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Identifying and Addressing Environmental Effects and User Conflicts for Offshore Wind on the West Coast

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Sacramento CA, July 29th 2014

Today….

- West coast offshore wind resources
- Bottom-mounted vs. floating wind
- Setting environmental priorities for offshore wind
  - Strategies
  - Stressor/receptor interactions
  - Regulatory and user interactions
- Suitability analysis for CMSP
- Tethys as a resource

Offshore Wind Resources on West Coast

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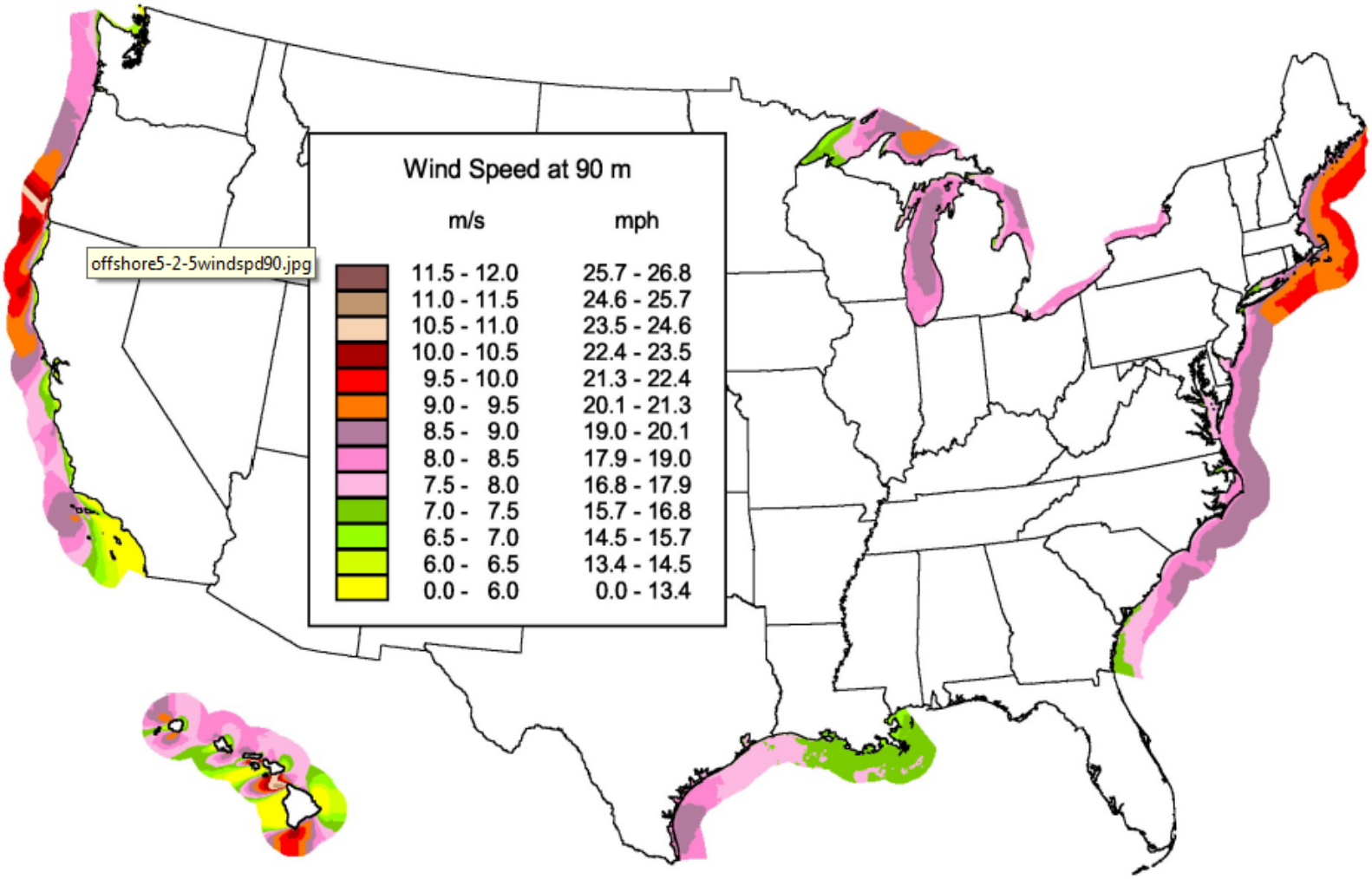

Bottom-Mounted versus Floating OSW Turbines

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Overall Strategy for Environmental Conditions

1. Determine environmental priorities for interaction b/tw specific OSW technology and marine animals, habitats, ecosystem processes:
    - Scientific literature, databases and studies
    - In consultation with resource agencies and stakeholders
2. Determine gaps in baseline data, plan studies to fill gaps.
3. Work with regulatory and resource agencies to help inform siting and permitting processes.
4. Determine post-installation monitoring needs, design monitoring studies, progressing towards mitigation, if needed.

