

Atlantic Large Whale Take Reduction Plan:

Introduction to NMFS' Co- Occurrence Model

Presentation to:

Annual Meeting of the Marine
Mammal Commission

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Service

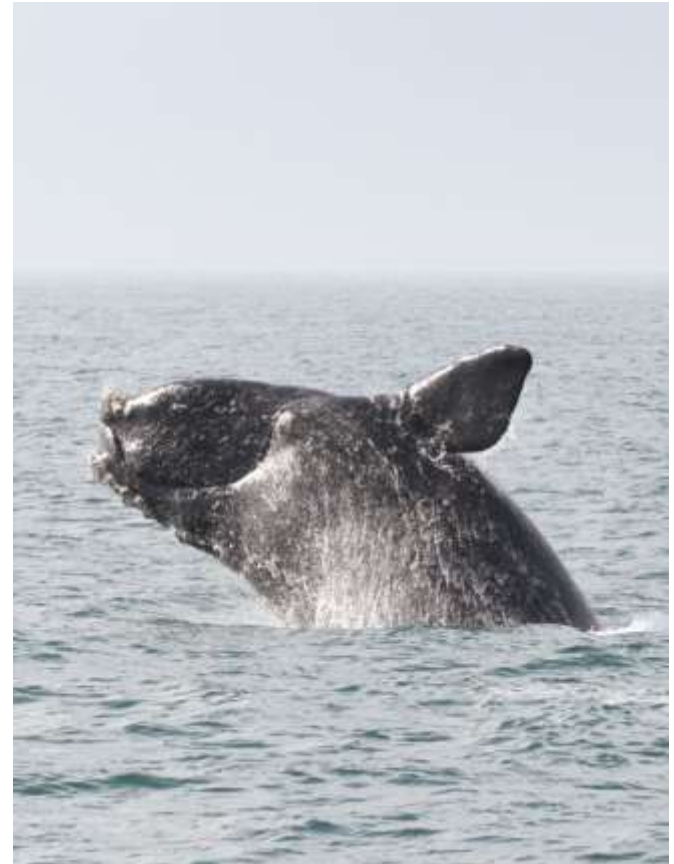
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Goals of the Modeling Effort

- ❖ Provide members of the ALWTRT with data to build a common understanding of:
 - The seasonal distribution of commercial fishing gear off the Atlantic coast.
 - The seasonal distribution of North Atlantic right whales, humpback whales, and fin whales in these waters.
- ❖ Support development of NMFS' vertical line strategy for the ALWTRP.
- ❖ Provide analytic support for NMFS' rulemaking process.



North Atlantic right whale (*Eubalaena glacialis*)
Photo: Georgia Department of Natural Resources

Ideal: Link Model Directly to Goals of ALWTRP

- ❖ ALWTRP goals:
 - Near-term: reduce mortality/serious injury below PBR.
 - Long-term: reduce rates of serious injury or mortality to near zero.
- ❖ Ideal model would permit NMFS/ALWTRT to evaluate the impact of potential management measures directly against these goals.
- ❖ Requires understanding of the factors that determine:
 - *Probability* that an entanglement will occur.
 - Likelihood of serious injury/death *in the event of an entanglement*.
- ❖ $P(\text{Entanglement}_{\text{Location, Time}}) = f(Q_{\text{gear}}, Q_{\text{whales}}, \text{fishing practices, whale behavior, etc.})$.
- ❖ $P(\text{SI/M} \mid \text{Entanglement}) = f(\text{characteristics of entangled whale, nature of gear, disentanglement efforts, etc.})$.
- ❖ Current knowledge and available data are inadequate to support reliable assessment of entanglement risks.

Alternative: Examine Indicators of Risk

- ❖ Co-occurrence model instead develops relative indicators of risk:
 - The number of commercial gillnet and trap/pot vessels that engage in fishing at a particular location/time of year.
 - The quantity of gear these vessels deploy.
 - Historical data on the seasonal distribution of strategic stocks, by species, in waters subject to the ALWTRP.
 - The potential for members of strategic stocks to be present at places and times that commercial fishing gear is deployed.
- ❖ Developing even these indicators requires reliance on data that are incomplete and of inconsistent quality.
- ❖ Also requires reliance on professional judgment of NMFS gear experts, members of the TRT, and other stakeholders.

Guidelines for Model Design and Development

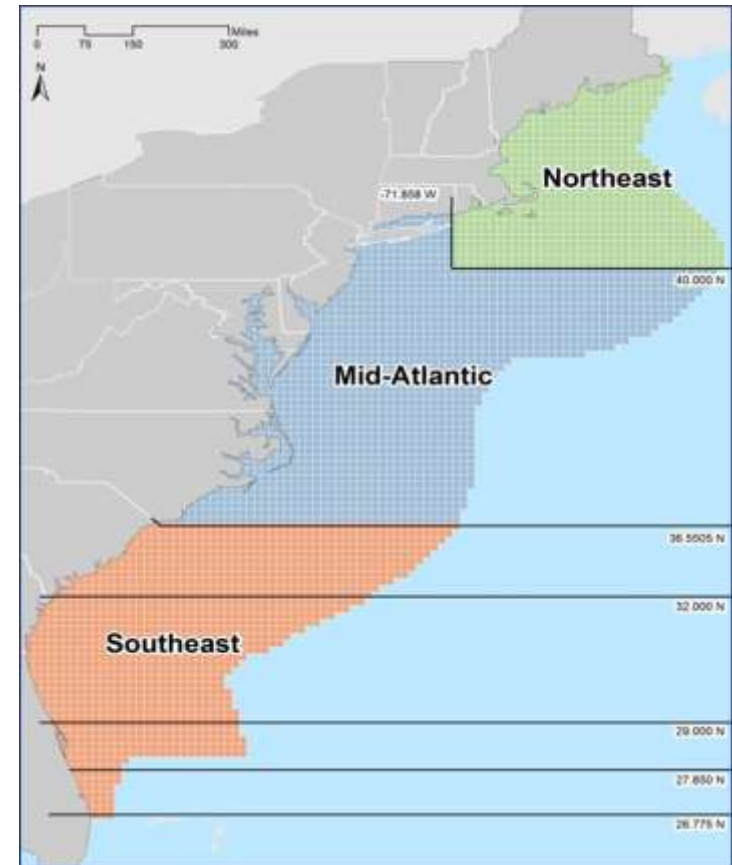
- ❖ Design the model with sufficient flexibility to:
 - Incorporate data from disparate sources.
 - Analyze a range of management measures (e.g., closures, gear modification requirements).
- ❖ Provide information on protected species and fishing activity in a variety of forms:
 - Maps/animations to illustrate spatial/temporal patterns.
 - Tables and charts to support numerical comparisons.
 - Range of indicators of fishing activity/potential for protected species to encounter commercial fishing gear.
- ❖ Maintain an open and transparent development process:
 - Involve the TRT in model design, data collection, and the development of key assumptions.
 - Adapt the model to evolve with the TRT's interests and needs.

Development Timeline

- 2005: Initial methods development and data collection.
- 2006: Working prototype for the Northeast region.
- 2007-2009: Expanded geographic scope/methods refinement.
- 2010: Module for analysis of management scenarios.
- 2011-2012: Analysis of TRT proposals.
Documentation and peer review.
- 2013: Analysis of proposed rule.
Draft Environmental Impact Statement.
- 2014: Analysis of final rule.
Final Environmental Impact Statement.
- 2014-2015: Analysis of exemption proposals.
Draft and Final Environmental Assessment.

