

Evaluating Potential for Impacts from Seal Collisions with Tidal Turbines

Biomechanical Modeling and Analysis of Strike Impacts to Sensitive Species

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Seal Collision with Tidal Turbines: Project Overview

This Project:

Permitting of tidal turbines in the United States, UK, and Canada is being delayed due to concerns over possible collisions of marine animals with turbine blades. This project investigated the risk to marine mammals, including the consequences to the animal of a collision, and the likelihood of a collision happening.

This project builds on collision risk studies for orca and tidal turbines that allowed Snohomish Public Utility District to obtain a permit to operate turbines in Puget Sound.

The Challenge:

No marine mammal collisions with tidal turbines have ever been observed. However, regulatory concerns continue and are slowing permitting. In addition, every potential collision has commonly been considered to be fatal.

Who Benefits:

Determining the risk of animal interactions with turbines can assist regulators and developers to reduce monitoring and mitigation requirements, and decrease time and cost to deployment.

Project Partners:

- Sandia National Laboratories (SNL)
- University of Washington, Friday Harbor Laboratory
- Sea Mammal Research Unit
- The Whale Museum

Technology Maturity

- Test and demonstrate prototypes
- Develop cost effective approaches for installation, grid integration, operations and maintenance
- Conduct R&D for Innovative MHK components
- Develop tools to optimize device and array performance and reliability
- Develop and apply quantitative metrics to advance MHK technologies

Deployment Barriers

- Identify potential improvements to regulatory processes and requirements
- **Support research focused on retiring or mitigating environmental risks and reducing costs**
- Build awareness of MHK technologies
- Ensure MHK interests are considered in coastal and marine planning processes
- Evaluate deployment infrastructure needs and possible approaches to bridge gaps

Market Development

- Support project demonstrations to reduce risk and build investor confidence
- Assess and communicate potential MHK market opportunities, including off-grid and non-electric
- Inform incentives and policy measures
- Develop, maintain and communicate our national strategy
- Support development of standards
- Expand MHK technical and research community

Crosscutting Approaches

- Enable access to testing facilities that help accelerate the pace of technology development
- Improve resource characterization to optimize technologies, reduce deployment risks and identify promising markets
- Exchange of data information and expertise

