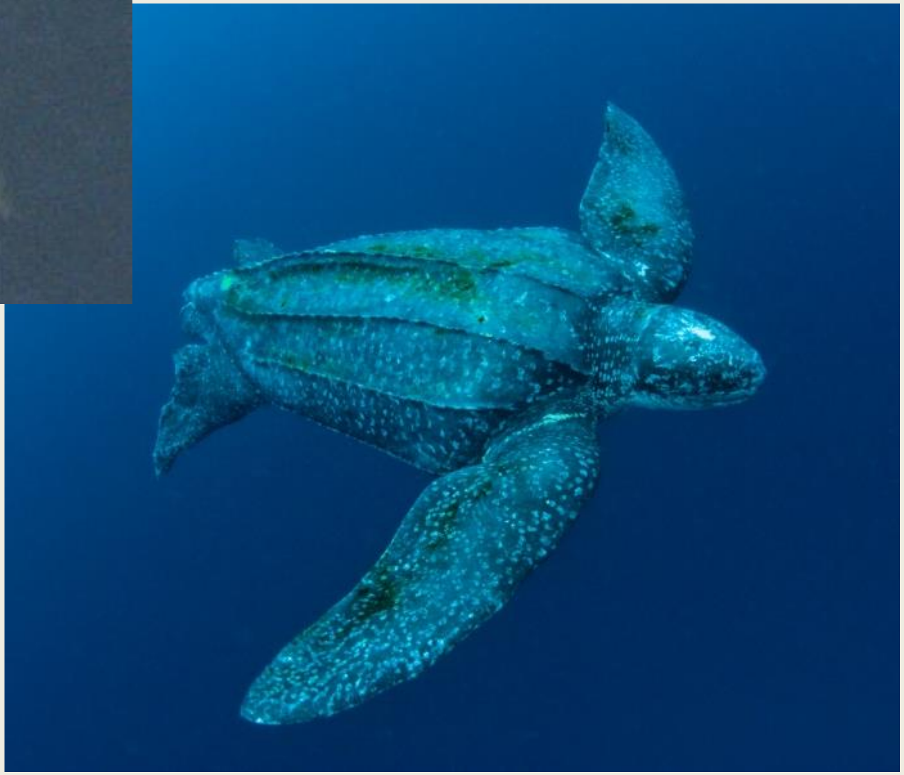
Wildlife distributions and habitat use on the mid-Atlantic Outer Continental Shelf



Kate Williams

Biodiversity Research Institute

17 November 2015

BIODIVERSITY RESEARCH INSTITUTE

K. Williams, I. Stenhouse, E. Connelly, S. Johnson, E. Adams, C. DeSorbo, M. Duron, A. Gilbert, C. Gray, D. Meattey, L. Savoy

B. Gardner, H. Goyert, N. Hostetter, R. Sollmann

R. Veit

D. Johnston, L. Pallin

A. Friedlaender

Funding Organizations:

U.S. Dept. of Energy WWPTO

Maryland Dept. of Natural Resources

Maryland Energy Administration

Other sources

Bureau of Ocean Energy Management

U.S. Fish and Wildlife Service

Sea Duck Joint Venture

The Bailey Wildlife Foundation

Collaborators:

HiDef Aerial Surveying, Inc.

Capt. Brian Patteson, Inc.

University of Oklahoma

USGS Patuxent Wildlife Research Center

Memorial University of Newfoundland

Canadian Wildlife Service

VA Dept of Game and Fisheries

DE Division of Fish and Wildlife

RI Division of Fish and Wildlife

University of Rhode Island

NC Wildlife Resource Commission

Background: Offshore wind & wildlife

- Positive impact on a global scale
  - Reduced carbon emissions
- Mostly negative effects on a local scale (?)
  - Mortality or injury
  - Displacement / attraction
  - Changes to habitat or prey
- Degree of effects on wildlife will vary
  - Scale of buildout, taxa that are exposed, local topography, etc.

Fox et al. 2006, Langston 2013, Petersen et al. 2006

Inform offshore wind development

- Provide baseline ecological data and analyses
  - Wildlife distribution patterns
  - Understand causes of these patterns
  - Movements (site fidelity, population connectivity)
- Develop technological resources for future monitoring and assessments

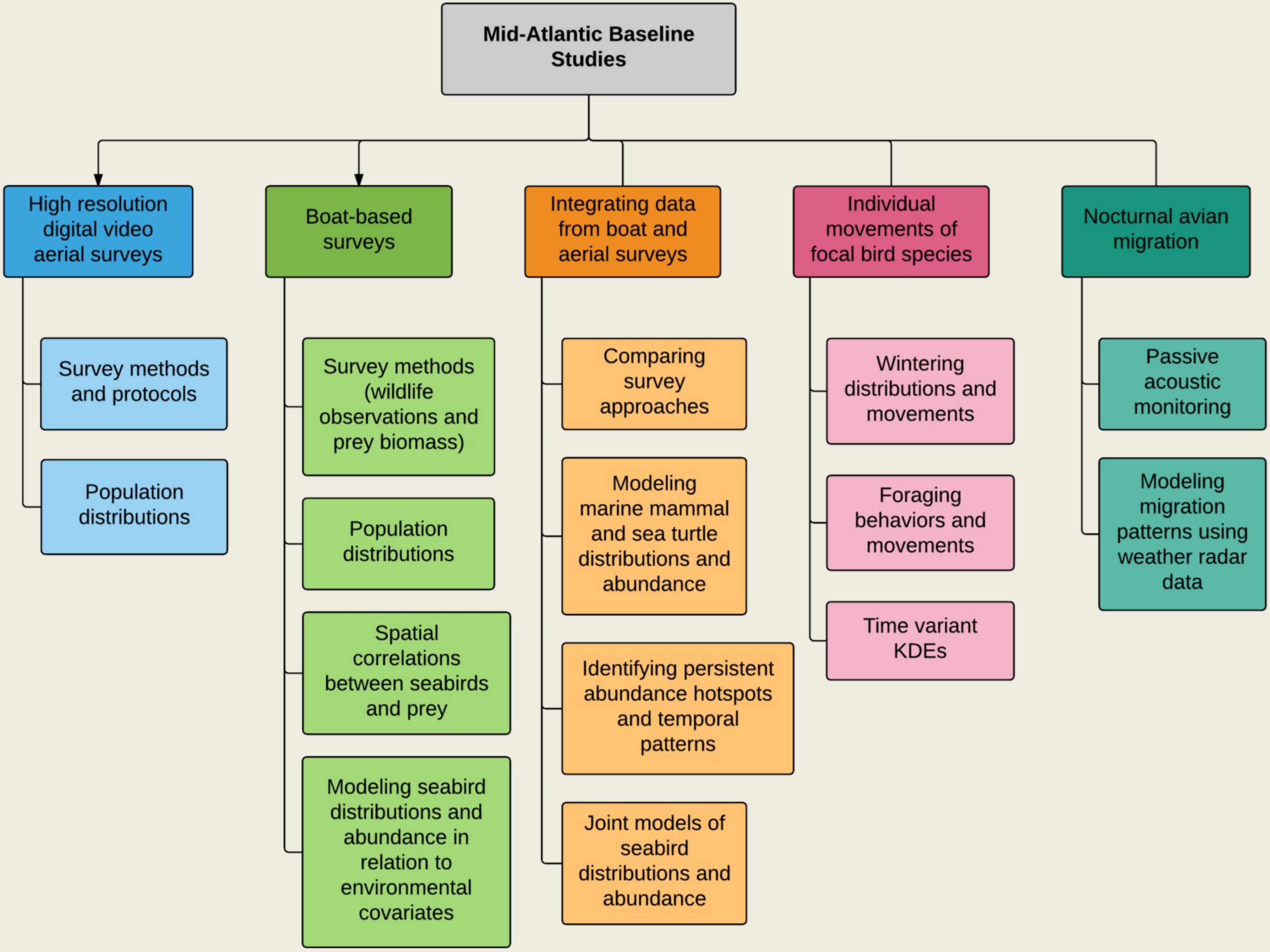
bri

Photo courtesy Nysted HavmØllepark

What makes this study important?

- 2+ years of baseline data for wind energy stakeholders
- Use of new technologies and approaches
- Scale of the study
  - Study area, # species observed, mix of tech
- Improved understanding of species composition and use →→ more sustainable offshore wind development

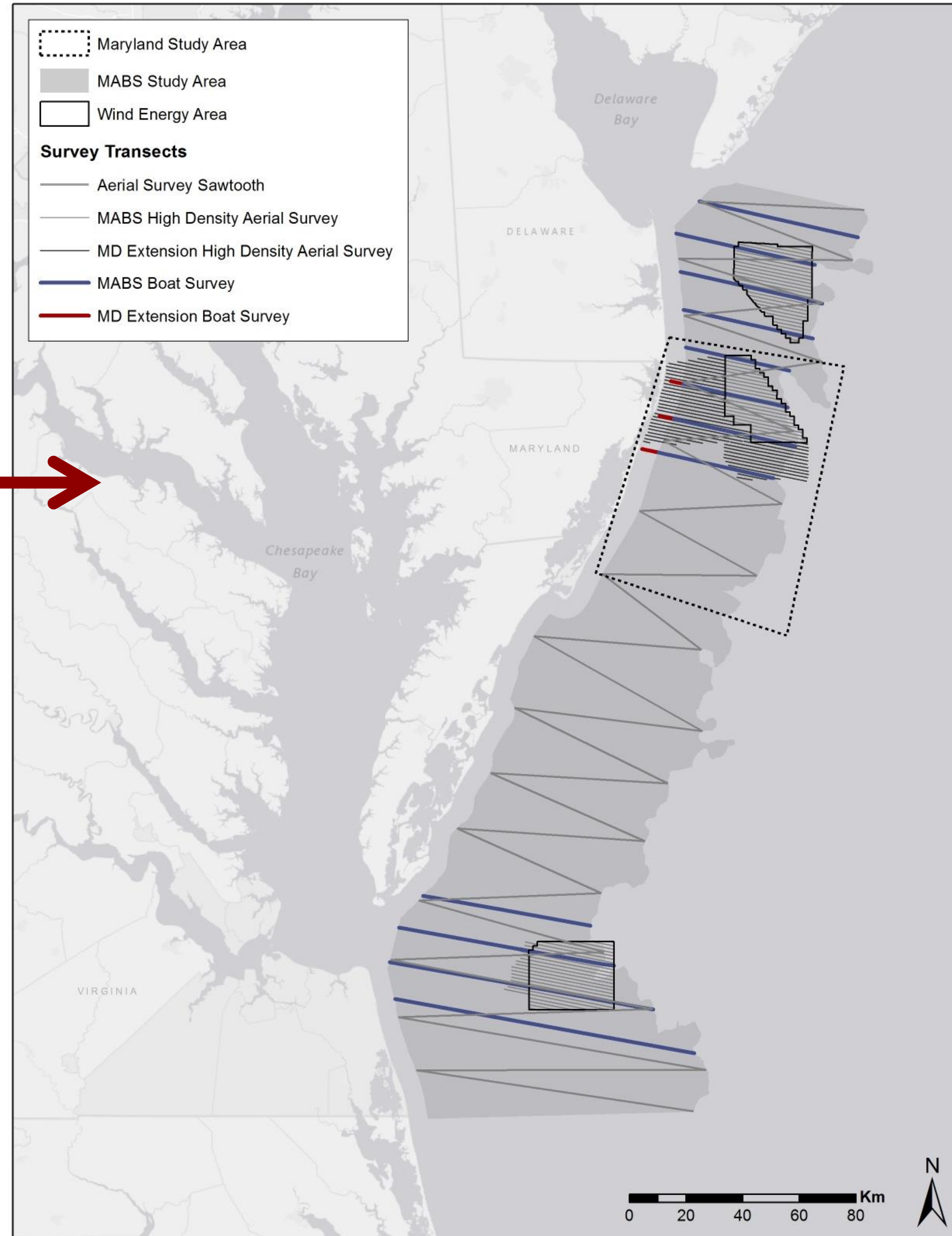
bri


Mid-Atlantic Baseline Studies
High resolution digital video aerial surveys
Survey methods and protocols
Population distributions
Boat-based surveys
Survey methods (wildlife observations and prey biomass)
Population distributions
Spatial correlations between seabirds and prey
Modeling seabird distributions and abundance in relation to environmental covariates
Integrating data from boat and aerial surveys
Comparing survey approaches
Modeling marine mammal and sea turtle distributions and abundance
Identifying persistent abundance hotspots and temporal patterns
Joint models of seabird distributions and abundance
Individual movements of focal bird species
Wintering distributions and movements
Foraging behaviors and movements
Time variant KDEs
Nocturnal avian migration
Passive acoustic monitoring
Modeling migration patterns using weather radar data

Key Findings

1. Boat-based and digital video aerial surveys each had specific advantages
2. Substantial variation in species composition and spatial patterns by season and year
3. Nearshore waters, particularly offshore of Chesapeake and Delaware Bays, were important to a wide range of species