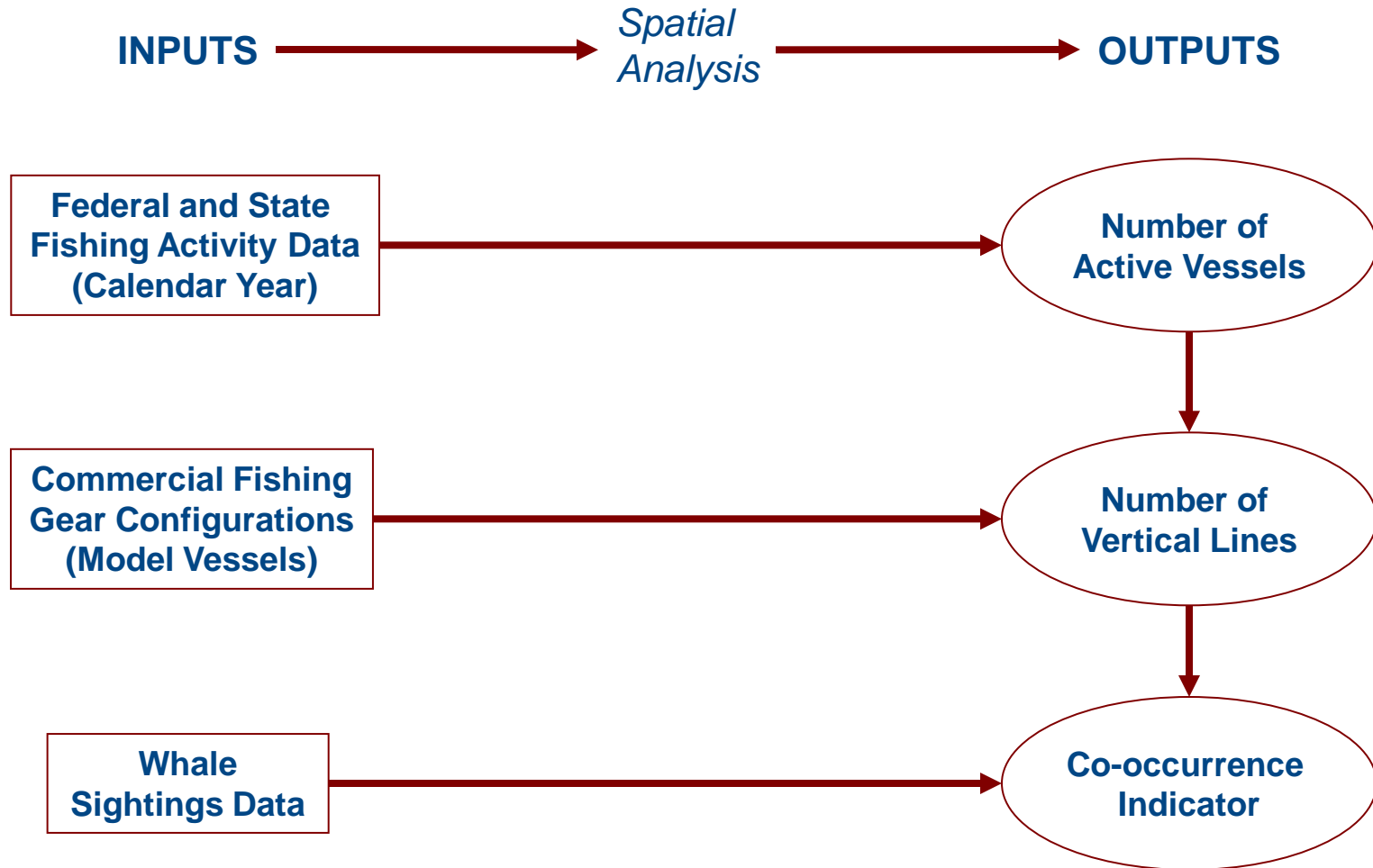
Model Scope and Resolution

- ❖ Software: MS Access/ArcGIS.
- ❖ Fisheries:
 - American lobster.
 - Sink and anchored gillnets.
 - Blue crab.
 - Other trap/pot (e.g., black sea bass).
- ❖ Protected species:
 - North Atlantic right whale.
 - Humpback whale.
 - Fin whale.
- ❖ Geographic resolution:
 - 1-minute grid cells (analysis of fishing activity and gear distribution).
 - 10-minute grid cells (SPUE, co-occurrence indicator and mapping).
- ❖ Temporal resolution: monthly.



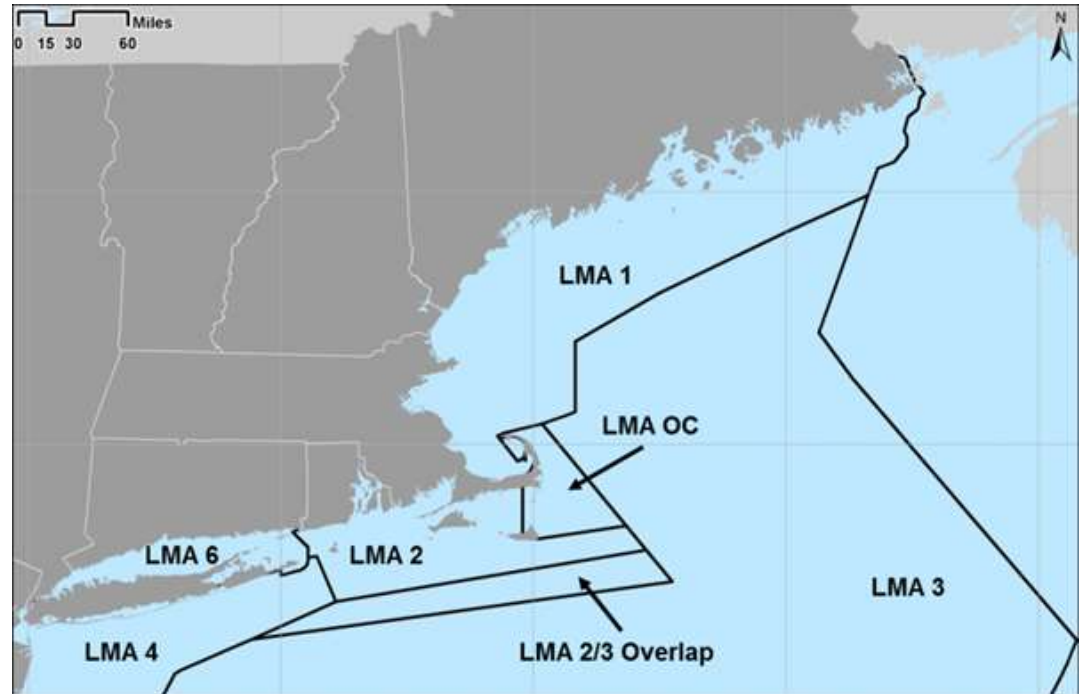
Geographic Scope: All waters subject to the requirements of the ALWTRP.

Conceptual Overview



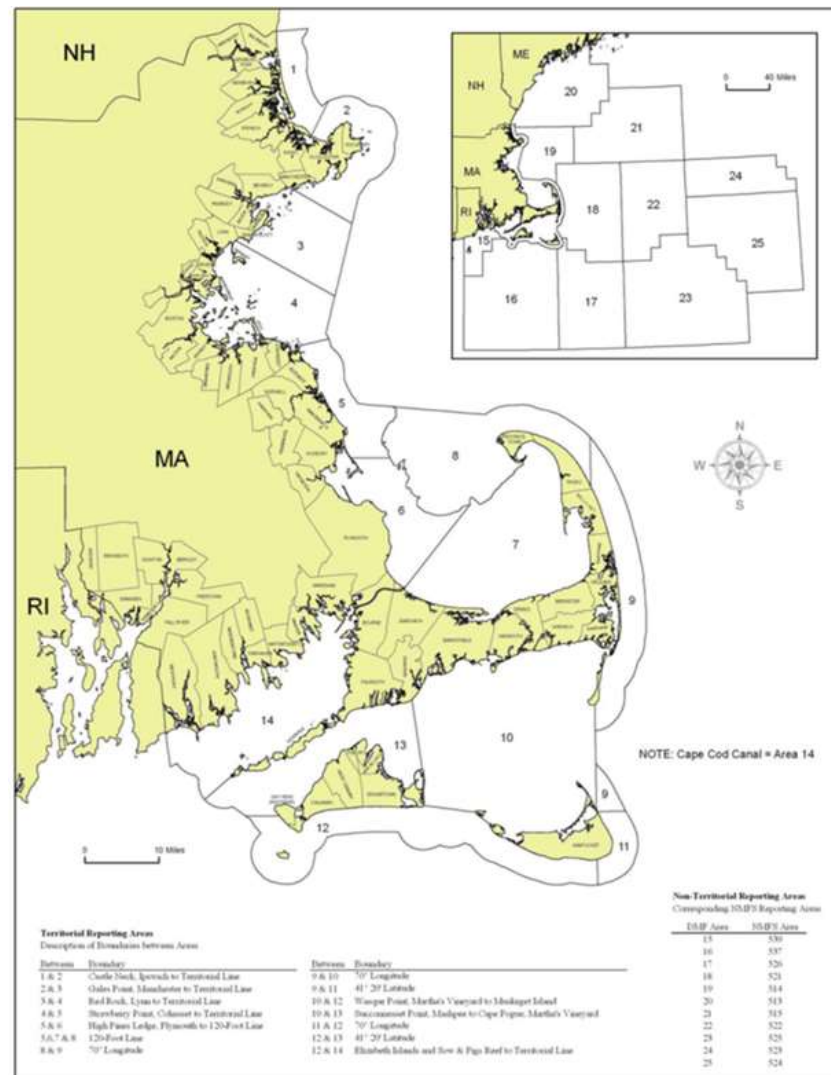
Data Sources: Vessel Activity - Federal

- ❖ Northeast Vessel Trip Report (VTR) data.
 - Lobster, blue crab, other trap/pot (OTP), gillnet.
 - Indicates location to nearest minute of longitude/latitude.
- ❖ NMFS Permit data - by Lobster Management Area.
- ❖ Southeast Logbook data.
 - Blue crab, other trap/pot, gillnet.
 - Report trip location to nearest degree of longitude/latitude.



