



# Marine Mammal Behavioral Response to Tidal Turbine Sound

DE-EE0006385

Marine and Hydrokinetics Program

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## Project Summary

The project team used playback of turbine sound in Admiralty Inlet, WA to study the behavioral responses of harbor seals and harbor porpoises. Harbor seals showed no measurable response to a broadband source level of 158 dB re 1  $\mu$ Pa. Harbor porpoise avoidance to 300 m was observed during the first trial, but this declined during the second trial, and was not observable in the third.

## Project Objective & Impact

- Because of the documented effects of underwater noise on marine life, most marine energy developments are required to characterize acoustic emissions. This implicitly presumes that audibility of acoustic emissions is an effective proxy for behavioral response.
- This study used playbacks of turbine sound to directly evaluate the behavioral effects of this sound on abundant marine mammals in the project area: harbor seals and harbor porpoises.

## Project Information

Project Principal Investigator(s)

Brian Polagye  
Jason Wood (SMRU Consulting)

WPTO Lead

Samantha Eaves

Project Partners/Subs

SMRU Consulting  
UW Applied Physics Laboratory

Project Duration

- December 1, 2013
- March 31, 2018

## 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

## 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

Acoustic emissions are an unavoidable byproduct of marine energy harvesting.

An improved understanding of marine mammal response to these emissions is needed to contextualize their significance.

## Total Project Budget – Award Information

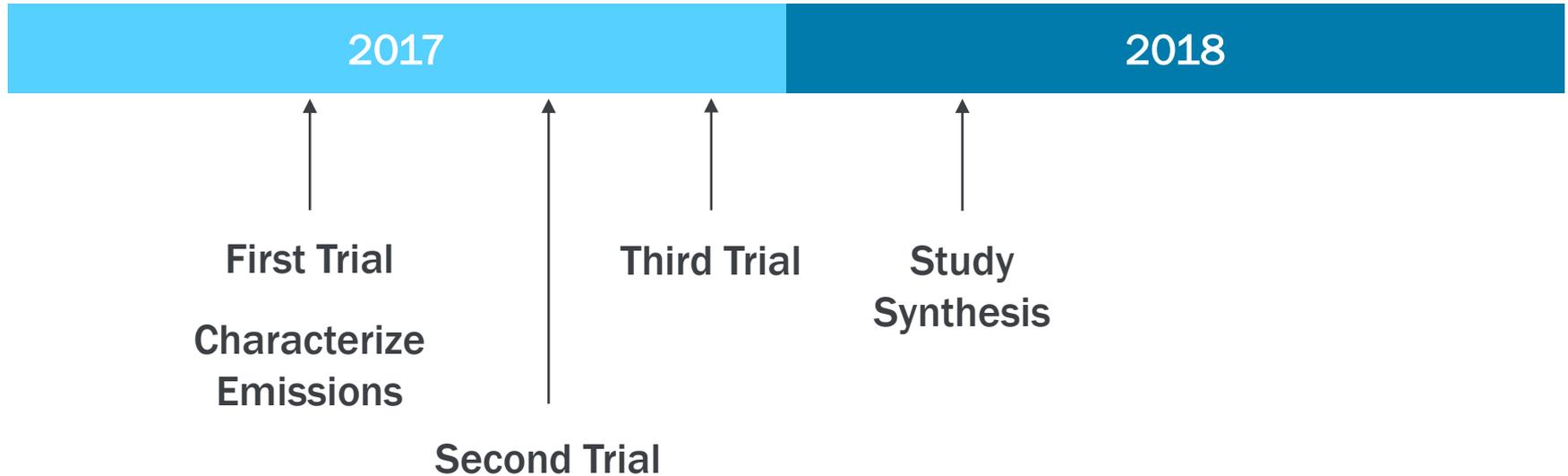
DOE	Cost-share	Total
\$400k	\$100k	\$500k

## Total Actual Costs FY17–FY19 Q1 & Q2 (October 2016 – March 2019)

FY17	FY18	FY19 (Q1 & Q2 Only)	Total
Costed \$305k	Costed \$190k	Costed \$0k	Total \$495k

