Oregon Offshore Wind Roadmap – Science and Uncertainty

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Today…

- What do we know about floating offshore wind's environmental effects?
- How do we know this?
- How do we deal with uncertainty?

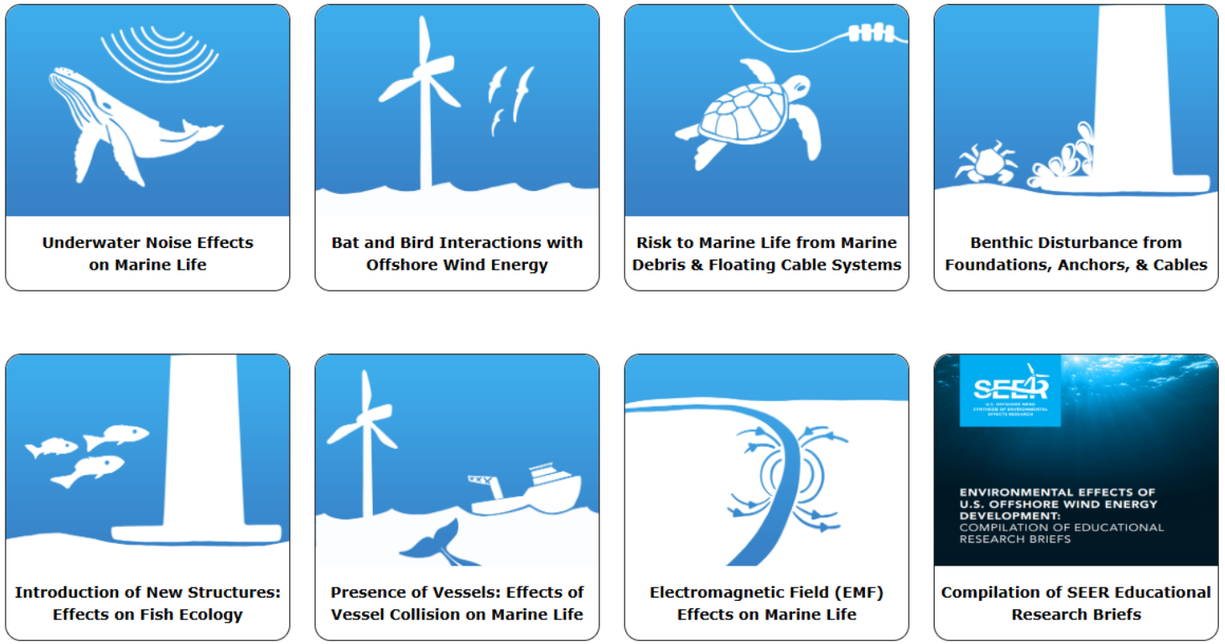
Potential Environmental Effects of Floating Wind

- Research and monitoring at existing floating wind farms around the world are beginning to build the evidence base.
- Data from other industries provide insights into floating wind energy's potential effects, monitoring, and mitigation.

Illustration by Joshua Bauer, National Renewable Energy Laboratory.

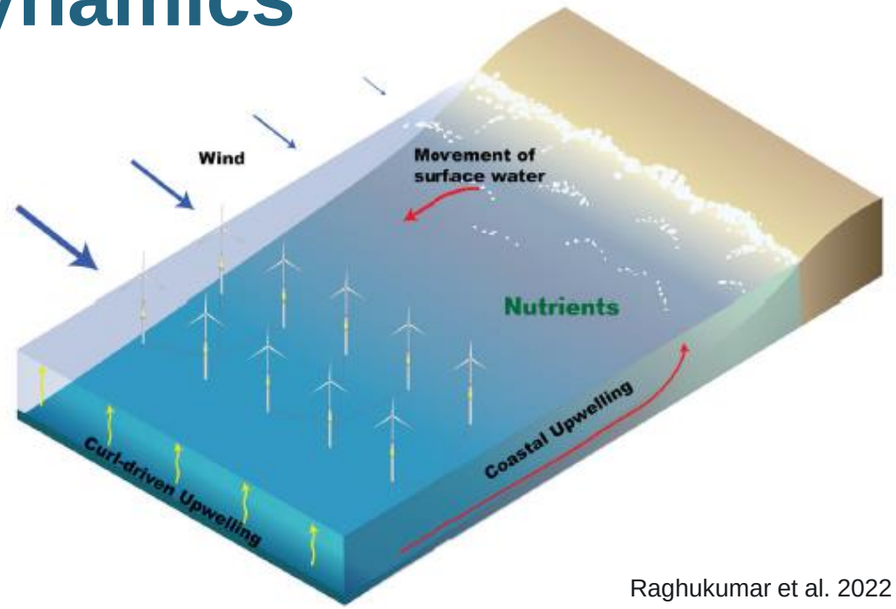
Potential Environmental Effects of Floating Wind

- Environmental effects of offshore renewable energy can be examined with a stressor-receptor framework.
- Stressors are the parts of a windfarm that may cause harm or stress to receptors, such as animals, habitats, and ecosystem processes.
- Several potential interactions, or risks, are associated with offshore wind's development lifecycle.