Identifying Environmental Priorities

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Understand project to determine key stressors as trigger points
- Location
- Depth
- Physical characteristics of platform, turbine, tower, power cables
- Substrate/anchoring mechanism

Field Studies:

California -
State of CA, UC and CSU systems

Oregon –
OSU NNMREC studies for test site
Seabird studies (OSU, USFWS)

Identify specific populations, habitats at potential risk, taking into account regulatory status

Theoretical Studies:
Case study for offshore wind in West Coast Environmental Protocols off west coast (as hypothetical) = WindFloat

ERES screening analysis of fixed bottom and floating OSW (PNNL)

Priority Environmental Interactions

Engage with agencies and stakeholders to understand appropriate baseline assessment and post-installation monitoring needs

Examining Environmental Interactions

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Receptor Group	Species	Information	Outcome (Based on potential for temporal and spatial interaction)
Birds	Short-tailed Albatross	Distributed along continental shelf and in coastal upwelling spots; OR is southern portion of range. Follows fishing vessels. ESA: Fed. and State End.	**Important interaction:** for all phases of project; especially operation. Consult USFWS.
	Marbled Murrelet	Forage mostly nearshore (1-5 miles) on schooling fish; seen up to 45 miles offshore. ESA: Fed. and State Th.	**Potentially important interaction:** Interaction possible for monopoles, unlikely for floating. Consult USFWS.
	Xantus's Murrelet	Mostly found in S. California, can migrate North into British Columbia. Nest within Channel Islands. After breeding, some move far out to sea. ESA: State Th.	**Potentially important interaction:** Interactions possible for monopoles, unlikely for floating; Consult USFWS.
	California Least Tern	Nest in San Francisco Bay, Sacramento River delta, and Southern CA. Feed in nearshore; migrate south during the winter. ESA: State and Fed. End.	**Potentially important interaction:** Interaction unlikely. Consult USFWS.
	Common Murre	Dive up to 180 meters; found in open ocean. MBTA.	**Potentially important interaction:** Interaction possible for monopoles, unlikely for floating. Consult USFWS.
	Leach's Storm Petrel	Pelagic breeders; may fly 100 miles offshore. Flies low over water and have been known to follow ships. MBTA.	**Potentially important interaction**; interaction may be unlikely. Consult USFWS.
	Brown Pelican	Feed on schooling fish; typically found in coastal areas. ESA: State End; MBTA	Probably not found at sites; Consult USFWS.

Examining Environmental Interactions

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Receptor Group	Species	Information	Outcome (Based on potential for temporal and spatial interaction)
Marine Mammals	Gray whales	Migrate along CA coast, generally closer to shore but can be 9-23 km offshore. ESA: State End.	**Potentially important seasonally:** interaction potential not clear. Consult NOAA.
	Blue, Sei, North Pacific Right, Fin, and Humpback Whales	Migrate along Pacific coast near continental shelf; distance from shore and general distribution varies. ESA: Fed End.	**Potentially important seasonally:** interaction potential not clear. Consult NOAA.
	Southern Sea Otter	Primarily coastal species; found between Santa Barbara County to San Mateo County. ESA: Fed. Th.	**Potentially important interaction:** interaction potential unlikely. Consult USFWS and NOAA.
	Steller Sea Lion (E. DPS)	Generally found nearshore, but can be 10-15 nm from land; several haulout and rookery sites along CA coast. ESA: Fed. Th.	**Potentially important interaction:** federally protected, interaction possible for monopoles, unlikely for floating. Interaction potential unlikely. Consult NOAA.
	Dall's Porpoise	Found in offshore waters within shelf and slope habitat; prefers water more than 600 ft. deep.	Lower priority interaction; consult NOAA.
	Northern Elephant Seal	Generally coastal; Come ashore in Mexico and CA to breed; live offshore rest of life. Migrate north (AK, N. Pacific) twice a year.	**Potentially important seasonally**: may be found in deep water offshore, feeding or migrating. Interaction potential unlikely. Consult NOAA.
Terrestrial Mammal	Hoary Bat	Migratory tree roosting bat; known to migrate to Farallon islands 48KM W. of SF, CA.	**Potentially important interaction:** highly dependent on location of wind farm; Consult USFWS.

