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Floating Offshore Wind Platforms and Whale Encounter

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Premise:

- ▶ Potential for entanglement or other deleterious interaction of marine animals with mooring lines and draped cables
- ▶ Concerns raised by stakeholders, regulators in US
- ▶ Recent discussion has parsed into:
 - Primary entanglement – animal tangles in line
 - Secondary entanglement – derelict fishing gear entangles on lines, then entangles marine mammals, sea turtles, etc.

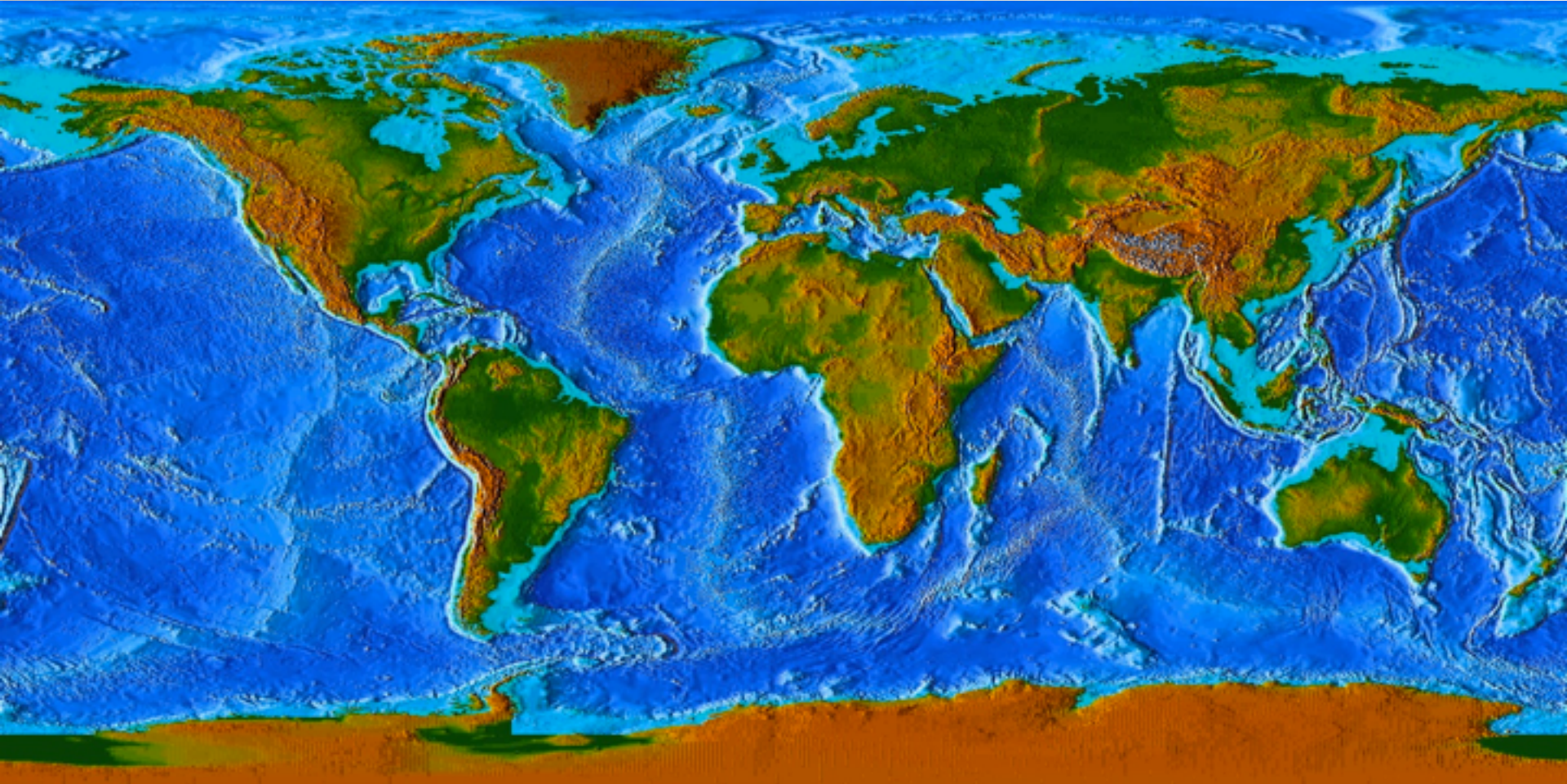
- ▶ US agency leasing seabed 3+ miles offshore (BOEM)
- ▶ Asked PNNL to address issue