Changes to Ecosystem Dynamics

- Development of floating wind can change coastal, benthic, and pelagic ecosystems.
- Installation of anchors, cables, and scour protection can disturb benthic systems, but these effects are often localized and temporary.
- Substructures, moorings, and anchors may act as artificial reefs.
- There is some concern that large floating wind farms could affect ocean dynamics, such as coastal upwelling.



Raghukumar et al. 2022

Monitoring Methods

- Build on existing sampling programs
- Trawl surveys
- Scuba diving surveys
- Hydroacoustic surveys
- Fish tagging (telemetry)
- Gill nets, traps or pots
- Associated statistical analyses
  - E.g., BACI or BAG

Best Management Practices

- Siting away from sensitive habitats and fish migration routes
- Minimizing seafloor disturbance during construction and installation
- Foundation designs for target fish populations and habitat needs
- Proper burial of mooring anchors and cables

Underwater Sound

- Construction sound associated with vessel traffic, mooring and anchor installation, and cable burial is localized and temporary, but may disrupt some acoustic signals.
- During operations, sound and vibrations from floating wind turbines are transmitted via the turbine, substructure, and moorings.
- Acoustic data from existing floating turbines suggest that operational sound is like sound from fixed-bottom wind turbines, which is considered a low risk.

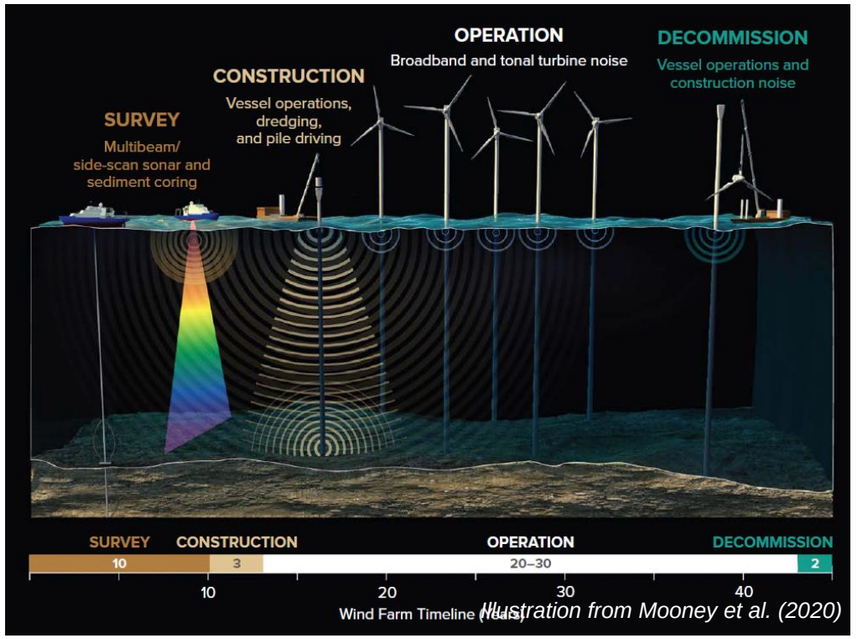


Illustration from Mooney et al. (2020)

Monitoring Methods

- Passive acoustic monitoring
- Use of animal tagging
- Vessel-based surveys
- Aerial surveys

Mitigation Methods

- Noise reduction technologies
  - e.g., Bubble curtains, Isolation casings, Cofferdams, Hydro sound dampers
- Time of year restrictions
- Protected Species Observers
  - Maintain exclusion areas
- Soft start for pile driving
- Shut down and delay of pile driving

Entanglement

- The likelihood of marine animal entanglement with floating wind's moorings and cables is very low.
- These structures have large diameters and are spaced far apart.
- Marine animals generally have the sensory capacity to avoid these hazards.
- There is little to no evidence that marine animals might become entangled by debris caught on floating wind moorings and cables.

