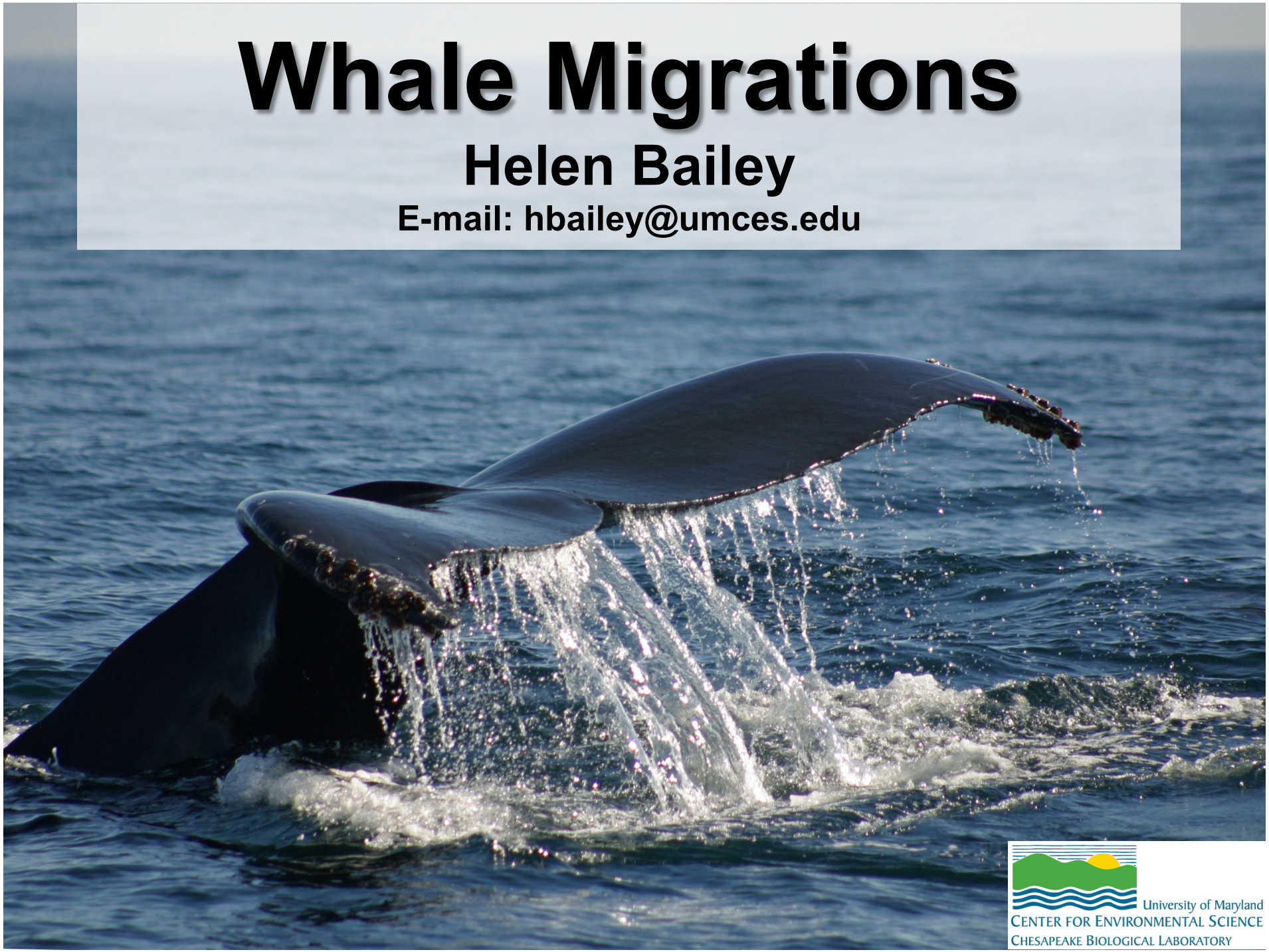
Whale Migrations

Helen Bailey

E-mail: hbailey@umces.edu



University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE
CHESAPEAKE BIOLOGICAL LABORATORY

Outline

- Why migrate?
- What can we learn from animal movements?
- Movement ecology initiative at CBL
- Whale movements and distribution
- New developments

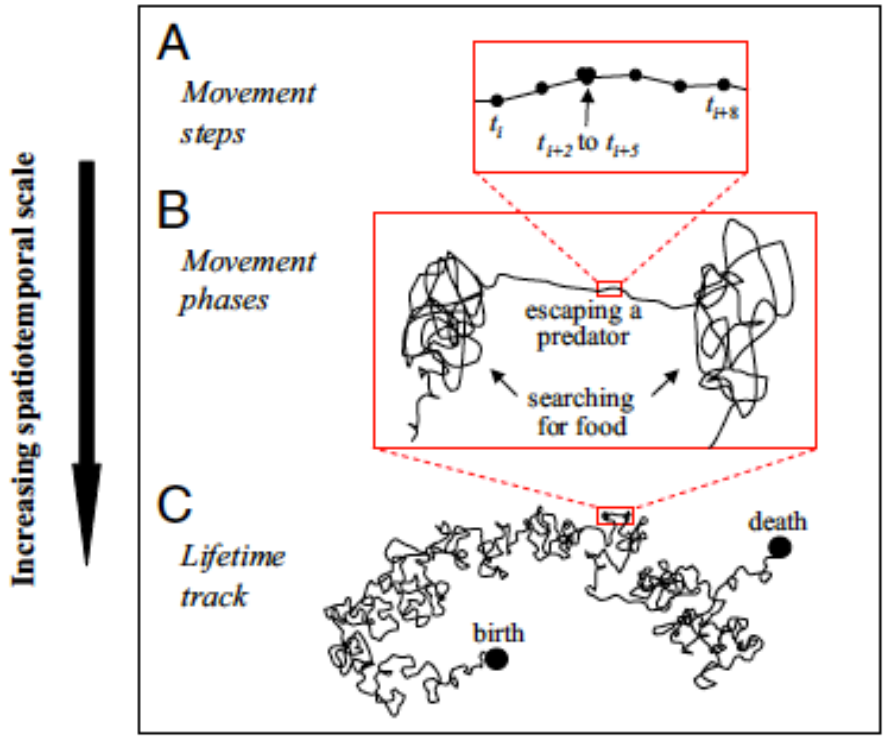
Migration

- Follow resources
  - Food
  - Suitable breeding grounds and nursery habitat

Humpback whale

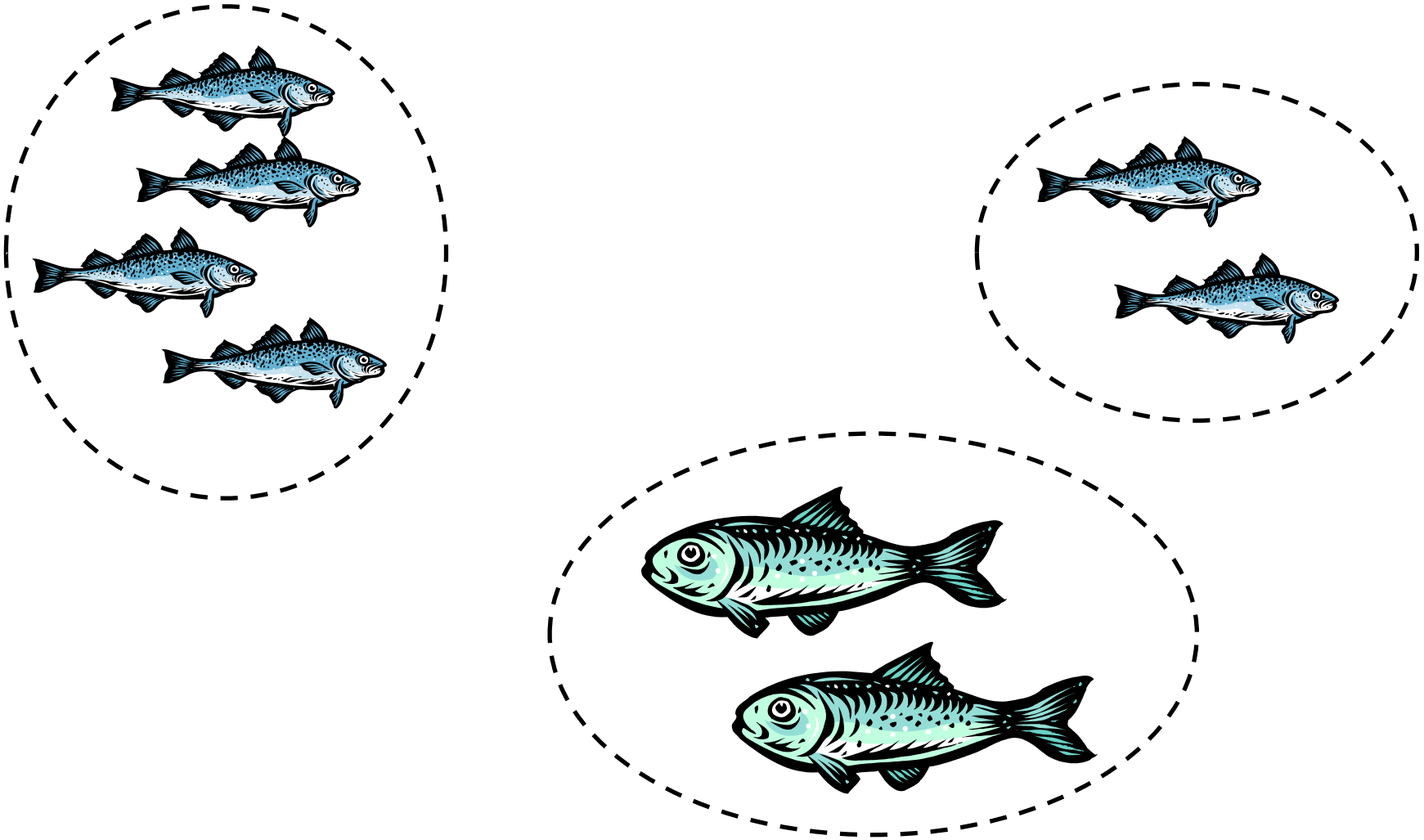
Movement Ecology

- Understanding the causes, mechanisms, patterns, and consequences of movement phenomena
- Linking movements to specific internal traits or behaviours

