding and extinction as fall chinook salmon. In addition, the recommended measures that should result in increased spawning escapement for fall chinook salmon should also benefit spring/summer chinook salmon.

2.4.3 Effects on Fall Chinook Salmon

In its decision to list Snake River fall chinook salmon as a threatened species, NMFS identified hydroelectric projects, including Federal projects, as one of the causes of the species' decline. 56 Fed. Reg. 14654, 14660 (April 22, 1992). Although, based upon their analyses, the action agencies expect their proposed action to increase the rate of survival of juveniles and adults above the rate of survival that would occur under baseline period (1989-1990) operating conditions, mortality to the species will still occur. The action agencies believe that their actions are likely to adversely affect the listed species, and they will formally consult with NMFS about whether and how their actions, in combination with possible actions of others, can avoid jeopardy to the species. This formal consultation will be part of NMFS' comprehensive consultations on harvest, habitat, hydroelectric and hatchery activities affecting listed species. The action proposed by the action agencies has been evaluated in the context of foreseeable actions by others.

NMFS expects each segment affecting a listed species (i.e., harvest, habitat, hydroelectric, and hatcheries) to contribute to improved survival of the species. Additionally, actions taken in 1993 and future years, if continued for four complete life cycles (16 years), should result in stabilization of the species abundance at pre-ESA levels. This latter level is taken to be the mean abundance in the five years prior to initiation of the petitions (i.e., 1986 to 1990).

The long-term modeling projections of population trends for fall chinook salmon are positive. Biological modeling projections show improvements in juvenile migration survival in 1993 and future years. Life cycle modeling projections show that the improvements in juvenile passage survival and adult escapement in combination with improvements in other life stages resulting from habitat, harvest, and adult migration measures will lead to a reversal of the current population decline and increased population levels in the future. Referencing NMFS' expectations, the positive population trends over a 40-year period shows that actions at all life stages can enable the species to not only avoid jeopardy but also improve toward recovery.

Due to incomplete scientific information on these species, projections about future runs, whether based upon empirical or modeling analyses, cannot be

made with precision. For a discussion of uncertainty, see Sections 2.0, 2.2.2, and 2.3.1 of this Assessment.

These factors place importance on considering information which suggests possible continued low population levels for Snake River fall chinook salmon over the next few years. The slight decline in the species' population since 1976, combined with the occurrence of low jack counts and low numbers of redds in 1992, warrant concern that adult returns may not improve over the next few years. Continued exposure of a small population to the short term risks of inbreeding and erosion of genetic variability may inhibit reversal of the species' population decline.

A consensus regarding the minimum acceptable effective size for a population does not exist. Until this issue is resolved, the various Federal agencies whose actions affect these fish should endeavor to reduce the risk of small population problems by increasing the effective population size. The action agencies support additional research to reduce the uncertainty involved in evaluating impacts on the listed species.

To provide prompt, near term benefits in spawning escapement, action agencies recommend implementation of measures emphasizing benefits to returning adults. Such measures may be implemented by the various Federal agencies affecting the life stages of Snake River fall chinook salmon, including agencies other than the Corps, BoR, and BPA. Consideration of measures implementable by these many entities is consistent with NMFS' endeavor to conduct comprehensive consultation and permit processes for all activities affecting listed species and with the need to consider the cumulative effects of these various actions on the listed species.

The action agencies proposal includes many measures to benefit returning adults in addition to juveniles and thereby minimize the short term risks to the population. They are described in this Assessment and in greater detail in the SEIS. See "Non Flow Measures" Section 1.1.2 and Appendix A. Based on NMFS' expectations, the action agencies conclude that their actions are not likely to jeopardize the listed species or result in the destruction or adverse modification of their critical habitat.

The action agencies also propose to work with other entities to help implement a measure to provide flows from the Hells Canyon Dam complex to protect the spawning and rearing habitat below the dam (i.e., prevent dewatering of redds).

As a conservation measure, the action agencies propose to work with other entities to evaluate and, if appropriate, plan enhancement of spawning areas (e.g., adding spawning substrate or gravel bars to existing and potential spawning areas) in the reach below Hells Canyon, lower reaches of other tributaries, and below the lower Snake River dams, as identified and deemed beneficial by ongoing life history research.

