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California Marine Renewables Environmental Regulatory Workshop

In conjunction with:

2018 California Offshore Wind Industry Symposium
Sponsored by Pacific Offshore Energy Trust (POET)
March 14, 2018, 9:00 a.m. to 5:00 p.m.

poet PACIFIC OCEAN ENERGY TRUST

Andrea Copping, Pacific Northwest National Laboratory
Sharon Kramer, H. T. Harvey & Associates

H. T. HARVEY & ASSOCIATES
Ecological Consultants

Today's Agenda

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Time	Topic	Participants
9:00–9:30	Introductions, agenda review, purpose of day	Jason Busch
9:30–10	Background of the workshop, intent, and state of the science	Andrea Copping Sharon Kramer
10:15–11	Dashboards: reviewing and updating the current state of the science	Andrea Copping Sharon Kramer
11–12:30	Deep Dive: Seabird Interactions	David Ainley, Sharon Kramer Scott Terrill, Shari Matzner, Roberto Albertini
12:30–1:30	Lunch Presentation: Data Basin	Jim Strittholt, Conservation Biological Institute
1:30–3:00	Deep Dive: Whale Interactions—Entanglement and Encounters	Pete Nelson Andrea Copping
3:00–3:30	Break	
3:30–4:30	Breakout groups facilitated discussion: • Gauging the risks • Road to retiring risk	Andrea Copping Sharon Kramer Sarah Courbis
4:30–4:45	Reports from breakout groups	
4:45–5:00	Next steps	Jason Busch

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ENVIRONMENTAL EFFECTS OF MARINE ENERGY DEVELOPMENT AROUND THE WORLD

OES OCEAN ENERGY SYSTEMS
An IEA Technology Initiative

ANNEXIV

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

http://tethys.pnnl.gov/publications/state-of-the-science-2016

Collision Risk (Seabirds)

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- Similar concerns as for terrestrial wind projects: strike, collision, avoidance
- Land-based wind models for addressing collision can be adapted to offshore wind (OSW), but seabird and land bird behaviors differ
- Monitoring injury/mortality of seabirds from OSW will be challenging; land-based wind survey and search protocols won't work
- Avoidance/displacement may or may not be an additional concern
- Findings from European OSW not likely to widely apply to West Coast.

Collision Risk (Seabirds) - Dashboard

Collision Risk (Seabirds) Literature

Total of 91 papers on collision risk for OSW on *Tethys*.

- Adams, J.; Kelsey, E.; Felis, J.; Pereksta, D. (2016). Collision and Displacement Vulnerability Among Marine Birds of the California Current System Associated with Offshore Wind Energy Infrastructure. Report by US Geological Survey (USGS). pp 116 https://tethys.pnnl.gov/publications/collision-and-displacement-vulnerability-among-marine-birds-california-current-system
- Suryan, R.; Albertani, R.; Polagye, B. (2016). A Synchronized Sensor Array for Remote Monitoring of Avian and Bat Interactions with Offshore Renewable Energy Facilities. Report by Oregon State University and University of Washington. pp 33. https://tethys.pnnl.gov/publications/synchronized-sensor-array-remote-monitoring-avian-and-bat-interactions-offshore
- Ainley, D.; Porzig, E.; Zajanc, D.;, Spear, L. (2015) Seabird Flight Behavior and Height in Response to Altered Wind Strength and Direction. *Marine Ornithology* 43:25-36. https://tethys.pnnl.gov/publications/seabird-flight-behavior-and-height-response-altered-wind-strength-and-direction
- Cleasby, I.; Wakefield, E.; Bearhop, S.; Bodey, T.; Votier, S.; Hamer, K. (2015). Three Dimensional Tracking of a Wide-Ranging Marine Predator: Flight Heights and Vulnerability to Offshore Wind Farms. *Journal of Applied Ecology*, 52(6), 1474-1482. https://tethys.pnnl.gov/publications/three-dimensional-tracking-wide-ranging-marine-predator-flight-heights-and
- Brabant, R.; Vanermen, N.; Steinen, E.; Degraer, S. (2015). Towards a Cumulative Collision Risk Assessment of Local and Migrating Birds in North Sea Offshore Wind Farms. *Hydrobiologia*, 756(1), 63-74. https://tethys.pnnl.gov/publications/towards-cumulative-collision-risk-assessment-local-and-migrating-birds-north-sea
- Fijn, R.; Krijgsveld, K.; Poot, M.; Dirksen, S. (2015). Bird Movements at Rotor Heights Measured Continuously with Vertical Radar at a Dutch Offshore Wind Farm. *Ibis*, 157(3), 558-566. https://tethys.pnnl.gov/publications/bird-movements-rotor-heights-measured-continuously-vertical-radar-dutch-offshore-wind