- Project initiation was delayed until FY17
  - Originally scoped to study marine mammal response to Snohomish PUD / OpenHydro turbines
  - Initially, attempted rescope to Tidal Energy Ltd. project in Ramsey Sound
- Lower than expected costs during data analysis phase resulted in a \$5k balance at project completion that has been de-obligated

## Major Milestones



## Management Approach

- Coordination calls / emails during surveys
- Periodic group check-in calls
- Email and collaboration tools for analysis and report drafting

- **Success Factors**

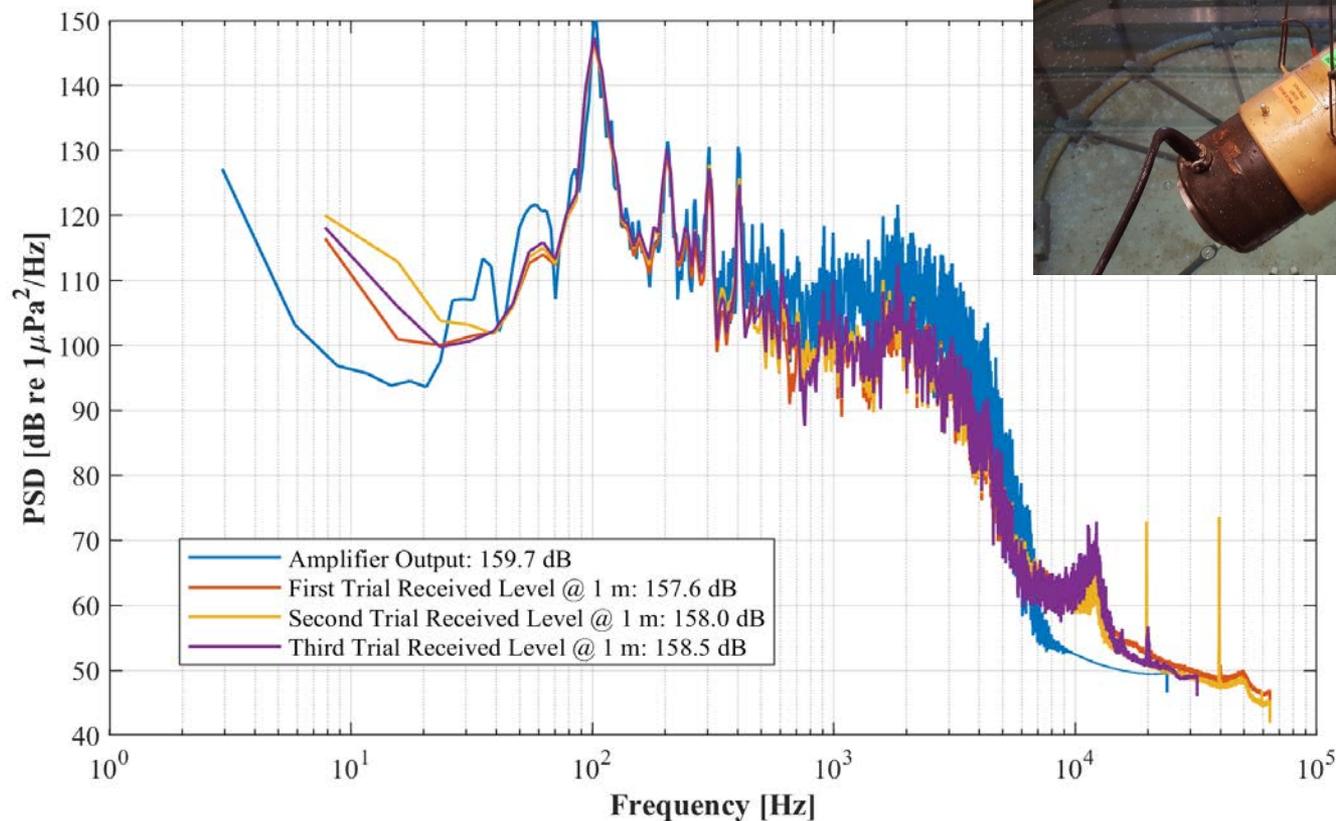
- *Technical*: Produce representative turbine sound and collect interpretable behavioral observations of marine mammals
- *Market*: Provide information that can help retire acoustic risk
- *Business*: Demonstrate effectiveness of survey technique

