Siting Analysis for Potential Near-Term Offshore Wind Farm Development: Georgia, South Carolina, and North Carolina

Phase 2A of the Southeast Ocean-Based Renewable Energy Infrastructure Project

Final Report - March 2011

Prepared for:

Georgia Environmental Finance Authority,
North Carolina State Energy Office,
South Carolina State Energy Office,
Southern Alliance for Clean Energy, and
US Department of Energy

Prepared by:

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GEO-MARINE GMI
A Subsidiary of Applied Research Associates, Inc.

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LIST OF ACRONYMS AND ABBREVIATIONS

°C	Degrees Celsius
%	Percent
ACCSP	Atlantic Coastal Cooperative Statistics Program
ASMFC	Atlantic States Marine Fisheries Commission
BOEMRE	Bureau of Ocean Energy Management, Regulation and Enforcement
CFR	Code of Federal Regulations
DOE	Department of Energy
DPS	Distinct Population Segment
E	Endangered
EA	Environmental Assessment(s)
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESRI	Environmental Systems Research Institute, Inc.
FMC	Fishery Management Council
FMP	Fishery Management Plan
ft	Foot(Feet)
GIS	Geographic Information System
GMFMC	Gulf of Mexico Fishery Management Council
GMI	Geo-Marine, Inc.
HAPC	Habitat Areas of Particular Concern
HMS	Highly Migratory Species
HSP	Historic Shipwreck Preserve
in	Inch(es)
km	Kilometer(s)
m	Meter(s)
m/s	Meter(s) per Second
MAFMC	Mid-Atlantic Fishery Management Council
MCAS	Marine Corps Air Station
MCB	Marine Corps Base
mi^2	Square Mile(s)
MMPA	Marine Mammal Protection Act
MPA	Marine Protected Area
MPRSA	Marine Protection Research and Sanctuaries Act
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
MTS	Marine Transportation System
MU	Management Unit
MW	Megawatt(s)
NDBC	National Data Buoy Center
NEFMC	New England Fishery Management Council
NM	Nautical Mile(s)
NM^2	Square Nautical Miles
NMFS	National Marine Fisheries Service
NMS	National Marine Sanctuary
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
OCS	Outer Continental Shelf

LIST OF ACRONYMS AND ABBREVIATIONS (*continued*)

OPAREA	Operating Area
ppm	Part(s) per Million
RoRo	Roll-on/Roll-off
RSA	Regional Sailing Association
SAB	South Atlantic Bight
SABSOON	South Atlantic Bight Synoptic Offshore Observational Network
SAFMC	South Atlantic Fishery Management Council
SAR	Stock Assessment Report
SAV	Submerged Aquatic Vegetation
SAYRA	South Atlantic Yacht Racing Association
SCUBA	Self-contained Underwater Breathing Apparatus
SMZ	Special Management Zone
SUSLME	Southeast United States Continental Shelf Large Marine Ecosystem
T	Threatened
UNC	University of North Carolina
U.S.	United States
USACE	United States Army Corps of Engineers
UXO	Unexploded Ordnance
VACAPES	Virginia Capes
WWII	World War II

EXECUTIVE SUMMARY

This analysis is a part of a multi-phased project to understand the infrastructure required to develop gigawatt-scale offshore wind development. This siting analysis identifies offshore areas off of North Carolina, South Carolina, and Georgia where ocean-based renewable energy may be most feasible, taking into consideration geological, environmental, economic, military, transportation, and other constraints. Factors that may preclude offshore wind development were analyzed including marine mammals, sea turtles, birds, fishes, essential fish habitat (EFH), corals, submerged aquatic vegetation (SAV), commercial and recreational fisheries, maritime traffic, military munitions training areas, mining or dumping grounds, subsea pipelines, shipwrecks, self-contained underwater breathing apparatus (SCUBA) sites, and buoys and weather stations.

To assess locations where offshore development may have the least intrusive impact, an index of the relative sensitivity of the Study Area was developed. The index was created to spatially visualize the number of factors (in GIS layers) per area to evaluate the relative degree of intrusiveness and depict areas that may be more or less suitable for development. Areas that are lower on the intrusiveness scale on the index (i.e., they have seemingly fewer total factors that may affect development) are likely more favorable for development; however, those areas that show high or moderate overlap of factors should not be dismissed as areas of development; rather these regions may require additional research. The index was used as a tool to spatially distinguish between areas of differing intrusiveness for potential wind farm development. A total area of 411 mi^2 has been identified as Study Blocks for wind farm development at 300-megawatt (MW) size or larger for inclusion in the next phase of this project. This total area is a part of nine different study blocks that are at least 27 mi^2 or greater in size. Two study blocks are located off the coast of North Carolina, one study block is located off the coasts of North Carolina and South Carolina, three study blocks are located off the coast of South Carolina, one study block is located off the coasts of South Carolina and Georgia, and two study blocks are located off the coast of Georgia.

The analysis has resulted in a uniform regionally-focused dataset that is being used to identify potential offshore wind energy development study blocks specifically for the next phases of the project. The next phases will use the study blocks identified to estimate offshore wind energy generation potential and electric transmission requirements. This analysis is not meant to be comprehensive and should not be used in lieu of more specific resource studies, but it provides a good synthesis of available baseline data for initial planning purposes. The results identify areas within which it may be feasible to develop gigawatt-scale offshore wind facilities; however, it is likely that only a very small portion of them would be developed in the near-term. Additionally, these areas are identified based on very specific factors relevant to this analysis and thus do not necessarily represent the only areas available for offshore wind development within the Study Area. Further research and consultation with numerous agencies is required before any areas may be developed.

1.0 INTRODUCTION

1.1 BACKGROUND

This analysis will assist the selection and development of transmission infrastructure to support gigawatt-scale, ocean-based renewable energy resources located off the coasts of North Carolina, South Carolina, and Georgia. This analysis is Phase 2A of a multi-phased project that is a collaboration among state, regional, and national agencies to create a thorough understanding of the infrastructure required to develop gigawatt-scale ocean renewable energy resources in an economic manner. Phase 2A is a siting analysis that will identify the areas where offshore wind farms are most likely to be built in the near term (10 years) based on quantitative data available. It draws from and augments the information provided in Phase 1 of the project that was an ocean-based renewable energy assessment off North Carolina as well as off of Georgia. In that phase, multiple ocean-based renewable energy technologies were evaluated; however, only offshore wind energy was deemed to be commercially viable within the next 10 years. Phase 1 studies were conducted by the Georgia Institute of Technology (Georgia Institute of Technology 2010) and the University of North Carolina at Chapel Hill (UNC 2010) in addition to ongoing work for offshore South Carolina.