Examining Environmental Interactions

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Receptor Group	Species	Information	Outcome (Based on potential for temporal and spatial interaction)
Fish	Coho and Chinook Salmon; Steelhead	Anadromous; distribution varies along the CA coast. ESA: Fed and State Th and End.	**Potentially important seasonally:** Little interaction expected; Consult NOAA.
	Green Sturgeon	Anadromous: Critical habitat at various spots along CA coast. Effected by EMF? ESA: Fed. Th	**Potentially important seasonally:** Interaction potential unlikely offshore. Consult NOAA.
	Pacific Herring	Commercially and ecologically important species. Distribution varies along CA coast.	**Potentially important interaction:**. Little interaction expected; Consult NOAA.
	Albacore Tuna	Highly migratory species; commercial fishing industry. ~40+ miles offshore, sometimes around 20.	**Potentially important seasonally:** Interaction potential not clear. Consult NOAA.
	Common Thresher Shark	Highly migratory species; inhabit continental and open ocean waters. Electroreceptors (EMF)	**Potentially important interaction:** Interaction potential not clear. Consult NOAA.
Reptiles	Leatherback sea turtle	Critical habitat extends off the CA coast. ESA: Fed. End.	**Potentially important seasonally:** interaction potential not clear. Consult NOAA.
Habitats	Deep sea corals and rocky reefs	Both found along W. coast; rocky reefs designated as HAPCs.	**Potentially important interaction:** Not known if exist at site, specific locations unknown. Consult NOAA.

Interactions that Matter

→ Location Matters

→ Technology-specifics matter

- Stressor – any part of an offshore wind installation that may cause stress to the marine environment:
  - Construction noise (pile driving)
  - Turbine and tower
  - Platform (floating)
  - Anchor lines (floating)
  - Power cable
- Receptor – that portion of the marine environment that might be harmed by the offshore wind installation
  - Marine animals (birds, marine mammals, fish, turtles, invertebrates)
  - Habitats (bottom habitats, water column, intertidal)
  - Ecosystem Processes (changes in sediment transport, water quality, etc.)

Refining the List of Environmental Priorities

- Examine occurrence/abundance of animals and habitats at project site offshore
- If animals are present, will they be affected by floating OSW:
  - Rotor swept area and height over sea surface
  - Cetacean interaction with mooring lines & cables
  - Pinniped haul outs
  - Popular fishing areas
  - Acoustic output and vibrations from turbines affecting marine mammals
- (in contrast to) Fixed bottom turbines
  - Pile driving noise
  - May affect habitats due to scour of soft-bottom sediments

Priority Environmental Interactions – assuming offshore floating turbines off Oregon

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1. Birds: Short-tailed Albatross, shearwaters, petrels, maybe murrelets, terns.
2. Hoary bats
3. Marine Mammals
    1. Cetaceans: Humpback and other great whales (Blue, Sei, North Pacific Right, and Fin whales)
    2. Pinnipeds: Steller sea lions and northern elephant seals
4. Fish
    1. Coho salmon and green sturgeon
    2. Albacore and other commercially important fish species
5. Deep sea corals and rocky reefs
6. Sea turtles

Identifying Priorities – Other Considerations

→ Regulations
→ Current Ocean Uses

- Regulatory status:
  - Endangered Species Act (ESA)
  - Marine Mammal Protection Act (MMPA)
  - Migratory Birds Treaty Act (MBTA)
  - Magnuson-Stevens Fisheries Conservation and Management Act (MSFCMA)
  - State statutes and regulations, local, tribal considerations

Examples of Federal and State Interactions (California)

