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

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Disclosure

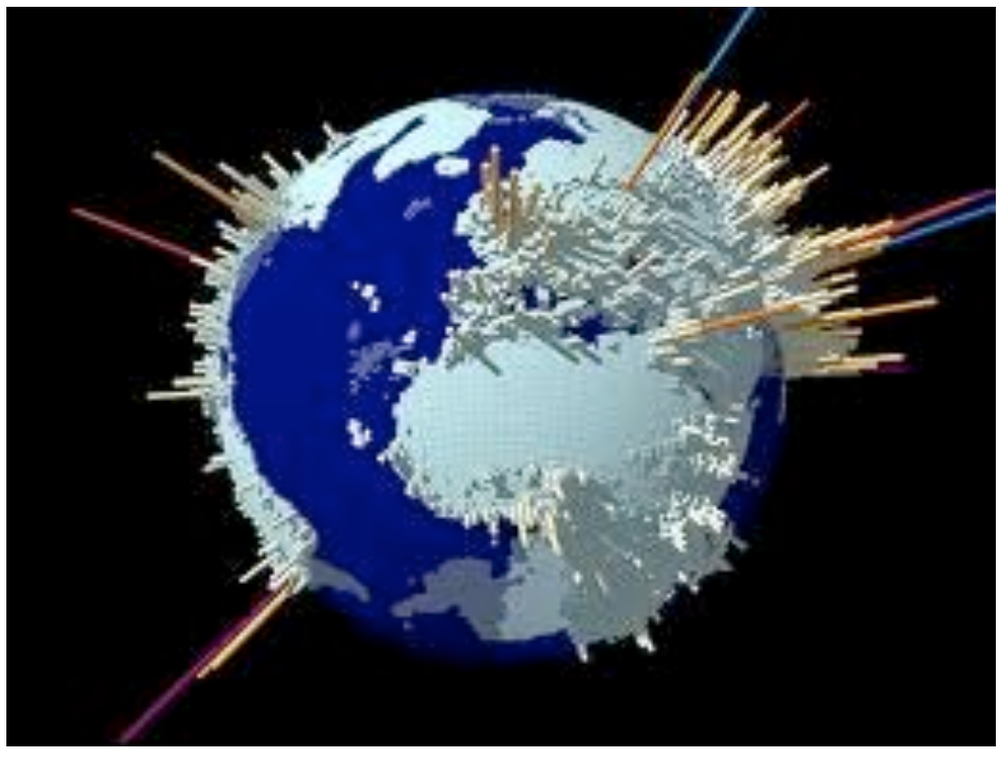
- Heather Deese (Island Institute) and I share management of the team of PIs who are studying environmental impacts of a 1/3-scale turbine (~ 100 ft tall) in UMaine's designated Monhegan test site.
- This discussion takes a broader view backwards and forwards and farther offshore.

U.S. DEPARTMENT OF ENERGY

DeepCwind CONSORTIUM

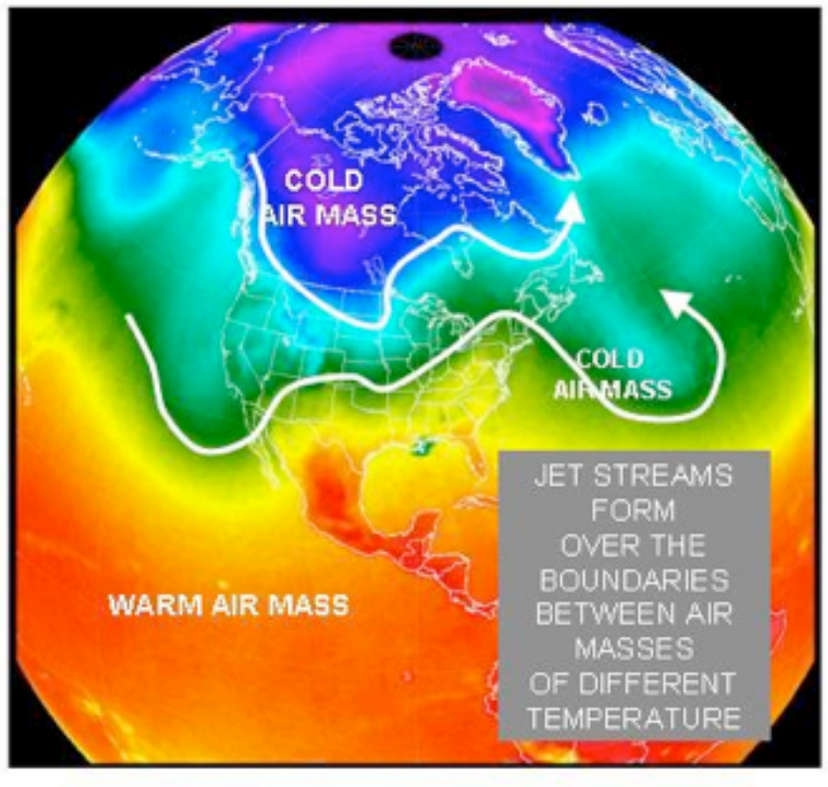
Trade-offs become more severe and complex