This siting analysis identifies offshore areas off of North Carolina, South Carolina, and Georgia where ocean-based renewable energy may be most feasible, taking into consideration geological, environmental, economic, military, transportation, and other constraints on the placement of these projects; however, this analysis is not meant to be comprehensive. It results in the identification of areas within which it may be feasible to develop gigawatt-scale offshore wind facilities. Although this study identifies suitable areas for development, it is likely that only a very small portion of them would be developed in the near-term. Additionally, these areas are identified based on very specific factors relevant to this analysis and thus do not necessarily represent the only areas available for offshore wind development within the Study Area. Further research and consultation with numerous agencies is required before any areas may be developed.

The siting analysis has resulted in a uniform regionally-focused dataset that is being used to identify potential offshore wind energy development study blocks specifically for the next phases of the project. Phase 2B will take the study blocks identified to create electric generation output data in order to estimate offshore wind energy generation potential and load. Phase 2C will be a southeastern ocean based transmission study to understand the costs and operating impacts of significant amounts of wind power on the grids and to help in future transmission planning.

1.2 STUDY AREA

The Study Area is located almost wholly in the South Atlantic Bight (SAB) (i.e., the waters of the northwestern Atlantic Ocean off the coasts of southern North Carolina, South Carolina, Georgia, and northeastern Florida). The Study Area includes the offshore environment off of North Carolina, South Carolina, and Georgia up to 50 nautical miles (NM) from shore (**Figure 1**). It covers 36,345 square miles (mi^2) of ocean area within and north of the SAB. The shoreward boundary ranges from waters at the state line between North Carolina and Virginia to waters at the state line between Georgia and Florida. A portion of Pamlico Sound was also included in the Study Area. Adjacent to the Study Area is a long chain of small barrier islands and beaches. These unconnected islands are separated from each other by narrow tidal inlets and are separated from the mainland by shallow sounds and estuaries. Some of the dominant coastal

Figure 1. Study Area.

features of the Study Area include: Albemarle Sound, Pamlico Sound, and Cape Fear (North Carolina); Winyah Bay and St. Helena Sound (South Carolina); and Little Tybee Island and St. Andrew Sound (Georgia).

2.0 METHODS

The offshore waters of North Carolina, South Carolina, and Georgia were evaluated up to 50 NM from each state's shore to identify potential wind farm development zones. All areas of unsuitable water depth (greater than 30 meters [m] depth) or unsuitable estimated wind speeds (less than 7.5 meters per second [m/s]) were excluded; these areas were excluded because they are considered not commercially viable for offshore wind energy technology in this study's timeline. Water depth plays a role in the costs of installation of wind turbines. As water depth increases, the price of construction increases due to the potential need to use expensive jacketed foundations and marine vessels for installation (Snyder and Kaiser 2009). According to the 1986 Atlas, areas that are designated as having average wind speeds of at least 6.4 m/s are suitable for most wind turbine applications; however, wind turbine installations in the offshore environment are generally created in areas with average wind speeds of at least 7.5 m/s due to the economics of the site (higher costs of construction, development, maintenance, and financing, etc. for offshore sites) (USACE 2006). The distribution of annual average wind speeds for the study area is shown in **Figure 2**. Factors that may preclude offshore wind development were analyzed. These include ecological factors such as marine mammals, sea turtles, birds, fishes, essential fish habitat (EFH), corals, and submerged aquatic vegetation (SAV) and non-ecological factors such as fisheries, maritime traffic, military munitions training areas, mining or dumping grounds, subsea pipelines, shipwrecks, self-contained underwater breathing apparatus (SCUBA) sites, and buoys and weather stations. The methods for the analysis of these factors are discussed below.

2.1 LITERATURE AND DATA SEARCH

Prior to the production of this report, a thorough and systematic search for relevant scientific literature and data was conducted. Information, data, and literature that were deemed vital to the production of this report were identified, obtained, reviewed, and then catalogued. Of the available scientific literature (both published and unpublished), the following types of documents were utilized in the siting analysis: journals, periodicals, bulletins, monographs of scientific and professional societies, theses, dissertations, symposium proceedings, project reports, threatened (T) and endangered (E) species recovery plans, stock assessment reports (SARs), Environmental Assessments (EAs), Environmental Impact Statements (EISs), Fishery Management Plans (FMPs), and other technical reports published by government agencies, private businesses, or consulting firms. Geo-Marine, Inc.'s (GMI) in-house marine science database and other databases were consulted during the search for data and information on the occurrence of ecological and non-ecological factors present in the Study Area. In addition, the data and reports that were used from Phase 1 studies conducted by the Georgia Institute of Technology (Georgia Institute of Technology 2010) and the University of North Carolina at Chapel Hill (UNC 2010) are due specific mention. Independent research has been and is being conducted off South Carolina with the Palmetto Wind Initiative. Several buoys have been placed off locations near Winyah Bay and Little River to evaluate the local wind speed (Coastal Carolina University 2010).

2.2 SPATIAL DATA REPRESENTATION—GEOGRAPHIC INFORMATION SYSTEM

The geographical representation of ecological and non-ecological factors found within the Study Area is a primary component of this siting analysis. The resource data and information used to