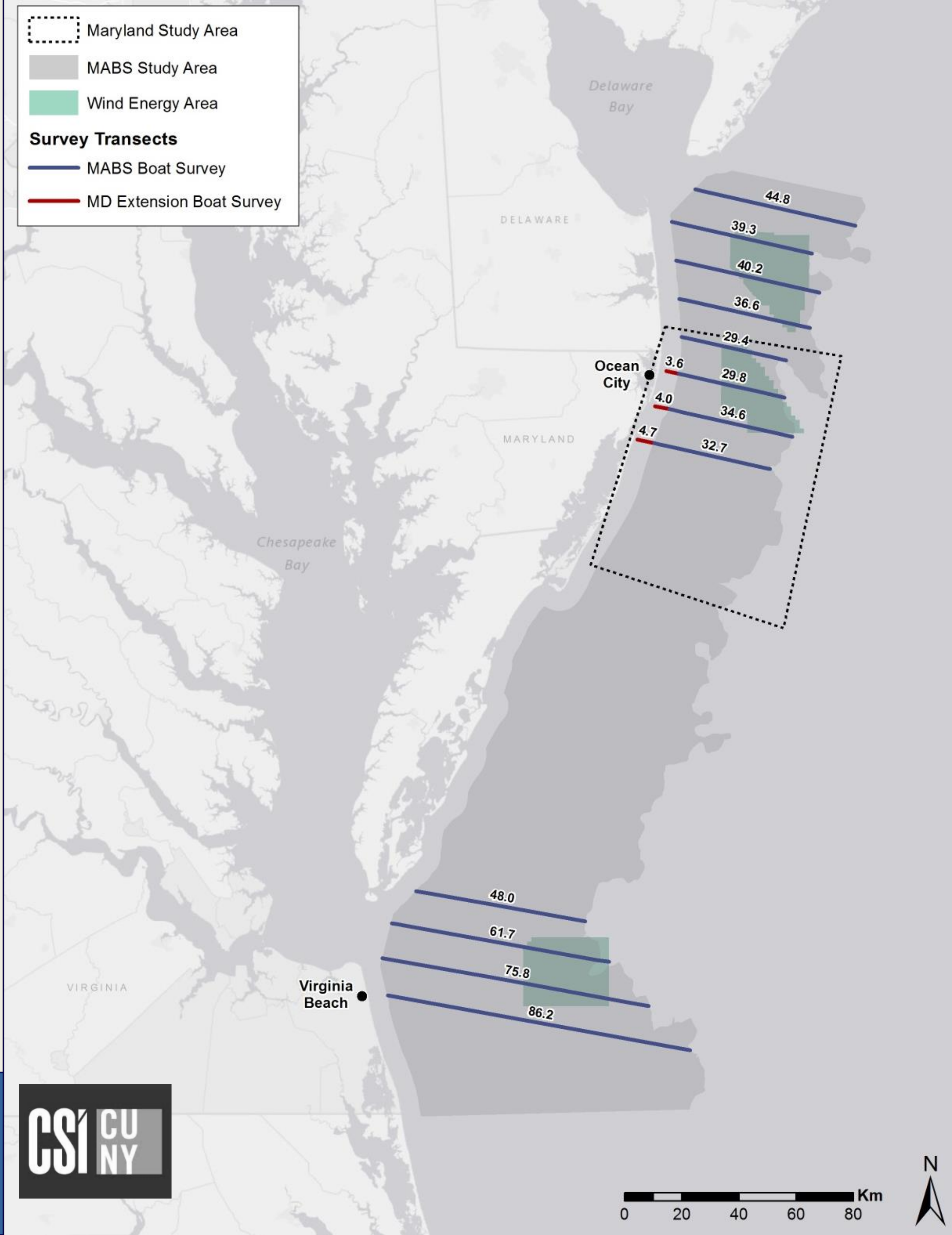
Survey Methods



Boat surveys

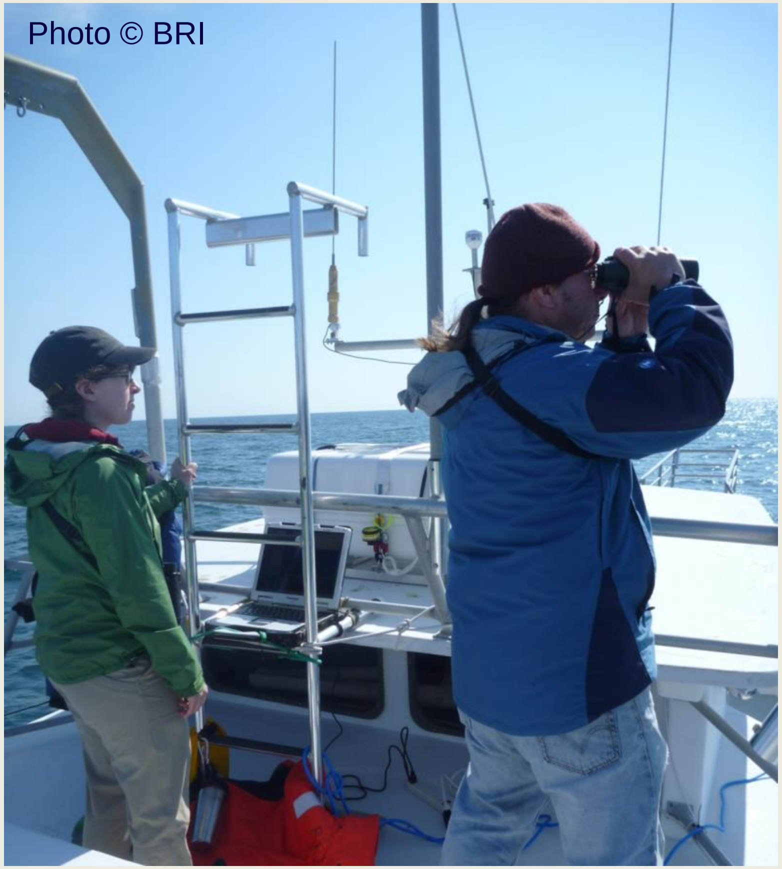
55’ charter vessel

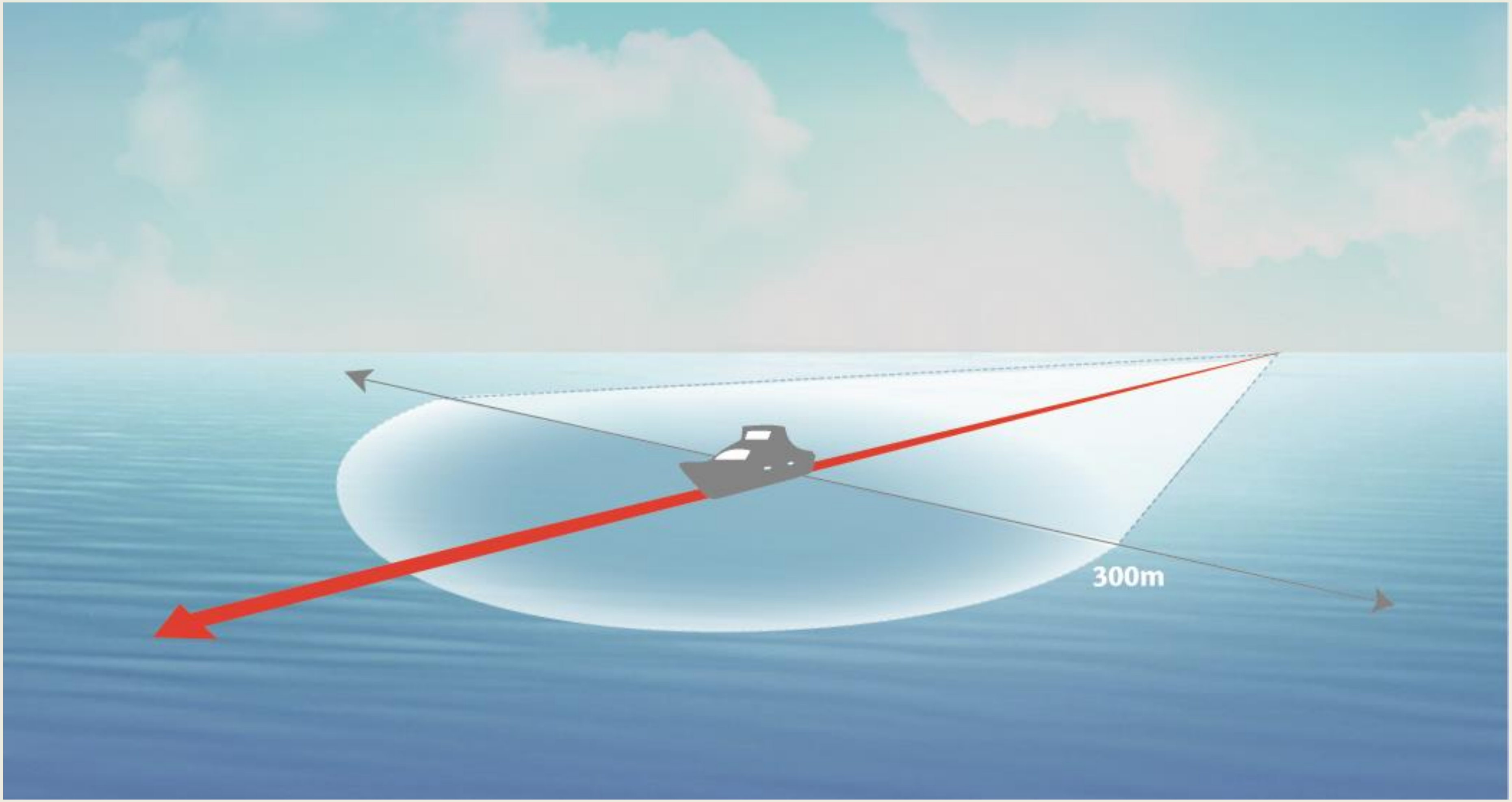
Photo courtesy of Capt. Brian Patteson Inc.



Boat surveys

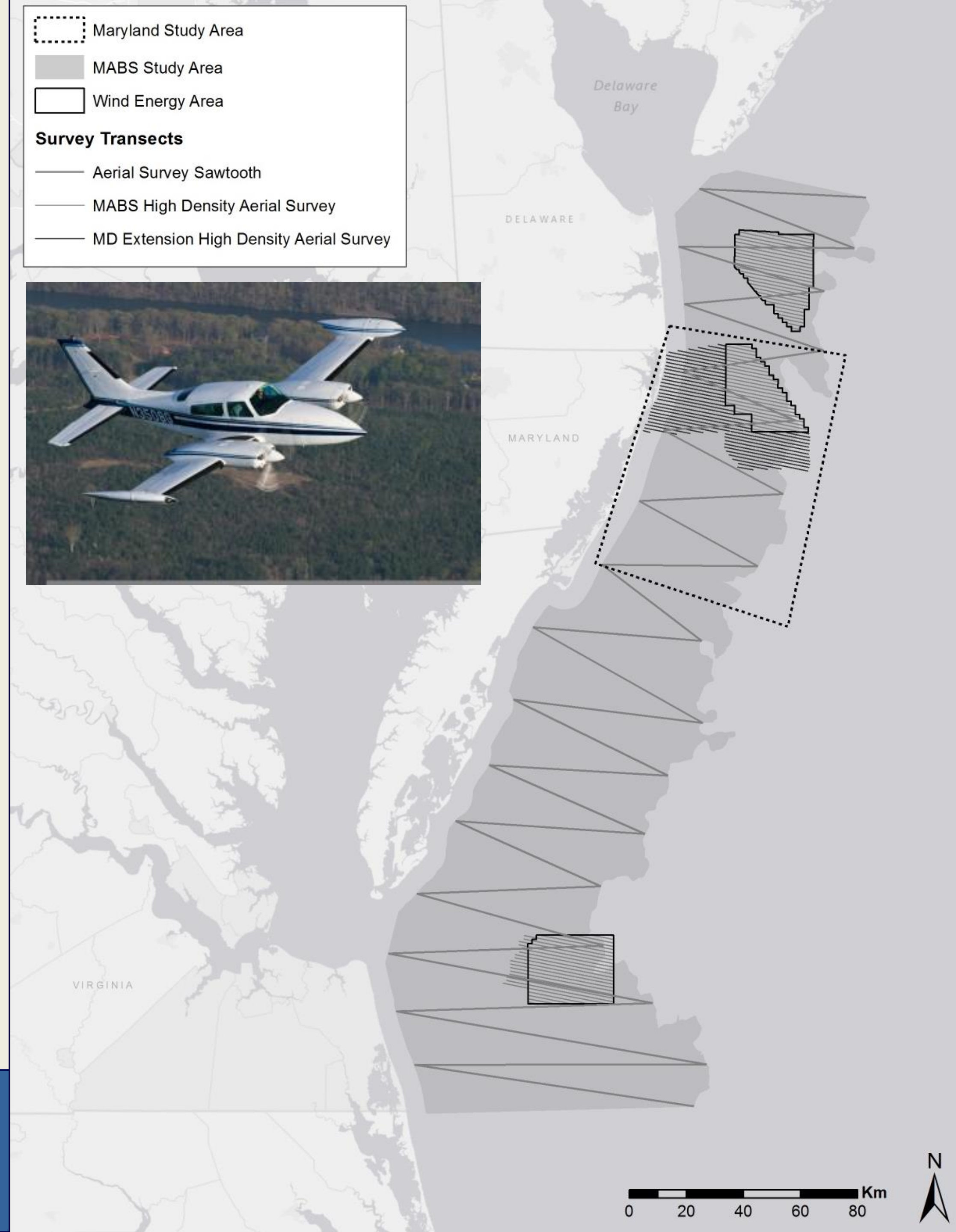
- Combo strip and line transects @ 10 knots
- One observer and one recorder/observer (dLOG)
- Identify and record animals (distance, angle, behavior, etc.)
- Hydroacoustic data




300m

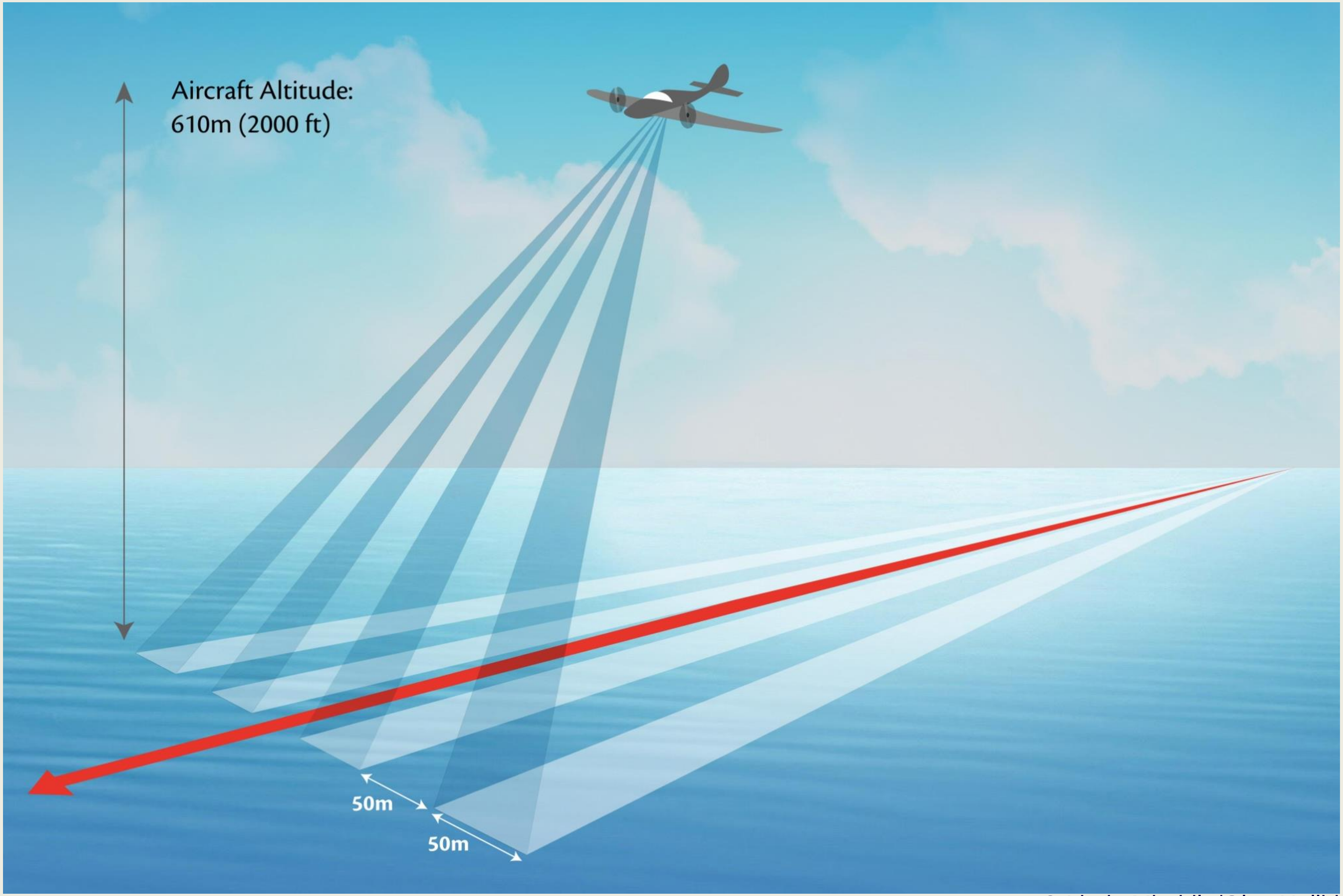
High resolution digital video aerial surveys

- 15 surveys/ 2 yrs
- 4 belly-mounted cameras
- 2 cm ground spatial resolution (GSR)
- GPS coordinates for each video frame
- ~8 frames/sec



bri

HiDef AERIAL SURVEYING

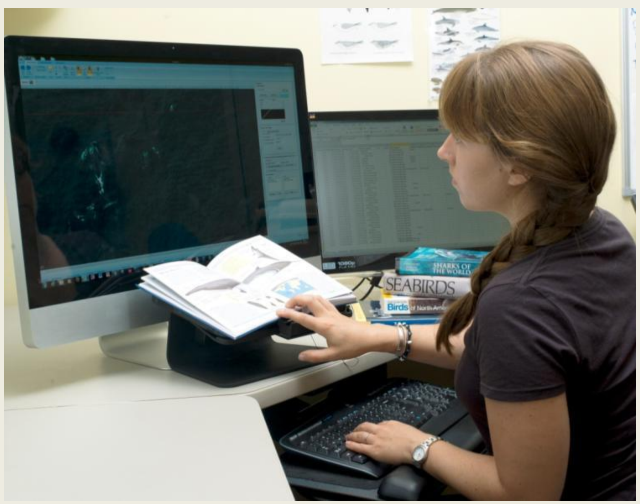


bri

HiDef
AERIAL SURVEYING

Video Review

- Full QA process
- Flight height calculated from video images

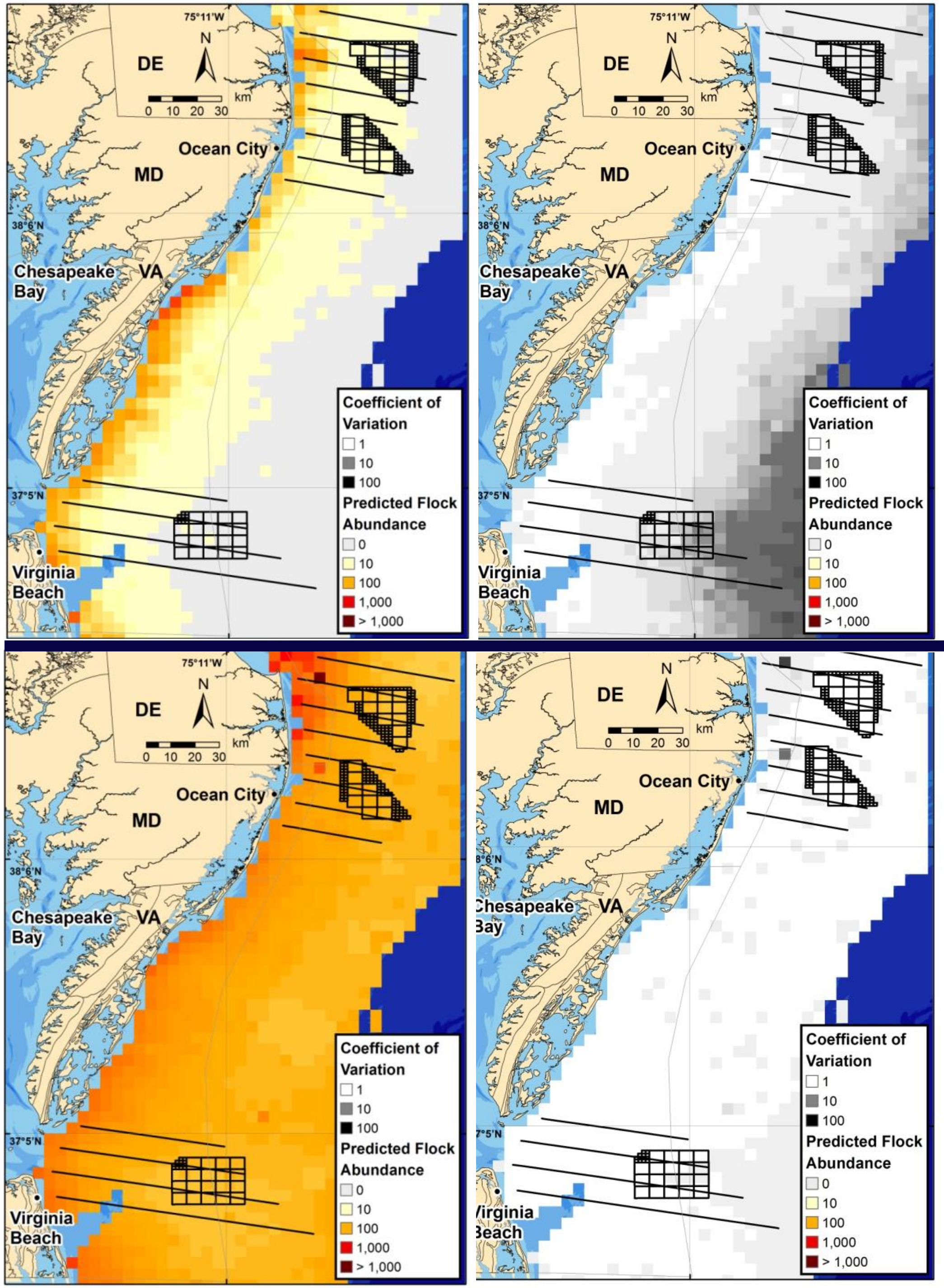


Modeling

- Seabird GLMs (NCSU)
  - Hierarchical community distance sampling model
  - Habitat modeling
  - Species ID model
  - Comparison of boat and aerial habitat models
  - Integrated modeling framework
- Marine mammal GAMs (Duke)
  - Distance sampling with environmental covariates
- Sea turtle GAMs (Duke)
  - Abundance modeling with environmental covariates

bri

- Distance to shore
- Seafloor slope
- Sediment grain size
  - Proxy for benthic assemblages
- Sea surface temperature
- Daily salinity
- Monthly chlorophyll anomaly
  - Index of extreme values of primary productivity at the sea surface



NC STATE UNIVERSITY

Geographic and temporal patterns

- **Seasonal patterns**
  - Temporal bar charts (boat + aerial)
  - Model-predicted abundance (boat and/or aerial)
  - Utilization distributions (telemetry)
- **Persistent patterns**
  - Persistent hotspots of relative abundance (boat + aerial)
- **Case studies**
  - All of the above



Photos from top: © Michael O'Neill/Oceans-Image/Photoshot, © Daniel Poleschook, © HiDef Aerial Surveying ,Ltd.

