



# Webinar Series

## ***Potential Effects of Offshore Renewable Energy: Knowledge and Resources***

For best results, please ensure your video is turned “off” and that you are “muted”.

Submit any questions to Jason Busch in the comment section. All questions will be addressed during a Q&A session upon the conclusion of the webinar.

A link to the recording of the webinar will be made available on the POET website.

# Today's Presenters



**Andrea Copping, Ph.D. – Senior Research Scientist, Pacific Northwest National Laboratory**

- Researches effects from the development of wave and tidal energy and offshore wind installations
- Leads OES-Environmental – an international project on environmental effects of marine energy
- Serves as a Distinguished Faculty Fellow in the School of Marine and Environmental Affairs at UW
- Serves as Associate Editor of Coastal Management Journal; editorial board for International Marine Energy Journal



**Alicia M. Gorton, Ph.D., PMP – Project Manager, Pacific Northwest National Laboratory**

- Serves as Program Manager of the DOE Lidar Buoy Program, facilitating metocean data collection for the offshore wind industry
- Provides technical and management expertise to projects sponsored by DOE's Water Power Technologies Office and Wind Energy Technologies Office and the Bureau of Ocean Energy Management
- Serves on editorial board of Marine Technology Society Journal



**Geneva Harker-Klimeš, Ph.D. – Coastal Sciences Division Director, Pacific Northwest National Laboratory**

- Serves as Division Director of the Coastal Sciences Division, including PNNL's Marine Sciences Laboratory
- Served as project manager of the Triton Initiative, supporting the development of environmental technologies specifically for studies around marine renewable energy devices
- Worked as an environmental consultant for renewable energy in Europe for 13 years



# Potential Effects of Offshore Renewable Energy: Knowledge and Resources

## Part 1: Marine Renewables and Offshore Wind

POET Webinar  
April 15, 2020

**Andrea Copping**

**Alicia M. Gorton**

**Genevra Harker-Klimeš**

Pacific Northwest National Laboratory



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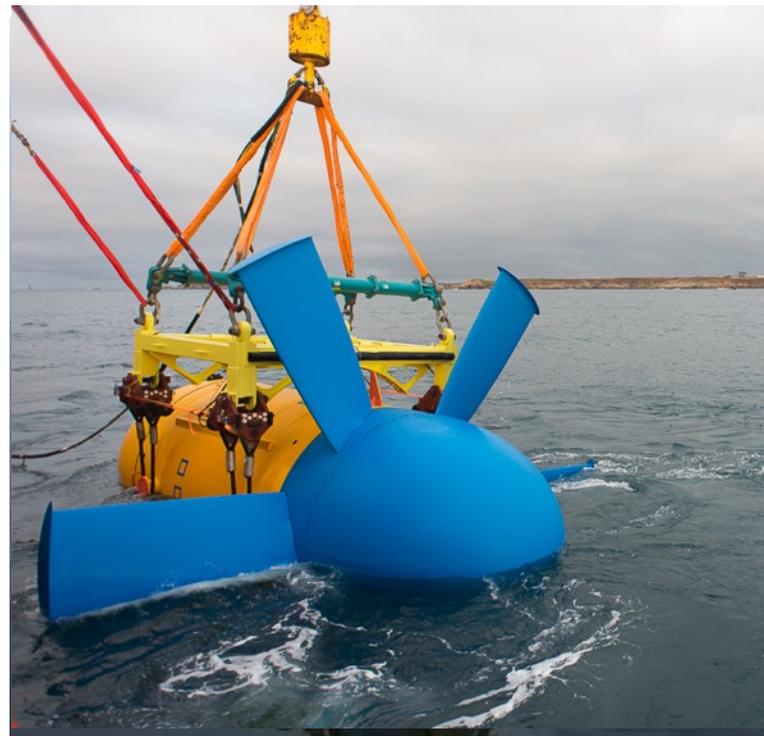
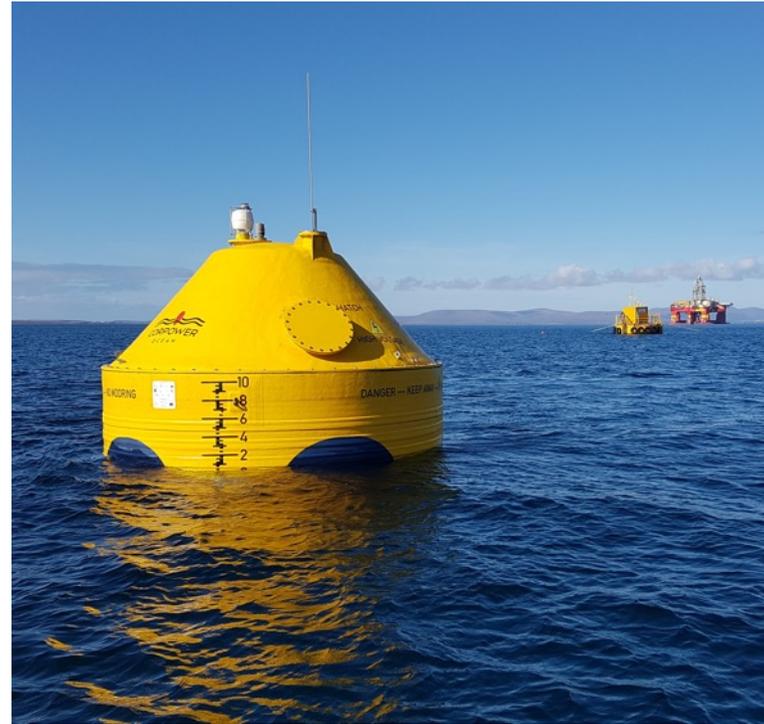


## Today...

- Marine renewable energy (MRE) and floating offshore wind (OSW)
  - Similarities and differences among the technologies and their effects
- Knowledge gained from MRE and application to OSW
- Resources for further investigation
  - *Tethys*
  - *2016 State of Science Report*
  - *2020 State of Science Report*
- Offshore Wind Synthesis of Environmental Effects Research (SEER) Project
  - Facilitate knowledge transfer for OSW around the world
  - Synthesize and disseminate existing knowledge about environmental effects research