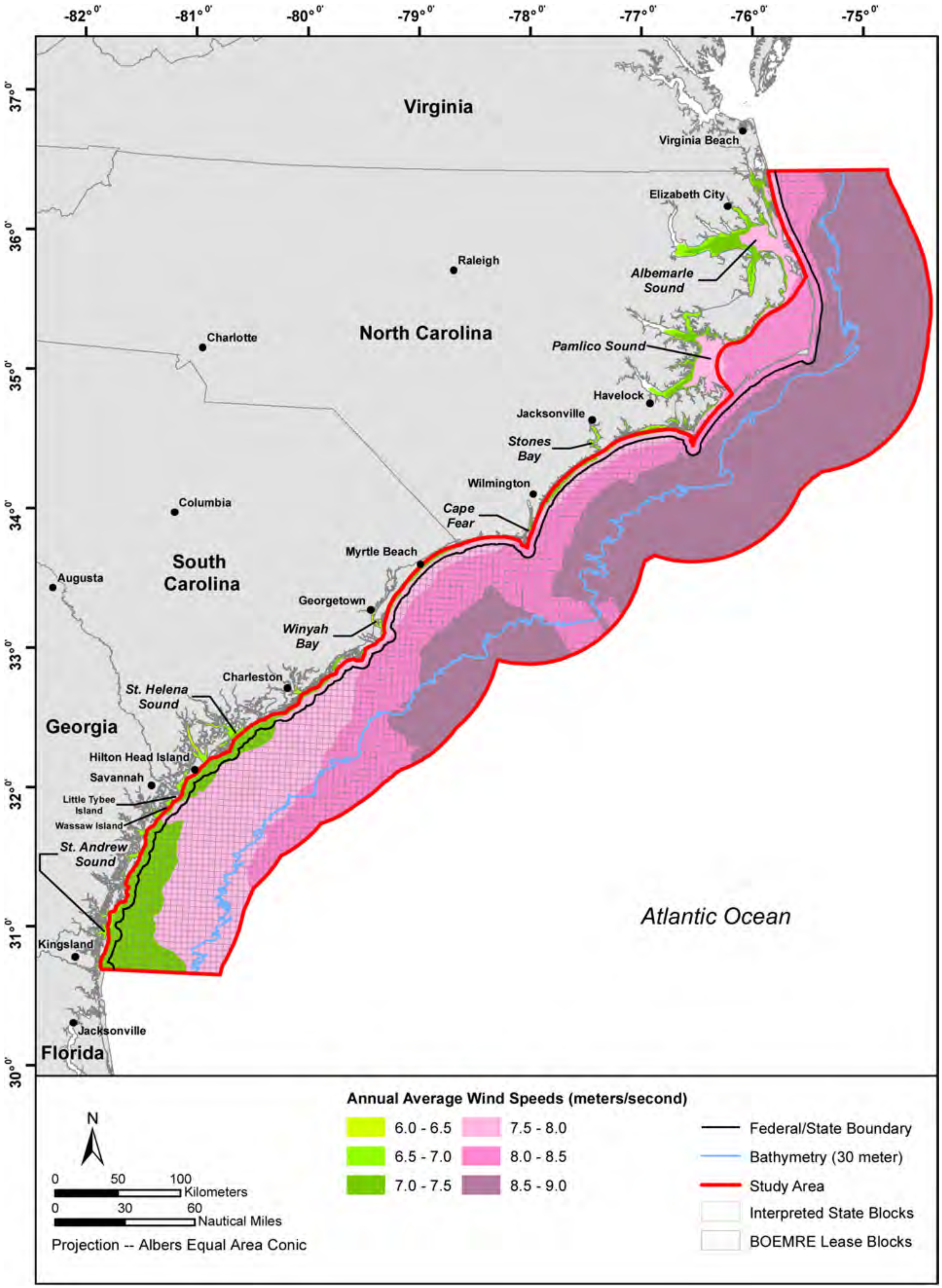


Figure 2. Annual average wind speed (m/s) in the Study Area. Source data: DOE (2010).

determine suitable areas for this project were retrieved from a wide variety of sources, were in disparate formats, covered a broad range of time periods, and represented differing levels of accuracy as well as quality assurance.

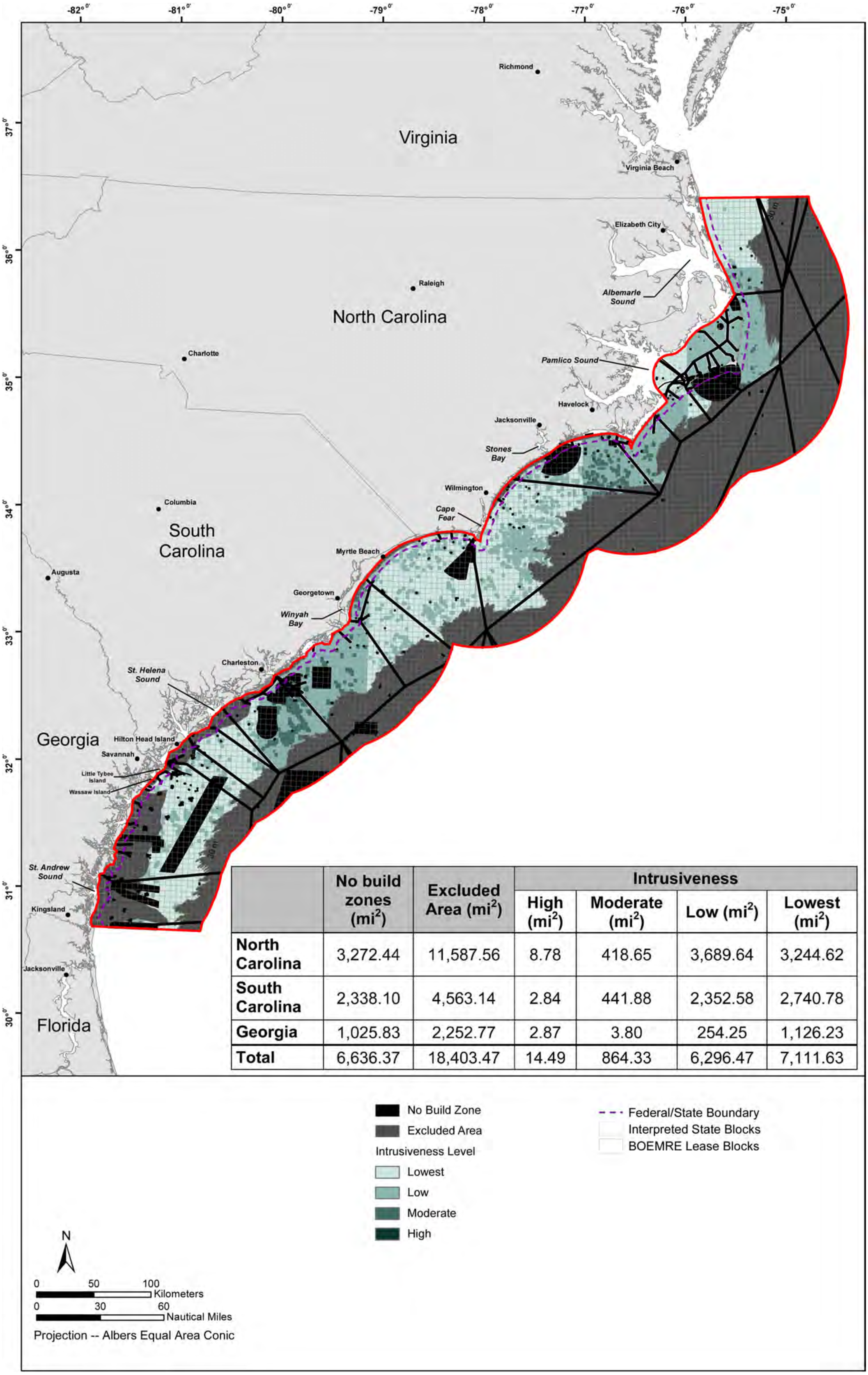
A geographic information system (GIS) was used to store, manipulate, and display the spatial data and information accumulated for the Study Area. For this project, Environmental Systems Research Institute, Inc.'s (ESRI) ArcView® version 9.2 GIS software was used to create the map figures. ArcView® was chosen for this project due to its widespread use, ease of operation, and its ability to create multiple views and layouts within the same project file.