7 billion people now
10 billion by 2050



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

Linking energy, food and environmental policy



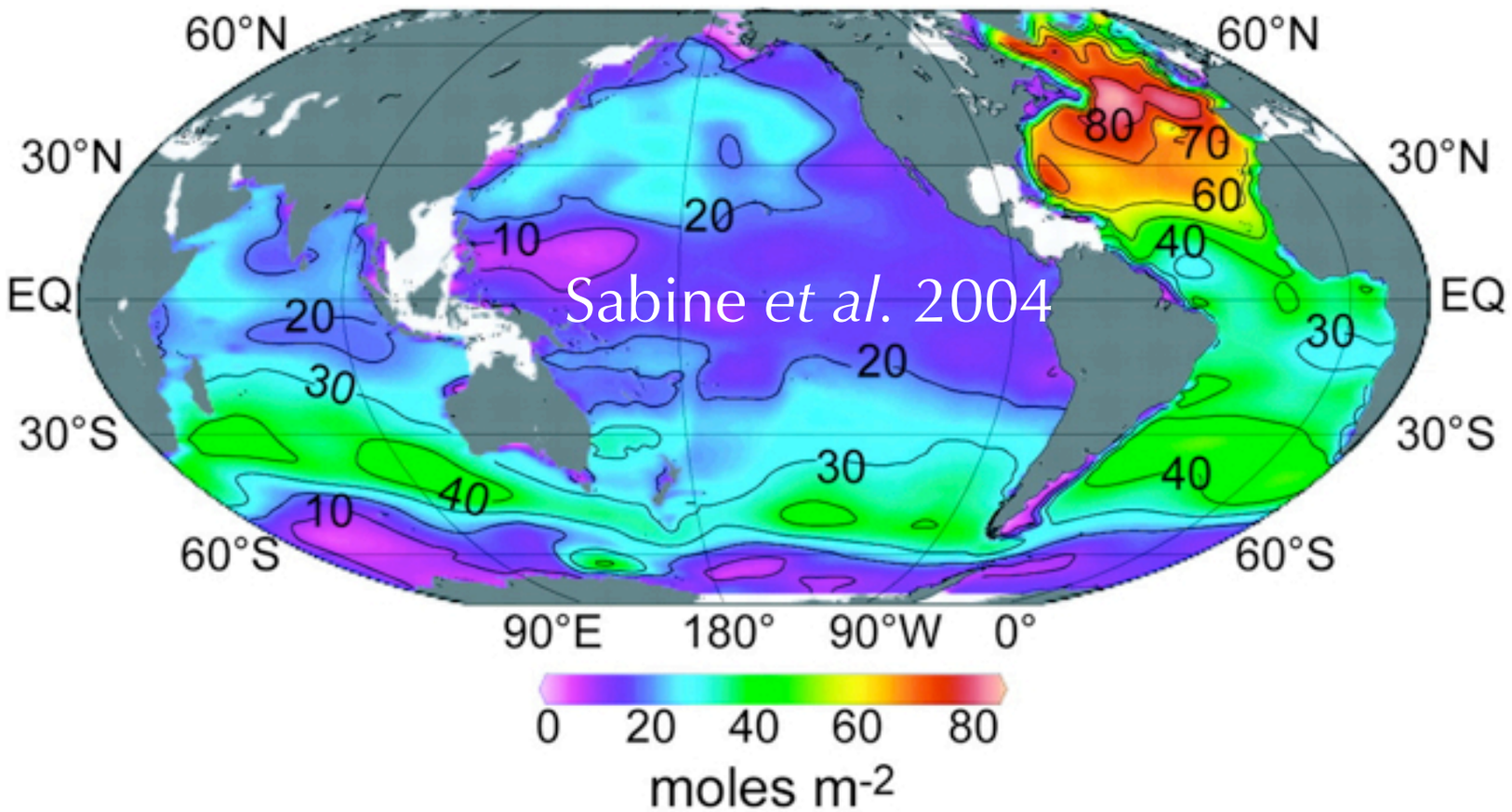
Maine, exhaust pipe of the nation

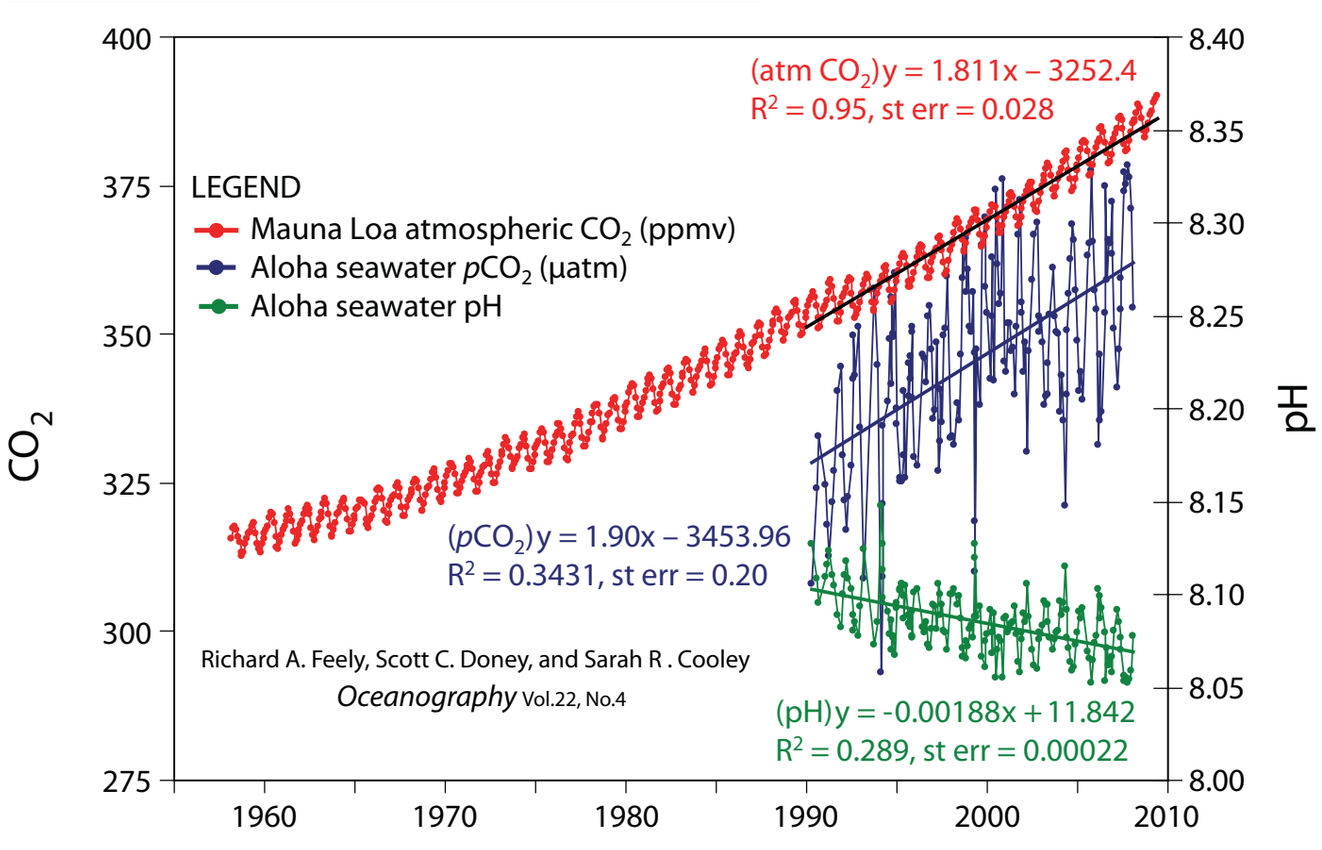
- Do you want offshore wind power?
- It's not a yes-or-no question.