For full listing go to: https://tethys.pnnl.gov/poet-workshop-dashboard-collision-risk-offshore-wind

Cetacean Interaction - Dashboard

Entanglement is the unintended restraint or capture of marine animals entwined by strong, flexible materials of anthropogenic origin

- All scenarios are hypothetical for OSW and MHK
- For floating platforms, entanglement could be *direct, secondary,* or *tertiary*
- Key animal groups (mostly ESA-listed species and marine mammals):
  - Large cetaceans—whales
  - Small cetaceans, pinnipeds, sea turtles, sea birds, fishes

Definition: sensu Harnois et al. 2015

Cetacean Interaction - Dashboard

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Cetacean Interaction Literature

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Total of 41 papers on cetacean interaction with marine renewable energy (MRE) on *Tethys*.

- Knowlton, A.; Robbins, J.; Landry, S.; McKenna, H.; Kraus, S.; Werner, T. (2016). Effects of fishing rope strength on the severity of large whale entanglements. *Conservation Biology*, 30(2), 318-328. https://tethys.pnnl.gov/publications/effects-fishing-rope-strength-severity-large-whale-entanglements
- Harnois, V.; Smith, H.; Benjamins, S.; Johanning, L. (2015). Assessment of Entanglement Risk to Marine Megafauna due to Offshore Renewable Energy Mooring Systems. *International Journal of Marine Energy*, 11, 27-49. https://tethys.pnnl.gov/publications/assessment-entanglement-risk-marine-megafauna-due-offshore-renewable-energy-mooring
- Wood, M.; Carter, L. (2008). Whale Entanglements With Submarine Telecommunication Cables. *IEEE Journal of Oceanic Engineering*, 33(4), 445-450. https://tethys.pnnl.gov/publications/whale-entanglements-submarine-telecommunication-cables
- Woodward, B.; Winn, J.; Moore, M.; Peterson, M. (2006). Experimental Modeling of Large Whale Entanglement Injuries. *Marine Mammal Science*, 22(2), 299-310. https://tethys.pnnl.gov/publications/experimental-modeling-large-whale-entanglement-injuries
- Winn, J.; Woodward, B.; Moore, J.; Peterson, M.; Riley, J. (2008). Modeling whale entanglement injuries: An experimental study of tissue compliance, line tension, and draw-length. *Marine Mammal Science*, 24(2), 326–340. https://tethys.pnnl.gov/publications/modeling-whale-entanglement-injuries-experimental-study-tissue-compliance-line-tension
- Robbins, J.; Mattila, D. (2004). Estimating humpback whale (Megaptera novaeangliae) entanglement rates on the basis of scar evidence. Report by Provincetown Center for Coastal Studies. pp 22. https://tethys.pnnl.gov/publications/estimating-humpback-whale-megaptera-novaeangliae-entanglement-rates-basis-scar-evidence
- Heezen, B. (1957). Whales entangled in deep sea cables. *Deep Sea Research*, 4, 105-114. https://tethys.pnnl.gov/publications/whales-entangled-deep-sea-cables