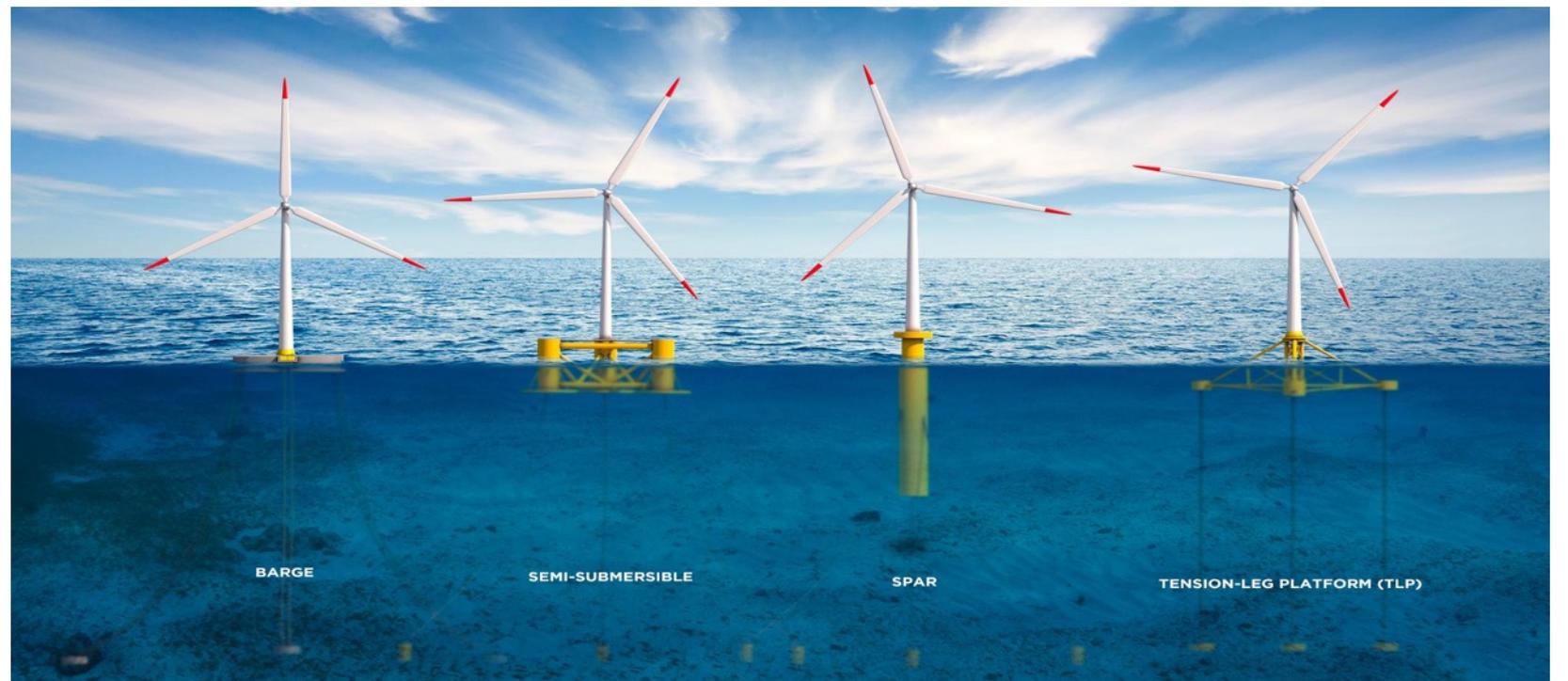
## Marine Renewable Energy (MRE)

- Captures energy directly from ocean waves, tides, and currents (and other mechanisms)
- Deployed at offshore, nearshore, and shore-based locations
- Variety of technologies undergoing testing and commercial development

