Risks to Birds and Wildlife from Offshore Wind Farms: BOEMRE NC Task Force

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Merged results of two studies with multiple partners:

- UNC-Chapel Hill Wind Power Feasibility – 2009 - funded by the North Carolina General Assembly
- UNC-Chapel Hill Survey of Seabirds and Wildlife for Risk Assessment -2011 – funded by Duke Energy

COASTAL WIND

Energy for North Carolina's Future

A Study of the Feasibility
of Wind Turbines in the
Pamlico and Albemarle Sounds
and in Ocean Waters
Off the North Carolina Coast

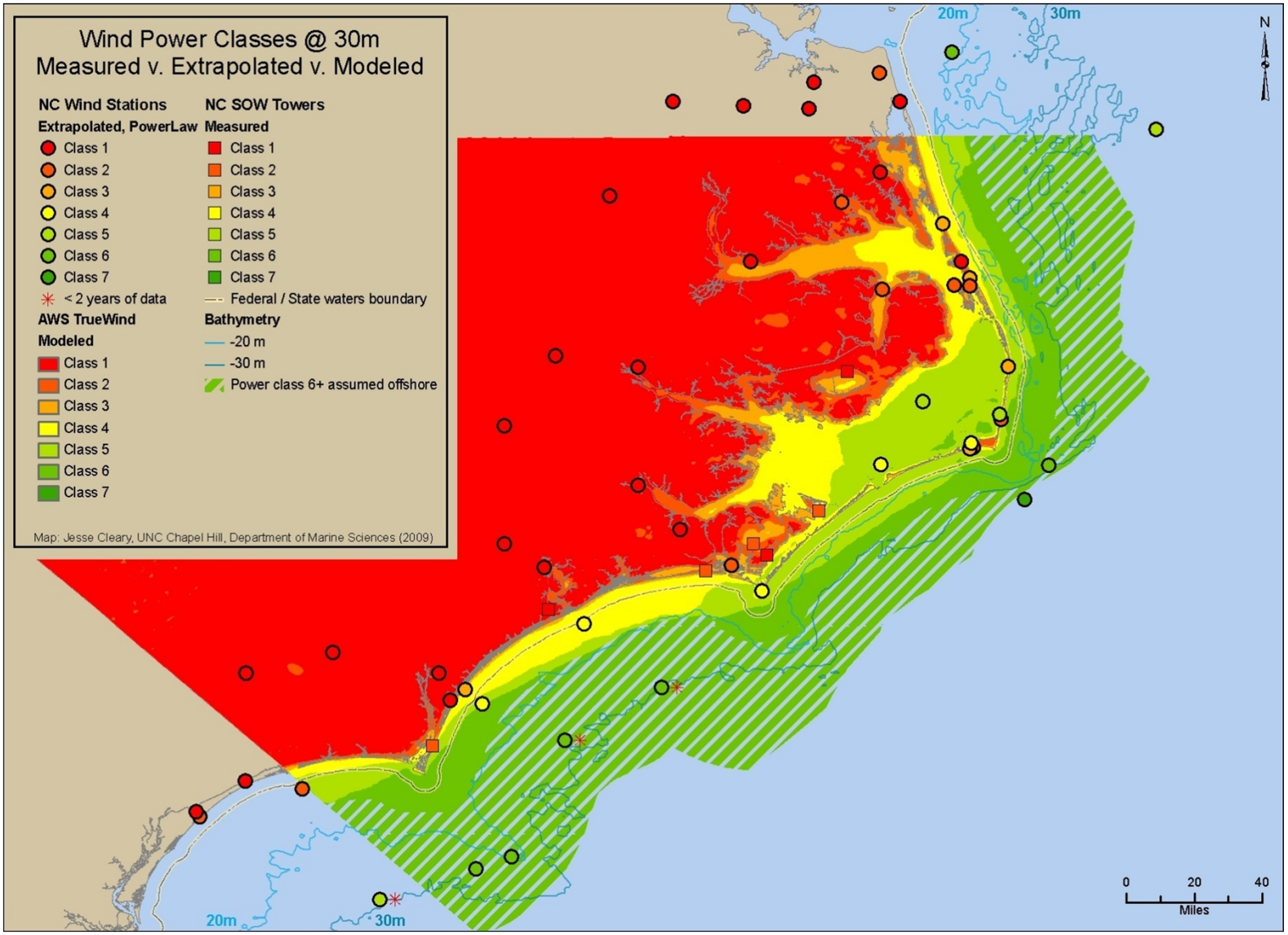
THE UNIVERSITY
of NORTH CAROLINA
at CHAPEL HILL

Prepared for the North Carolina General Assembly by the University of North Carolina at Chapel Hill | June 2009

Coastal Wind Energy Study

- Requested by the North Carolina General Assembly
- University of North Carolina at Chapel Hill designated to conduct the study beginning in Fall 2008
- Study completed in June 2009; full report available: www.climate.unc.edu/coastal-wind
- Study area
  - Pamlico and Albemarle Sounds
  - Coastal ocean in waters less than 30 meters in depth (wind assessment to 50 meters in depth)

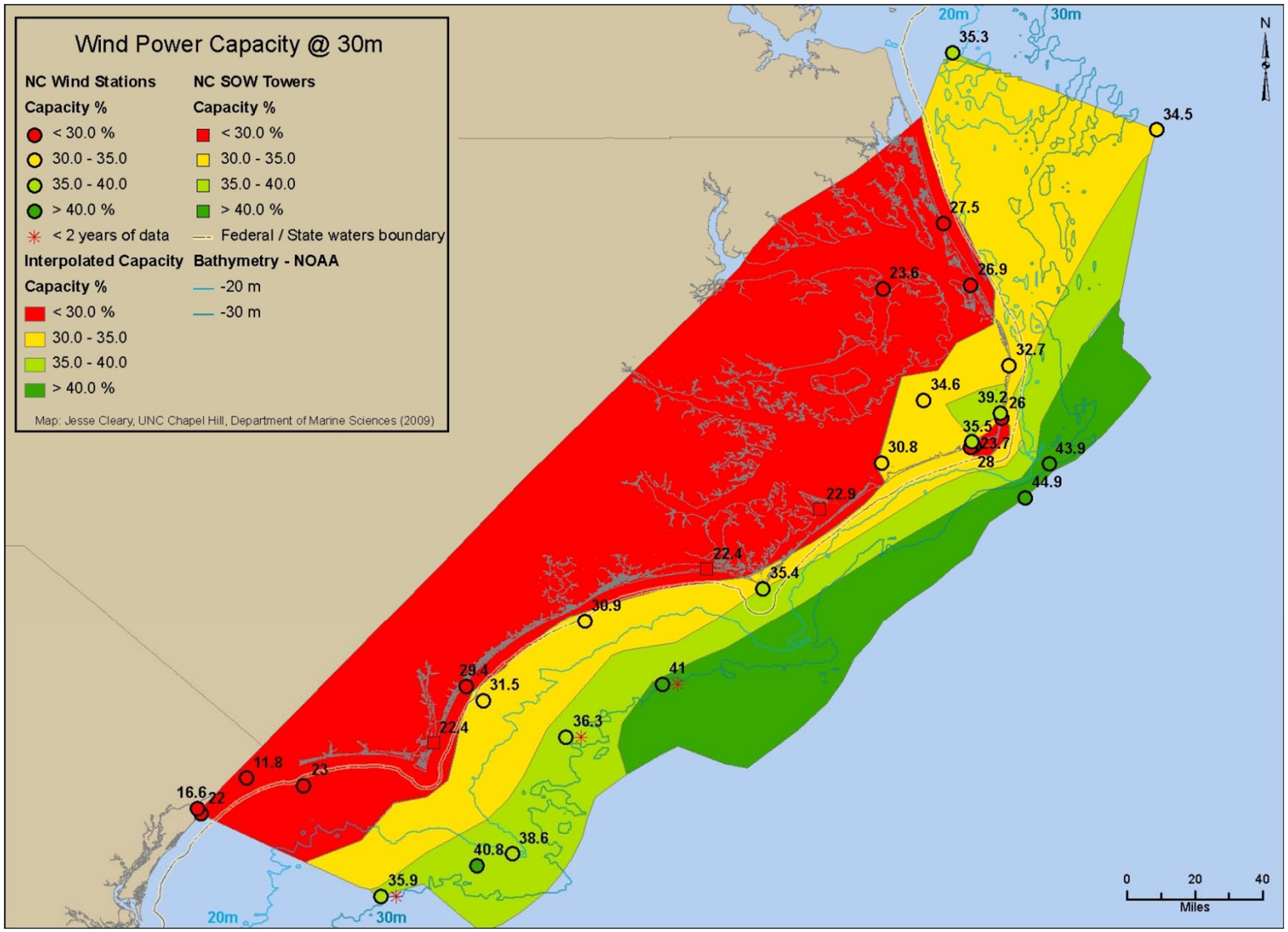
Wind Power Class



Capacity Factor

- Power generation is dependent on the generator used
- Simple but realistic approach is to use power curve for common wind turbine to convert wind speed to power
- Power curves for 3-3.6 MW turbines all similar – kick-in speed of 3-5 m/s, rated power at 15 m/s, no output above 25 m/s
- Capacity factor is simply the average output from a generator divided by its maximum output, expressed as a percentage
- Used measured over-water wind records to estimate capacity factor