Adjustments to the Federal hydro-system alone cannot provide significant near term benefits to spawning escapement. Other Federal agencies may be able to effectively institute measures to increase the numbers of returning adult spawners that would remedy the projected suboptimum situation at the reproductive life stage. Several forums exist in which decisions affecting this life stage are made, such as the US/Canada Treaty negotiations, PFMC harvest regulations, and decisions affecting in-river harvest rates.

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Acronym Table

BO	Biological Opinion
BoR	Bureau of Reclamation
BPA	Bonneville Power Administration
C&S	ceremonial and subsistence (harvest fisheries)
Corps	U.S. Army Corps of Engineers
CREM	Columbia River Ecosystem Model
CRiSP.0	Columbia River Salmon Passage model, first version
CRITFC	Columbia River Inter-Tribal Fish Commission
CSC	Computer Sciences Corporation
CWT	coded wire tag
EFHRL	Eagle Fish Health Research Laboratory
ESA	Endangered Species Act
ESU	evolutionarily significant unit
FCRPS	Federal Columbia River Power System
FGE	fish guidance efficiency
FPDEP	Fish Passage Development and Evaluation Program
FPP	Fish Passage Plan
FTOT	Fish Transportation Oversight Team
FY	fiscal year
HYSSR	Hydrosystem Seasonal Regulatory Model
IDFG	Idaho Department of Fish and Game
IDP	Idaho Power
kaf	thousand acre-feet
MAF	million acre-feet
MOA	memorandum of agreement
MOP	minimum operating pool
NMFS	National Marine Fisheries Service
NMFS ETSD	NMFS' Environmental Technical Services Division
NPPC	Northwest Power Planning Council
OA/EIS	1992 Options Analysis/Environmental Impact Statement
ODFW	Oregon Department of Fish and Wildlife
Oncorhynchus nerka, or *O. nerka*	sockeye salmon
Oncorhynchus tshawytscha, or *O. tshawytscha*	chinook salmon
PAM	Passage Analysis Model
PFMC	Pacific Fisheries Management Council
PIES	Project Improvements for Endangered Species
PIT tag	passive integrated transponder tag

PITAGIS, or PTAGIS	PIT tag Information System
PSC	Pacific Salmon Commission
SBT	Shoshone-Bannock Tribes
SEIS	Supplemental Environmental Impact Statement
SLCM	Stochastic Life Cycle Model
SPM	System Planning Model
SRW	Snake River wild (salmon)
USFWS	U.S. Fish and Wildlife Service
WDF	Washington Department of Fisheries
WDW	Washington Department of Wildlife

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APPENDIX A

1993 NONFLOW ACTIONS

Introduction

The 1993 nonflow actions not related to flow improvements are already programmed and will be implemented independent of any interim flow improvement measures adopted. The 1993 nonflow actions include project operations elements such as maintenance of the fish facilities, operation of the fish transportation program, provision for spill at selected dams, and others. Also included in the 1993 nonflow actions are continuation of the squawfish monitoring program, law enforcement, continuation of the PIT tag program, construction of projects authorized under the Projects Improvements for Endangered Species Program, and an experimental fish harvest reduction project.

Nonflow Project Operations

The 1993 nonflow project operations are represented by the Draft 1993 Fish Passage Plan (FPP). The Draft 1993 FPP contains detailed criteria for operation and maintenance of fish passage facilities and project operation procedures for fish passage at Corps projects on the lower Snake and lower Columbia Rivers. It also includes research occurring at the projects in 1993, the Fish Transportation Oversight Team's Annual Work Plan for 1993, BPA's System Load Shaping Guidelines to Enable Operating Turbines at Peak Efficiency in 1993, the Dissolved Gas Monitoring Program and proposed changes to project operations at Bonneville. Changes to project operations at Bonneville include completion of fish guidance efficiency (FGE) improvements at the second powerhouse, operation of the second powerhouse prior to the first in the spring, and minimum spill limits. The 1993 proposed spill at The Dalles, John Day, and Ice Harbor will be in accordance with the Fish Spill Memorandum of Agreement and the April 1992 Biological Opinion. No spill is

proposed for Lower Monumental due to installation of the juvenile bypass and transportation facilities. The Draft 1993 FPP has been provided to NMFS as a part of the 1993 Section 7 consultation. (Letter from Robert P. Flanagan (Corps) to Rolland Schmitten (NMFS) January 5, 1993.) The Draft 1993 FPP also discusses hatchery releases. Proposed 1993 hatchery operations will be described in the Hatchery Biological Assessments, and submitted to NMFS as part of the 1993 Section 7 consultation.

