Anticipated environmental effects of offshore wind development in the Gulf of Maine

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Disclosure

- Heather Deese (Island Institute) and I share management of the team of PIs who are studying environmental impacts of a 1/3-scale turbine (~100 ft tall) in UMaine’s designated Monhegan test site.

- This discussion takes a broader view backwards and forwards and farther offshore.
Trade-offs become more severe and complex

7 billion people now
10 billion by 2050

Linking energy, food and environmental policy

http://www.flickr.com/photos/arenamontanus/375127836/in/photostream/

Maine, exhaust pipe of the nation
Do you want offshore wind power?

It’s not a yes-or-no question.

Multiple Choice, with Consequences

- Coal
- Oil
- Natural gas
- Biomass
- Fission
- Fusion
- Hydro
- Solar
- Wind
- Geothermal
- Efficiency
- Fewer people
Fossil-Fuel CO$_2$ in the Ocean

\[ (\text{atm CO}_2) y = 1.811x - 3252.4 \]

\[ R^2 = 0.95, \text{ st err} = 0.028 \]

\[ (pCO_2) y = 1.90x - 3453.96 \]

\[ R^2 = 0.3431, \text{ st err} = 0.20 \]

\[ (pH) y = -0.00188x + 11.842 \]

\[ R^2 = 0.289, \text{ st err} = 0.00022 \]

**LEGEND**

- Red: Mauna Loa atmospheric CO$_2$ (ppmv)
- Blue: Aloha seawater $p$CO$_2$ (µatm)
- Green: Aloha seawater pH

**Surface-ocean pH**

Down 0.1 from pre-industrial

Down 0.3 more by 2100,

250% more H$^+$ than pre-industrial
Why the European experience does not apply

- Technologies and deployment methods are different (pile driving vs. anchors/moorings)
- The environment is different (most European “offshore” turbines are in water < 20 m deep, vs. a water column > 100 m deep; high physical energy vs. low physical energy at the seabed)
- The communities are different (shallow vs. deep; deep water has distinct benthic and pelagic communities; sand vs. mud; summer stratification)
Three ecosystems & multiple scales

Aerial (Birds, Bats, Insects)

Pelagic

Demersal, Benthic

Collision, Barotrauma

Upwelling?
Mixing, Structuring

Buoyancy Stabilized
Barge with catenary mooring lines

Ballast Stabilized
Spar buoy with catenary mooring, drag-embedded anchors

Mooring Line Stabilized
Tension leg platform with suction pile anchors

Structuring
Not covered

• Overwater noise
• Underwater noise
• Visual aesthetics
• Mammals

Fair game for questions and discussion
Summer and Fall Hot Spot + Crossing Flyways

Spring Bloom Starts Here (Jan-Feb)
Why migration rates and paths are poorly known

Birds leaving island roost

Wave clutter

http://www.crh.noaa.gov/grb/?n=060810

http://mmc.nrlssc.navy.mil/Symposium/Proceedings/Chen/Paper/figure2.jpg
Bird and wave backscatter signals arrive simultaneously. So unambiguous bird detection is limited to the range of the radar signal before it reaches the sea surface. Practical range for resolution of small, individual songbirds is < 3 km.
Structural Changes

Fish Attraction Device (FAD) in the Celebes Sea

- Structural complexity
- Fouling
- New food chains
- “Reef effect”

<http://www.advancedh2opower.com/framework/MHK%20KB%20Images/fishattractiondeviceandartificalreeffectsFigure1.jpg>
Functional Changes?


- Upwelling
- Stirring
- Productivity

This effect could be important offshore because deep waters of the Gulf of Maine stratify in summer. Would it be bad or good? It is yet untested.

Upwelling velocities could exceed 1 m d^{-1}
Effectively closed areas — to mobile gear

*Lophelia pertusa*, reef building, deep-water coral that grew on base of Brent Spar

- > 70% of bottom ≥ 100 m deep is mud
- Potential substrate and refuge for large structure makers (corals and sponges)
- Anchors provide habitat complexity for lobster
- Recovery of structure-building infauna (e.g., tube-building worms)
- Siting and number important to fishermen
Conclusions

• A wide range of effects is expected because four distinct communities are involved:
  • Flying vertebrates and insects
  • Pelagic community and seas that stratify
  • Benthic community
  • Fishing community

• All of these effects are scale and location dependent; predictions of effects contain much uncertainty.

• Adaptive management with monitoring at each significant scale-up would appear to be the only rational approach.