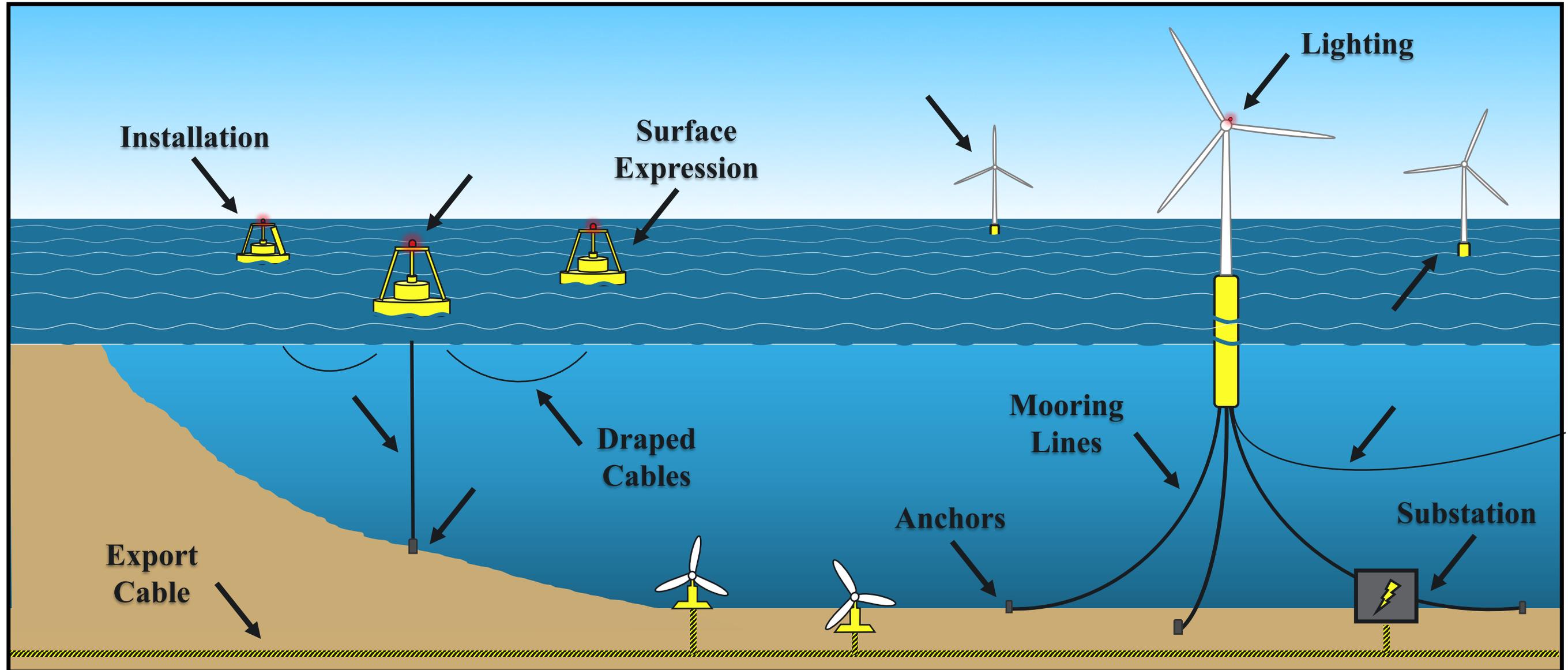


## Floating Offshore Wind Energy (OSW)

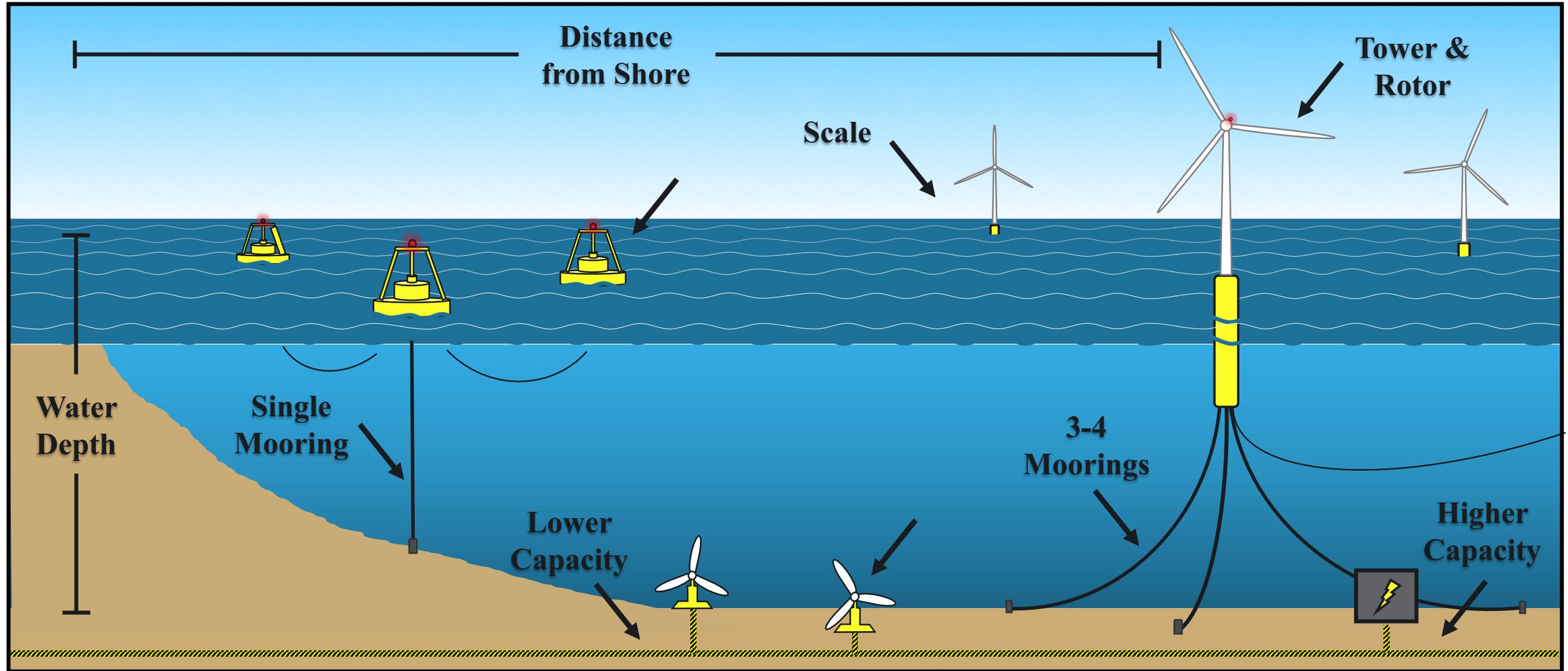
- Captures energy from offshore wind, generally strong and persistent
- Fixed bottom most common
- Variety of floating foundation types undergoing testing
- Few full-scale pilot installations worldwide



# Effects that are similar between MRE and OSW



# Effects that differ between MRE and OSW



# 2016 State of the Science Report

- Developed and published by IEA Ocean Energy Systems-Environmental (OES-E)
- Summarizes interactions and effects of MRE devices on the marine environment, the animals that live there, and the habitats that support them
- Useful to researchers, regulators, MRE device and project developers, policy makers, resource managers, and other stakeholders
- Serves an update and complement to the 2013 Annex IV Report



[https://tethys.pnnl.gov/publications/  
state-of-the-science-2016](https://tethys.pnnl.gov/publications/state-of-the-science-2016)

From MRE:



**Collision Risk**



**Underwater Noise**



**Electromagnetic Fields**



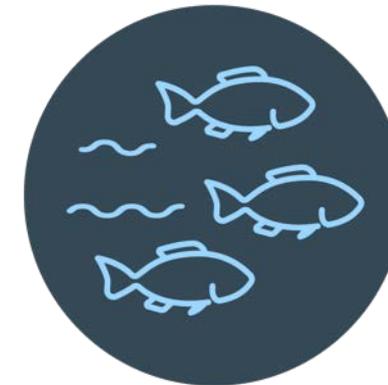
**Habitat Change**



**Oceanographic Systems**



**Entanglement**



**Displacement**

# Collision Risk Knowledge from MRE



- Tidal turbines' rotating blades may cause injury and/or death to marine mammals, fish, and diving seabirds
- Wave devices thought to pose low risk due to few submerged moving parts
- No observations of marine mammal or diving seabird collisions
- Observations of fish interactions have shown no harm
- Technologies to observe collision are not well developed and difficult to operate in high-energy environments

Increased sharing of existing information	████████████████████
Improved modeling of interaction	██
Monitoring data needed to verify findings	██
New research needed	██



# Collision Risk Application to Floating Wind



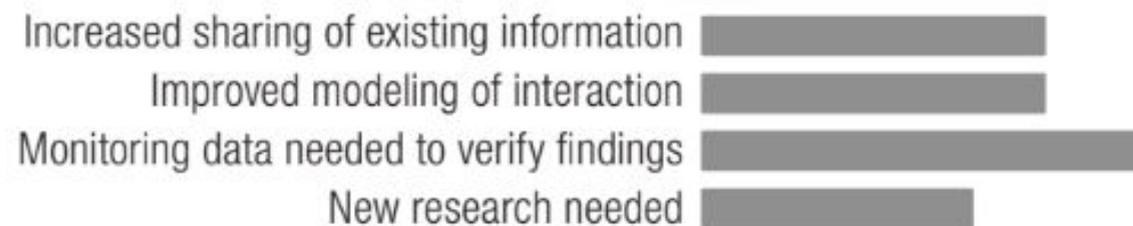
- Collision risk for OSW concerns turbine blades at top of tower
  - Concern for birds and bats
- Observing collisions also difficult around turbines (though not as hard)
  - Cannot pick up carcasses as for land-based wind
- Like tidal, approach for OSW is to understand presence of species at risk
  - Distance offshore, flight height, migratory patterns
- Relative risk also influenced by:
  - Technology-specific variables
  - Location
  - Weather
  - Lighting
  - Wind farm layout



# Underwater Noise Knowledge from MRE



- Animals use sound in the marine environment for communication
- Behavioral changes or physical harm can occur from anthropogenic noise
- MRE sound assessment focused on operational (not construction) noise
- Measuring underwater noise from WECs & turbines, we have tools:
  - US action thresholds (NOAA) for MM, guidance for fish (BOEM)
  - International standards for measuring underwater sound (IEEE-TC114)
- Wave energy converters (WECs) and turbine noise measure under thresholds