Squawfish Management

Predation may be a substantial source of mortality for juvenile salmon migrating downstream through reservoirs on the lower Snake and Columbia rivers. Squawfish are the primary predator of juvenile salmon in the hydrosystem. BPA funds a multi-faceted program to reduce squawfish predation, including removal fisheries, harvest technology research, prey protection measures, and basic biological research. The management program is based on the premise that a sustained, annual squawfish harvest rate of 10 to 20 percent of the total population will result in a reduction in losses of juvenile salmonids due to predation by 50 percent or more within 10 years (Beamesderfer et al., 1990). Additional reductions in predator-related mortality may be realized through prey protection measures. The squawfish management program will continue in 1993.

Law Enforcement

The Columbia River Inter-Tribal Fish Commission (CRITFC), the Oregon State Police, the Washington Department of Fisheries (WDF) and the Idaho Department of Fish and Game (IDFG) procured necessary equipment, hired additional law officers, and implemented enhanced inter-agency operations. The program is now at full force and will continue. If success is clearly demonstrated by 1995, BPA will seek long-term Federal funding for increased law enforcement. Such Federal funding is intended to provide an added level of effort to that provided by State and Tribal entities under normal conditions.

PIT-Tagging Program

Mainstem passage Passive Integrated Transponder (PIT) tag data provides key information used for making real-time decisions related to the Smolt Monitoring/Water Budget Management Program. PIT tags are the best available method for investigating relationships among flows, spill, travel time, smolt condition, smolt survival, and adult production. Time series PIT tag data are needed for evaluation of the effectiveness of the Water Budget, spill usage, and related actions in improving downstream migrant survival.

About 200,000 Columbia River juveniles will be marked with unique PIT tags and will migrate to sea during 1993. (Approximately 120,000 were marked in 1991 and 1992.) If 1993 detection/recovery rates of PIT tagged juveniles are comparable to rates observed in 1991 and 1992, it is likely that information on 33% to 40% of the of PIT-tagged fish will be recovered from fish passing through bypass and fish monitoring facilities of the Snake, Columbia and Yakima Rivers.

The five permanent PIT tag interrogation sites will continue to operate in 1993:

- Lower Granite (adult)
- Lower Granite (juvenile)
- Little Goose (juvenile)
- McNary (juvenile)
- Prosser (juvenile)

The recently completed Lower Monumental Dam bypass system (which can interrogate 100% of collected juveniles) will be added as a permanent PIT tag interrogation site in 1993. Portable PIT tag detection systems at John Day Dam and Powerhouse 1 of Bonneville Dam will continue to operate. The existing portable PIT tag detection systems at smolt monitoring and research trapsites will continue to operate. Additional portable PIT tag detection systems will be installed and operational at other trapsites, such as the reintroduced Salmon River smolt monitoring site.

Project Improvements for Endangered Species

The Project Improvements for Endangered Species (PIES) program was initiated by the Corps in 1991. PIES consists of multiple individual projects involving the juvenile bypass, adult fishway, or transportation program facilities at each dam.

PIES projects will be implemented over a period of years. Some PIES actions have already been completed, but most are currently in the study or plans-and-specifications stage. Existing schedules and budgets for the PIES program indicate that most of these improvements will be implemented by FY 1994, and all will be completed by FY 1996.

A detailed status of the elements in the PIES has been provided to NMFS as part of the 1993 Section 7 consultation. (Letter from Robert P. Flanagan (Corps) to Rolland Schmitten (NMFS) January 5, 1993.)

Experimental Fish Harvest Reduction Project

BPA is proposing to fund an experimental fish harvest reduction project designed to cost-effectively achieve greater escapement of Columbia River Basin salmon stocks. Specifically, this proposed project is aimed at improving escapement of Snake River fall chinook salmon stocks currently listed as threatened under the ESA.

