3rd Generation Adaptable Monitoring Package

DE-EE0007827

Marine and Hydrokinetics Program

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Project Overview

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Project Summary

The 3G-AMP combines real-time, machine learning algorithms with modular hardware to characterize marine animal activity at marine energy sites accurately, at low cost, and without biasing animal behavior.

Real-time information about animal activity can close the loop for adaptive management and accelerate risk retirement.

Project Objective & Impact

- *Problem*: Low-probability, high-consequence environmental interactions (e.g., collision) cannot be retired by continuously archiving sensor data.
- *Objective*: Continuously observe marine environment and process data in real-time using machine learning to rapidly characterize animal activity.
- *Impact*: Prove the effectiveness and flexibility of the AMP architecture to reduce barriers to commercial adoption.

Project Information

Project Principal Investigator(s)

- Brian Polagye
- Andy Stewart (*departing*)
- Chris Bassett (*incoming*)

WPTO Lead

- Samantha Eaves

Project Partners/Subs

- MarineSitu, Inc.
- NOAA NMFS AK Fisheries Science Center

Project Duration

- December 2016
- November 2019 (*pending extension*)

Alignment with the Program

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Marine and Hydrokinetics (MHK) Program Strategic Approaches

Data Sharing and Analysis

Foundational and Crosscutting R&D

Technology-Specific Design and Validation

Reducing Barriers to Testing

Alignment with the MHK Program

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Reducing Barriers to Testing

- Enable access to world-class testing facilities that help accelerate the pace of technology development
- Work with agencies and other groups to ensure that existing data is well-utilized and identify potential improvements to regulatory processes and requirements
- **Support additional scientific research as needed, focused on retiring or mitigating environmental risks and reducing costs and complexity of environmental monitoring**
- Engage in relevant coastal planning processes to ensure that MHK development interests are equitably considered

The 3G-AMP's modular, endurance-tested design expands monitoring capabilities while reducing monitoring complexity.

Project Budget

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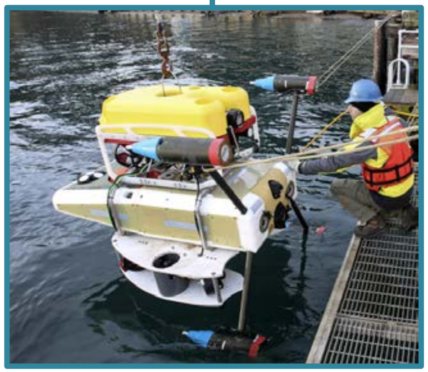
Total Project Budget – Award Information		
DOE	Cost-share	Total
$1397k	$158k	$1555k

FY17	FY18	FY19 (Q1 & Q2 Only)	Total Actual Costs FY17–FY19 Q1 & Q2 (October 2016 – March 2019)
Costed	Costed	Costed	Total
$148k	$649k	$231k	$1028k

- **Project benefited from concurrent activities associated with:**
  - Development of illumination system for fish reaction study (NOAA)
  - Fabrication of an AMP for WETS (DOD NAVFAC) powered by a WEC
  - Data streams from AMP deployment at WETS (DOE iAMP)
  - Graduate student support (NSF Graduate Research Fellowship)

Management and Technical Approach

2G-AMP
2015-2016



2.5G-AMP
2017

3G-AMP
2019

AutoAMP
2017

Autonomous Battery-powered

WAMP
2018

Autonomous Wave-powered

Management and Technical Approach

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Planned

2017	2018	2019

Deploy baseline AMP

Hardware and Software Upgrades

Deploy 3G-AMP at MSL

Deploy 3G-AMP at WETS

Actual

2017	2018	2019

Deploy baseline AMP

Long-lead items and serial design decisions →

Deploy 3G-AMP at MSL

Deploy 3G-AMP at WETS

Management and Technical Approach

- **Success Factors**
  - *Technical*: Demonstrated reliability and flexibility
  - *Market*: Demonstrated ability to retire risk
  - *Business*: Commercially-viable entity offering AMP services
- **Challenges**
  - *Marine energy market size*: Limited number of deployments large enough to warrant AMP-scale environmental monitoring
  - *Cost perception*: AMP backbone costs equivalent to a single sensor (e.g., multibeam sonar), but end-users perceive high system cost
  - *Replacement perception*: Potential end-users underestimate the cost and complexity of hardware and software integration (perception that DIY is cheap and easy)