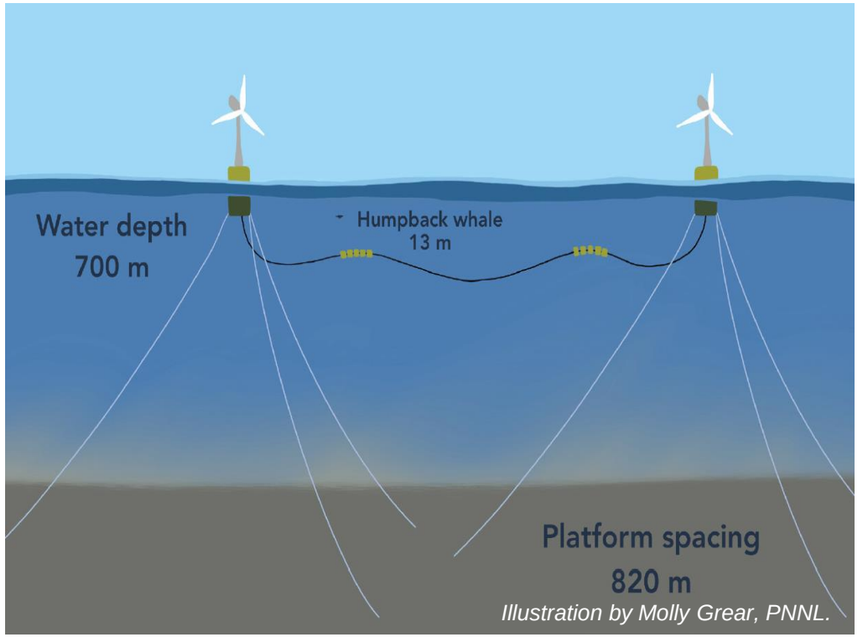


Illustration by Molly Grear, PNNL.

Recommended Entanglement Monitoring & Mitigation

- Use of underwater cameras
- Monitoring mooring line loads/motion
- Use of underwater vehicles to detect and remove marine debris

Potential Environmental Monitoring

- Aerial and drone surveys
- Remote sensing technologies
- Passive acoustics
- Underwater cameras
- Animal tagging

Vessel Strikes

- Vessel strikes between marine mammals and sea turtles and wind's construction and maintenance vessels is another concern.
- Vessel type, vessel speed, and species type are all primary factors in determining how severe an animal's injury will be.
- Whether an encounter involves a strike depends on several factors.
- These risks are generally mitigated by use of protected-species observers, reducing vessel speeds, and route restrictions.

Monitoring Methods

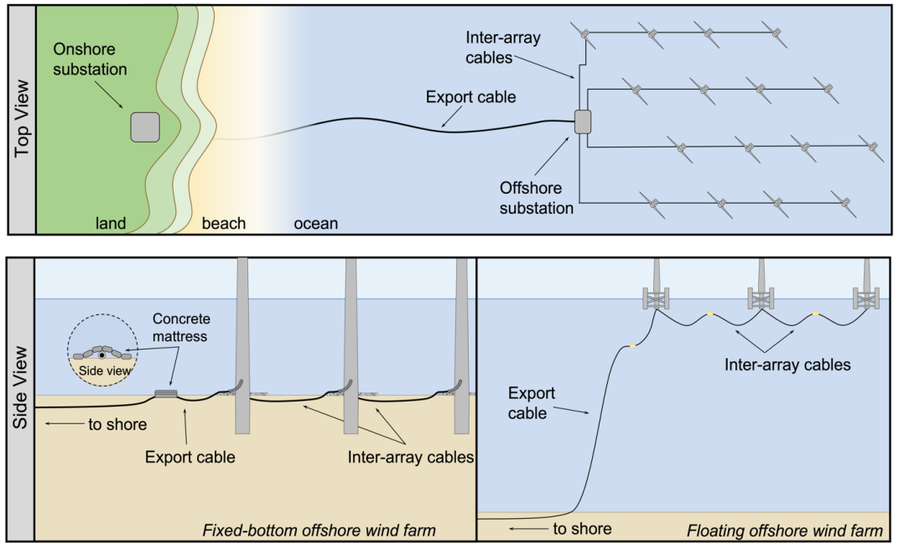
- Protected Species Observers (PSOs)
- Passive acoustic monitoring systems
- Aerial surveys (early warning system)
- Real-time vessel-based reporting
- Vessel-based tracking software
- Mobile phone alerting systems

Mitigation Methods

- Reducing vessel speed
- Changing vessel course
- Vessel speed and route restrictions
  - e.g., Ship Strike Reduction Rule
- Vessel exclusion zones
- Seasonal management areas
- Voluntary dynamic management areas

Electromagnetic Fields (EMFs)

- EMFs are generated around power export cables, inter-array cables, and offshore substations.
- Depending on the amount of power transmitted, EMFs may affect the behavior of some crustaceans and elasmobranchs.
- Overall, the effects of EMFs have been considered negligible to minor and a less significant issue than other environmental effects at offshore wind farms, but confidence remains low.