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





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)

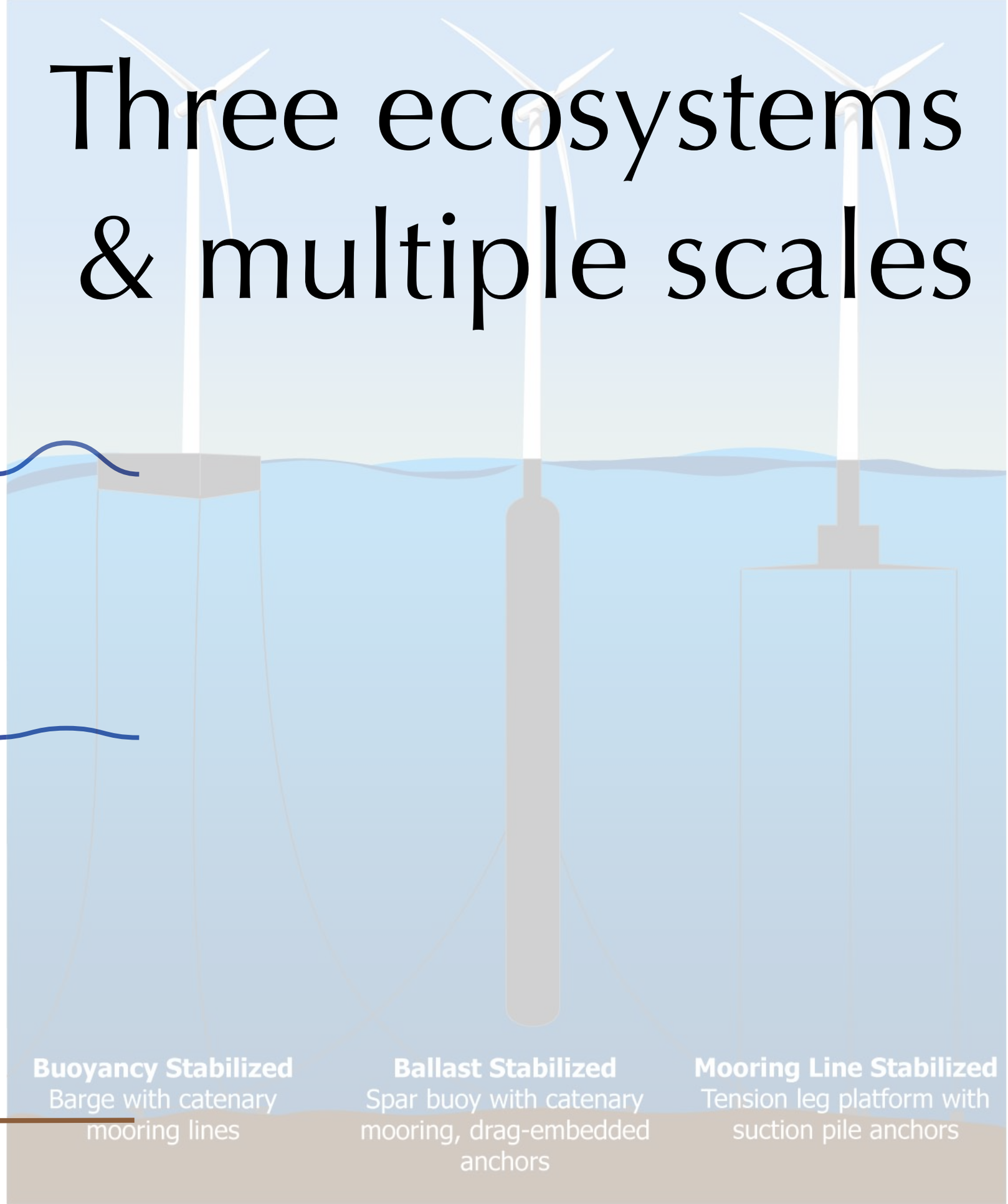