Capacity Factor Map



Ecological Impacts, Synergies, Use Conflicts

C. Peterson (Marine Sciences, UNC Chapel Hill)
S. Fegley (Marine Sciences, UNC Chapel Hill)
Joan Meiners (Marine Sciences, UNC Chapel Hill)

- Mortality risks to birds and bats from direct contact with rotors and pressure effects of vortices: risks of displacement from habitat
- Risks to marine mammals, sea turtles, fish, and bottom-dwelling invertebrates and key habitats
- Conflicts with commercial fishing and recreation
- Synergies with other ecosystem services
- Conflicts with military, sand mining, and cultural (including NPS viewscapes and shipwrecks) uses

Procedure for Estimating Risk

Interview experts, managers, bird watchers, fishermen, and duck hunters:

- 54 in-person interviews
- 5 phone interviews

Review relevant literature:

- 21 environmental assessments
- 21 government reports
- 40 peer-reviewed articles
- 14 unpublished manuscripts

Accumulate and organize pertinent information:

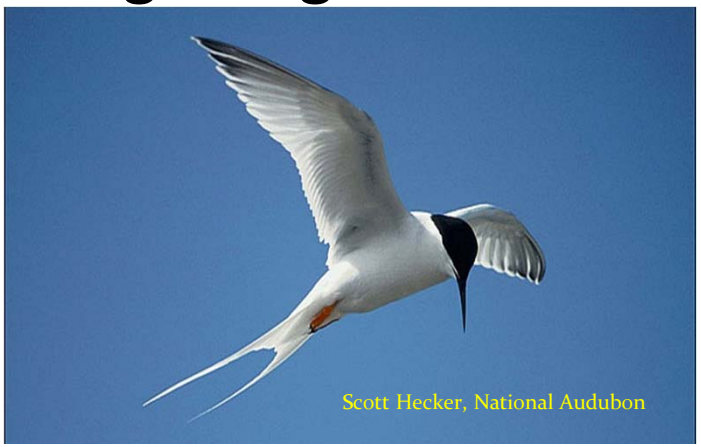
- distributions and temporal patterns of organisms
- possible presence of endangered, threatened, or species of concern
- specific behavioral responses to structures, noises, and visual cues
- distribution of fishery habitat and fishing activities

Estimation of risk:

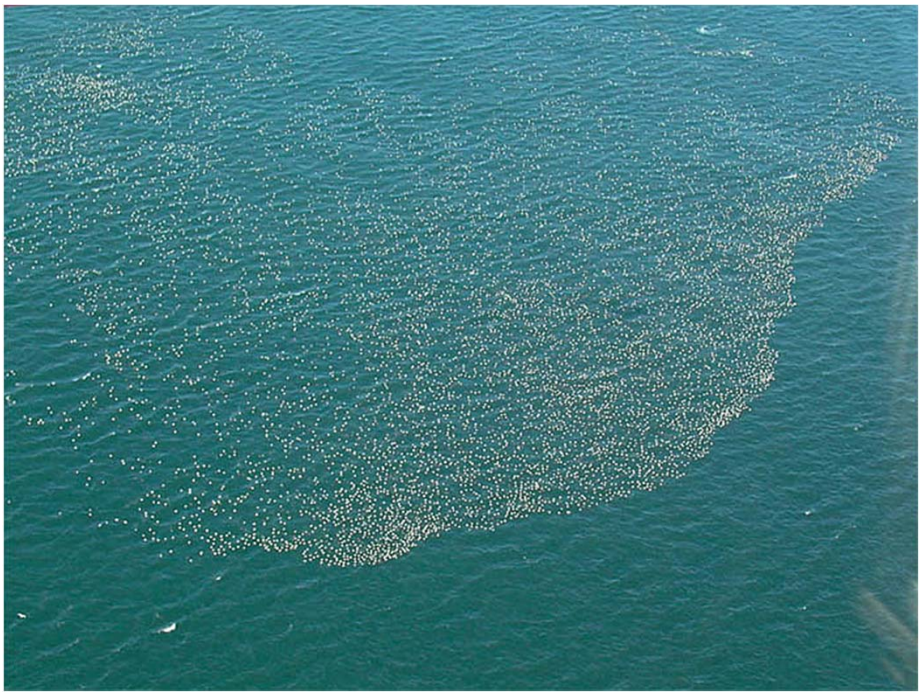
- examine accumulated information for patterns and specific concerns
- use general ecological data and paradigms to reduce uncertainty
- consult with experts again on preliminary assessments

Bird and Bat Risk Distribution

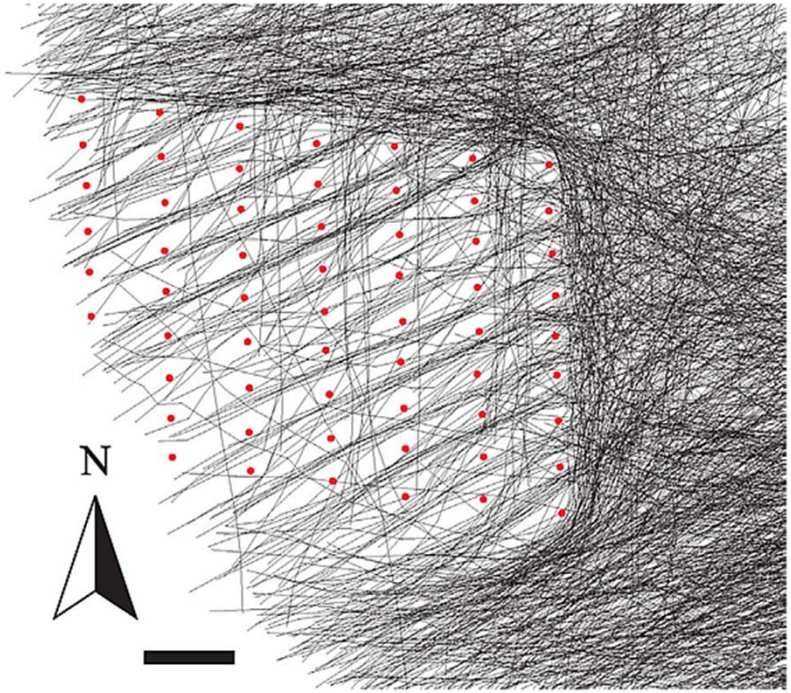
- Risk assessment – combines abundance and behavior
  - Mortality risk from encounter with blades
  - Turbine avoidance can also reduce fitness by exclusion from key foraging habitat or by energetic costs of inducing longer flight paths (especially for migrating shorebirds and ducks)



Behavioral Responses (an example)



Aerial photograph of a flock (a “raft”) of 20,000 common eiders – photograph by Simon Perkins, Mass Audubon