End-User Engagement and Dissemination Strategy

- **Industry Interviews – BP1**

Wave Energy Device Developers	Current Energy Developers	Test Facilities	Supporting Organizations
• Oscilla Power • Columbia Power • NWEI • Ocean Energy Ltd.	• ORPC • Verdant Power • OpenHydro • MeyGen • Instream Energy	• PMEC • WETS • EMEC	• UMaine • SMRU consulting • PNNL • Aquatera

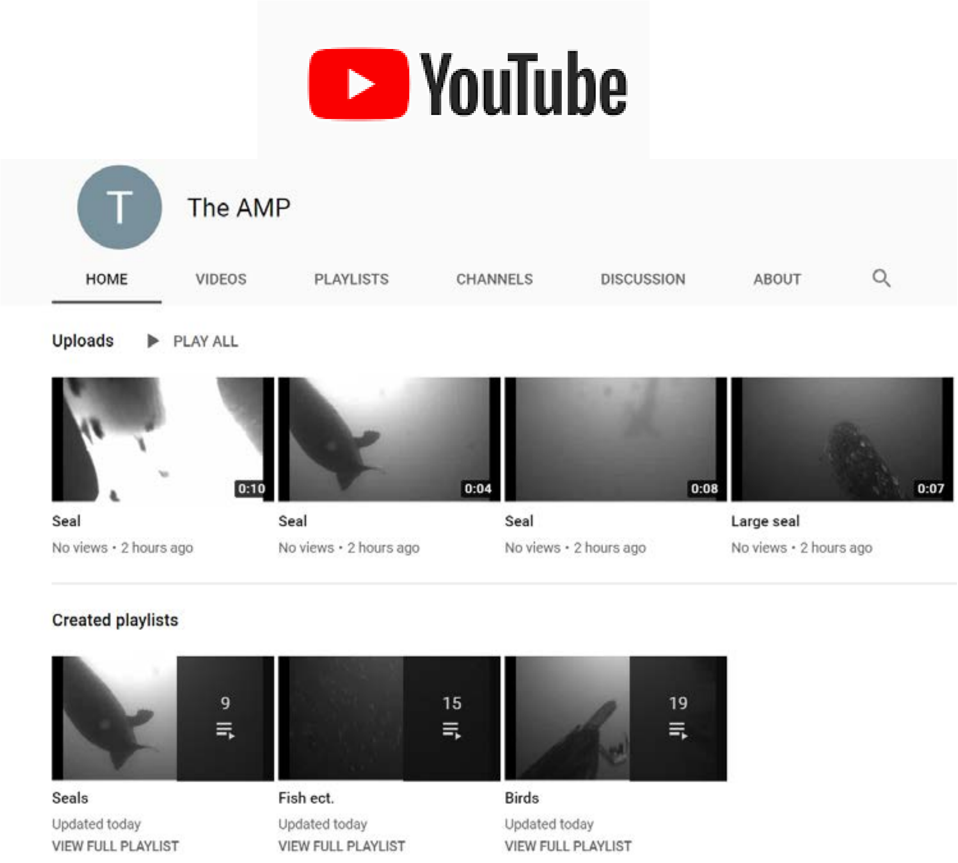
  - Need for demonstrations at fully energetic sites
  - Specific monitoring requirements for each project
  - Data visualization and acceptance

MarineSitu

- **ORPC contract for camera system software development**
- **FORCE Pathway Project contract for imaging sonar review**