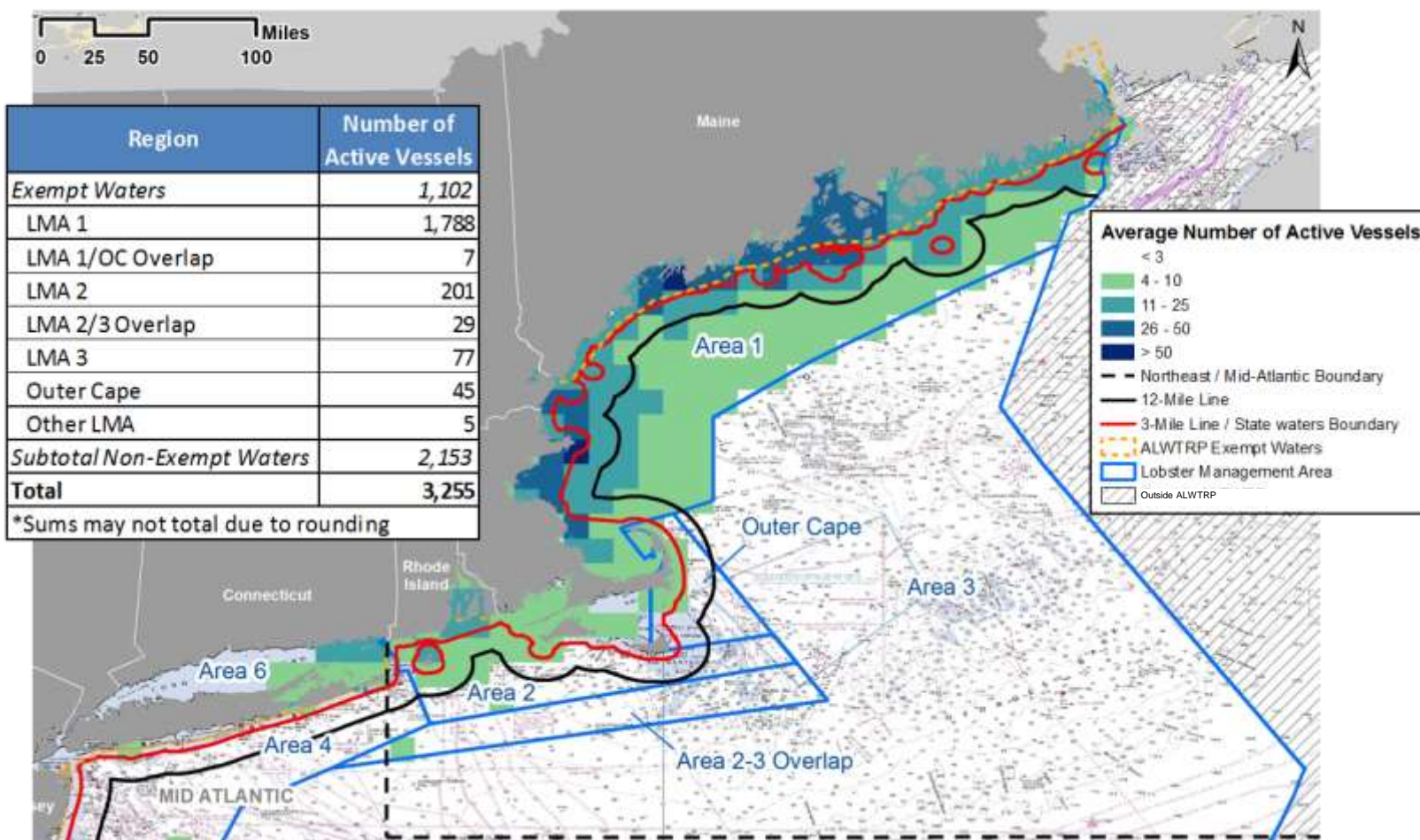
Data Sources: Vessel Activity - State

- ❖ Obtained via outreach to representatives of state fishery management agencies on TRT.
- ❖ Includes exempt and non-exempt waters.
- ❖ Sources vary by state:
 - Trip reports.
 - Monthly catch reports.
 - Permit data and dealer reports.
 - Surveys.
- ❖ Typically indicates location by state management zone.



Illustrative Results: Vessel Activity

2010/2011 Northeast Baseline (Monthly Average)
Estimated Number of Active Vessels ~ All Fisheries



Data Limitations: Location of Vessel Activity

- ❖ Northeast VTR - “average” location.
- ❖ Southeast Logbook - coarse resolution.
- ❖ Federal lobster permits impose no trip reporting requirements.
 - Forces reliance on permit data for “lobster-only” vessels.
 - Activity associated with these vessels is assumed to be evenly distributed throughout each LMA - in each case, a very broad area.
- ❖ State sources - often coarse.

ESTIMATE OF ACTIVE LOBSTER VESSELS NOT SUBJECT TO TRIP REPORT REQUIREMENTS (JULY 2011)

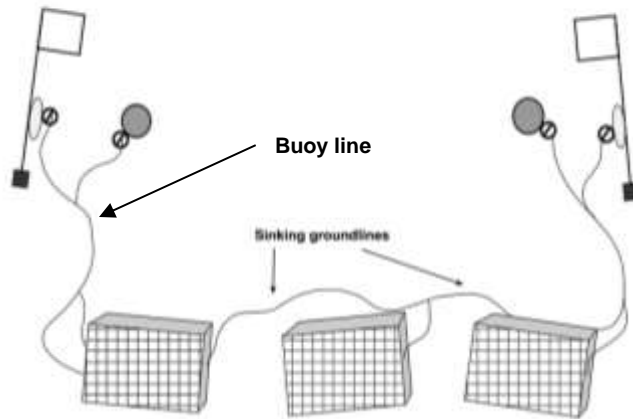
Area	Fed Vessels without VTR Requirements	Total Federal Vessels	Share of LMA's Active Vessels
LMA 1	1,071	1,217	88%
LMA 2	73	129	57%
LMA 3	21	60	36%
OCC	7	24	29%

Vertical Line Use

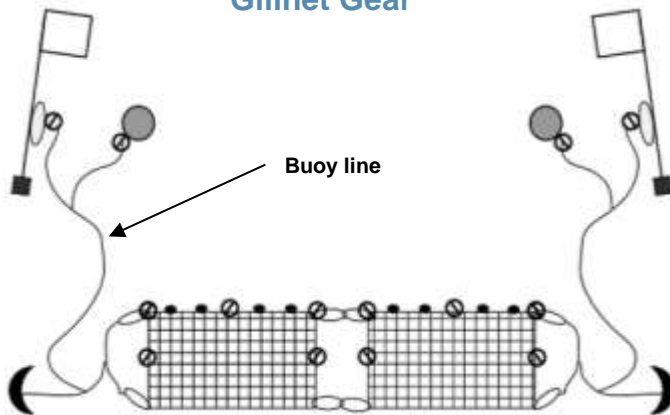
- ❖ Estimates of vertical line use are based on “model vessel” approach:
 - Each model vessel is designed to represent a group of vessels that share similar gear configurations.
 - The model currently incorporates ~300 model vessels.
- ❖ Users can assign model vessels to a suite of regions, including:
 - Lobster Management Areas.
 - ALWTRP trap/pot areas.
 - Federal waters off the coast of Maine delineated by distance from shore.
 - State waters (exempt and non-exempt); and
 - State fishery management areas (where available).

Variables that Characterize Model Vessels

Trap/pot Gear



Gillnet Gear



❖ Trap/pot model vessels:

- Total traps fished.
- Number of traps per trawl.
- Number of endlines (i.e., buoy lines) per trawl.
- Length of groundline between traps.
- Number of anchors per trawl.
- Length of anchor lines.

❖ Gillnet vessels:

- Total strings fished.
- Net panels per string.
- Endlines per string.
- Number of anchors per string.
- Length of anchor lines.

Data Sources: Model Vessels - Federal Waters

❖ Gillnet:

- Based on Northeast Domestic Fisheries Observer Program data, 2009-2011.
- Differentiated by region (Northeast and Mid-Atlantic/Southeast).

❖ Lobster:

- Based on best professional judgment (BPJ) - NMFS gear specialists.
- Differentiated by region (Northeast nearshore, Mid-Atlantic nearshore, and offshore).
- For nearshore waters off Maine and Massachusetts, also draw on state reports and surveys.

❖ Blue crab:

- Mid-Atlantic - average of configurations reported for ocean waters under DE, MD, VA, or NC jurisdiction.
- Southeast - average of configurations reported for ocean waters under SC, GA, or FL jurisdiction.

Data Sources: Model Vessels - Federal Waters

- ❖ Other trap/pot: based on BPJ of NMFS gear specialists and/or TRT members for specified region/fishery.
 - Northeast state waters - shrimp.
 - Northeast nearshore waters - scup, black sea bass, shrimp, hagfish, and conch/whelk.
 - Northeast offshore waters - hagfish and red crab.
 - Mid-Atlantic nearshore waters- black sea bass (north and south of Cape Hatteras), scup, and conch/whelk.
 - Mid-Atlantic offshore waters - hagfish and red crab.
 - Southeast nearshore - black sea bass.
 - Southeast offshore waters - black sea bass.