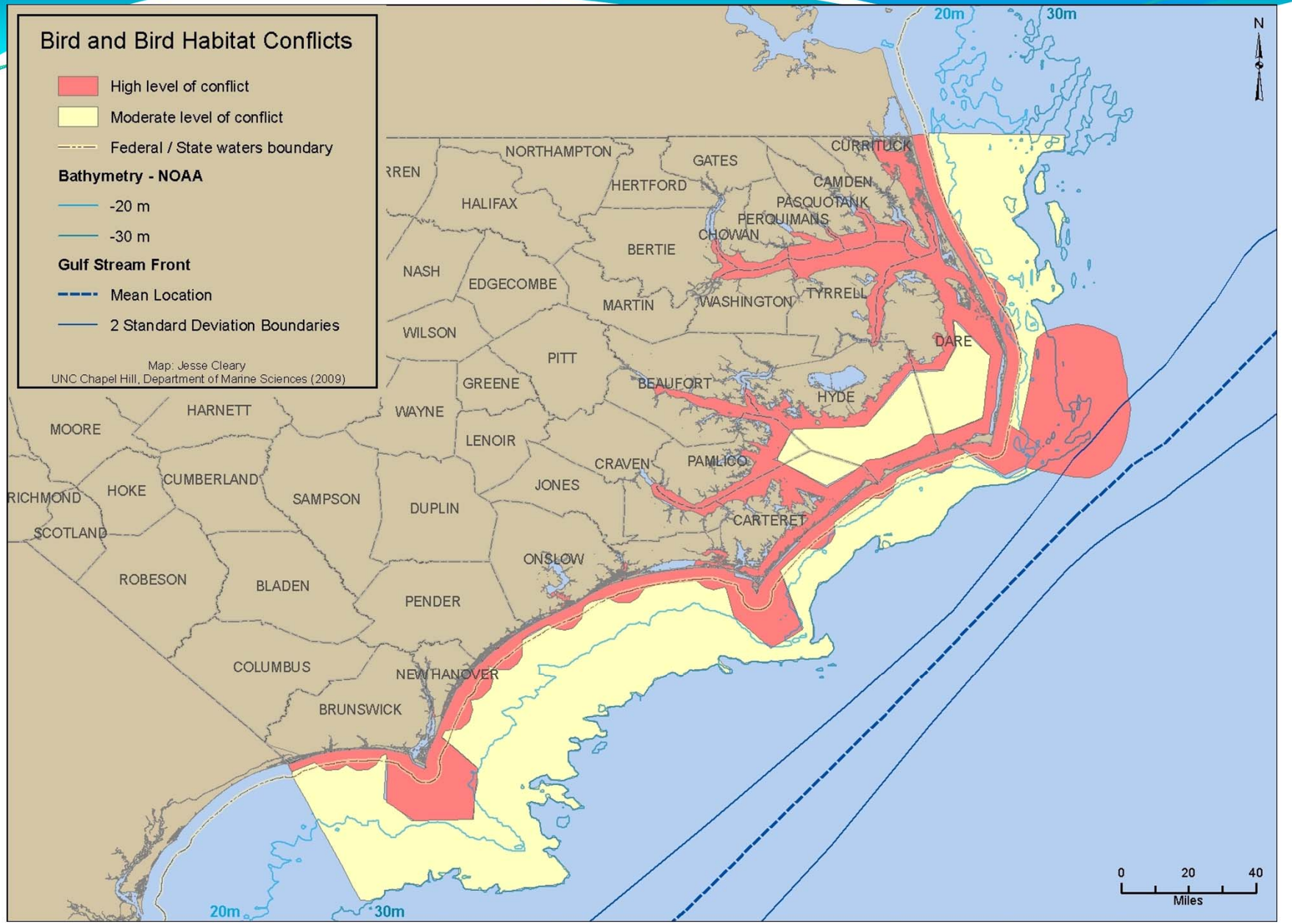
Compilation of radar tracks for common eiders and geese flying near and through an offshore, Danish wind mill farm (individual mills are represented by red dots – Desholm and Kahlert 2005). These results are controversial; the wind mills interfere with the radar used to document flight paths.

Bird and Bat Risk Distribution

- Birds at risk
  - Passerines (songbirds) during their nocturnal, seasonal (fall, spring)migrations
  - Threatened and endangered (piping plover, roseate tern, Bermuda petrel) plus declining species (red knot, other migrating shorebird species) during fall/spring migrations and summer/winter residence
  - Large-bodied, slow fliers (pelicans, gulls)
  - True pelagic seabirds (albatross) – Gulf Stream risks
- Bats at risk – migrating insectivorous species on land

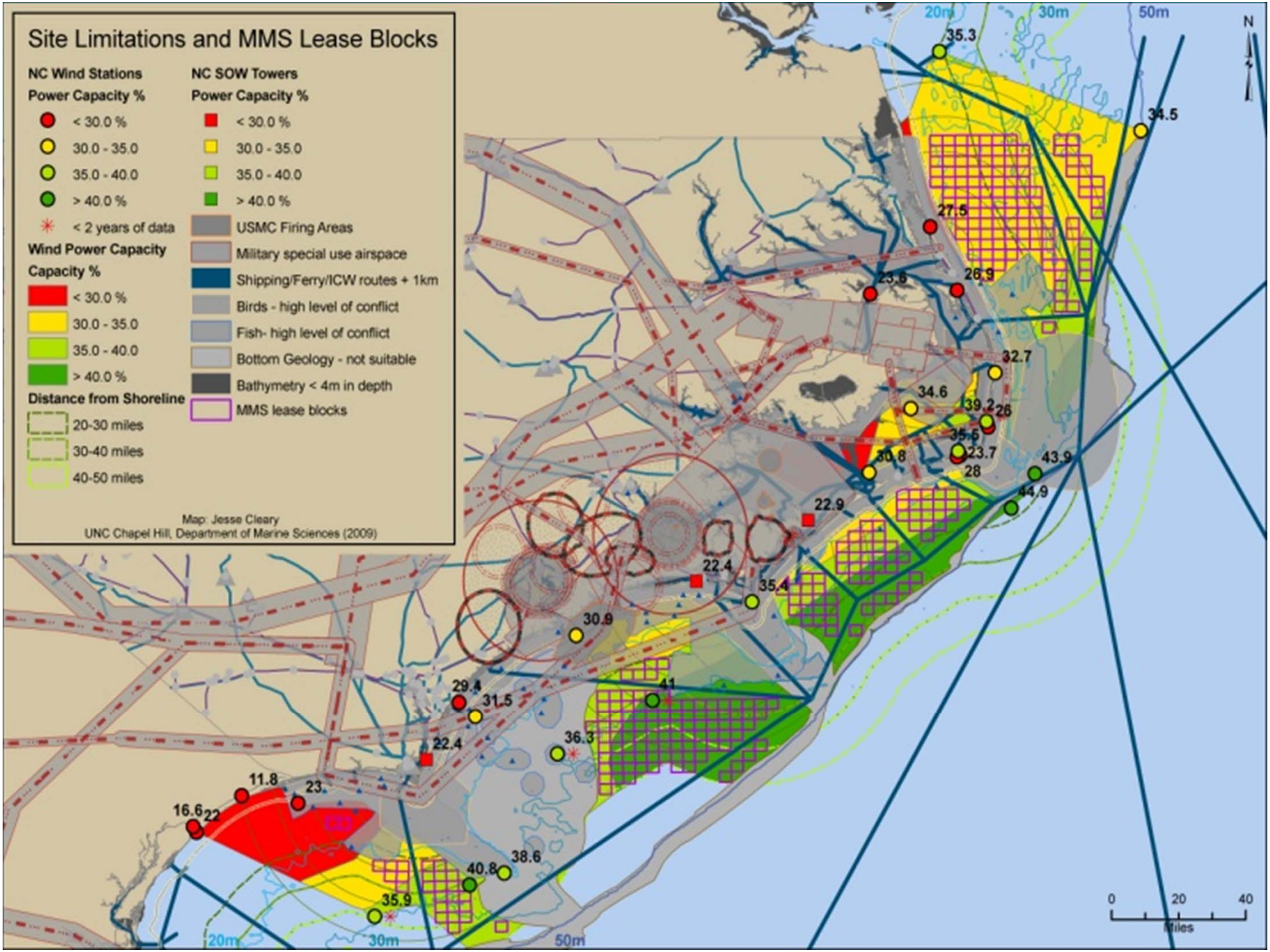
Avoid High-Use Sites to Protect Seabirds