Collision, Barotrauma

Pelagic

Upwelling? Mixing, Structuring

Demersal, Benthic

Structuring

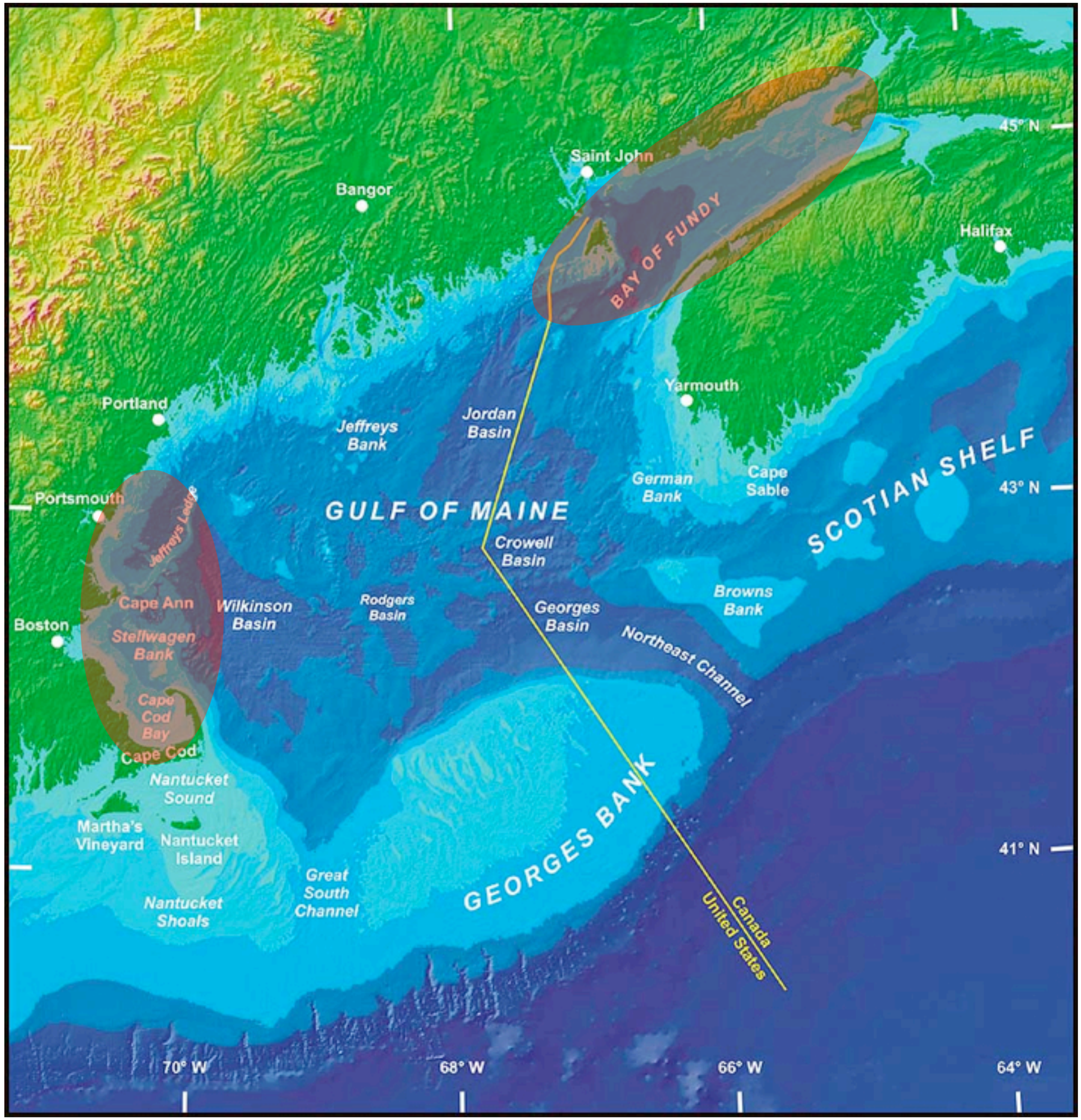


Not covered

- Overwater noise