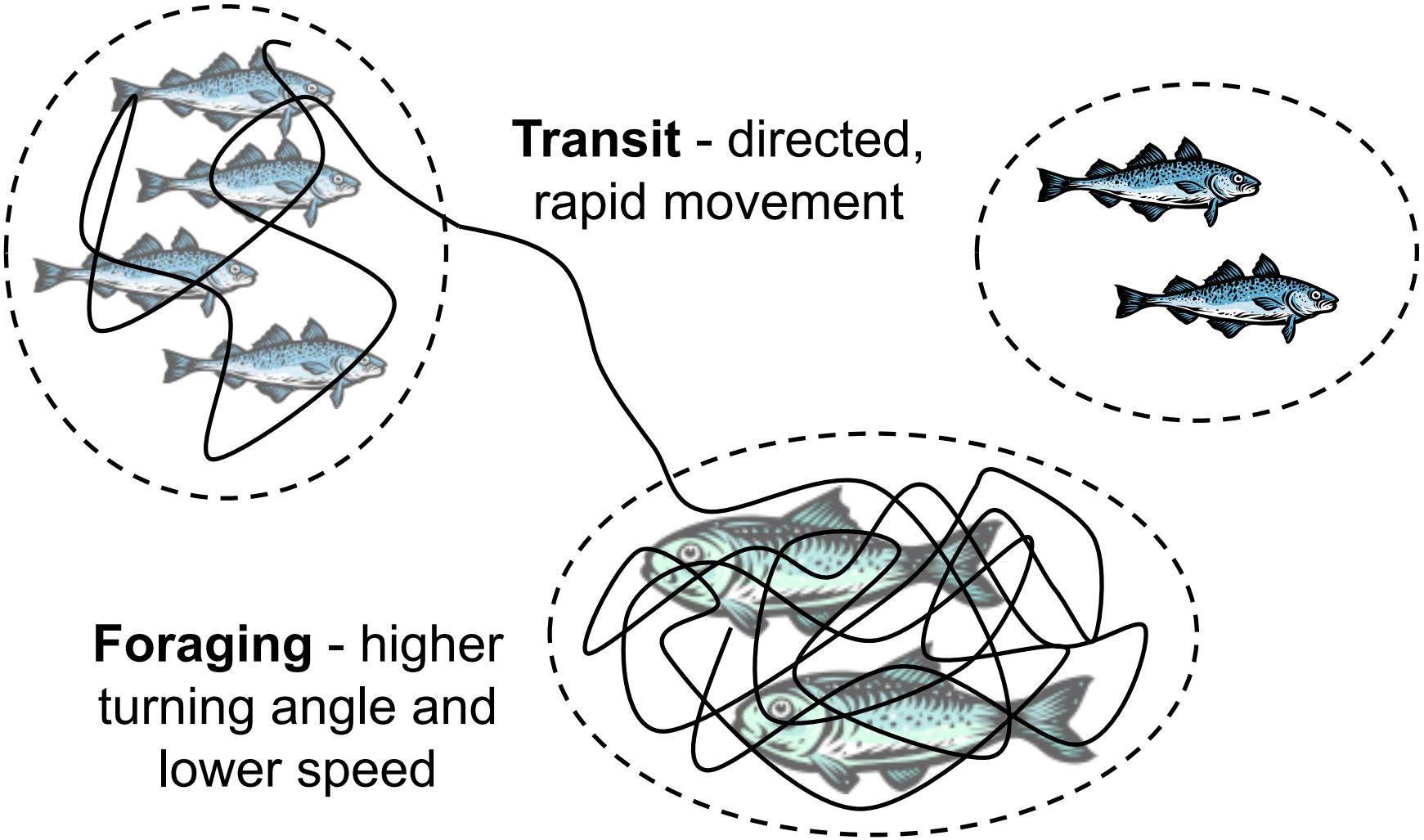


From Nathan et al. 2008

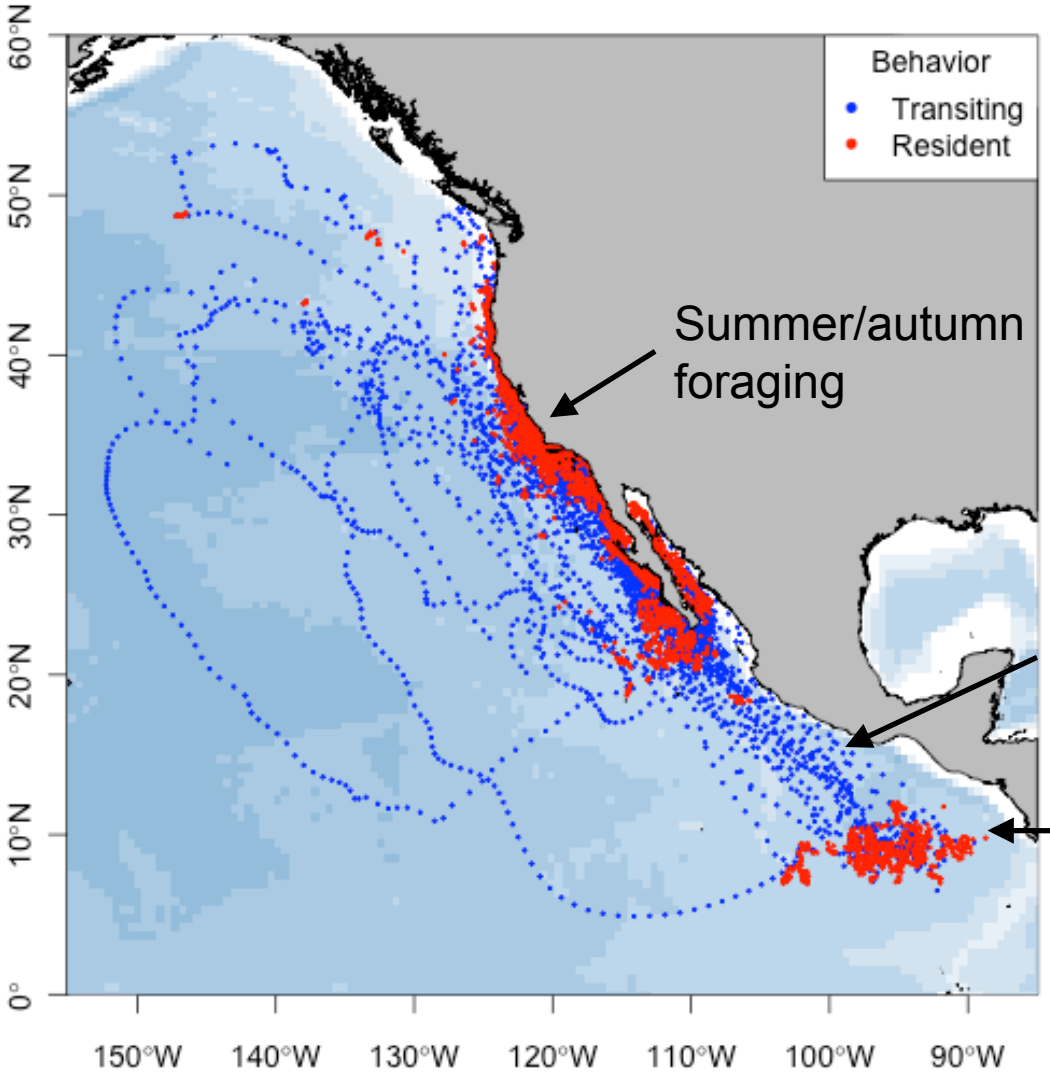
Movement phases



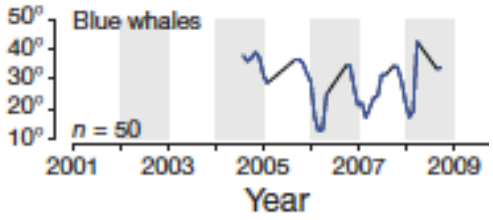
Movement phases



Large-scale movements

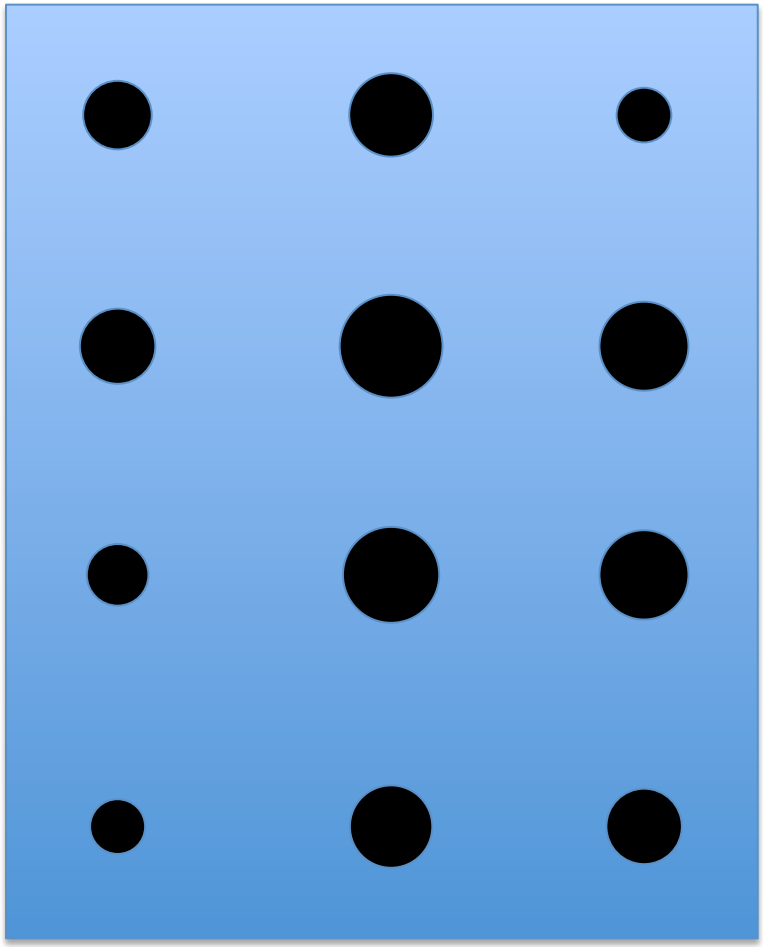


Bailey et al. 2009

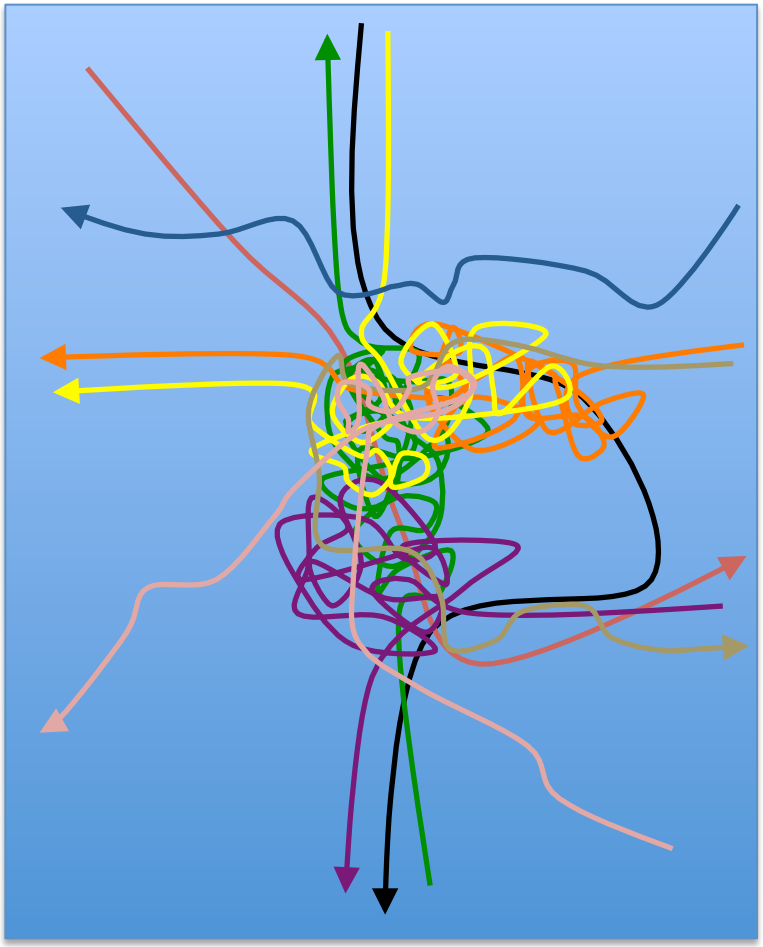


Block et al. 2011

Survey limitations

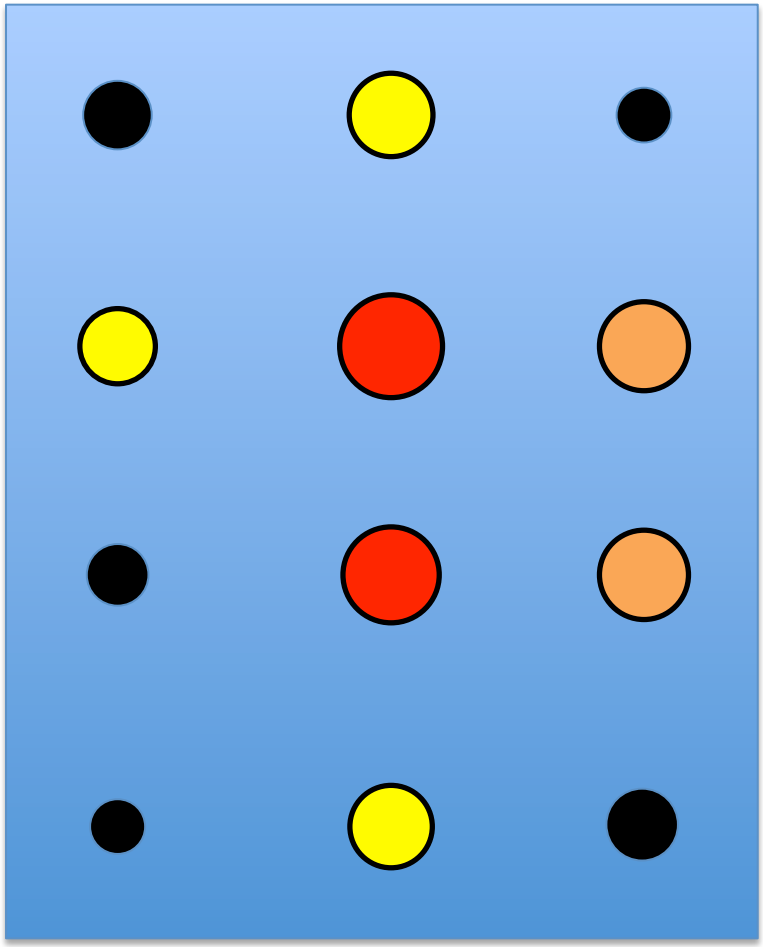


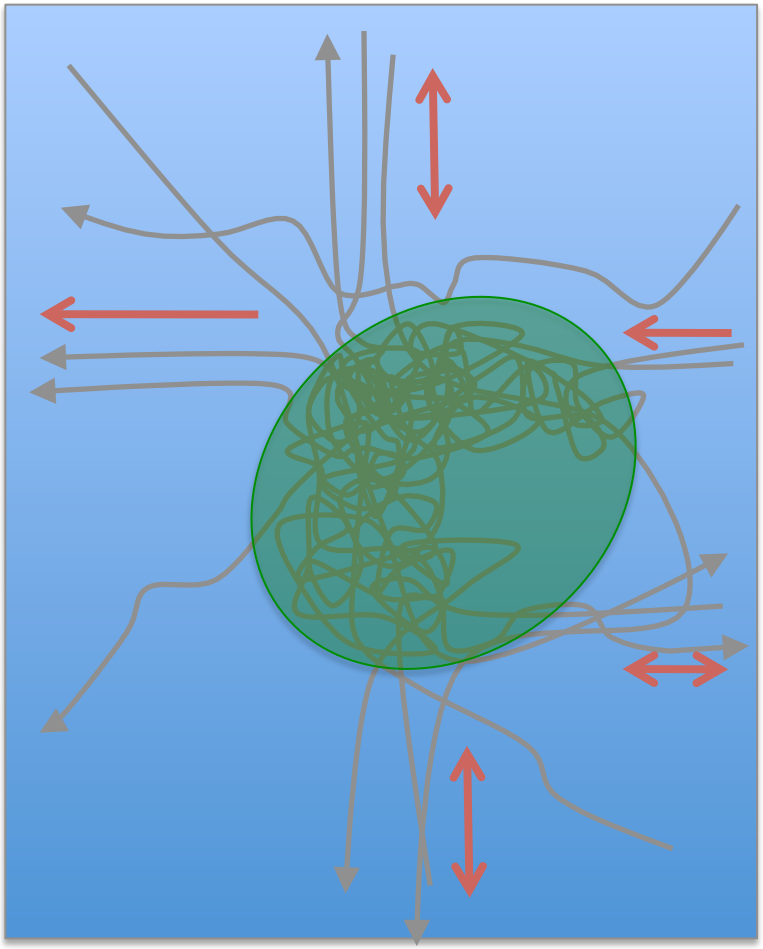
Survey catch or sightings



Tracks

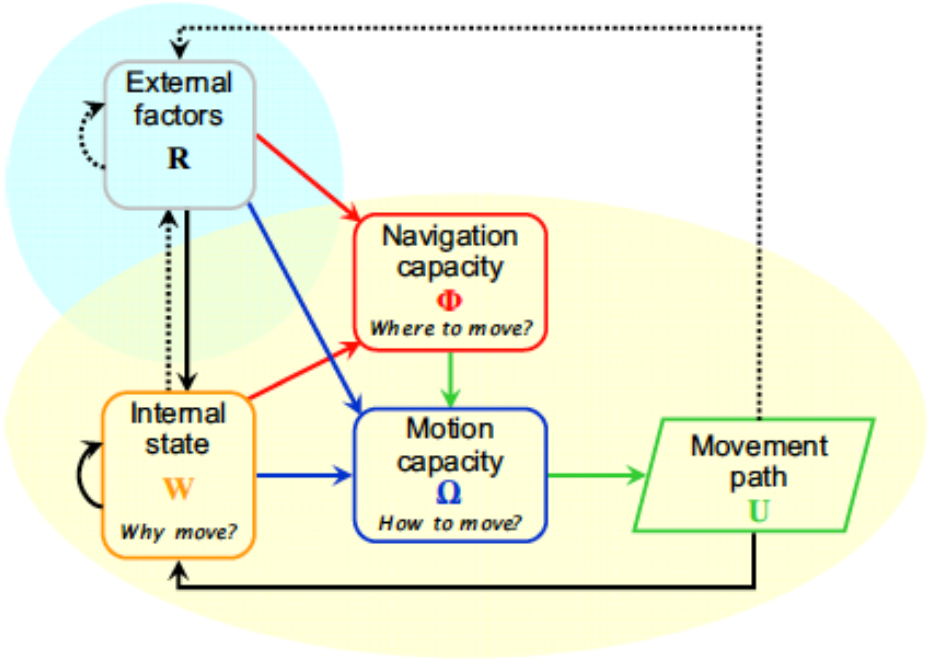
Survey limitations





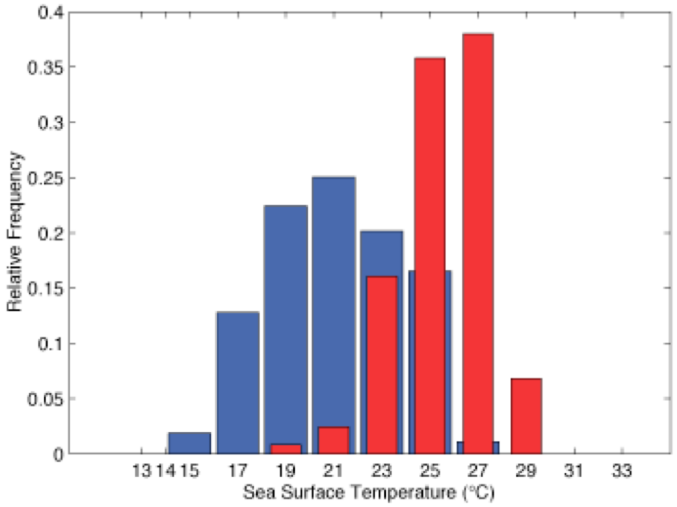
Benefits of movement studies

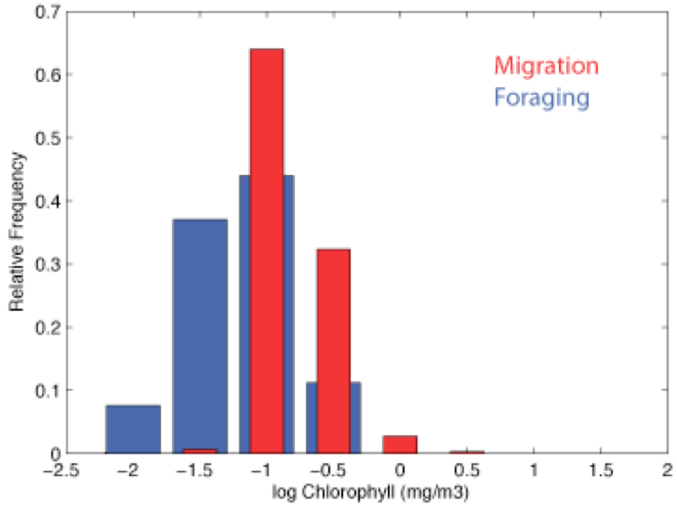
- Focus on individual animals and bridge the gap with population dispersal
- Movement incorporates BOTH spatial and temporal dynamics