Underwater Noise

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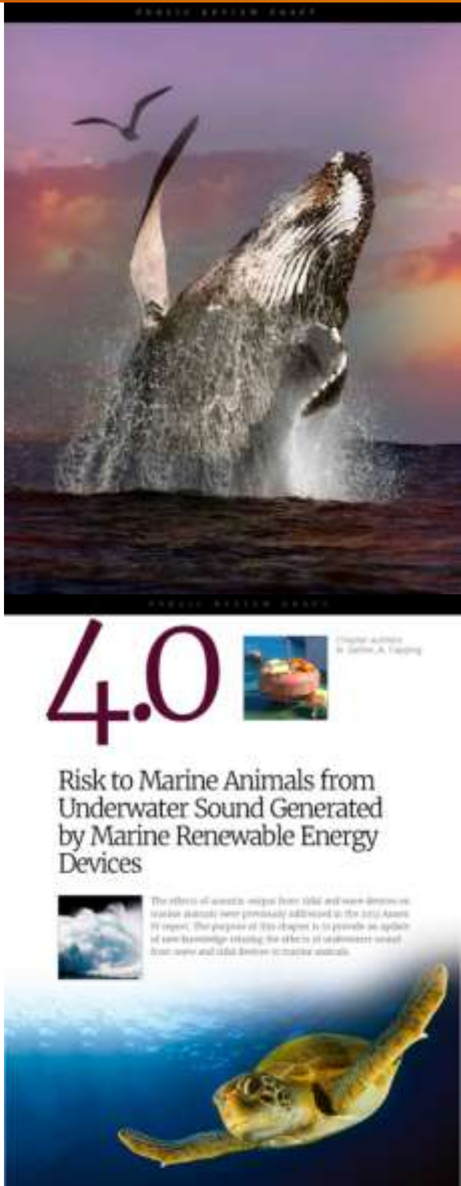
- Marine animals use underwater sound for navigation and communication.
- Sound from MRE devices may add to other anthropogenic sounds and could disturb animals, especially marine mammals and fish.
- Noise from single turbines and WECs are being measured, and predictions can be made about what arrays may sound like to marine animals.
- Excess underwater noise could cause physical harm, including:
  - loss of hearing ability,
  - physical harm to tissues, and/or
  - behavioral changes
- Additional data are needed to understand how sounds may affect animals.



Acoustic Output (Noise) - Dashboard

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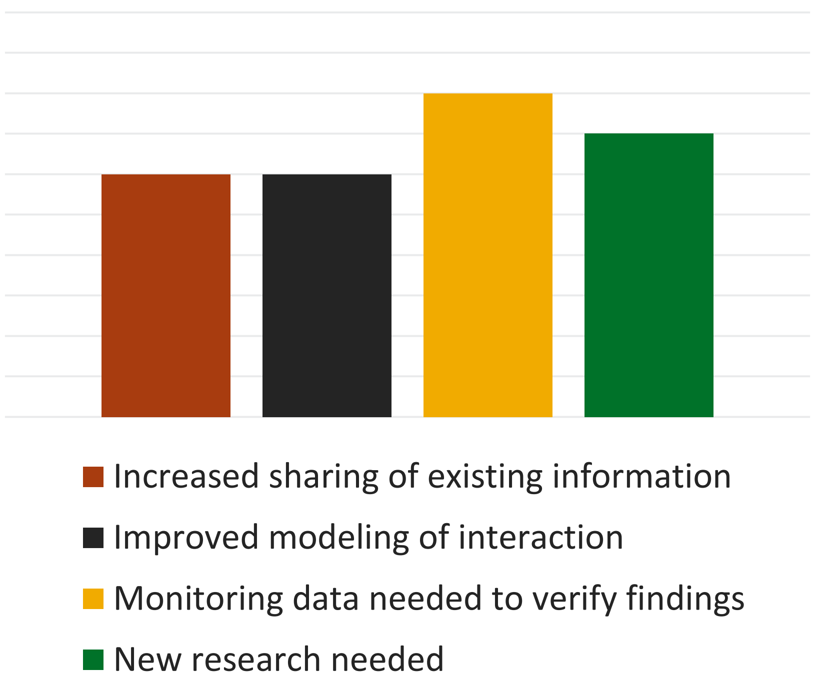


Underwater Noise - Newer Literature

Total of 309 papers on underwater noise for marine renewable energy on *Tethys*.

