

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

Pete Jumars, Director
School of Marine Sciences
University of Maine
jumars@maine.edu



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.



U.S. DEPARTMENT OF
ENERGY

DeepCwind
CONSORTIUM

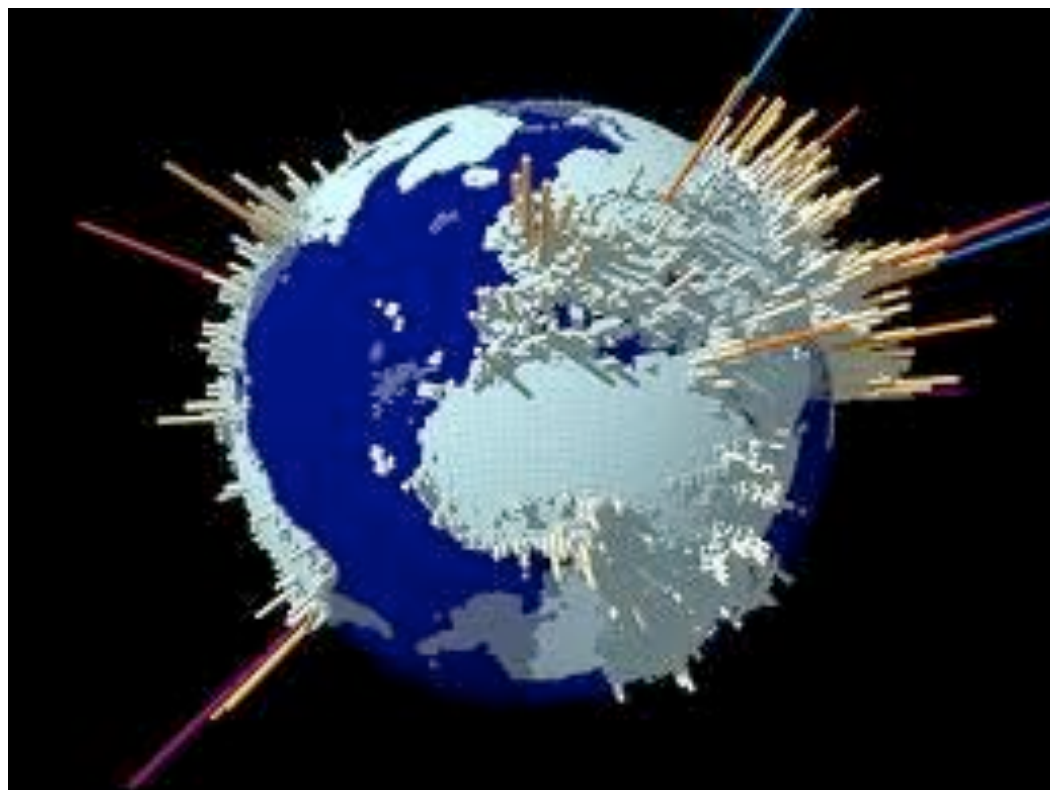
The logo for the DeepCwind Consortium, featuring the text "DeepCwind" in blue and "CONSORTIUM" in grey, with a stylized graphic of wind turbines in blue and green.