End-User Engagement and Dissemination Strategy

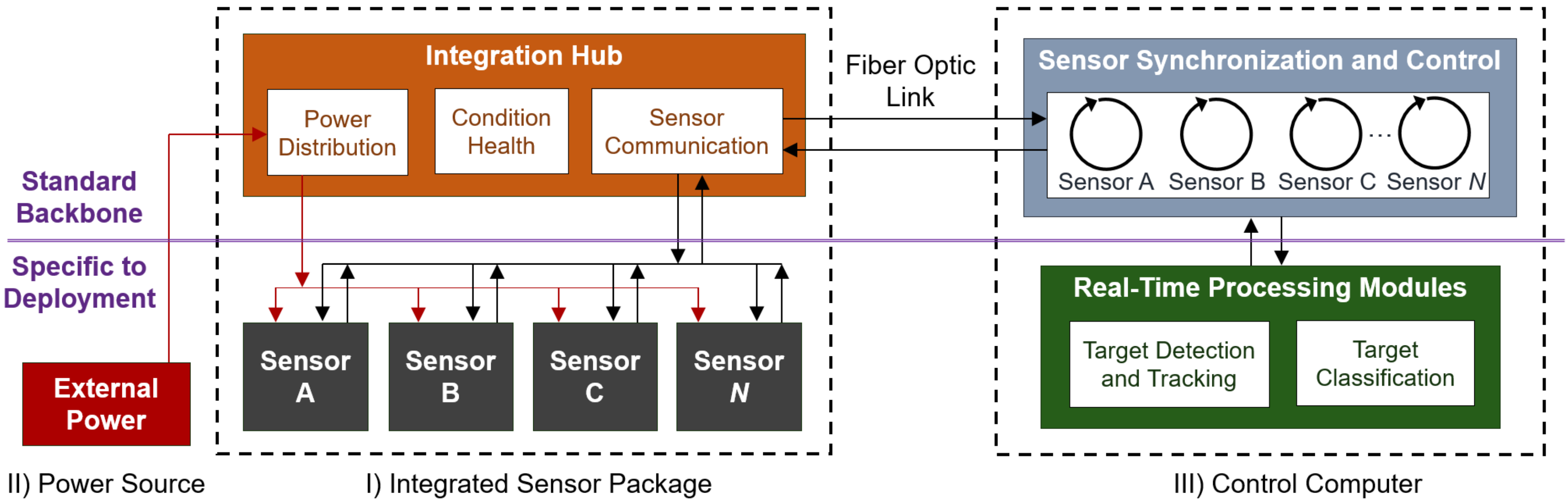
- **Presentations**
  - OES Collision Workshop
  - EIMR conference
  - METS conference
- **Publications**
  - Cotter et al. (2019) - Acoustic characterization of sensors used for marine environmental monitoring
  - Cotter and Polagye (*in review*) - Automatic classification of biological targets in a tidal channel using a multibeam sonar