- Bevelhimer, M.; Deng, D.; Scherelis, C. (2016). Characterizing Large River Sounds: Providing Context for Understanding the Environmental Effects of Noise Produced by Hydrokinetic Turbines. *Journal of the Acoustical Society of America*, 139(1), 85-92. https://tethys.pnnl.gov/publications/characterizing-large-river-sounds-providing-context-understanding-environmental-effects

- Farcas, A.; Thompson, P.; Merchant, N. (2016). Underwater Noise Modelling for Environmental Impact Assessment. *Environmental Impact Assessment Review*, 57, 114-122. https://tethys.pnnl.gov/publications/underwater-noise-modelling-environmental-impact-assessment

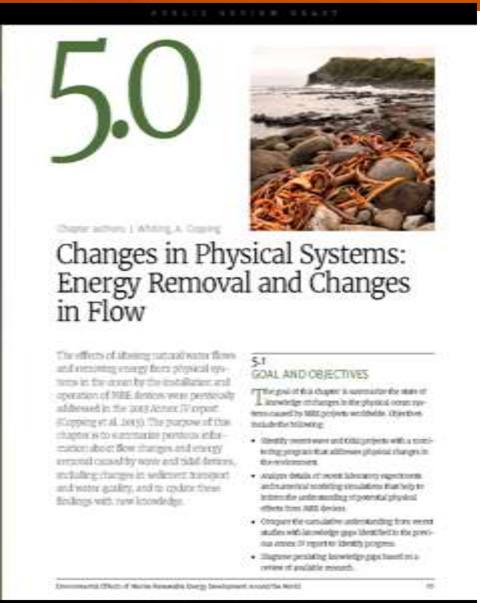
- Schramm, M.; Bevelhimer, M.; Scherelis, C. (2017). Effects of Hydrokinetic Turbine Sound on the Behavior of Four Species of Fish Within an Experimental Mesocosm. *Fisheries Research*, 190, 1-14. https://tethys.pnnl.gov/publications/effects-hydrokinetic-turbine-sound-behavior-four-species-fish-within-experimental

- Garrett, J.; Witt, M.; Johanning, L. (2016). Underwater Sound Levels at a Wave Energy Device Testing Facility in Falmouth Bay, UK. The Effects of Noise on Aquatic Life II (pp. 331-339). New York: Springer. https://tethys.pnnl.gov/publications/underwater-sound-levels-wave-energy-device-testing-facility-falmouth-bay-uk

- Murphy, P. (2015). *Estimation of Acoustic Particle Motion and Source Bearing Using a Drifting Hydrophone Array Near a River Current Turbine to Assess Disturbances to Fish*. Masters Thesis, University of Washington. https://tethys.pnnl.gov/publications/estimation-acoustic-particle-motion-and-source-bearing-using-drifting-hydrophone-array

For full listing go to: https://tethys.pnnl.gov/poet-workshop-dashboard-underwater-noise

Changes in Physical Systems


5.0

Changes in Physical Systems: Energy Removal and Changes in Flow

5.1
GOAL AND OBJECTIVES

- Placement of MRE devices in the oceans can change circulation and remove energy from the system, as well as potentially change patterns of sediment movement.
- The amount of change that will result from single devices or small arrays is likely to be immeasurably small.
- Numerical models suggest that changes may be measureable only with the operation of very large arrays that are probably too large to be realistically considered for most water bodies.

