Pacific Northwest NATIONAL LABORATORY

ES ENVIRONMENTAL

Offshore energy development and environmental sustainability

Andrea Copping
Pacific Northwest National Laboratory

CET Partnership - Online Workshop

U.S. DEPARTMENT OF ENERGY BATTELLE

PNNL is operated by Battelle for the U.S. Department of Energy

What I want to talk about today….

- Importance of considering environmental effects of marine renewable energy (MRE)
- Strategies for understanding environmental effects
- Up to date knowledge about environmental effects
- What does environmental sustainability look like?


Wave Swell

In order to get devices in the waters, one must consider:

Resource characterization

Resource characterization

Siting

Tank testing

Resource characterization

Siting

Tank testing

Resource characterization

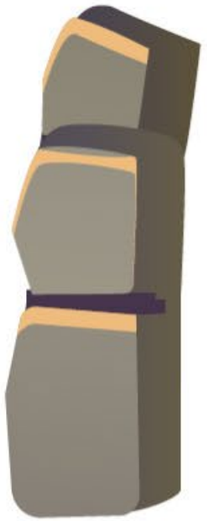
Engineering design

Siting

Moorings

Tank testing

Resource characterization



Engineering design

Siting

Moorings

Tank testing

Resource characterization

Survivability

Engineering design

Siting

Fabrication

Moorings

Tank testing

Resource characterization

Survivability

Engineering design

Siting

Fabrication

Moorings

Tank testing

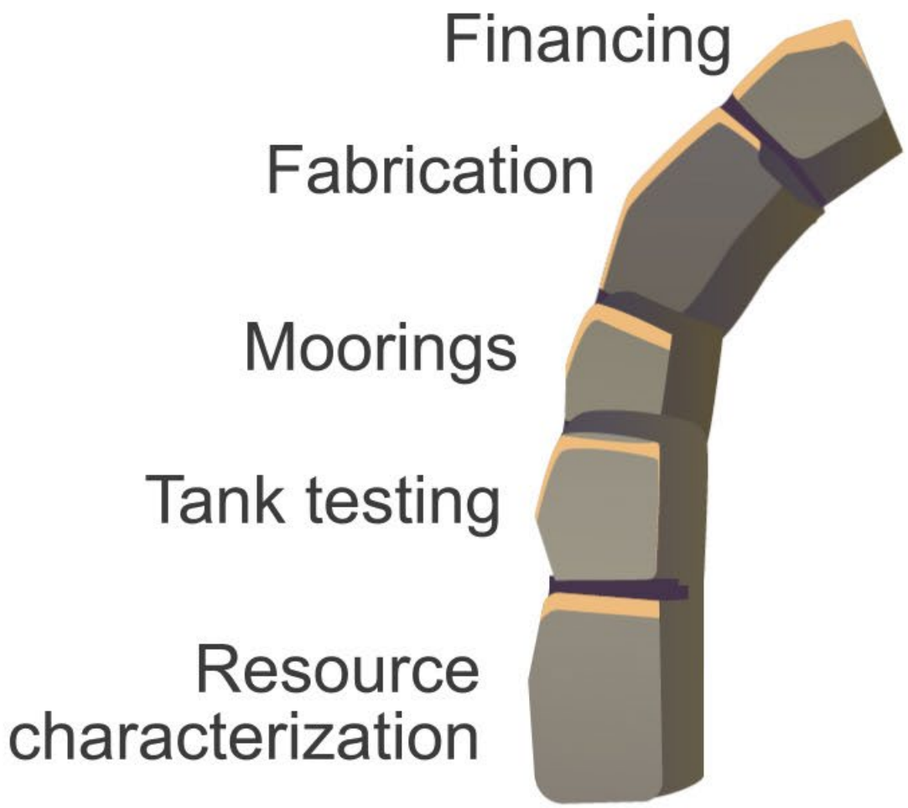
Resource characterization

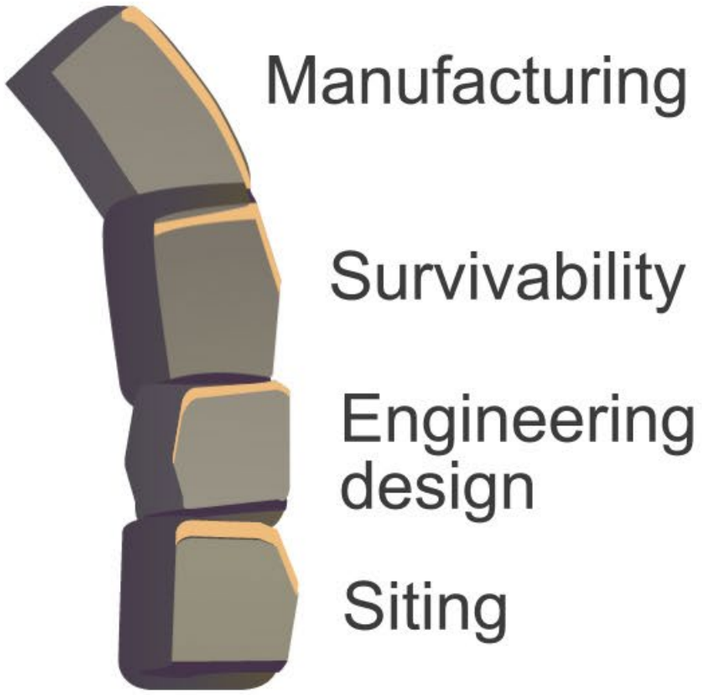
Manufacturing

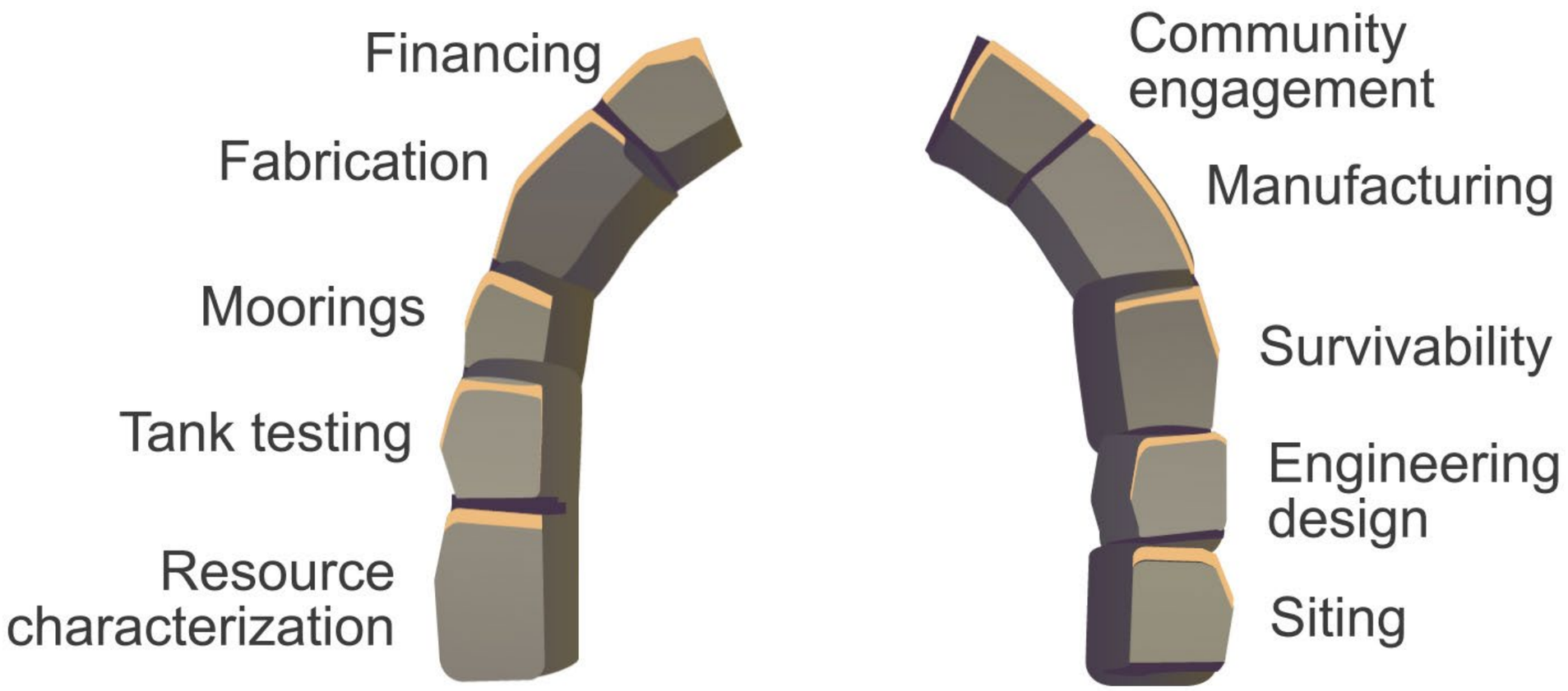
Survivability

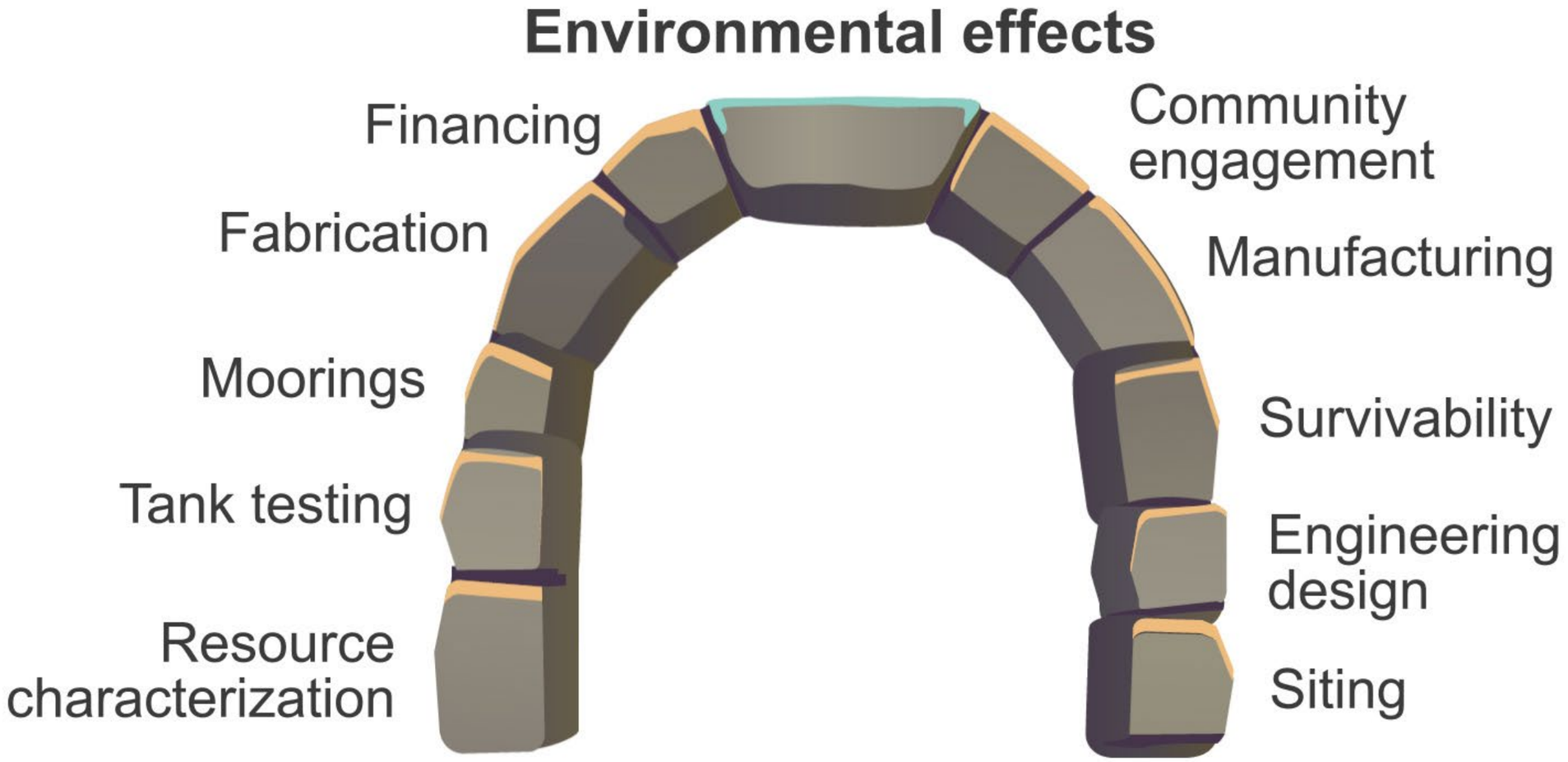
Engineering design

Siting


Financing
Fabrication
Moorings
Tank testing
Resource characterization


Manufacturing
Survivability
Engineering design
Siting


Financing
Fabrication
Moorings
Tank testing
Resource characterization
Community engagement
Manufacturing
Survivability
Engineering design
Siting


Environmental effects
Financing
Fabrication
Moorings
Tank testing
Resource characterization
Community engagement
Manufacturing
Survivability
Engineering design
Siting

Why Study the Environmental Effects of MRE?