- Inferences can be made about behavior and functional habitat use
- Can assess fine-scale responses to events



From Nathan et al. 2008

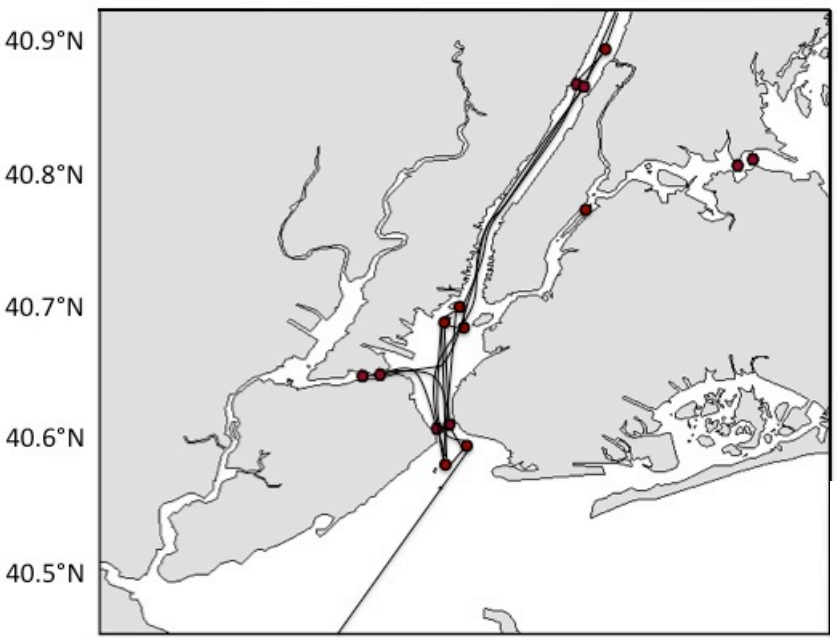
Functional habitat use



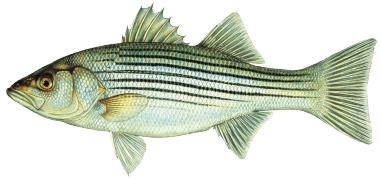


From Shillinger et al. 2011

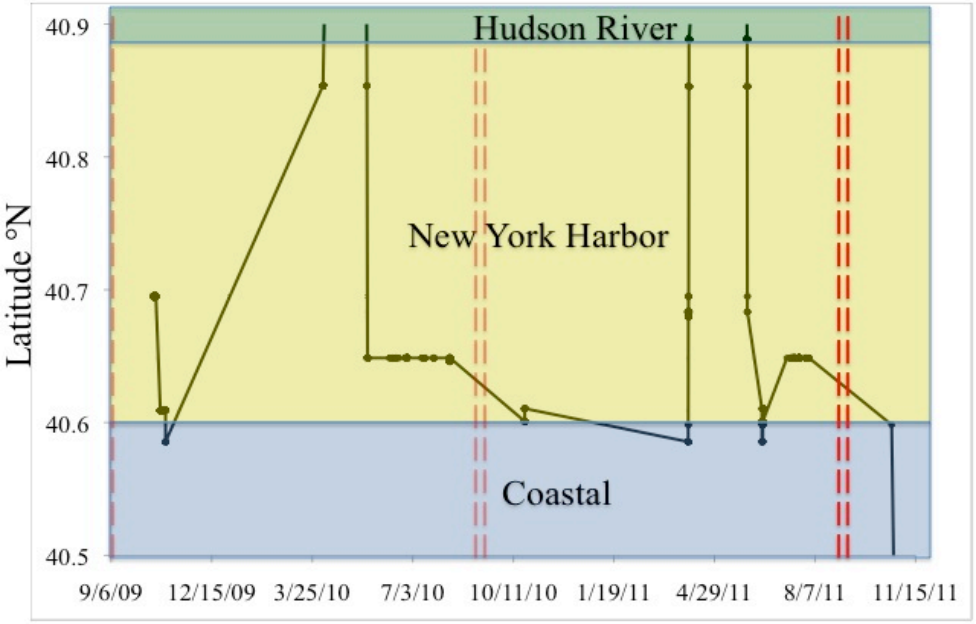
Response to events - Storms



Reconstructing movements from acoustic tag detections.



Do storms cause displacement or other changes in movement behavior?

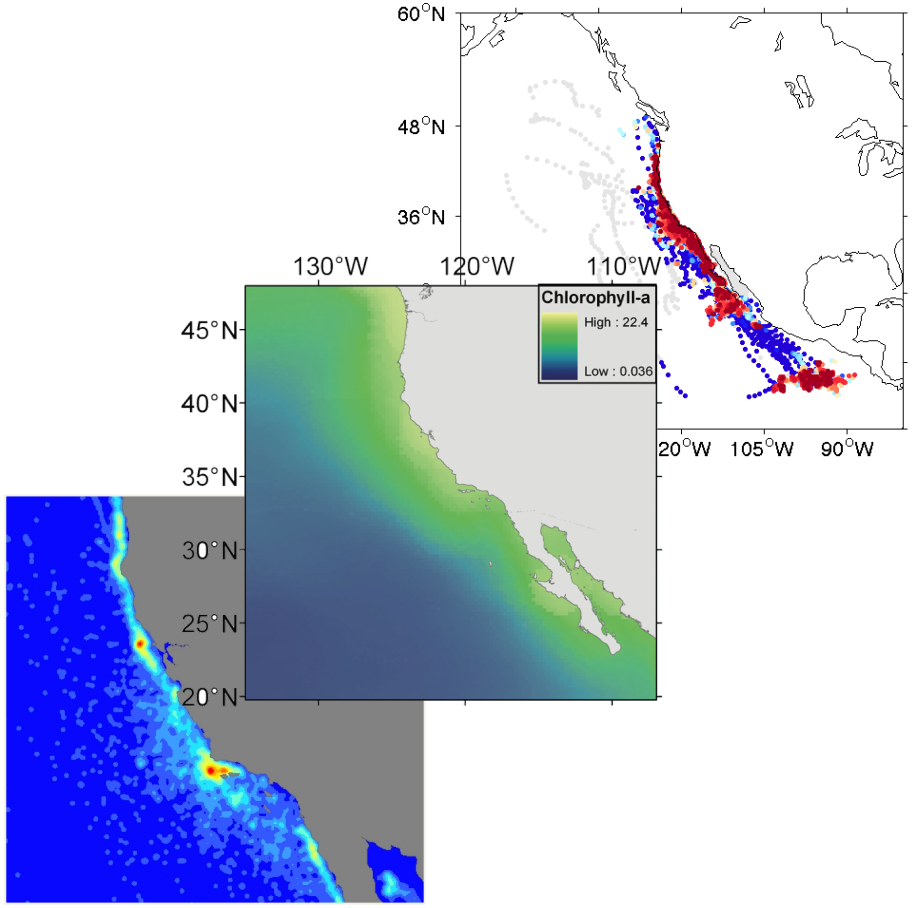


WhaleWatch Goals

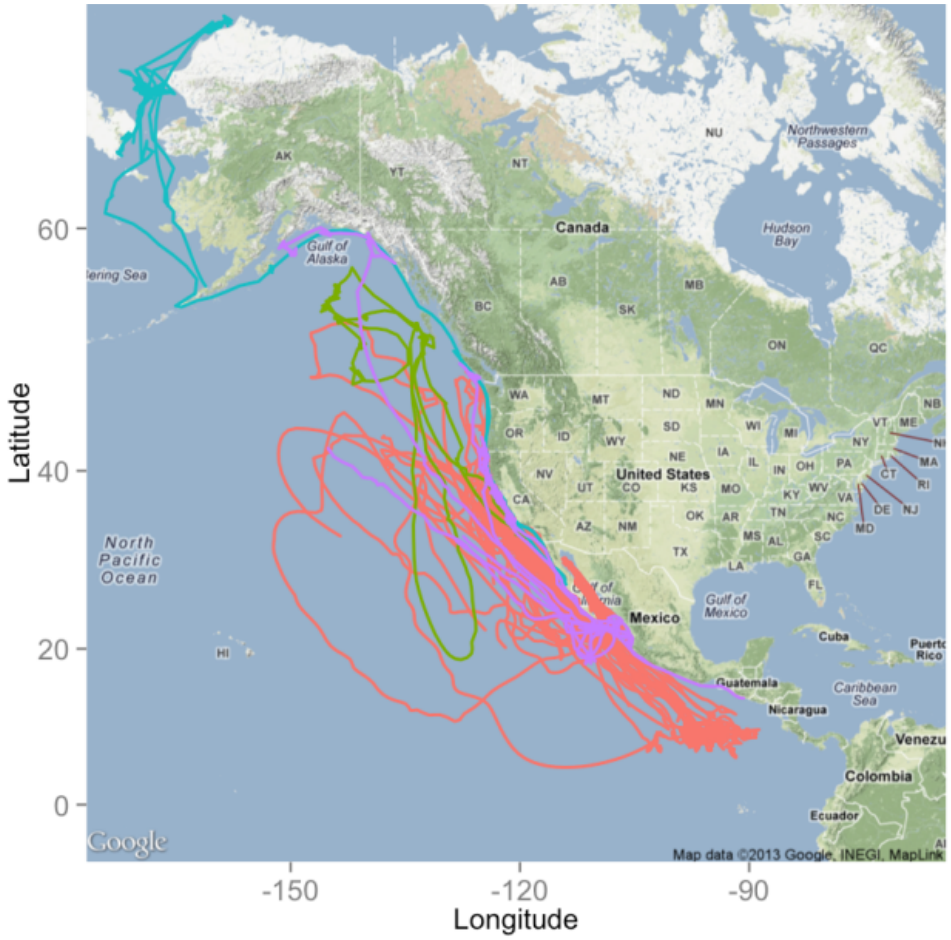
- Use satellite data to develop habitat models that will allow us to identify large whale hotspots and provide a tool for estimating occurrence and behavior in the California Current System. This will assist management efforts to mitigate against human impacts.