- **Challenges**

- *Cost-effectiveness of Sound Source*: Relatively large fraction of project cost due to vessel operations required to deploy / recover mooring for each trial (in original scope, this was “free”)
- *Vessel Presence / Absence*: For budgetary reasons, the playback system was deployed from a moored vessel and this vessel was only present during the playback periods, not control periods

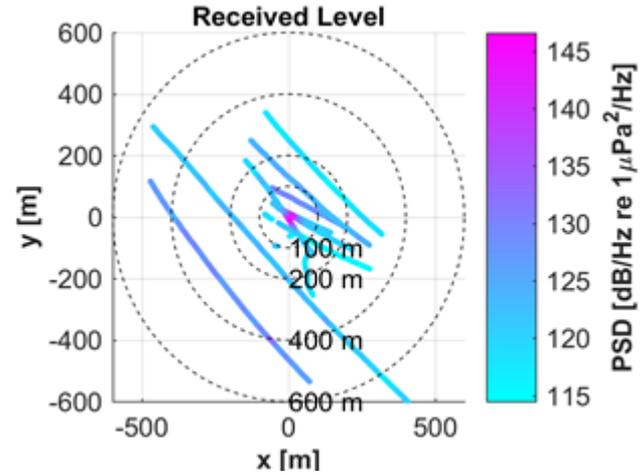
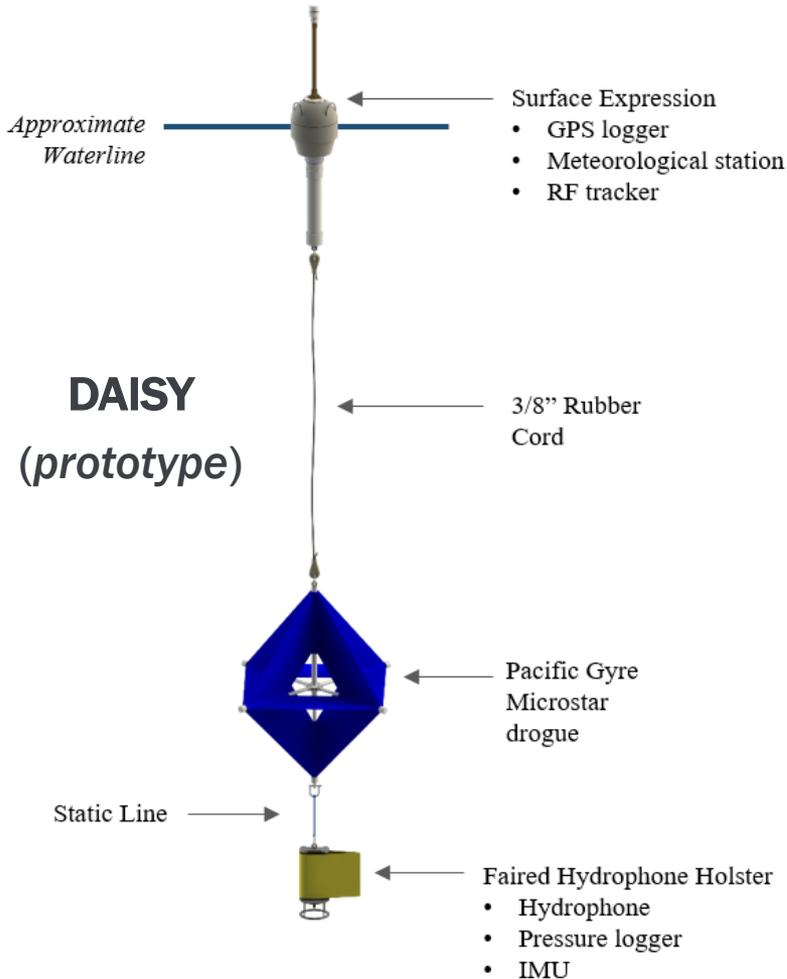
- **Study structure**
  - Survey methodology mirrored marine mammal monitoring plan developed for Snohomish PUD demonstration (collaborative dialogue between UW, SMRU Consulting, and NMFS)
  - Analysis structured to enable comparison with results of similar UK study
- **Presentations**
  - *Methodology*: 2017 Ocean Renewable Energy Conference
  - *Study Outcomes*: No presentations – results synthesized at end of project period of performance
- **Publications**
  - Archival publication intended, but still pending due to time commitments of key personnel