- Drivers for marine renewable energy (MRE) are clear
- MRE in early stage of development, deployment, and commercialization
- Environmental concerns continue to slow consenting / permitting worldwide
- Collecting & sharing information can be key strategy to progressing MRE

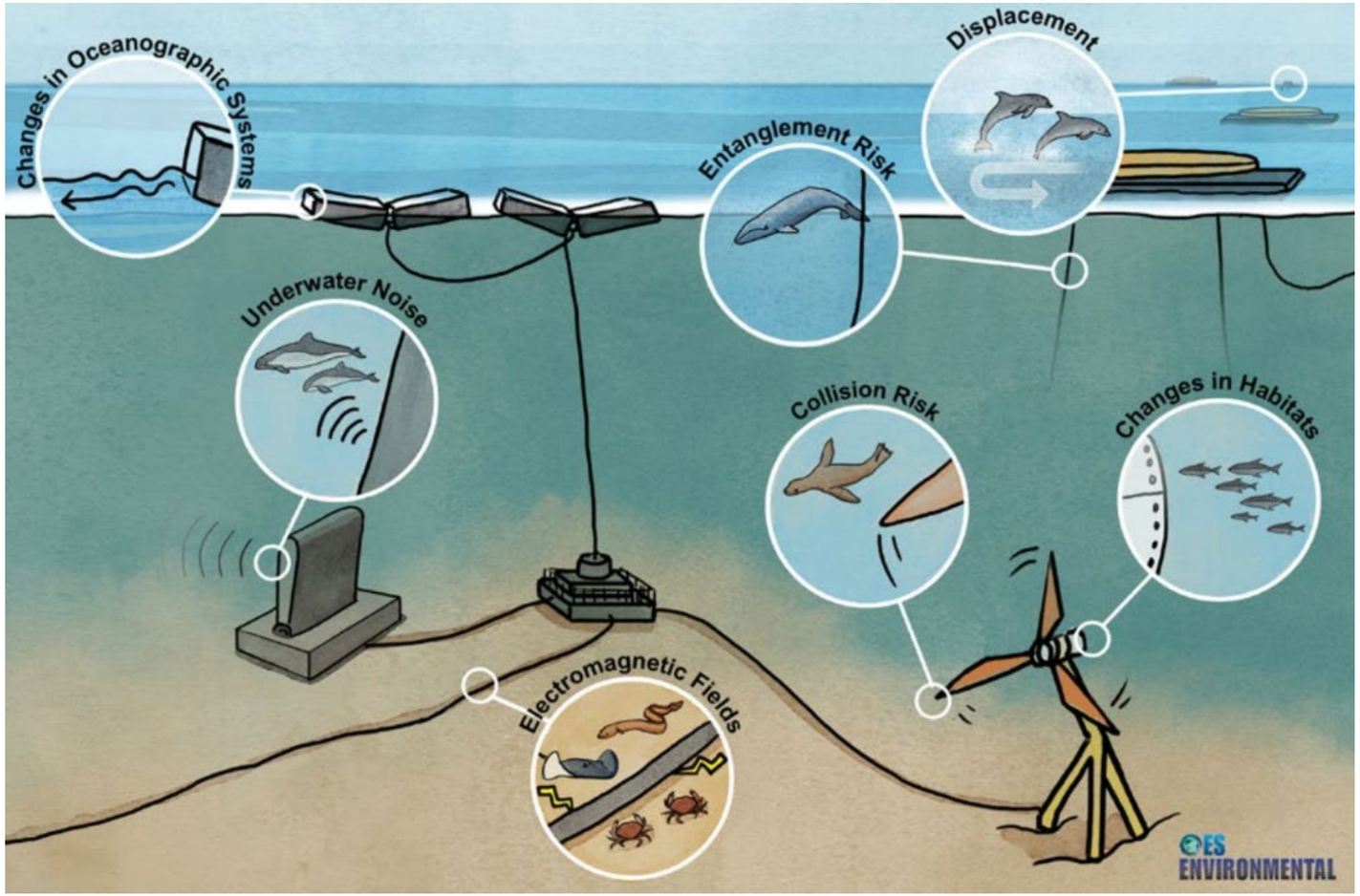
OES-Environmental

- Established by the International Energy Agency-Ocean Energy Systems in 2010
- Examines environmental effects of MRE development to advance the industry in a responsible manner
- Led by the U.S. Department of Energy Water Power Technologies Office and implemented by Pacific Northwest National Laboratory
- Phase 4: 16 member countries
- New Phase 5 beginning now

Environmental Effects of MRE

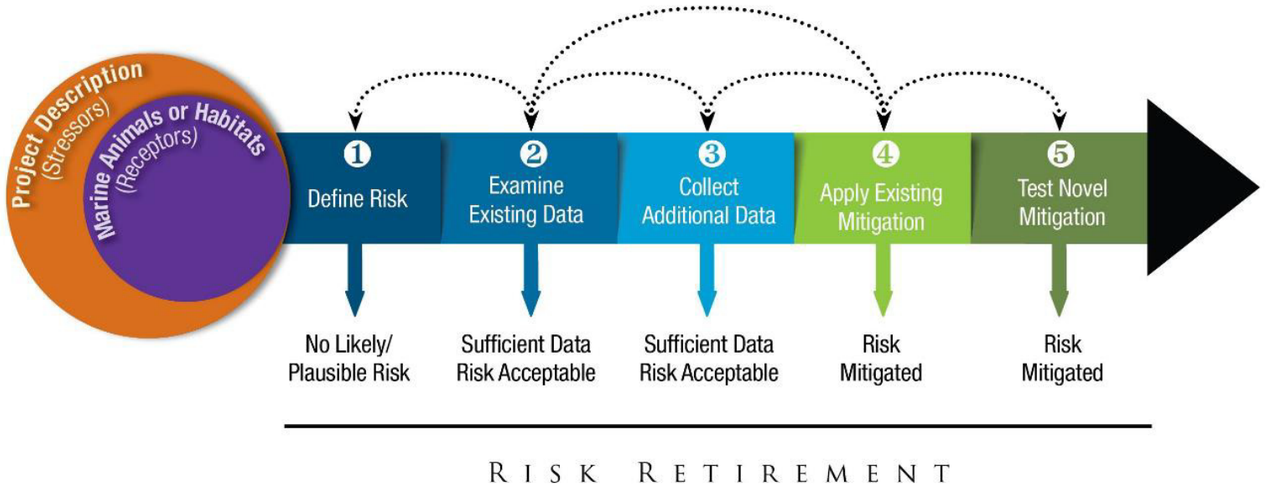
- Stressors – Marine energy devices, systems that may cause harm
- Receptors – Marine animals, habitats, ecosystem processes