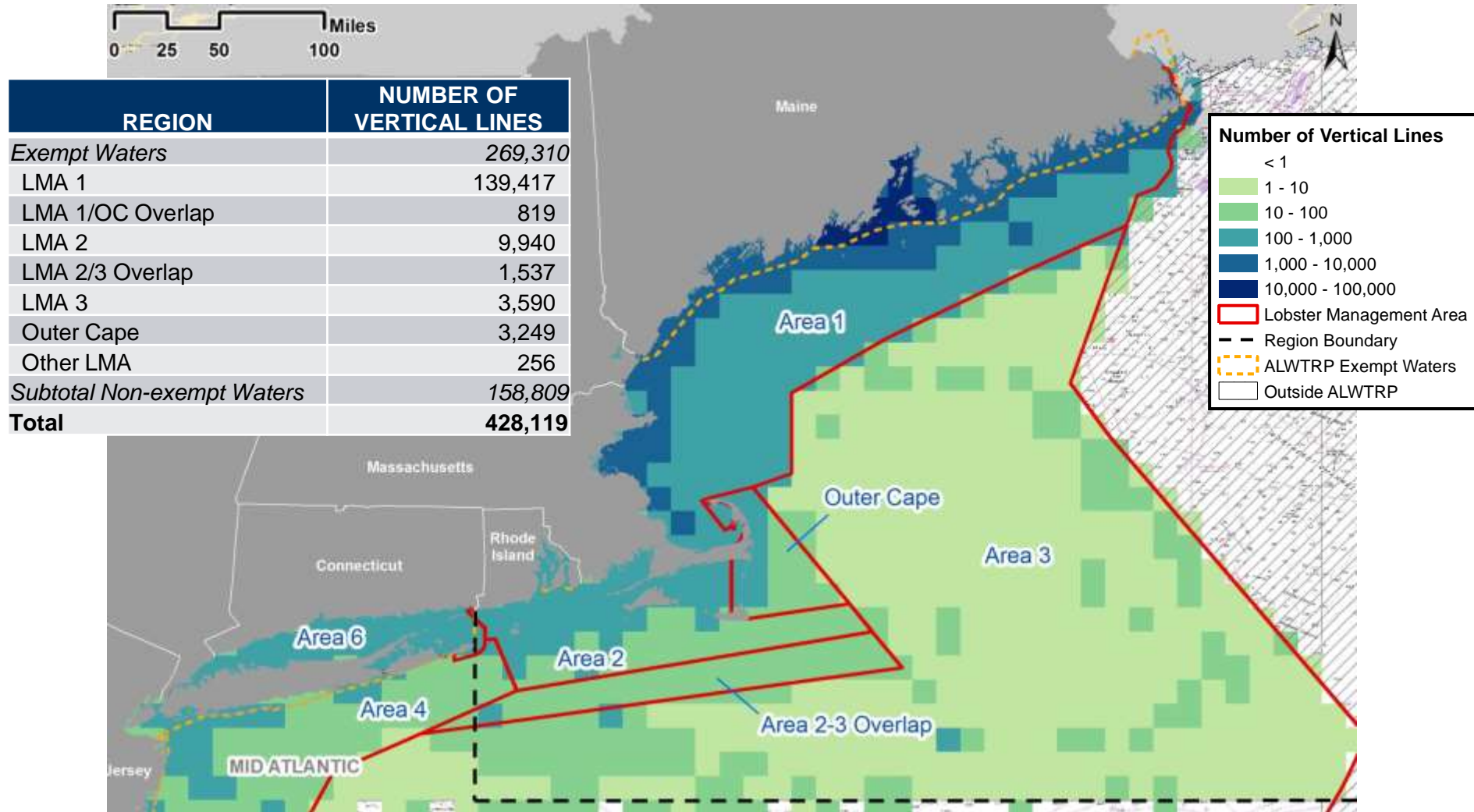
Data Sources: Model Vessels - State Waters

- ❖ Development of model vessels for state waters draws on best available information from each state.
- ❖ Obtained via outreach to commercial fishermen and representatives of state fishery management agencies on TRT.
- ❖ These individuals have reviewed and commented on IEC's documentation of the data, assumptions, and methods employed to estimate vertical line use in their states.

STATE	SOURCE	STATE	SOURCE
ME	Survey	DE	Reporting
NH	Reporting	MD	Reporting/BPJ
MA	Reporting/Survey	VA	Reporting
RI	Reporting	NC	Survey/BPJ
CT	Reporting	SC	Reporting
NY	Survey/BPJ	GA	Survey
NJ	BPJ	FL	Reporting