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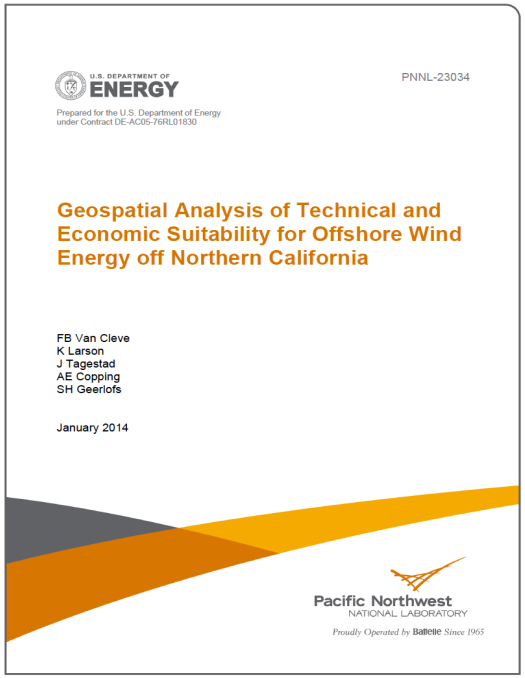
Federal Agencies	Jurisdiction	California Agencies	Jurisdiction
Bureau of Ocean Energy Management	Leasing, lead agency for NEPA **outside state waters**	CA Department of Fish and Game	California Endangered Species Act (CESA), Listed species
U.S. Army Corp of Engineers	CWA 404; Rivers and Harbors Act, Lead agency for NEPA **within state waters**	California Coastal Commission	CZMA, Coastal Development Permit
U.S. Fish and Wildlife Service	ESA, MBTA	California State Lands Commission	California Environmental Quality Act (CEQA); seabed leasing
NOAA Fisheries	ESA, MMPA, MSFCA, CZMA	State and Regional Water Quality Control Boards	State Water Quality Certifications; Wetlands and riparian areas;
Federal Energy Regulatory Commission	Interconnect	California Natural Resources Agency	California Environmental Quality Act (CEQA)
U.S. Coast Guard	Navigation	California Ocean Protection Council	California Environmental Quality Act (CEQA)
Federal Aviation Administration	Aviation, Flight paths		
DOD - Navy	Military shipping, operations		

Ocean Uses

- Current ocean uses:
  - Commercial fishing
    - Nearshore (crabbing, salmon)
    - Offshore (albacore, whiting)
  - Recreational fishing
  - Boating, surfing
  - Conservation
- Important to engage with each group, esp. fishing and environmental
- Fishing is tough - our experience with WindFloat Pacific in Oregon
- Key solution: need CMSP, Wind Energy Areas…??

Renewable Ocean Energy Suitability Mapping

- Developed to inform WA CMSP process
- To identify most "desirable" locations for potential energy development, in next 5-7 years
- Methods = expert interviews + geospatial analysis; adapted/expanded from suitability analysis by Parametrix and OWET in Oregon
- OSW suitability completed off northern California, just finishing up off Oregon
  - Includes OSW fixed foundation and floating platform
  - Analysis of suitability via 8 attributes of site quality, grid connection, and shore-side support
  - Scope is limited to technical and basic economic feasibility



Model Development

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Parametrix

Example = scored attribute tables for offshore wind floating platform

Site Quality Sub-Model

Attribute: Mean Annual Wind Speed*

Ref.	Classification	Score
1	0-6.0 m/s	0
2	6.0-6.5 m/s	2
3	6.5-7.0 m/s	5
4	7.0-7.5 m/s	9
5	> 7.5 m/s	10

*Measured at 90 meters above the surface

Attribute: Depth

Ref.	Classification	Score
1	0m < 10m	0
2	10m < 20m	0
3	20m < 30m	0
4	30m < 40m	0
5	40m < 50m	5
6	50m < 60m	8
7	60m < 200m	10
8	200m < 300m	9
9	300m < 1000m	8
10	>1000m	7

Attribute: Substrate

Ref.	Classification	Score
1	Rock	1
2	Gravel	2
3	Sand	3
4	Cobble	2
5	Mud	3

Grid Connection Sub-Model

Attribute: Distance to Substation

Ref.	Classification	Score
1	<5 NM	10
2	5 NM < 10 NM	9
3	10 NM < 15 NM	7
4	15 NM < 20 NM	4
5	> 20 NM	1

Attribute: Distance to Shore

Ref.	Classification	Score
1	1 NM < 5 NM	10
2	5 NM < 10 NM	8
3	10 NM < 15 NM	6
4	15 NM <20 NM	3
5	> 20 NM	1

Attribute: Distance to KV Line

Ref.	Classification	Score
1	0 <3 NM	10
2	3 NM < 6 NM	9
3	6 NM < 9 NM	8
4	9 NM < 12 NM	4
5	12 NM < 15 NM	2
6	> 15 NM	1