Physical Changes - Dashboard

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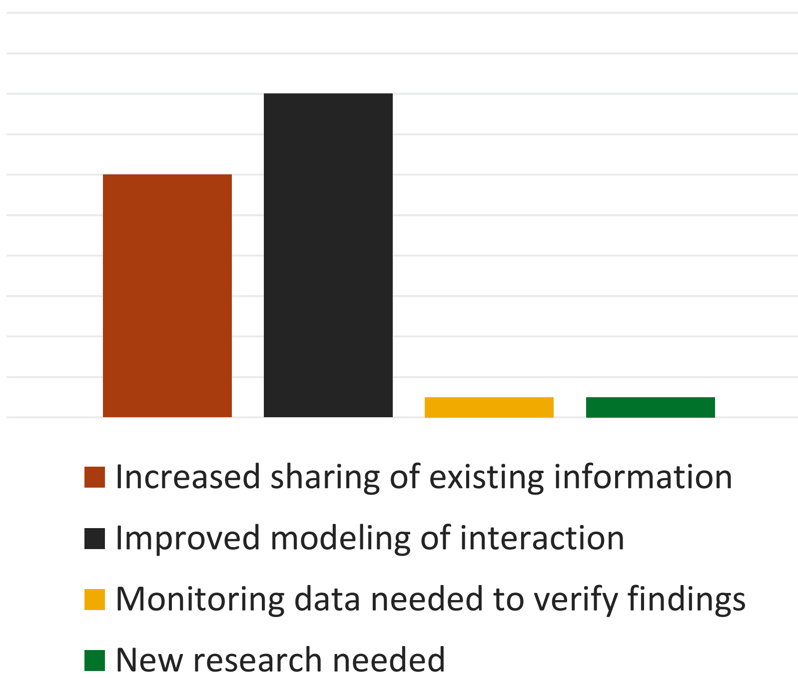

Physical Systems - Newer Literature

Total of 253 papers on physical systems and marine renewable energy on *Tethys*.

- van der Molen, J.; Ruardij, P.; Greenwood, N. (2016). Potential Environmental Impact of Tidal Energy Extraction in the Pentland Firth at Large Spatial Scales: Results of a Biogeochemical Model. *Biogeosciences*, 13, 2593-2609. https://tethys.pnnl.gov/publications/potential-environmental-impact-tidal-energy-extraction-pentland-firth-large-spatial
- Fairley, I.; Masters, I.; Karunarathna, H. (2015). The Cumulative Impact of Tidal Stream Turbine Arrays on Sediment Transport in the Pentland Firth. *Renewable Energy*, 80, 755-769. https://tethys.pnnl.gov/publications/cumulative-impact-tidal-stream-turbine-arrays-sediment-transport-pentland-firth
- Ashall, L.; Mulligan, R.; Law, B. (2016). Variability in Suspended Sediment Concentration in the Minas Basin, Bay of Fundy, and Implications for Changes due to Tidal Power Extraction. *Coastal Engineering*, 107, 102-115. https://tethys.pnnl.gov/publications/variability-suspended-sediment-concentration-minas-basin-bay-fundy-and-implications

For full listing go to: https://tethys.pnnl.gov/poet-workshop-dashboard-physical-systems