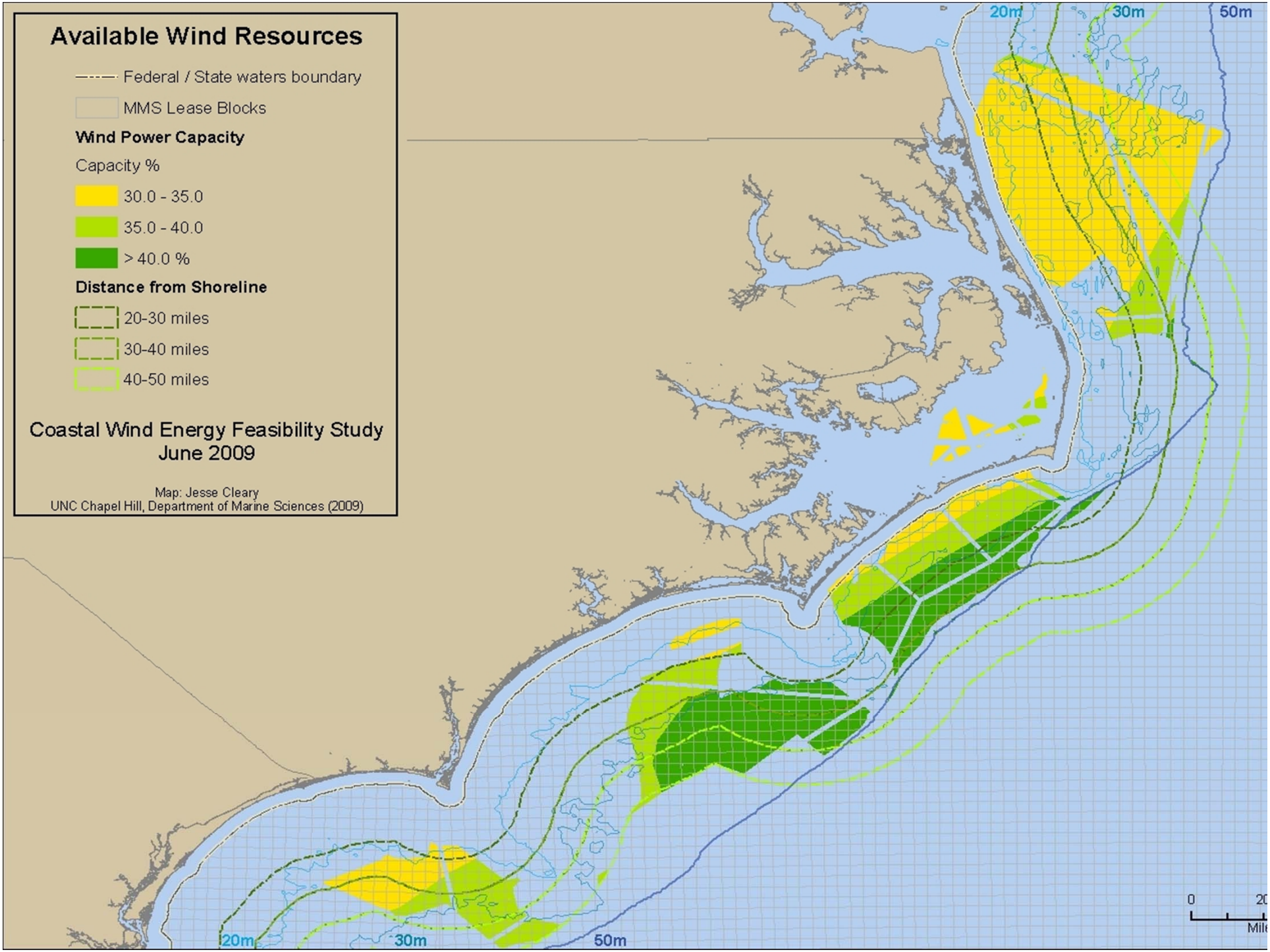
- Gulf Stream track range plus buffer around it
- All 3 capes (Hatteras, Lookout, Fear)
- The “Point” where Gulf Stream and Labrador Current meet and diversity and productivity are high
- Radius of 5 miles around each inlet
- Shallow waters less than 4 m depth
- Localities near any land – separation by at least 2 miles


Bird and Bird Habitat Conflicts
High level of conflict
Moderate level of conflict
Federal / State waters boundary
Bathymetry - NOAA
-20 m
-30 m
Gulf Stream Front
Mean Location
2 Standard Deviation Boundaries
Map: Jesse Cleary
UNC Chapel Hill, Department of Marine Sciences (2009)
20m
30m
N
NORTHAMPTON
GATES
CURRITUCK
HERTFORD
CAMDEN
HALIFAX
PASQUOTANK
PERQUIMANS
CHOWAN
BERTIE
NASH
EDGECOMBE
MARTIN
WASHINGTON
TYRRELL
WILSON
DARE
PITT
GREENE
BEAUFORT
HYDE
HARNETT
WAYNE
MOORE
LENOIR
CRAVEN
PAMLICO
CUMBERLAND
HOKE
JONES
SAMPSON
DUPLIN
CARTERET
SCOTLAND
ONSLOW
ROBESON
BLADEN
PENDER
COLUMBUS
NEW HANOVER
BRUNSWICK
0
20
40
Miles

Sea Turtles and Marine Mammals

- Protected under Endangered Species Act and/or Marine Mammal Protection Act
- Risk of noise during installation – resulting in displacement, hearing injury, and/or communication disruptions
  - Right and humpback whales and others – winter/spring in ocean
  - Loggerhead, Kemp's ridley, green, leatherback – year-round in ocean and sound
  - Bottlenose dolphin – all year in ocean and sound
  - Manatee – summer/fall in sound
- Risk during operation – electromagnetic fields around cable