Shore-side Support Sub-Model

Attribute: Distance to Service Port

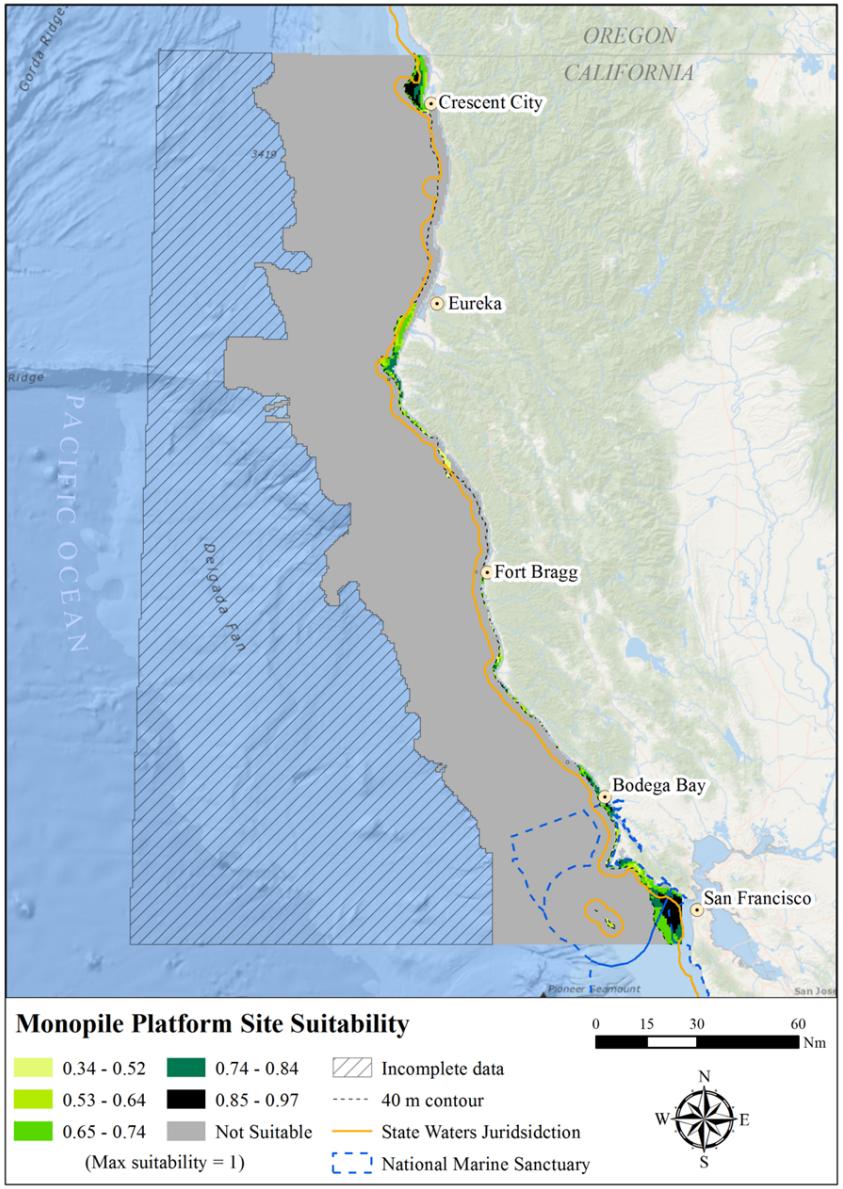
Ref.	Classification	Score
1	<5 NM	10
2	5 NM < 10 NM	9
3	10 NM < 15 NM	8
4	15 NM < 20 NM	7
5	20 NM < 25 NM	6
6	25 NM < 30 NM	5
7	30 NM < 50 NM	3
8	>50 NM	1

Attribute: Distance to Deepwater Port*

Ref.	Classification	Score
1	<5 NM	10
2	5 NM < 10 NM	10
3	10 NM < 20 NM	10
4	20 NM < 30 NM	9
5	30 NM < 40 NM	8
6	40 NM < 50 NM	7
7	50 NM < 100 NM	4
8	100 NM < 150 NM	3
9	150 NM < 200 NM	2
10	>200 NM	1