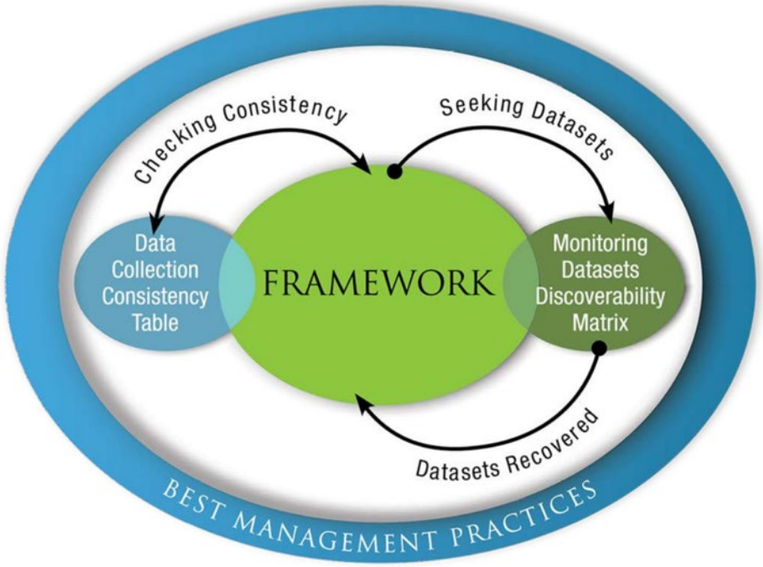
Priority stressor-receptor interactions



Risk Retirement

“For certain interactions, potential risks need not be fully investigated for every project (1 - 6 devices), but rather, we need to rely on what is already known: consented projects, research, analogous industries. A “retired risk” can be reexamined in the future.”