Trade-offs become more severe and complex

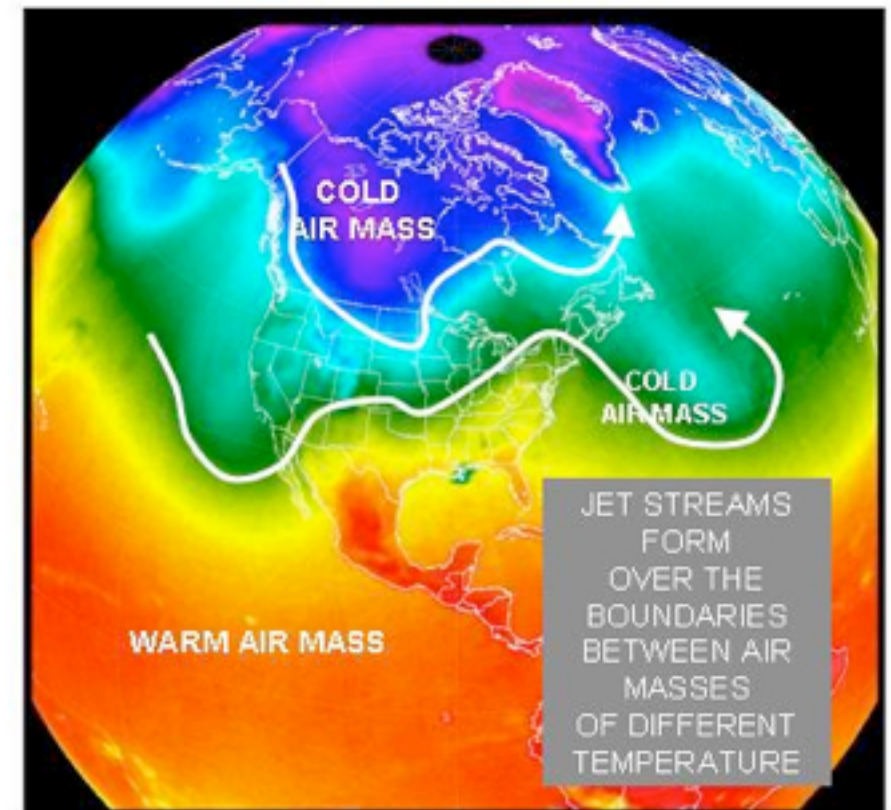
7 billion people now
10 billion by 2050



Linking energy, food
and environmental policy



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