## Repeatable Acoustic Signature

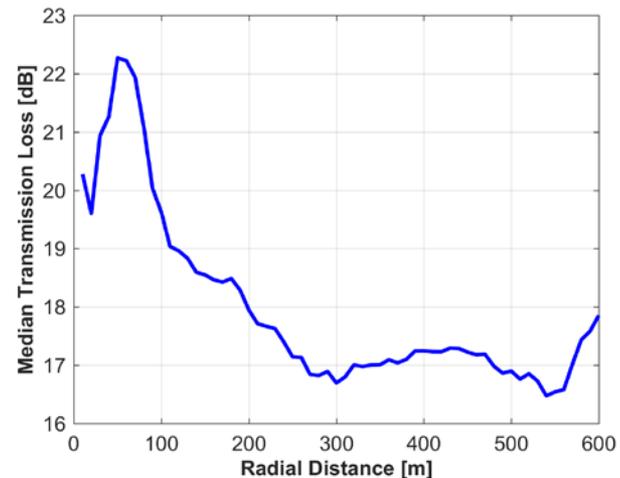


**J11 Source**

## In-Situ Characterization of Transmission Loss



**Received level (100 Hz band)**



## Marine Mammal Observations: Vantage Point Survey

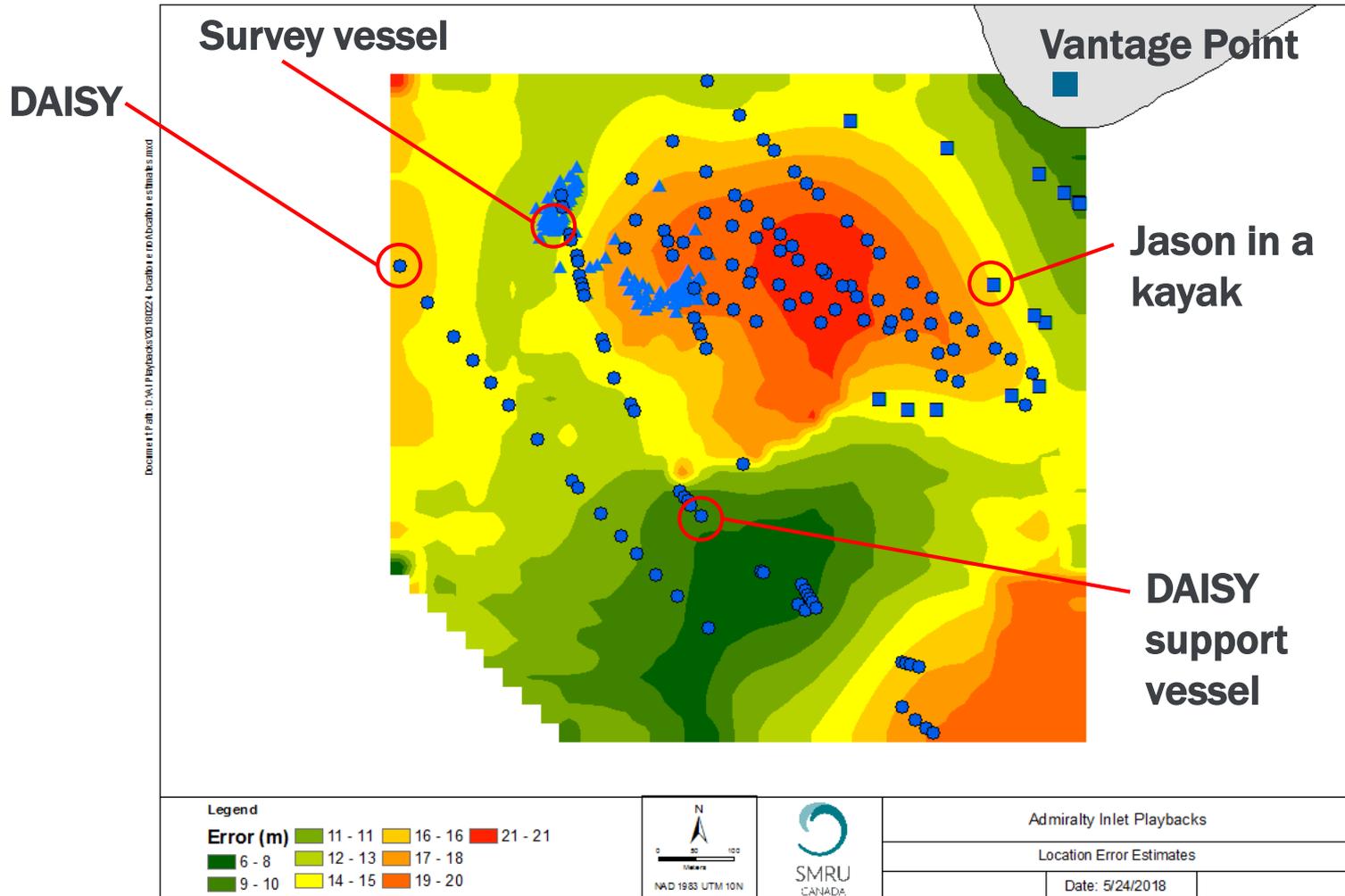


**Survey vessel**

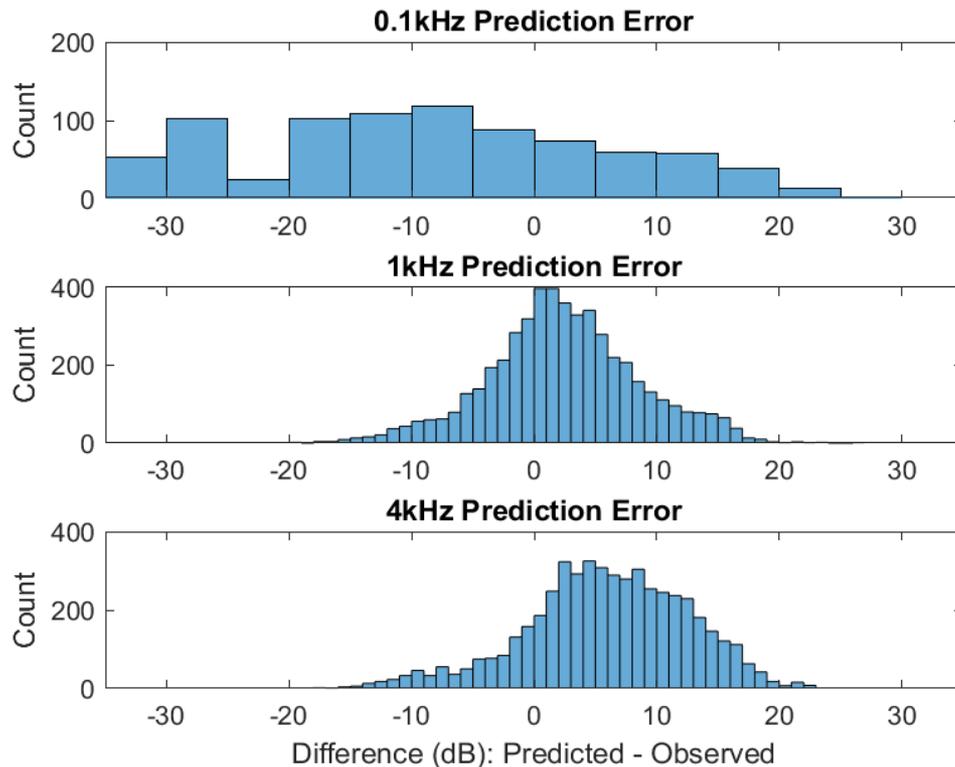
**Harbor porpoise**

**Credits: Frances Robertson (SMRU Consulting)**

## Location Accuracy