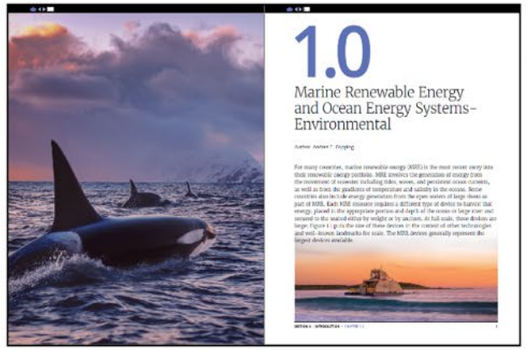


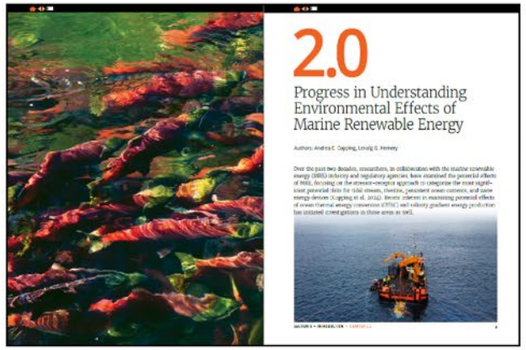


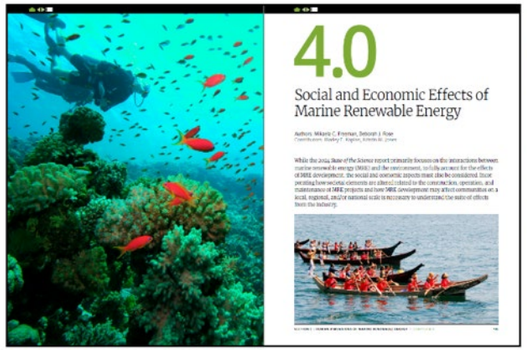
Data Transferability Process

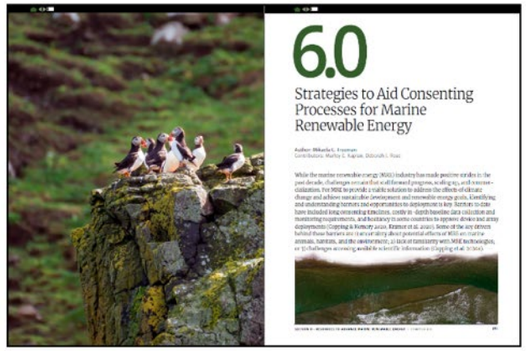
2024 State of the Science Report

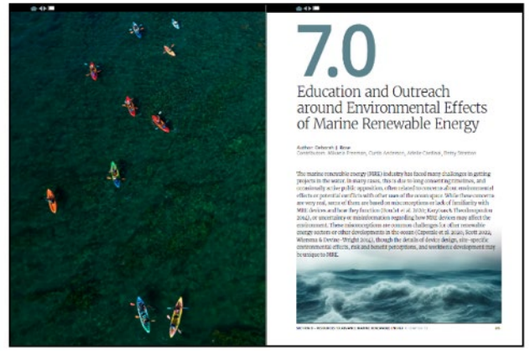
https://tethys.pnnl.gov/2024-sos

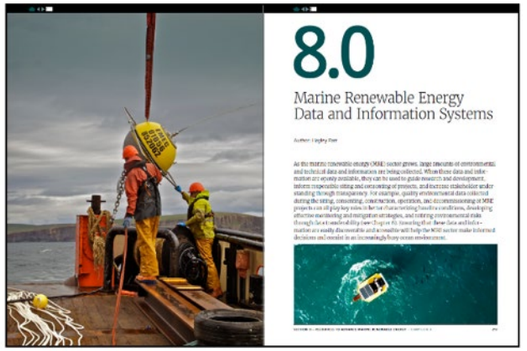


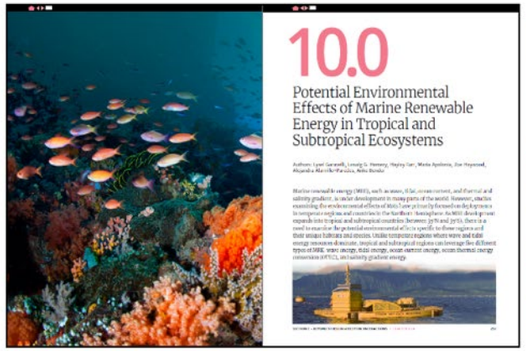


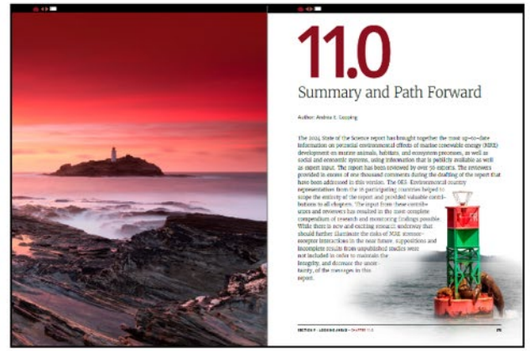






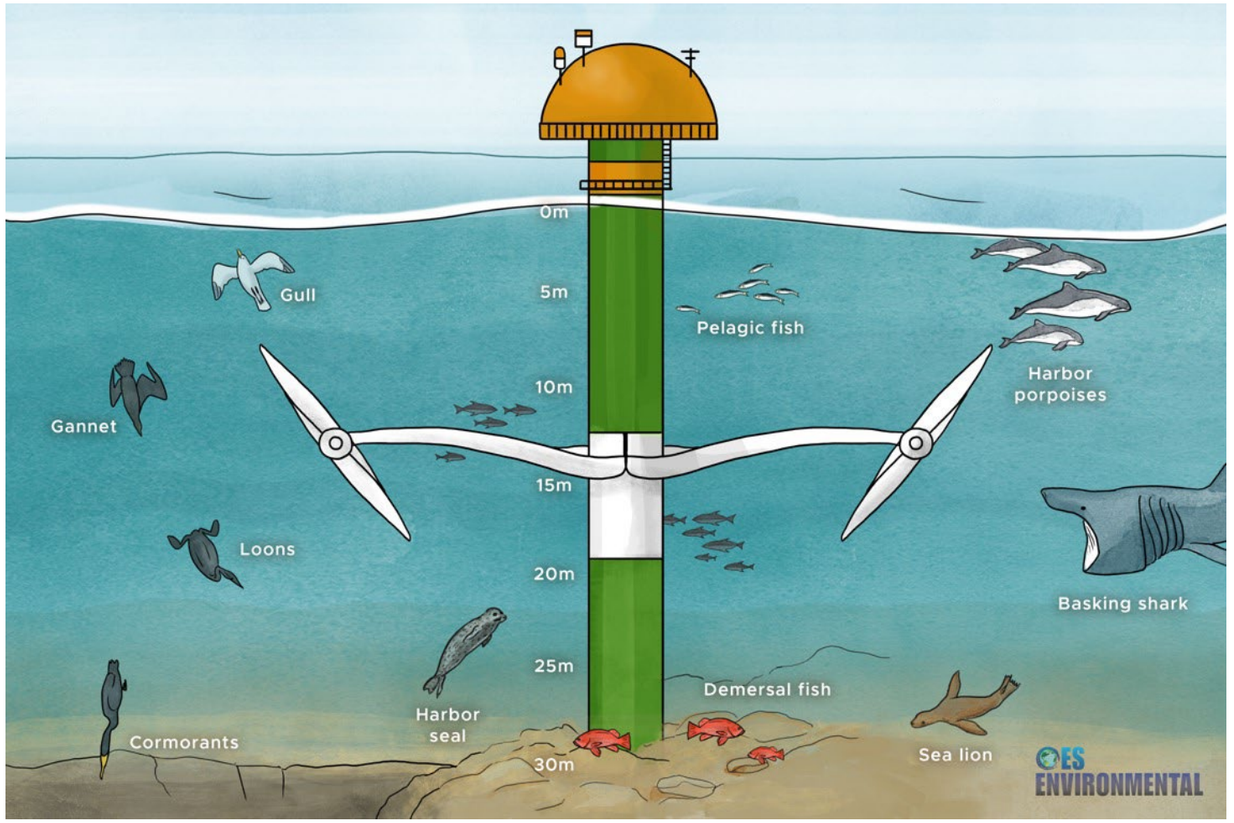




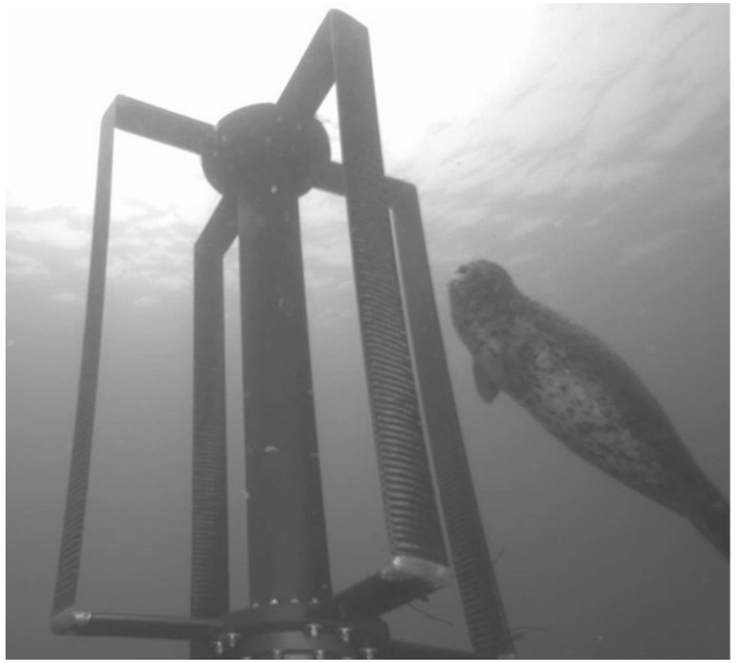


Collision Risk of Marine Animals around Turbines

- Physical contact between marine animals (marine mammals, fish, diving birds, sea turtles) and moving parts of devices
- Main barrier to turbine consenting/ permitting
- Perceived risk remains high due to uncertainties
- No collisions seen to date, but difficult environment
- More underwater video becoming available
- Modeling approaches need data for validation