Seasonal patterns and interannual variation

- The presence and relative abundance of species in the study area varied widely during non-breeding, breeding, and migratory periods.
- Wide variation in distribution and abundance patterns by taxon (see case studies)
- Also large amount of interannual variation in environmental conditions and distributions

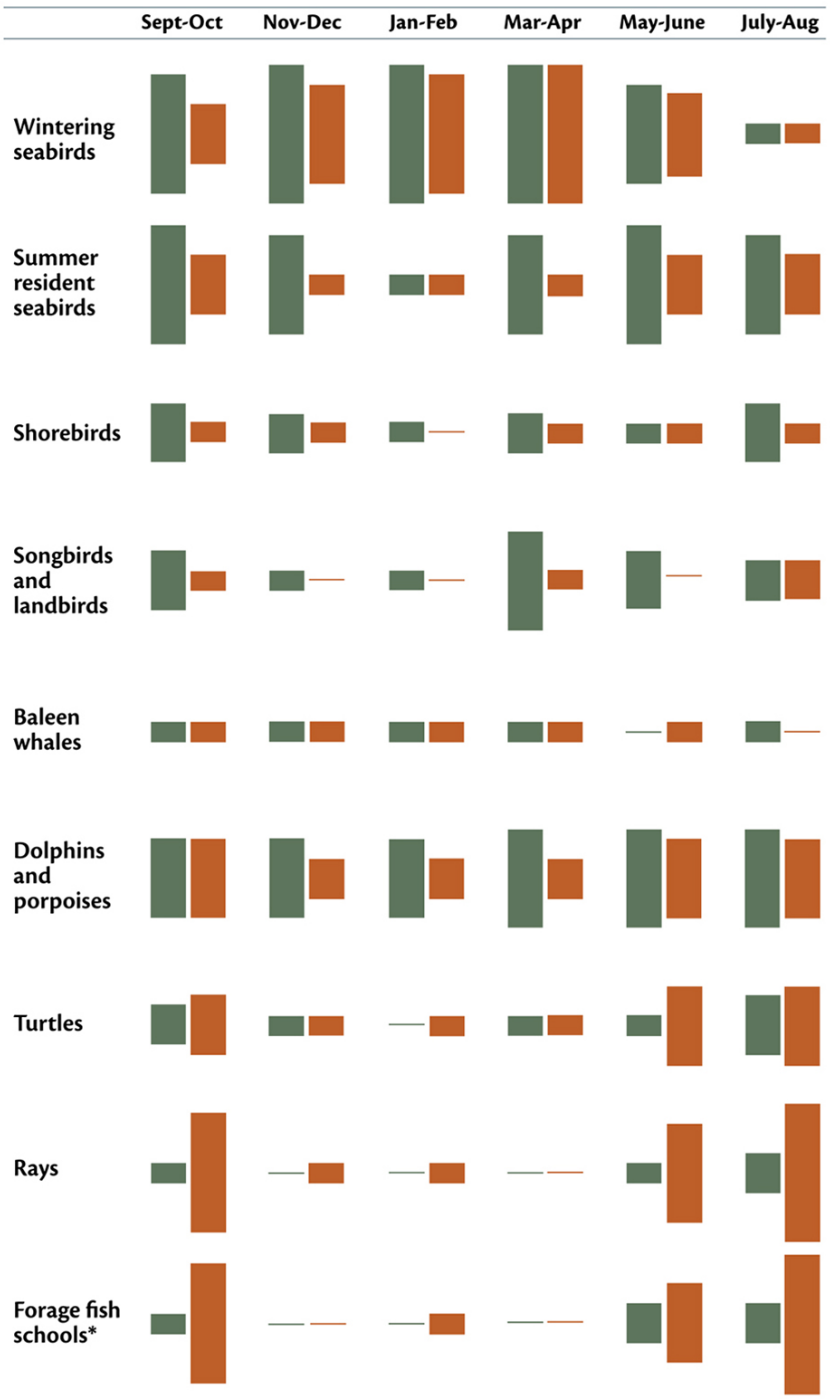
Temporal Trends in Abundance

Temporal changes in relative abundance for taxonomic groups.

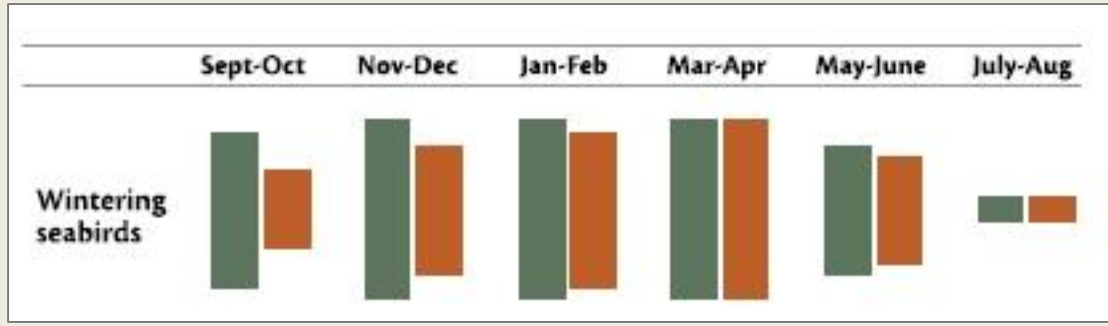
Data are from boat-based surveys (■) and high resolution digital video aerial surveys (■).

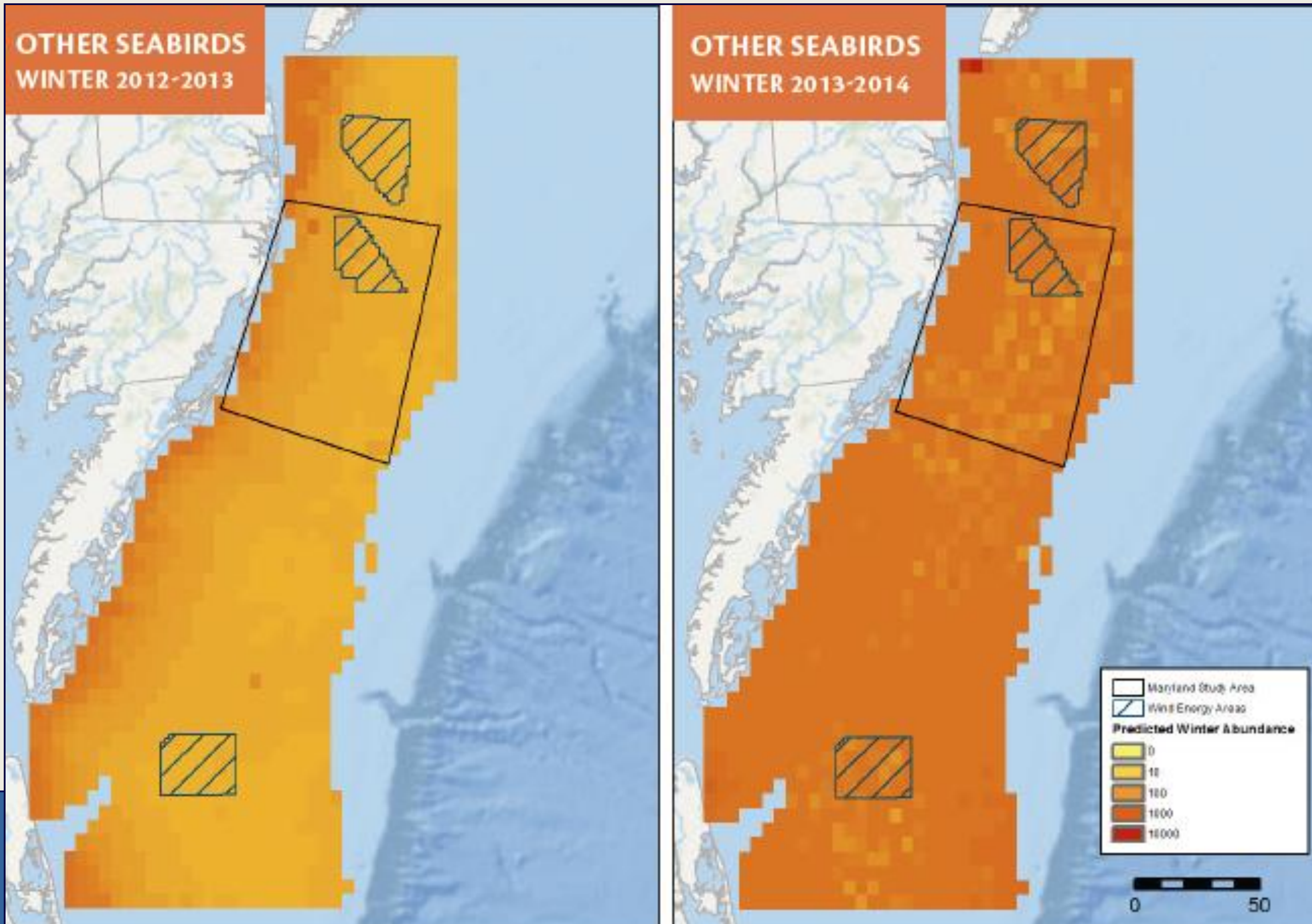
Species included in each category are listed in Williams *et al*. (2015).

*Forage fish were identified as schools, not as individuals, unlike the other animal groups.



Wintering Seabirds



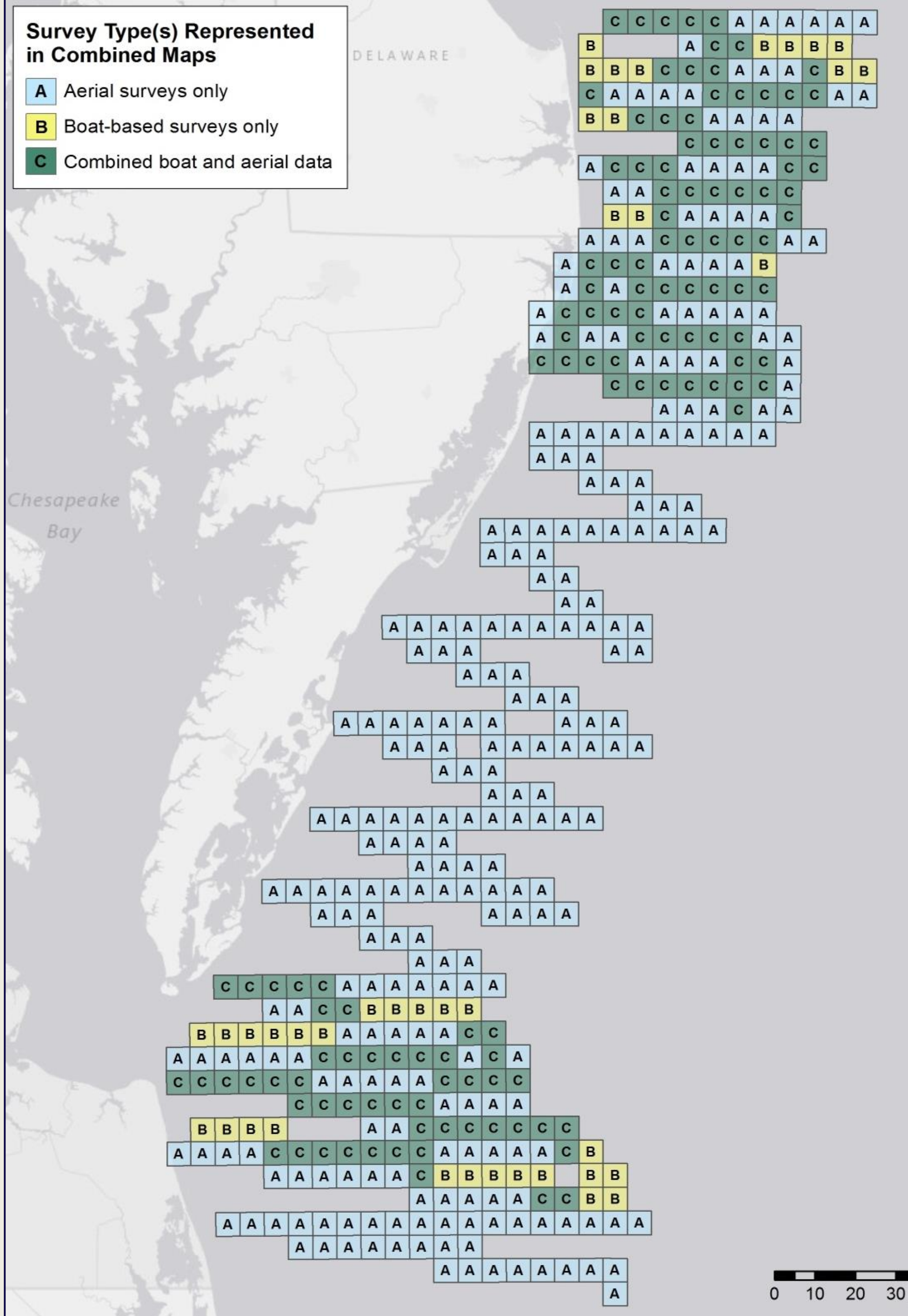


NC STATE UNIVERSITY

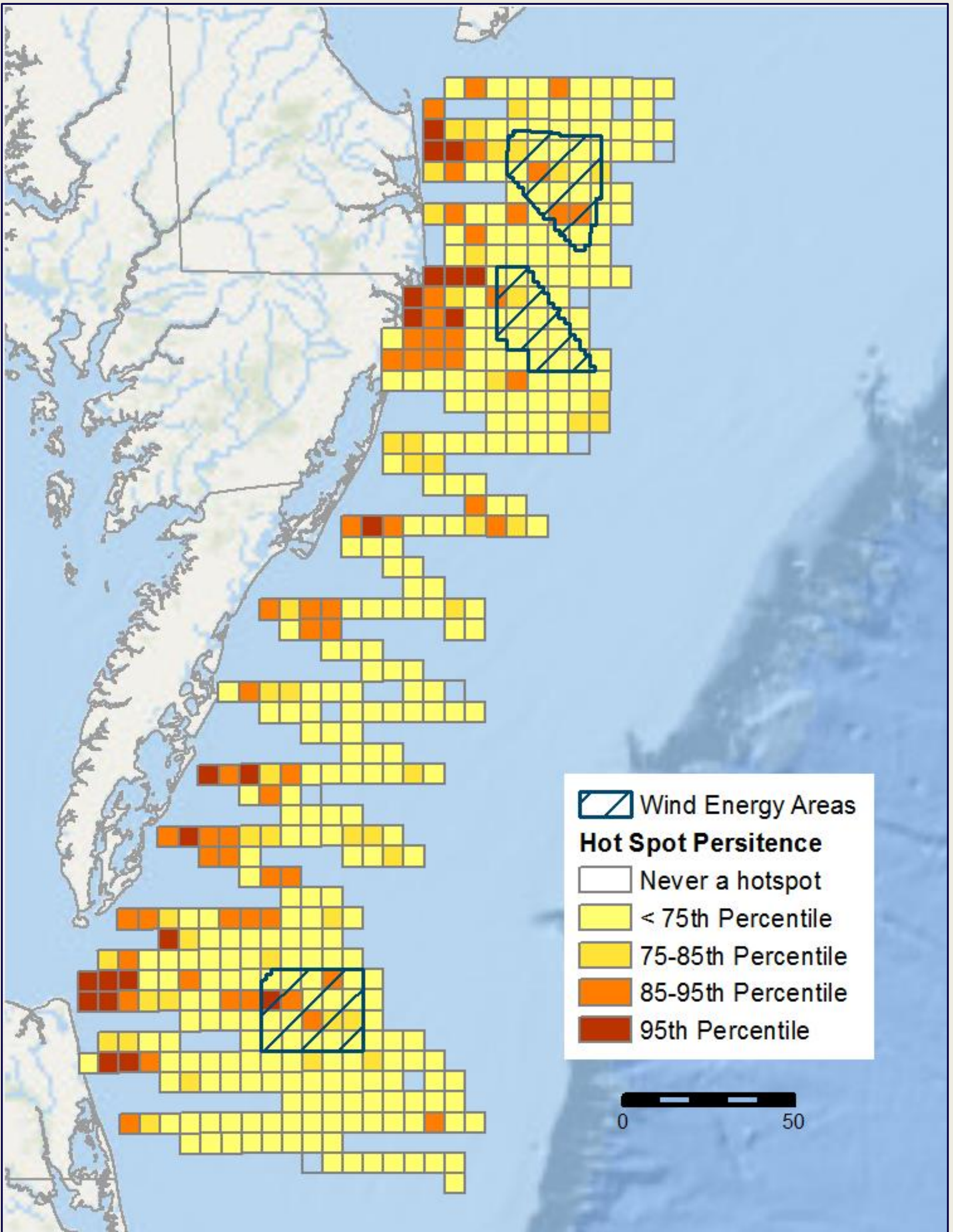
Persistent Hotspots of Relative Abundance

- Identify spatial patterns of species abundance that persist over time and may indicate the locations of important habitat areas (Santora & Veit 2013)
  - Identify locations where animals consistently observed in #s > standardized baseline