The Columbia River non-Indian commercial gillnet fishery consists of over 800 licensed fishing vessels in Oregon and Washington. These vessels fish for salmon and sturgeon on the mainstem Columbia River. Although regulated under the Columbia River Compact (Compact), the gillnet fleet's harvest capacity has expanded to the point where mainstem harvest rates on weak salmon stocks has significantly increased. In 1993, the Compact is expected to continue to aggressively control excessive mainstem harvest rates and benefit weak salmon stocks by reducing the length of the gillnet season.

Another method of controlling excessive harvest rates, which can be used in conjunction with restricted seasons and quotas, is to reduce the number of fishing vessels that are potentially capable of harvesting weak salmon stocks. This proposed project would attempt to assess whether the existing harvest capacity of the mainstem non-Indian commercial gillnet fleet can be further reduced by contracting with fishers not to fish on an experimental basis in 1993. Those participating would not be able to fish during the 1993 fall season, when adult upriver fall chinook salmon are migrating up the mainstem Columbia River. Those salmon not harvested would be allowed to pass through inriver fisheries to increase escapement and accelerate the recovery of threatened Snake River fall chinook salmon stocks. The project should also increase escapement of other depressed anadromous stocks.

The overall proposed project would involve a temporary contract with fishers during the 1993 fall fishing season. The general contractual terms would likely include the following elements:

- Allow fishers holding valid 1991 and 1992 Oregon and Washington Columbia River commercial gillnet licenses to participate.

- Voluntary participants would be restricted from fishing the mainstem Columbia River during the agreed upon time frame when fall chinook salmon are migrating, but would be allowed to maintain their licenses to fish in non-mainstem fisheries for other productive salmon species.

- The price established for the contract would likely be based on each fishing vessel's average historical Columbia River salmon landings during 1986-1990. In cases where a license was purchased after 1986, lease-back prices would be based on average landings since the time licenses were purchased. Should fall chinook salmon runs in the Columbia River be greater than predicted, participating fishers would be appropriately compensated through a post-season payment plan for the additional fish that could have been harvested.

- The experimental contract program would be monitored and evaluated to determine the level of voluntary participation, degree of harvest management cooperation by the Compact, increase in escapement of upriver fall chinook stocks, and fishers' compliance with the terms of BPA contracts.

Research on Smolt Survival Estimation

The recent advent of PIT tag technology in the Columbia basin and recently developed analytical approaches (Burnham et al. 1987, Dauble et al. in press) permit feasibility assessments of acquiring reliable smolt survival estimates. The National Marine Fisheries Service, together with the University of Washington (Iwamoto et al. 1993), has developed a study design to improve methods of measuring smolt travel time and survival through specified Columbia River reaches. This research, proposed to begin in 1993, will test and validate a method for estimating smolt survival with measurable precision.

The 1993 pilot study will utilize PIT tag technology and recently developed analytical approaches to estimate smolt survival and travel time through the Snake River to Lower Granite Dam. Hatchery-reared yearling chinook salmon will be used to field test and evaluate design elements and logistical constraints. If successful, research will continue in 1994 to refine the statistical methodology and to define and eliminate logistical constraints. In 1995 and 1996, previous years' findings will be applied toward determining survival estimates for wild chinook salmon migrants.

APPENDIX B

HARVEST, HABITAT AND HATCHERIES

Ocean Harvest

There are no specific data on ocean distributions, contributions to fisheries or harvest rates of wild/naturally spawning Snake River sockeye salmon, spring chinook salmon, summer chinook salmon, or fall chinook salmon because none of these fish have been identifiable in the previous catches (e.g., by physical, electronic, visual, or genetic means). No information is available on ocean harvest of Snake River sockeye salmon. It is only known that the total population size of this stock in the ocean is very low. In the future, all Snake River sockeye salmon released in the natural environment will be PIT tagged. Some ocean harvest information will be collected, though sample sizes will be small.