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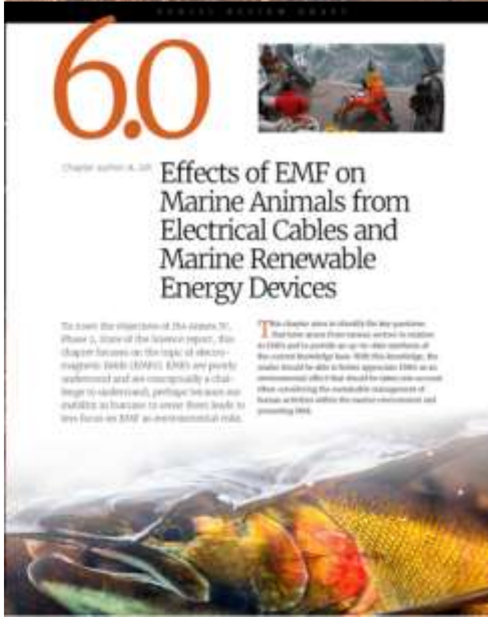
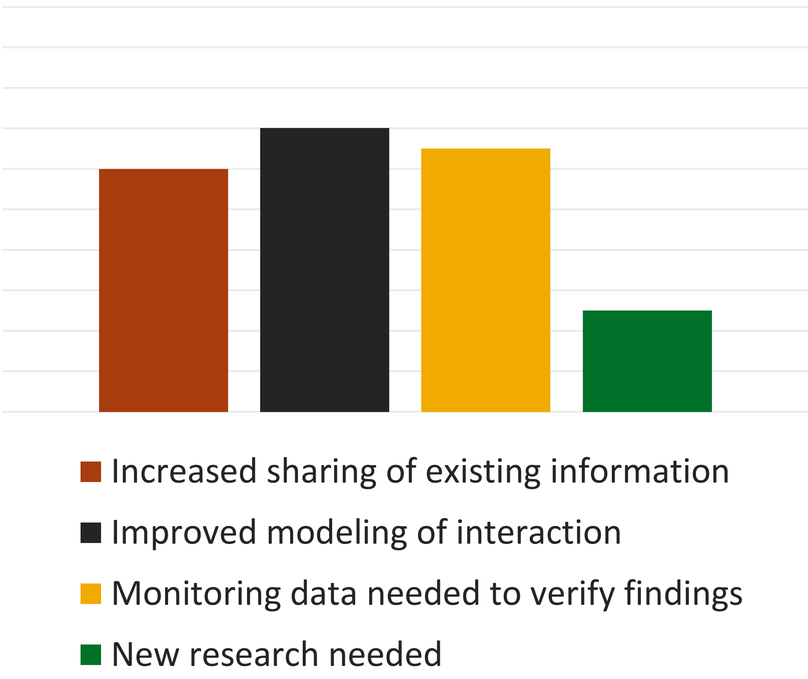
Electromagnetic Fields (EMFs)

- Additions of EMFs from power export cables and energized parts of devices can add to naturally occurring magnetic fields, and have potential to disturb certain marine animals.
- Some animals, including some elasmobranchs and invertebrates, are known to be electro- or magneto-sensitive and could be disturbed by EMFs from MRE devices.
- Power cables generally will be buried and effectively shield the environment from EMFs.
- Most studies to date have focused on behavioral responses of animals to EMFs.
- Lab and field studies have shown no evidence that EMFs, at the levels expected from MRE devices, will have an effect on any species.


6.0
Effects of EMF on Marine Animals from Electrical Cables and Marine Renewable Energy Devices

Electromagnetic Fields - Dashboard



Electromagnetic Fields - Newer Literature

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Total of 111 papers on EMFs from MREs on *Tethys*.

- Dhanak, M.; Kilfoyle, A.; Ravenna, S.; Coulson, R.; Frankenfield, J.; Jermain, R.; Valdes, G.; Spieler, R. (2015). *Characterization of EMF Emissions from Submarine Cables and Monitoring for Potential Responses of Marine Species*. Paper Presented at the 11th European Wave and Tidal Energy Conference, Nantes, France. https://tethys.pnnl.gov/publications/characterization-emf-emissions-submarine-cables-and-monitoring-potential-responses

- Kavet, R.; Wyman, M.; Klimley, A.; Vergara, X. (2016). Assessment of Potential Impact of Electromagnetic Fields from Undersea Cable on Migratory Fish Behavior. Report by Electric Power Research Institute (EPRI). pp 87. https://tethys.pnnl.gov/publications/assessment-potential-impact-electromagnetic-fields-undersea-cable-migratory-fish

- Love, M.; Nishimoto, M.; Clark, S.; Bull, A. (2015). Identical Response of Caged Rock Crabs (Genera Metacarcinus and Cancer) to Energized and Unenergized Undersea Power Cables in Southern California, USA. *Bulletin of the Southern California Academy of Sciences*, 1(114), 9. https://tethys.pnnl.gov/publications/identical-response-caged-rock-crabs-genera-metacarcinus-and-cancer-energized-and

- Love, M.; Nishimoto, M.; Clark, S.; Bull, A. (2016). Renewable Energy in situ Power Cable Observation. Report by University of California Santa Barbara for the Bureau of Ocean Energy Management (BOEM). pp 106. https://tethys.pnnl.gov/publications/renewable-energy-situ-power-cable-observation