Approach

1. Apply a state-space model to provide regularized daily positions from whale satellite telemetry data
2. Identify core area hotspots
3. Develop habitat preference models using remotely sensed environmental data
4. Develop a NOAA website with an automatically updating map predicting whale densities based on the current environmental conditions.

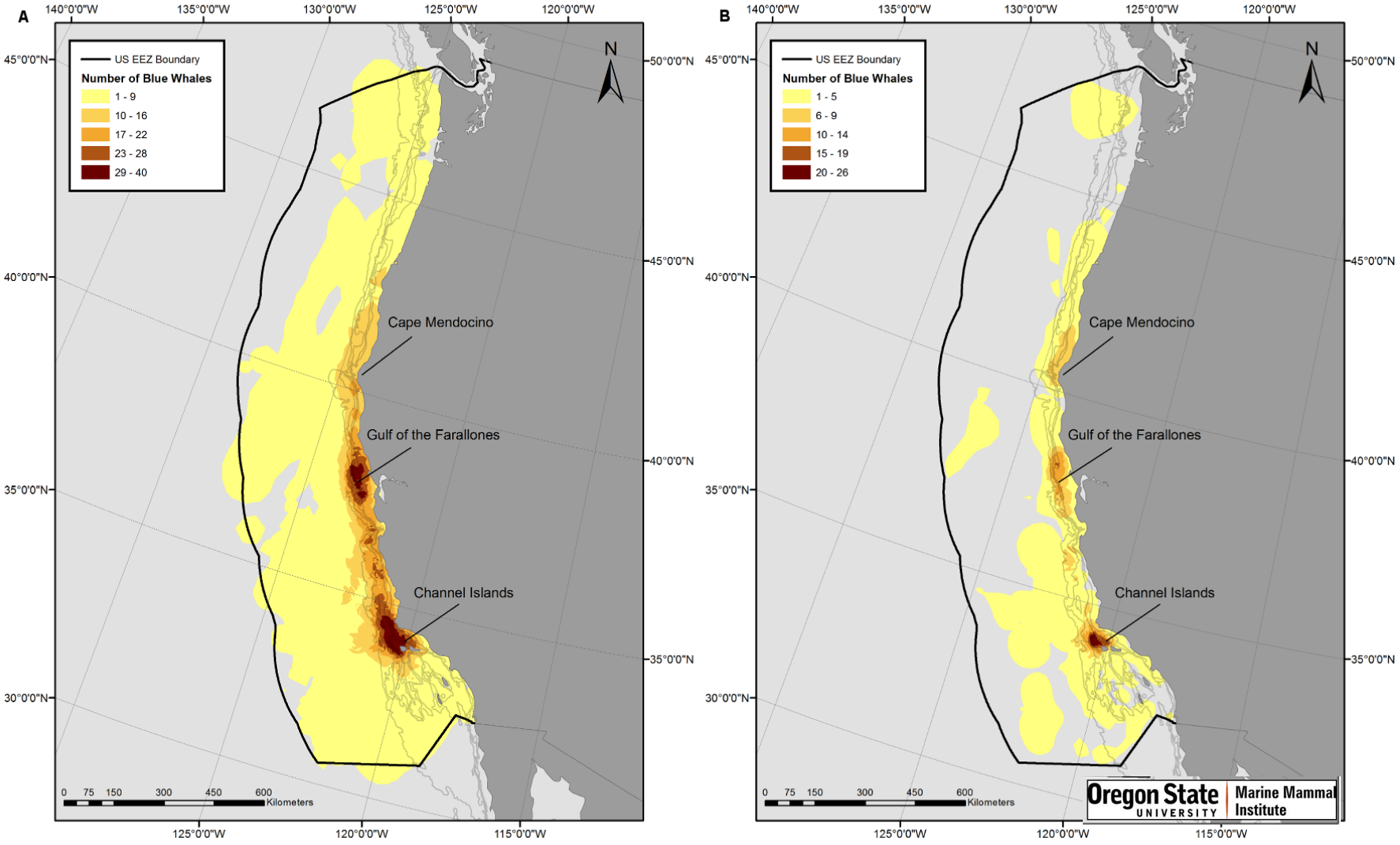


Whale Satellite Telemetry Data



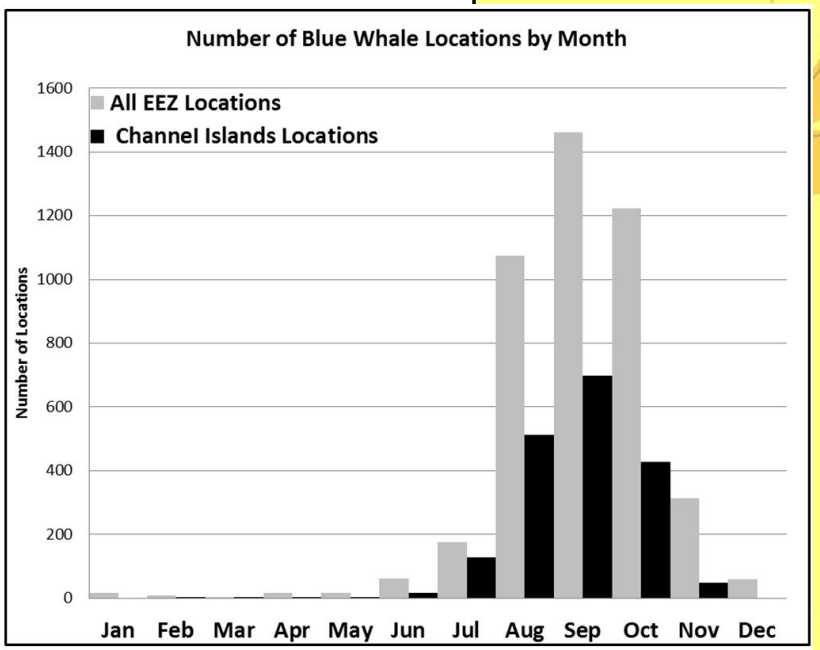
Telemetry data from: Bruce Mate, OSU Marine Mammal Institute