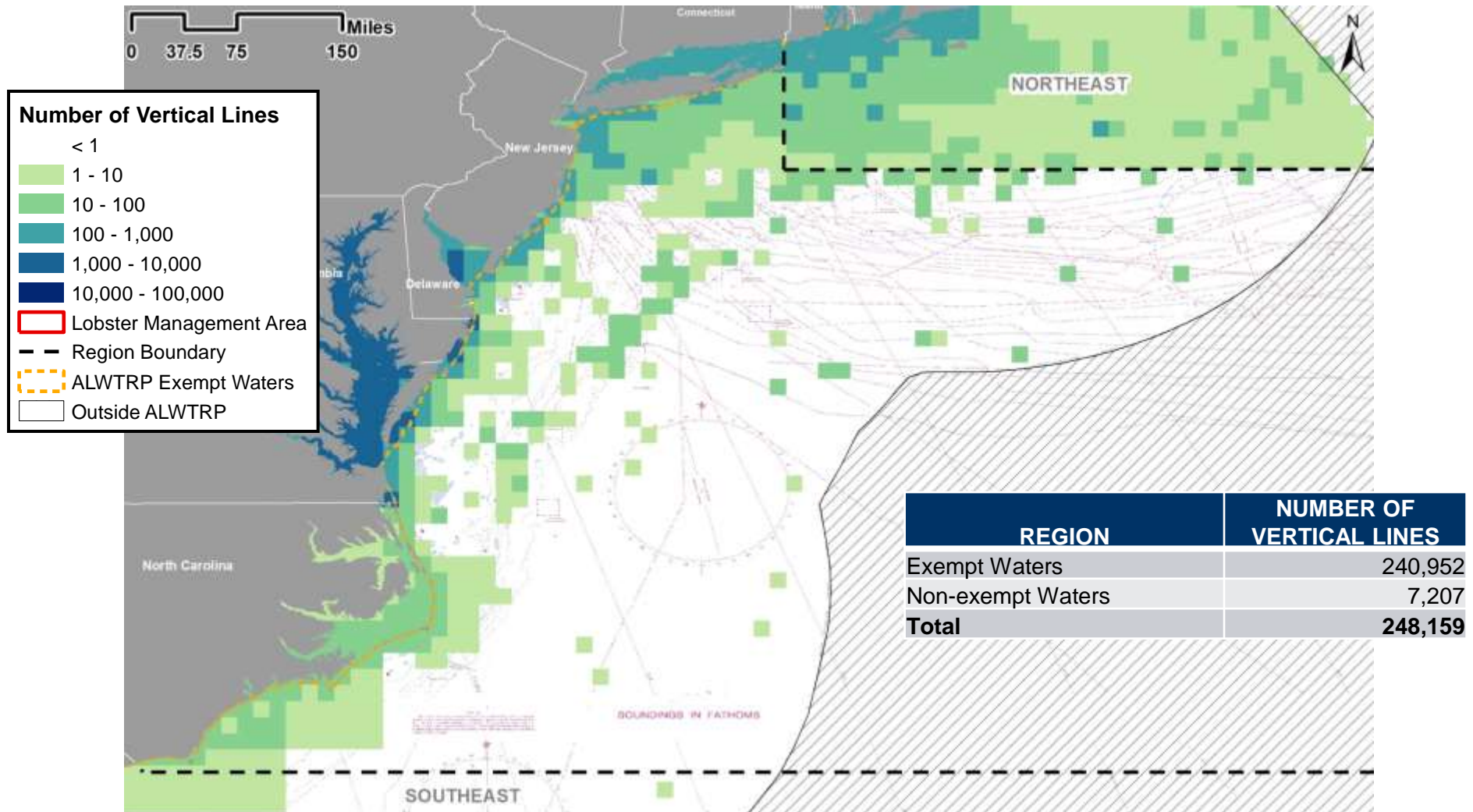
Illustrative Results: Northeast

Annual Average Estimated Number of Vertical Lines ~ All Fisheries



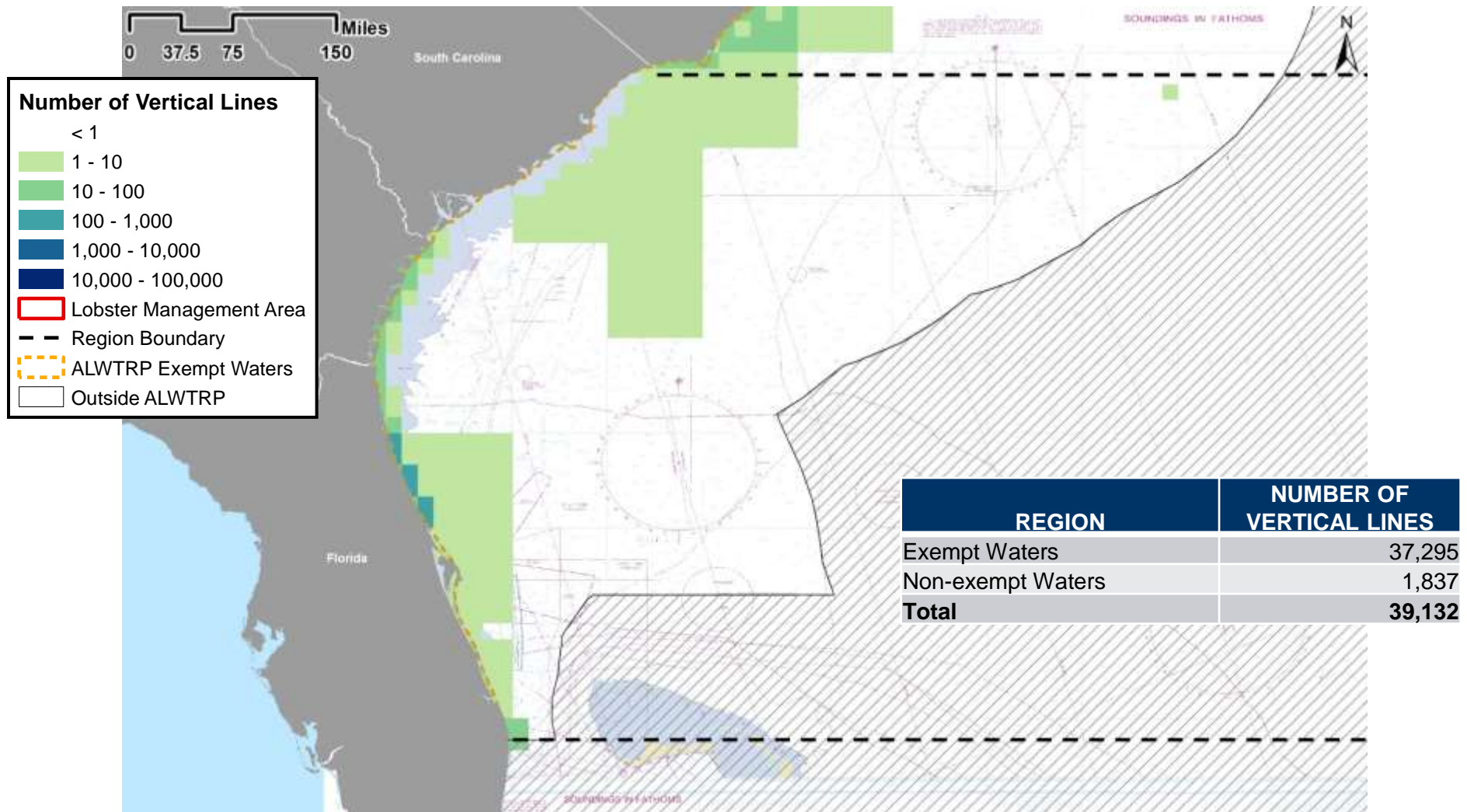
Illustrative Results: Mid-Atlantic

Annual Average Estimated Number of Vertical Lines ~ All Fisheries



Illustrative Results: Southeast

Annual Average Estimated Number of Vertical Lines ~ All Fisheries, Non-exempt Waters



Data Limitations: Model Vessels

- ❖ Reporting on gear configurations/vertical line use in most fixed gear fisheries is not routinely required.
- ❖ For several areas/fisheries, assumptions concerning gear configurations are based partly or completely on professional judgment.
- ❖ In some instances (e.g., Maine), periodic surveys have provided a higher degree of resolution on gear configurations.
- ❖ Other states (e.g., Massachusetts) have conducted surveys on vertical line use, providing a basis for calibrating gear configuration assumptions.
- ❖ Still others (e.g., New Hampshire) are considering including vertical line use as a reporting requirement.
- ❖ Maintaining such efforts and emulating them elsewhere is necessary to generate better data on vertical line use.

Data on Seasonal Distributions of Whales

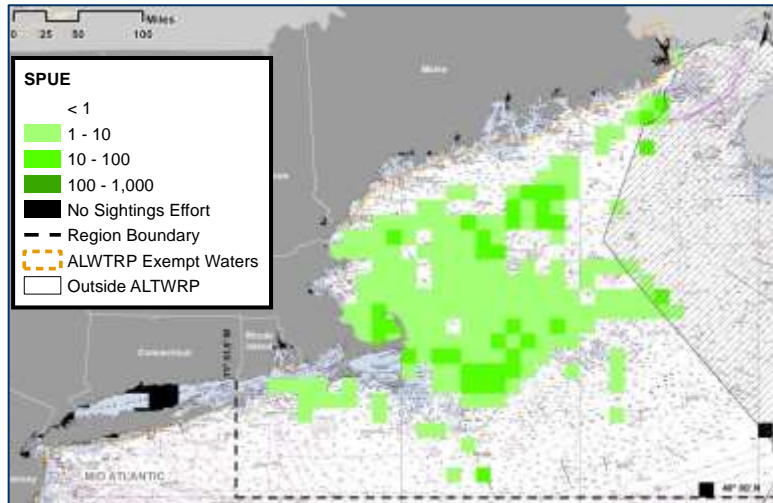
- ❖ Source: North Atlantic Right Whale Consortium (NARWC).
- ❖ NARWC draws on an amalgamated dataset of shipboard and aerial surveys that meet the following minimum standards:
 - Provide sufficient records of the survey platform's time and position to reconstruct its trackline;
 - Have been conducted with at least one trained observer who recorded periods of dedicated observation or no observation;
 - Report the whale species, group size, and position for each sighting;
 - Provide data on sightings conditions.
- ❖ Only includes records that meet NARWC's standards for acceptable sightings conditions.
- ❖ Dataset provided for modeling purposes only includes sightings of live whales, and excludes records in which the identification of the species is uncertain.

Data on Seasonal Distributions of Whales (cont.)

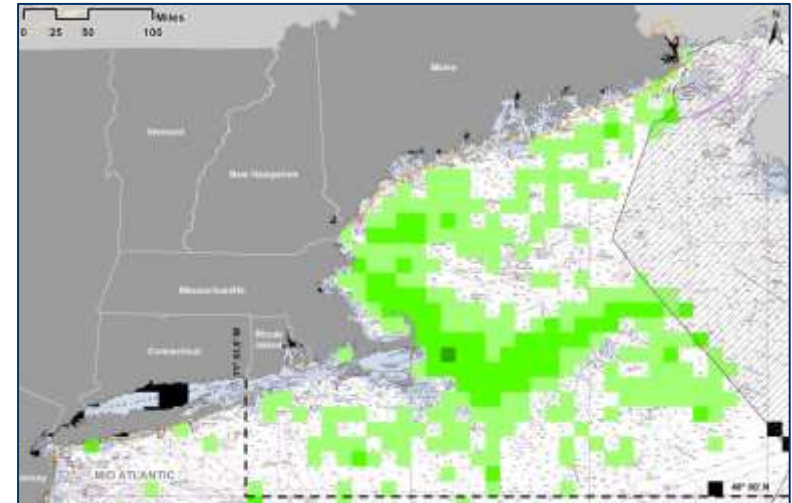
- ❖ Dataset incorporates records dating back to late 1978 (CETAP) and is periodically updated to include most recent surveys.
- ❖ Provides following information by location (10-minute grid cell) and month:
 - Effort (total kilometers surveyed);
 - Sightings (individuals of each species observed);
 - SPUE, i.e., individuals of each species observed per 1000 kilometers of valid effort.
- ❖ Model can present SPUE on an absolute or relative basis, indexed on a scale of 0 to 1000.
- ❖ Dataset provided for modeling purposes includes sightings of right, humpback, and fin whales.
- ❖ For management purposes, TRT and NMFS have chosen to develop recent regulatory measures based on the distribution of right whales and humpback whales.

Survey Effort & SPUE Scores: Northeast

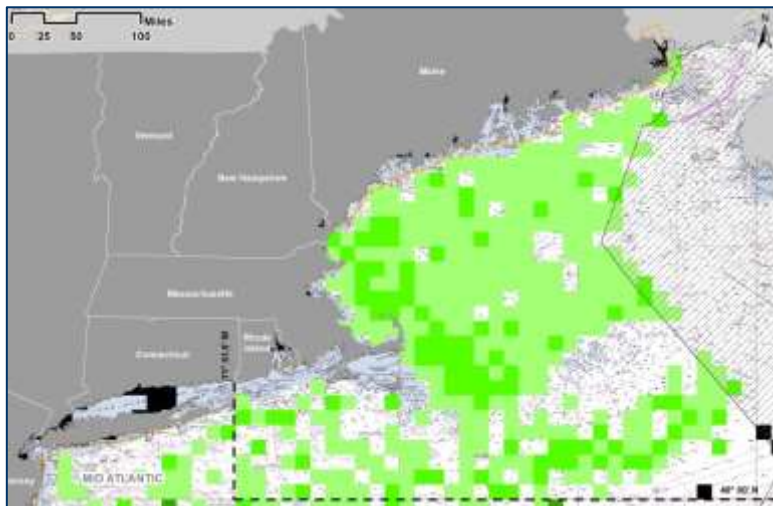
Right Whale (Monthly Average)