Maine, exhaust pipe
of the nation

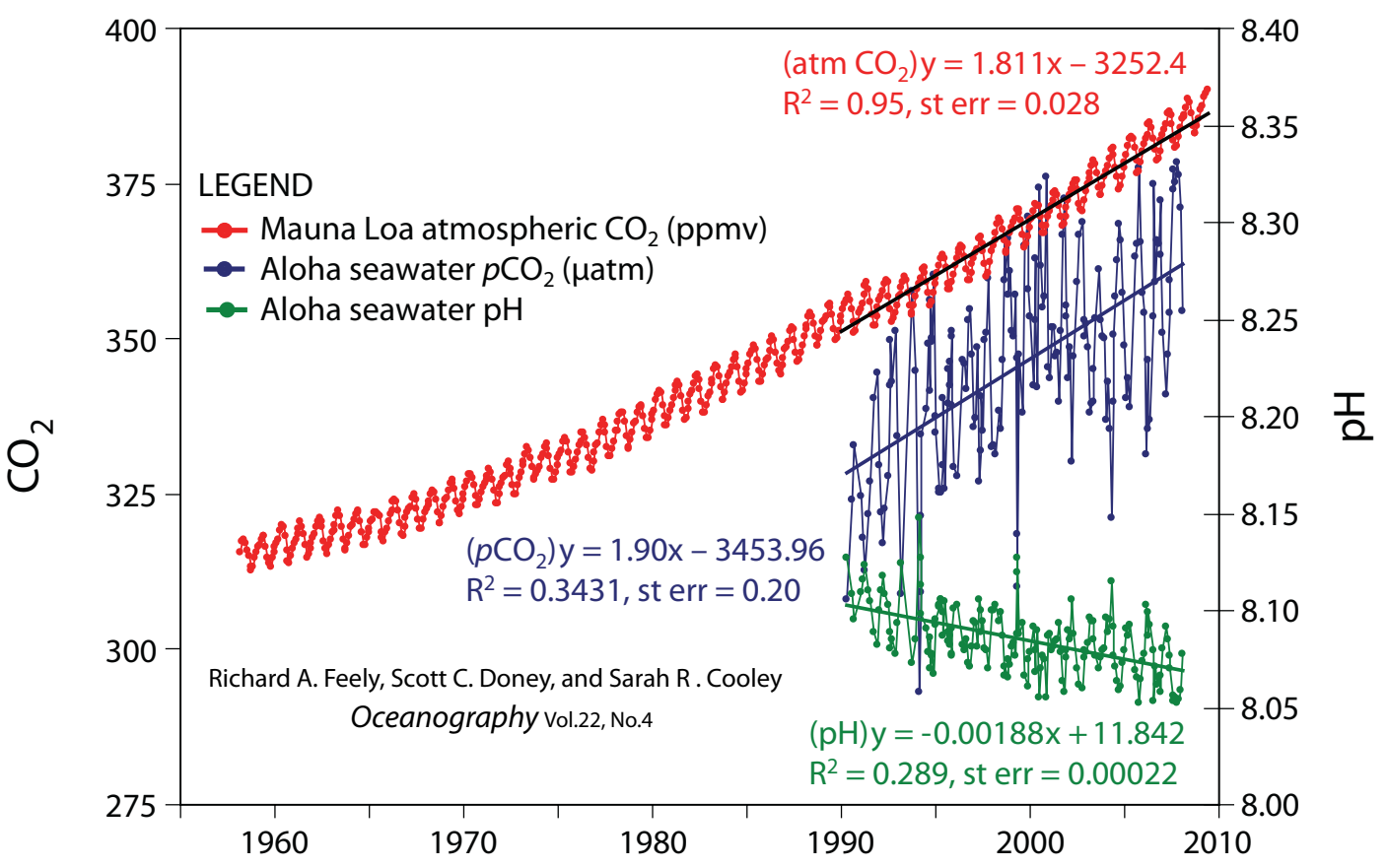
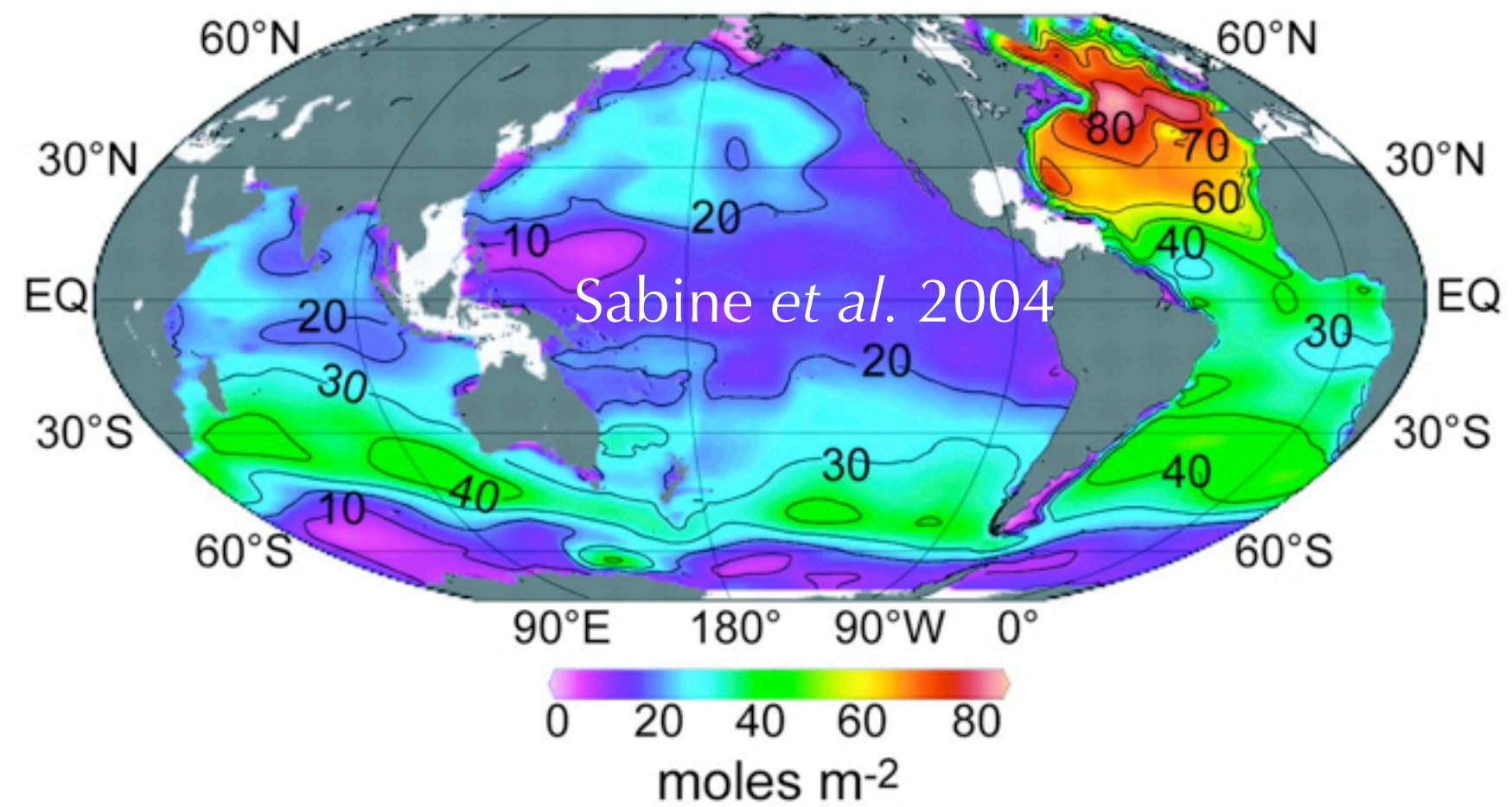
- Do you want offshore wind power?
- It's not a yes-or-no question.