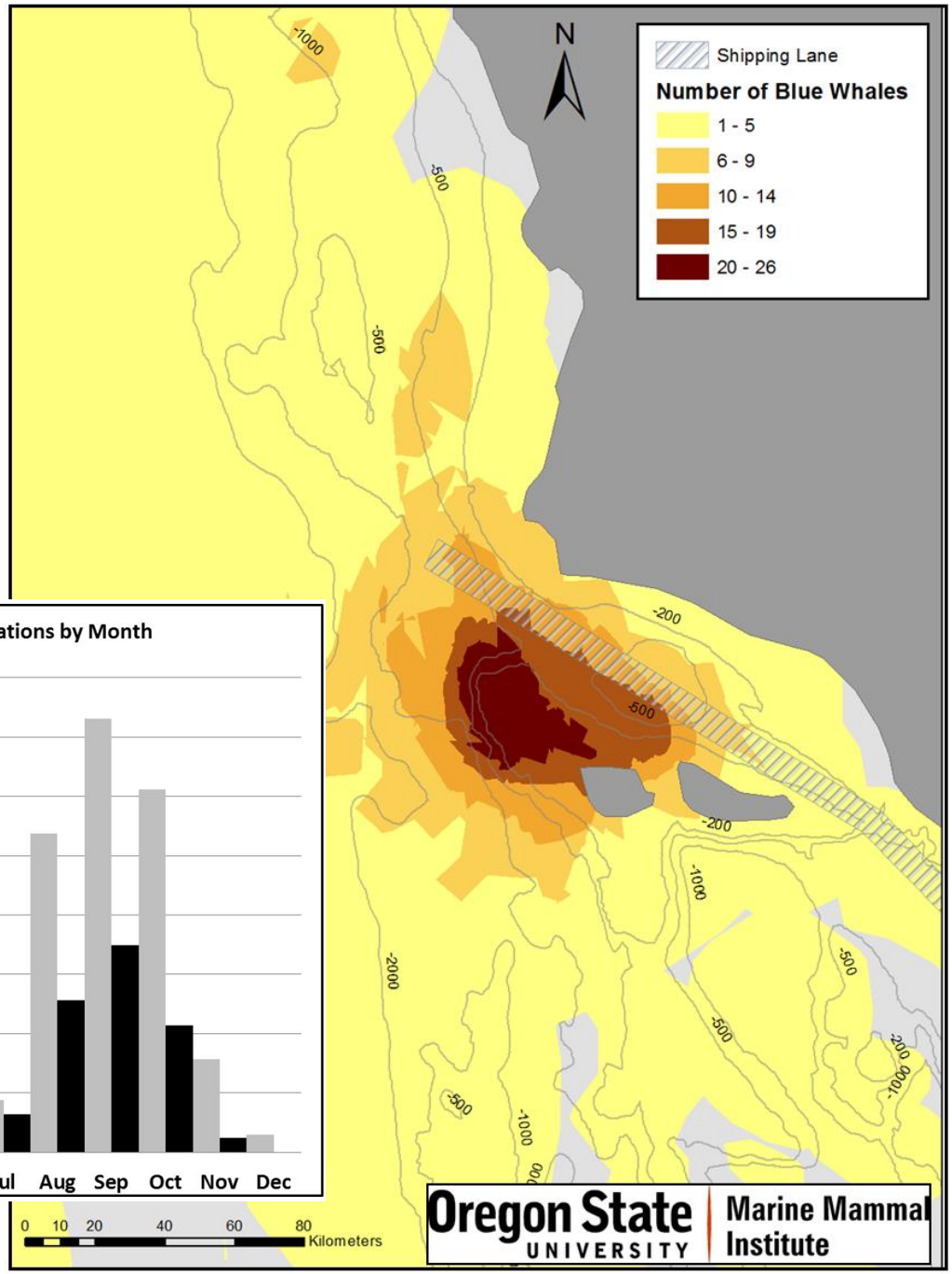
Blue whales



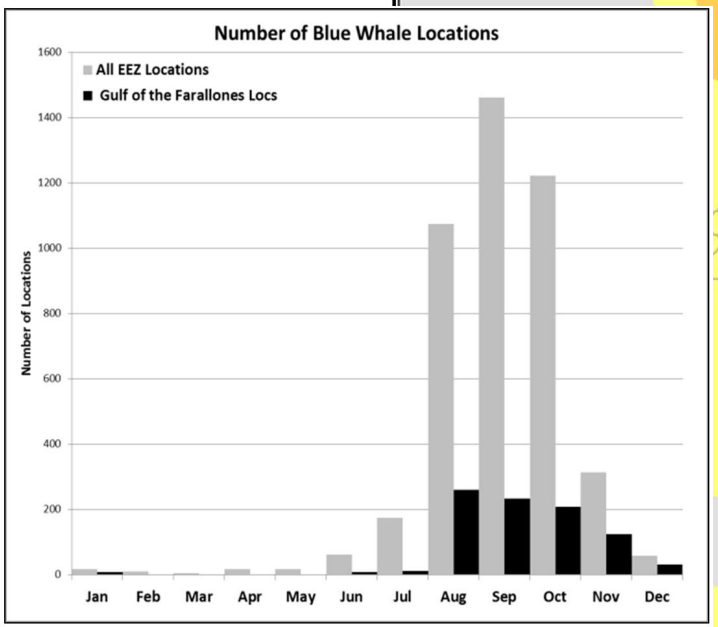
Irvine et al. Submitted

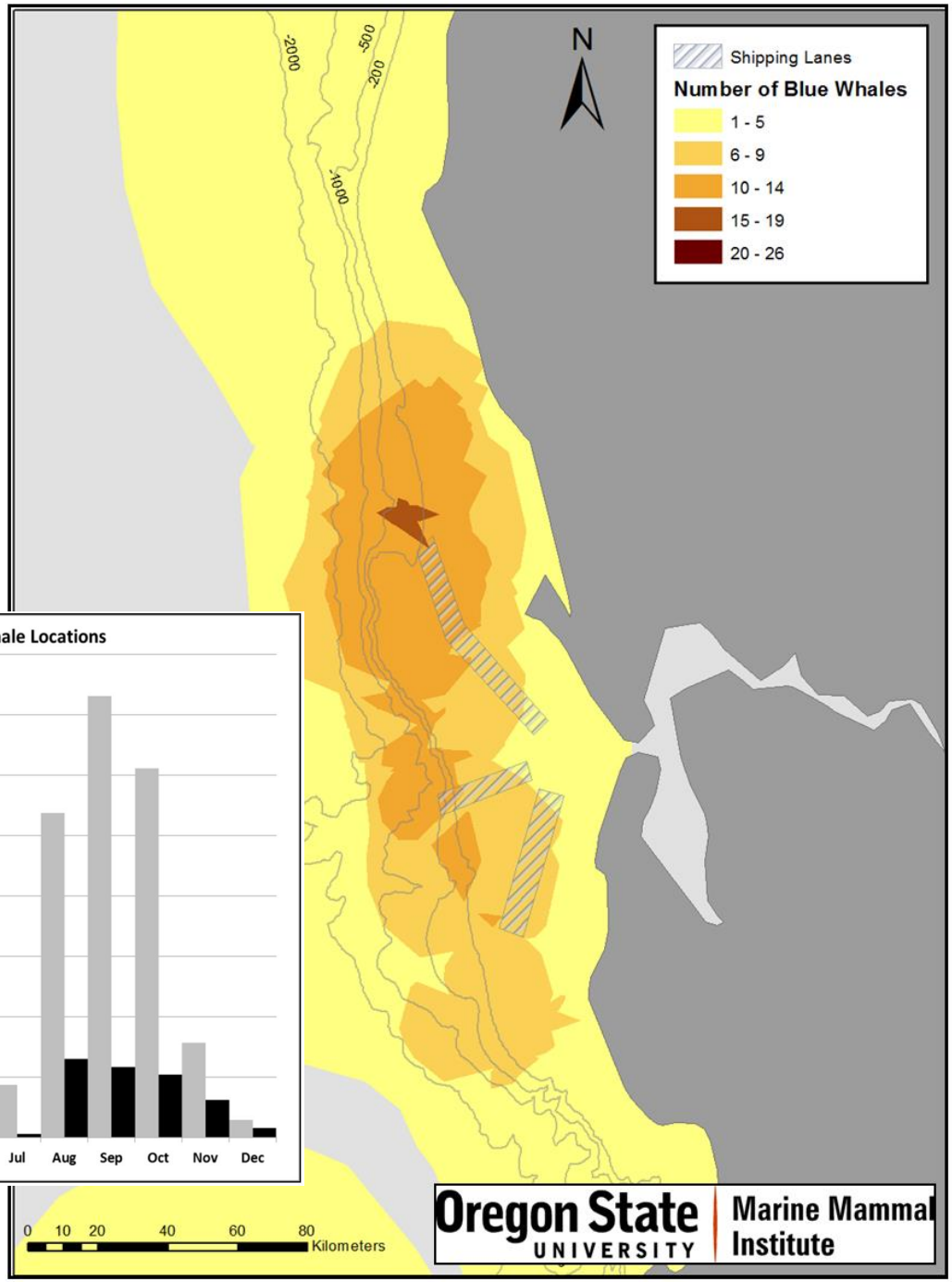
Southern California Bight





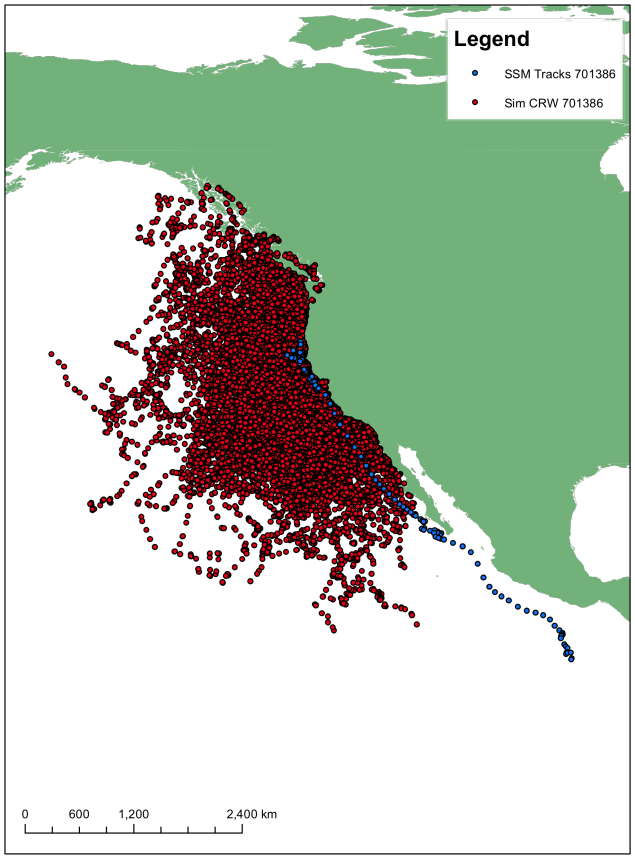
Gulf of the Farallones

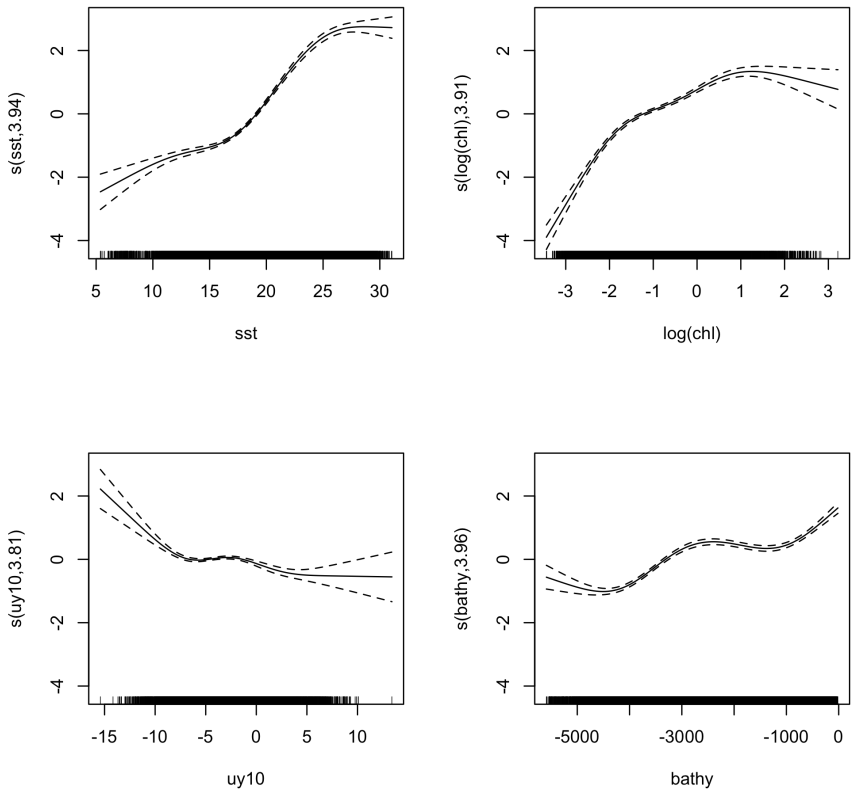




Habitat-based model

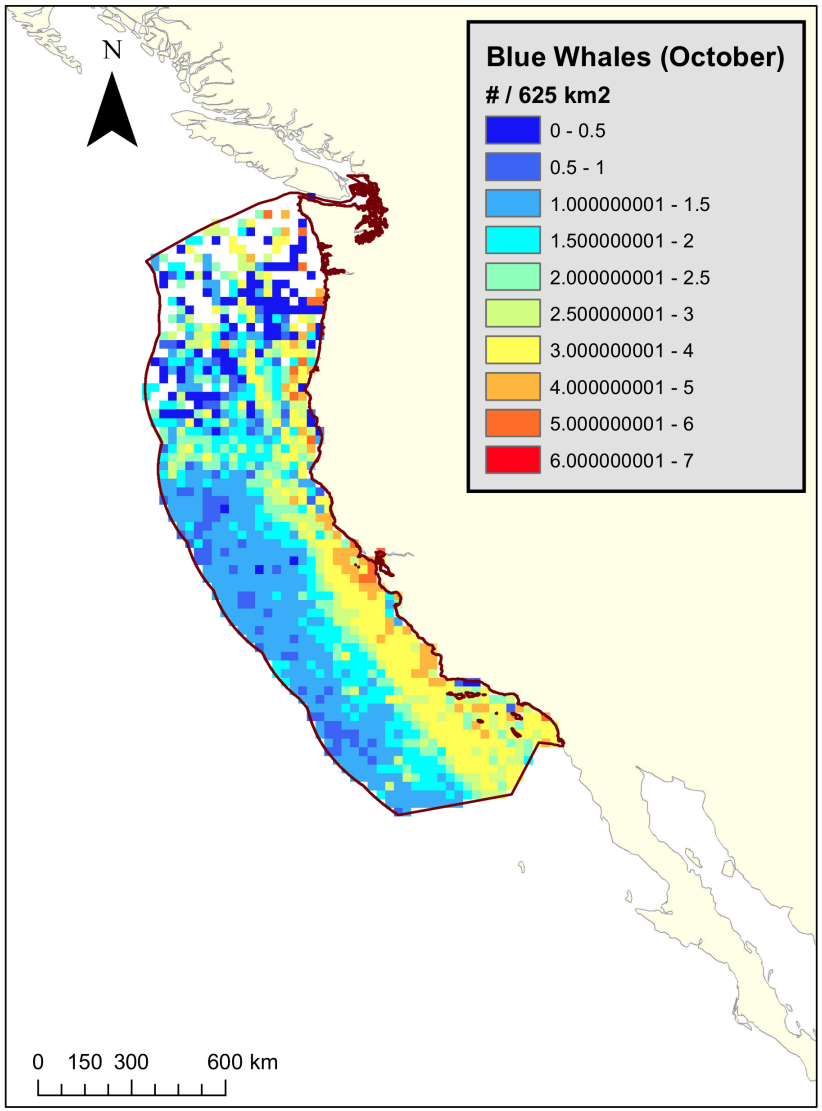
- Generated correlated random walk (CRW) tracks to compare with real whale tracks.
- Fit a generalized additive mixed model (GAMM).

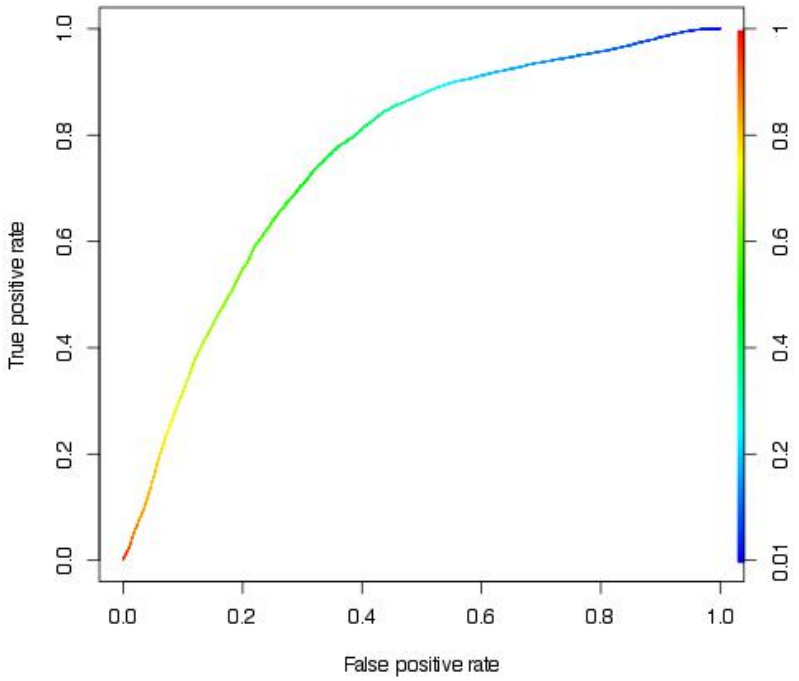




Hazen et al. in prep.