Assessment

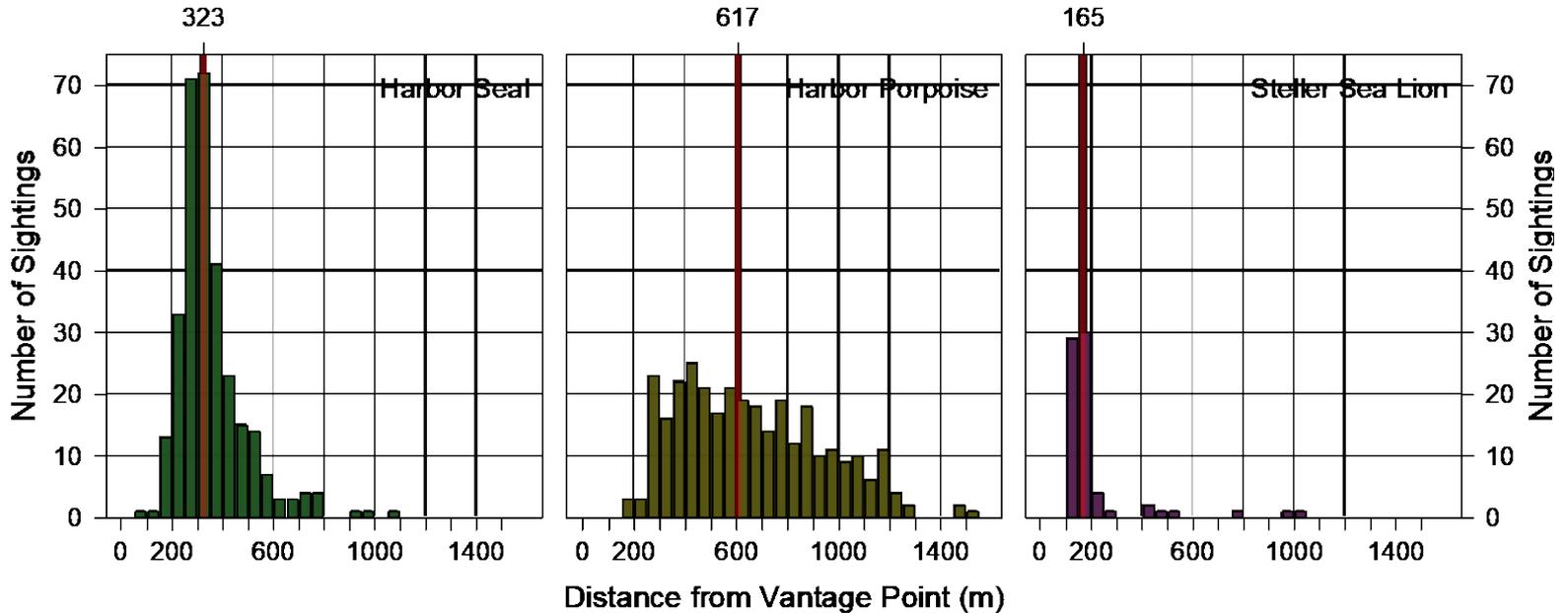


## Signal Excess Model



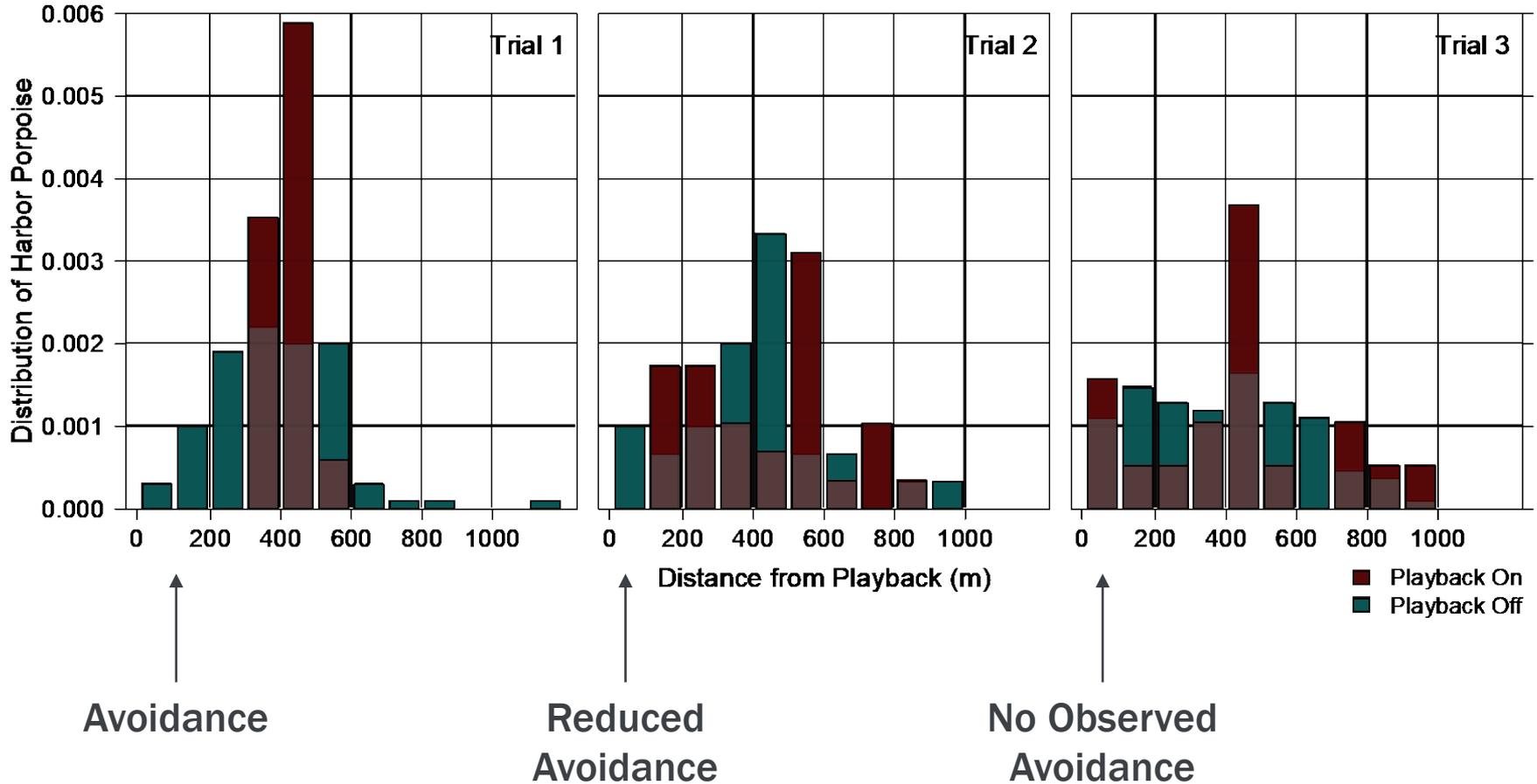
- **Estimate ambient noise at location of animal**
  - Compare to playback received level to determine audibility
- **Model components**
  - Sediment transport ( $f > 1$  kHz)
  - Vessel traffic (broadband)
- **Uncertainty**
  - Low-frequency noise under-predicted
  - High-frequency noise over-predicted