Multiple Choice, with Consequences

- Coal
- Oil
- Natural gas
- Biomass
- Fission
- Fusion
- Hydro
- Solar
- Wind
- Geothermal
- Efficiency
- Fewer people



Fossil-Fuel CO₂ in the Ocean



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)

*Collision,
Barotrauma*

Pelagic

*Upwelling?
Mixing,
Structuring*

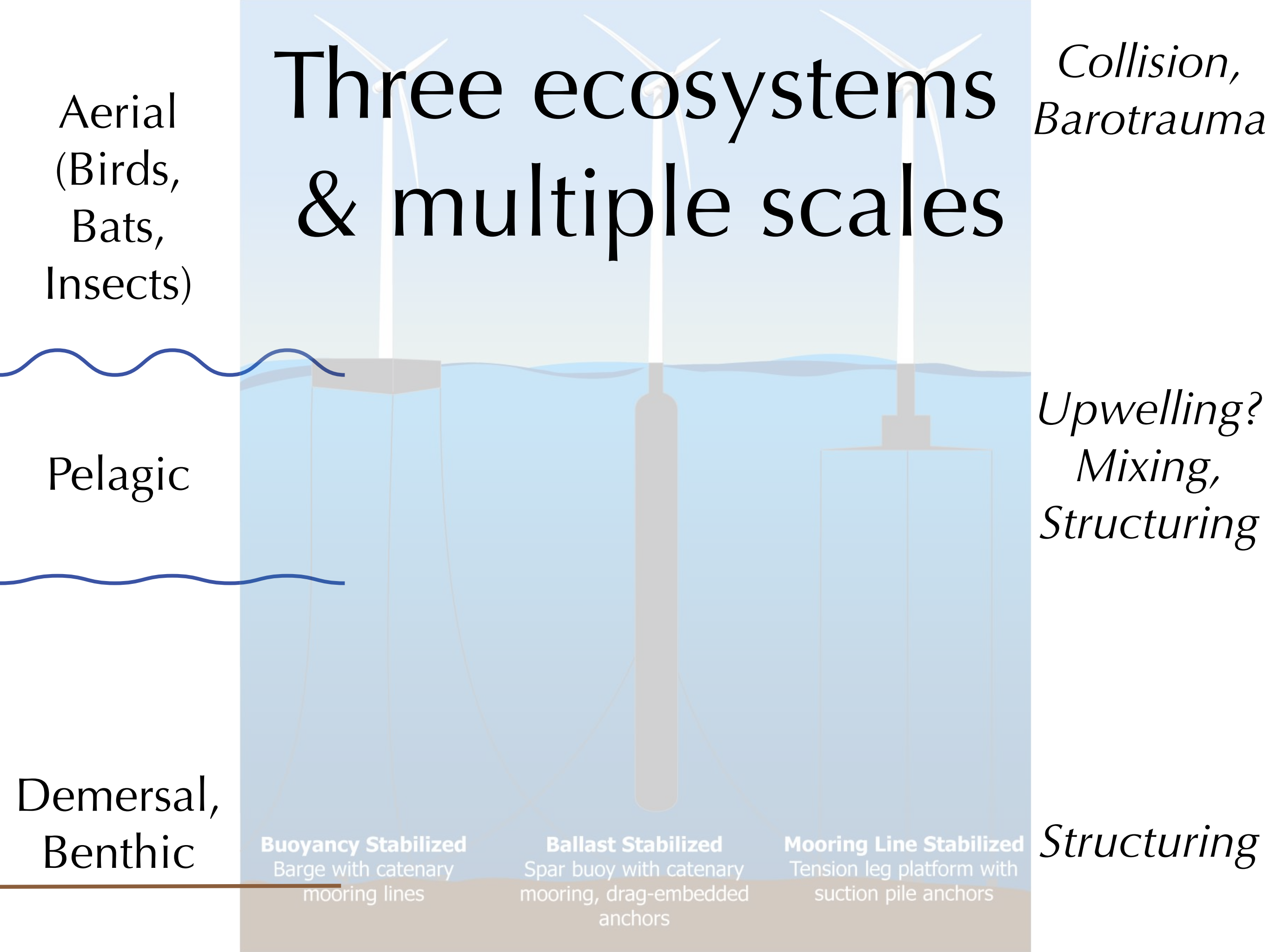
Demersal,
Benthic

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

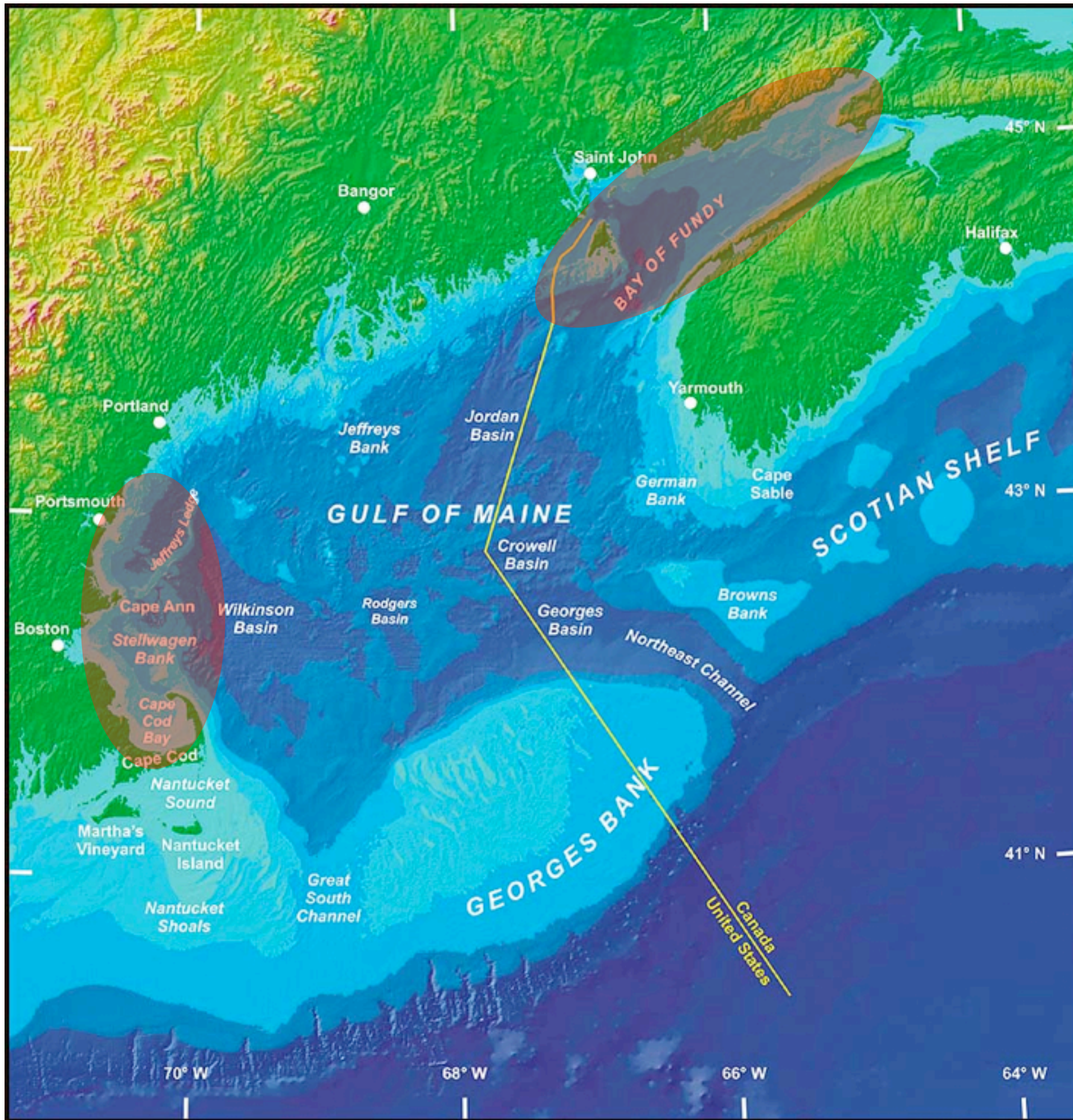


Not covered

- Overwater noise
- Underwater noise
- Visual aesthetics