Monitoring Methods

- Deploying devices to measure the magnetic or induced electric fields by:
  - Towing behind a boat
  - Attaching to an ROV
  - Stationing near the cable
- Tracking marine animals to identify behavioral changes near EMF (e.g., using telemetry)

Mitigation Methods

- **Siting:** Routing cables to avoid habitat areas with species of concern
- **Burial:** Burying cables to add physical separation between EMF and benthos
- **Placement:** Decreasing the distance between parallel cables

Effects on Birds and Bats

- Risks include disturbance from construction activities, displacement from habitat or migration routes, and collision with turbine blades.
- Depending on the wind farm's location, layout, and other characteristics, some bird and bat species may be attracted to or avoid the array.
- Bat activity may be lower offshore than on land, but substantial data gaps remain.
- Monitoring technologies include acoustic detectors, digital aerial surveys, cameras, radar, strike indicators, and telemetry.


ThermalTracker. Photo from PNNL.


Photo by Dennis Schroeder, NREL.

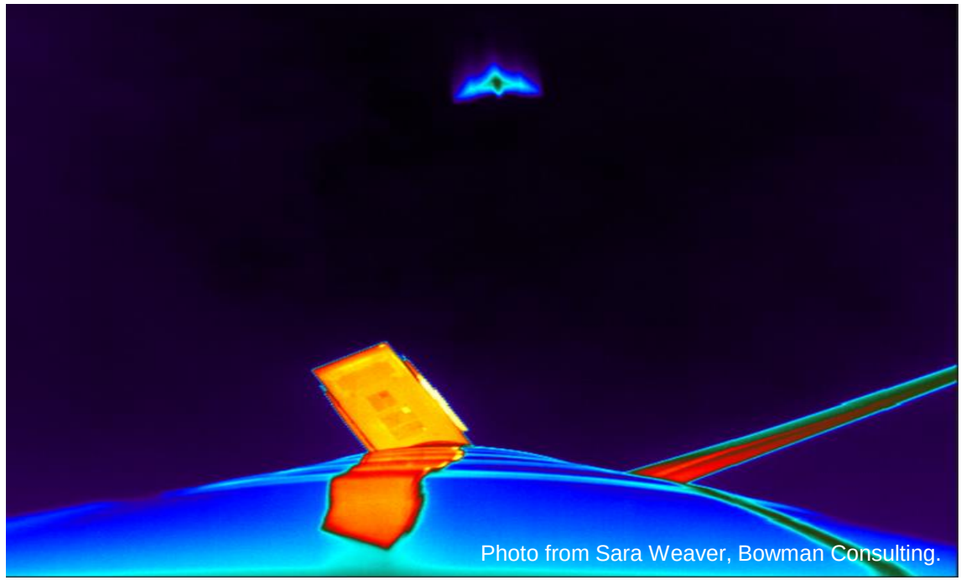
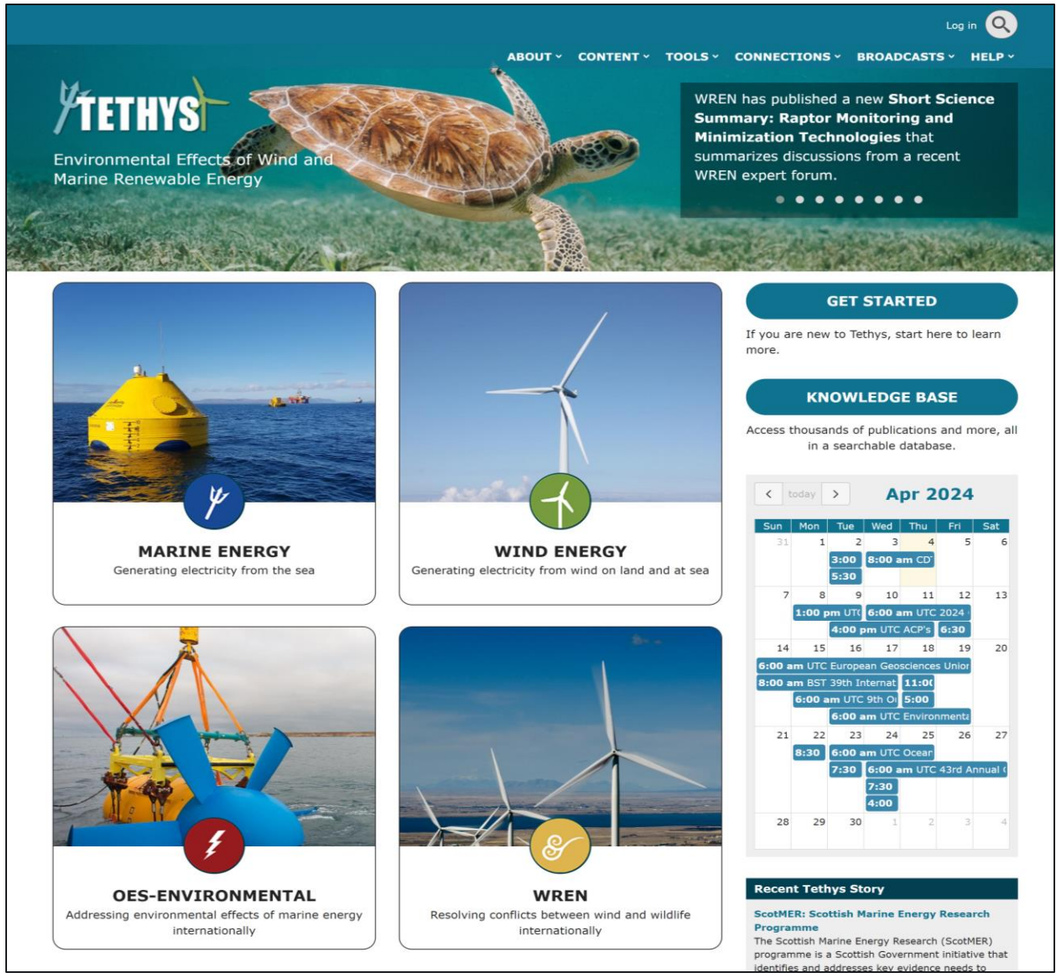