## Observed Animal Distributions and Counts



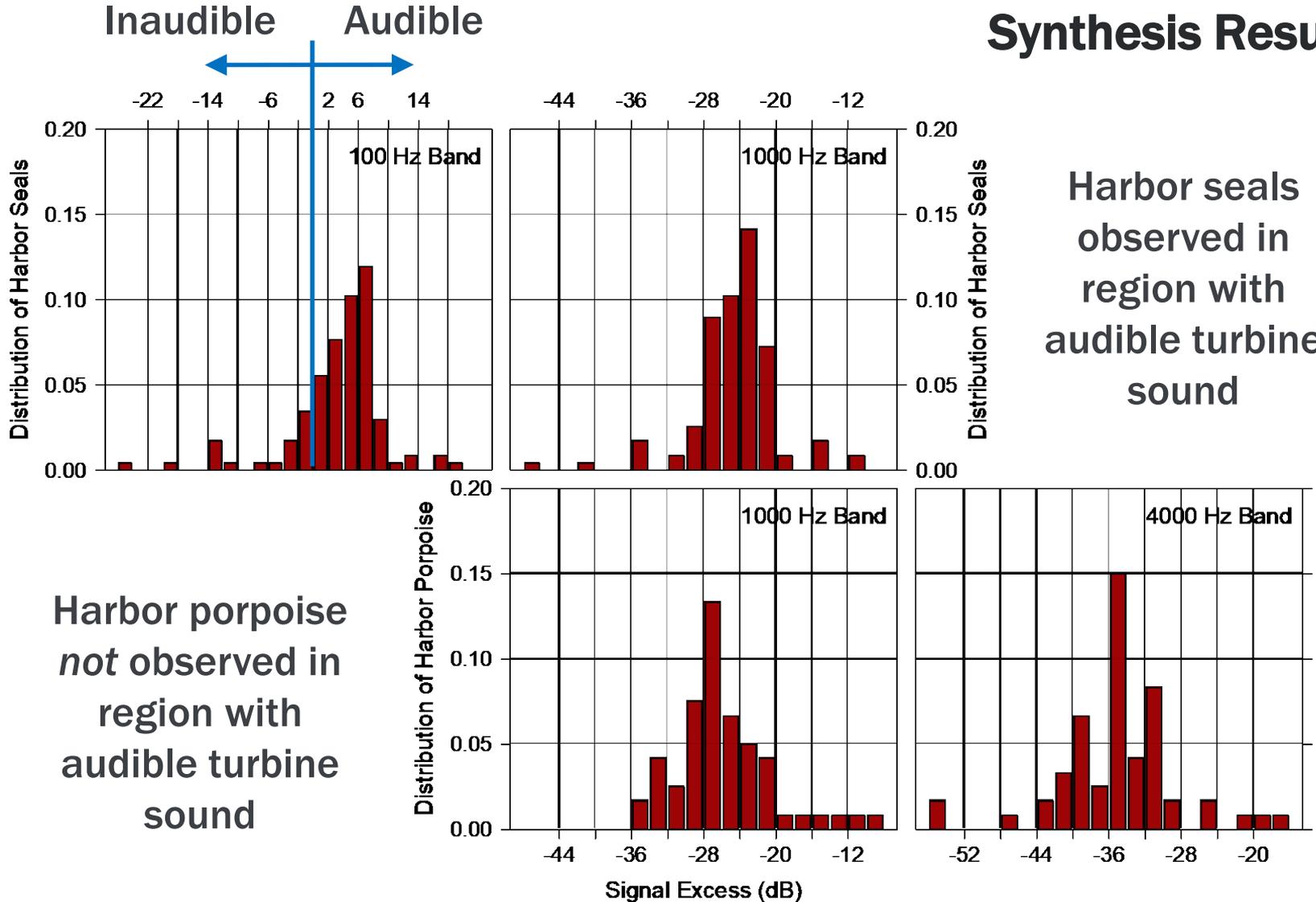
Species	Trial 1 (Spring)	Trial 2 (Summer)	Trial 3 (Fall)
Harbor seal	245	128	323
Harbor porpoise	233	45	100
Stellar sea lion	7	2	216

## Animal Distribution: Harbor Porpoise



# Technical Accomplishments (Cont.)

## Synthesis Results



- **Harbor seals**
  - No significant response to simulated turbine noise *at these received levels*
  - UK study observed avoidance to higher source levels and different frequency distribution
- **Harbor porpoise**
  - Strong indication of avoidance to 300 m in Trial 1
  - Decreased avoidance in Trial 2 and no avoidance in Trial 3
  - Could be habituation to vessel, but vessels are common in Admiralty Inlet
- **Lessons learned**
  - J11 transducer effective at reproducing turbine sound
  - Vantage point surveys are cost-effective
  - Higher-fidelity models for signal excess required