- Underwater noise
- Visual aesthetics
- Mammals

Fair game for questions and discussion

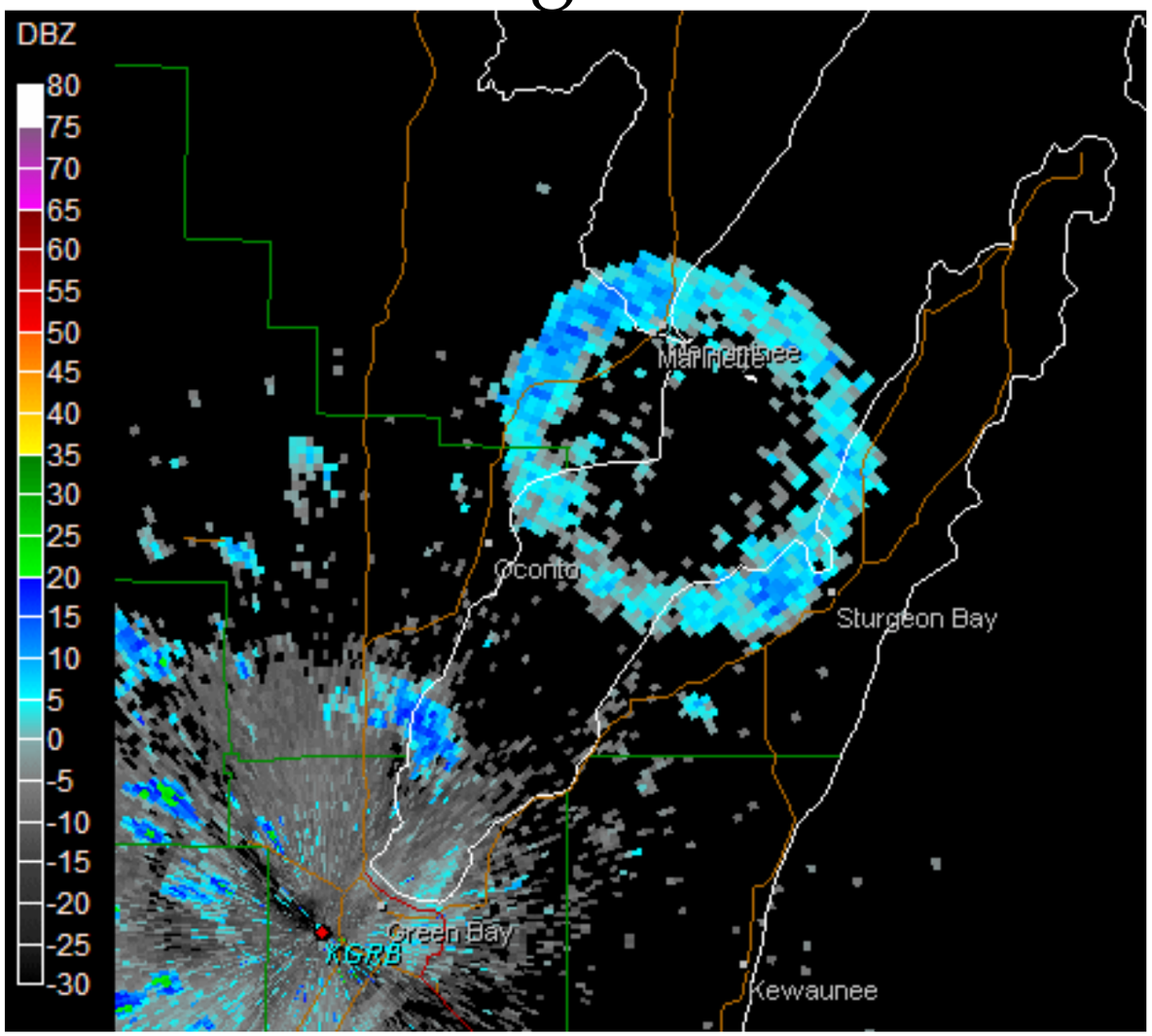
Spring Bloom Starts Here (Jan-Feb)