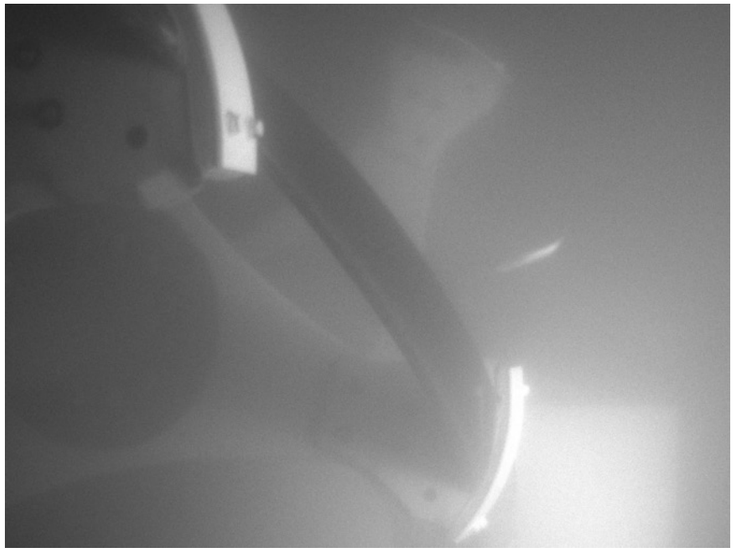


Collision Risk of Marine Animals around Turbines



© NAVFAC / UW

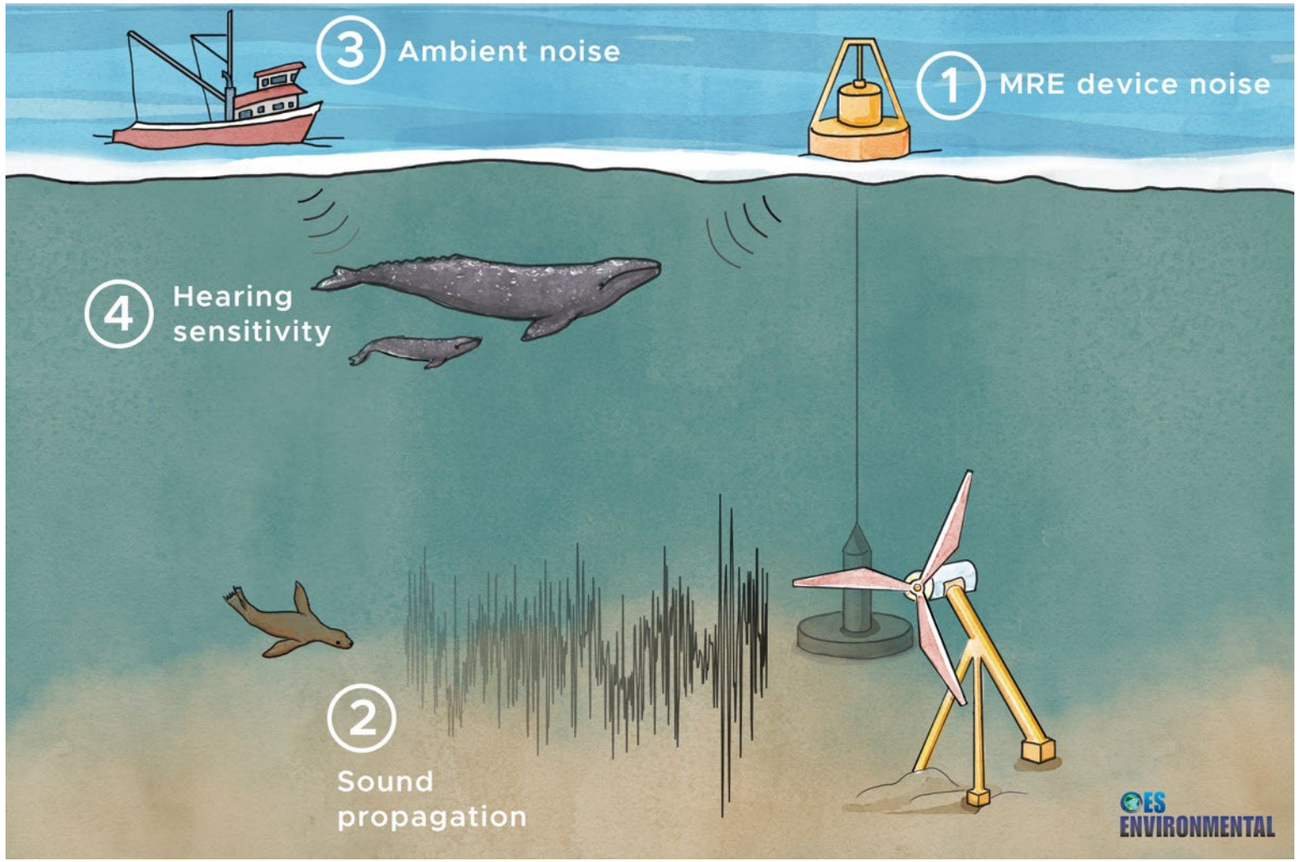
© Nova Innovation



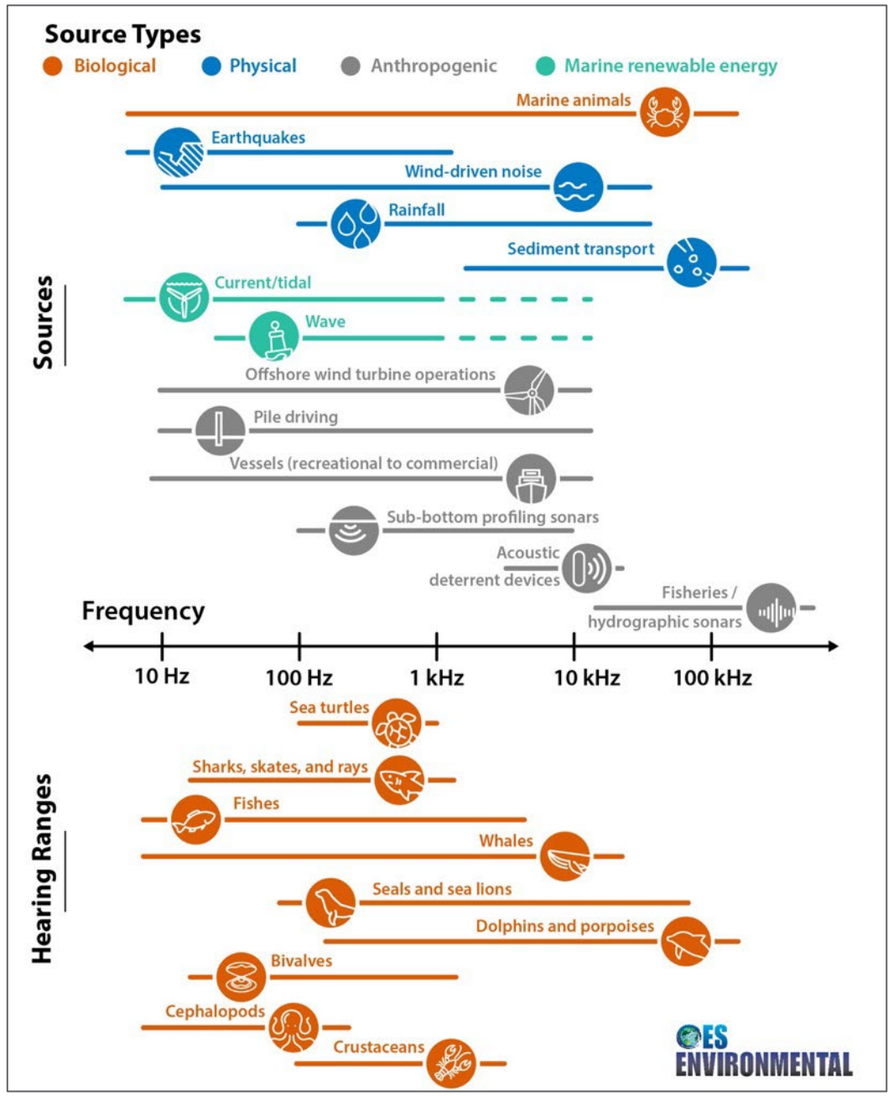
© Courtney / UAF

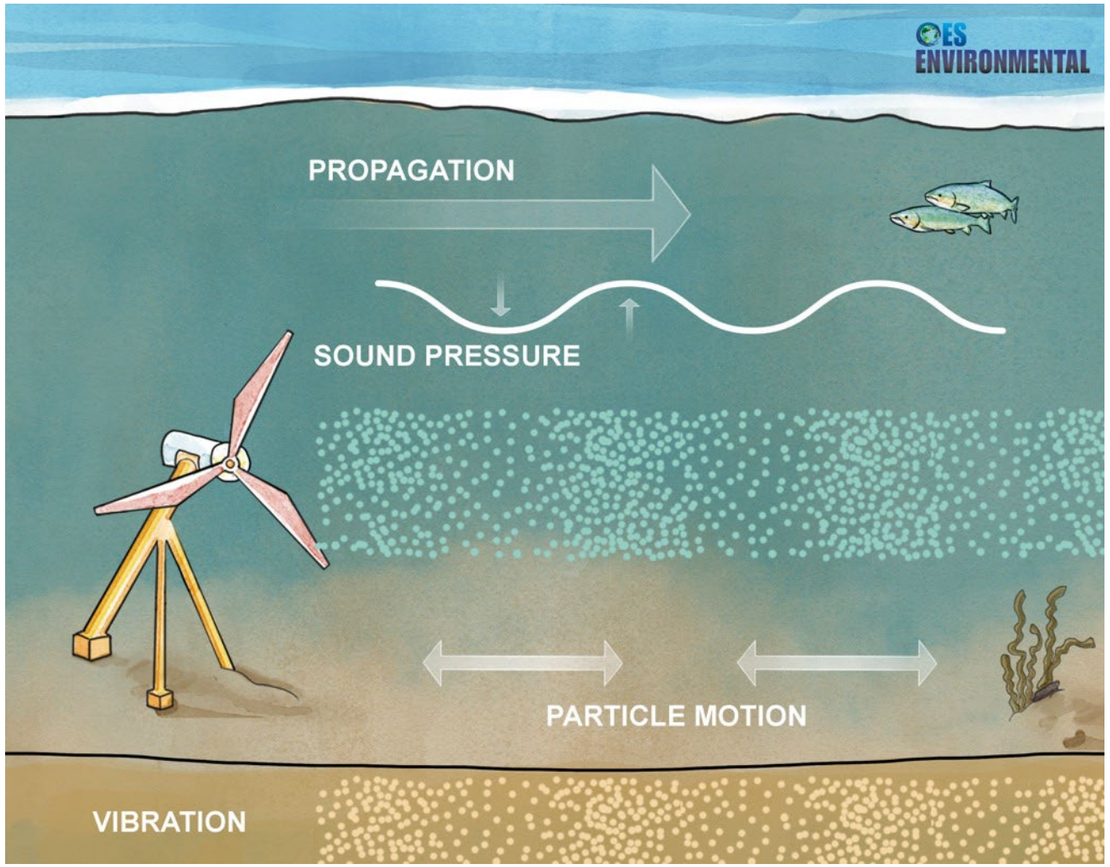
Risks to Marine Animals from Underwater Noise

- Marine animals navigate, communicate with sound