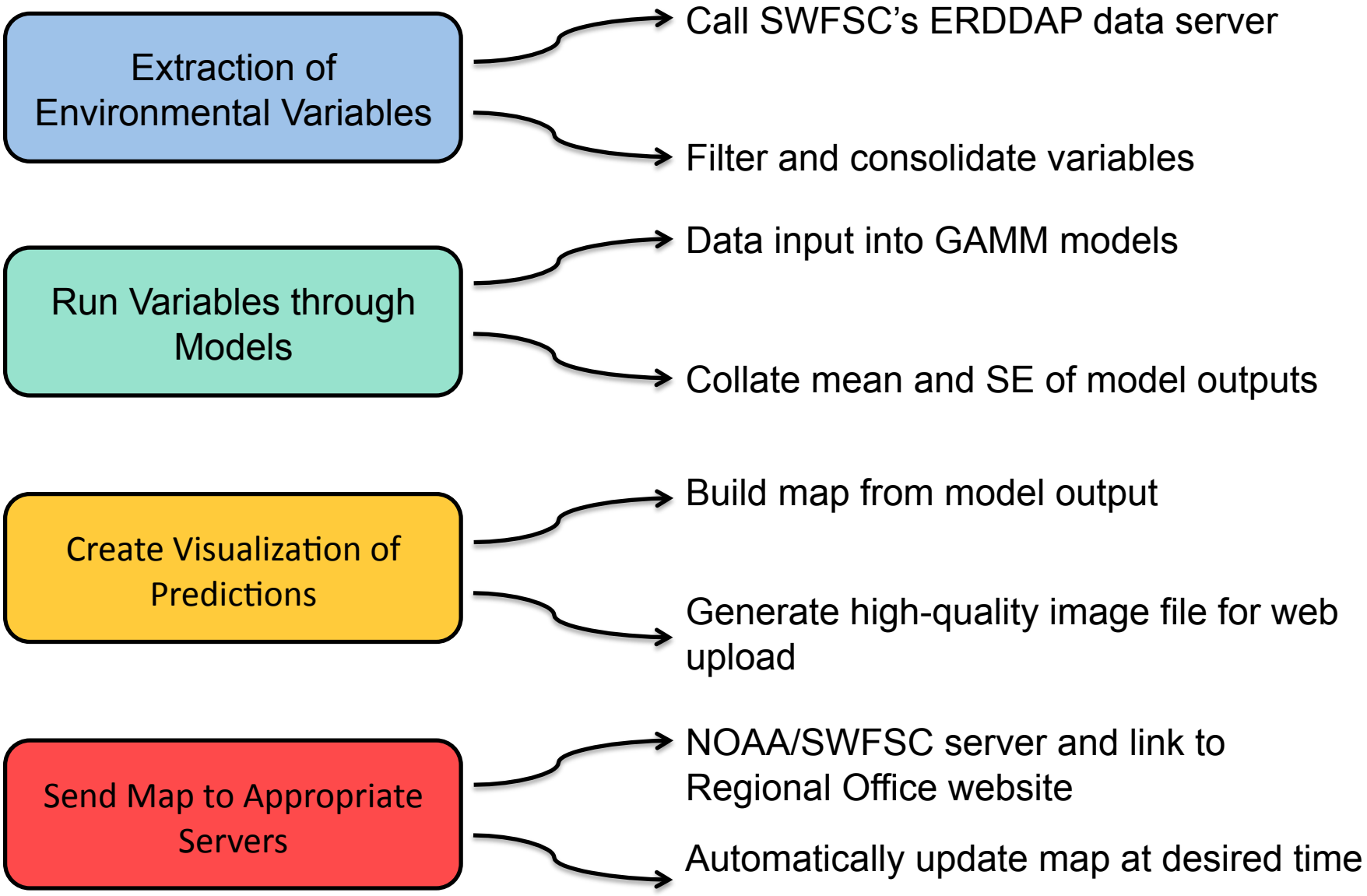
Results



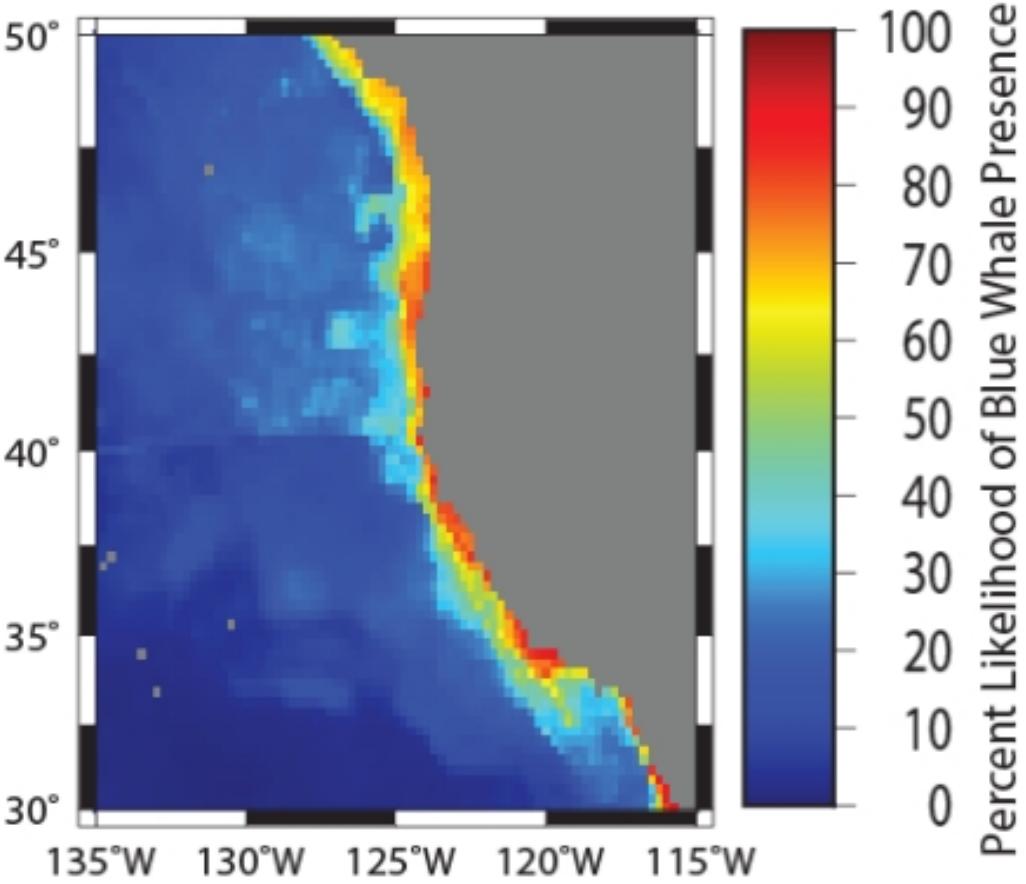


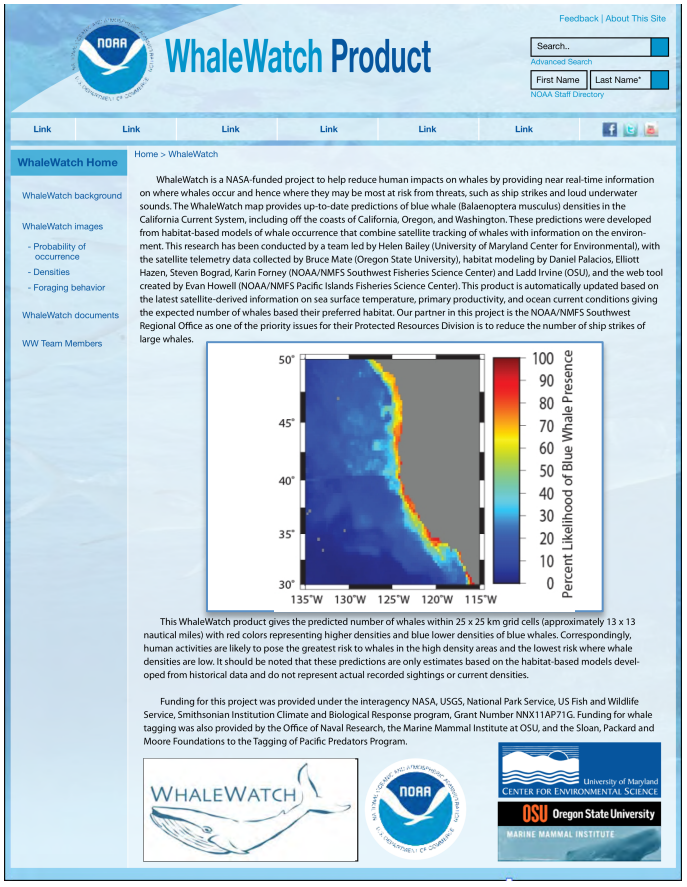
Hazen et al. in prep.