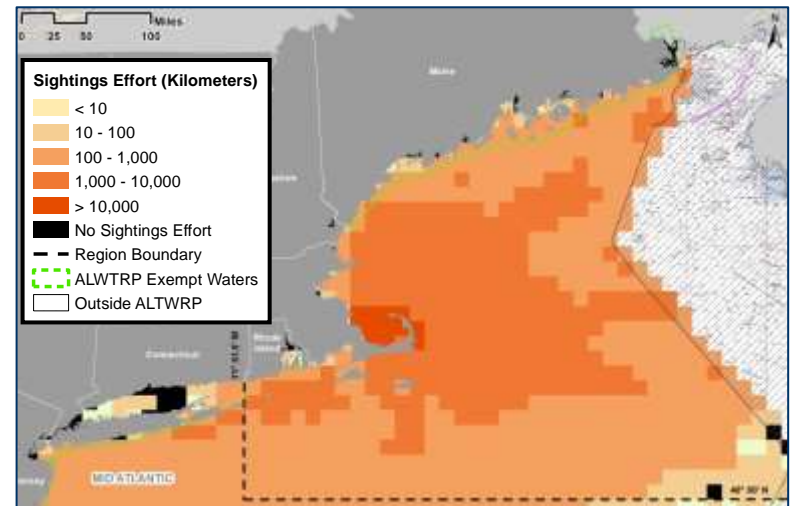
Humpback Whale (Monthly Average)



Fin Whale (Monthly Average)

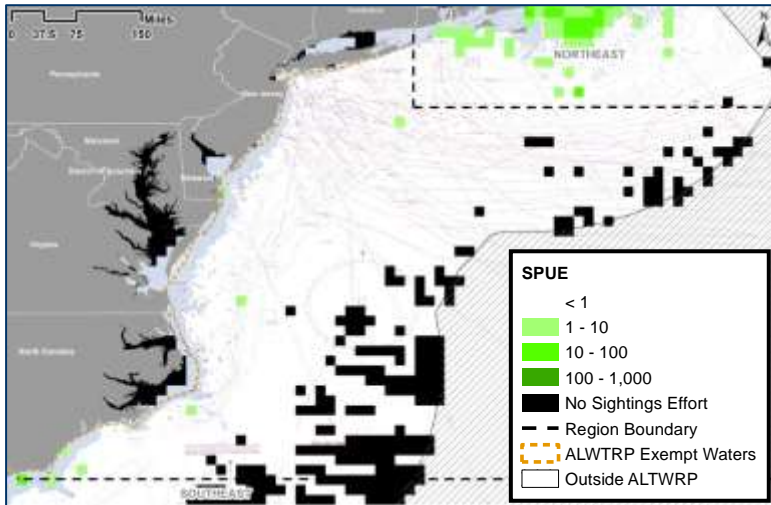


Effort (Cumulative Across all Years)

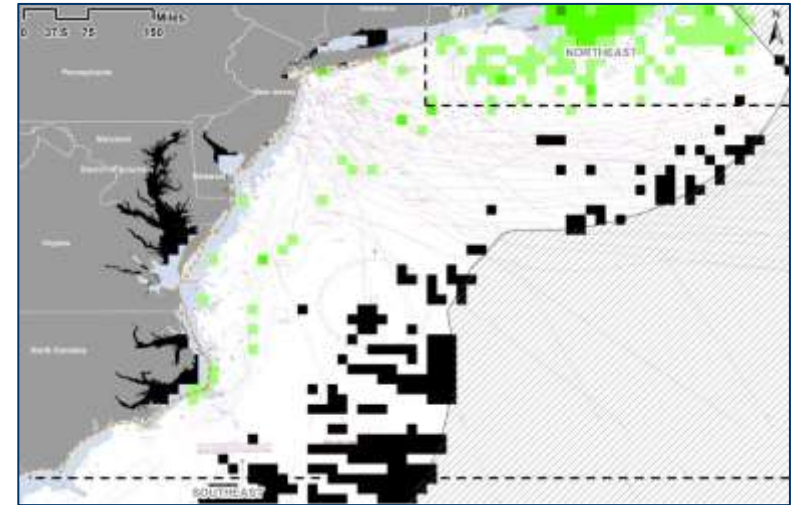


Survey Effort & SPUE Scores: Mid-Atlantic

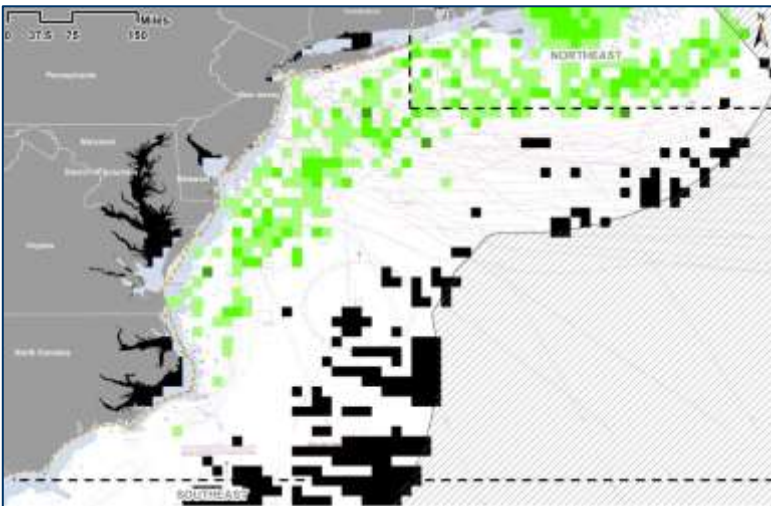
Right Whale (Monthly Average)



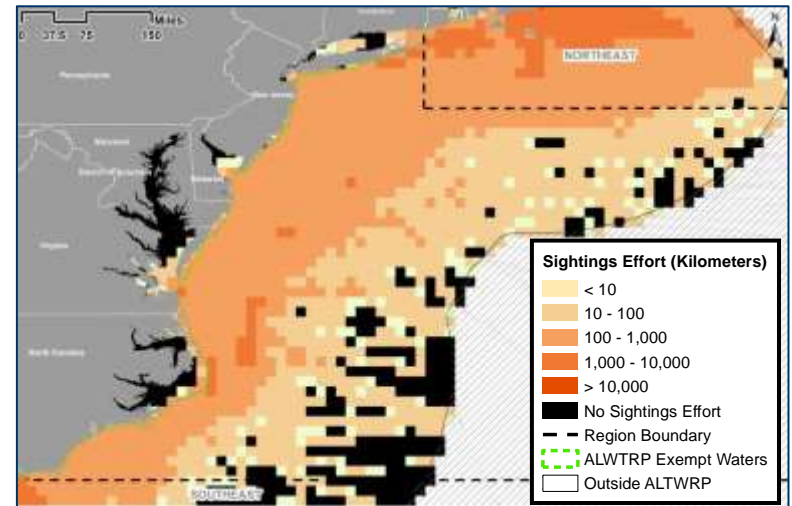
Humpback Whale (Monthly Average)



Fin Whale (Monthly Average)

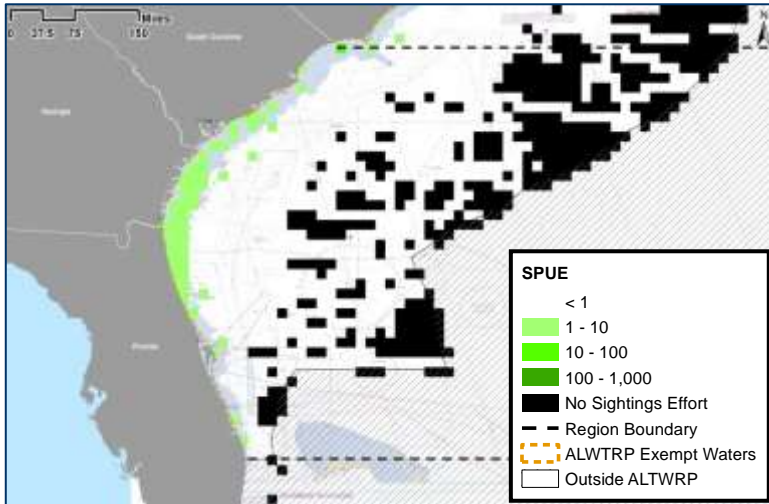


Effort (Cumulative Across all Years)