Photo from Sara Weaver, Bowman Consulting.

Visit Tethys for More Information & Resources

- Online knowledge hub with information and resources on environmental effects of land-based wind, offshore wind, and marine energy
- Over 10,000 documents, including journal articles, conference papers, and reports
- Additional features and resources include:
  - Events Calendar
  - Tethys Blast Newsletter
  - Environmental Webinars
  - Offshore Wind Metadata
  - Monitoring & Mitigation Technologies Tool
  - Tethys Stories

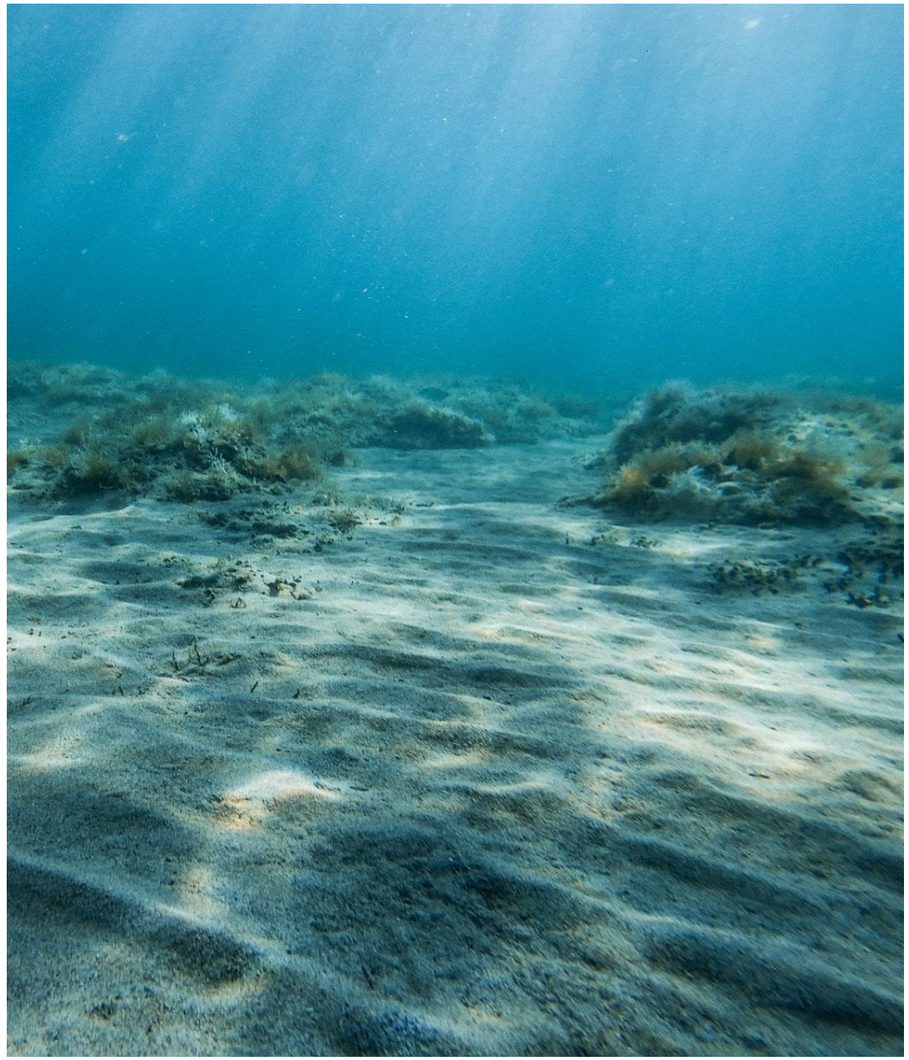


TETHYS BLAST

https://tethys.pnnl.gov

Uncertainty – Scientific and Management

- Many areas of scientific uncertainty
  - Pertinence of interaction
  - Estimates of populations at risk (abundance, density, location, demographics, seasonality)
  - Measurement accuracy and precision
  - Calibration and validation of instruments
  - Realism of numerical models (also validation)
- Management uncertainty
  - Applicability of regulation for specific interactions
  - Ability to measure change from baseline
  - Effective mitigation measures
  - Enforcement capabilities
  - Effective alternatives