Due to limited numbers of marked fish and low sampling rates in ocean fisheries, only limited harvest information is available on the surrogate stocks. Based on the available information, the ocean harvest of Snake River spring and summer chinook salmon is presumed to be low, i.e., about 5 percent (Don McIsaac, ODFW, pers. comm., 1991). However, a recent analysis of coded wire tag (CWT) data by PFMC (Table B-1) indicated that ocean fisheries may have a much higher impact on Snake River summer chinook salmon than on spring chinook salmon (PFMC, 1992b).

Table B-1. Analysis of coded wire tag data from 1976-87 releases for Snake River spring and summer chinook salmon; tabular values show the number of tags recaptured in ocean fisheries compared to in-river fisheries and escapement combined (PFMC 1992b).

SNAKE RIVER STOCK	NUMBER TAGGED	TOTAL OCEAN FISHERIES (U.S. component)	IN-RIVER FISHERIES & ESCAPEMENT
Spring Chinook salmon (Rapid River & Sawtooth hatcheries)	2.8 million	4 (0)	622
Summer Chinook salmon: (McCall hatchery)	--	27 (20)	195

Of ocean recaptures, summer chinook salmon were primarily taken in U.S. fisheries while spring chinook salmon were recaptured in Canadian fisheries; none were recaptured in Alaskan waters.

In contrast, Snake River fall salmon salmon experience relatively high harvest rates in the ocean fisheries. Based on the PFMC chinook salmon harvest model and 1984 and 1985 brood CWT data, Dygert (1992) estimated that ocean fisheries harvest 47.1% of 4-year-old Snake River fall chinook salmon -- the PSC component is 43.5% and the PFMC component is 3.6%. PFMC's analysis of CWT releases of fingerling, non-transported fall chinook salmon from Lyons Ferry Hatchery indicate that the stock is widely distributed.

Snake River fall chinook salmon are harvested by marine troll, sport and net fisheries from southern California to Alaska. Based on 1992 regulations, the greatest proportion of the ocean harvest occurs in Canadian fisheries; i.e., about 75% of age-3 and 86% of age-4 (Table B-2, PFMC 1992b).

Table B.2. Distribution of ocean fishery impacts on Lyons Ferry fall chinook salmon, under the Council's 1992 regulations.

AREA	Age-3	Age-4
Council Area Salmon Fisheries	0.0285 (23.5%)	0.0361 (7.7%)
Southeast Alaska	0.0021 (1.8%)	0.0318 (6.8%)
Canada	0.0907 (74.7%)	0.4029 (85.6%

The PFMC is responsible for establishing harvest regulations for ocean fisheries. On April 17, PFMC made final recommendations of ocean commercial and sport seasons. PFMC completed a BA of these fishing regulations on listed ESA stocks on April 30 (PFMC 1992b), and the Secretary of the Department of Commerce approved the regulations on May 1, 1992. The regulations established a 1992 harvest ceiling of 113,000 chinook salmon for all fisheries north of Cape Falcon, Oregon to the U.S.-Canada border. This ceiling was the same as the 1991 quota.

Snake River fall chinook salmon was the major Columbia River ESA stock impacted by ocean fisheries. The 1992 regulations are estimated to decrease ocean exploitation rates on Snake River fall chinook salmon by 40% (3% north of Cape Falcon, and 64% south of Cape Falcon) compared to the 1986-90 average. Major harvest reductions occurred south of Cape Falcon to protect the Klamath River fall chinook salmon -- the primary natural chinook salmon stock for which PFMC managed the region (spawning escapement objectives for this stock are established, but were not met in 1992).

Columbia River Fisheries

Sockeye Salmon

No sockeye salmon are harvested commercially in the mainstem Columbia River below its confluence with the Snake River; very limited harvest is permitted in Zone 6. This moratorium is due to moderate to low run sizes of mid-Columbia sockeye salmon populations as well as ESA concerns for the listed Snake River population.

Spring Chinook Salmon

The lower gill net fishery is allocated an incidental catch of 4.1% of the upriver bright run. The Zone 1-6 fishery is allowed 7% of the upriver run. The pre-season run-size projection of upriver spring chinook salmon was 71,400 adults. Based on this projection, the targeted harvest rate was 3.6% for the Zone 1-5 lower river fisheries and 7% for Zone 6 Treaty fisheries (Table B-3).