2.3 Index Development

To assess locations where offshore development may have the least intrusive impact and identify the ecological and non-ecological factors in the Study Area, an index of the relative sensitivity of the Study Area was developed. The index was created to summarize visually the overlapping factors of the Study Area and depict areas that may be more or less suitable for development. The index includes data collected during Phase 1 studies, through review of published literature, and from resource agencies such as National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS), and Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE). The factors that were included in the index include: artificial reefs, marine protected areas (MPAs), Habitat Areas of Particular Concern (HAPC), EFH, known obstructions, known shipwrecks, unexploded ordnance (UXO), mining and dumping grounds, shipping lanes, commercial and recreational fishing, and bird, marine mammal, and sea turtle primary occurrence areas. These factors were visualized spatially in GIS layers and the number of layers per area was used to evaluate the relative degree of intrusiveness in a given area. Areas that are lower on the intrusiveness scale on the index (i.e., they have seemingly fewer total factors that may affect development) are likely more favorable for development; however, those areas that show high or moderate overlap of factors should not be dismissed as areas of development; rather these regions may require additional research. Only areas described as "Excluded Areas" or "No Build Zones" (obstructions, shipping lanes, traffic separation zones, shipwrecks, restricted military areas, areas directly overlaying subsea pipelines, areas that have wind speeds less than 7.5 m/s or depths greater than 30 m, etc.) should be avoided. The index is to be used only as a guide to help determine on a very broad scale those locations within the Study Area that may be most suitable for offshore development as well as those areas that may need to be avoided. Additional data may be required by state and/or federal agencies for offshore development at specific sites. The index allows the synthesis of the physical, biological, and socioeconomic resources data of the Study Area. It was developed as a planning guide to assist with the rapid evaluation of potentially intrusive areas within the Study Area (**Figure 3**). In general, the index is a useful tool for preliminary planning because it provides a quick overview of the potentially sensitive resources off the North Carolina, South Carolina, and Georgia coasts. The index is very general and should not be used in lieu of more specific resource studies, but it provides a good synthesis of available baseline data for initial planning purposes.

The resources (features) considered for the index included:

- Artificial reefs
- Marine protected areas (MPAs)
- Habitat areas of particular concern (HAPCs)
- Essential Fish Habitat (EFH)



	No build zones (mi²)	Excluded Area (mi²)	Intrusiveness			
			High (mi²)	Moderate (mi²)	Low (mi²)	Lowest (mi²)
North Carolina	3,272.44	11,587.56	8.78	418.65	3,689.64	3,244.62
South Carolina	2,338.10	4,563.14	2.84	441.88	2,352.58	2,740.78
Georgia	1,025.83	2,252.77	2.87	3.80	254.25	1,126.23
Total	6,636.37	18,403.47	14.49	864.33	6,296.47	7,111.63

Figure 3. Index of relative intrusiveness for the siting and development of offshore wind resources within the Study Area.

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- Known obstructions
- Known shipwrecks
- Unexploded ordnances (UXOs)
- Shipping lanes Marine mammal, sea turtle, and bird primary occurrence areas
- Commercial fishing effort
- Recreational fishing effort

During development of the index, it was determined that shipping lanes, marine traffic, obstructions, mining/dumping areas, pipelines, MPAs, artificial reefs, shipwrecks, restricted areas, and UXO/danger areas were “no build zones”; therefore, those features were shaded black on the index map (**Figure 3**). Shipping lanes and traffic separation schemes were given a buffer of 1 mi to account for shipping lane deviation. Shipwrecks, obstructions, artificial reefs, hard bottom, and coral were given a buffer of 0.5 mi to account for data inaccuracy. In some cases, the object or area (e.g., a shipwreck or dumping ground) that may potentially inhibit wind farm development in an area may occupy only a small area within a lease block. For the purposes of the index, any lease block with a “no build” factor inside its boundaries was excluded in its entirety; however, the data will provide additional information on blocks such as these. For example, when a lease block has a small piece of hard bottom data associated with it or a shipwreck within its boundaries and it is of specific interest, then that lease block can be investigated further for possible suitable wind farm development.

2.4 Spatial Index Creation with Geographic Information Systems

To create the map depicting the spatial extent of independent physical, biological, and socioeconomic features within the Study Area, selected features were represented as mapping layers which were additively combined and displayed within a continuous surface. The manipulation and conversion of these selected input features allowed for different feature types to be combined for analysis. The majority of the features used to develop the index were in a vector format, either derived from hard copy georeferenced sources or existing databases. The vector data were converted into Boolean grids, a raster format which was classified as having either a presence (1) or absence (0). The production of these raster grids facilitated the use of features created by statistical and geographic analyses.

Instead of a multi-classed representation, GMI used the largest number of classes possible for the index while still preserving the spatial distribution of the data. The processed, ranked, and classified data were then incorporated into a Boolean addition overlay. By adding rasters, the physical, biological, and socioeconomic features were synthesized to produce a comprehensive visual output.

The index exists as a map (**Figure 3**) that overlays all the data available for each resource area to identify areas within the Study Area where overlap exists among resource types. The data for each resource area were visualized in the appropriate number of layers and all layers were then visualized in one map. Areas where there is overlap based on a simple additive approach were grouped into levels of intrusiveness to give a relative view of the resource structure within the Study Area. The approach taken for each resource category is outlined below.