- Acoustic output from turbines and wave energy converters add to existing noise
- Greatest concerns for marine mammals, some fish
- Generally low frequency noise, low amplitude
- IEC TC114 specification to measure noise, US regulatory standards
- Considered retired for small numbers of devices (1-6)



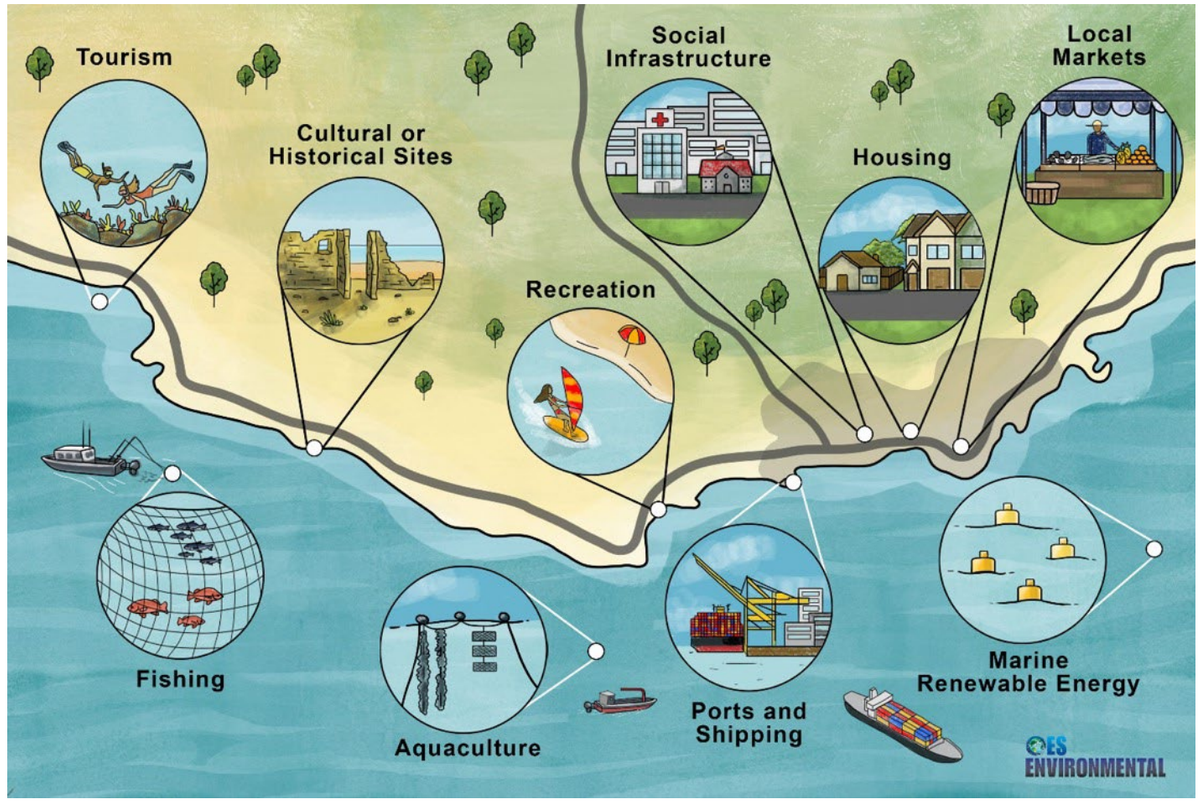
Risks to Marine Animals from Underwater Noise