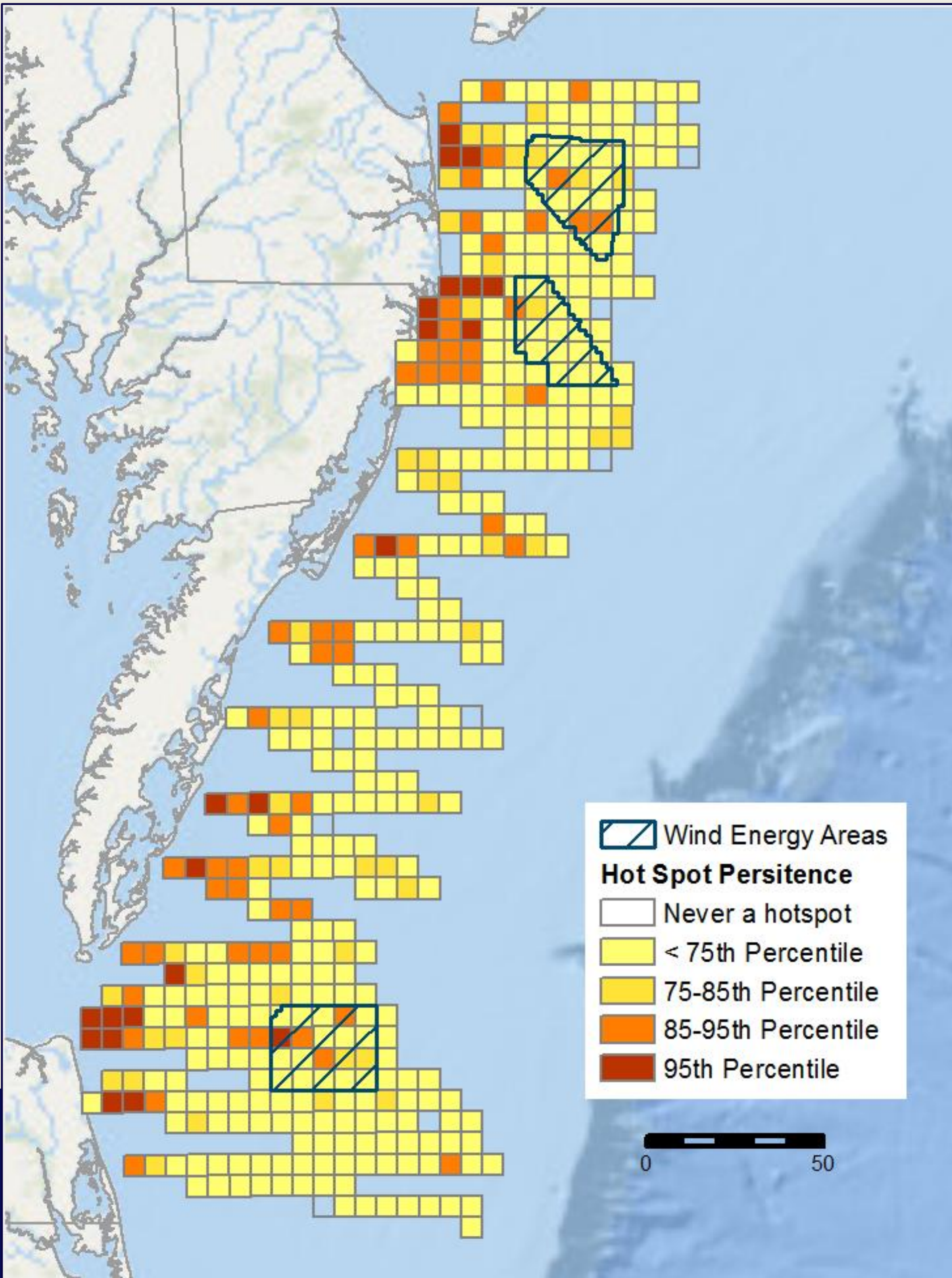
- Boat and aerial data handled independently:
  - Gamma distribution fitted to non-zero counts from each survey; top quartile = survey-specific hotspots
- Datasets combined:
  - Weighted by effort-corrected total abundance for each dataset
  - Across all times surveyed: what % of time is block a hotspot?



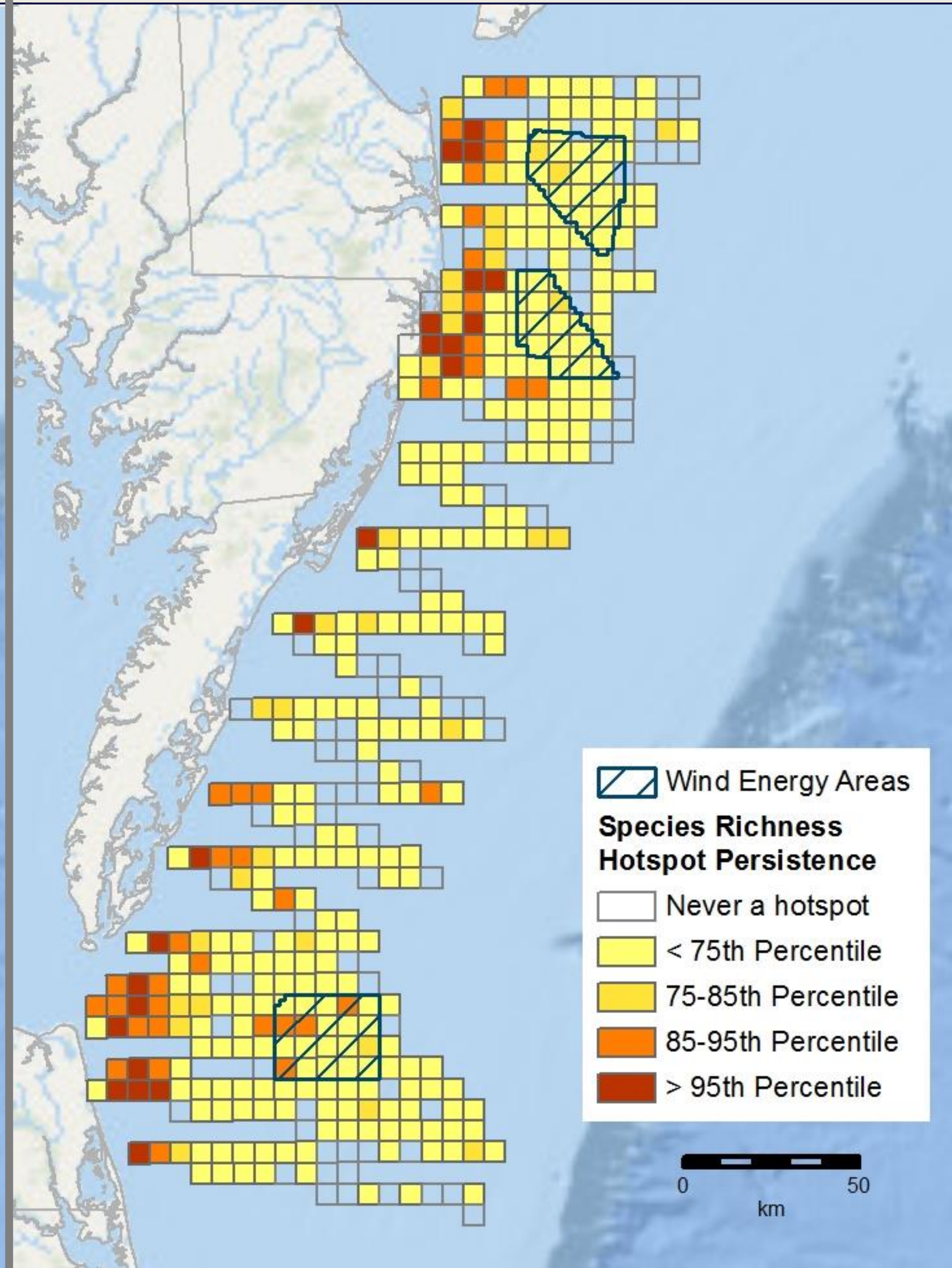
Abundance (all species)



Abundance (all species)



Species richness



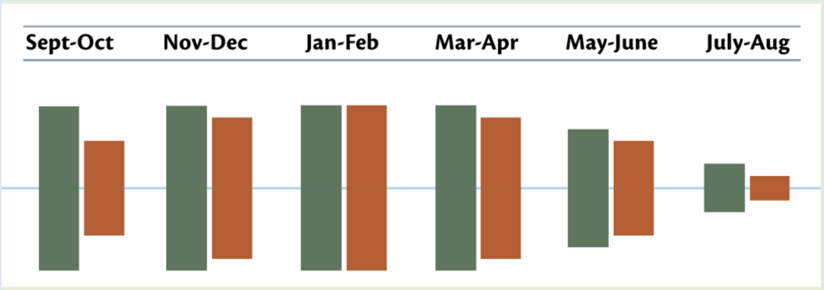
[CASE STUDY]

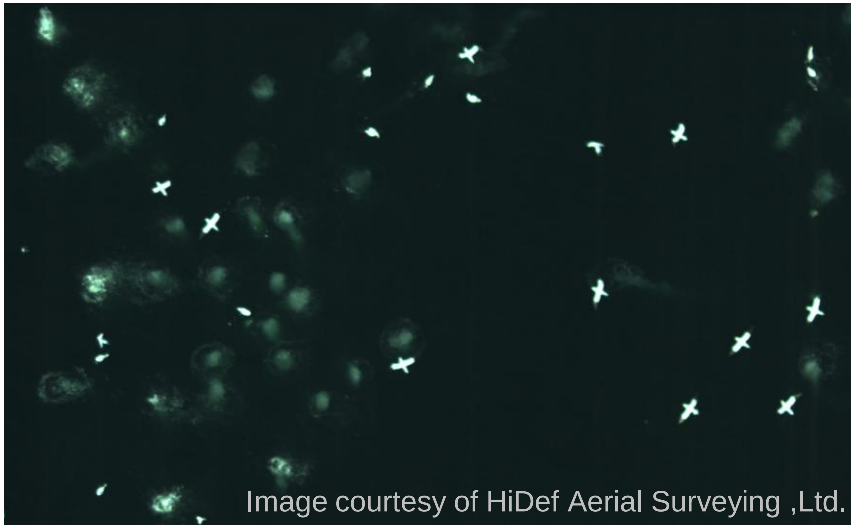
Northern Gannets

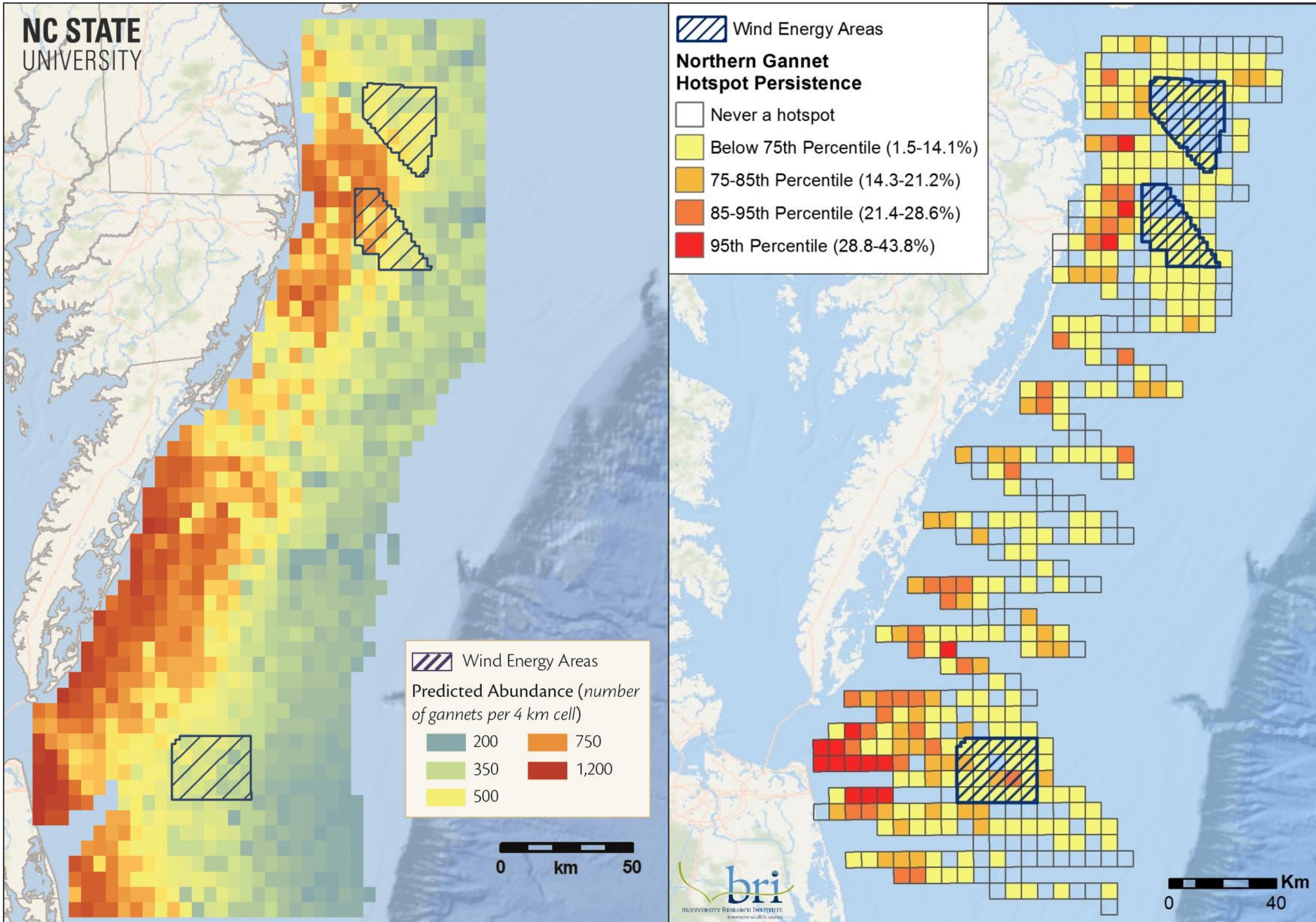
CONTEXT

- European studies indicate a range of possible effects, including collision mortality and displacement

Seasonal Patterns:






NC STATE
UNIVERSITY
Wind Energy Areas
Predicted Abundance (number of gannets per 4 km cell)
200
350
500
750
1,200
0
km
50
Wind Energy Areas
Northern Gannet
Hotspot Persistence
Never a hotspot
Below 75th Percentile (1.5-14.1%)
75-85th Percentile (14.3-21.2%)
85-95th Percentile (21.4-28.6%)
95th Percentile (28.8-43.8%)
bri
Km
0
40

[CASE STUDY]

Northern Gannets

TAKE HOME MESSAGES

- The broad-scale distribution in winter may increase likelihood of interaction with offshore wind
- Foraging areas defined by a wide variety of characteristics. Development could cause displacement almost anywhere across the shelf, but particularly within ~30-40 km of shore.

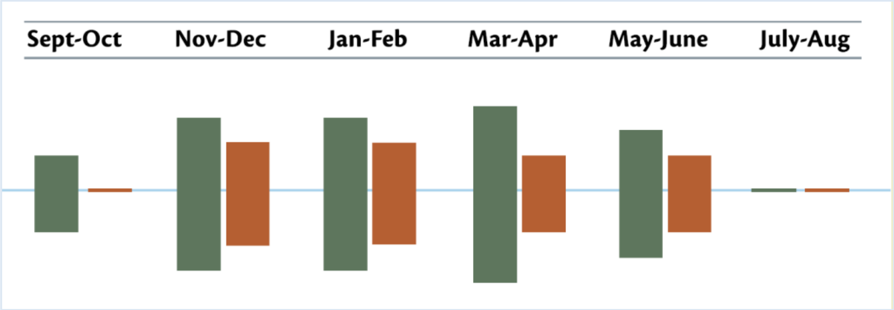
[CASE STUDY]