Summer and Fall Hot Spot + Crossing Flyways

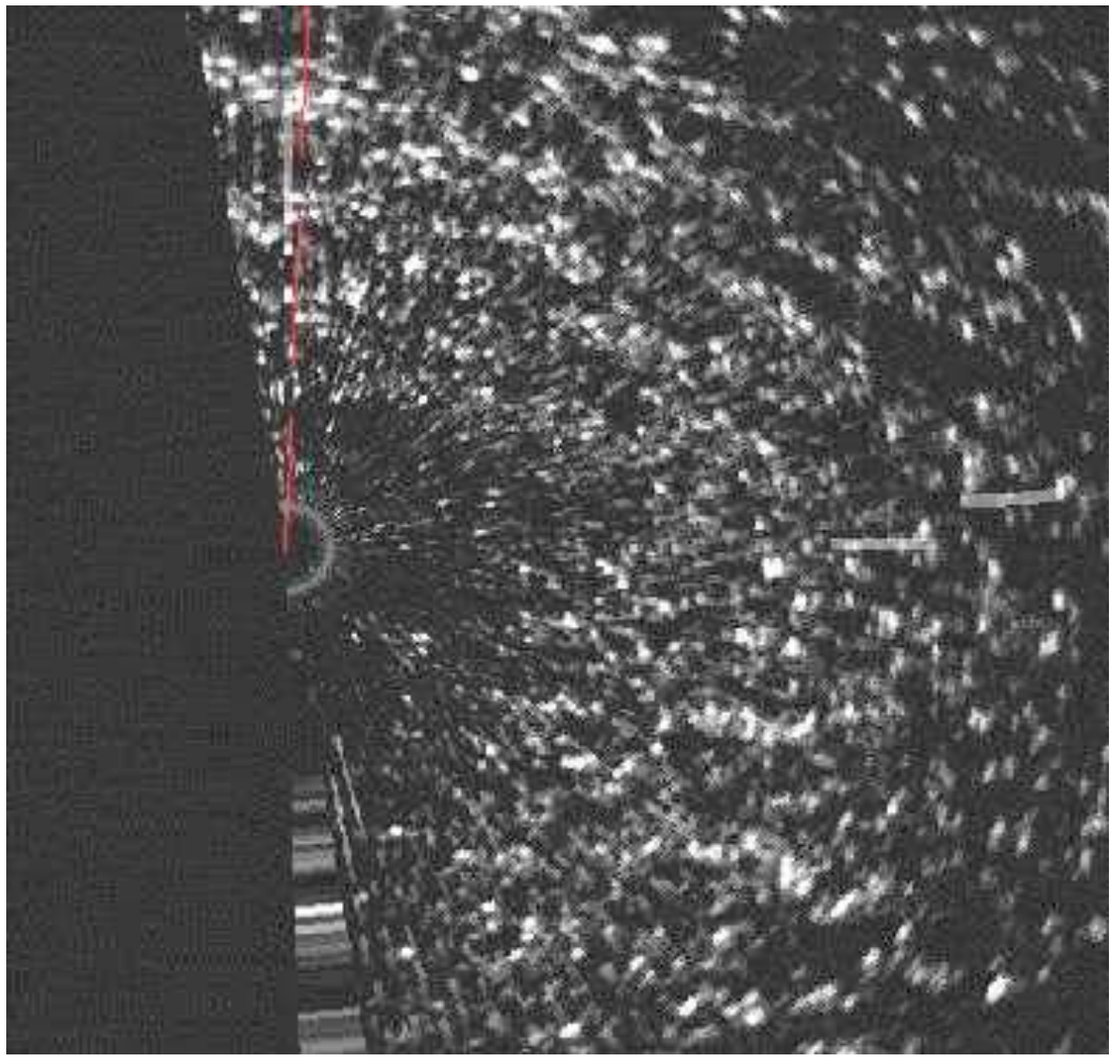
Why migration rates and paths are poorly known