# Underwater Noise Application to Floating Wind



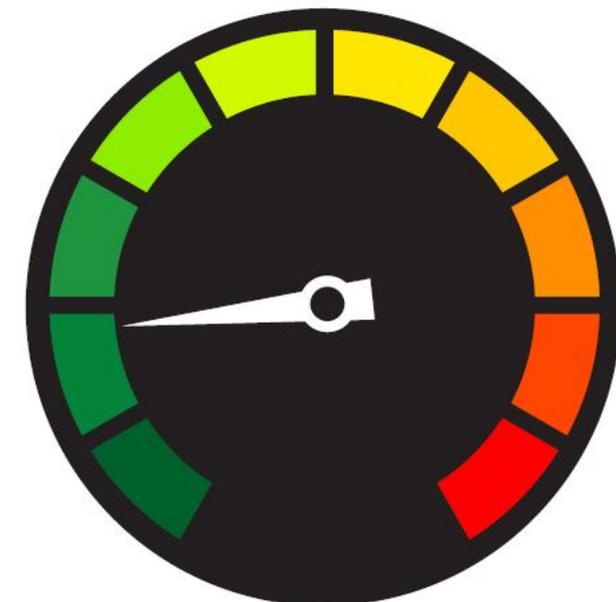
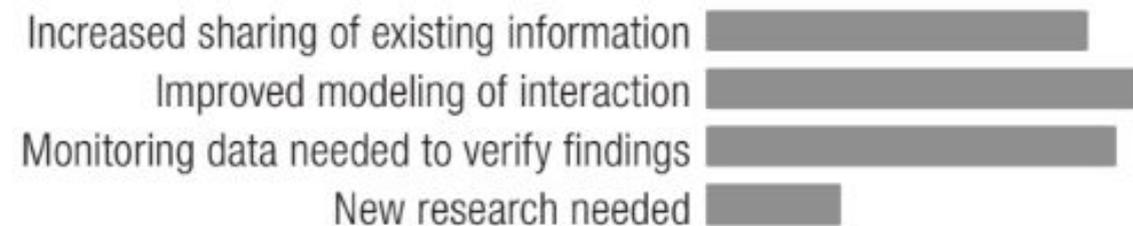
- Noise from turbine blades and PTO in air generally not considered excessive
- Vibration from tower could transmit underwater (likely ~10%)
- Potential for small amount of sound to disturb marine mammals, fish



# Electromagnetic Fields (EMFs) Knowledge from MRE



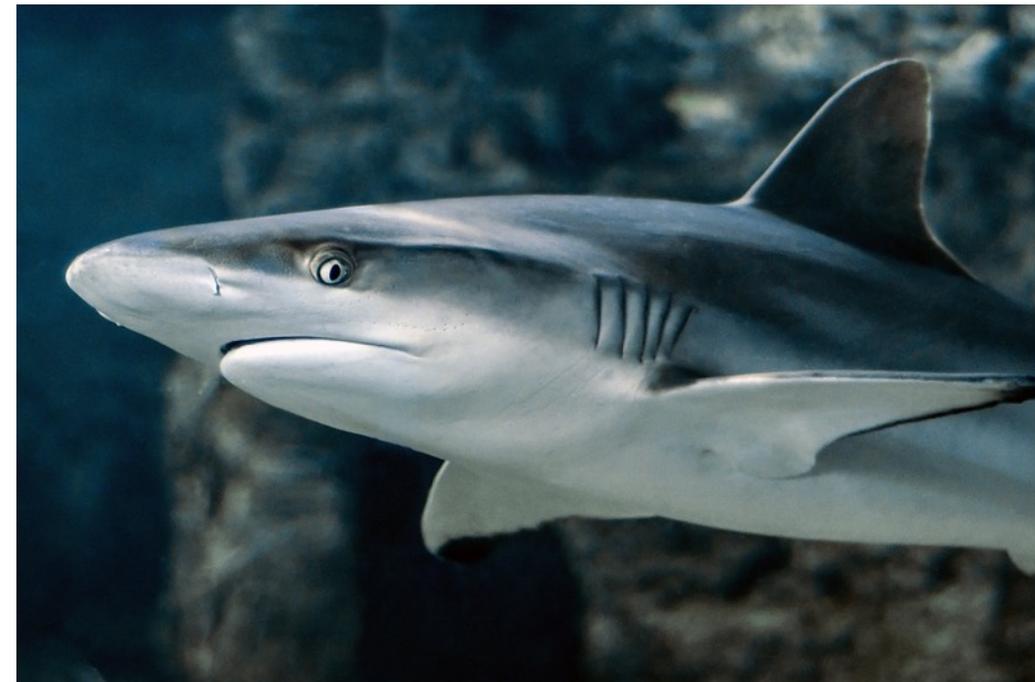
- EMFs from electrical cables and substations may affect certain sensitive organisms
- Lab and field studies show changes and effects for some species, but not expected to cause deleterious impacts at MRE levels of power
- No regulatory action thresholds or standard methods for measurement
- Burial or mitigation possible (to separate animals from EMF)
- Relatively low risk



# Electromagnetic Fields (EMFs) Application to Floating Wind



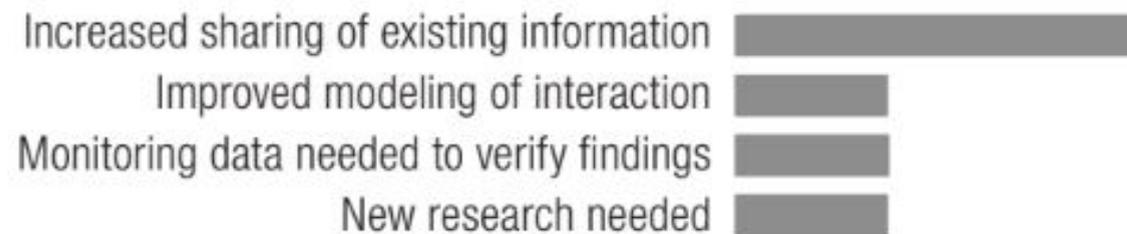
- Higher capacity OSW cables will emit higher levels of EMFs
- Understanding presence of sensitive species is important
- Cables draped between platforms may expose more pelagic species
  - Modeling shows die-off of field within 1m