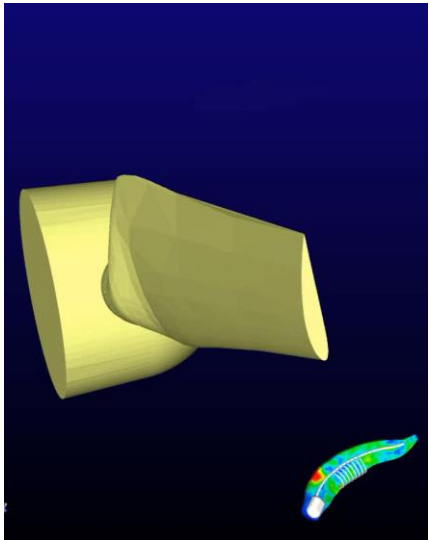
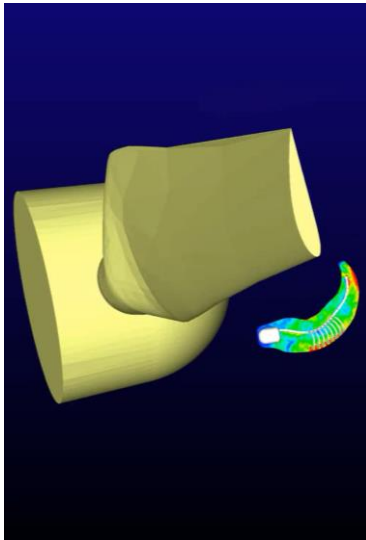
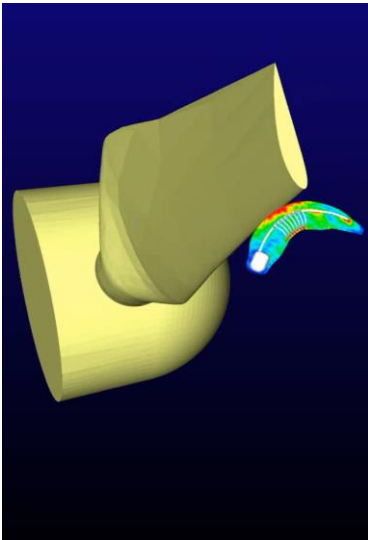
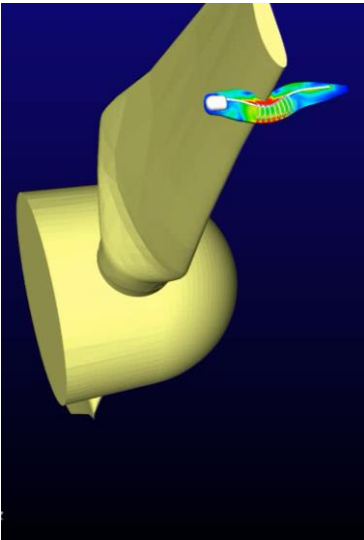
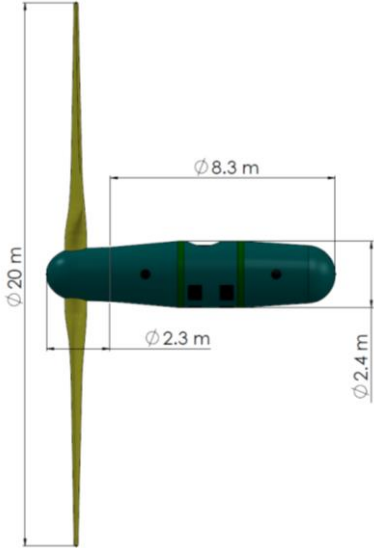
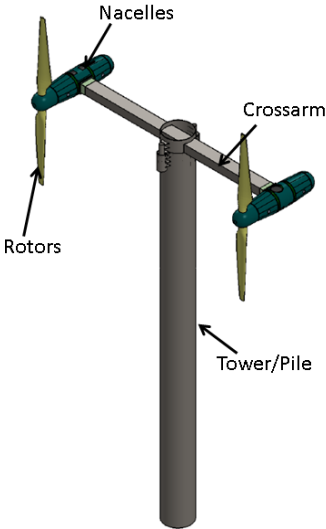
Deployment Barriers