Birds leaving island roost



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

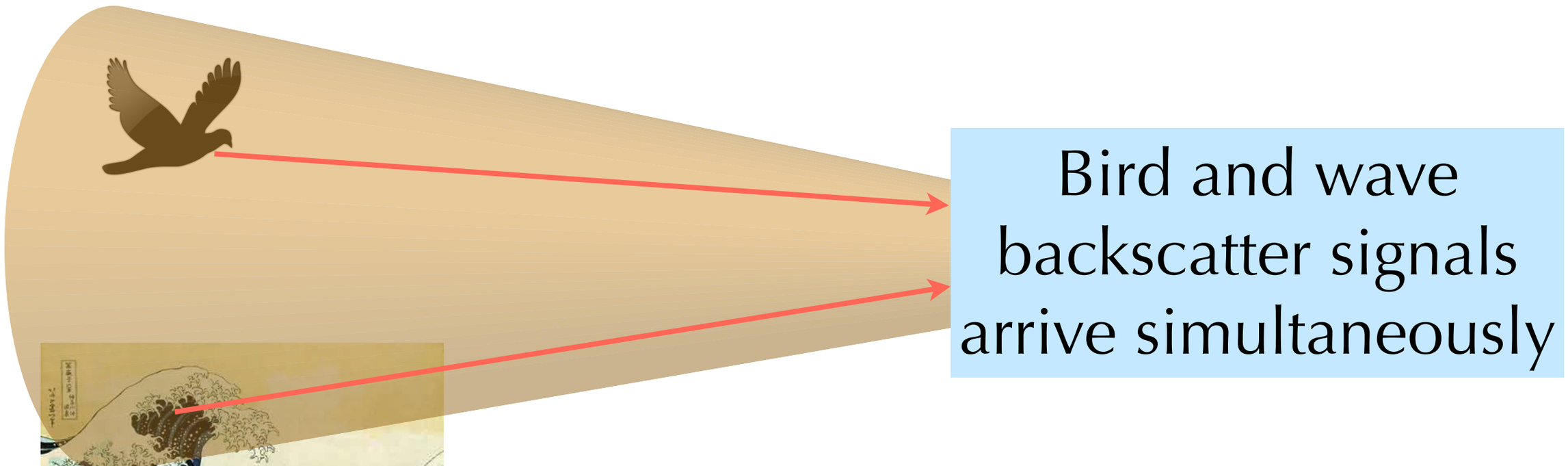
Wave clutter



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

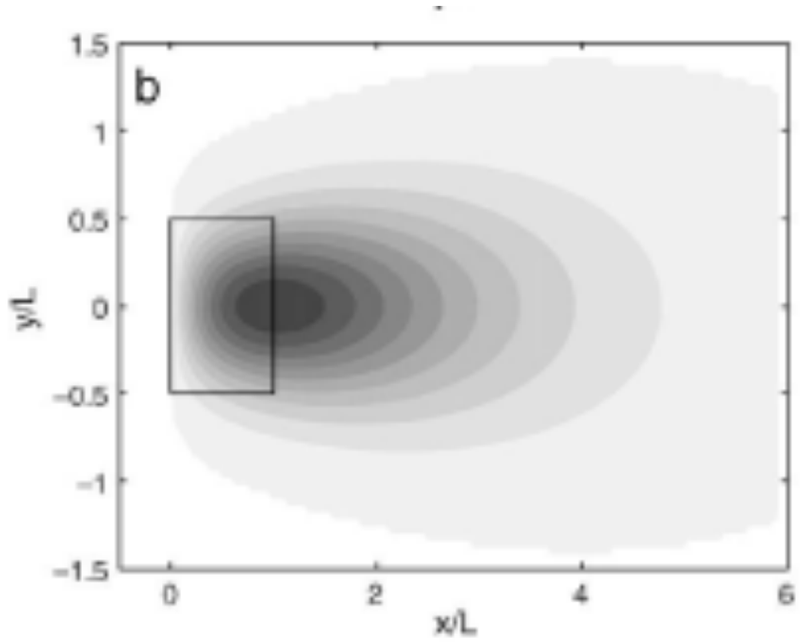
Structural Changes

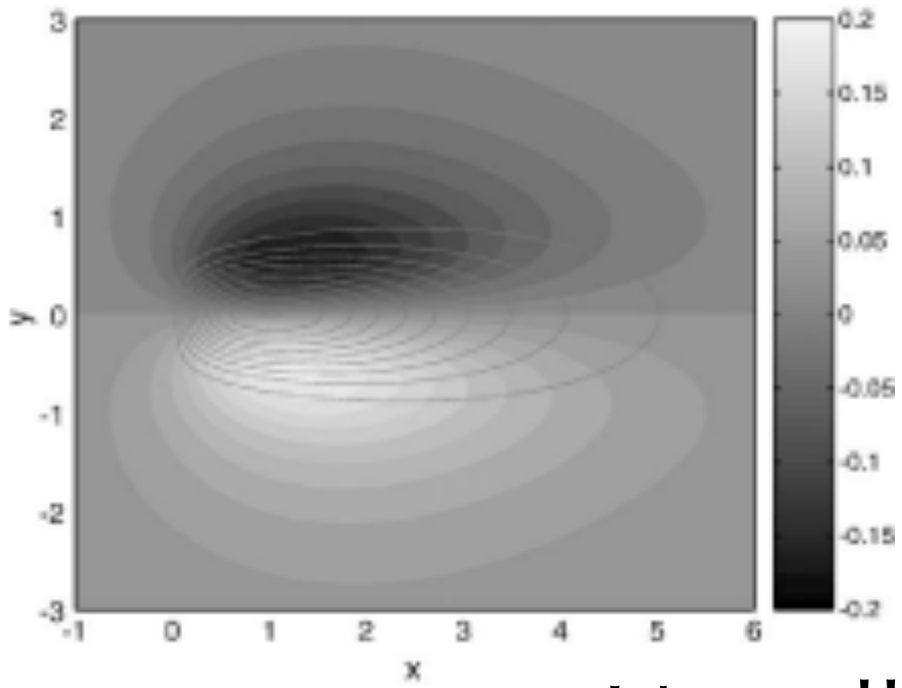
Fish Attraction Device (FAD) in the Celebes Sea

<http://www.advancedh2opower.com/framework/MHK%20KB%20Images/fishattractiondeviceandartificalreefeffectsFigure1.jpg>

- Structural complexity
- Fouling
- New food chains
- "Reef effect"

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

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

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

http://news.bbc.co.uk/olmedia/50000/images/_51662_brent300.jpg

- > 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.