Red-throated Loons

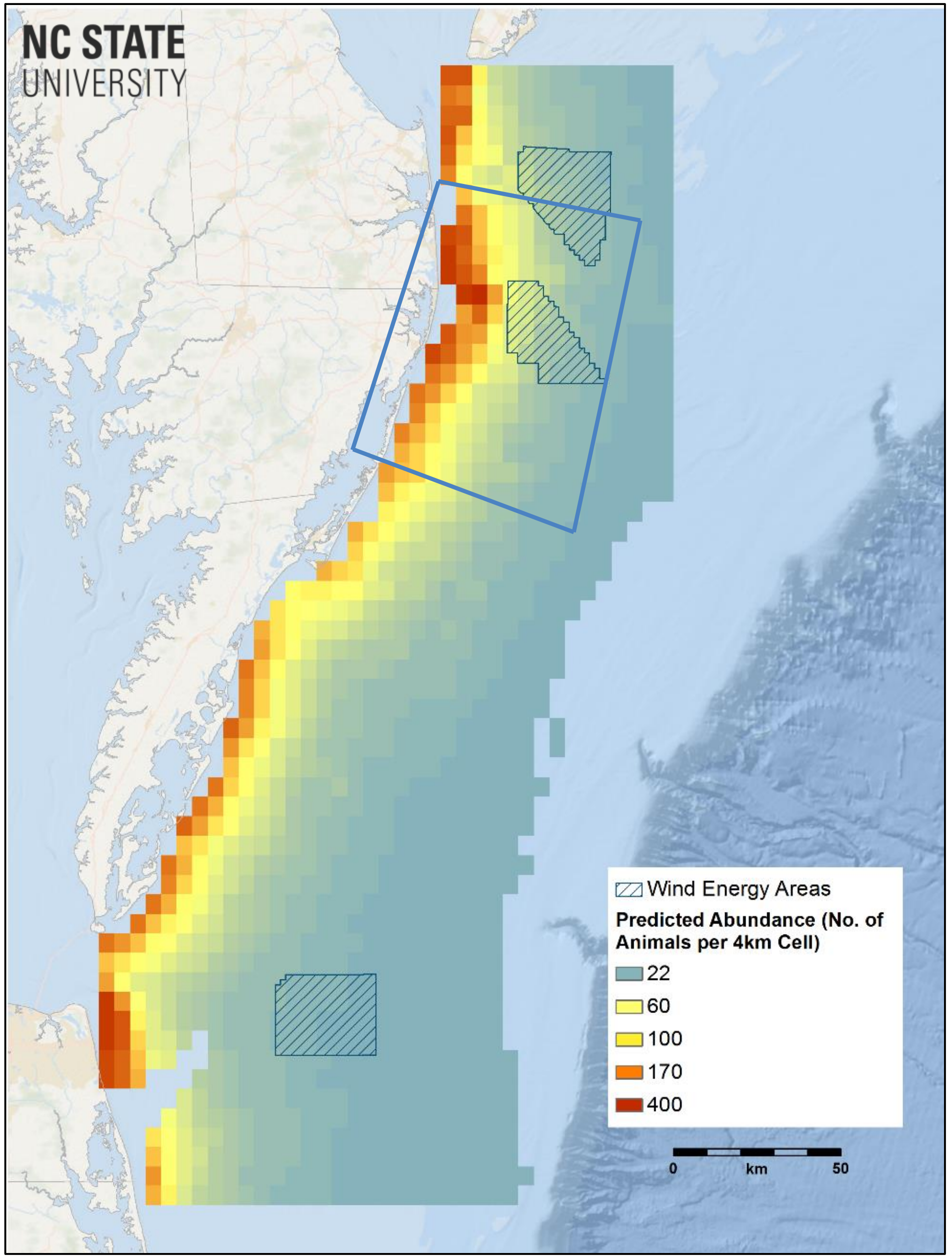
CONTEXT

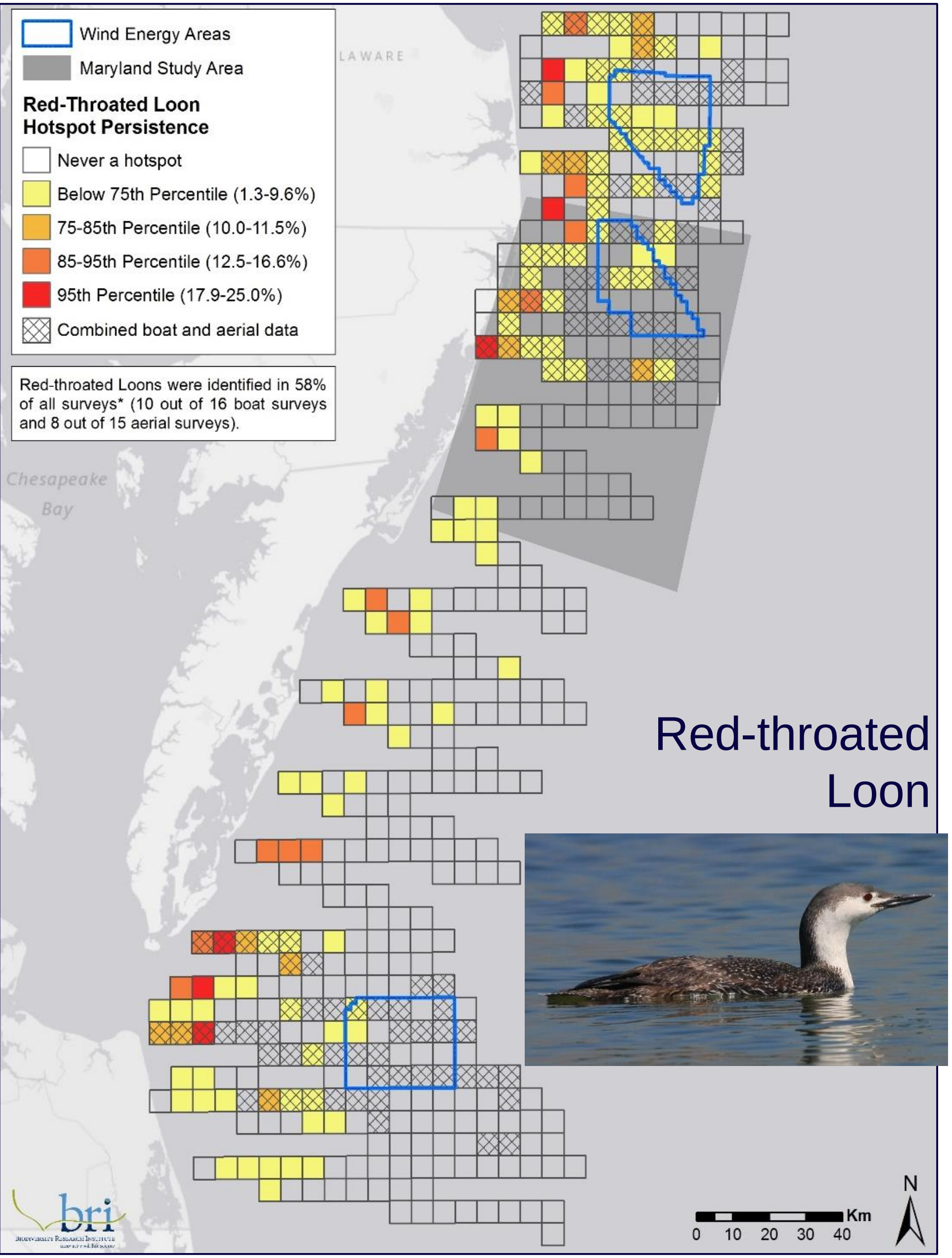
- European studies indicate long-term, localized displacement, and disturbance by vessel traffic

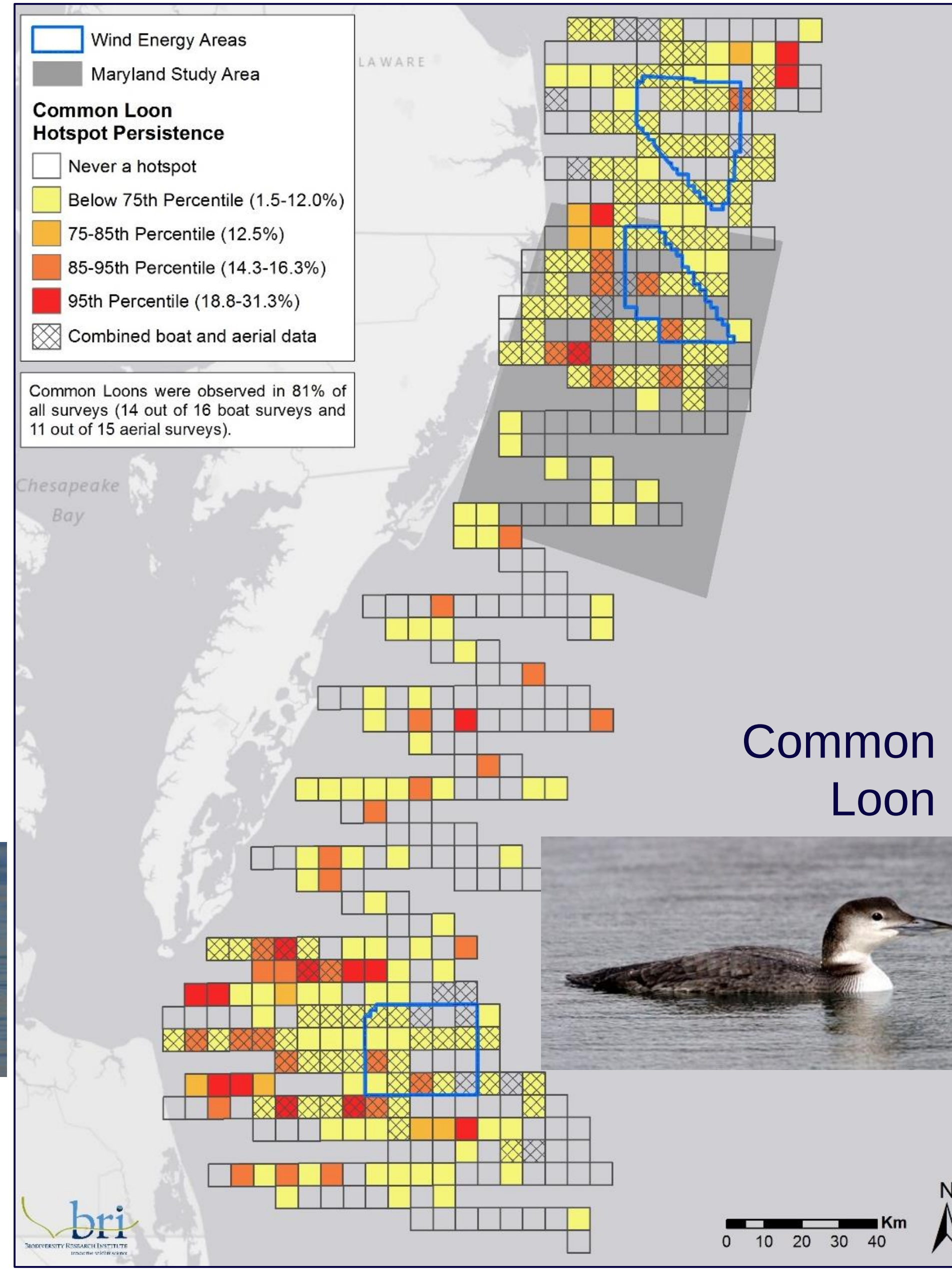
Seasonal Patterns:



Red-throated Loon




Wind Energy Areas
Maryland Study Area
Red-Throated Loon
Hotspot Persistence
Never a hotspot
Below 75th Percentile (1.3-9.6%)
75-85th Percentile (10.0-11.5%)
85-95th Percentile (12.5-16.6%)
95th Percentile (17.9-25.0%)
Combined boat and aerial data
Red-throated Loons were identified in 58% of all surveys* (10 out of 16 boat surveys and 8 out of 15 aerial surveys).
LAWARE
Chesapeake
Bay
Red-throated
Loon
Km
0 10 20 30 40
N
bri


Wind Energy Areas
Maryland Study Area
Common Loon
Hotspot Persistence
Never a hotspot
Below 75th Percentile (1.5-12.0%)
75-85th Percentile (12.5%)
85-95th Percentile (14.3-16.3%)
95th Percentile (18.8-31.3%)
Combined boat and aerial data
Common Loons were observed in 81% of all surveys (14 out of 16 boat surveys and 11 out of 15 aerial surveys).
LAWARE
Chesapeake
Bay
Common
Loon
Km
0 10 20 30 40
N
bri

[CASE STUDY]

Red-throated Loons

TAKE HOME MESSAGES

- In winter, most commonly located west (inshore) of the existing WEAs
- Overlap with existing mid-Atlantic WEAs during migration when moving farther offshore

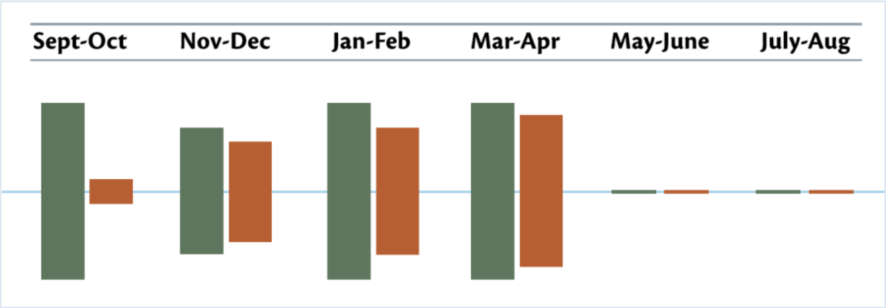
[CASE STUDY]

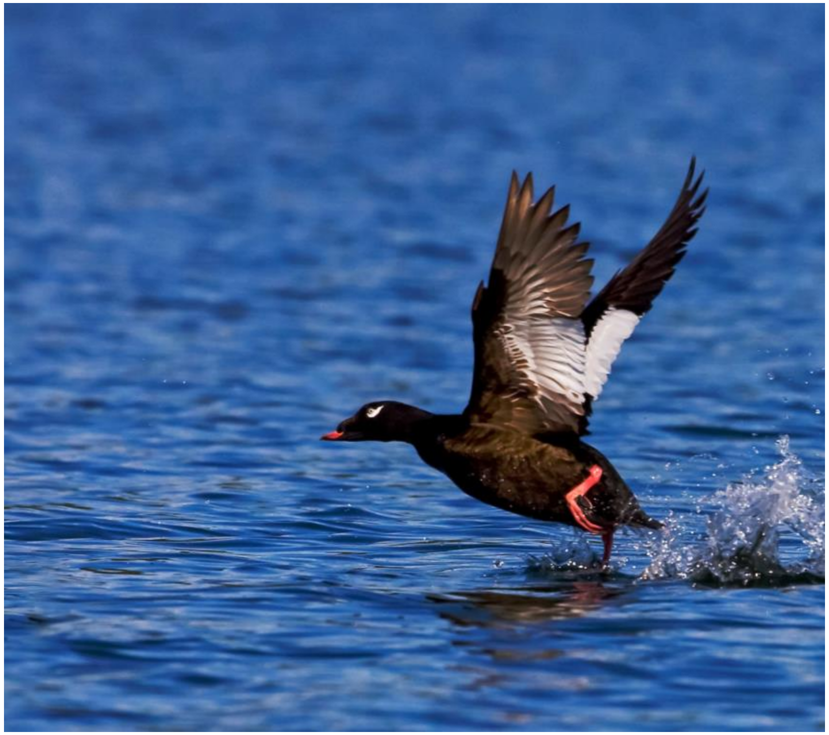
Scoters

CONTEXT

- European studies indicate long-term, localized displacement, and disturbance by vessel traffic

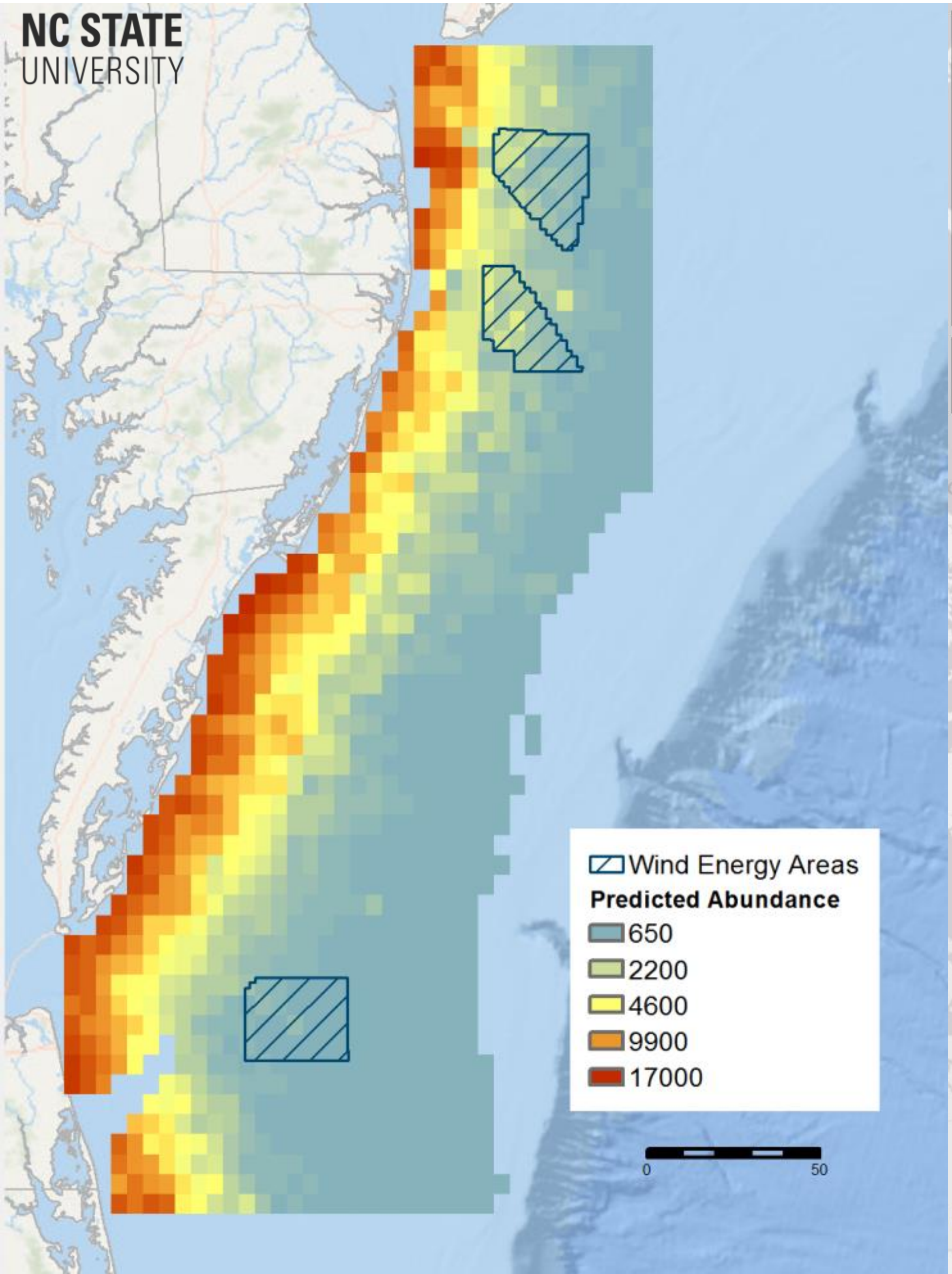
Seasonal Patterns:

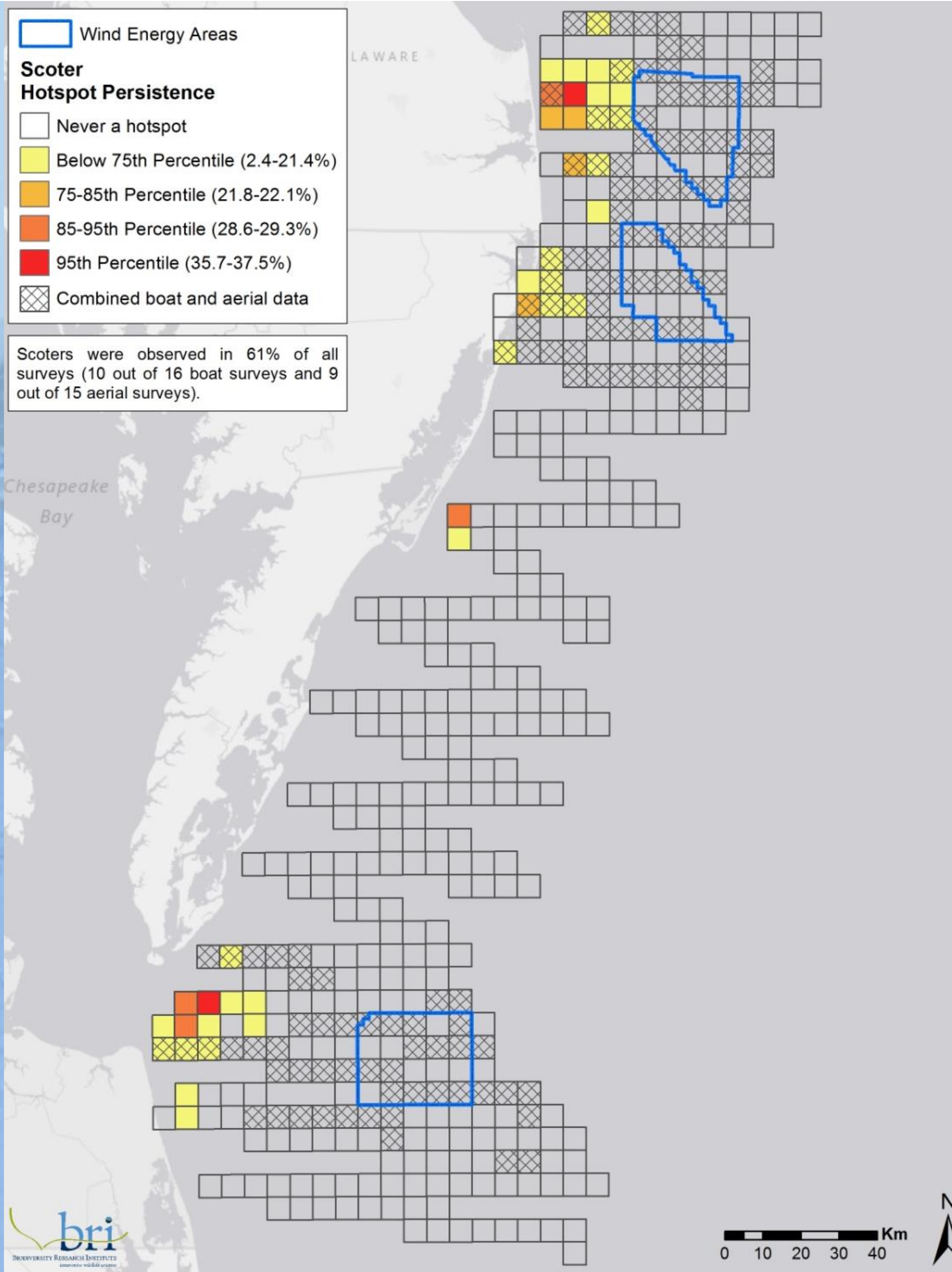




Photos © Daniel Poleschook

All Scoters (BLSC, SUSC, WWSC)





[CASE STUDY]

Scoters

TAKE HOME MESSAGES

- In winter, most commonly located west (inshore) of the existing WEAs (distributions largely driven by water depth)

- Construction and operations activities in the mid-Atlantic, including vessel traffic, is most likely to cause localized displacement of scoters if these activities occur within about 20 km of shore

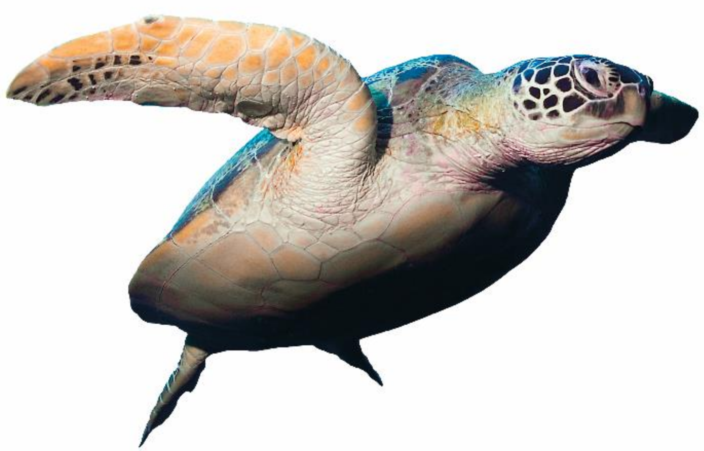
[CASE STUDY]

Sea Turtles

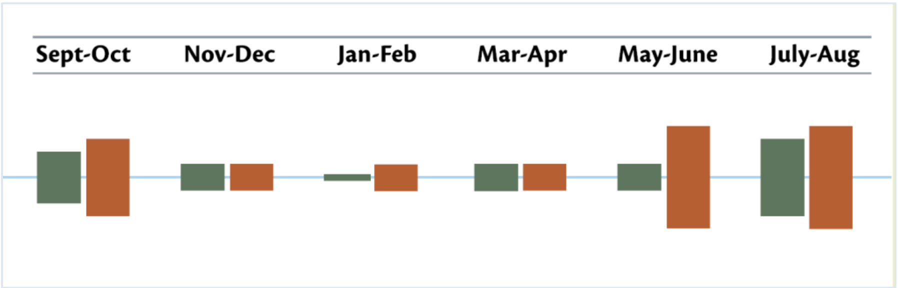
Top © Michael O'Neill/Oceans-Image/Photoshot
Bottom © Soren Egeberg

CONTEXT

- Effects on sea turtles remain poorly understood, especially noise and potential for collision with vessels

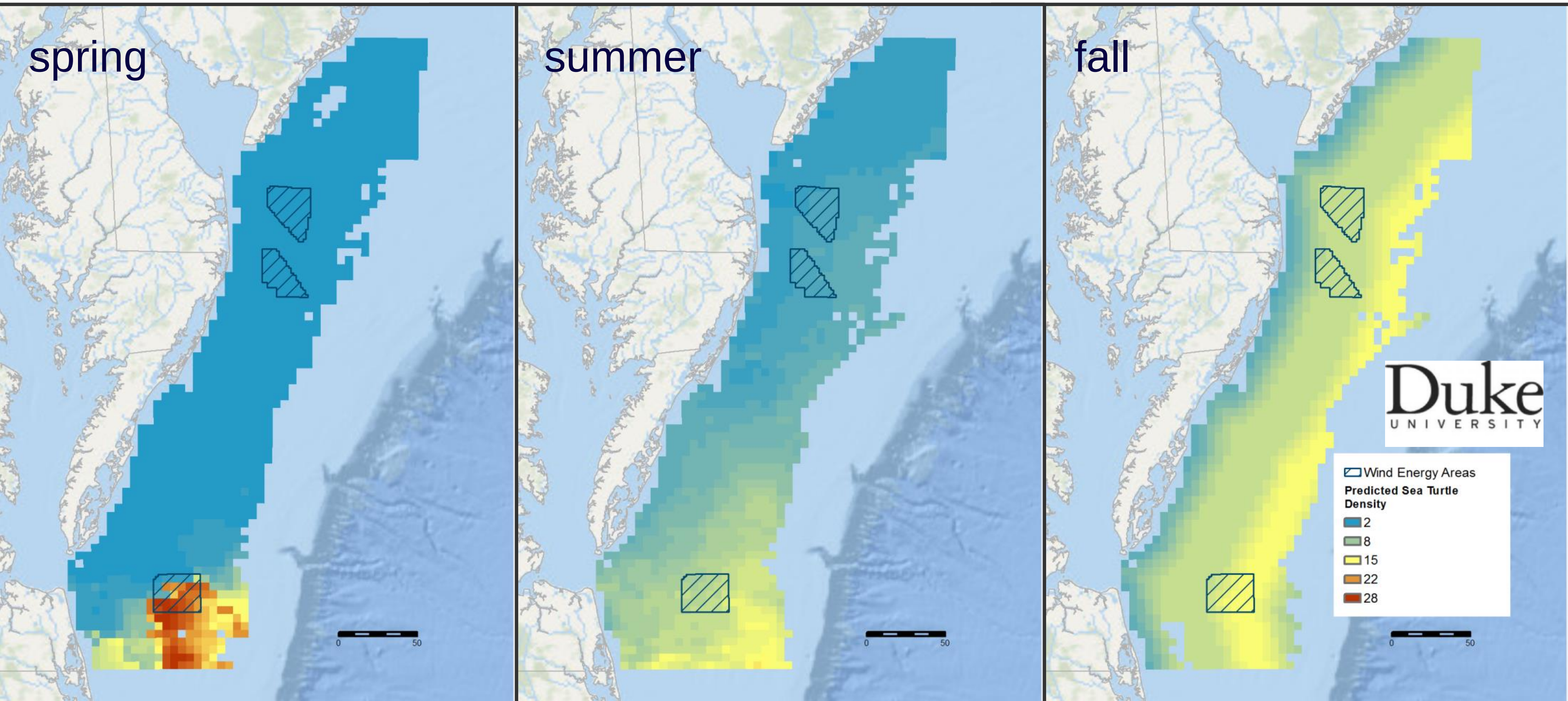


Seasonal Patterns:



- Surveys recorded all five species occurring in the region; Loggerheads and Leatherbacks most frequently observed

- Model predicted distributions indicated greatest densities further offshore, and most widespread across the shelf in the fall



[CASE STUDY]

Sea Turtles

TAKE HOME MESSAGES

- May be species-specific differences in habitat use that we could not detect
- Construction of offshore wind energy facilities in mid-Atlantic WEAs likely to occur in warmer months, and sea turtles will be present during these periods.
- Digital aerial surveys have higher detection rates than any other approach, but need greater species differentiation

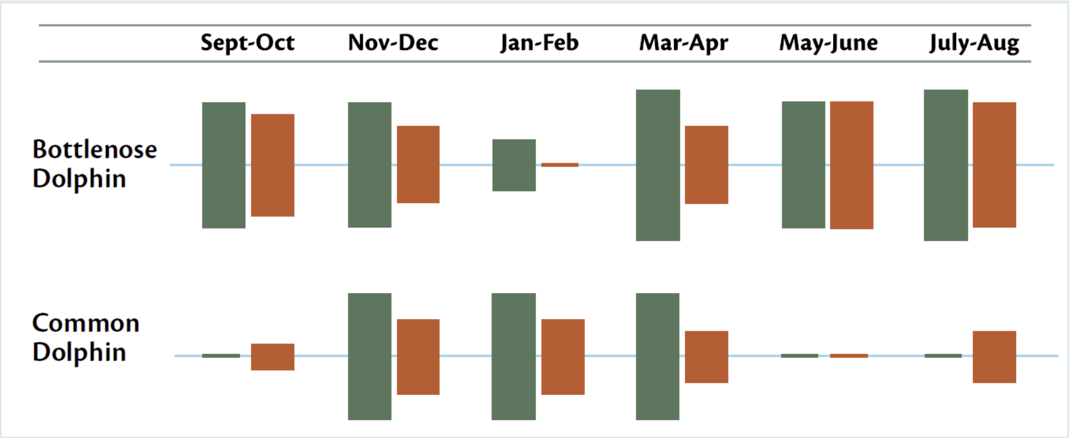
[CASE STUDY]

Cetaceans

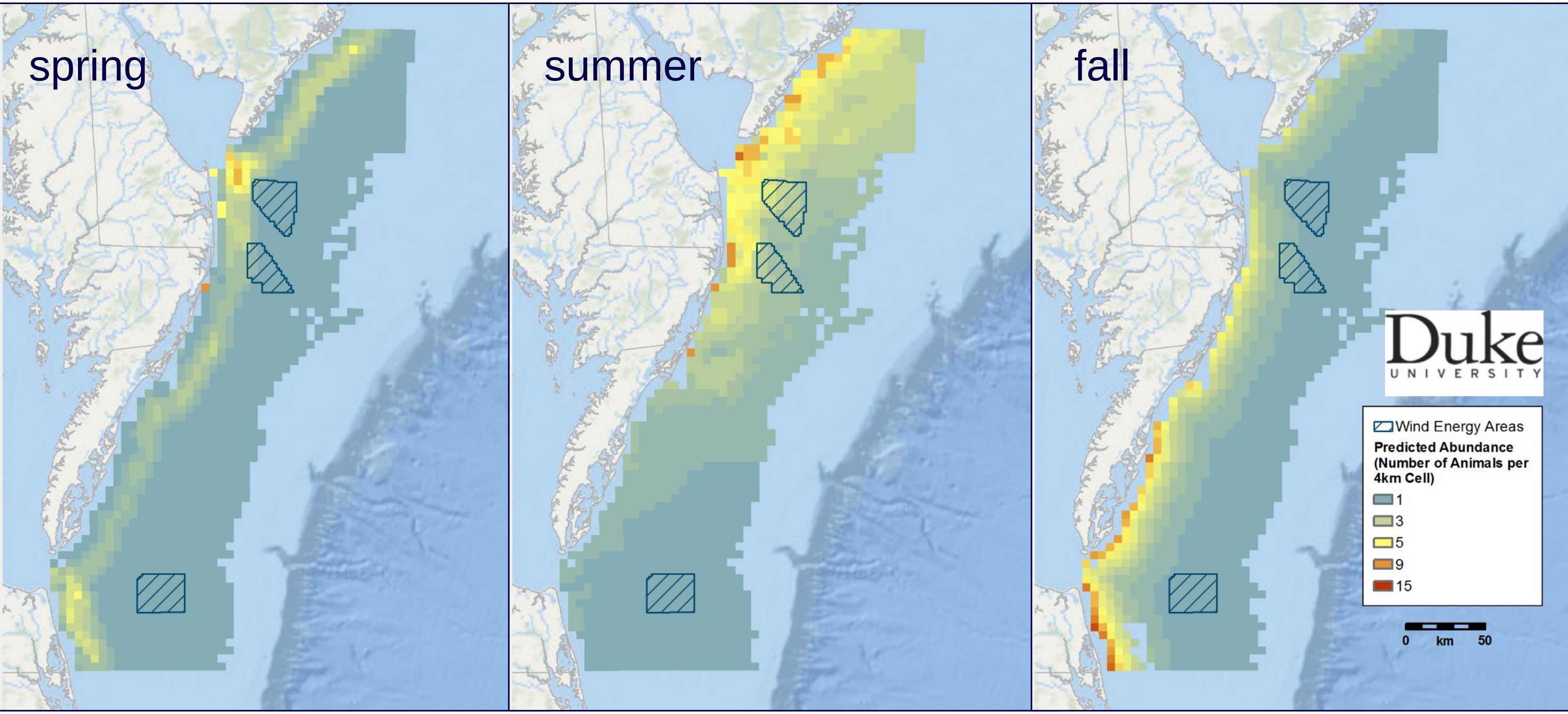
CONTEXT

- Underwater noise may affect all marine mammals, especially during construction.
- Lack of understanding of the hazards posed to baleen whales make these species a particular concern

Seasonal Patterns:



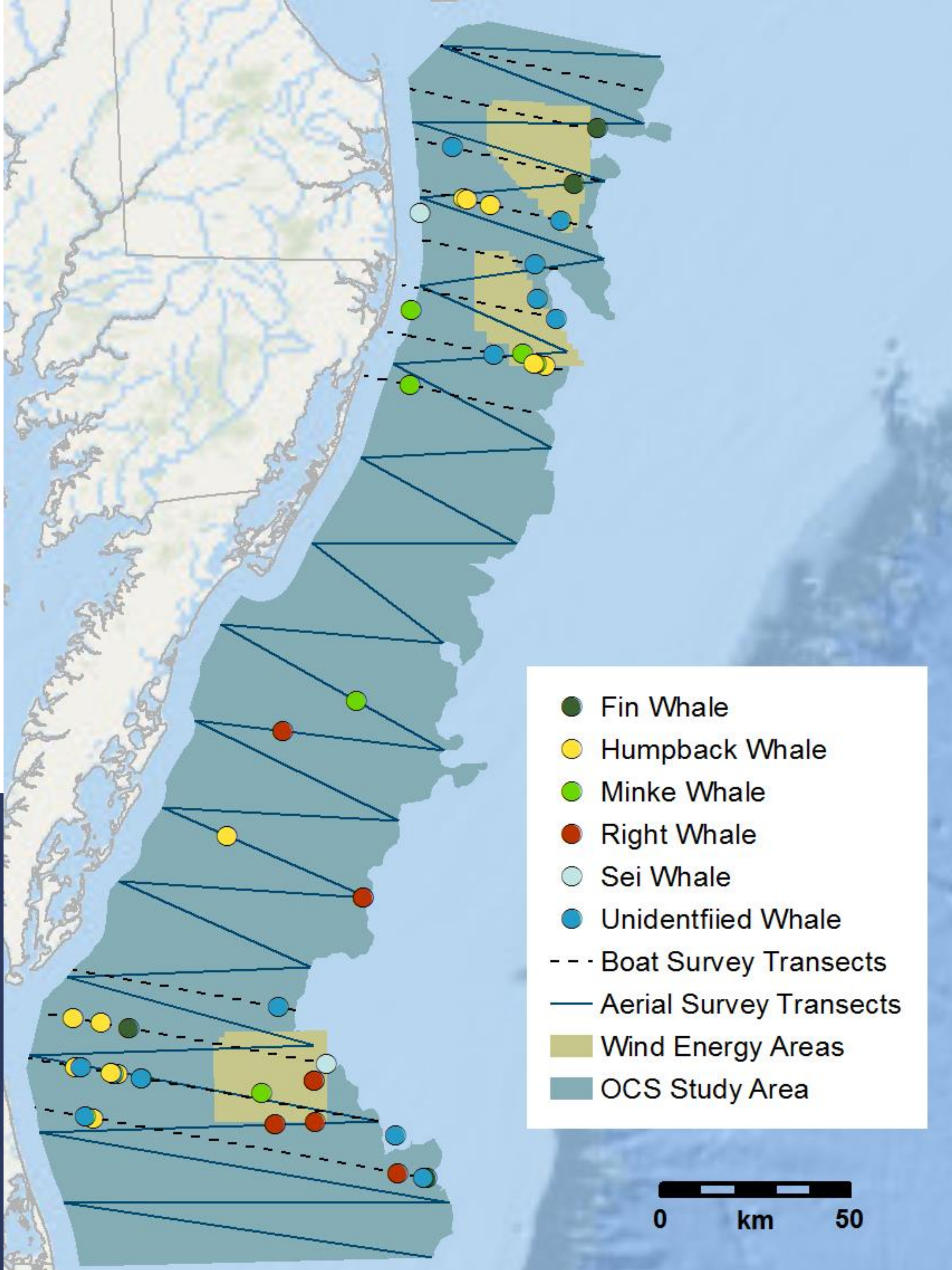
Bottlenose Dolphins



Baleen Whales

- 52 observed in total
- Mostly Dec-March (>75%)
- 9 North Atlantic Right Whales (Feb-March)