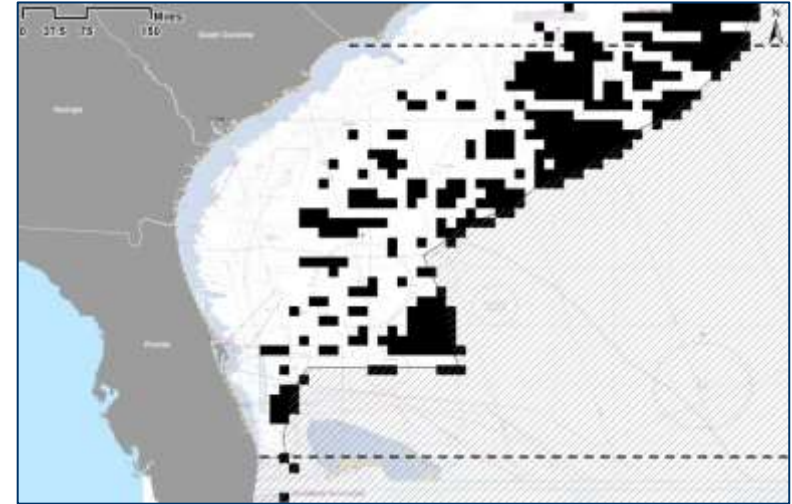


Survey Effort & SPUE Scores: Southeast

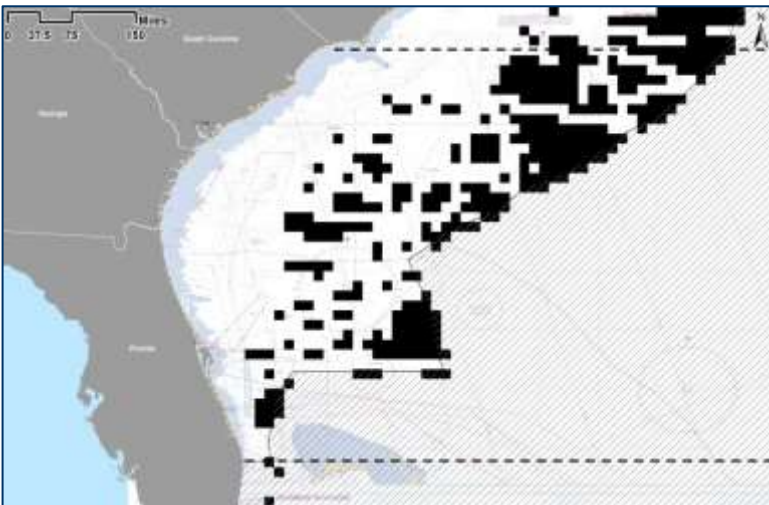
Right Whale (Monthly Average)



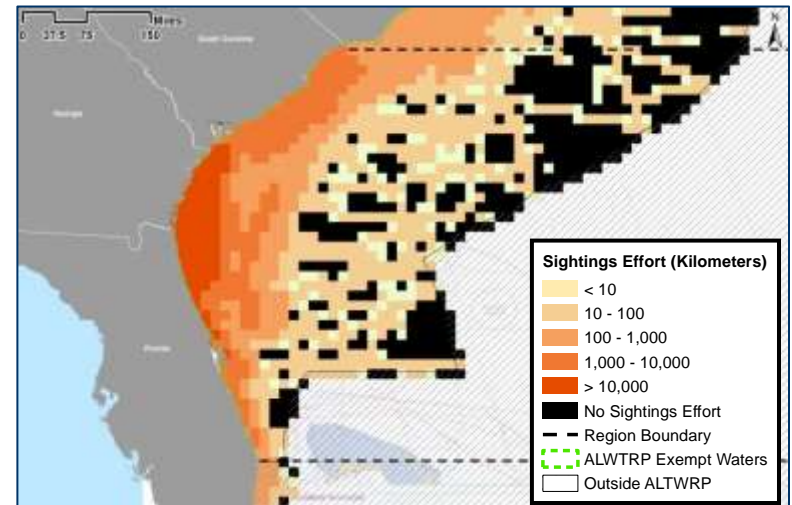
Humpback Whale (Monthly Average)



Fin Whale (Monthly Average)



Effort (Cumulative Across all Years)



Data Limitations: Whale Sightings

❖ Data are not precise:

- Dataset gives equal weight to sightings reported from survey platforms - airplanes and ships - that are known to differ with respect to search efficiency.
- Dataset does not adjust SPUE values to account for variation in search efficiency across species.

❖ Data are incomplete:

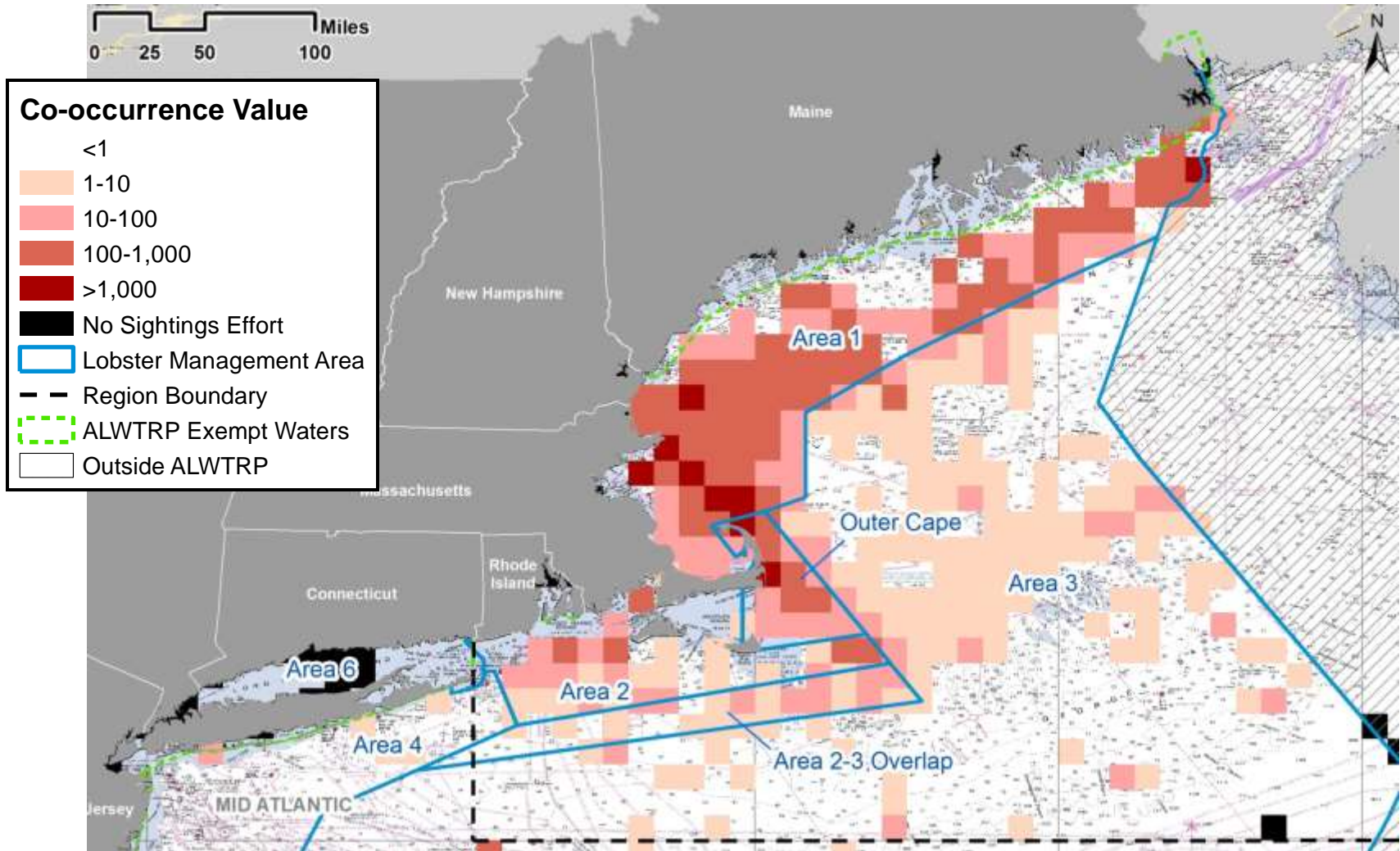
- Survey effort in some areas/months is low or non-existent.
 - Opportunistic sightings indicate the presence of whales in some of these areas/months.
 - Sensitivity analysis developed for most recent EIS adjusted SPUE based on opportunistic sightings; showed relatively minor effect for the alternatives under consideration.
- Other/emerging sources (e.g., acoustic data) are of growing interest to the TRT.

Co-Occurrence of Whales and Vertical Line

- ❖ Model provides a *relative indicator* of the potential for whales to encounter gear in different areas and at different times of year: the “co-occurrence” score.
 - All SPUE and vertical line values are indexed on a scale of 0 to 1,000.
 - For each grid cell, the indexed values are then multiplied to generate a combined indicator score, which may range in value from 0 to 1 million.
- ❖ The model can generate co-occurrence scores for individual whale species or for any combination of the three.
- ❖ For management purposes, NMFS and the TRT have chosen to evaluate recent regulatory measures based on their effect on co-occurrence scores for right whales and humpback whales, combined.