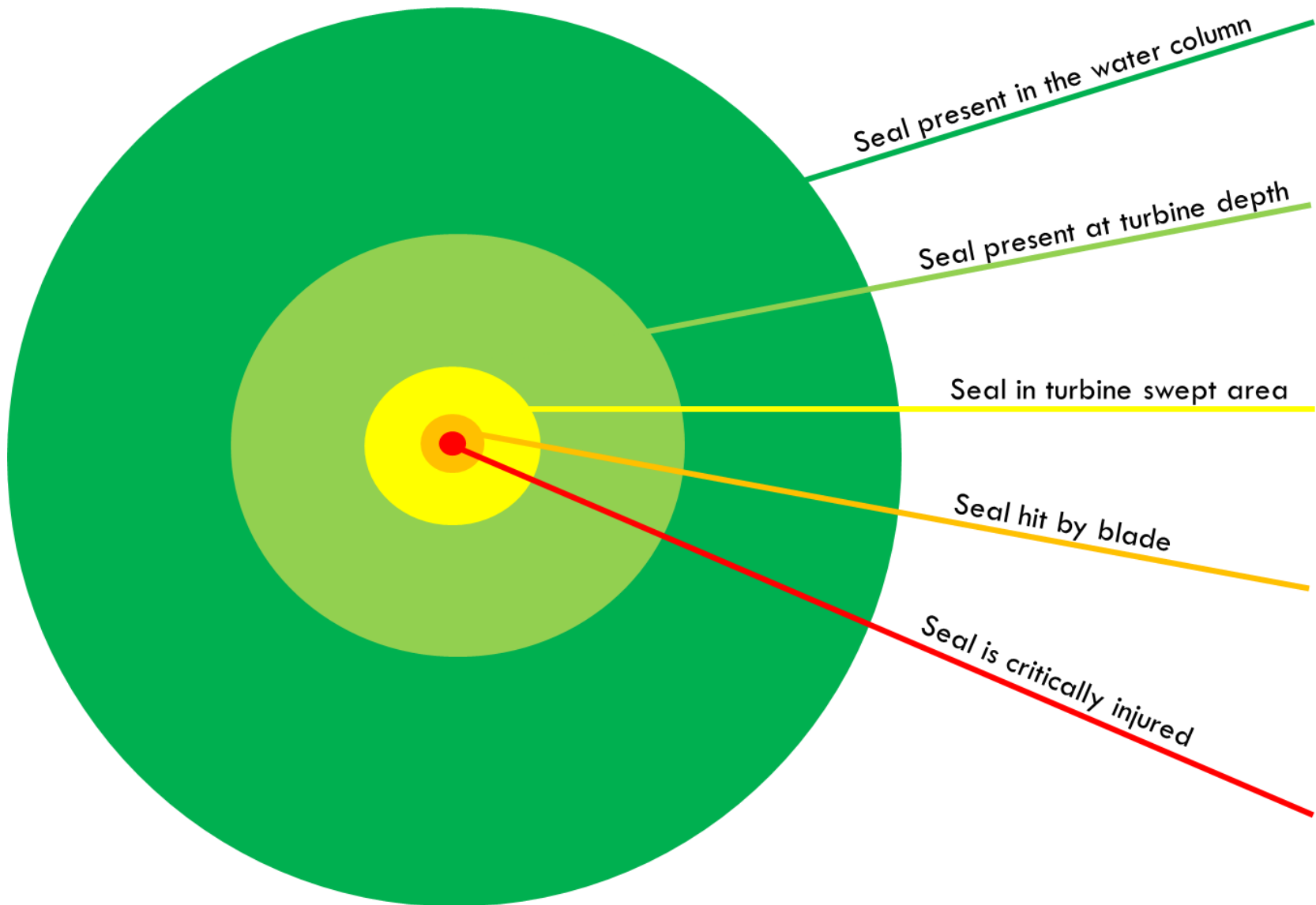
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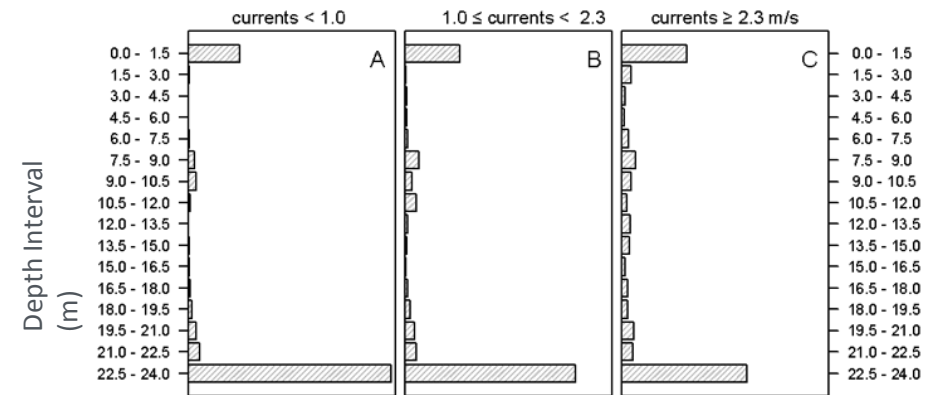
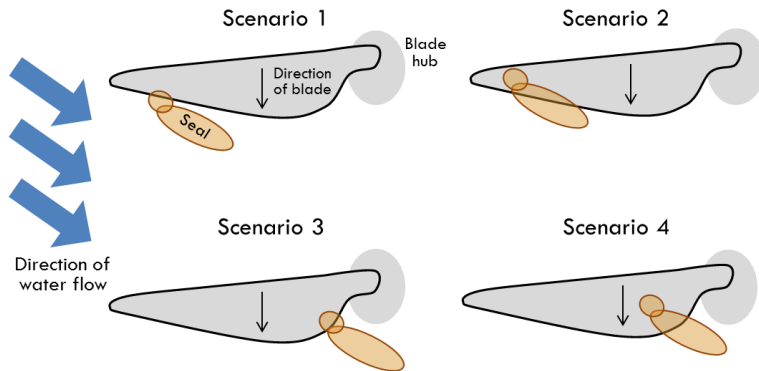
Target: Understanding the risk of seal collision will help reduce monitoring and mitigation requirements for tidal turbine deployment.