Hodges *et al*. 2015. *Endangered Species Research* 28: 225-234



[CASE STUDY]

Cetaceans

TAKE HOME MESSAGES

- Relatively little known about migratory routes of many rare whale species in the region, although we are beginning to fill this gap
- Dolphins present in and around the WEAs year-round
- Bottlenose Dolphins are most likely to be exposed to development activities in western areas of the mid-Atlantic WEAs in spring and fall, as well as in northern WEAs during summer
- Common Dolphins have a more offshore distribution and may be particularly abundant in WEAs during winter and spring

Other interesting findings

- Forage fish
- Bats
- Peregrine Falcons
- Rays
- Seabird satellite telemetry: preliminary findings
- Flight height data from digital video aerial surveys
- Patterns of nocturnal avian migration (measured using NEXRAD weather radar)

Overall Summary

- Optimal survey approach will depend on study location and goals
- Common nearshore distribution patterns in the mid-Atlantic; bays have a strong influence
- Wide variation in distribution and abundance patterns (annually, seasonally, and between taxa)

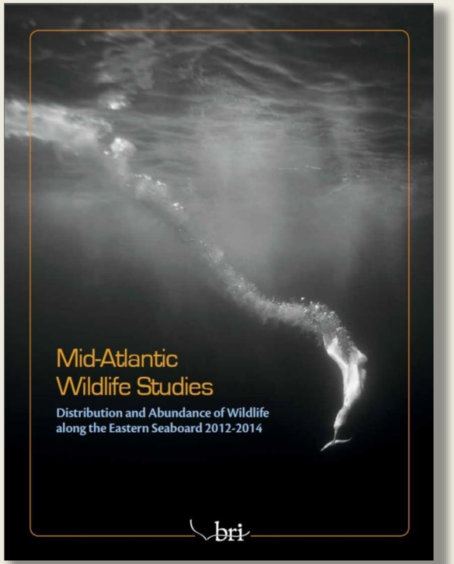
bri

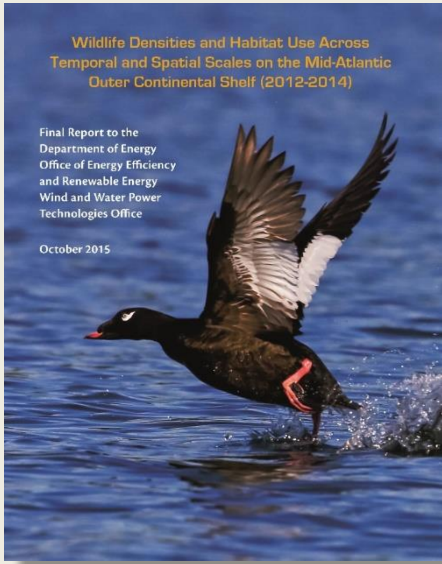
Implications

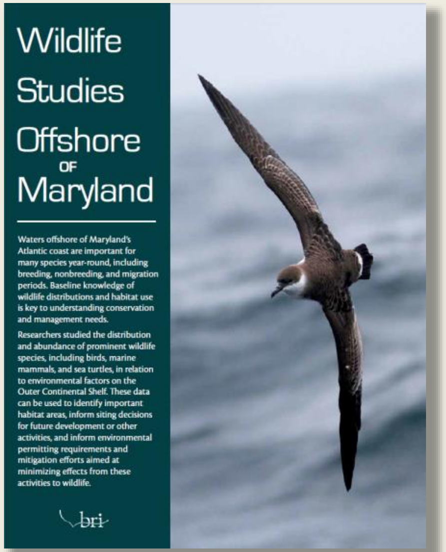
- Siting
- Permitting
- Potential mitigation approaches
- Exposure = first step

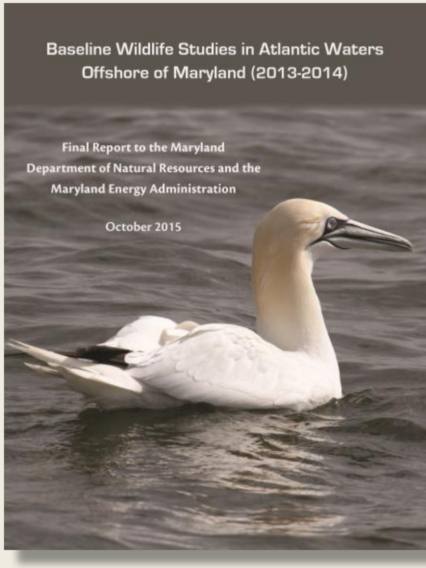
Reports and Data

- Final technical & summary reports
  - www.briloon.org/mabs/reports
  - Tethys Knowledge Base (http://tethys.pnnl.gov/knowledge-base)
- Survey data
  - www.briloon.org/mabs/data
  - Northwest Atlantic Seabird Catalog (FWS/BOEM)
  - MARCO Data Portal - Coming Soon!! (http://midatlanticocean.org/data-portal/)









Upcoming Webinar

- Study methods and methods comparisons
  - IEA Task 34 WREN webinar
  - Tuesday, December 2, 11 am-12:30 pm
  - http://tethys.pnnl.gov/events/wildlife-monitoring-and-wind-energy

This material is based upon work supported by:

U.S. Department of Energy
Maryland Department of Natural Resources
Maryland Energy Administration

(award DE-EE0005362)

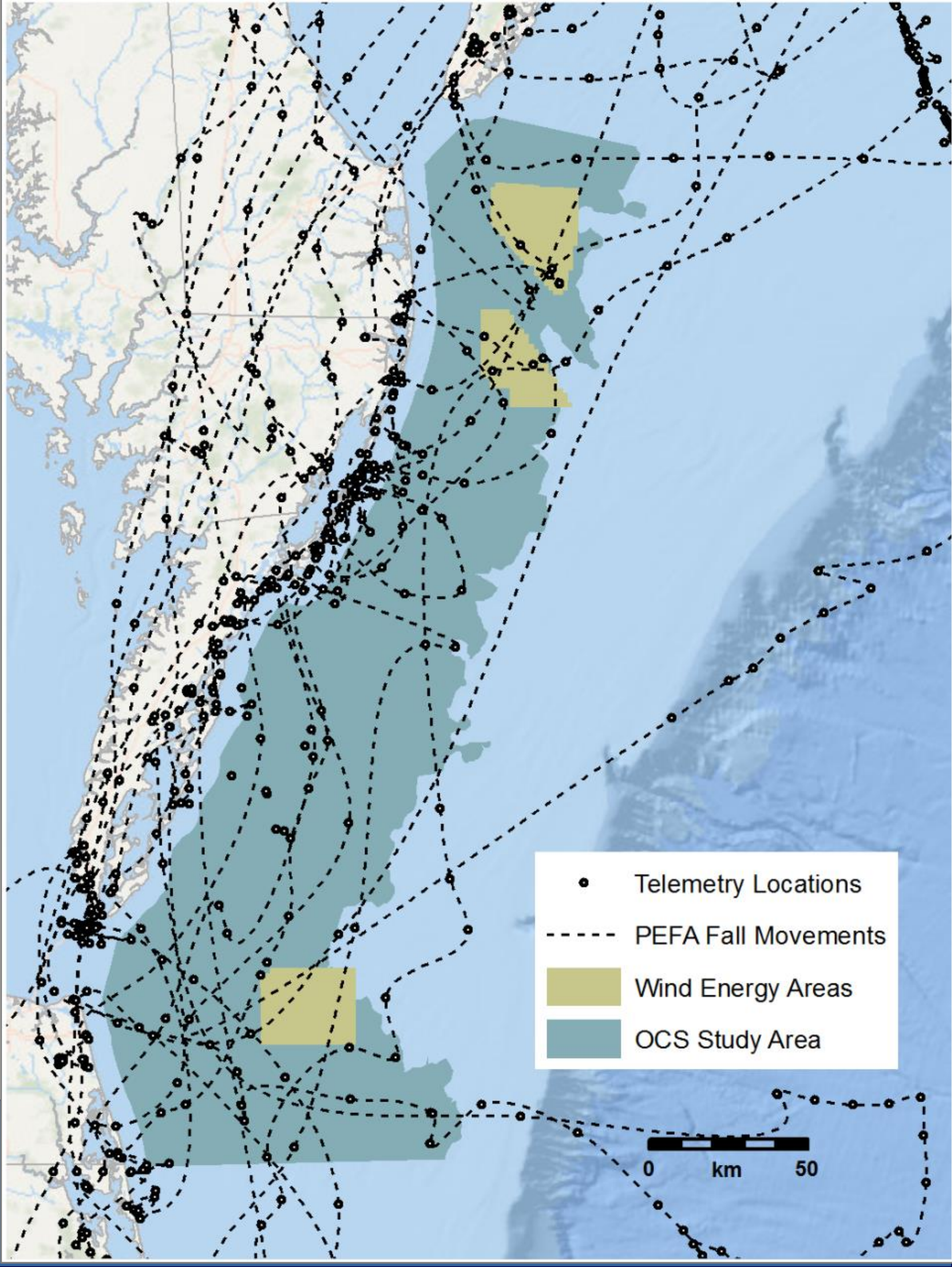
Photo © Kate Sutherland

Kate.williams@briloon.org

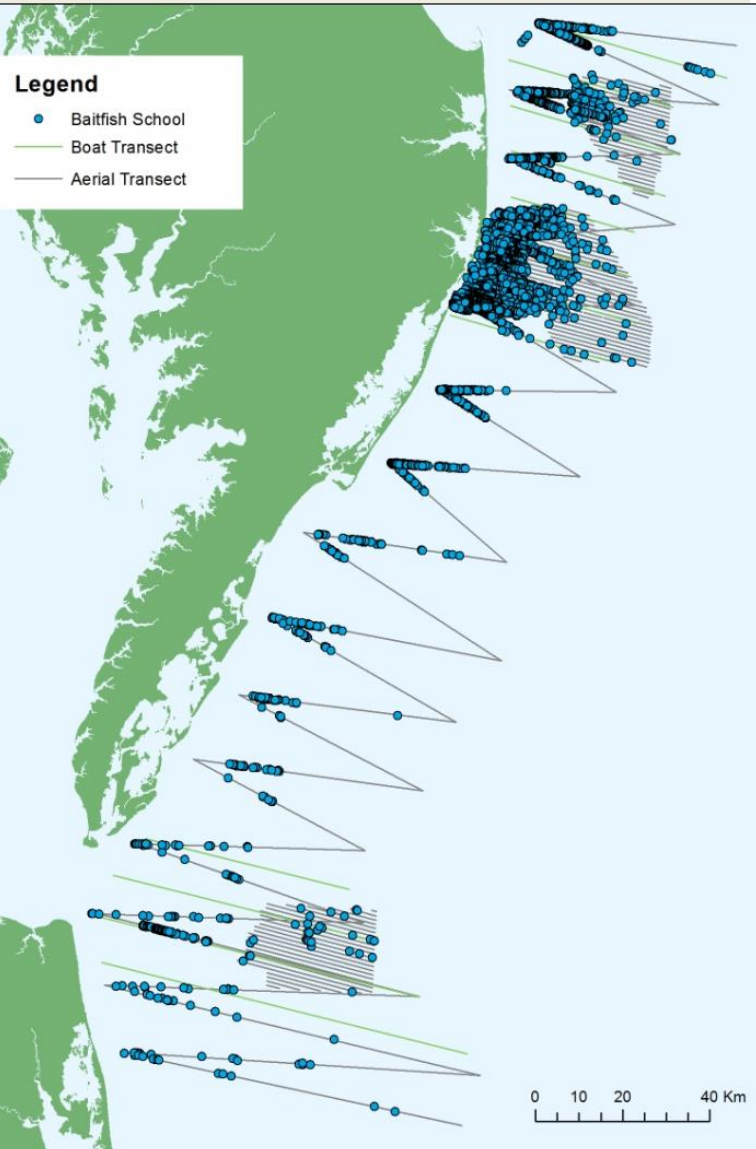
www.briloon.org/mabs

NC State University · CSI CUNY · Duke University · OSU Oregon State University · bri