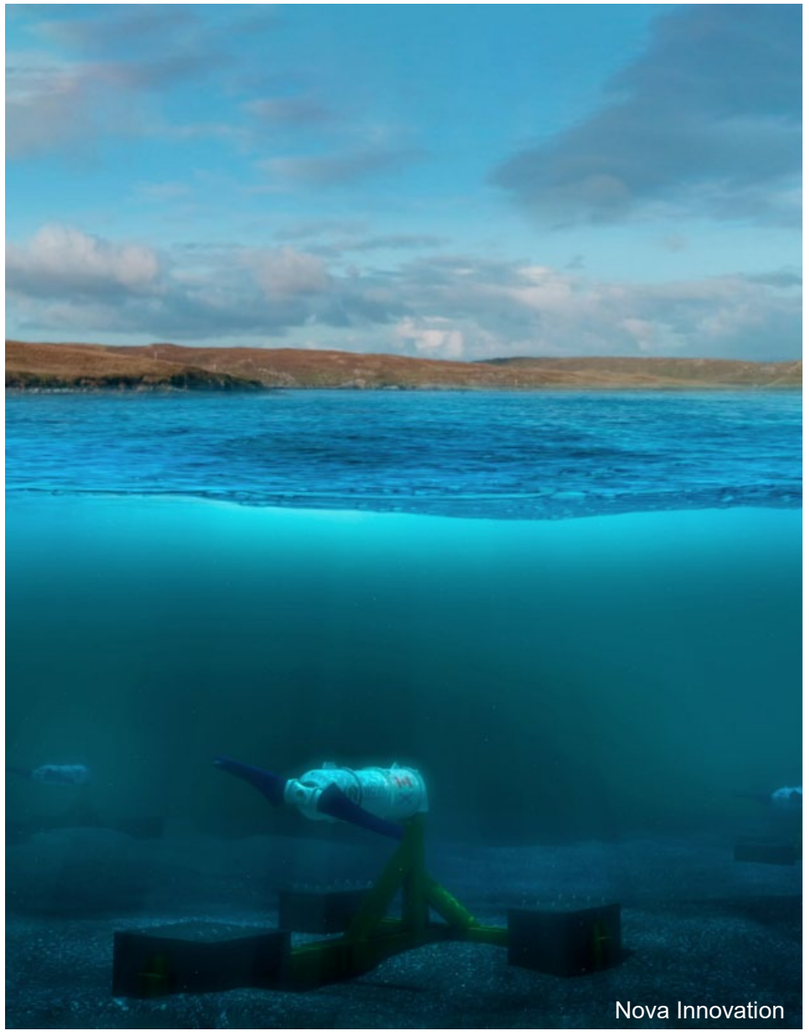
Social and Economic Effects of Marine Energy

- Social and economic effects often confounded with environmental effects
- Limited research in this area, few methods for consistent measurement
- Documented effects on fisheries, ports, supply chain, indigenous people, tourism, energy users
- Benefits such as employment, economic development also come with social and economic costs
- Early and often stakeholder engagement needed



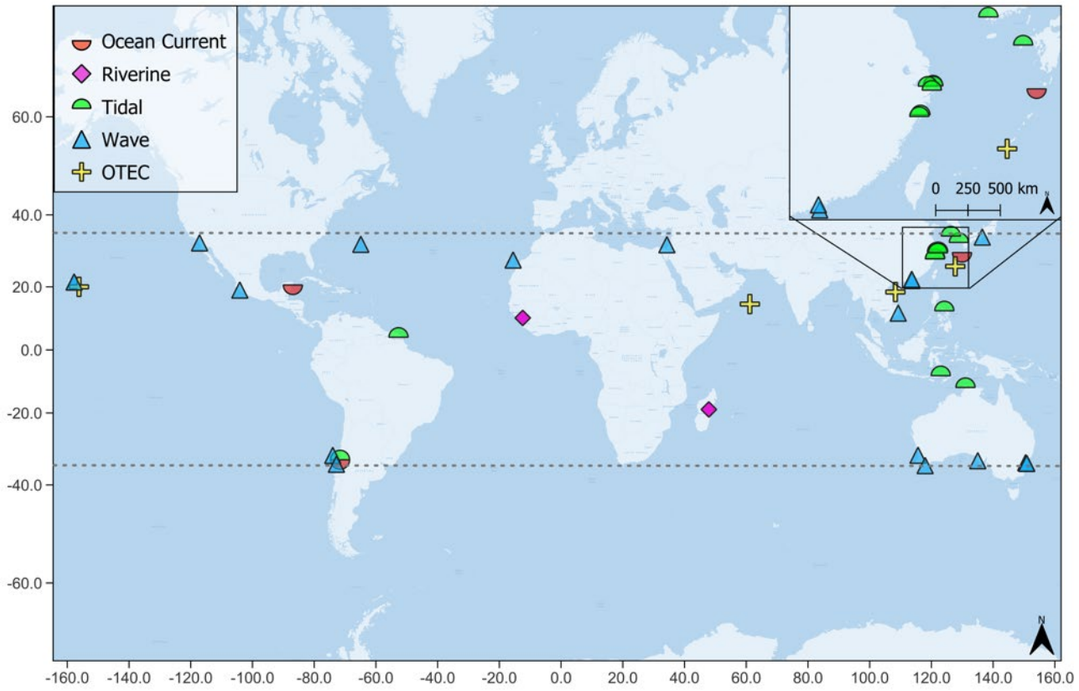
Beyond Single Devices: System-Wide Effects

- Scaling environmental effects knowledge from single devices to arrays
- Adding MRE to ecosystem models to understand effects
- Adding MRE to cumulative effects of other anthropogenic activities in the ocean
- Scaling may not be linear or additive
- Journal papers on each
  - Scaling Up: https://www.sciencedirect.com/science/article/pii/S0048969723054268?via%3Dihub
  - Others in preparation



Potential Effects in Tropical and Subtropical Ecosystems

- Most environmental effects information derived from temperate systems
- MRE projects in tropical and subtropical regions are growing
- Tropical ecosystems have higher biodiversity
- Unique habitats like coral reefs, mangroves, etc.
- Social acceptance strongly tied to ecological health
- Need to address entire ecosystems not just stressor-receptor relationships



Environmental Sustainability

- Need to understand:
  - Potential risks to marine animals, habitats, ecosystem processes
  - Specifics about what parts of WEC or turbine, or other parts, represent risk

- Need to have:
  - Post-installation monitoring data that demonstrates risk (or lack thereof)
  - Means to communicate level of risk to regulators that is accessible
  - Good communication and collaboration for data collection and analysis globally

It takes a global village of researchers:

PNNL Team

Andrea Copping, Lysel Garavelli, Lenaïg Hemery, Mikaela Freeman, Hayley Farr, Deborah Rose, Marley Kaplan, Kristin Jones, Amy Woodbury

OES-Environmental Representatives

Elizabeth Fulton (Australia), Daniel Hasselman (Canada), Teng Xin/Shuang Wang (China), Hans Chr Soerensen (Denmark), Nolwenn Quillien/Lydie Couturier (France), Purnima Jalihal (India), Anne Marie O'Hagan (Ireland), Daisuke Kitazawa (Japan), Deborah Lithgow/M. Luisa Martínez (Mexico), Jérémie Carles (Monaco), Jan Sundberg (Sweden), Inês Machado (Portugal), Srikanth Narasimalu (Singapore), Juan Bald (Spain), Millie Green (United Kingdom), and Andrea Copping (United States)

Pacific Northwest NATIONAL LABORATORY

ES ENVIRONMENTAL

Thank You!

Andrea Copping
andrea.copping@pnnl.gov

2024 State of Science Report

U.S. DEPARTMENT OF ENERGY BATTELLE

PNNL is operated by Battelle for the U.S. Department of Energy