Table B-3. Projected catches of spring chinook salmon in 1992 winter and spring fisheries, based on a projected run size of 71,400 upriver fish.

Fishery	Total Catch	Upriver (number)	Catch (percent)	Snake River Catch - wild (12.84%)
Winter gill net	7,800	1,080	1.5%	138
March sport		1,500	2.1%	238
Treaty Gill net	–	3	(89-91 average)	–
C&S	–	4,998	7%	642
Test Fisheries	--	114 (handle 465)		15

Because of a late run, the early Zone 1-5 gill net fishery did not reach expected harvest numbers. In addition, the upriver run-size projection underestimated the actual run, which was 89,715 adults. The lower sport and commercial river harvest rate was only 1.4% instead of 3.6% (Table B-4). Even though the number of fish harvested in Zone 6 was higher than projected, the harvest rate was under 7%.

Table B-4. Actual catches of spring chinook salmon in 1992 winter and spring fisheries, based on an actual run size of 89,715 upriver fish.

Fishery	Total Catch	Upriver (number)	Catch (percent)	Snake River Catch - wild (12.84%)
Winter gill net, February 16-28	4,686	216	0.2%	
Sport, March 1-27	4,722	1,074	1.2%	
Total lower river catch	9,408	1,290	1.4%	
Treaty Gill net for steelhead and sturgeon	--	53	0.06%	--
C&S	--	5,694	6.4%	
Test Fisheries	--			

Summer Chinook Salmon

The USFWS BA of in-river summer and fall fisheries has been completed. As in previous years, there will be no targeted summer chinook salmon fishery. The take will be limited to the Zone 6 C&S harvest according to U.S. v. Oregon; this has been 100 fish or less for the past three years. The 1992 harvest in C&S fisheries is also estimated at less that 100 summer chinook salmon. The projected 1992 run size of summer chinook salmon at the mouth of the Columbia River is 24,200; 15 percent, or 3,664 fish, are estimated to be wild Snake River summer chinook salmon.

Fall Fishery Summary

The last seasons were set at the final Compact meeting on October 21, 1992. Lower river (Zone 1-5) gillnet fisheries escalated in the latter part of the season due to increased run size projections of coho salmon -- from a pre-season forecast of 60,900 to an estimate of 115,000-125,000 adults as of October 21. The ratio of chinook salmon to coho salmon was high in the early season and declined in the late season; gillnet mesh size was restricted to a 7-inch maximum to target coho salmon. Total catch up to October 17 was 15,000 coho salmon and 16,000 chinook salmon. The catch during October 18-23 was 13,000 coho salmon and 500 chinook salmon, and projected catch for the final week of the season, which ends October 30, is 11,000 coho and 400 chinook salmon.

The total estimated catch for the Zone 1-5 fishery is 39,000 coho salmon and 16,900 chinooksalmon. The catch of Snake River wild chinook salmon in the Zone 1-5 fisheries was projected to be 144 through October 22.

The final Zone 6 fishery of October 12-17 targeted steelhead, with incidental catches of upriver bright chinook salmon. The Zone 6 fall fishery lasted 8 weeks and included 31 days of fishing. The total catch was 48,811 steelhead, 31,519 chinook salmon, 1,116 coho salmon, and 597 walleye. The total catch of upriver fall chinook salmon in Zone 6 Treaty fisheries was 15,820, of which an estimated 362 were wild Snake River fall chinook salmon. An estimated 200 fall chinook salmon were taken in sport fisheries. The final in-river fishery will be a set-line sturgeon fishery from October 26 through the end of November in Bonneville Pool; an in-season technical review will occur on November 15.

The total estimated commercial salmonid catch in Zone 1-6 in-river fall fisheries is 40,000 coho salmon, 50,000 total fall chinook salmon, and 48,811 steelhead through the end of October (Table B-5). The estimated total number of fall chinook salmon run entering the Columbia River was 151,200, including 30,000 Bonneville Pool Hatchery, 44,200 McNary bright and 77,000 upriver bright. The current estimate of adult upriver bright fall chinook salmon is 66,300, considerably greater than the pre-season forecast.