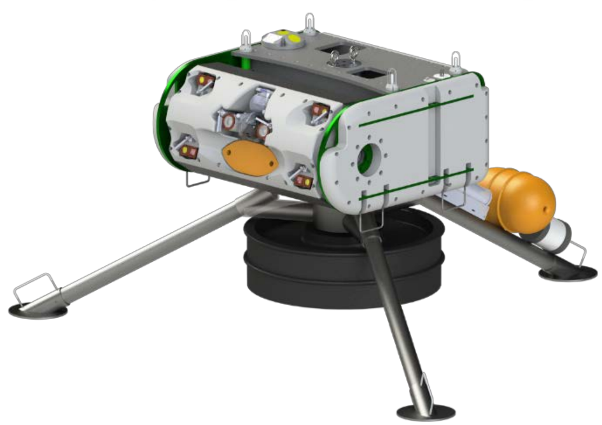


Public Dissemination

Technical Accomplishments

AMP Architecture Overview





Technical Accomplishments

Jan. 16 - Deployment

Jan. 22
Umbilical damage

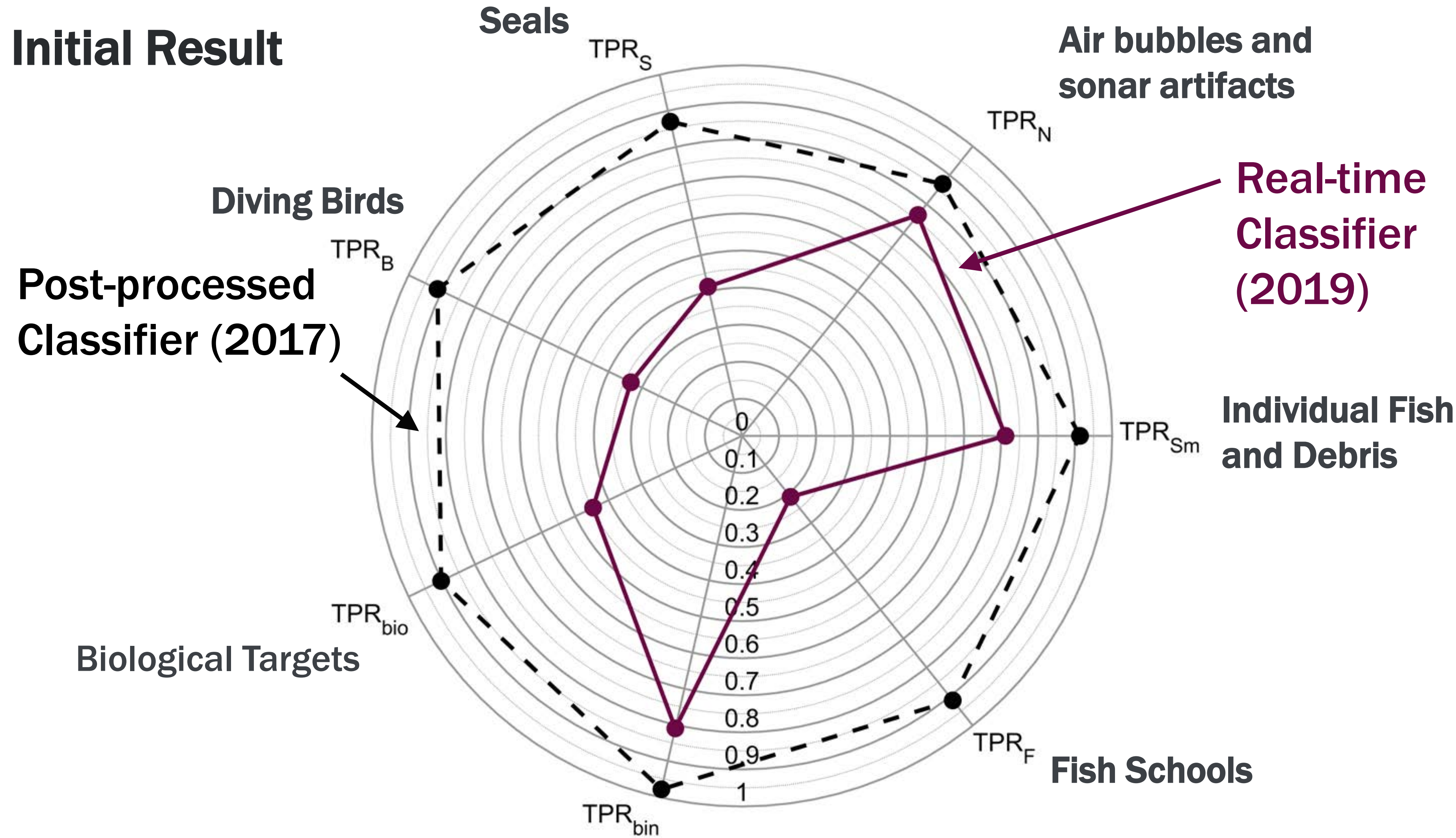
Jan. 29
Recovery
Umbilical replacement
Redeployment