Floating Offshore Wind...also Wave



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Great Whales of the Pacific Ocean



Humpback



Blue Whale



Fin Whale



Grey Whale



Minke Whale



Sei Whale

Entanglement vs Encounter

- ▶ Physics of taut or semi-taut lines, no loose end
- ▶ Large whales could enter floating wind array and encounter:
 - Mooring lines
 - Draped inter-array cables

- ▶ Likelihood of encounter based on:
 - Geometry of mooring lines
 - Depth of draped cables in water column
 - Whale behavior: swimming, foraging, diving
 - Whale detection of lines and avoidance, influenced by:
 - Material properties of lines and cables
 - Movement in the water column

- ▶ Important consideration - Physical scale of:
 - Wind farm
 - Water depth
 - Whale dimensions

Model Animation of Whale Encounter

Purpose: Define likelihood, mechanics of humpback whale encounter

Method: create an animation (video) of this encounter, realistic dimensions of renewables farm & whales, common whale behaviors.

Assumptions:

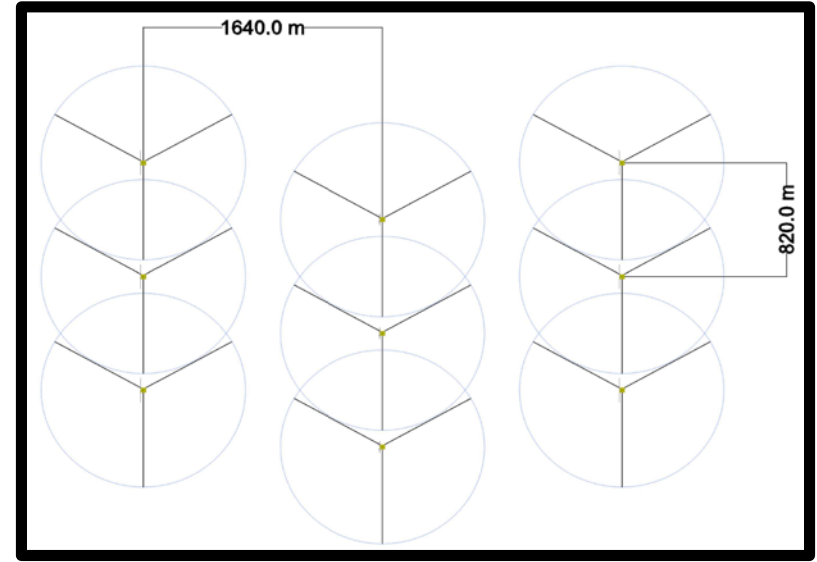
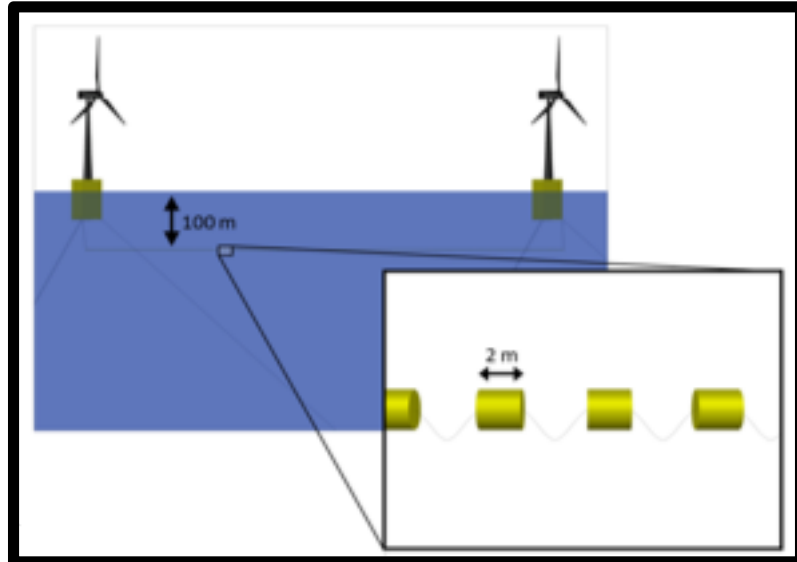
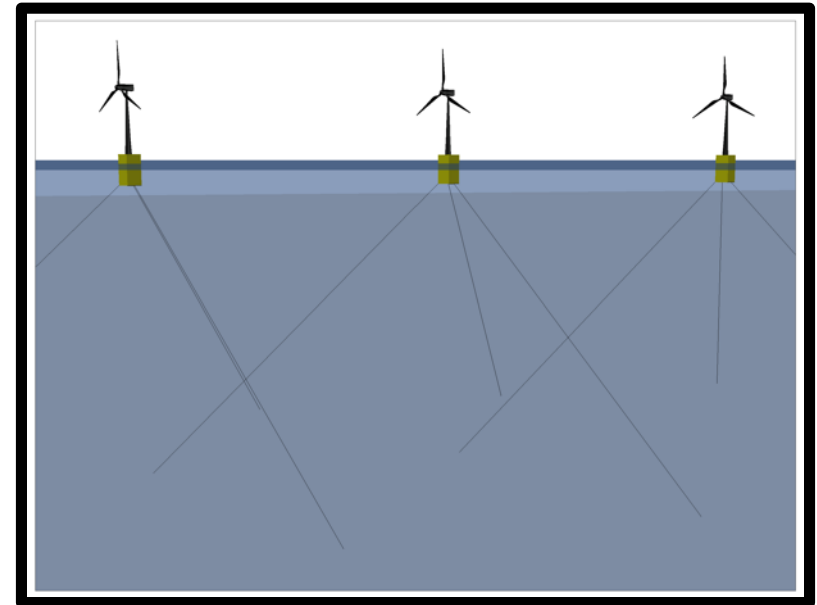
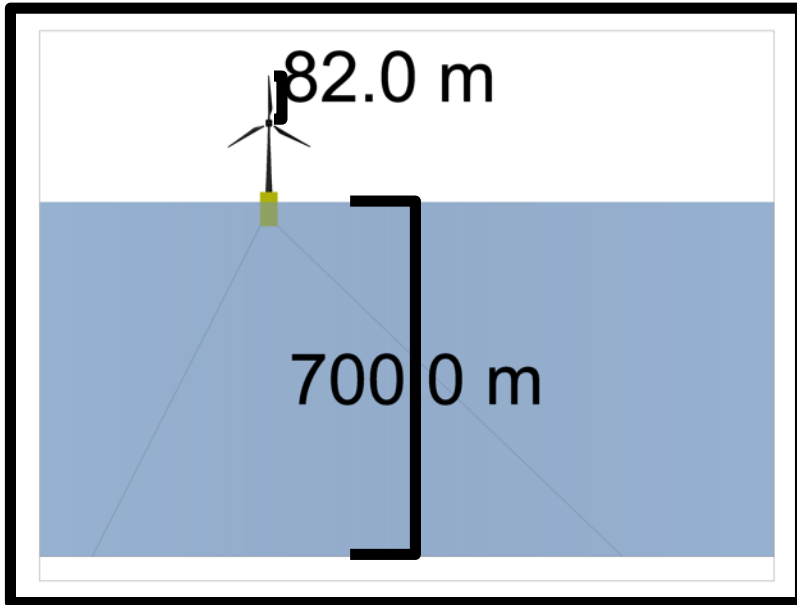
▶ Floating wind farm:

- 9 turbines/platforms
- 8MW turbines
- 700 meters of water

▶ Humpback Whale:

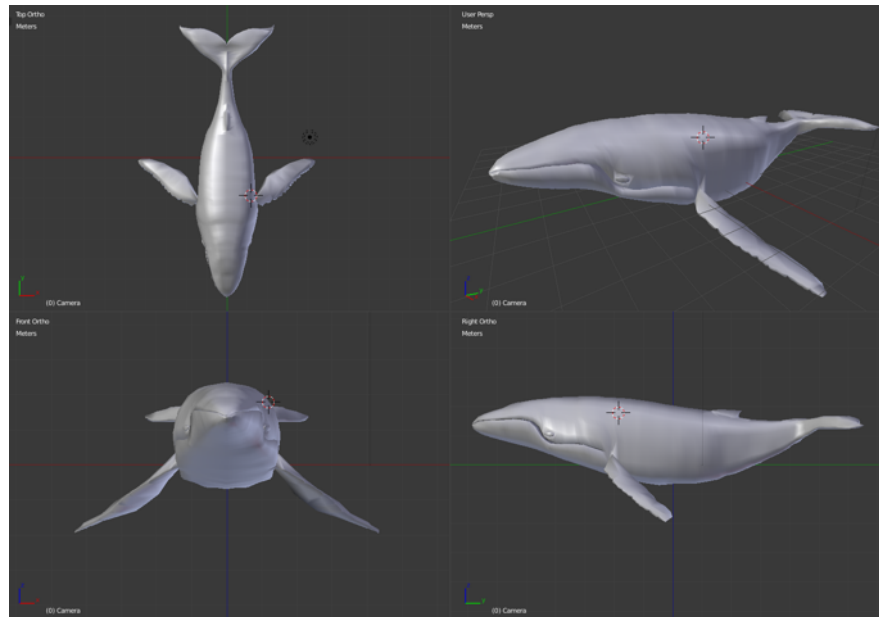
- Adult female and calf pair largest, most at risk
- Mother and calf will traverse array, mother will dive to forage
- Dimensions and behavior from the literature

Mock up of Offshore Floating Wind Farm



Modeling the Whales

	Measurement		Measurement
Adult Female Length	13.18 m	Calf Length	6.59 m
Adult Female Girth	9.85 m	Calf Girth	4.92 m
Adult Female Fluke Length	4.44 m	Calf Fluke Length	2.22 m
Adult Female Flipper Length	4.06 m	Calf Flipper Length	2.03 m