The index was created using eight different layers as well as data which was designated as being excluded due to it being prohibitive to wind farm development (**Table 1**).

In providing the level of intrusiveness, each layer is added to any other layers that occupy the same space. The number of layers associated with a particular lease block or grid (100 m by 100 m) gives a quantitative value to the level of intrusiveness. For instance, if a particular lease block is part of a sand borrow area, has hard bottom habitat associated with it, and has expected occurrences of marine mammals, sea turtles, and birds, then the lease block would be given an intrusiveness value of five because there are five layers associated with that lease block. All areas have at least four layers associated with them (marine mammal occurrence, sea turtle occurrence, bird occurrence, and EFH). Areas with only four layers associated with them are of the lowest intrusiveness value; areas with five layers associated with them are of low intrusive value; areas with six layers associated with them are of moderate intrusive value; and areas with seven layers associated with them are of high intrusive value. The areas that had eight layers associated with them were either in the excluded area or no build areas, so they will not be seen on the map.

Table 1. Factors that went into the development of the index.

Layer	Factor
1	Sand Borrow Areas
2	Marine Mammal Occurrence
3	Sea Turtle Occurrence
4	Bird Occurrence
5	Fisheries Use
6	Hard Bottom and HAPC
7	EFH
8	North Atlantic Right Whale Critical Habitat
No Build Areas	Artificial Reefs, Obstructions, Shipping Lanes/Separation Schemes, Ferry Routes, Marine Protected Areas, Dumping Ground Areas, Military Practice Areas, Restricted Areas, and Danger Areas/UXO

Due to the nature of the layers, the driving factors for the index include hard bottom, HAPC, fisheries, sand borrow areas, and any excluded or no build areas. Marine mammals, sea turtles, birds, and EFH were deemed to have equal intrusiveness throughout the Study Area and therefore did not give the index discernable detail. Also, the North Atlantic Right Whale critical habitat is located within an area that is either in an excluded or no build area. The development of each layer is described in the following sections.

2.5 USING THE INDEX

The index provides a visual representation of the number and distribution of physical, biological, and socioeconomic resources within the Study Area. Although the index clearly shows areas of high intrusiveness and low intrusiveness, the user cannot discern which resources are found within each of the grid blocks by simply looking at the map (**Figure 3**). In addition, the areas of intrusiveness are relative and may only be evaluated unto themselves. As such, the final dataset is available in an electronic format (Google Earth files) to allow the user to lay each data set within individual grid or lease blocks on top of one another for each area of specific interest. This will provide information on the resources found within a given area as well as the number of factors (ecological and non-ecological) associated with a particular block or grid. This information can provide an understanding of the intrusiveness factor for each grid within the Study Area.

2.6 Ecological Factor Layers

2.6.1 Marine Mammal, Sea Turtle, and Bird Layers

Information collected from available literature and data sources were used to identify expected primary areas of occurrence based on habitat associations and known distributions of marine mammals, sea turtles, and birds. Primary occurrence is defined as an area where a species is expected to be found regardless of how abundant it may be. These primary occurrence areas were used to develop spatially-discrete representations of marine mammal, sea turtle, and bird distributions (layers) for the siting analysis. The layer for each animal group encompasses the areas of primary occurrence for all species which have at least a portion of their primary occurrence in the Study Area. These primary occurrence areas represent ecologically valuable zones within which potential offshore wind farm development may be intrusive. Although the distributions of all species were considered in identifying potentially intrusive regions for wind farm development, the final layer chosen to represent primary occurrence in the Study Area for each species group is not indicative of all species that may occur in the area. Each layer reflects the known distribution for species that have primary occurrence in the Study Area including species listed as T or E under the Endangered Species Act (ESA), but it does not encompass sporadic occurrences of cryptic species, such as beaked whales (*Kogia* spp.), or other species which do not typically occur in the shallow, nearshore Study Area. In addition to the primary occurrence layers for marine mammals, sea turtles, and birds, the North Atlantic right whale (*Eubalaena glacialis*) critical habitat designated under the ESA is included as a separate layer in the siting analysis.

Seasonal variations in occurrence were not accounted for in any of the siting analysis layers because marine mammal, sea turtle, and bird species with primary occurrence in the Study Area may occur there during any time of the year. Seasonal variations could also be a factor in regulatory requirements that distinguish between offshore wind farm construction and offshore wind farm operations post-construction. Species abundance estimates specific to the Study Area are not available but will be important information for the next phase of planning offshore wind farm development due to the regulatory requirement for quantitative estimates of the number of potentially impacted individuals.

2.6.1.1 Limitations of Primary Occurrence Layers

Much of what is known about marine mammal, sea turtle, and bird occurrence in the Study Area relies upon sighting data collected during aerial or shipboard surveys. These data are very useful for understanding the distribution and abundance of species but also have some limitations. For instance, current survey data do not exist for the entire Study Area throughout the year. Therefore, sighting data for all species occurring in the Study Area are lacking in both temporal and spatial coverage.

2.6.2 Fishery Management Unit Mapping Layers: Designated Essential Fish Habitat and Habitat Areas of Particular Concern

A review of the literature and data sources on fishery management units (MUs) and their designated EFH and HAPC was conducted to generate mapping layers delineating areas ecologically important to species and potentially sensitive to human-induced impacts.

The Study Area includes the dolphin-wahoo, shrimp, coastal migratory pelagic, spiny lobster, snapper-grouper complex, and coral, coral reefs, live hard bottom fishery MUs (SAFMC and

NMFS 2009) as well as the temperate and highly migratory species (HMS) fishery MUs (NEFMC 2003; NMFS 2001, 2009). The Gulf Stream plays a key role in supporting the dolphin-wahoo, shrimp, and coastal migratory pelagic EFH by transporting all stages of development from the wider Caribbean region to the Study Area (SAFMC and NMFS 2009). Further, the dynamic upwelling that takes place along frontal boundaries and frontal eddies (Yoder et al. 1981) generated by the western edge of the Gulf Stream and shelf waters generate localized areas of high surface productivity and influence phytoplankton biomass which in turn influences fisheries.