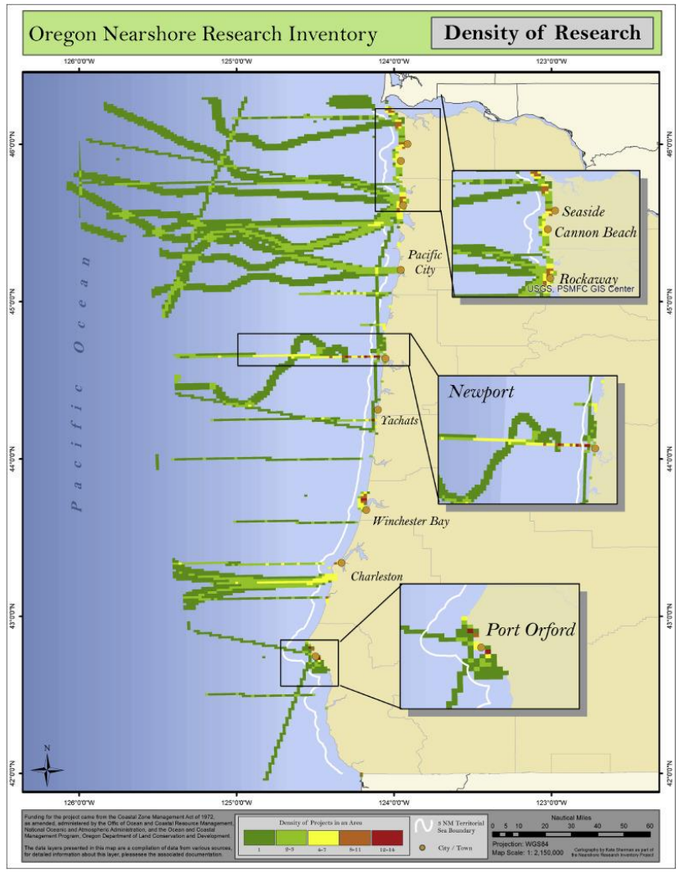
Levels of Certainty

- Domain:
  - Floating offshore wind
  - Fixed bottom offshore wind
  - Land-based wind
- Source of the information:
  - Field observations
  - Models
  - Field data used to validate models

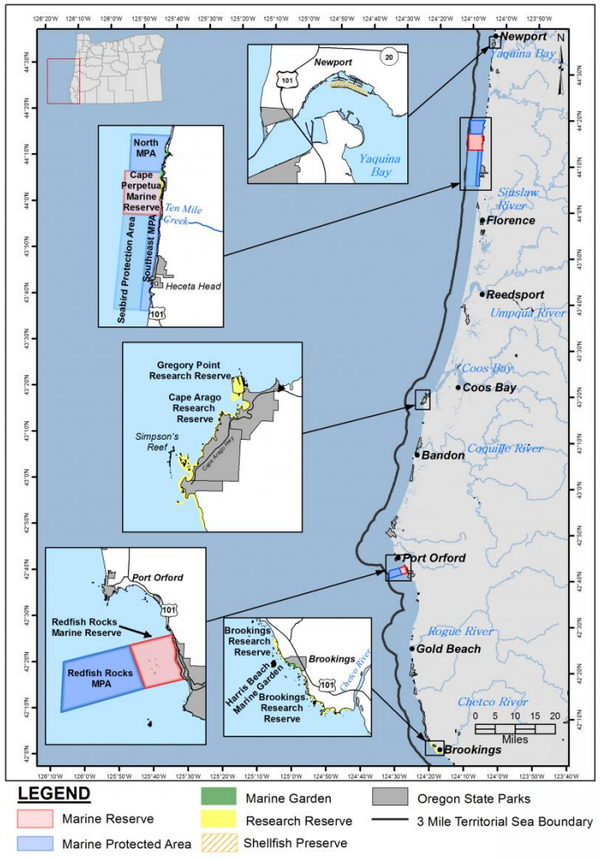
Strategies for Dealing with Uncertainty

- Marine spatial planning (MSP)
- Mitigation hierarchy
- Adaptive management
- Combination of two or more strategies