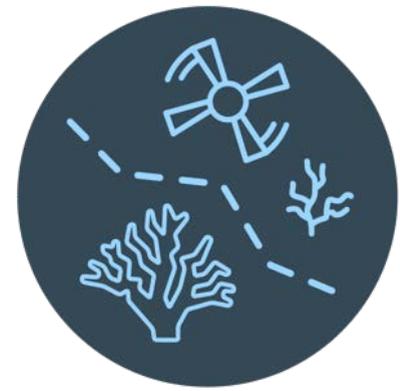
# Habitat Change Knowledge from MRE



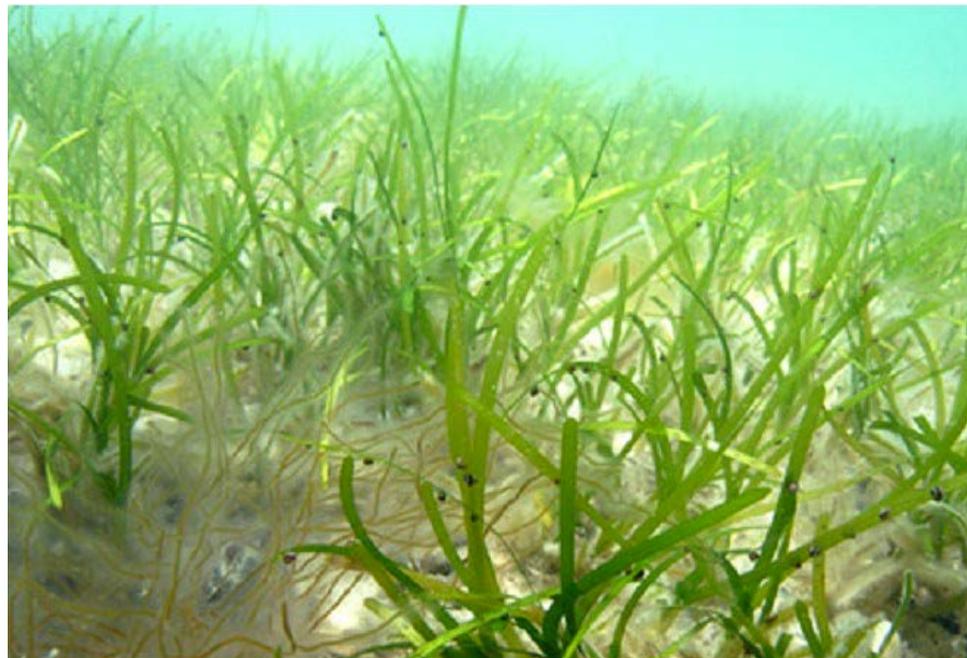
- Placement of foundations, anchors, cable route in benthic habitat
- Mooring lines in water column
- Siting is most important: avoid rare/unique or slow growing habitats
- Changes in habitats may alter species abundance, patterns of ecological succession, perhaps allow non-native species to establish, affect behavior
- Benthic communities and reefing fish not adversely affected by MRE devices
- Relatively low risk



# Habitat Change Application to Floating Wind



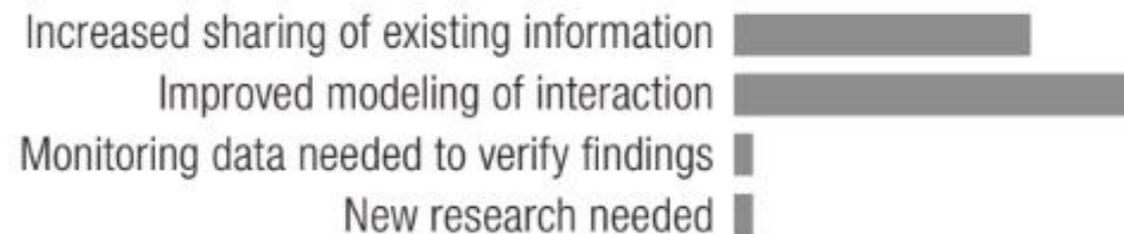
- Similarly, effects of anchors and cable route on benthos
- Mooring lines in water column on pelagic species, generally in deeper water
- Local biodiversity may change in the vicinity of floating foundations, mooring systems, and cables
- Floating OSW likely sited further offshore, less biologically diverse/abundant waters



# Oceanographic Systems Knowledge from MRE



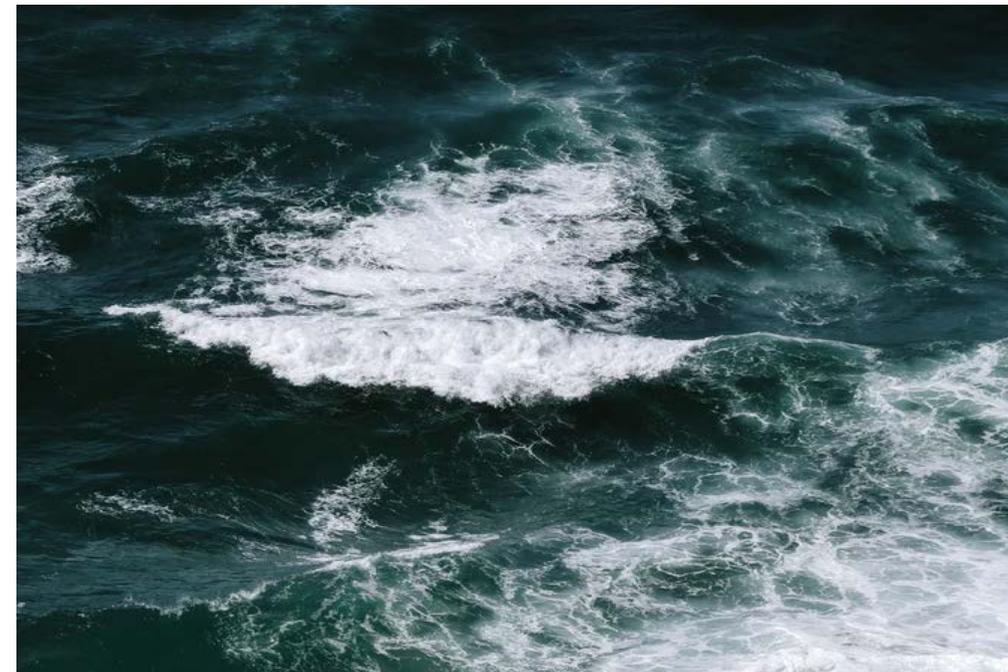
- Operation of turbines may change natural currents, flow patterns, remove energy from the system
- Operation of WECs may change wave heights
- May cause cascading effects on sediment transport, water quality, food webs
- Single device effects less than natural variability, will need to re-examine for arrays
- Numerical models are analytical tool of choice
- Risk is likely low



# Oceanographic Systems Application to Floating Wind



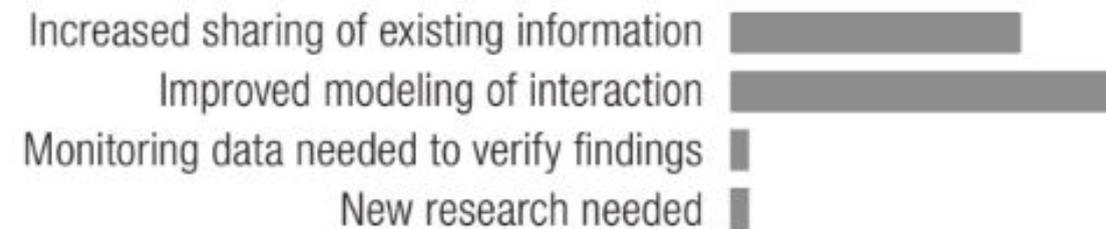
- Similar effects with floating foundations as with WECs: decrease in wave heights, changes in wind-driven waves
- Sited in deep waters far from shore: potential for large farms to interact with ocean currents
- Sited with the wake effect in mind