- Mammals

Fair game for
questions and
discussion

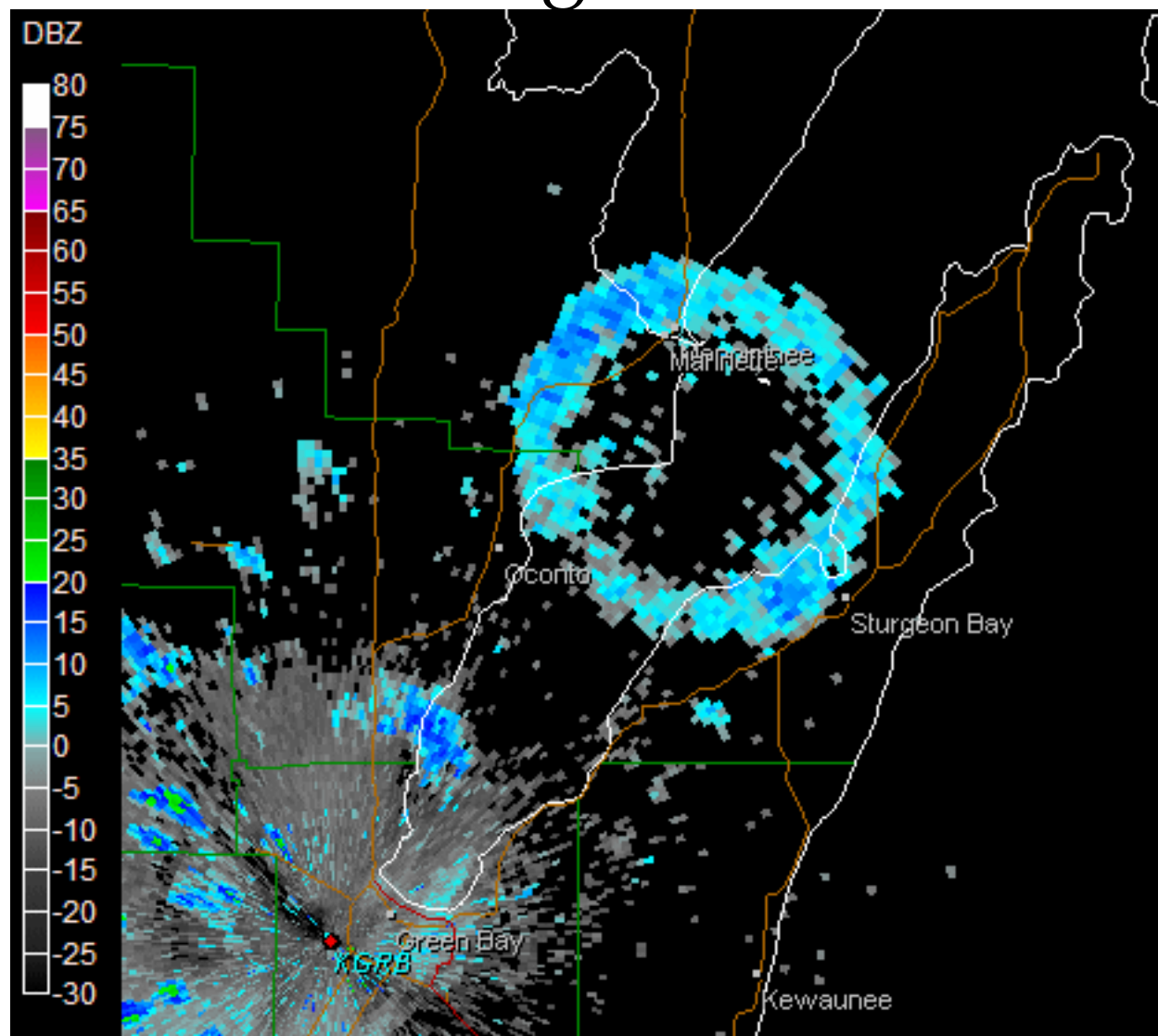
Spring Bloom Starts Here (Jan-Feb)



Summer and Fall Hot Spot + Crossing Flyways

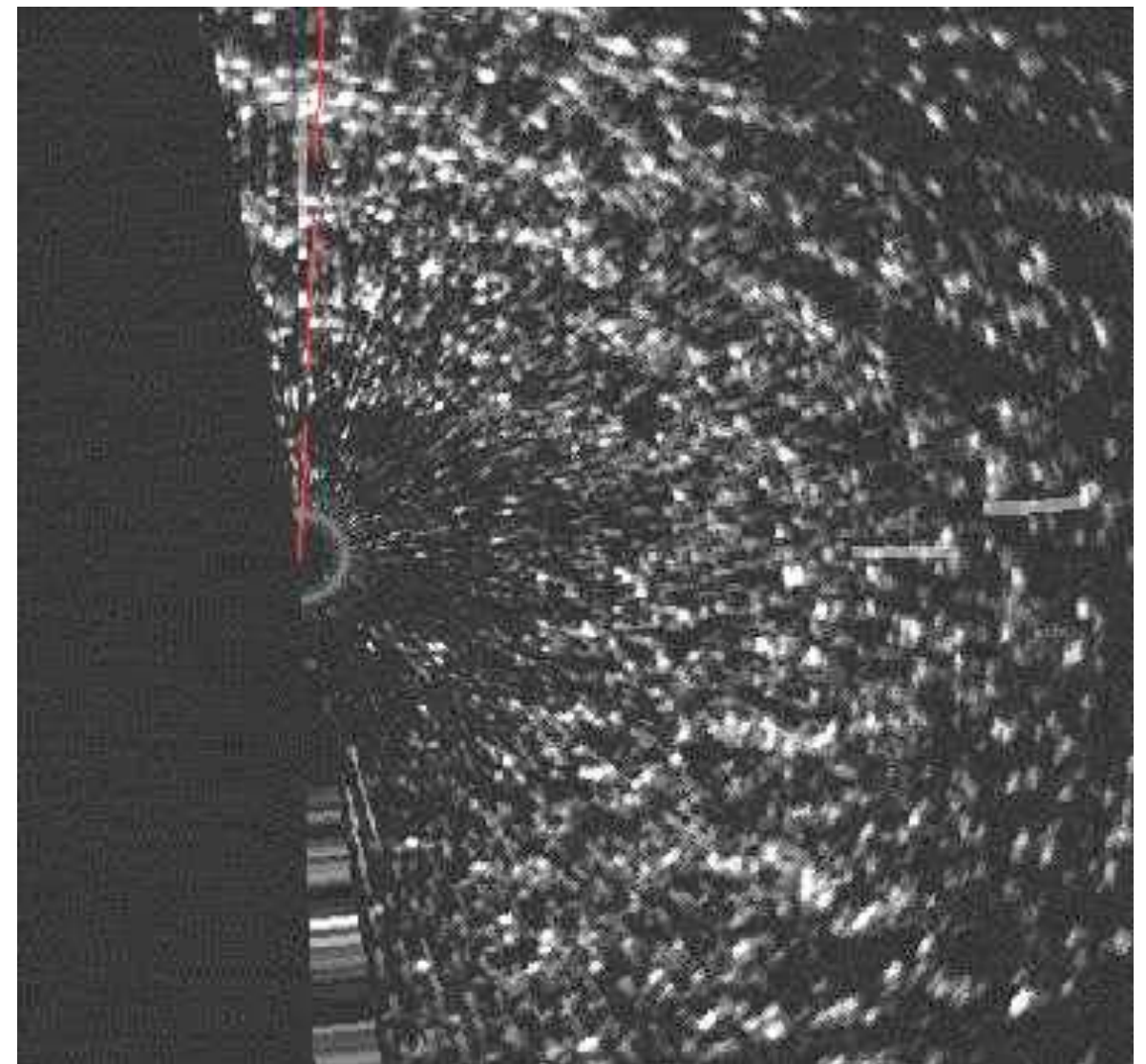
Why migration rates and paths are poorly known