Automated Data Processing

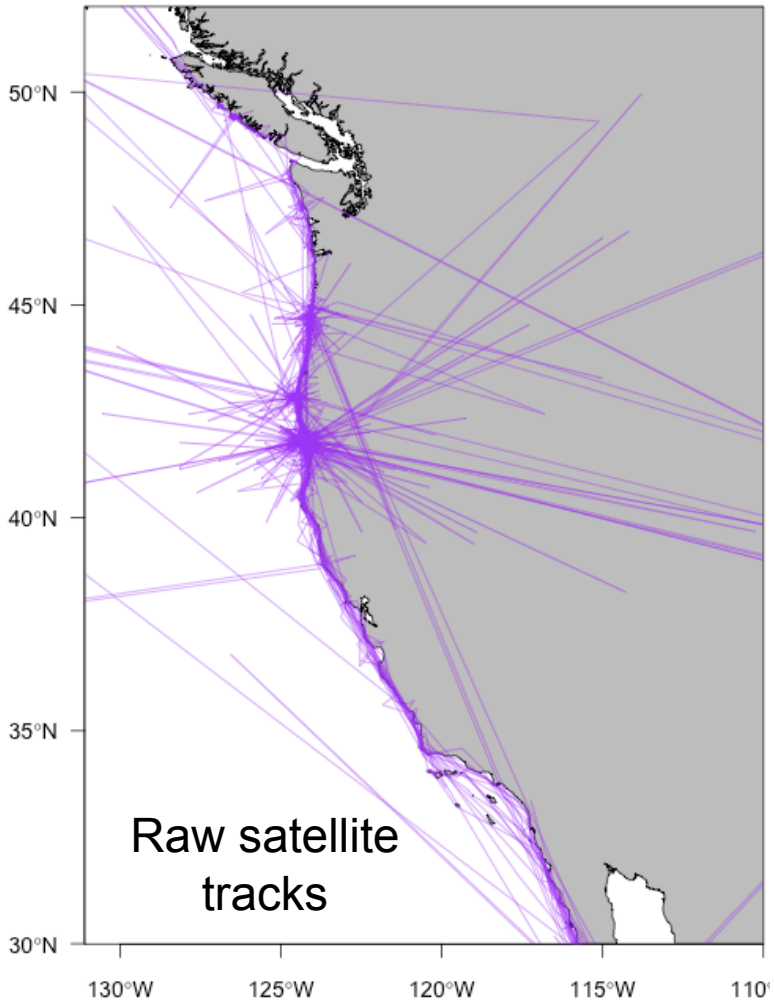


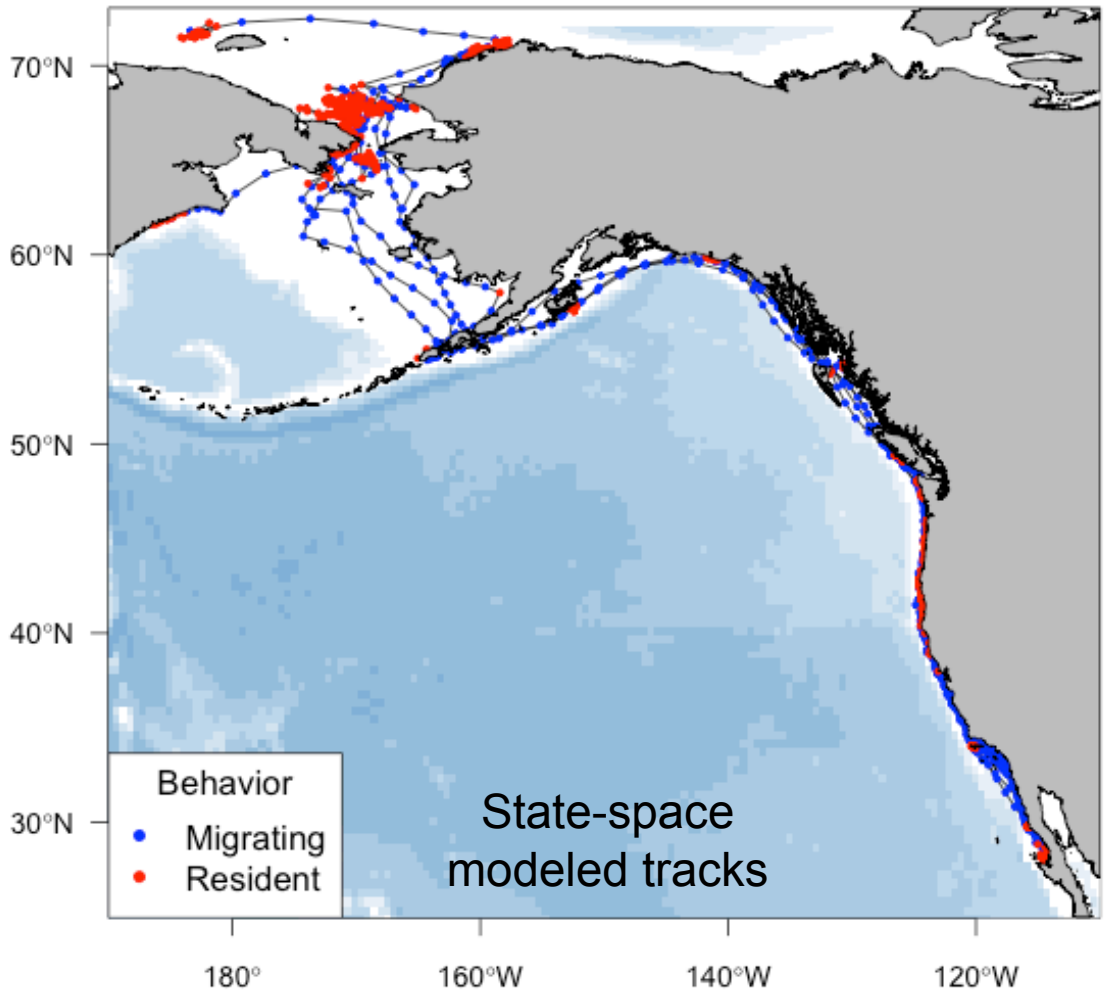
Example predictions



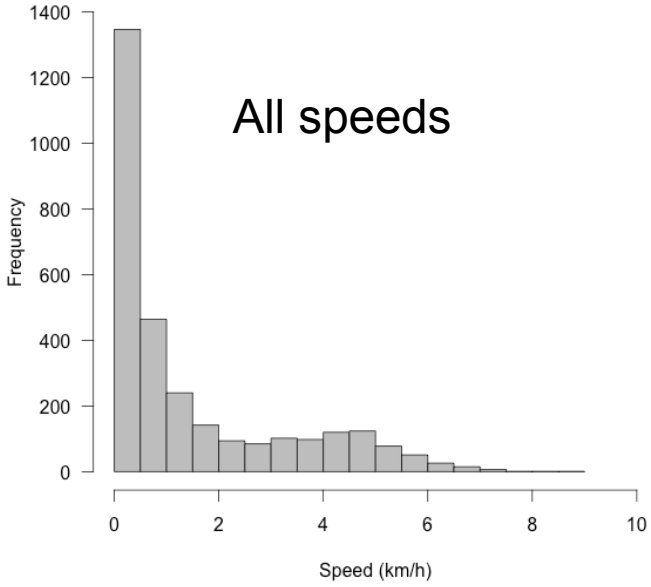


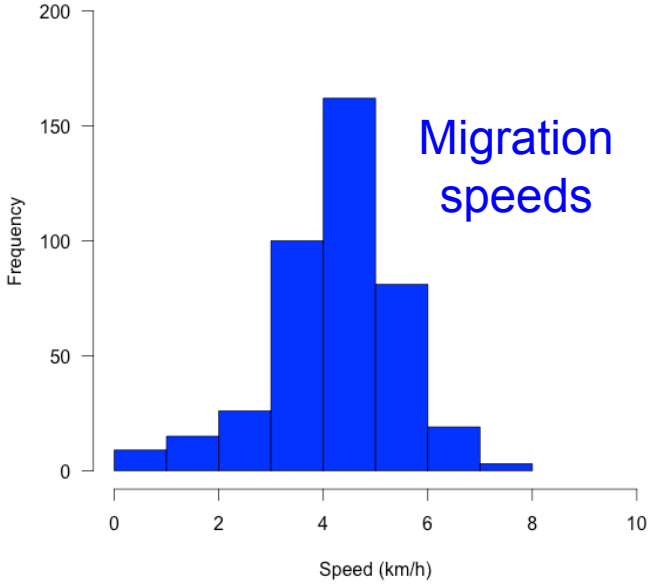
Gray whales

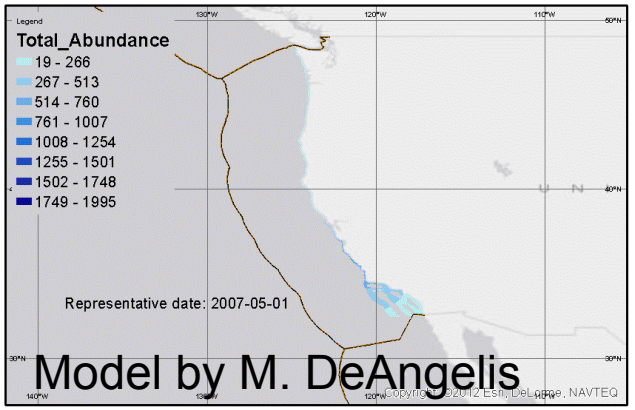

50°N
45°N
40°N
35°N
30°N
130°W
125°W
120°W
115°W
Raw satellite tracks

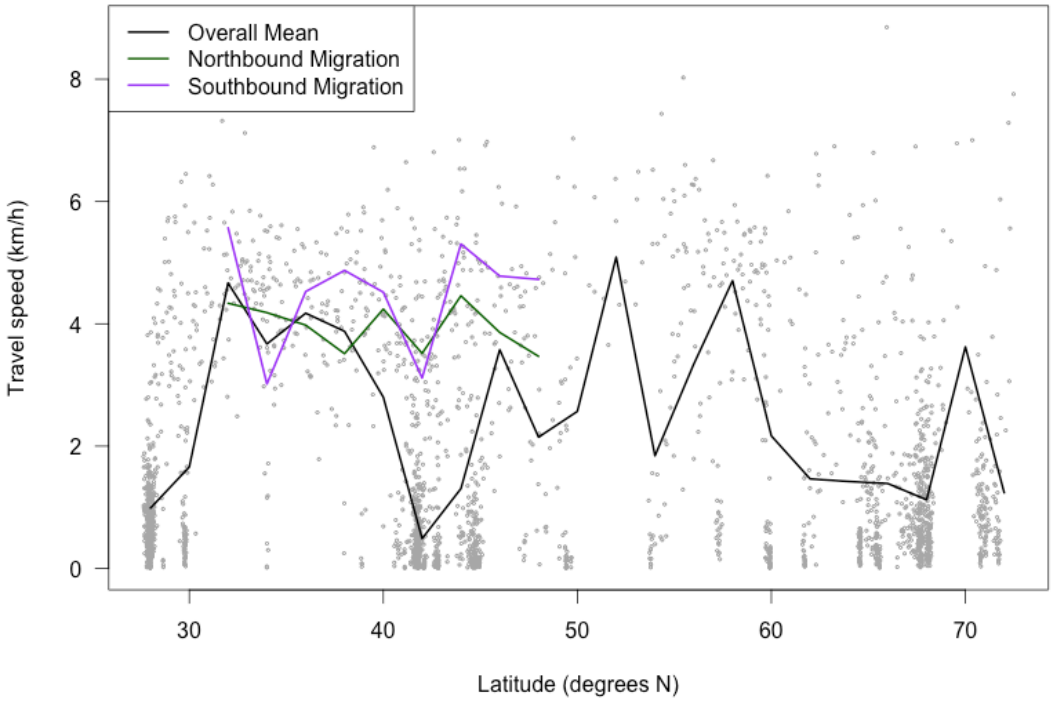

70°N
60°N
50°N
40°N
30°N
180°
160°W
140°W
120°W
Behavior
Migrating
Resident
State-space modeled tracks

Gray whale speeds



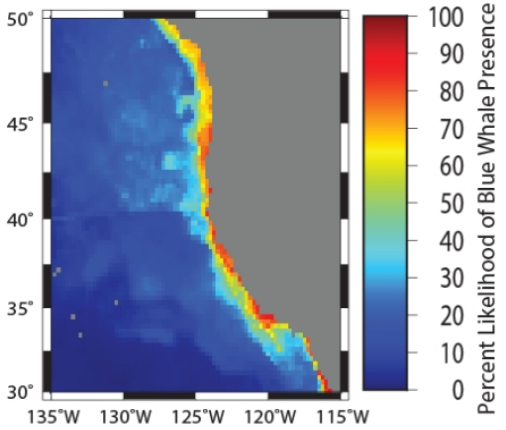


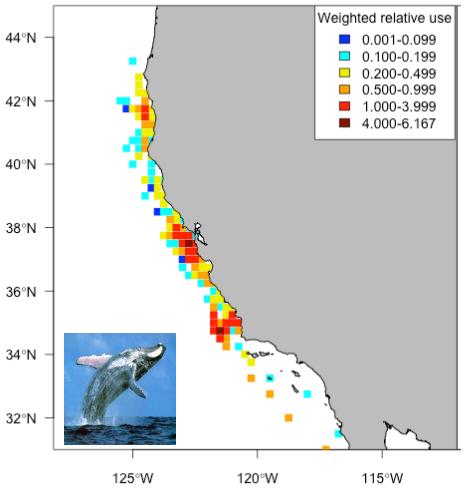




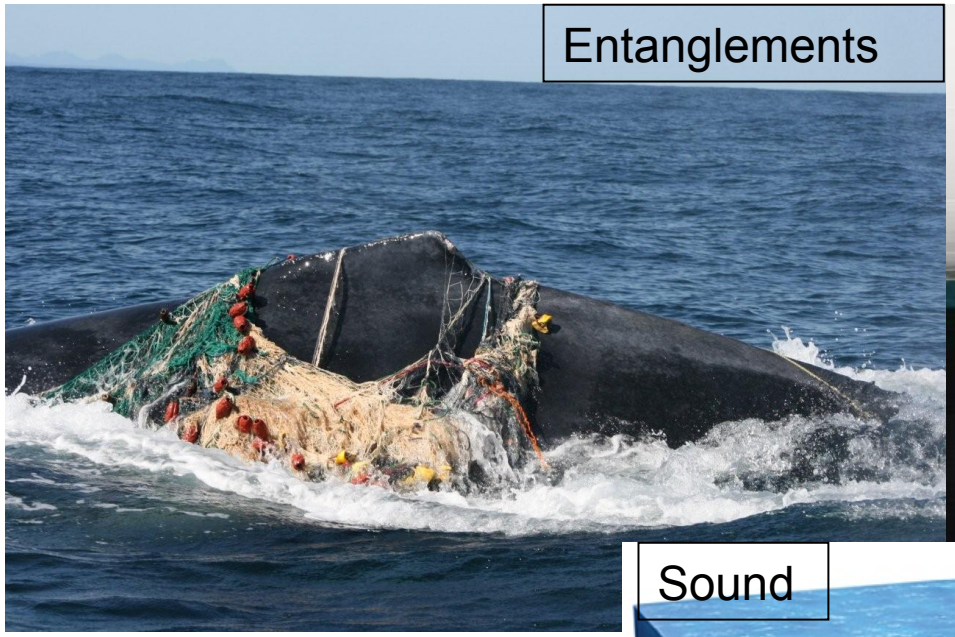
Next steps

- Complete automated processing procedure for development of near real-time tool.
- Transitioning process:
  - Demonstrate tool and website plan to our partner, Monica DeAngelis at NOAA West Coast Regional Office.
  - Use NOAA/SWFSC server to host tool and establish publicly accessible website through NOAA Regional Office.
- Complete analysis for humpback whales and synthesis information for all 4 whale species.