The projected 1992 run size of Snake River wild (SRW) fall chinook salmon was 2,141 adults, compared to 1,844 in 1991. An estimated 535 SRW fall chinook salmon were harvested in the commercial fisheries in 1992. Based on pre-season run-size projections, the estimated harvest rate on SRW fall chinook salmon was 11.6 %. Due to a larger than expected run, however, fishing effort increased and the actual 1992 in-river harvest rate on SRW fall chinook salmon was 24.0% (7.1% non-Treaty and 16.9% Treaty). The 1992 management ceiling was 28.2%; previous in-river harvest rates were 26.8% in 1991, and a mean of 47.0% during 1986-1990.

The count of fall chinook salmon at McNary Dam was 50,911 adults as of October 25. It has substantially exceeded the fishery management goal of 45,000. The count of adult Snake River fall chinook salmon at Lower Granite Dam (not corrected for strays) was 856 as of December 9. A preliminary estimate of the total 1992 run of SRW fall chinook salmon salmon past Lower Granite Dam is 535 adults (Don Swartz, ODFW, 10/29/92). In comparison, the total 1991 Snake River fall chinook salmon run past Lower Granite Dam was 630 adults; 318 were considered as wild. Thus, the 1992 run is estimated at 68% greater than in 1991. Prognosis for the future, however, is questionable since this year's jack count (101 as of December 9) is the lowest on record.

Table B-5. Actual catches of fall chinook salmon in 1992 fisheries, and estimated harvest rates based on an estimate run size of 77,000 upriver bright fall chinook salmon and 2,141 Snake River wild fall chinook salmon entering the Columbia River mouth.

Fishery	Total Catch	Upriver (number)	Bright Catch (percent of run)	Snake River Catch - wild number (%)
Lower River gill net, Zone 1-5	16,900	5,750		146 (6.8%)
Sport: Buoy-10	10,500	500		
Lower Columbia River	1,300	500		25 (1.2%)
Total lower river catch	28,700	6,750	8.77%	
Treaty Gill net, Zone 6	31,519	15,820	20.55%	362 (16.9%)
C&S				
Zone 6 Sport	100	100	0.1%	2 (0.1%)
Total:	89,019	22,670	29.44%	535 (25.0%)

Habitat

Pool habitat changes of Columbia River basin tributaries occupied by ESA listed salmon have been documented by Sedell and Everest (pers. comm., 1992). They examined and compared historic (Bureau of Fisheries) and more recent (US Forest Service) stream habitat surveys. Table B-6 shows frequency changes of large pools in the Snake River subbasin from 1935 to 1992. The average change in pool frequency was -41% for managed basins and +29% for unmanaged (wilderness) basins.

Table B-6 Changes in the frequency of large pools in the Snake River subbasin 1935-1992[4]

Managed Basins		1935-1941		1987-1992		
	miles	number of pools	number of pools/mile	number of pools	number of pools/mile	Percent change
Tucannon Basin, WA	52.1	152	2.9	413	7.9	172%
Asotin Basin, WA	26.0	116	4.5	77	3.0	-33%
Salmon River Basin, ID	106.4	1115	10.5	533	5.0	-52%
Grande Ronde River Basin, OR	104.9	904	8.6	329	3.1	-64%
Clearwater River Basin, ID	5.2	40	7.7	14	2.7	-65%
Total	289.4	2327	8.0	1366	4.7	-41%

[4]More than 3 feet deep and with an area of more than 25 yd^2.
Table from Sedell and McIntosh, PNW Research Station, 11/12/92.

Table B-6, continued

Non-managed Basins		1935-1941		1987-1992		
	miles	number of pools	number of pools/mile	number of pools	number of pools/mile	Percent change
Salmon River Basin, ID	70.5	514	7.3	664	9.4	29%

Hatchery Releases

Fisheries agencies and tribes provided release schedules for juvenile fish in their weekly Fish Passage Center report. Releases were coordinated to coincide with Water Budget and other coordinated flow augmentations, and with wild fish migration. See Table B-7.

Table B-7. Numbers of hatchery fish released into the Snake and Columbia river systems in 1992.