For full listing go to: https://tethys.pnnl.gov/poet-workshop-dashboard-electromagnetic-fields

Changes in Habitats

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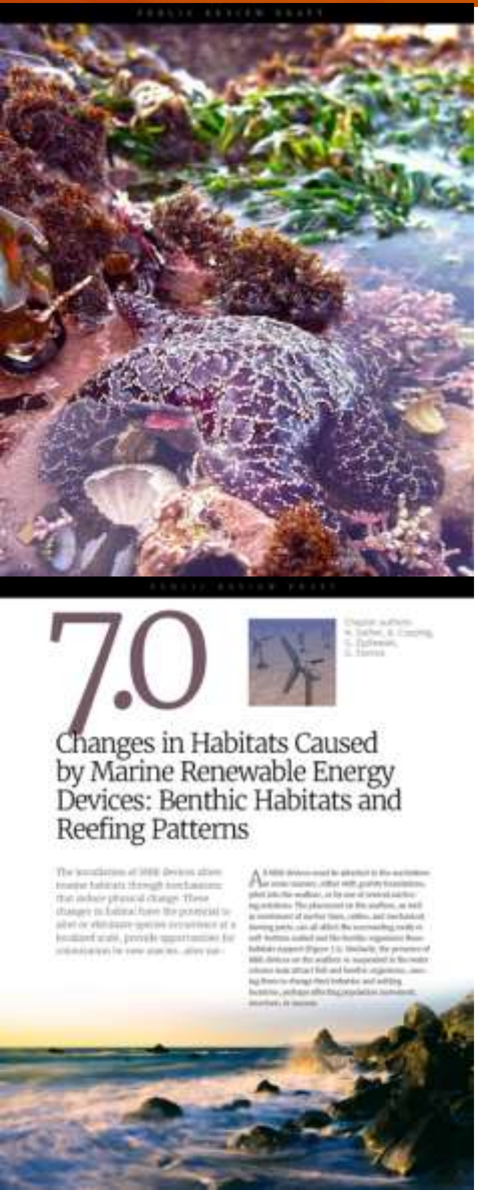
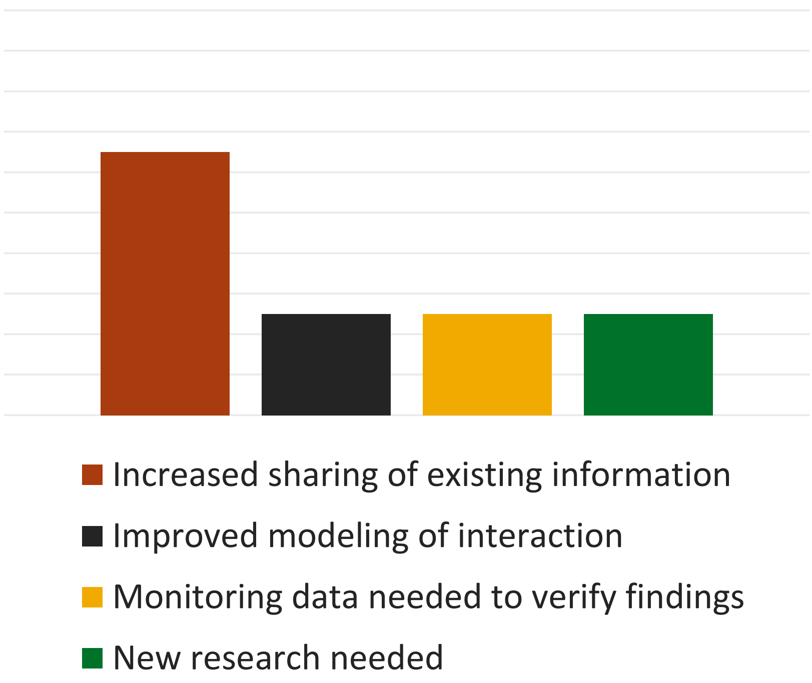


- MRE devices can change bottom habitats by disturbing sediments under their foundations, as well as around anchors and mooring lines.
- Devices will attract fish and invertebrates, which will remain around the parts of the devices and systems.
- No evidence to date of significant negative effects occurring to benthic areas around MRE developments, or that marine animals reefing around devices will harm fish populations.