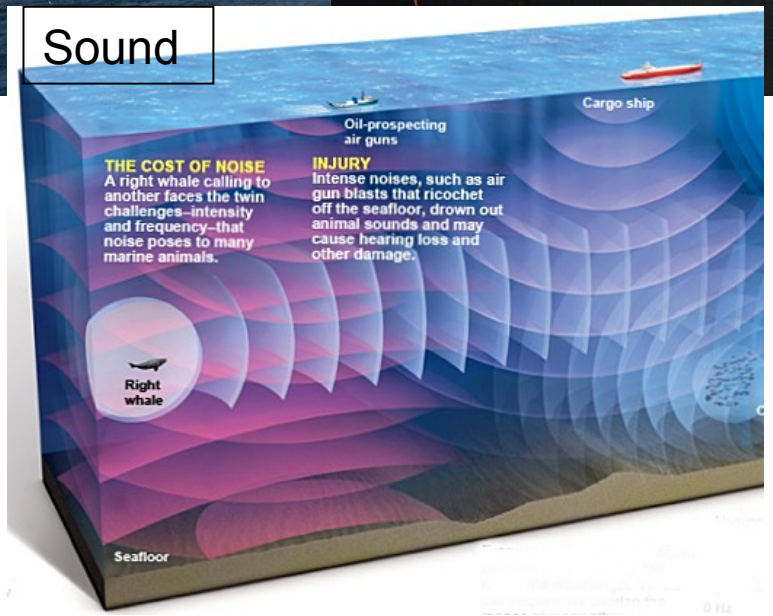




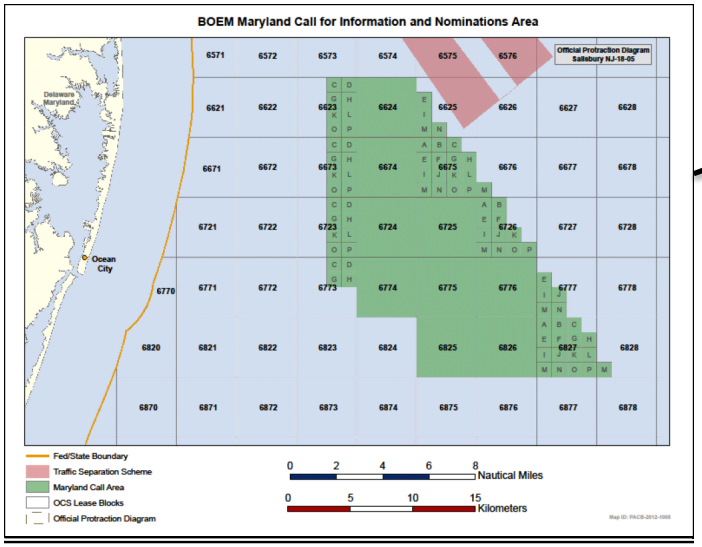
Threats


Entanglements

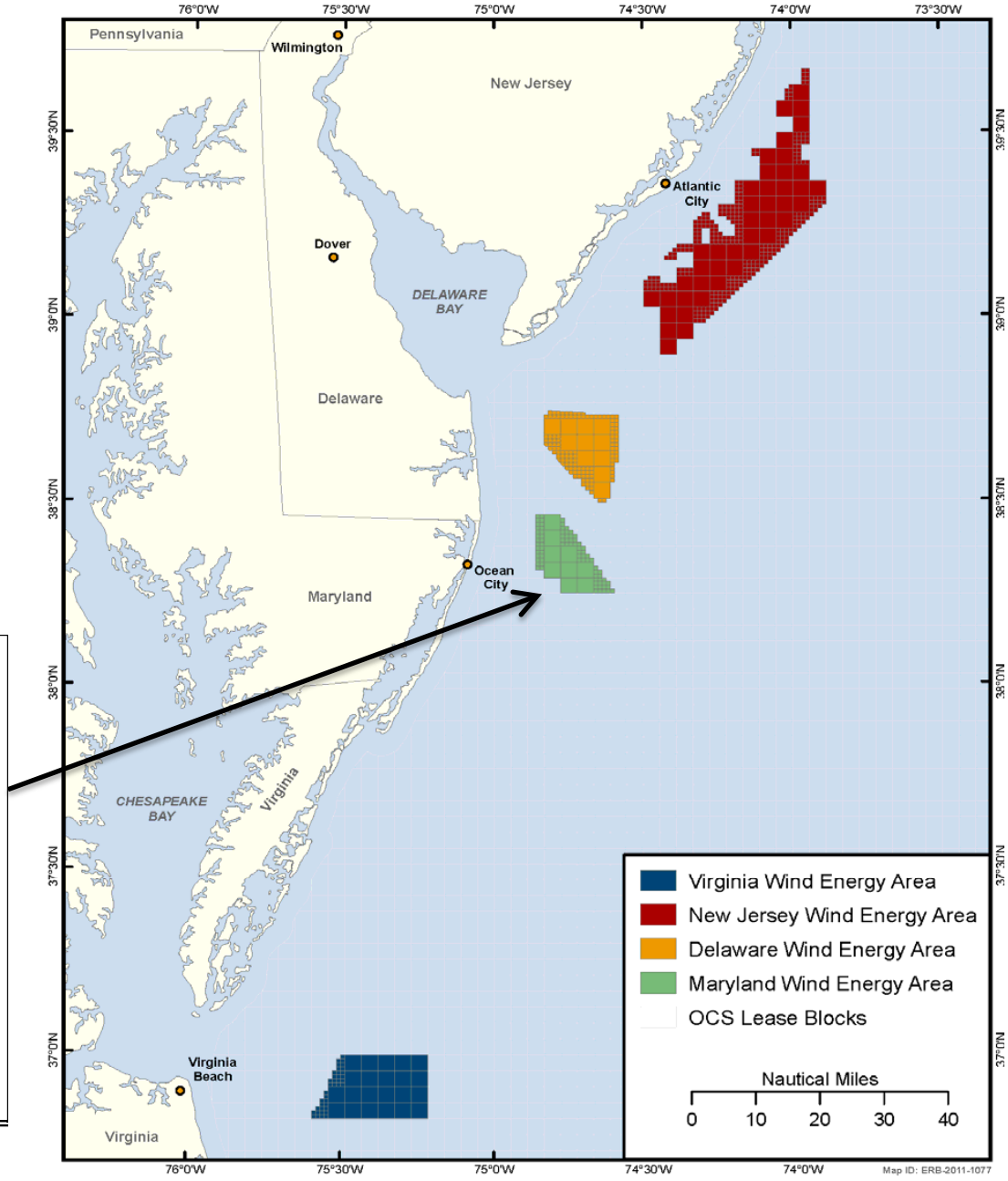

Ship strikes


Sound
Cargo ship
Oil-prospecting air guns
THE COST OF NOISE
A right whale calling to another faces the twin challenges–intensity and frequency–that noise poses to many marine animals.
INJURY
Intense noises, such as air gun blasts that ricochet off the seafloor, drown out animal sounds and may cause hearing loss and other damage.
Right whale
Seafloor

Offshore development - wind energy areas

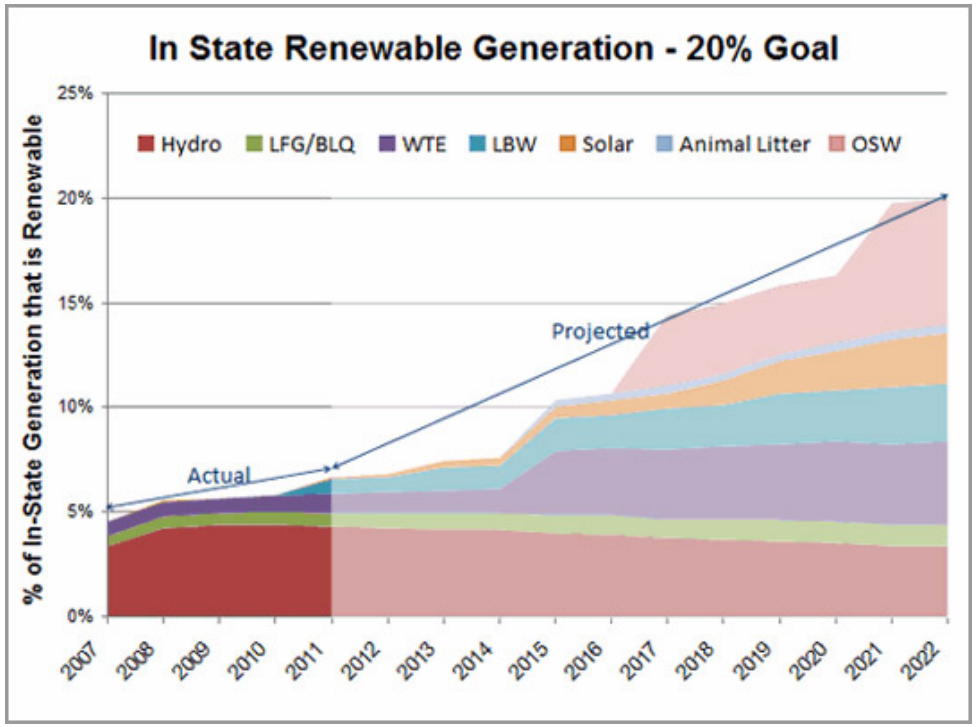


Maryland's "Wind Energy Area"



Renewable Energy Targets

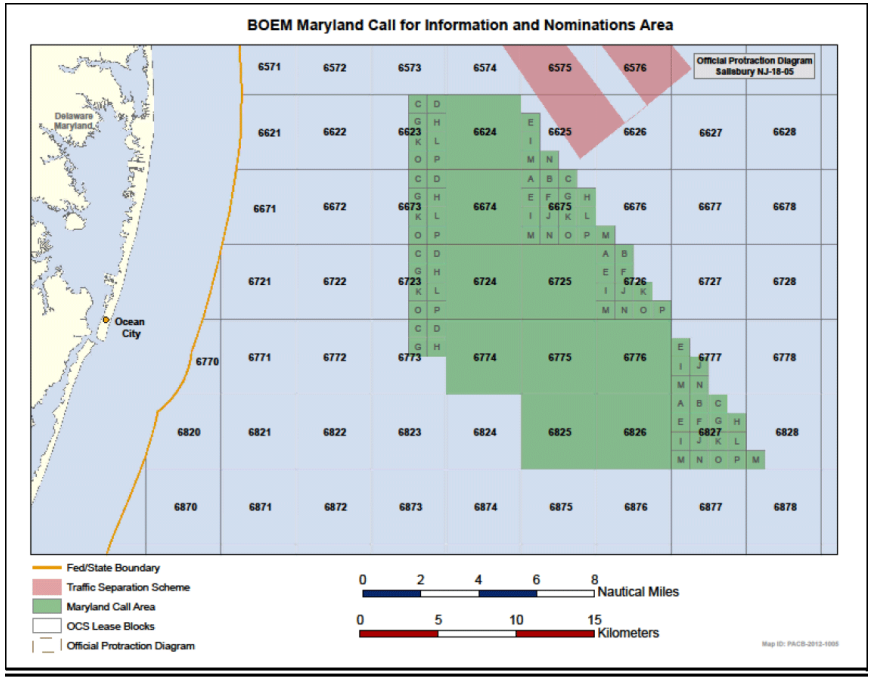
- Maryland committed to getting 20% of the State's electricity from renewable sources by 2022. Currently at about 6% (~700 MW).
- Land-based renewables (e.g. solar, wind) will only meet 36% of the goal and offshore wind can help fill the gap.



http://www.dnr.state.md.us/ccs/coastal_resources/oceanplanning/

Renewable Energy Targets

- An area 10-23 miles off the coast identified as suitable for offshore wind turbines.
- A 500 MW project would power more than half of the homes in Baltimore City.

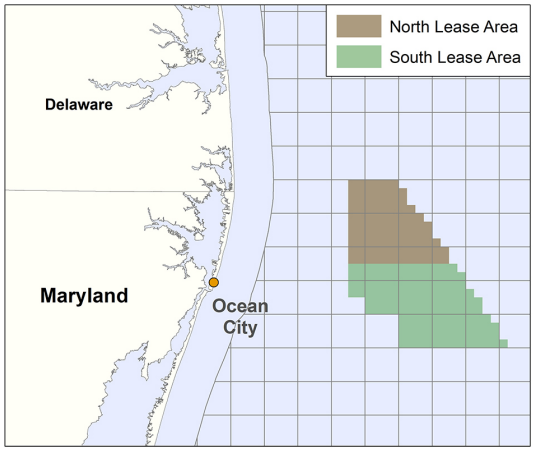


Maryland's "Wind Energy Area"

http://www.governor.maryland.gov/wind.asp

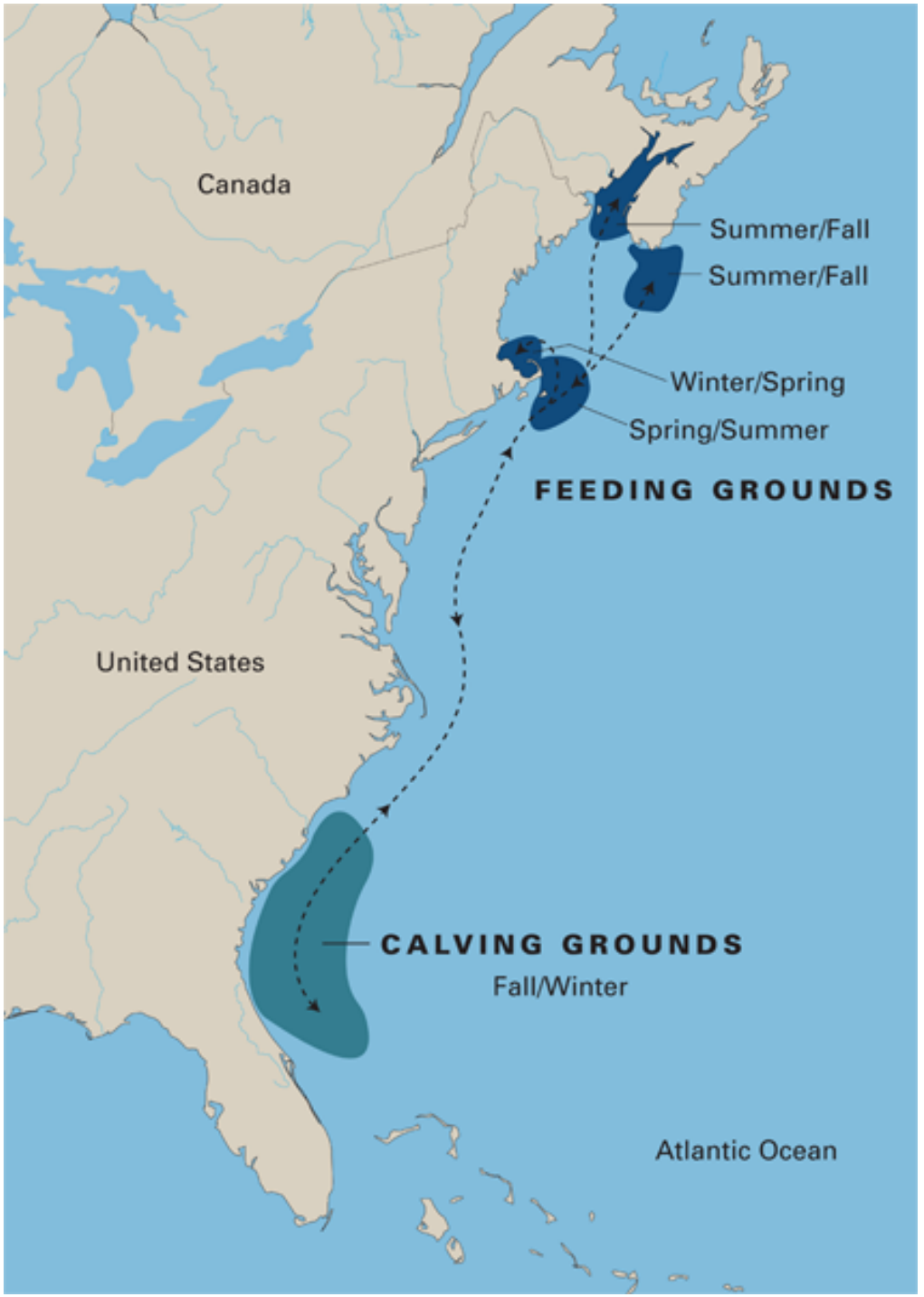
Offshore Wind Energy Act

- The Maryland Offshore Wind Energy Act passed in March 2013.
- Provides $1.7 billion in subsidies over next 20 years for Maryland offshore wind development.
- A target project of 200 MW would require the installation of about 40 turbines off the coast of Ocean City.

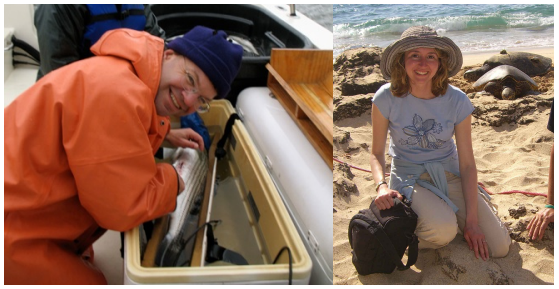


Baseline Environmental Data

Example: Right whales



Conclusions



- Movement patterns can be used to identify hotspots, migratory routes and habitat use of aquatic species.
- Effective method for quantifying long-term, broad and fine-scale movements.
- Ability to infer behavior and essential habitat.
- Identify responses to events, changes in the environment, and human developments.
- Important implications for management.

Acknowledgements

- Thanks to everyone at CBL and UMCES for their advice and support.
- Funding for WhaleWatch was provided under the interagency NASA, USGS, National Park Service, US Fish and Wildlife Service, Smithsonian Institution Climate and Biological Response program, Grant Number NNX11AP71G.
- The support of field crews was essential to the success of the whale tagging operations. Tagging was supported by private donors to the MMI Endowment at OSU, as well as the support from ONR and the Sloan, Packard and Moore foundations to the TOPP program.

Thank you!

E-mail: **hbailey@umces.edu**

Web: **www.umces.edu/cbl/faculty/hbailey**

UMCES Offshore Wind Group:

http://www.umces.edu/cbl/wind