Marine Spatial Planning

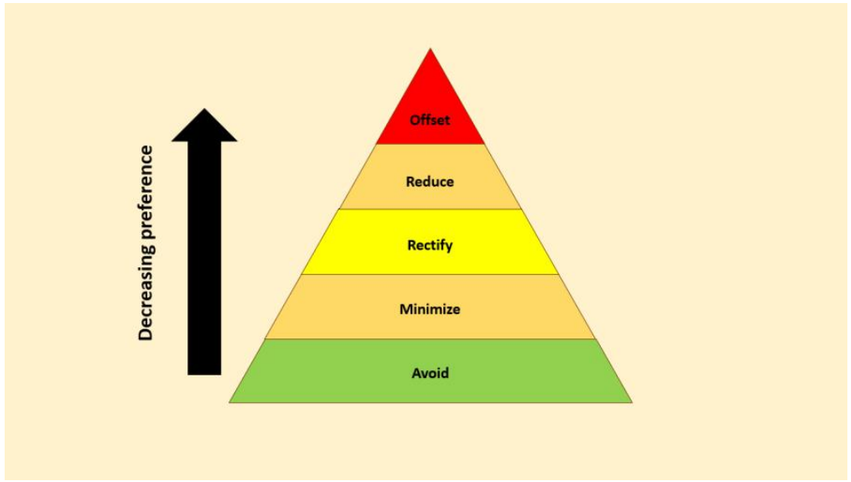


TNG Graphics

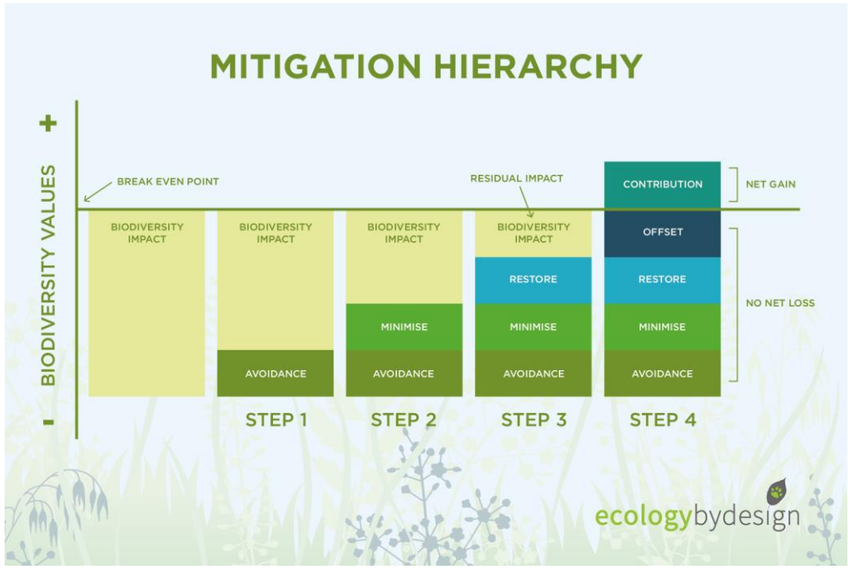


Oregon Conservation Strategy

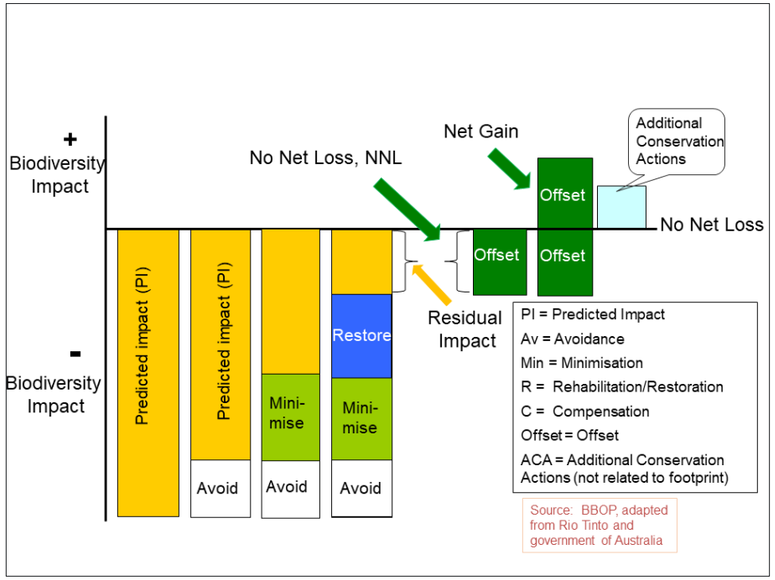
Mitigation Hierarchy



- Simplest form of protection for habitat, species (and maybe processes)
- Underlies/works well with regulations