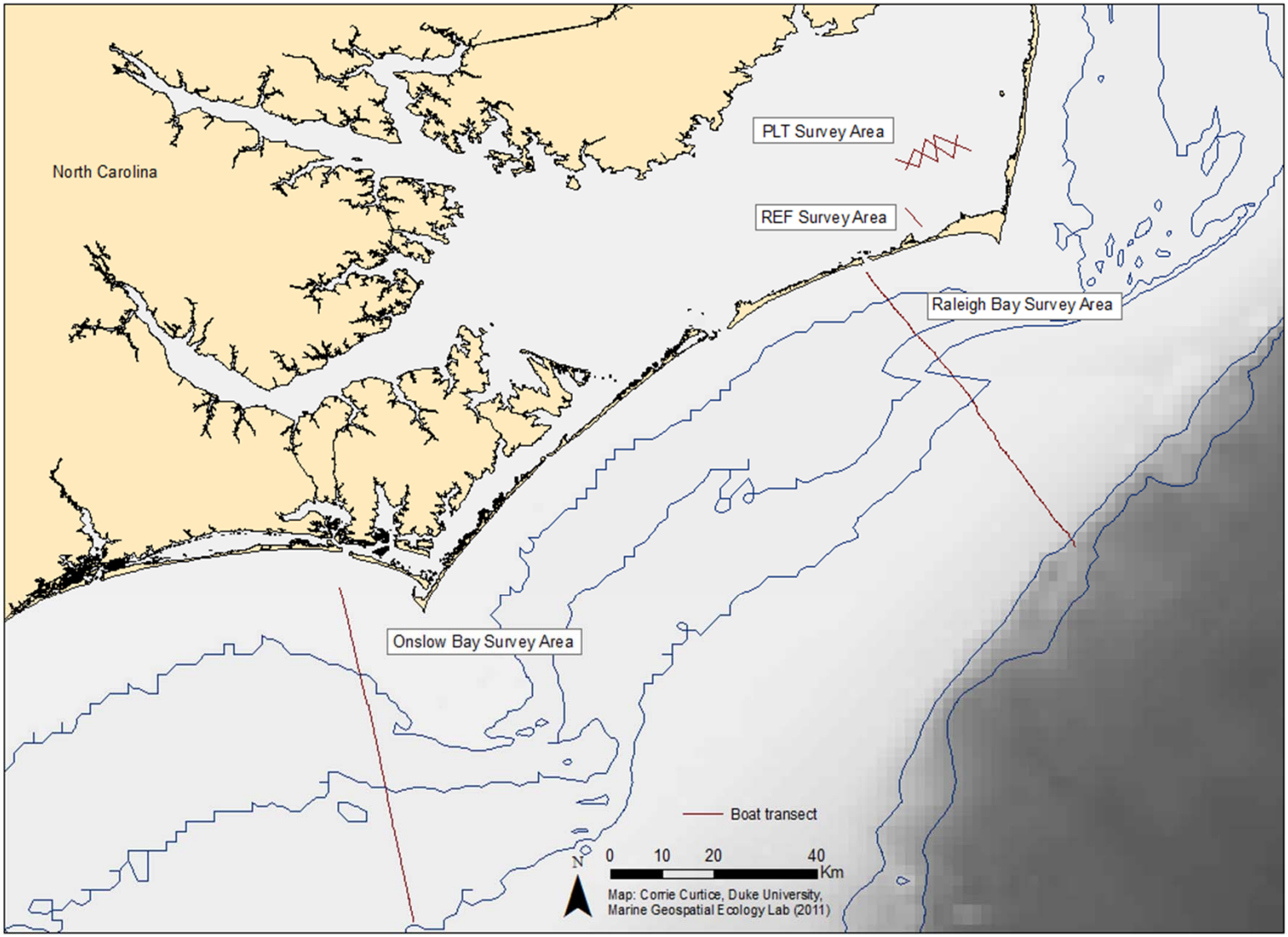

Site Limitations and MMS Lease Blocks
NC Wind Stations
Power Capacity %
< 30.0 %
30.0 - 35.0
35.0 - 40.0
> 40.0 %
< 2 years of data
NC SOW Towers
Power Capacity %
< 30.0 %
30.0 - 35.0
35.0 - 40.0
> 40.0 %
USMC Firing Areas
Military special use airspace
Shipping/Ferry/ICW routes + 1km
Birds - high level of conflict
Fish- high level of conflict
Bottom Geology - not suitable
Bathymetry < 4m in depth
MMS lease blocks
Wind Power Capacity
Capacity %
< 30.0 %
30.0 - 35.0
35.0 - 40.0
> 40.0 %
Distance from Shoreline
20-30 miles
30-40 miles
40-50 miles
Map: Jesse Cleary
UNC Chapel Hill, Department of Marine Sciences (2009)
20m
30m
50m
N
0
20
40
Miles


Available Wind Resources
Federal / State waters boundary
MMS Lease Blocks
Wind Power Capacity
Capacity %
30.0 - 35.0
35.0 - 40.0
> 40.0 %
Distance from Shoreline
20-30 miles
30-40 miles
40-50 miles
Coastal Wind Energy Feasibility Study
June 2009
Map: Jesse Cleary
UNC Chapel Hill, Department of Marine Sciences (2009)
20m
30m
50m
20m
30m
50m
0

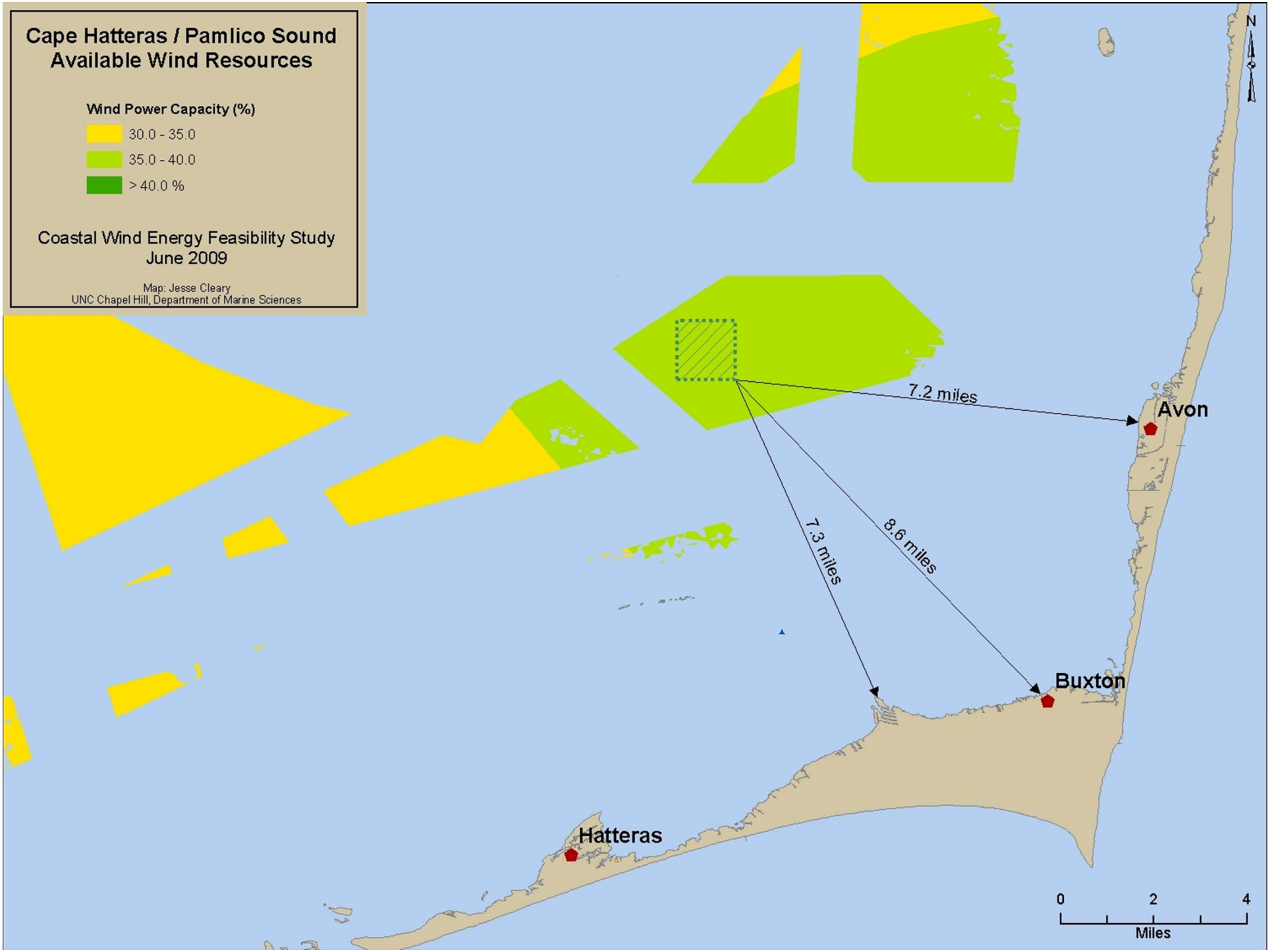
Duke Energy Survey of Seabirds and Wildlife for Risk Assessments

- Pamlico Sound - 98 days of small-boat surveys from Jan 2010 – Jan 2011 - half in calm (<10 knots), half in windy (10-25 knots) condition at boat speed of 6 knots
  - Potential Pilot site 7-10 miles out in sound
  - Reference site near shore inside of reef
- Coastal ocean shelf: from inlet out to 57-65 km
  - Into Raleigh Bay from Hatteras Inlet – 21 surveys
  - Into Onslow Bay from Beaufort Inlet – 4 surveys