# Entanglement Knowledge from MRE



- Potential for entrapment/entanglement for large marine animals, especially migratory whales
- Need loop or loose end to entangle (concerns from fishing gear, old style submarine cables)
- No observations made of marine animals becoming entangled in taut mooring lines
- Overall risk from this stressor is likely very low for MRE



# Entanglement Application to Floating Wind



- Many MRE devices require only a single mooring line, while floating offshore wind platforms have 3 or 4
- Floating OSW more likely to be sited further offshore and in less biologically diverse and abundant marine areas
- Stakeholders remain concerned for direct interaction, or secondary risk from derelict fishing gear snagged on mooring lines





# Entanglement Application to Floating Wind

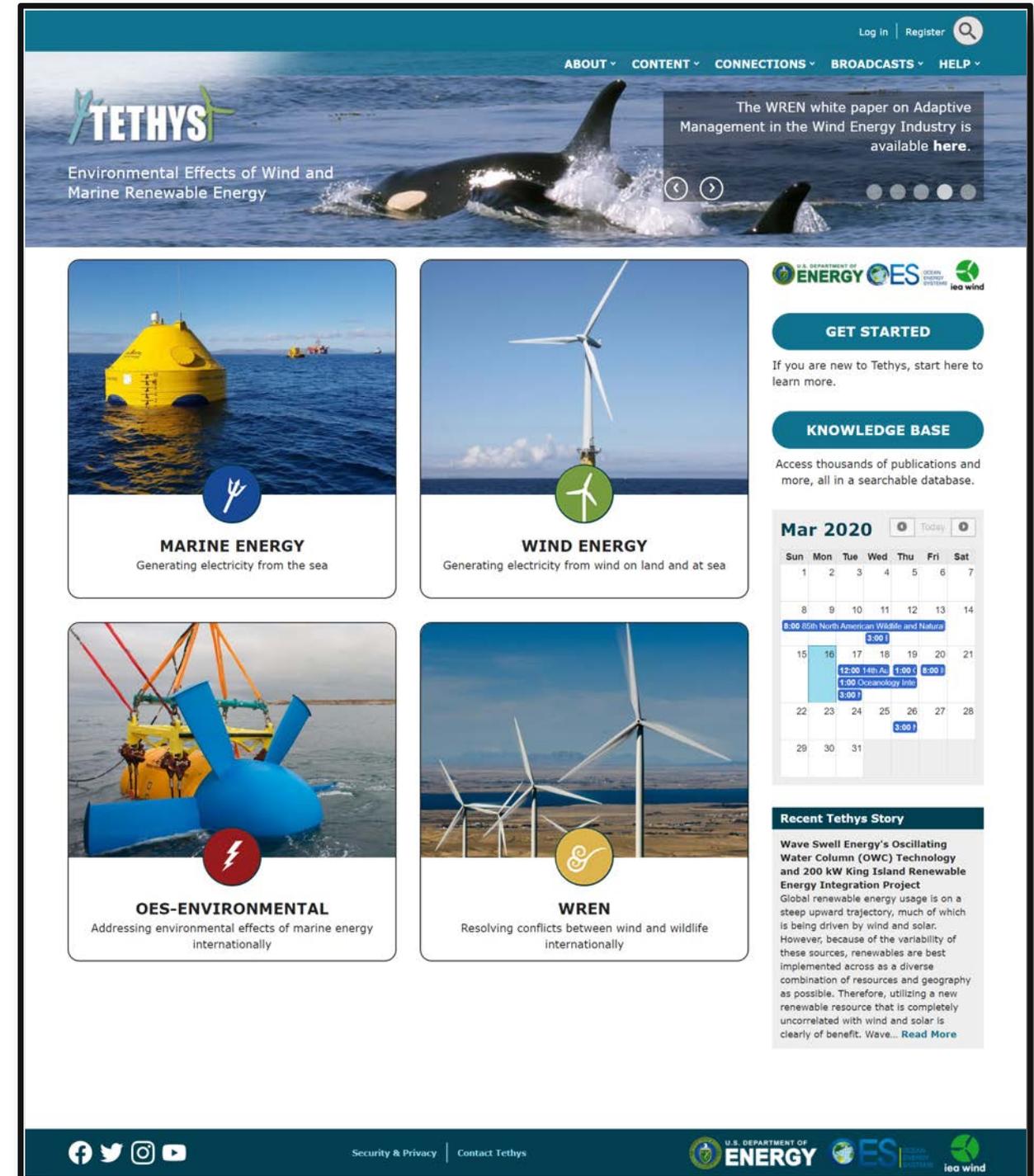


Animation: Humpback Whales and Floating Offshore Wind Farms

<https://tethys.pnnl.gov/publications/humpback-whales-floating-offshore-wind-farm-animation>



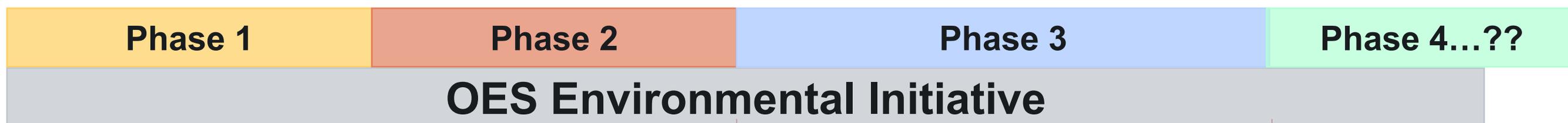
- *Tethys* hosts over 6,000 scientific papers, reports, and other documents
- Searchable by knowledge base, map viewer
- Other resources:
  - Archived webinars
  - Tethys Blasts
  - Tethys Stories
  - Events Calendar
  - OES-Environmental Metadata
- And many other additional resources



The screenshot shows the Tethys website homepage. At the top, there is a navigation bar with links for ABOUT, CONTENT, CONNECTIONS, BROADCASTS, and HELP. A search bar is located in the top right corner. Below the navigation bar is a large banner image of an orca with the TETHYS logo and the text "Environmental Effects of Wind and Marine Renewable Energy". A notification box on the right side of the banner reads: "The WREN white paper on Adaptive Management in the Wind Energy Industry is available here." Below the banner are four main content cards: MARINE ENERGY (Generating electricity from the sea), WIND ENERGY (Generating electricity from wind on land and at sea), OES-ENVIRONMENTAL (Addressing environmental effects of marine energy internationally), and WREN (Resolving conflicts between wind and wildlife internationally). To the right of these cards is a sidebar with a "GET STARTED" button, a "KNOWLEDGE BASE" section, a calendar for March 2020, and a "Recent Tethys Story" section. The footer contains social media icons, a "Security & Privacy" link, a "Contact Tethys" link, and logos for the U.S. DEPARTMENT OF ENERGY, EES, and IEA WIND.