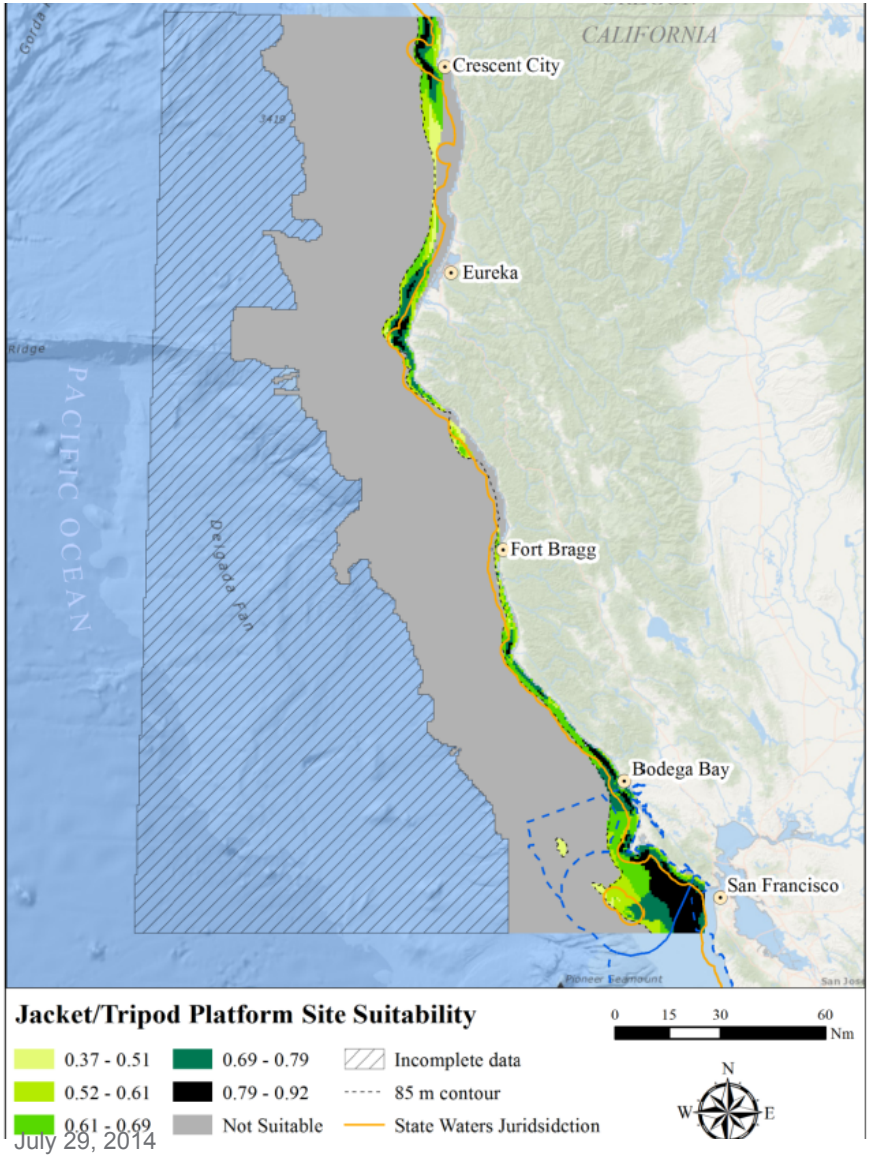
*If ocean access from the port is blocked by an overwater structure > 180m, the port is not considered.

Monopile Site Suitability



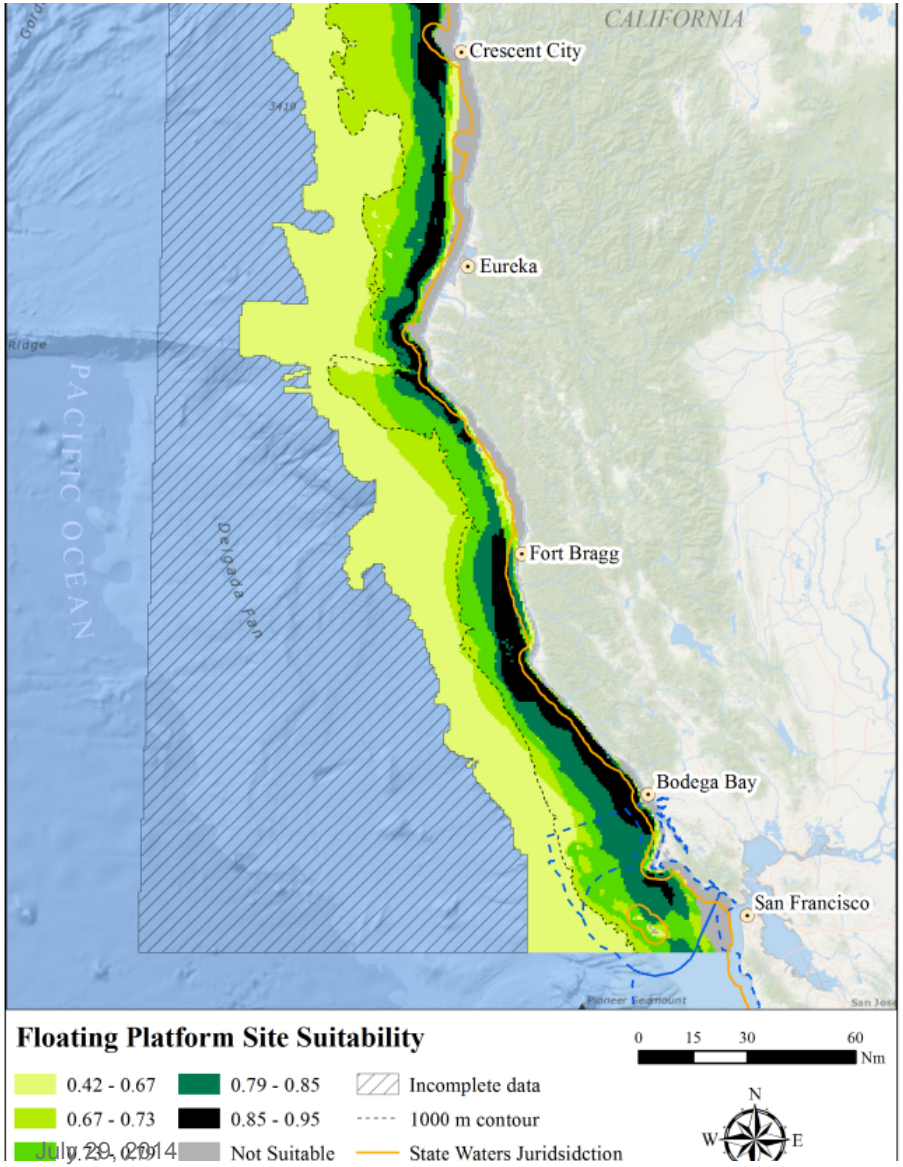
- Water depths ~0-30m
- Very limited potential for monopole wind
- A few sites near Crescent City, San Francisco Bay