North Carolina Central Coast



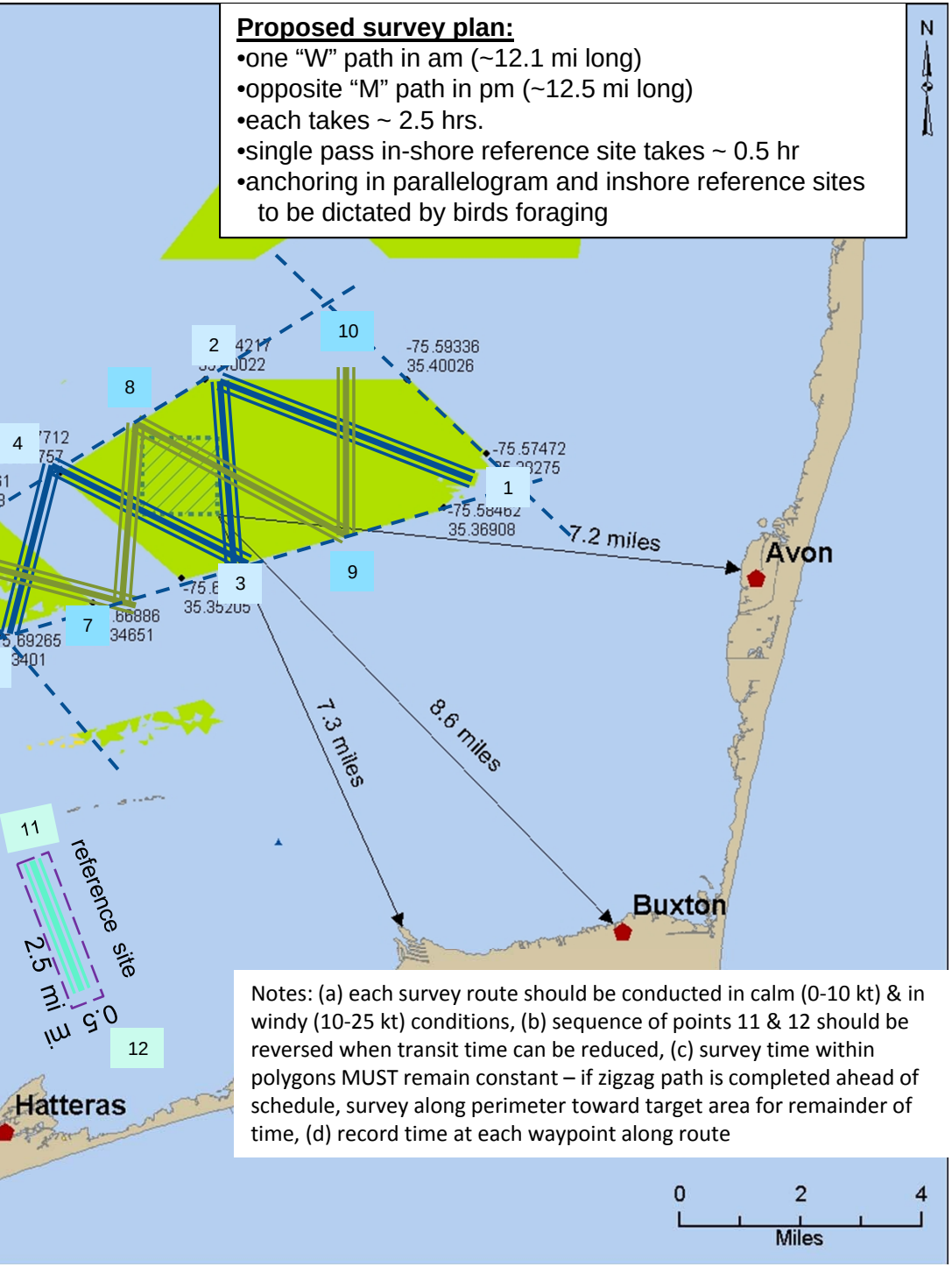
Map of central North Carolina coast showing transect locations for surveys in the pilot (PLT) and reference (REF) areas in Pamlico Sound, and in the offshore areas of northern Raleigh Bay and eastern Onslow Bay


Cape Hatteras / Pamlico Sound
Available Wind Resources
Wind Power Capacity (%)
30.0 - 35.0
35.0 - 40.0
> 40.0 %
Coastal Wind Energy Feasibility Study
June 2009
Map: Jesse Cleary
UNC Chapel Hill, Department of Marine Sciences
N
7.2 miles
7.3 miles
8.6 miles
Avon
Buxton
Hatteras
0
2
4
Miles

Waypoint	Latitude	Longitude
1	35.36012	-75.7085
2	35.34651	-75.6689
3	35.3939	-75.6569
4	35.3618	-75.6082
5	35.4032	-75.6028
6	35.3401	-75.6927
7	35.3776	-75.6771
8	35.3552	-75.6362
9	35.4002	-75.6422
10	35.3763	-75.5773
11	35.2763	-75.6918
12	35.2450	-75.6623

Proposed survey plan:

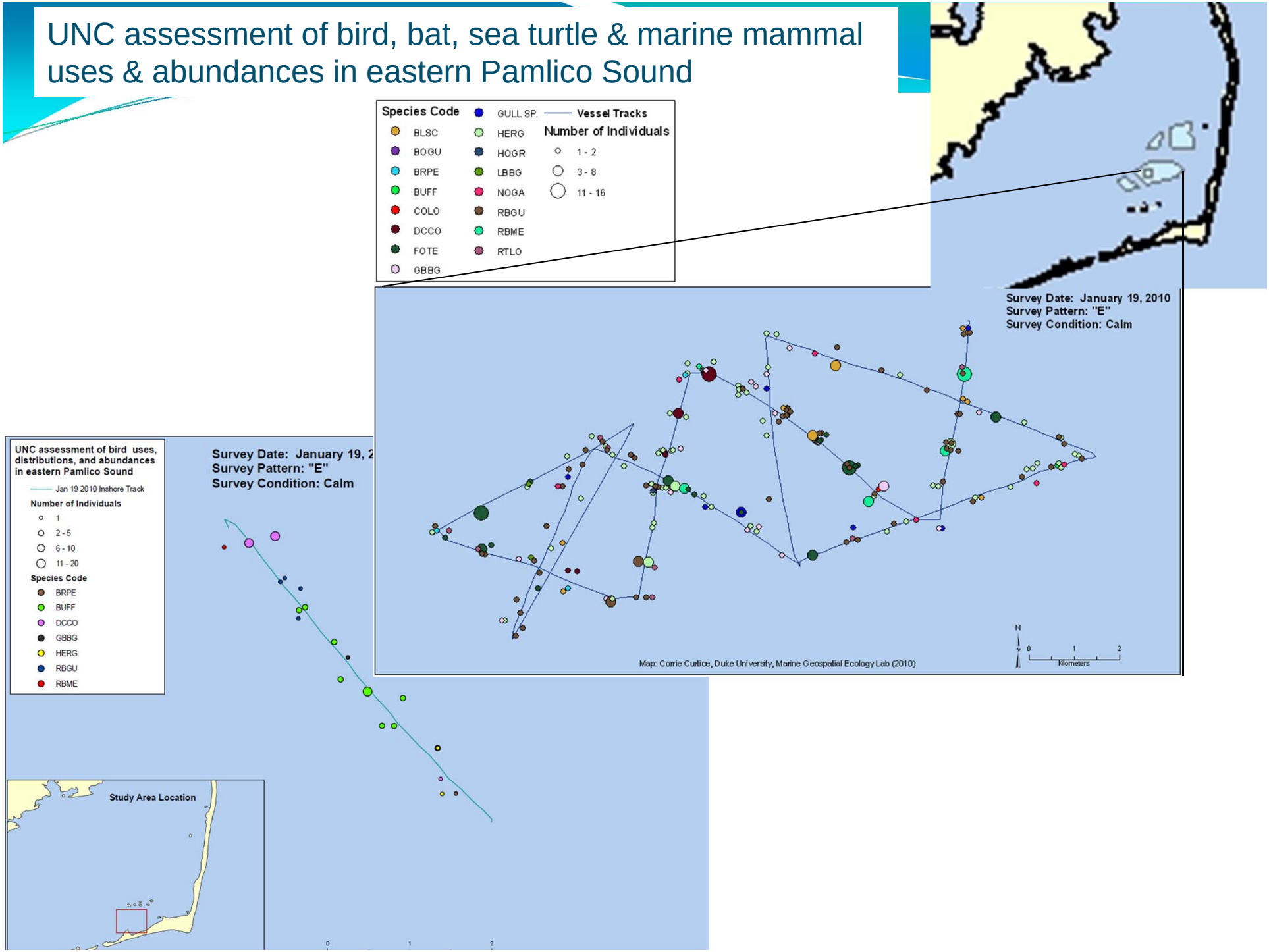
- one "W" path in am (~12.1 mi long)
- opposite "M" path in pm (~12.5 mi long)
- each takes ~ 2.5 hrs.
- single pass in-shore reference site takes ~ 0.5 hr
- anchoring in parallelogram and inshore reference sites to be dictated by birds foraging