The spiny lobster and snapper-grouper complex EFH are influenced by the Gulf Stream and continental shelf sediments/substrates (SAFMC and NMFS 2009). The Gulf Stream transports the various life stages of these fisheries from the wider Caribbean region to the Study Area. Sediments/substrates of the continental shelf provide the habitats that support the settlement, growth and reproduction of these fisheries (SAFMC and NMFS 2009).

The temperate species and HMS EFH are influenced by the Gulf Stream and southward flowing surface currents (NEFMC 2003; NMFS 2001, 2009). Temperate species are influenced by southward flowing currents entering the vicinity of Study Area including the coastal influence of Chesapeake Bay plume water that jets southward as far as Cape Hatteras, North Carolina, and causes frontal boundaries with enhanced primary productivity (Pickard and Emery 1990), and the remnants of the southeasterly flowing Labrador Current which directs the flow of cold, temperate waters over the Hatteras-Cape Cod shelf. The transport of HMS to the Study Area is influenced both by southward flowing currents and the Gulf Stream (i.e., some species originate from northerly locations while others come from the south). The enhanced primary productivity that occurs along the western boundary of the Gulf Stream and into the Study Area as induced by frontal eddies and dynamic upwelling along frontal boundaries (Yoder et al. 1981) support both temperate and HMS.

EFH designations (the dolphin-wahoo, shrimp, coastal migratory pelagic, spiny lobster, snapper-grouper complex, temperate and HMS fishery MUs) were grouped into a single mapping layer since the geographical delineations of these fishing units do not preclude human use such as offshore wind development.

2.6.2.1 Coral, Coral Reefs, and Live Hard Bottom

Coral, coral reefs, and live hard bottom EFH and HAPC were assigned a separate mapping layer to indicate the presence of benthic resources sensitive to human-induced disturbances that could preclude offshore wind development. This layer was developed using available, existing data. The grouping of these sensitive resources does not necessarily indicate that they have the same level of sensitivity to human-induced change. The grouping displays sensitive resources that would probably require a similar level of avoidance to prevent impacts. Proposed development within HAPC will, however, need to prevent impacts on sensitive habitats and on the ecological function the habitat provides, prevent long-term stress on the habitat, and not affect rare habitats (NMFS 2007).

2.6.3 Non-Ecological Factor Layers

2.6.3.1 Commercial and Recreational Fisheries Mapping Layer

The commercial and recreational fisheries layer provides locations of commercial fisheries with the highest landings (i.e., 2,000,000 to 50,000,000 live pounds) over a 16-year period (1990 to

2006) within the Study Area. This data was compiled by the Atlantic Coastal Cooperative Statistics Program (ACCSP) (SAFMC 2009). The available literature and data were reviewed to capture the locations of fishing hot spots within the Study Area which could hinder offshore wind development (Freeman and Walford 1976a, 1976b). Using these data, a single mapping layer was generated to depict highest offshore commercial fishing landings and recreational fishing hot spots. Included in the mapping layer were six coastal areas (blocks) within the Study Area each measuring one degree of longitude by one degree of latitude (~100 kilometers [km] per side) where landings exceeded 2,000,000 total live pounds (SAFMC 2009). ACCSP block number 635 covering the offshore area off the Outer Banks and ACCSP block 701 covering the Cape Lookout, North Carolina area and the adjacent half of Onslow Bay yielded 55,000,000 total live pounds of commercial fishing landings including brown shrimp (*Farfantepenaeus aztecus*), bluefish (*Pomatomus saltatrix*), Atlantic croaker (*Micropogonias undulatus*), and spot (*Leiostomus xanthurus*). Further south, ACCSP blocks 706 and 713 off Charleston, South Carolina, yielded 2,000,000 total live pounds of white shrimp (*Litopenaeus setiferus*). ACCSP Blocks 717 and 722 in the Brunswick, Georgia, area yielded 55,000,000 total live pounds of white shrimp (SAFMC 2009).

2.6.3.2 Other Non-ecological Factor Layers

Almost all of the non-ecological factors were considered inhibitive to wind farm development and were blacked out for the purposes of the final index. The following are all of the non-ecological factors that were blacked out: maritime traffic (buffer was included to account for ships that do not follow exactly along the lane), UXO/danger areas, restricted areas, mining/dumping areas, subsea pipelines, Gray's Reef National Marine Sanctuary (NMS), artificial reefs, and shipwrecks.

After an analysis of the SCUBA sites, sailing regattas, buoys and weather stations, and military munitions training areas, they were not considered inhibitive to wind farm development and were not included in the index. Discussion of the military munitions training areas, SCUBA sites, and buoys and weather stations in the Study Area are included in the results section of this report.

Sand borrow areas were not considered inhibitive to wind farm development and were given their own layer within the index.

3.0 RESULTS

3.1 SITING ANALYSIS

3.1.1 Areas for Potential Wind Farm Development

The index was used as a tool to spatially distinguish between areas of differing intrusiveness for potential wind farm development. In using the index, a total area of 7,111.63 mi^2 was indicated to be of lowest intrusiveness. These areas were used to form study blocks (areas of lowest intrusiveness that are 27 mi^2 in size or greater – large enough for a minimum offshore wind farm capacity of 300 MW). This is not to say that areas of low, moderate, or high intrusiveness are not available for wind farm development, but that as a result of our analysis, the areas designated as study blocks in **Figure 4** were determined to be the most suitable areas for development for wind farms at 300 MW or larger. **Table 2** provides the amount of area (mi^2) in the Study Area that has been designated as a no build zone, an excluded area, and with high, moderate, low, or lowest levels of intrusiveness.

Table 2. The amount of area (mi^2) in the Study Area that have been designated as a no build zone, an excluded area, and with high, moderate, low, or lowest levels of intrusiveness for North Carolina, South Carolina, and Georgia.

	No build zones (mi^2)	Excluded Area (mi^2)	Intrusiveness			
			High (mi^2)	Moderate (mi^2)	Low (mi^2)	Lowest (mi^2)
North Carolina	3,272.44	11,587.56	8.78	418.65	3,689.64	3,244.62
South Carolina	2,338.10	4,563.14	2.84	441.88	2,352.58	2,740.78
Georgia	1,025.83	2,252.77	2.87	3.80	254.25	1,126.23
Total	6,636.37	18,403.47	14.49	864.33	6,296.47	7,111.63

In developing the study blocks, it was necessary to limit the number of lease blocks deemed appropriate for wind farm development because without limitations the number of study blocks designated would result in an unrealistic offshore wind build-out scenario with nearly quintupling the amount of available area and therefore electric generation capacity. Out of the areas of lowest intrusiveness, areas within 25 NM from shore were included and suitable areas that were within 25 to 50 NM from shore were omitted from the designation of study blocks. In addition, because of the significant wind resources available in North Carolina versus Georgia, study blocks were designated only in areas with greater than the annual average wind speeds of 8.5 m/s for North Carolina; areas with greater than the annual average wind speeds of 8.0 m/s for South Carolina; and areas with greater than the annual average wind speeds of 7.5 m/s for Georgia.