Jacketed/Tripod Site Suitability



- Water depths ~30-60m
- More area available
- Most suitable sites around Crescent City, Humboldt, SF

Floating Offshore Wind Site Suitability



- Water depths >~50m
- Very large potential for floating wind from outer edge of depths for jacketed turbines, across shelf and onto continental slope, even deep sea (??)

Summing Up:

- West coast environment
  - Great wind resources: OR, WA, No. California (to Point Conception)
  - Important to determine animals, habitats at risk
- Collect, refine, set priorities for baseline data to inform siting and leasing/permitting processes
- Engage with stakeholders early and often, esp. ocean users; fishing communities for west coast = User conflicts could be decreased with CMSP, creating WEAs
- Once leasing/permitting underway:
  - Identify key interactions for post-installation monitoring
  - Design monitoring studies to examine interactions
  - Develop mitigation strategies if needed

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Environmental Effects of Renewable Energy from the Sea

Welcome to Tethys | **What is MHK?** | **What is Annex IV?** | **What is Offshore Wind?**

As industry, academia, and government seek to develop new renewable energy sources from tides, waves, and offshore wind, potential environmental effects must be evaluated and measured to ensure that aquatic and avian animals, habitats, and

Featured Links

- EIMR International Conference 2014
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Knowledge Base

The Knowledge Base compiles relevant documents, Annex IV metadata forms, and U.S. permitting sites into one table. Columns may be sorted alphabetically by clicking on the headers, while results can be narrowed by keyword searches and by selecting values in the boxes to the right. Learn more about the filtering here. More entries will load as you scroll down.

Tethys Map Viewer

Title	Author*	Date**	Type of Content	Technology Type	Stressor	Receptor	Collection
An Economic and Environmental Assessment of Transporting Bulk Energy from a Grazing Ocean Thermal Energy Conversion Facility	Gilmore, E., Blohm, A., Sinsabaugh, S.	November 2014	Journal Article	OTEC	N/A	Farfield Environment	Tethys
Simulating Blade-Strike on Fish Passing Through Marine Hydrokinetic Turbines	Romero-Gomez, P., Richmond, M.	November 2014	Journal Article	In-Stream, Tidal	Dynamic Device	Fish	Tethys
Is EIA Part of the Wind Power Planning Problem?	Smart, D., Stojanovic, T., Warren, C.	November 2014	Journal Article	Offshore Wind	N/A	N/A	Tethys
Wave Farm Impact: The Role of Farm-to-Coast Distance	Iglesias, G., Carballo, R.	September 2014	Journal Article	Wave	Energy Removal	Farfield Environment	Tethys
Characterizing the							