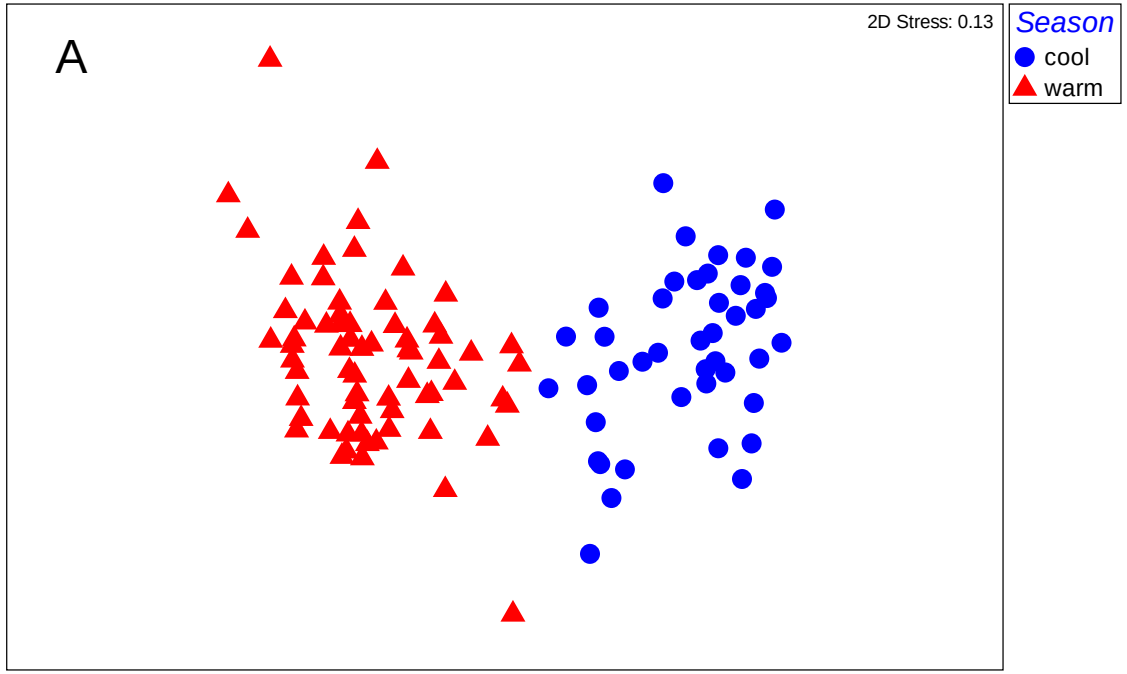
Survey route	Waypoint sequence			
	First light	Morning	Afternoon	Last light
A		1, 2, 3, 4, 5	6, 7, 8, 9, 10	11, 12
B	11, 12	10, 9, 8, 7, 6	5, 4, 3, 2, 1	
C		8,9,10;8,7,6; 11, 12	5, 4, 3; 1, 2, 3	
D		5, 4, 3, 2, 1	11, 12; 10, 9, 8; 6, 7, 8	

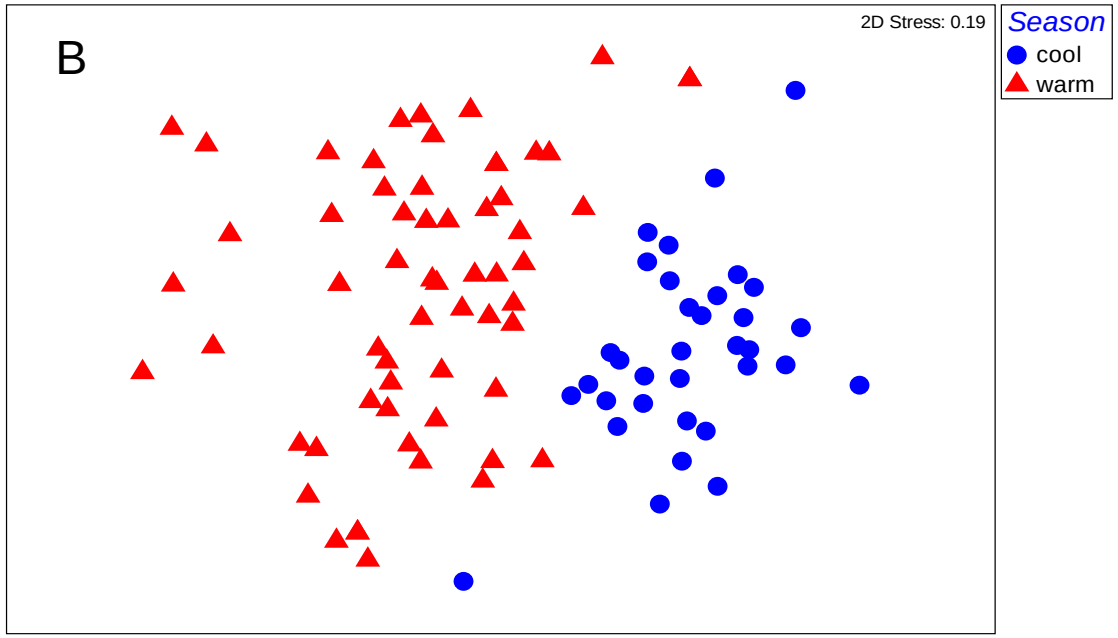
Notes: (a) each survey route should be conducted in calm (0-10 kt) & in windy (10-25 kt) conditions, (b) sequence of points 11 & 12 should be reversed when transit time can be reduced, (c) survey time within polygons MUST remain constant – if zigzag path is completed ahead of schedule, survey along perimeter toward target area for remainder of time, (d) record time at each waypoint along route

UNC assessment of bird, bat, sea turtle & marine mammal uses & abundances in eastern Pamlico Sound

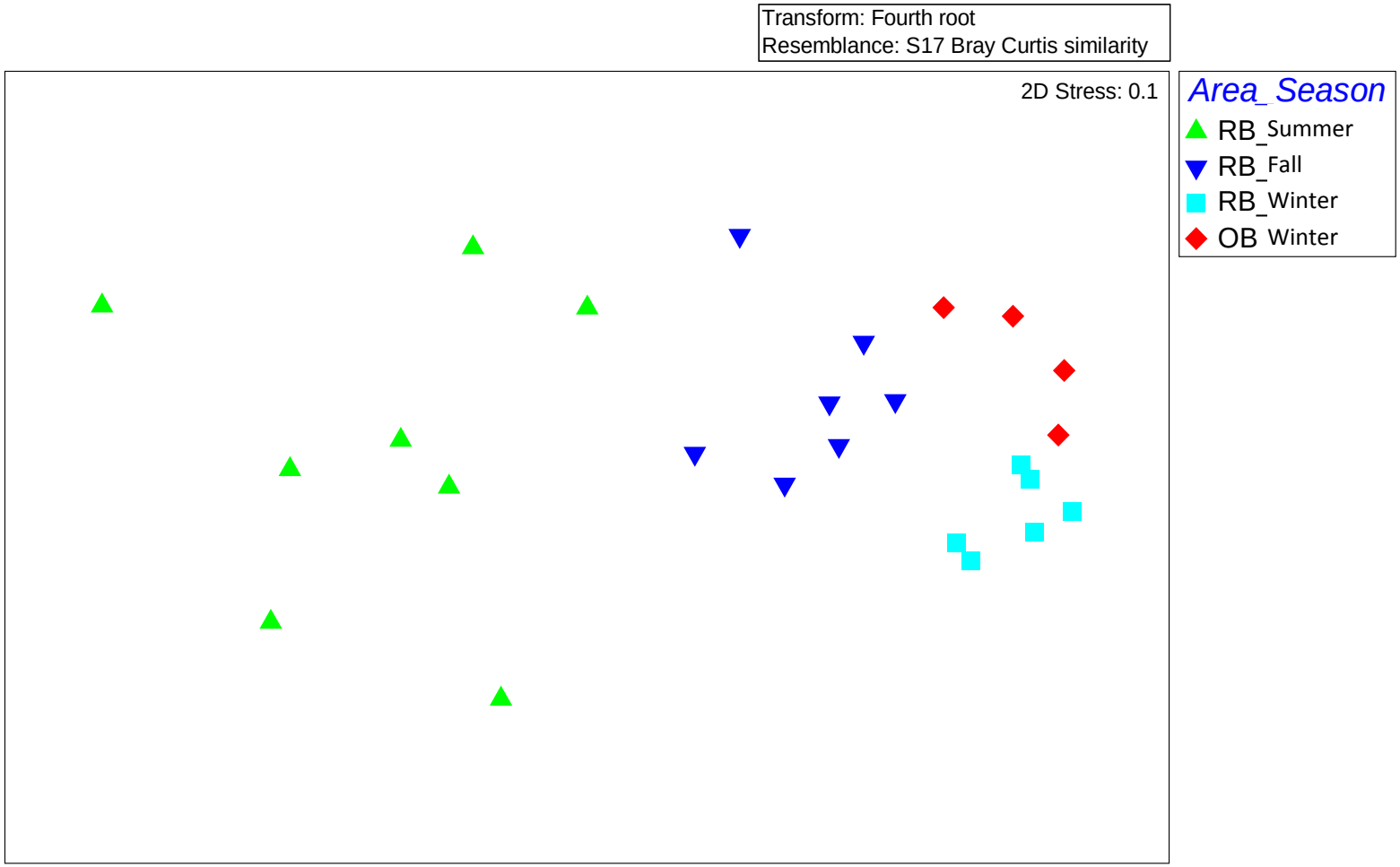


n-MDS plots of bird abundances observed from mid January 2010 to mid January 2011 in the pilot area (A) and the reference area (B) in Pamlico Sound





n-MDS plot of bird species and their abundances observed in northern Raleigh Bay (RB) in summer, fall and winter seasons, and in northeastern Onslow Bay (OB) (truncated winter season)