	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Snake River												
Above Lower Granite Dam												
Chinook salmon Fall		221										221
Chinook salmon Sp. and Sum.		5,527,965	2,459,046		67,404			305,600	2,444,800			10,804,815
Steelhead Win. and Sum.		227,500	9,551,029	242,951					425,230	456,426		10,903,136
Total		5,755,686	12,010,075	242,951	67,404			305,600	2,870,030	456,426		21,708,172
Above Lower Monumental Dam												
Chinook salmon Spring and Summer			99,057									99,057
Steelhead Win. and Sum.			288,366									288,366
Total			387,423									387,423
Upper Columbia												
Above Wells Dam												
Chinook salmon Sp. and Sum.			1,055,056	1,190,464								2,245,520
Total			1,055,056	1,190,464								2,245,520
Above Rocky Reach Dam												
Chinook salmon Fall				220,400								220,400
Chinook salmon Sp. and Sum.			817,700	377,840	765,693							1,961,233
Steelhead Win. and Sum.			47,360	29,600								76,960
Coho				435,200								435,200
Total			865,060	1,063,040	765,693							2,693,793
Above Rock Island Dam												
Chinook salmon Sp. and Sum.			2,258,034	1,048,535								3,306,569
Steelhead Win. and Sum.			266,693	210,480								477,173
Sockeye salmon					101,300				531,202			632,502
Total			2,524,727	1,259,015	101,300				531,202			4,416,244
Above Priest Rapids Dam												
Coho				388								388
Total				388								388

Table B-7, continued.

	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Mainstem Columbia												
Above McNary Dam												
Chinook salmon Fall					5,557,869							5,557,869
Chinook salmon Sp. and Sum.			1,200,000									1,200,000
Steelhead Win. and Sum.			530,396	50,951								581,347
Coho		689,930										689,930
Sockeye salmon					18,073		84,779			5,331		108,183
Total		689,930	1,730,396	50,951	5,575,942		84,779			5,331		8,137,329
Above John Day Dam												
Chinook salmon Fall		194,847		3,252,864	105,088				148,510			3,701,309
Chinook salmon Sp. and Sum.		196,657	90,796	5,937					158,436	159,624		611,450
Steelhead Win. and Sum.			3,998	71,935								75,933
Coho		909,088										909,088
Total		1,300,592	94,794	3,330,736	105,088				306,946	159,624		5,297,780
Above the Dalles Dam												
Chinook salmon Sp. and Sum.			1,087,310						68,856			1,156,166
Steelhead Win. and Sum.			163,265									163,265
Total			1,250,575						68,856			1,319,431
Above Bonneville Dam												
Chinook salmon Fall		7,587,284	4,173,677	12,876,673	9,597,217				148,510		3,200,000	37,583,361
Chinook salmon Sp. and Sum.		6,016,809	12,455,101	3,162,433	833,097		471,402	305,600	4,315,200	78,840	61,000	27,699,482
Steelhead Win. and Sum.		62,608	11,079,442	1,246,552					425,230	456,426		13,270,258
Coho		1,599,018	3,927,323	435,200			111,600					6,073,141
Sockeye salmon						286,648			531,202			817,850
Total		15,265,719	31,635,543	17,720,858	10,430,314	286,648	583,002	305,600	5,420,142	535,266	3,261,000	85,444,092
Below Bonneville Dam												
Chinook salmon Fall		10,043,137	12,262,139	17,788,324	28,870,809	4,890,884	536,892	72,600				74,464,785
Chinook salmon Sp. and Sum.	556,814	5,096,101	2,456,193	6,764,071	1,664,116	90,366	571,136	315,000		1,135,654	603,000	19,252,451
Steelhead Win. and Sum.			3,241,704	1,989,512	68,024							5,299,240
Coho		1,438,725	15,694,022	6,203,120	2,268,075	599,400						26,203,342
Chum		847,598										847,598
Cutthroat			13,024	13,025								26,049
Total	556,814	17,425,561	33,667,082	32,758,052	32,871,024	5,580,650	1,108,028	387,600		1,135,654	603,000	126,093,465
GRAND TOTAL	556,814	40,437,488	84,950,731	57,616,455	49,917,765	5,867,298	1,775,809	998,800	9,197,176	2,292,301	3,864,000	257,474,637