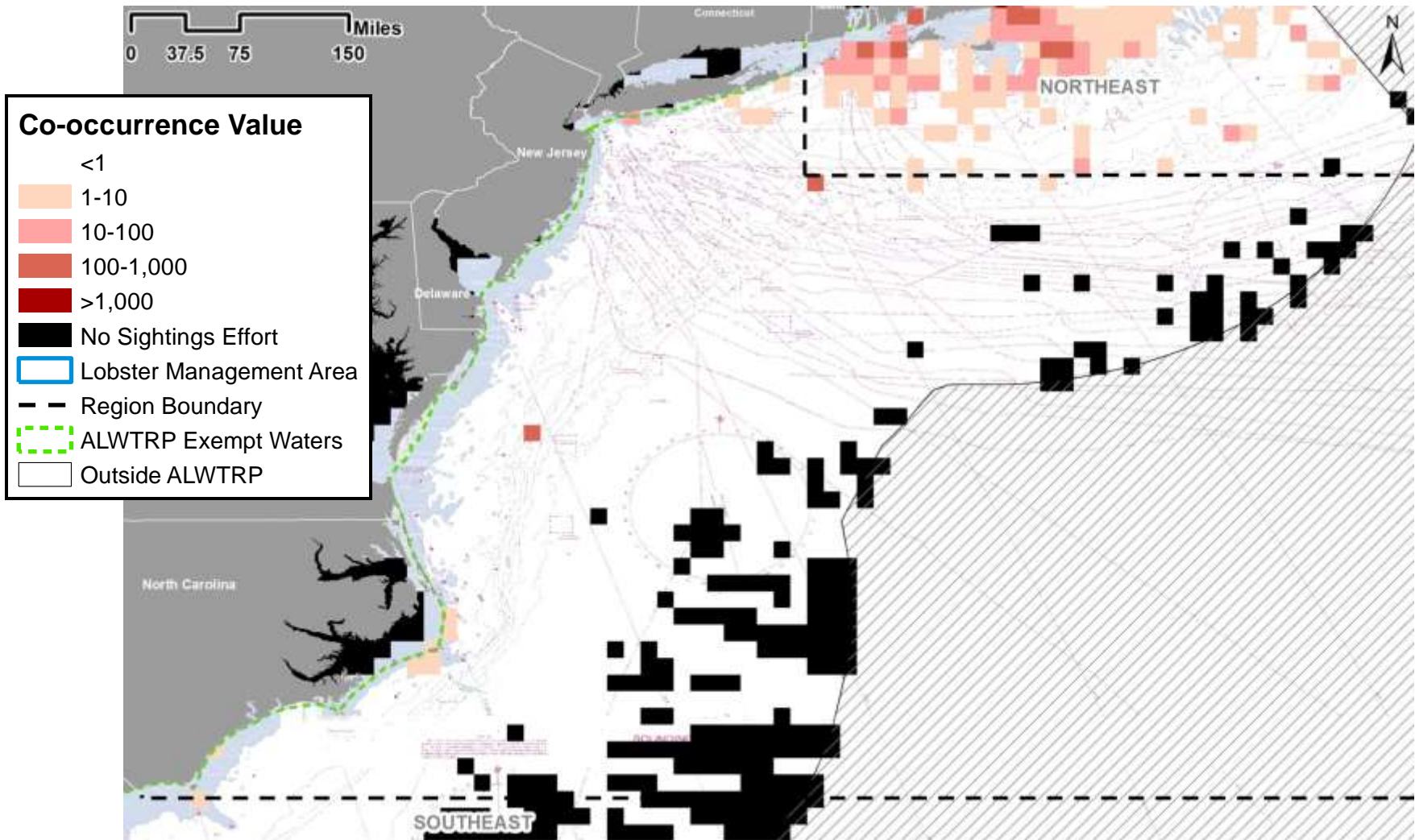
Illustrative Results: Northeast

Annual Average Co-occurrence of Vertical Lines and RW/HW
~ All Fisheries, Non-exempt Waters



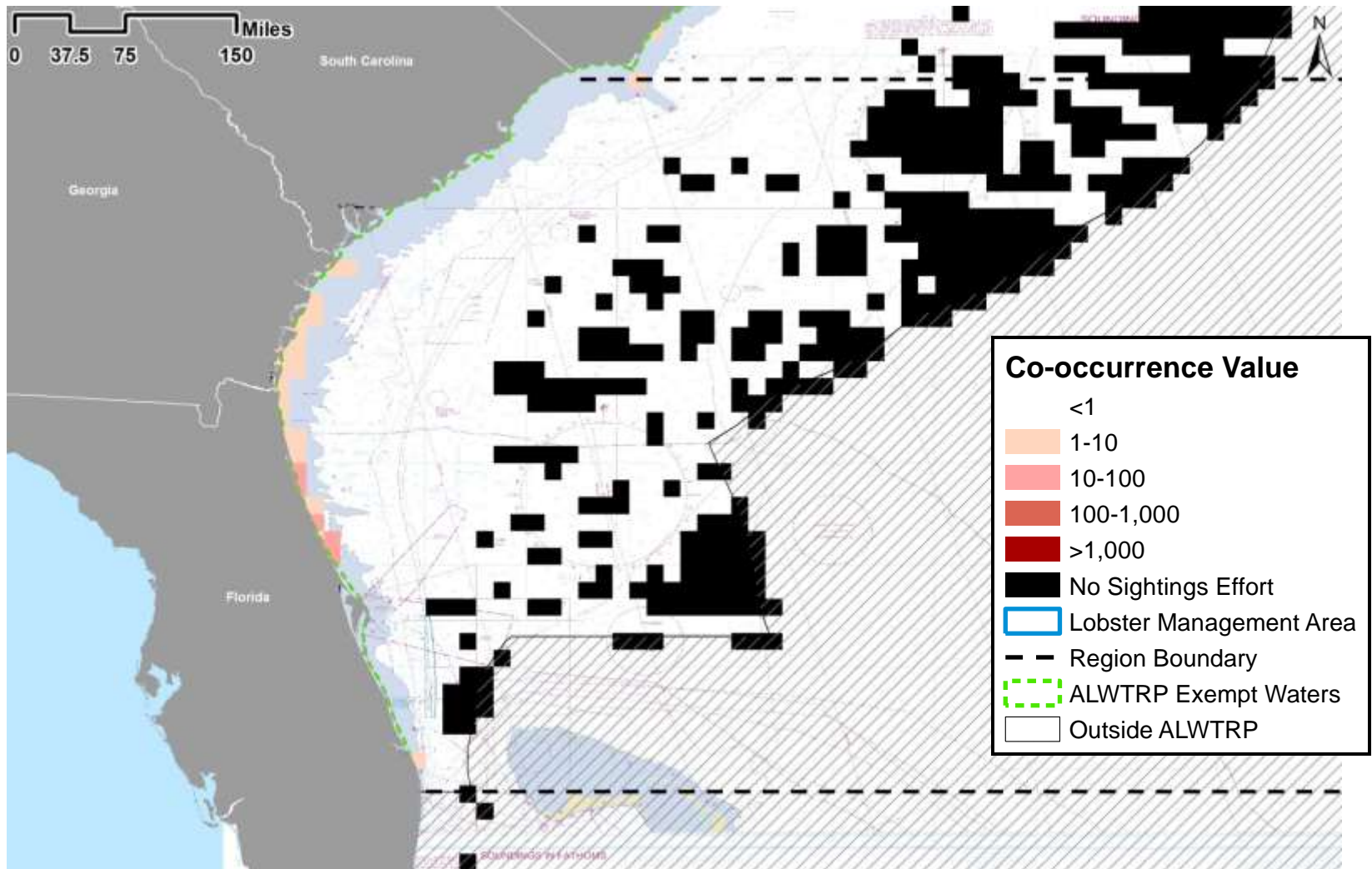
Illustrative Results: Mid-Atlantic

Annual Average Co-occurrence of Vertical Lines and RW/HW
~ All Fisheries, Non-exempt Waters



Illustrative Results: Southeast

Annual Average Co-occurrence of Vertical Lines and RW/HW
~ All Fisheries, Non-exempt Waters



Limitations: Co-Occurrence Scores

- ❖ Co-occurrence scores provide an imperfect basis for characterizing the potential for a whale to encounter vertical line.
 - Scores vary linearly with vertical line scores and SPUE scores.
 - The probability of an encounter is unlikely to vary in strict, direct proportion to these measures.
- ❖ The score does not address the probability of serious injury or death in the event of an entanglement.
- ❖ Co-occurrence scores are subject to all of the limitations in the underlying data cited above.

Advantages of Approach

- ❖ Makes transparent use of available data and helps drive investments in improving data.
- ❖ Provides a consistent basis for comparing the relative impact of alternative management measures.
- ❖ Facilitated development of Draft and Final EIS for Vertical Line Rule.
- ❖ Also facilitated rapid analysis of proposed changes to the rule in 2014 and 2015.
- ❖ Has improved the effectiveness of the TRT:
 - Better understanding of what is known and not known about the distribution of protected species and commercial fishing gear.
 - Improved basis for dialogue among stakeholders.

Lessons Learned

- ❖ Developing a model within a TRT construct requires:
 - Consistent support from NMFS management.
 - Commitment to transparency in working with the TRT.
 - Willingness to receive and act on constructive criticism.
 - Persistent effort to harness TRT's knowledge and expertise.
- ❖ When working with imperfect data:
 - Acknowledge data limitations early and often - and when possible, press for better data.
 - Maintain flexibility needed to work with data from disparate sources.
 - Seek improvements through development of relationships with key stakeholders.
 - Update data regularly to capture changes over time.
 - Stay open to new ideas.



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