174 days

97% uptime

May 28 - Recovery

Initial Result



Biological vs. Non-biological Target

Technical Accomplishments

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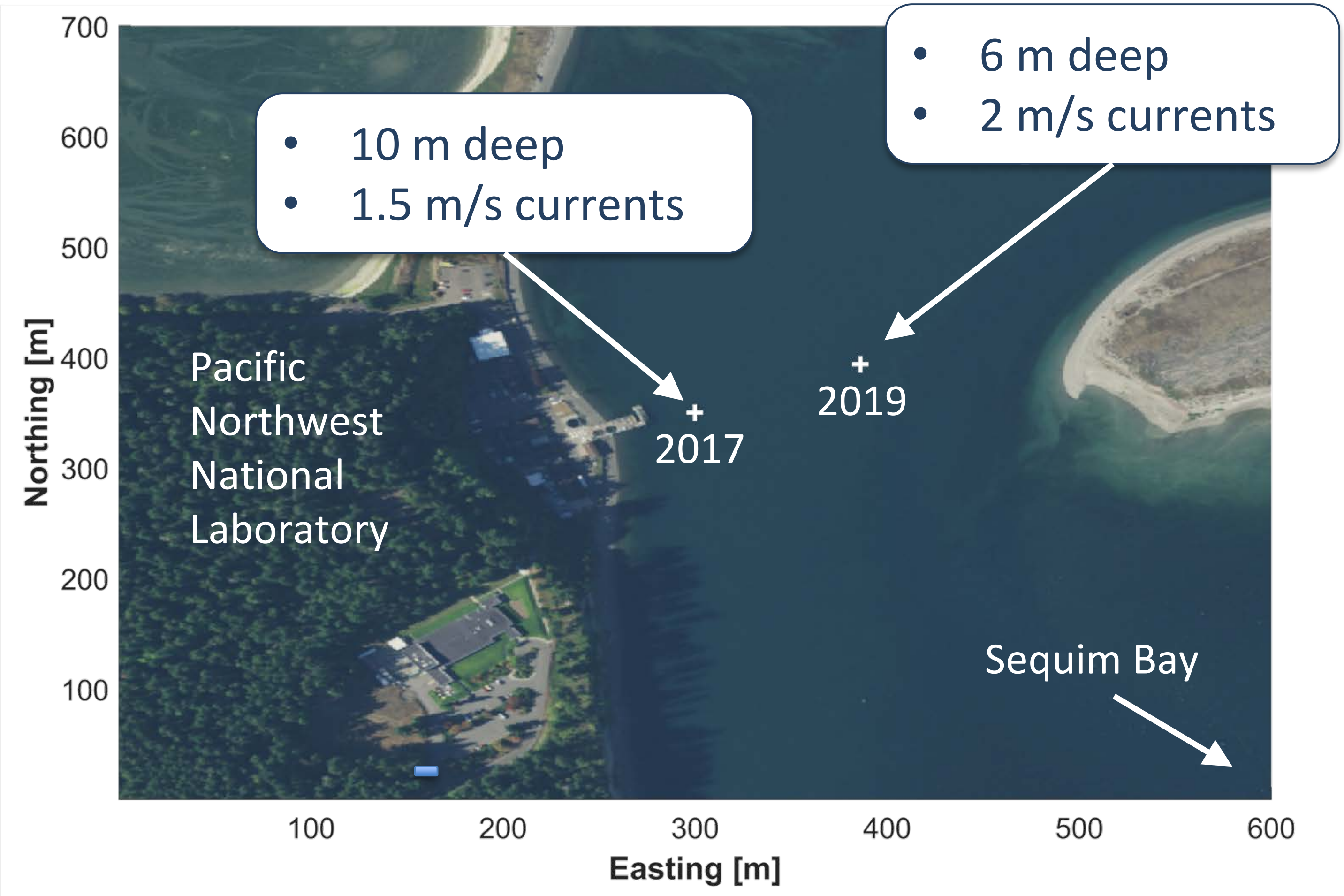
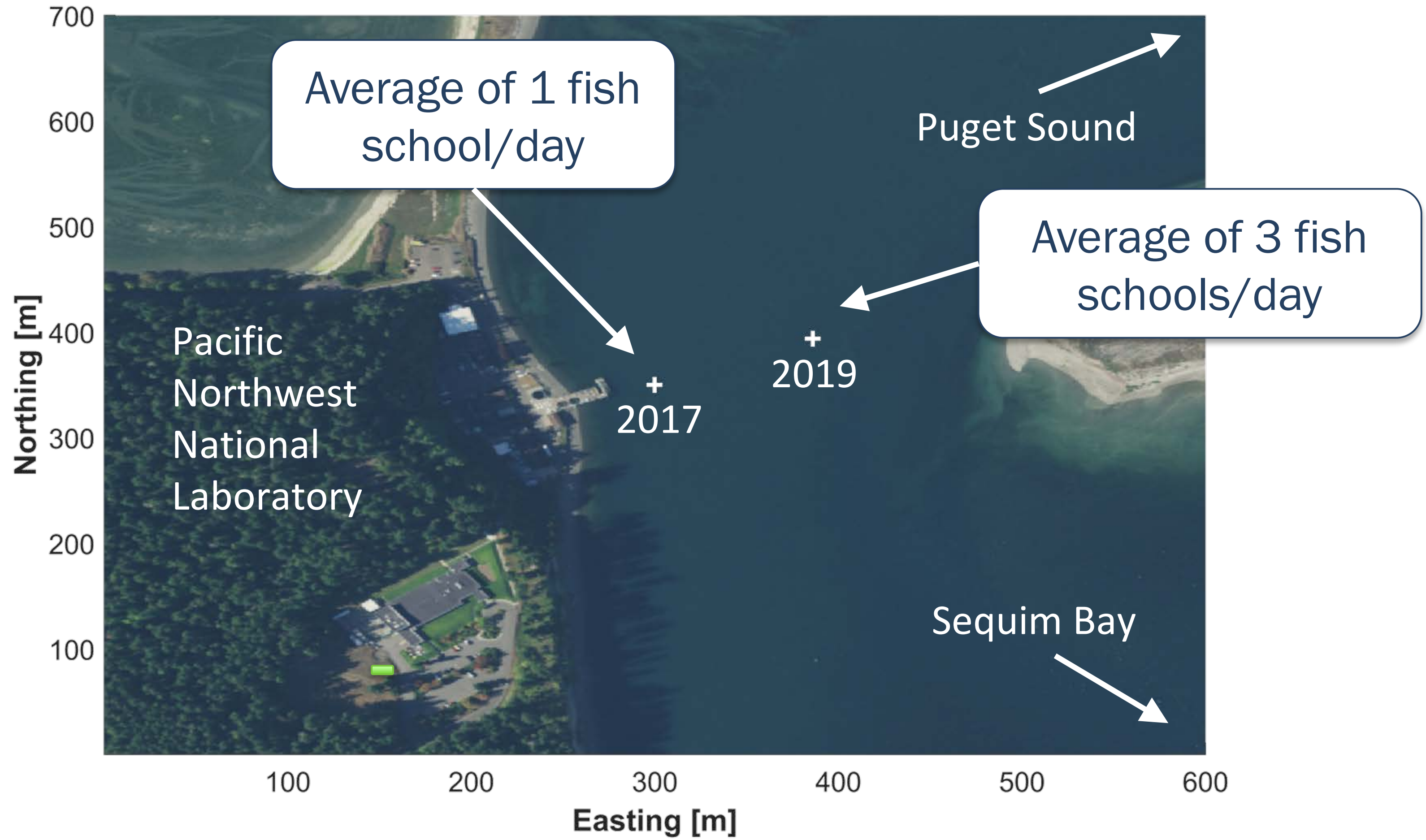
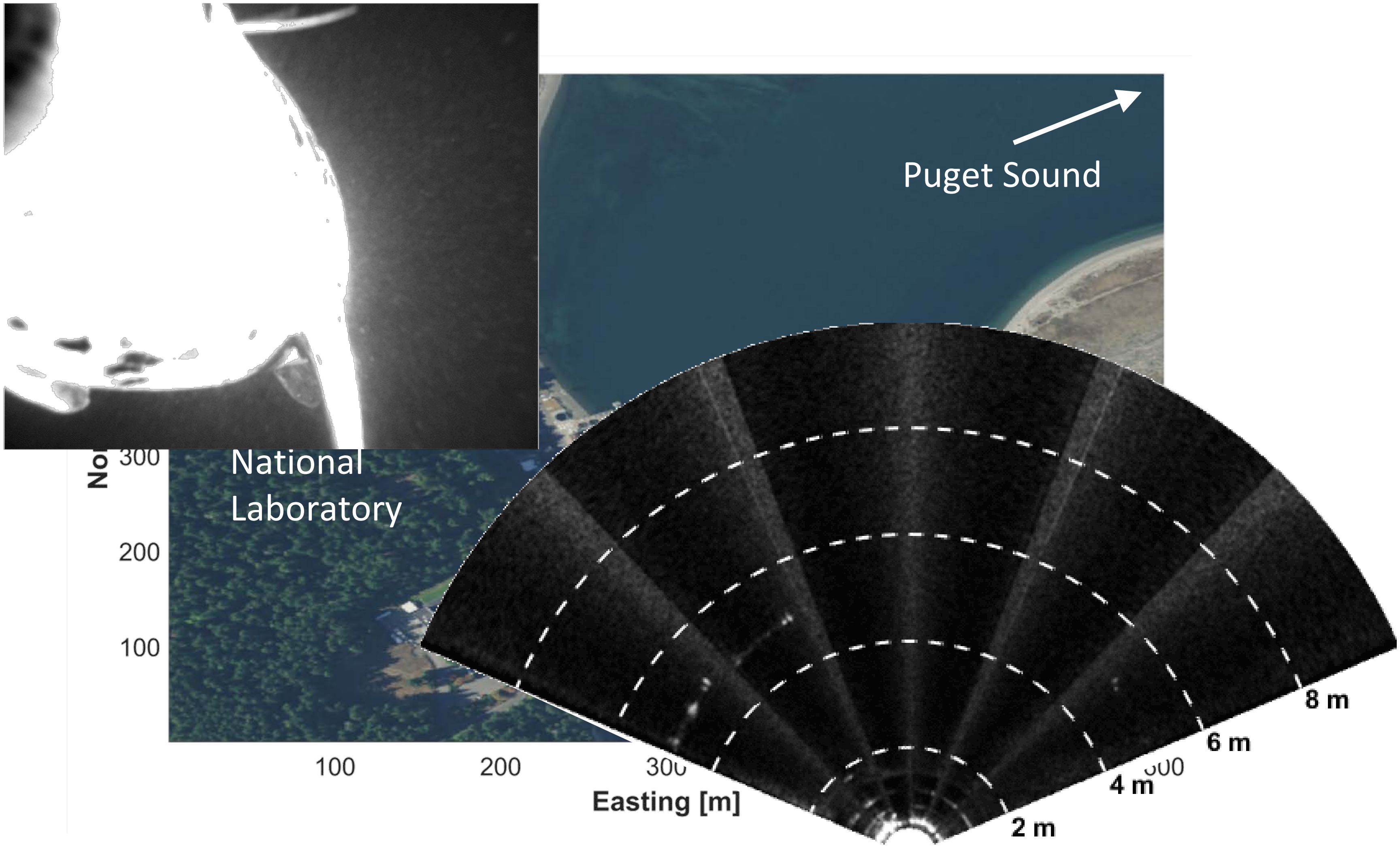