It should be noted that the index was based on many different datasets that have differing resolutions. An effort was made for a lease block to be 100 percent (%) free of any other intrusiveness values greater than the lowest; however, if a lease block was 99% free of any other intrusiveness values it was deemed to be a part of the study block. This was the case for some lease blocks that included hard bottom data due to the resolution of the data; however, for data such as traffic separation schemes or other hard-line data such as restricted areas, the lease block with 1% coverage of an excluded area was not included in the study block. For lease blocks that were excluded due to the presence of hard bottom habitat or other low resolution data (shipwrecks) it is noted in the GIS files that the area may not necessarily be excluded for wind farm development and that a survey may be needed to determine the presence/absence of the factor and/or its extent of occurrence within the lease block.

A total area of 411 mi^2 has been deemed most suitable for wind farm development. This is the amount of area within the study blocks. This is different than the total area indicated to be of lowest intrusiveness because the total area of lowest intrusiveness (7,111.63 mi^2) takes into account partial lease blocks whereas the area of study blocks (411 mi^2) only takes into account lease blocks that are 100 to 99% free of other factors. In addition, limitations of distance from shore and annual average wind speed were used in the designation of study blocks whereas, the total area of lowest intrusiveness takes into account the entire Study Area out to 50 NM and all annual average wind speeds greater than 7.5 m/s.

There are nine study blocks that are at least 27 mi^2 or greater in size that have been identified as a result of the analysis of the ecological and non-ecological factors within the Study Area.

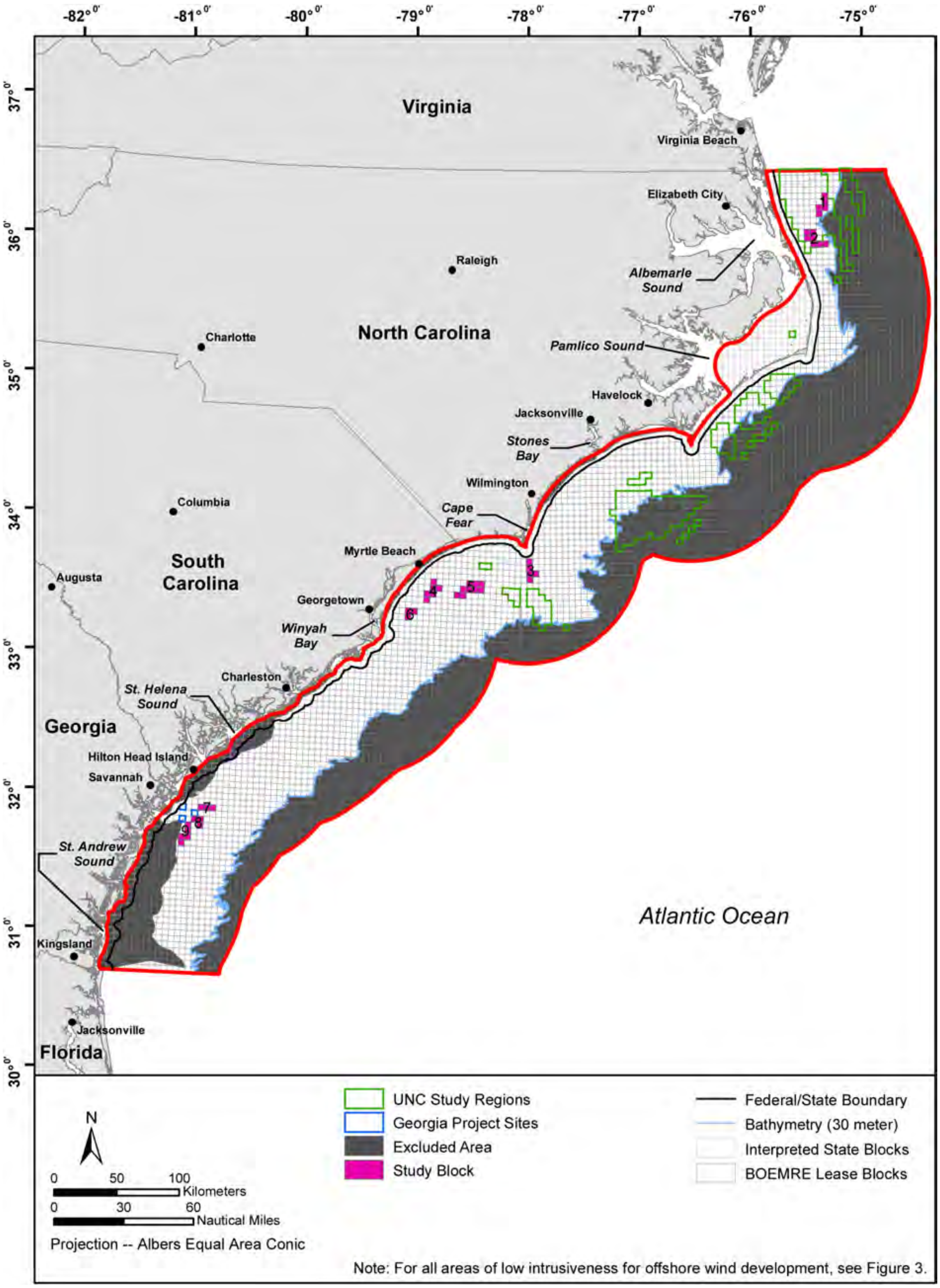

Figure 4. BOEMRE lease blocks (used as Study Blocks) with relative lowest intrusiveness for offshore wind development.