Changes in Habitats - Dashboard



Changes in Habitats - Newer Literature

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Total of 207 papers on changes in habitat for marine renewable energy on *Tethys*.

- Barillier, A.; Carlier, A. (2016). *Environmental Monitoring of the Paimpol-Brehat Tidal Project* [Presentation]. Presented at the 6th International Conference on Ocean Energy, Edinburgh, Scotland, UK. https://tethys.pnnl.gov/publications/environmental-monitoring-paimpol-brehat-tidal-project

- Kuhnz, L.; Buck, K.; Lovera, C.; Whaling, P.; Barry, J. (2015). Potential Impacts of the Monterey Accelerated Research System (MARS) cable on the seabed and benthic faunal assemblages. Report by Monterey Bay Aquarium Research Institute. pp 58. https://tethys.pnnl.gov/publications/potential-impacts-monterey-accelerated-research-system-mars-cable-seabed-and-benthic

- O'Carroll, J.; Kennedy, R.; Savidge, G. (In Press). Identifying Relevant Scales of Variability for Monitoring Epifaunal Reef Communities at a Tidal Energy Extraction Site. *Ecological Indicators*, 73, 388-397. https://tethys.pnnl.gov/publications/identifying-relevant-scales-variability-monitoring-epifaunal-reef-communities-tidal

- Staines, G.; Zydlewski, G.; Viehman, H.; Shen, H.; McCleave, J. (2015). *Changes in Vertical Fish Distributions Near a Hydrokinetic Device in Cobscook Bay, Maine, USA*. Paper Presented at the 11th European Wave and Tidal Energy Conference, Nantes, France. https://tethys.pnnl.gov/publications/changes-vertical-fish-distributions-near-hydrokinetic-device-cobscook-bay-maine-us

- Kramer, S. H.; Hamilton, C.; Spencer, G. ; Ogston, H. (2015) Evaluating the Potential for Marine and Hydrokinetic Devices to Act as Artificial Reefs or Fish Aggregating Devices, Based on Analysis of Surrogates in Tropical, Subtropical, and Temperate U.S. West Coast and Hawaiian Coastal Waters. OCS Study BOEM 2015-021. U.S. Department of Energy, Energy Efficiency and Renewable Energy, Golden, Colorado https://tethys.pnnl.gov/publications/evaluating-potential-marine-and-hydrokinetic-devices-act-artificial-reefs-or-fish

For full listing go to: https://tethys.pnnl.gov/poet-workshop-dashboard-changes-habitat

Deep Dives into Key Interactions

- Interactions for OSW developments that continue to hamper permitting
- Focus on animals, rather than habitats or ecosystem processes
- Importance of interactions is driven by key legislation:
  - Species with special protection are most important (usually Endangered Species Act)
  - Broad protection for cetaceans, pinnipeds, and sea otters (Marine Mammal Protection Act)
  - Protection for birds (Migratory Bird Treaty Act)

Deep Dives into Key Interactions

- Deep dives consist of:
  - Definition of the risk
  - Important considerations for the interaction
  - Scale of the problem
  - Pathway for “retiring” the risk
  - An example from the Pacific coast area

- Two key interactions being addressed today:
  - Seabird interactions
  - Whale entanglement and encounters

Key Interactions Addressed Today

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- **Seabird Interactions and Monitoring**

  Scott Terrill, David Ainley, Sharon Kramer,
  H. T. Harvey & Associates

  Roberto Albertini, Oregon State University

  Shari Matzner, Pacific Northwest National Laboratory

- **Whale Entanglement and Encounter**

  Pete Nelson, H. T. Harvey & Associates

  Andrea Copping, Pacific Northwest National Laboratory