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Content Type

- Journal Article (564)
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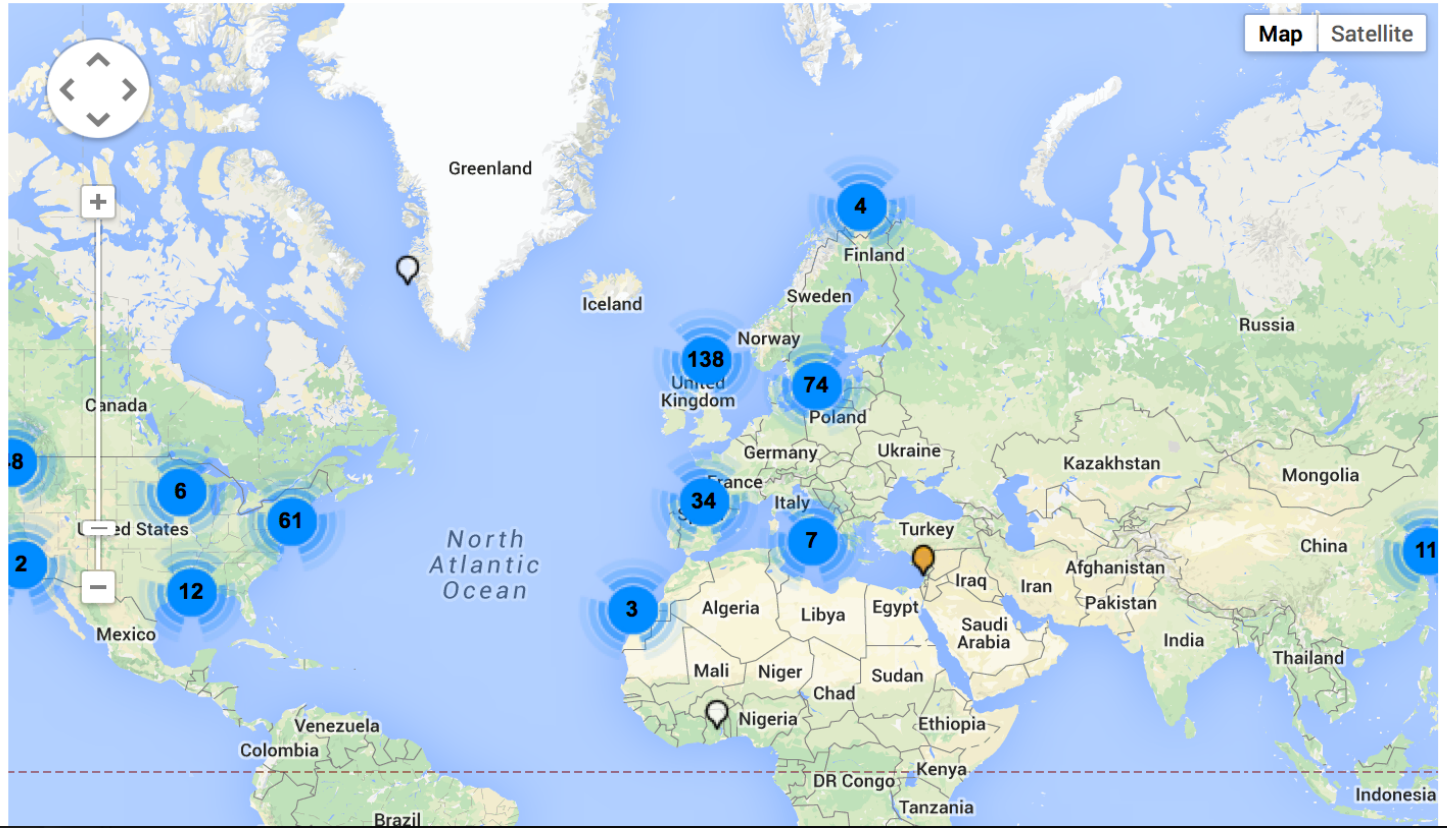
- Research Study Annex IV (48)

Map Viewer

The Map Viewer compiles documents, U.S. permitting sites, and international Annex IV project sites and research studies that are associated with a geographic location (but not all Tethys content is geotagged). This view allows panning and zooming, while results can be narrowed by keyword searches and by selecting values in the boxes to the right. Learn more about the filtering here. Clicking on a bubble will open a dialogue box with more information that links to the document page.

Tethys Knowledge Base



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Legend

- Documents (306)
- Project Site Annex IV (79)
- Research Study Annex IV (28)
- Permitting Site FERC (17)

Closely-packed items are clustered together. Clicking on the cluster allows you to navigate individual items. You

Thank you!

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I would like to thank my very talented research team, our many collaborators, DOE's Wind and Water Power Technologies Office, and the many offshore wind developers and researchers around the world.