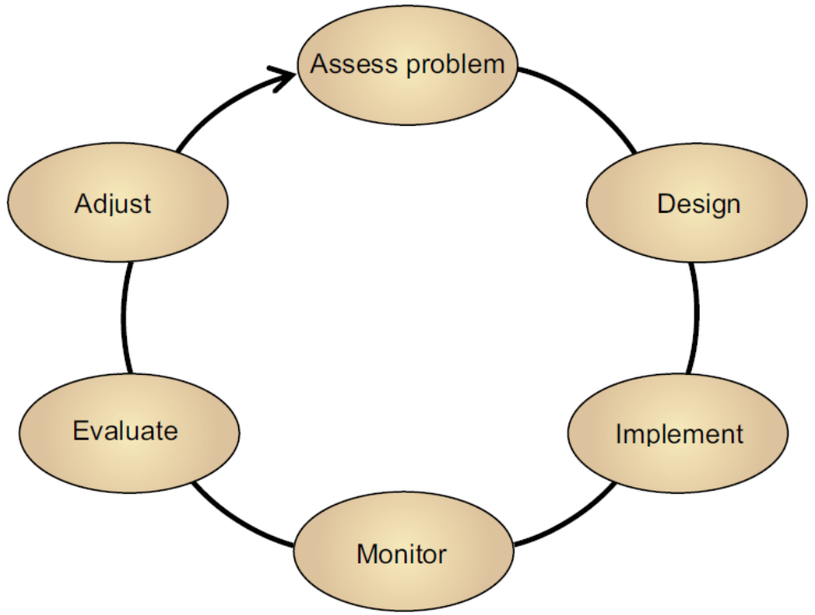
(Ecology by Design)



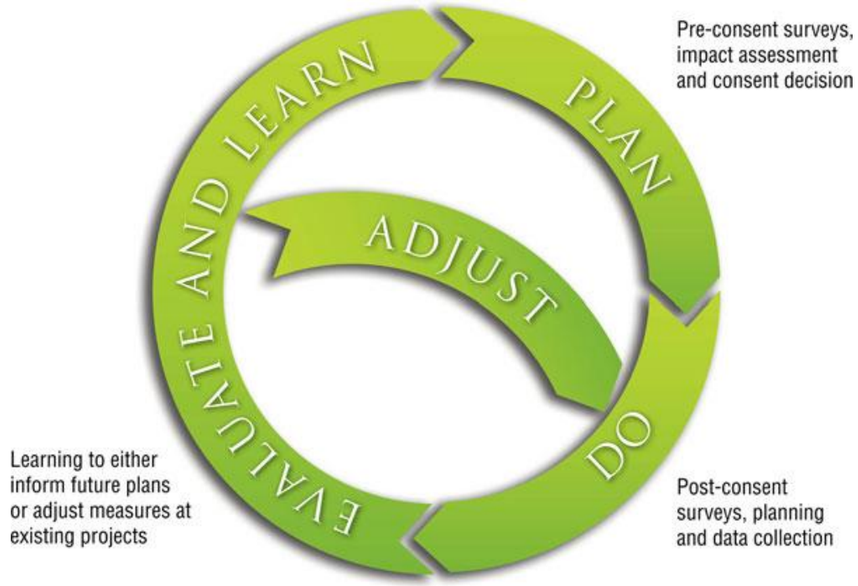
(After Mitchell 1997)

Adaptive Management

- Decision process that promotes flexible decision-making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood.
- Careful monitoring of outcomes advances scientific understanding and helps adjust policies or operations as part of an iterative learning process… (NRC 2004; Williams et al. 2009).
- Adaptive management = learning by doing



Iterative process = single-loop learning
(Williams et al. 2009)



Double-loop or institutional learning
(Drawn after From Resilience to Transformation: The Adaptive Cycle [2016])

Questions posed to determine whether Adaptive Management is appropriate

Question #	Question
1	Is there some kind of management decision to be made?
2	Can stakeholders be engaged?
3	Can management objective(s) be stated explicitly?
4	Is decision-making confounded by uncertainty about potential management impacts?
5	Can resource relationships and management impacts be represented in models?
6	Can monitoring be designed to inform decision-making?
7	Can progress be measured in achieving management objectives?
8	Can management actions be adjusted in response to what has been learned?
9	Does the whole process fit within the appropriate legal framework?

Williams et al. 2009

What would AM look like for floating offshore wind in a coastal area?

Steps one might take:

1. Determine whether AM is suited to the project (during project planning)
   - Level of uncertainty
   - Not in sensitive areas
2. Ensure robust monitoring plan (baseline and after installation and operation)
3. Convene AM team for life of project (after permitting, before construction)
   - Periodic checks on monitoring data (ongoing)
   - Recommend mitigation (ongoing)
4. Ensure other strategies – MSP, MH – are brought to bear (ongoing, as appropriate)

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Thank You!

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