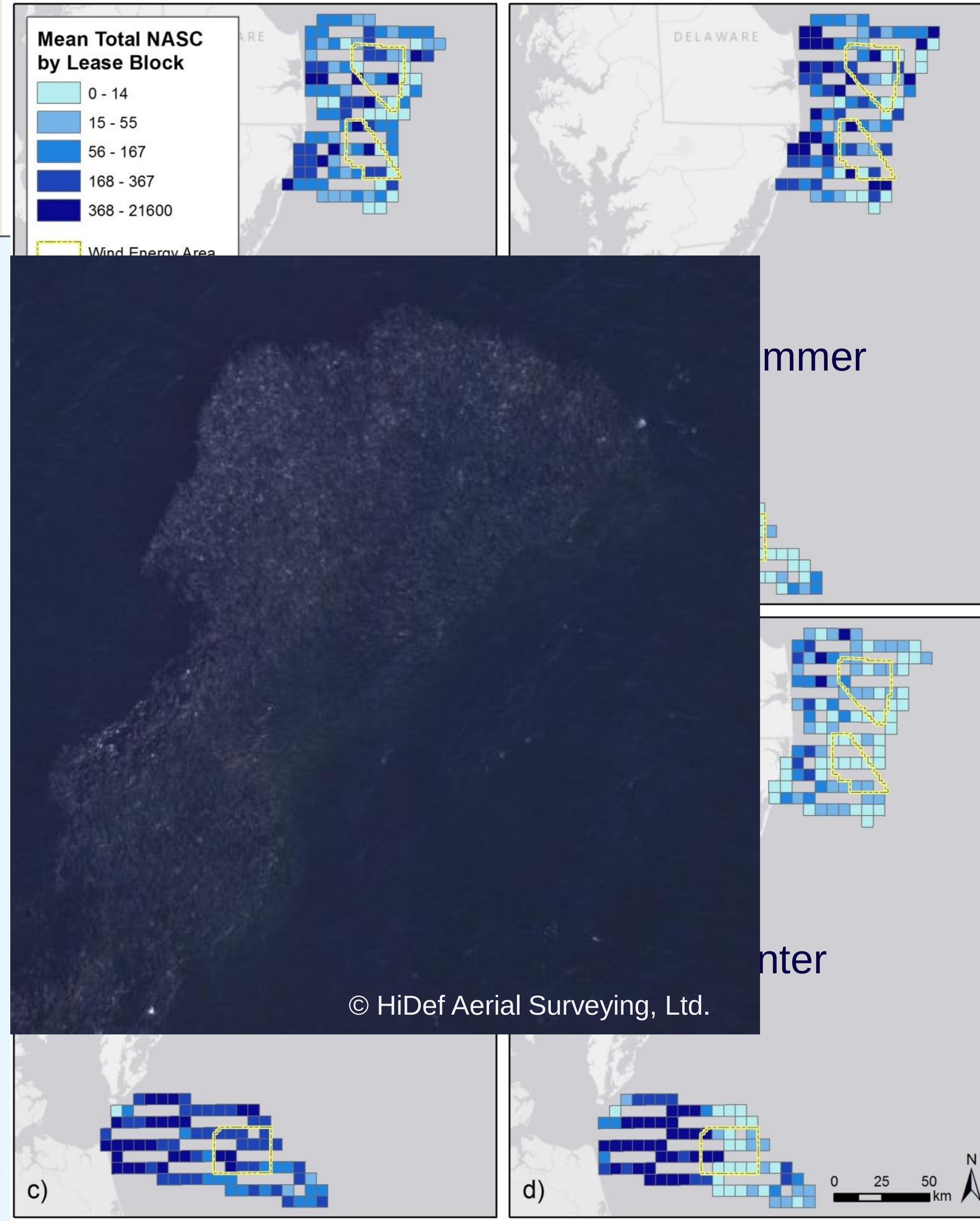
Peregrine Falcon migration



Forage Fish



Legend
Baitfish School
Boat Transect
Aerial Transect
0 10 20 40 Km

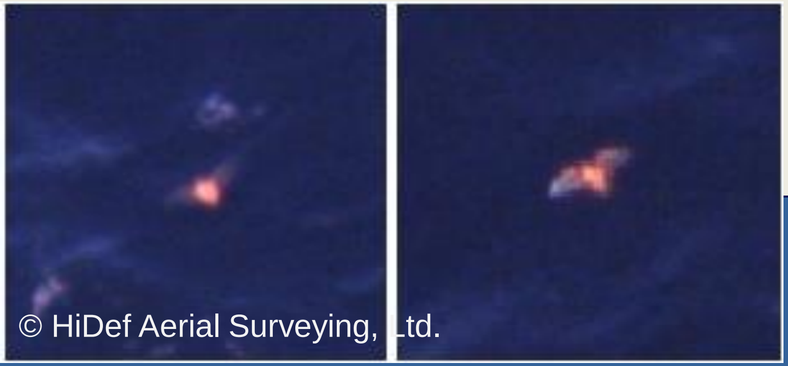


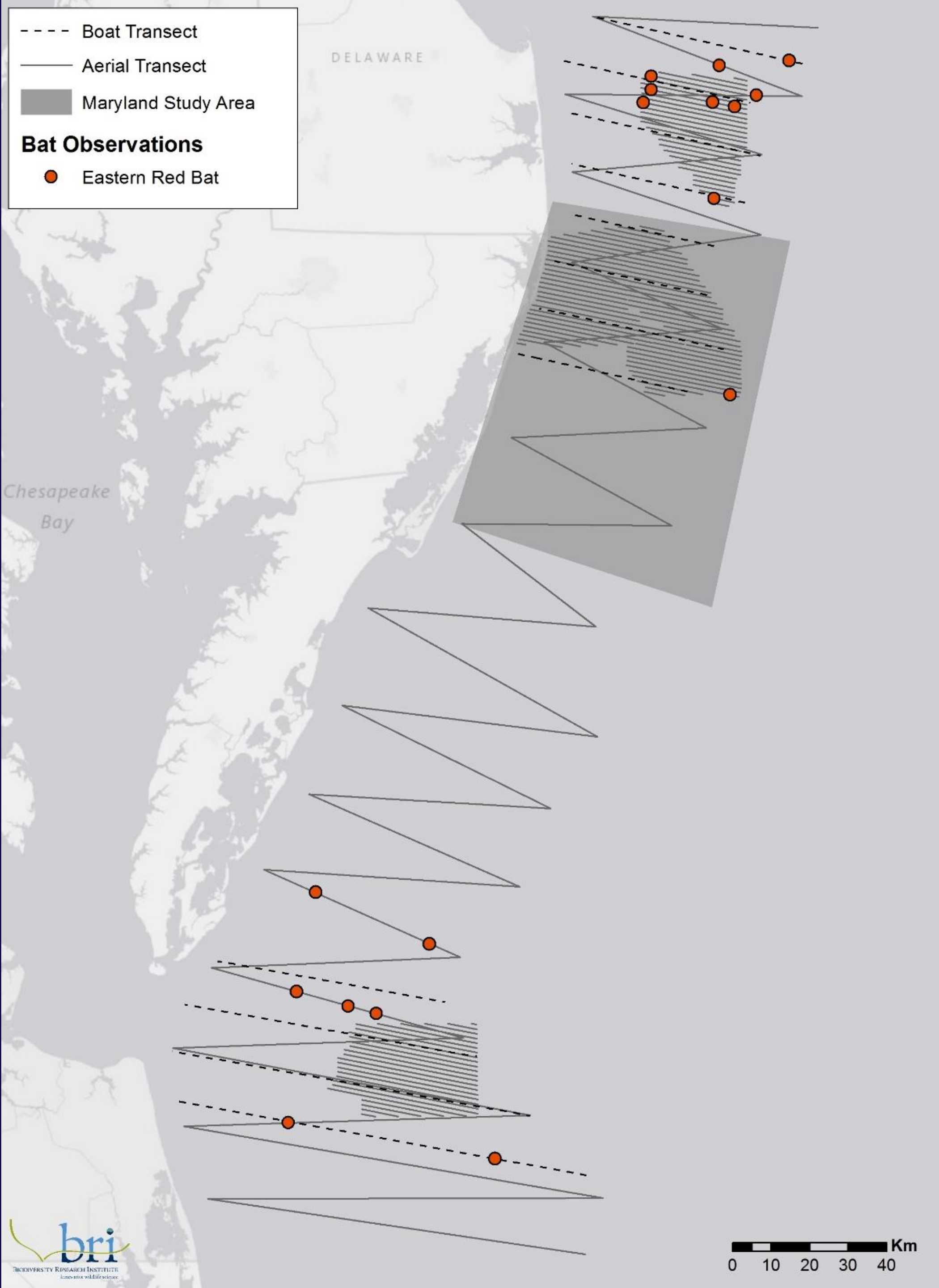
Mean Total NASC by Lease Block
0 - 14
15 - 55
56 - 167
168 - 367
368 - 21600
DELAWARE
mmer
nter
c)
d)
0 25 50 km
N
© HiDef Aerial Surveying, Ltd.

Bats

- 17 bats observed in surveys, mostly in digital aerial survey (~90%)
- Fall migration (September)
- 16 - 65 km offshore
- >200 m flight height (*n*=7)

Eastern Red Bats





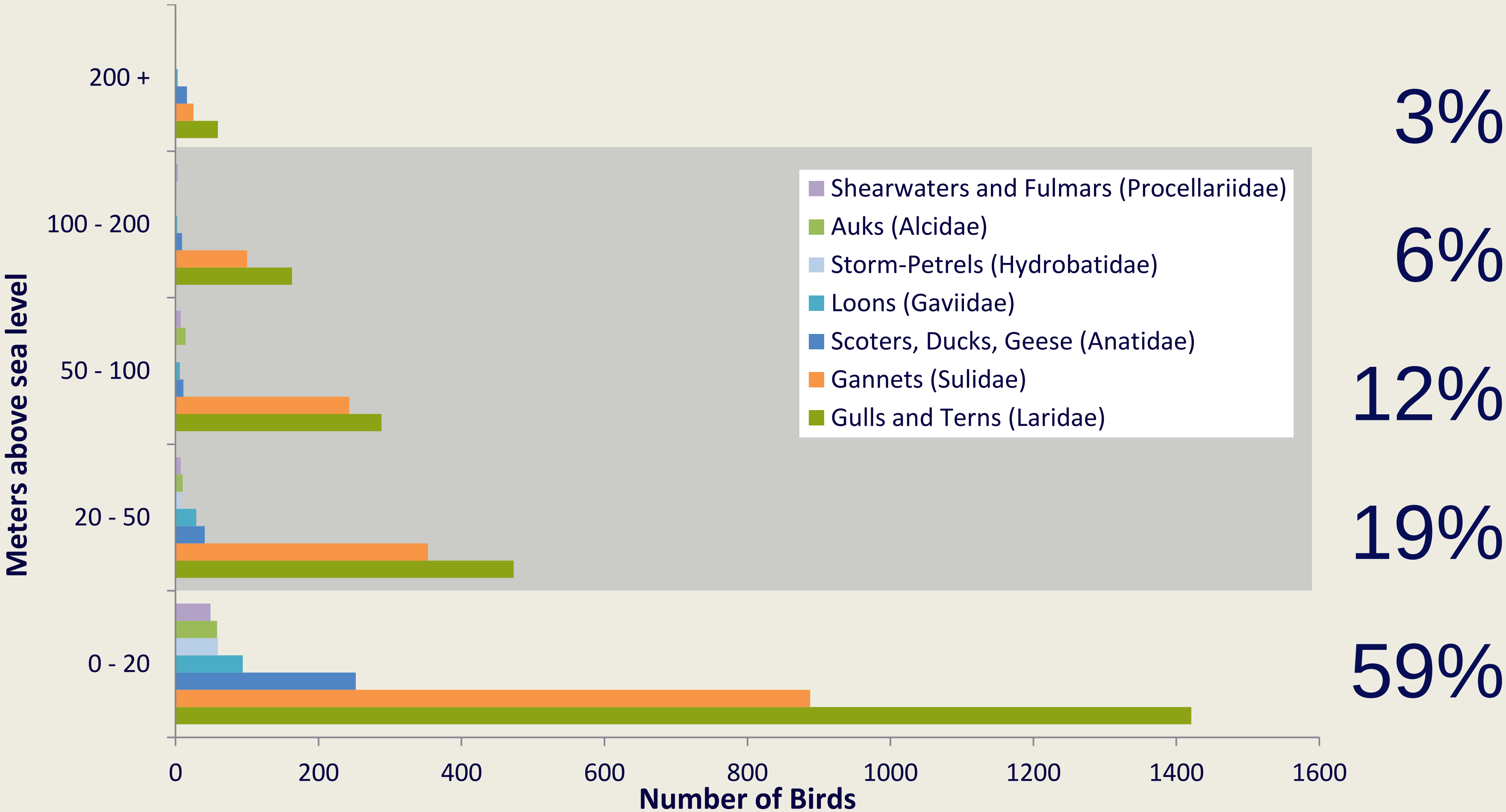
Sea turtles and Cownose Rays

- >12x as many turtles observed in digital aerial surveys as in boat-based surveys
  - Also better detection in digital aerial surveys than visual aerial? (Normandeau Assoc. Inc. 2012)
- >47,000 migrating Cownose Rays detected during aerial surveys

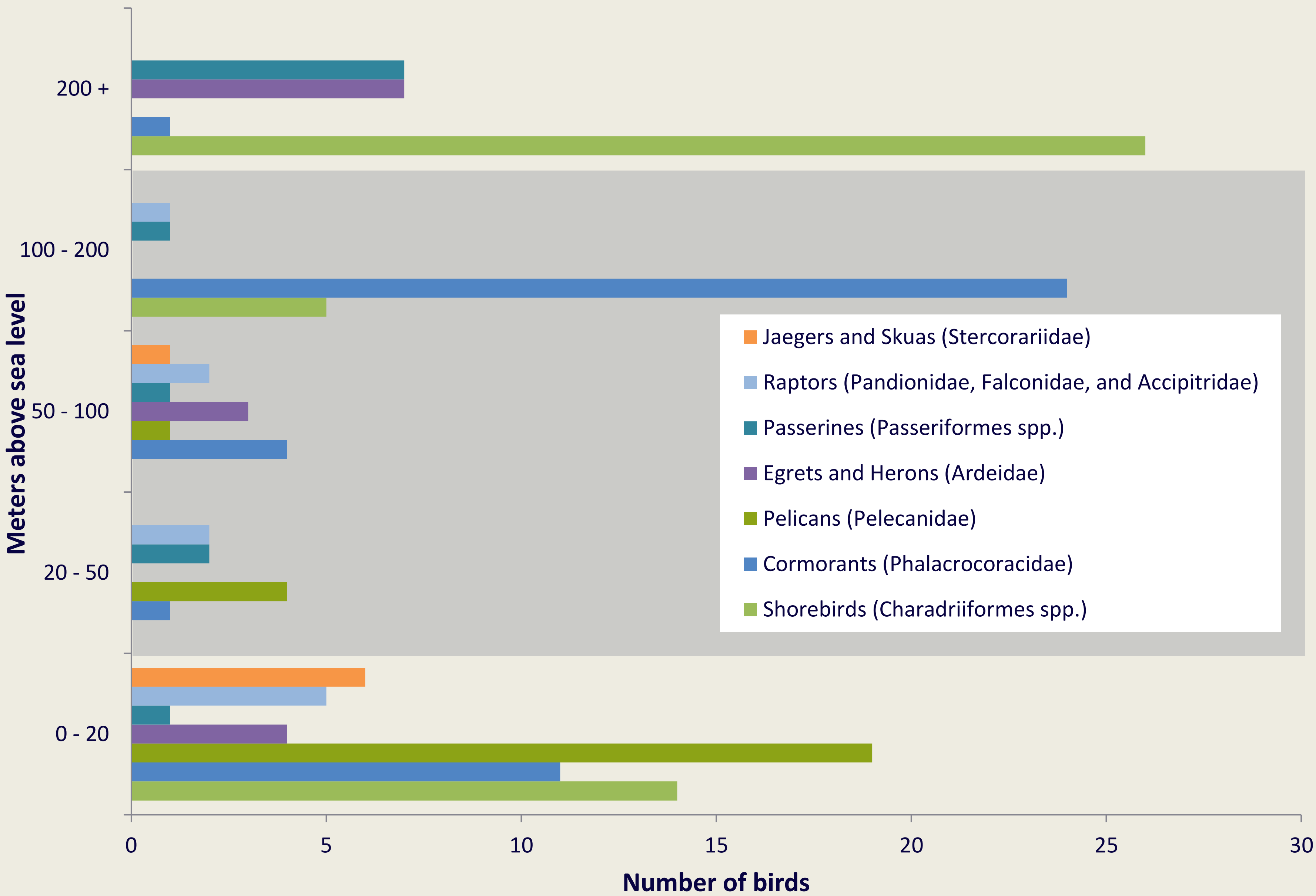
Images courtesy of HiDef Aerial Surveying ,Ltd.

Flight height estimation (n=5,299)

Parallax in digital video



(Hatch *et al*. 2013, PLoS ONE)

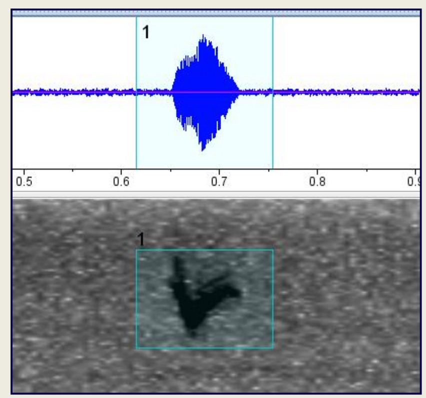


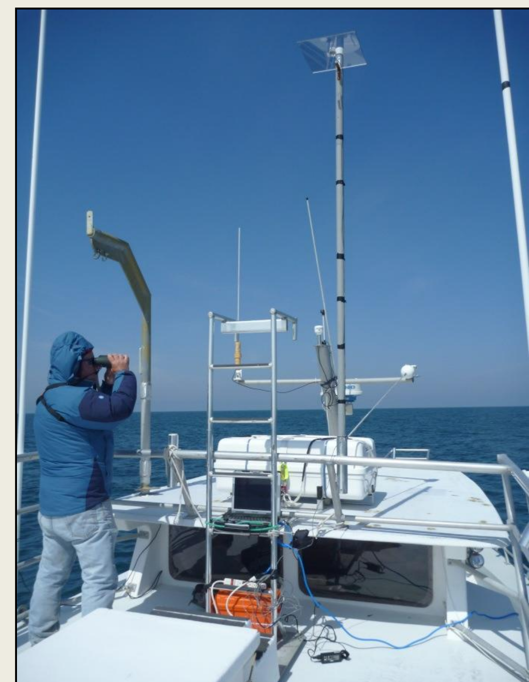
200 +
100 - 200
50 - 100
20 - 50
0 - 20
Meters above sea level
0
5
10
15
20
25
30
Number of birds
Jaegers and Skuas (Stercorariidae)
Raptors (Pandionidae, Falconidae, and Accipitridae)
Passerines (Passeriformes spp.)
Egrets and Herons (Ardeidae)
Pelicans (Pelecanidae)
Cormorants (Phalacrocoracidae)
Shorebirds (Charadriiformes spp.)

bri

Nocturnal Migration Monitoring

- NEXRAD: Next Generation Radar
- Nocturnal avian passive acoustic monitoring

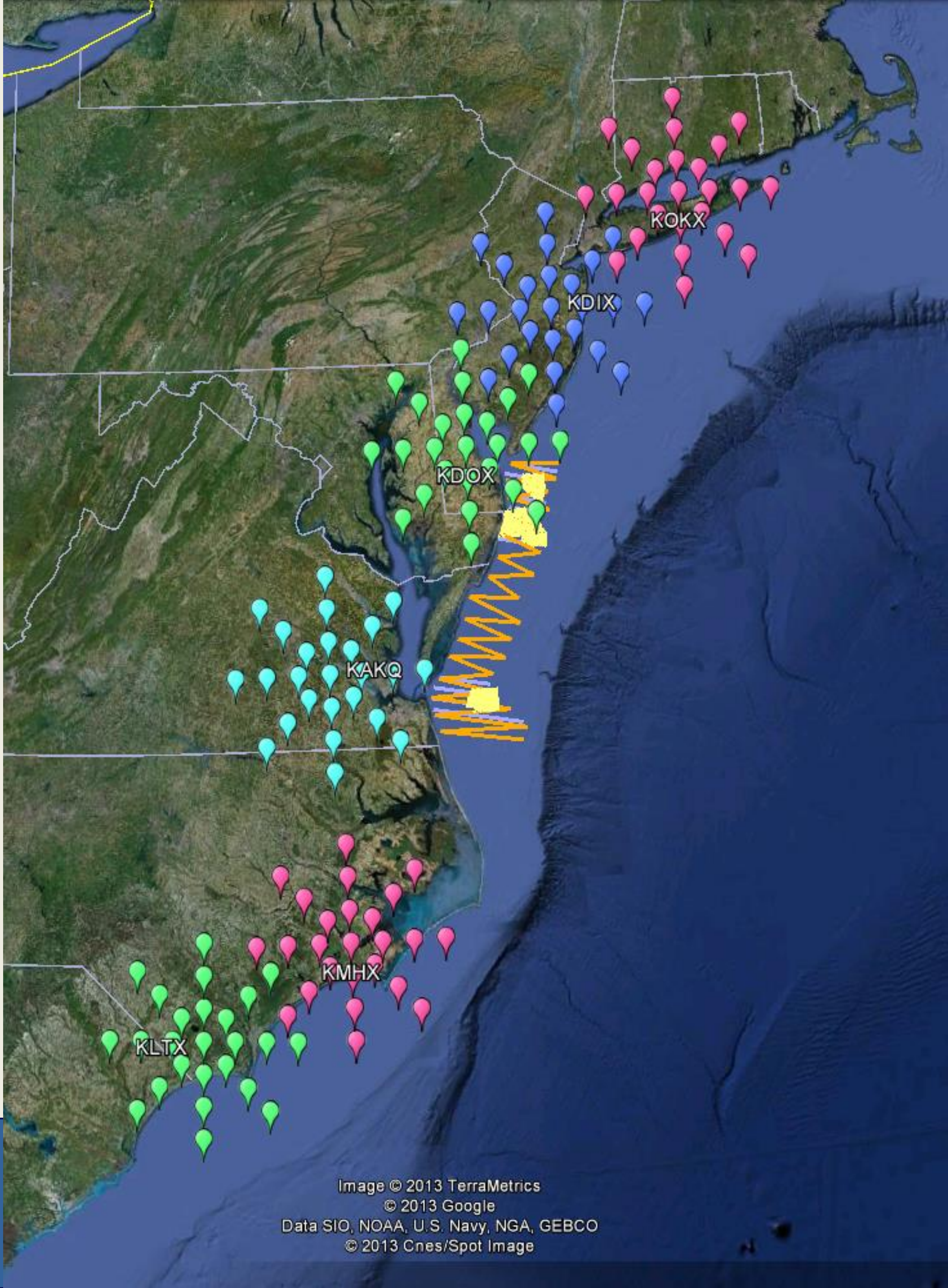




Left, images courtesy of the University of Oklahoma Animal Migration Research Group (www.soar.ou.edu). Right © Emily Connelly-BRI

WSR-88D Radar (NEXRAD)

- 6 radars
- 144 sites
- Measure of average flight activity during 6 hr period around midnight
- Compare radar activity between sites across the landscape



bri

Nocturnal avian migration