Technical Accomplishments



Technical Accomplishments



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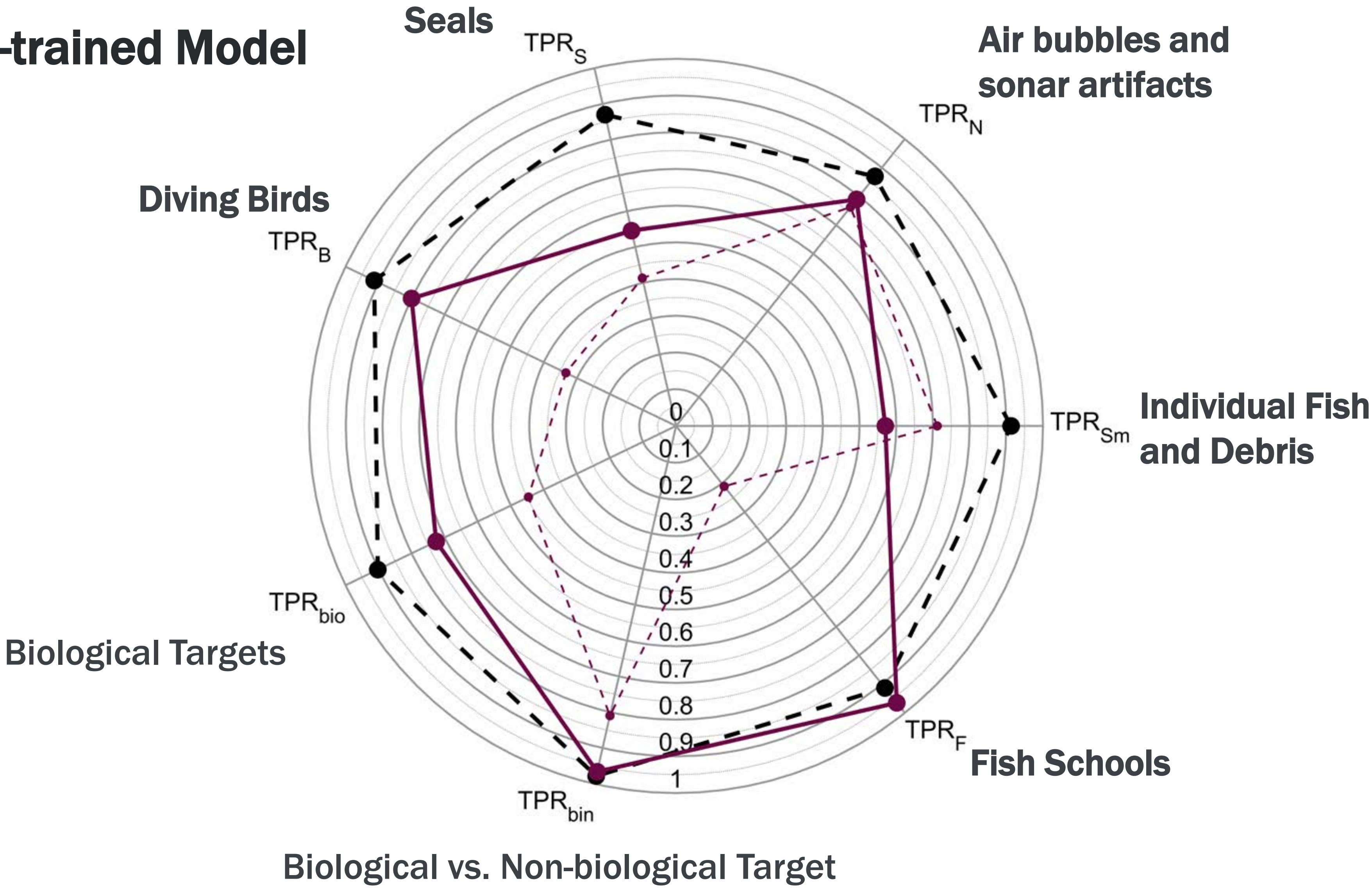
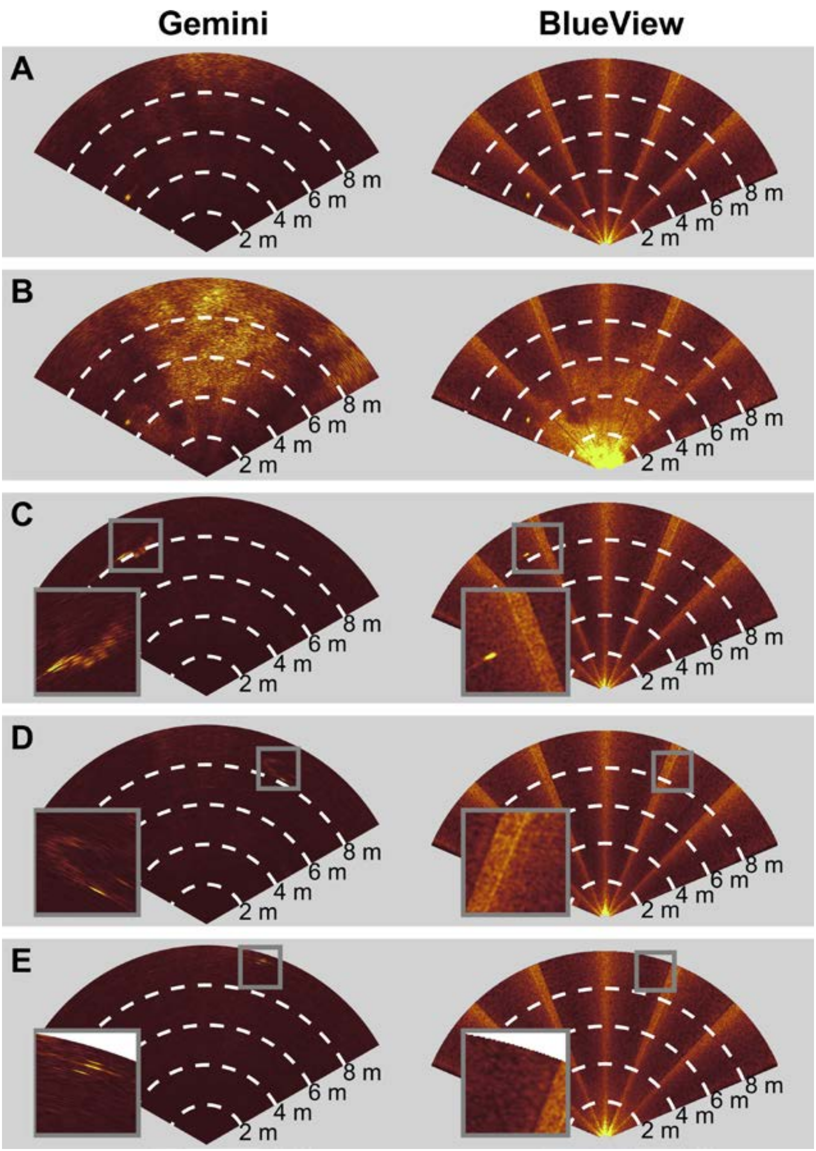
Re-trained Model



Progress Since Project Summary Submittal

- **Comparison of imaging sonars: Teledyne BlueView (2250 kHz) and Tritech Gemini (720 kHz)**
  - Easier for human reviewer to identify targets in BlueView
  - More targets detectable in Gemini
  - Similar automatic classification capabilities for detected targets
- **Go/No-Go decision for Budget Period 3**
  - Meeting on August 20



Future Work

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- **Budget Period 3:** WETS Deployment on OE 35 WEC