Impact: Retiring collision risk will accelerate permitting timelines and reduce costs for turbine deployment.

Endpoint: Peer-reviewed papers (submitted) that describe risk to seals from interactions with a tidal turbine, including probability of encounter and potential harm.







- Unique set of data
- First of its kind to bring together both halves of risk —**consequence** and the **probability** —for a marine mammal and a tidal turbine
- **OUTCOME:** Very low probability of collision (0.005% to 0.05% of passage rate), and significant injury only with some blade tip encounters

Technical accomplishments met and exceeded the original technical targets of the projects, including:

- Creating new methodologies for testing tissue
- Realistic approach scenarios for marine mammal to turbine blade
- Integrating datasets together into coherent whole and
- Three journal papers

Significant Dates and Schedule	Explanation
Project Initiation Date	November 2012
Project Completion Date	October 2016
Slipped milestones/schedule	Intermediate milestones slipped due to availability of stranded (dead) seals for tissue analysis. Schedule extended through 2016.

Go/No Decisions

Year	FY14	FY15	FY16
Go/No-Go decision point	None	If behavioral studies show seals can evade turbine, tissue studies may not be needed.	None
Outcome	-	Behavioral studies not sufficiently conclusive	-

Budget History

	FY2014		FY2015		FY2016
	DOE	Cost-share	DOE	Cost-share	DOE
PNNL and subcontractors	\$50K	\$0	\$300K	\$0	\$0
SNL	\$50K	\$0	\$100K	\$0	\$0

- No significant variances from planned budget
- Project budget expended as of end of FY16
- No other source of funds

Partners, Subcontractors, and Collaborators:

Project Partners	Role in Project
Pacific Northwest National Laboratory	Scenario development, tissue testing, data integration and interpretation, project management.
Sandia National Laboratories	Engineering model development and computational modeling of collision scenarios
Sea Mammal Research Unit Consulting	Analysis of seal telemetry data from UK.
Friday Harbor Laboratories, Univ. Washington	Assisted with seal tissue testing, provided equipment and laboratory space for PNNL staff.
SeaDoc Society	Provided marine veterinary assessment of the stranded seals.
The Whale Museum/San Juan Island Stranding Network	Provided stranded seal carcasses; analyzed morphometrics of San Juan harbor seal population.

Communications and Technology Transfer:

Type	Title and Submission/Venue
Journal paper	Empirical measures of harbor seal avoidance of an operational tidal turbine, Ecological Applications (submitted)
Journal paper	Understanding the Potential Risk to Marine Mammals from Collision with Tidal Turbines Int'l Journal of Marine Energy (submitted)
Journal Paper	Biomechanical properties of Harbor Seal skin and blubber as input to model blade strike impact. Experimental Biology (submitted)
Presentation	Potential Effects of the Interaction between Marine Mammals and Tidal Turbines – An Engineering and Biomechanical Analysis EWTEC 2013 (Aalborg)
Presentation	Risk to Marine Mammals from Collision with a Tidal Turbine METS 2015 (Washington DC)

FY17/Current research

Project has concluded, waiting for decisions on journal papers.

Proposed future research:

- Tidal turbines are ready for commercial deployment, yet are being stalled in order to understand this risk.
- The ability to understand the likelihood of marine animals colliding with turbines, and the extent of possible injuries, could help retire the risk. Verification of these results could occur as monitoring data become available.
- More work is needed on the risk from different turbine designs, and from multiple device arrays.