Birds leaving island roost



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

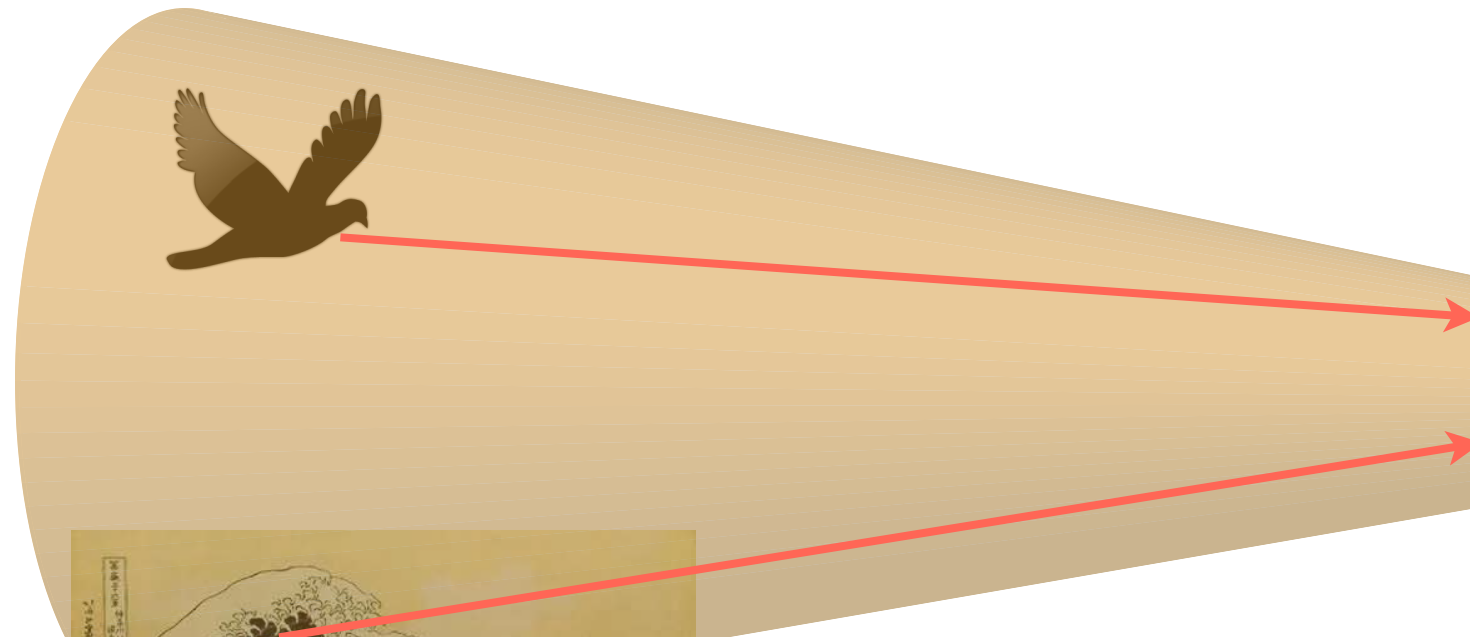
Wave clutter



<http://mmc.nrlssc.navy.mil/Symposium/Proceedings/Chen/Paper/figure2.jpg>

Ambiguities

Birds move



Bird and wave
backscatter signals
arrive simultaneously



Waves move

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

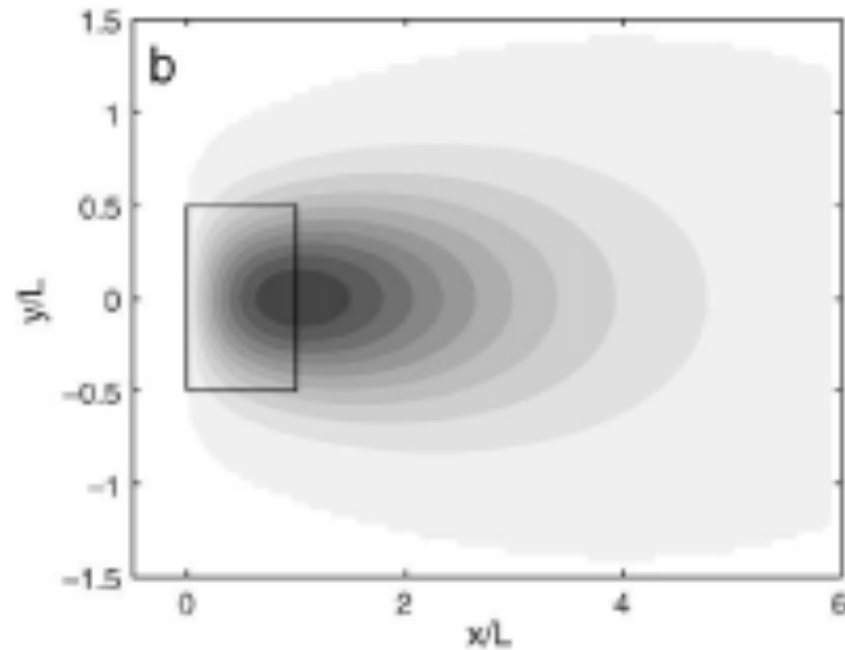


- Structural complexity
- Fouling
- New food chains
- “Reef effect”

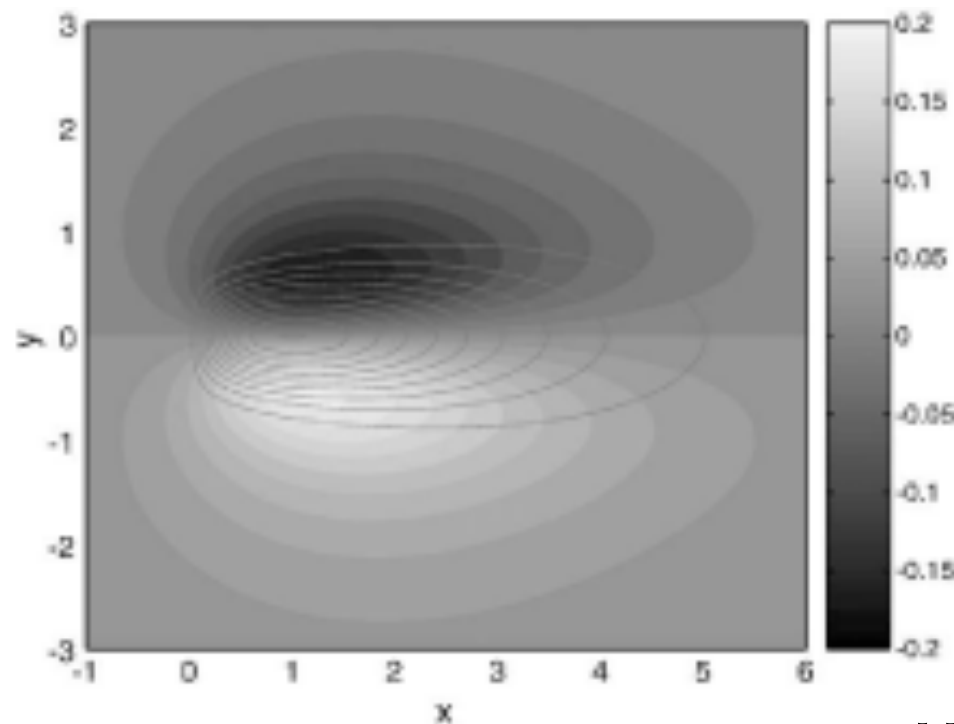
<<http://www.advancedh2opower.com/framework/MHK%20KB%20Images/fishattractiondeviceandartificialreefeffectsFigure1.jpg>>

Functional Changes?

Broström, G. 2008. On the influence of large wind farms on the upper ocean circulation. *Journal of Marine Systems* **74**: 585–591



- 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

<http://pirate6969.wordpress.com/2009/05/>



http://news.bbc.co.uk/olmedia/50000/images/51662_brent300.jpg

- > 70% of bottom \geq 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.