Bird density in Pamlico Sound by Season and Site

(average relative counts per 150 m x 150 m cell)

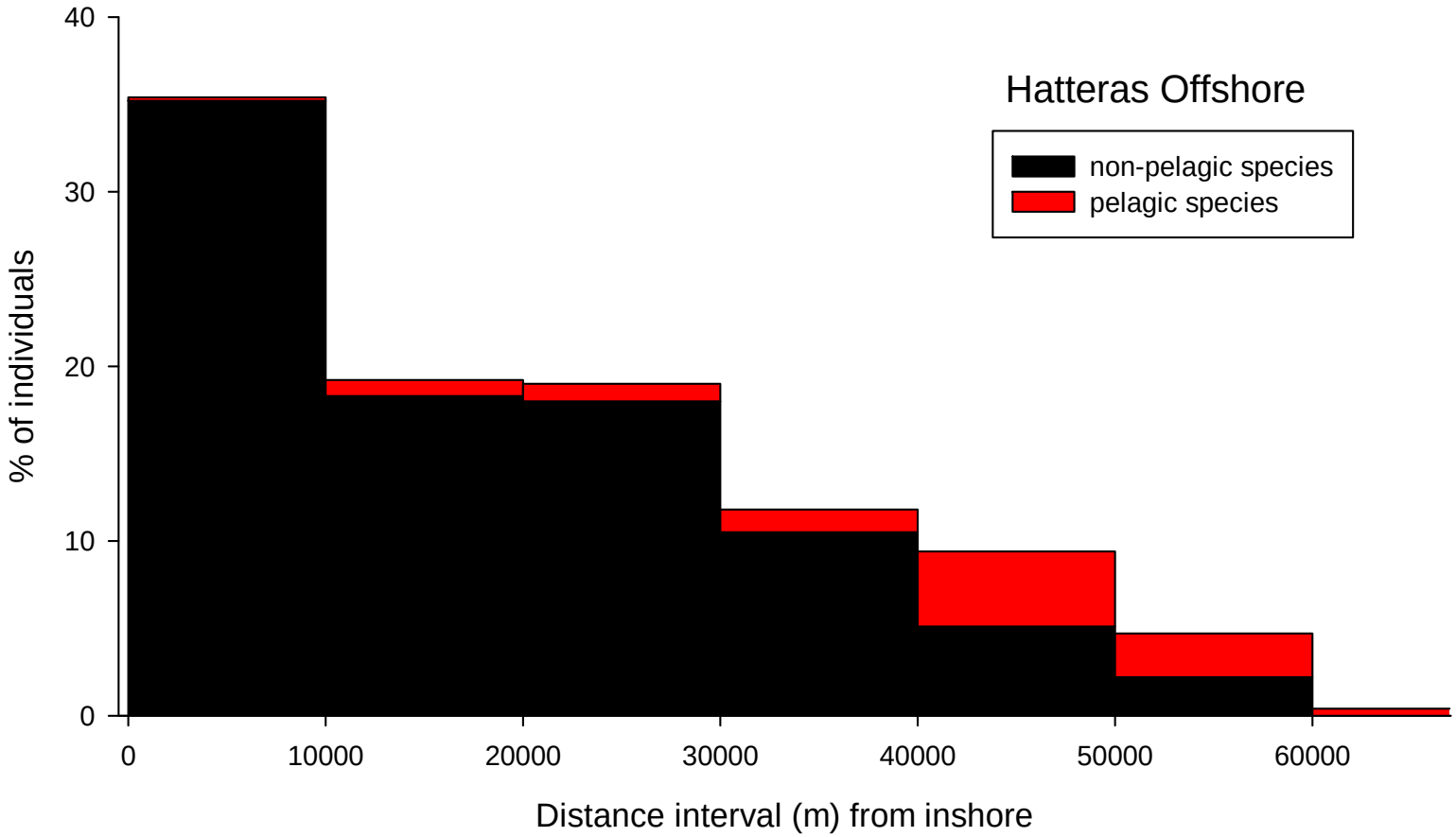
	Pamlico Sound Pilot site	Pamlico Sound Reference site	Average across sites
Cool Season	0.029	0.040	0.030
Warm Season	0.020	0.021	0.020
Average across seasons	0.026	0.033	0.026

Bird density in Coastal Ocean by Season and Site

(average relative counts per 150 m x 150 m cell)

	Hatteras Offshore	Onslow Bay Offshore	Average across sites
Summer Season	0.0011	ND	-
Fall Season	0.0008	ND	-
Winter Season	0.0010	0.0013	0.0011
Average across all seasons	0.0010	-	-

Percentage of Individuals of Non-pelagic (coastal) and Pelagic Birds Observed with Increasing Distance from Land



Bird Behavior Insights

- Only half the species flew within 26.5-135.5 m heights swept by rotor blades
- Of those, a small fraction of individuals did, except all 245 scaup
- Some gulls, pelicans, young terns flew over the 22-m high Bonner Bridge with little road clearance and dominated road-kills quantified on the bridge
- Flight paths of passerines in nocturnal migrations that follow Outer Banks still unspecified – we saw virtually no passerines over water, even at dawn and dusk
- High-tech instrumentation (radar, thermal, acoustic) may help, but use of air space is insufficient info w/o behavior
- Seaducks, like long-tailed, and coastal ducks, like scaup, often raft at night then make twice daily trips to and from foraging sites – on regular flyways?
- Albatrosses that forage at night may have elevated risk
- Only empirical assessments of impacts of operating wind turbines over ocean waters can provide rigorous assessments of true risks

Densities of Birds and Wildlife by Habitat

(average # of individuals per km^2)

Habitat	Birds[1]	Marine mammals	Sea turtles
Grassland wind farm site	261 – 318 (perched males)	-	-
Pamlico Sound	12.9	0.013	0.001
Coastal ocean shelf	5.0	0.41	0.035

[1] Despite densities in the coastal ocean of only about 1% of those on land habitats where wind farms are built, the average flight distances per day are likely far greater for seabirds, thereby enhancing relative risk.

Relative Risks across Taxa

- Judging by density only, seabird risks lower in coastal ocean than Pamlico Sound - 5.0 vs. 12.9 km^{-2}
- Locating wind farms 10-40 km from shore in coastal ocean further reduces density of birds at risk
- Judging by density only, marine mammal and sea turtle risks higher in coastal ocean than Pamlico Sound by 32-35 times
- Marine mammal and sea turtle risks arise from noise during construction not from spinning rotor blades
- Monopile emplacement noisier than deployment of more costly gravity-based structures – seasonal building windows?
- Noise even of monopile construction far less than noise of seismic exploration or well drilling associated with oil-and-gas

Threatened & Endangered Species Observed

Location	Birds	Sea turtles	Marine mammals
Pamlico Sound	none	loggerhead, Kemp's ridley	none (all bottlenose dolphin)
Coastal ocean	none	loggerhead, leatherback	humpback whale

Additional T & E Species known to Use the Location

Location	Birds	Sea turtles	Marine mammals
Pamlico Sound	piping plover	green	manatee
Coastal ocean	roseate tern, Bermuda petrel	Kemp's ridley, green	right whale & others

North Carolina's
Future?

Measures to Reduce Risk to Birds and Bats

- Do not use continuous lighting
  - Flashing lights attract fewer migrating birds
  - Red lights may be less attractive than white lights
- Reduce or eliminate perches
  - The absence of perches, nesting, and roosting sites decreases the frequency birds and bats closely approach wind mills
- Avoid white colors. Paint wind mill vanes in high contrast patterns.
  - White attracts insects; increased insect abundances attracts bats
  - Tests show that kestrels avoid moving wind mill vanes more readily if they have patterns painted on them
- Pilot studies and impact studies after installation and operation of the first wind farm will demonstrate whether other mitigation procedures are needed