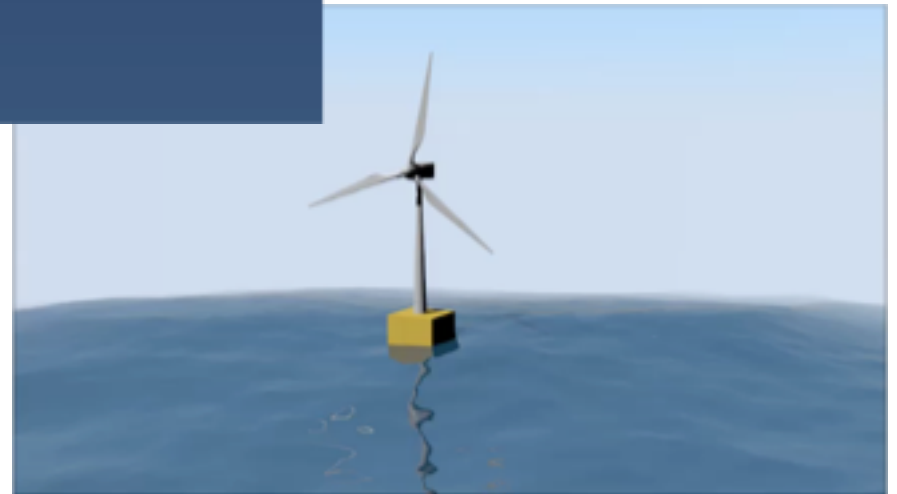
Preliminary Animations



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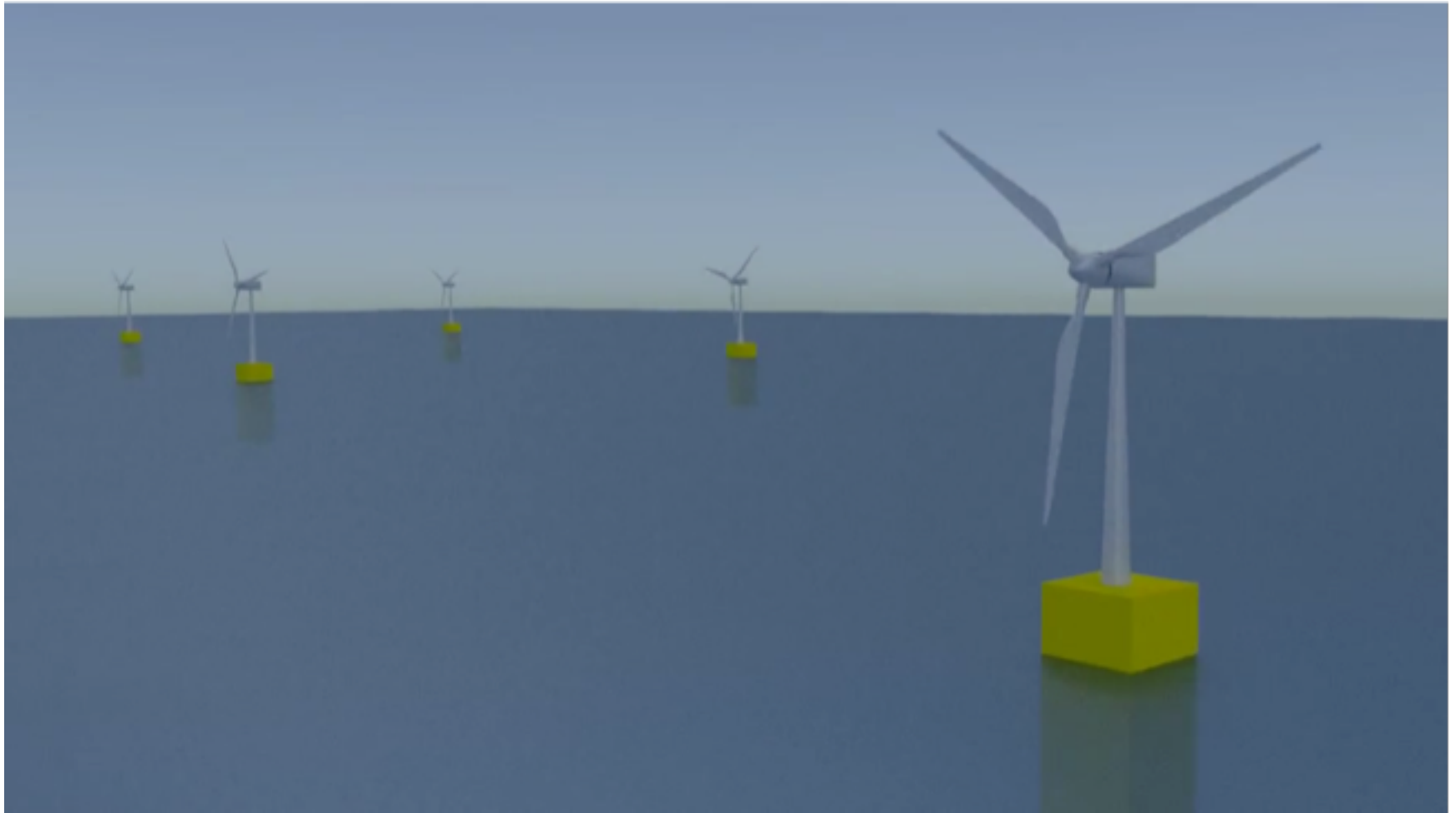


June 19, 2018

Adult Female Dives



Navigating the Array



A Sense of Scale



A Work in Progress:

- Animation to be completed summer 2018, approximately 3 minutes long.
- Combination of full scenes and zoomed in to show relative size of whales and lines.¹²



Use of Video Animations in Consenting

- ▶ Animations allow:
 - Visualization and enhanced understanding of potential future interactions between whales and offshore renewable installations.
 - Method to demonstrate and explain potential risk to public.
 - Animations have their limitations, driven by the imagination of the animator.

- ▶ This animation is neither predictive nor quantitative; could be improved by:
 - Modeling more detailed behavioral responses of the whales to MRE technologies.
 - Modeling encounter probability of whales entering area of wind farm.

Thank you!

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