# OES-Environmental (formerly Annex IV)

- OES-Environmental is a collaborative initiative of the Ocean Energy Systems (OES), under the International Energy Agency (IEA) Technology Network
  - Efficient government oversight
  - Data and information are widely accessible
  - Facilitate knowledge transfer
  - Phase 3: 15 nations participating

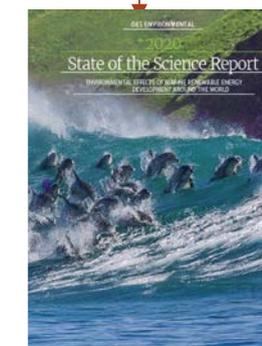


2010

2013

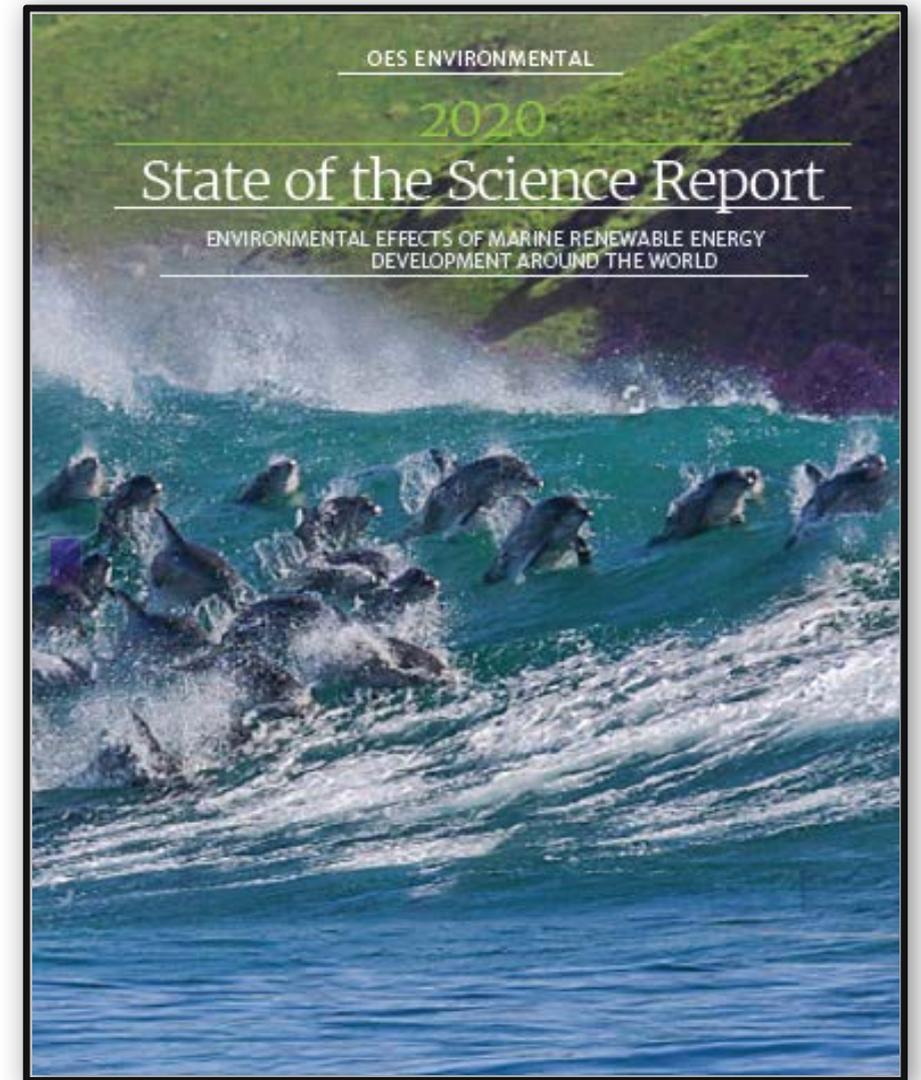
2016

2020



# 2020 State of the Science Report

- Summarizes:
  - Major stressor/receptor interactions
  - Environmental monitoring technologies
  - Management and planning measures
- Developed by 28 authors from 4 countries
- Reviewed by 60+ international scientists and engineers from 11 countries
- Serves as an update and complement to the 2016 State of the Science Report
- Public draft to be released in late May/early June; final draft to be released in late summer





## PNNL Team:

- Dr. Andrea Copping
- Dr. Lenaïg Hemery
- Dr. Alicia Gorton
- Jonathan Whiting, P.E.
- Mikaela Freeman
- Dr. Lysel Garavelli
- Hayley Farr
- Dorian Overhus
- Deborah Rose
- Levy Tugade
- Amy Woodbury



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# International, National, and Regional Perspectives and Projects for U.S. Offshore Wind Development



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# Offshore Wind and Environmental Effects

## International Perspectives

- Joint Industry Efforts
  - ORJIP Offshore Wind – Reducing the consenting risk for OSW developments to better inform consenting authorities on the true environmental risk of OSW
  - Wind Europe – Position paper on floating OSW



# Offshore Wind and Environmental Effects

## International Perspectives

- Councils / Initiatives
  - ICES – International Council for the Exploration of the Seas
  - WREN – Working Together to Resolve Environmental Effects of Wind Energy
- Literature and International Expertise
  - M. Perrow – Wildlife and Wind Farms, Conflicts and Solutions (Vols. 3 & 4)
  - Wind Energy – The Facts (WindFacts)
  - Danish Offshore Wind: Key Environmental Issues



# Offshore Wind and Environmental Effects

## U.S. East Coast Perspectives

- NYSERDA – New York State Energy Research and Development Authority
  - Focus: Coordination, collaboration, cumulative effects
- ROSA – Responsible Offshore Science Alliance
  - Focus: Regional research and monitoring of fisheries and OSW interactions
- RWSE – Regional Wildlife Science Entity
  - Focus: Regional research and monitoring of wildlife and marine ecosystems to support environmentally responsible development of OSW



# Offshore Wind and Environmental Effects

## U.S. West Coast Perspectives

- POWER – Pacific Ocean Wind Energy Research
  - Focus: Understand and articulate impacts of OSW development on the U.S. West Coast
    - Identify fundamental research topics
    - Develop scientifically defensible and testable hypothesis
    - Conduct research to advance the science and address knowledge gaps
    - Communicate and disseminate outcomes



# Offshore Wind and Environmental Effects

## National Perspectives

- SEER – U.S. Offshore Wind Synthesis of Environmental Effects Research
  - Focus:
    - Facilitate knowledge transfer for OSW around the world
    - Synthesize and disseminate existing knowledge about environmental effects research
    - Inform applicability to U.S. East and West Coast waters by building on existing work and collaborating with regional entities
    - Prioritize future research needs

# SEER: Project Goals



1

Succinctly summarize the understanding of environmental effects, monitoring tools, assessment methods, and mitigation strategies based on existing international research

2

Examine which of the state-of-the-art methods and technologies are relevant to environmental issues specific to the U.S. industry

3

Identify knowledge and research gaps on the:

1. Diversity of species, habitat use, and stressors
2. U.S. environmental legal/regulatory structure
3. Technological trends and innovations

# SEER: Outcomes



## Research Briefs

Review state of the knowledge on stressor / receptor interactions, provide evaluation of technical considerations, monitoring methods and technologies, mitigation measures, and cumulative impacts



## Research Recommendations

Summarize information gaps, barriers, and current challenges for U.S. East and West Coasts to inform or guide future development efforts



## Webinar Series

Disseminate findings presented in Research Briefs and Research Recommendations to the community through webinars and workshops

# SEER: Stakeholder Engagement



- Gather feedback on:
  - “Hot topics” for OSW environmental issues
  - Existing efforts that can be leveraged
  - Key environmental research gaps
- Stakeholders engaged with expert knowledge on global and U.S. East and West Coast environmental research and considerations:
  - Federal entities
  - Industry
  - NGOs / academia



Interviews



Webinars



Online Survey

# SEER: Research Topics of Interest



Noise & acoustic impacts



Electromagnetic fields –  
populations & migration patterns



Cable considerations – water  
column, benthos, & landfall



Floating turbine systems &  
deepwater ecosystems



Fish – foundations & artificial  
reef effects



Birds & bats – collisions, displacement, &  
avoidance



Marine mammals – noise, vessel traffic, &  
entanglement hazards



Benthic habitat disturbance – scour & anchors



Environmental monitoring technologies,  
methods, & best practices



Cumulative effects on vulnerable species  
& habitat

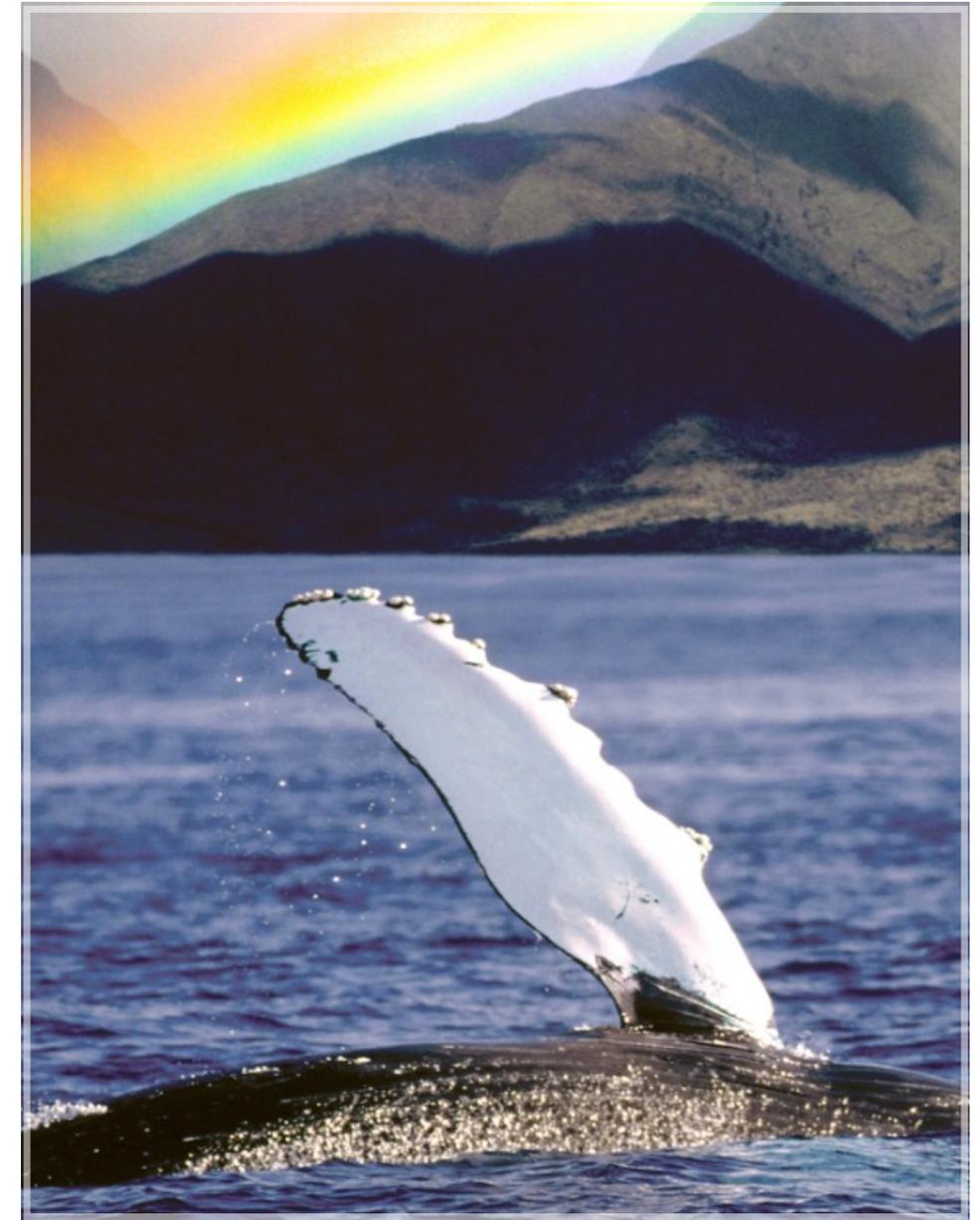
# SEER Next Steps: Regional Engagement and Collaboration



- Engage with U.S. East and West Coast regional entities
  - East Coast – Regional Wildlife Science Entity (RWSE)
  - West Coast – Pacific Offshore Wind Energy Research (POWER)
- Subject matter experts
- Reviewers
- Co-organize East / West Coast workshops
- Contribute to and provide feedback on research recommendations:
  - What is specific to the East / West Coast and its respective stakeholders?
  - What priorities have you identified that should be included?
- How can SEER support / contribute to what RWSE / POWER is doing?

## Summary

- Environmental effects of West Coast floating OSW can be informed by:
  - Extensive environmental knowledge from MRE
  - International OSW perspectives and expertise
- Investigations and issues that are peculiar to West Coast floating wind can become focus of investment for new knowledge
- Collaboration and knowledge dissemination needed between sectors and stakeholders to:
  - Support development of floating OSW
  - Protect the marine environment
  - Support existing users





# Thank You!

**Andrea Copping**  
[andrea.copping@pnnl.gov](mailto:andrea.copping@pnnl.gov)

**Alicia M. Gorton**  
[alicia.gorton@pnnl.gov](mailto:alicia.gorton@pnnl.gov)

**Genevra Harker-Klimes**  
[genevra.harker@pnnl.gov](mailto:genevra.harker@pnnl.gov)

**Hayley Farr**  
[hayley.farr@pnnl.gov](mailto:hayley.farr@pnnl.gov)



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# Webinar Series

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Questions or future webinar topics can be sent to [info@pacificoceanenergy.org](mailto:info@pacificoceanenergy.org)