Two study blocks are located off the coast of North Carolina, one study block is located off the coasts of North Carolina and South Carolina, three study blocks are located off the coast of South Carolina, one study blocks are located off the coasts of South Carolina and Georgia, and two study blocks are located off the coast of Georgia (**Figure 4**). In order to ensure at least one gigawatt of offshore wind energy capacity potential, at least 12 BOEMRE lease blocks needed to be identified for each state; however, the Georgia study area only has 11 lease blocks associated with the designated study blocks due to limitations in the amount of area available and limitations of the study variables. The offshore environment off of Georgia is limited by low annual average wind speeds as well as the presence of many excluding factors such as shipping lanes, artificial reefs, hard bottom, etc. **Table 3** provides the BOEMRE lease block number and latitude and longitude center point for each study block identified and ranked as having the lowest potential for intrusiveness in the Study Area.

Table 3. Study blocks in the Study Area as identified by BOEMRE lease blocks and latitude/longitude center points.

BOEMRE lease blocks	Latitude/Longitude Center Point
North Carolina	
Study Block 1: 45 mi^2	
6714, 6764, 6814, 6813, 6863	36.299, -75.369
Study Block 2: 62 mi^2	
7012, 7011, 7062, 7061, 7114, 7113, 7112	36.058, -75.445
North Carolina/South Carolina	
Study Block 3: 45 mi^2	
6203, 6253, 6304, 6303, 6353	33.668, -77.915
South Carolina	
Study Block 4: 53 mi^2	
6430, 6431, 6479, 6480, 6481, 6482, 6528, 6529, 6432	33.513, -78.761
Study Block 5: 80 mi^2	
6474, 6475, 6523, 6524, 6424, 6573	33.533, -78.430
Study Block 6: 27 mi^2	
6670, 6671, 6720	33.350, -78.945
South Carolina/Georgia	
Study Block 7: 27 mi^2	
6077, 6078, 6079	31.909, -80.619
Georgia	
Study Block 8: 27 mi^2	
6176, 6177, 6227	31.808, -80.687
Study Block 9: 45 mi^2	
6225, 6275, 6325, 6324, 6374	31.710, -80.792

Figure 4 also identifies known proposed projects from Phase 1 studies conducted by the Georgia Institute of Technology (Georgia Institute of Technology 2010) and the University of North Carolina (UNC) at Chapel Hill (UNC 2010). The study blocks do not coincide with the project sites resulting from Phase 1 studies. There are three proposed project sites (lease blocks 6126, 6174, and 6074) in Georgia that are located off of Little Tybee Island. These lease blocks were eliminated from consideration to be a part of a study block because they were either valued higher than the lowest intrusiveness (due to hard bottom habitat presence),

categorized as a no build zone, or are not at a large enough scale to accommodate at least 27 mi^2 of area for a wind farm project of 300 MW or larger. With a survey to determine the presence and extent of hard bottom within these lease blocks, they could be a suitable area for wind farm development.

The majority of the study regions used for the UNC study lie outside of the study blocks that were designated during the Phase 2A siting analysis. There are several reasons for this: 1) portions of the UNC study regions were located in areas that are greater than 30 m depth - this factor was designated as no build zone by the Phase 2A analysis; 2) portions of the UNC study areas are located within zones that are not categorized as having the lowest ecological intrusiveness; 3) portions of the UNC study areas are located between 25 and 50 NM from shore or annual average wind speeds less than 8.5 m/s – these were limitations used in the designation of study blocks. Study blocks 1 and 2 are wholly or partially encompassed by a portion of one of the UNC study regions. The project site within Pamlico Sound was valued as having an intrusiveness higher than the lowest primarily due to the extensive fisheries conducted in this area.

In many cases, data shows the presence of hard bottom to be associated with a certain lease block; this will cause the lease block to be rated at a higher intrusiveness level. If a survey is done to identify the presence/absence and extent of hard bottom, the lease block may be suitable for wind farm development.

This Phase 2A analysis was intended to identify a number of study blocks to provide enough area for analysis of a gigawatt-scale offshore wind development while being mindful that only a small portion of all the suitable areas would likely be developed in the next decade. Thus, the identified study blocks do not represent pre-approved areas nor do they represent the only available areas for potential wind development.

3.2 Ecological Factors

Ecological factors used here to define areas potentially sensitive to offshore wind farm development off of Georgia, South Carolina, and North Carolina or to be excluded from offshore wind farm development included marine mammals, sea turtles, coastal and marine birds, fishes (and associated habitats), benthic habitats, and submerged aquatic vegetation. The delineation of the occurrence of these organisms and habitats defined areas where offshore wind farm development could be limited pending further investigation since all areas were treated equally and in general spatial discrimination was not done. The occurrences of the various organisms and habitats included in the siting analysis were given equal weight. Impact analyses to date show that most of the impacts on the marine environment caused by offshore wind development take place during the construction phase (Wilhelmsson et al. 2010). Negative impacts are often spatially limited and include the loss of sensitive benthic species and habitat, as well as the temporary loss of feeding, spawning, and nursery habitat (Wilhelmsson et al. 2010).

Limitations to development in this siting analysis were derived from the number of overlapping ecological factor layers (see sections 2.4 Spatial Index Creation with Geographic Information Systems; 2.5 Using the Index; and 2.6 Ecological Factor Layers).

3.2.1 Marine Mammals

Marine mammals are an important and federally-protected marine resource in the Study Area. Forty marine mammal species have confirmed or potential occurrence in the Study Area based on known distribution and habitat associations (**Table 4**). Known or potential species include 35 cetaceans (whales, dolphins, and porpoises), four pinnipeds (seals), and one sirenian (manatee). All marine mammal species are afforded protection under the United States (U.S.) Marine Mammal Protection Act (MMPA). Seven of these marine mammal species are designated as T or E under the U.S. ESA and are afforded additional legal protection.

The southeast mid-Atlantic is an important geographic region for marine mammal species. Of the 40 marine mammal species with known or potential occurrence in the Study Area, 10 of these species are thought to have a primary occurrence in at least a portion of the Study Area (**Table 4**). Primary occurrence is defined as the areas where a species is expected to be found regardless of how abundant it may be. These areas of primary occurrence were determined based on known distributions and habitat associations of the species and were combined to provide the marine mammal layer (**Figure 5**) for the siting analysis. Primary occurrence in the Study Area is limited to species which primarily occur within the 30-m isobath off North Carolina, South Carolina, and Georgia. These species include the Atlantic spotted dolphin (*Stenella frontalis*), bottlenose dolphin (*Tursiops truncatus*), short-beaked common dolphin (*Delphinus delphis*), fin whale (*Balaenoptera physalus*), minke whale (*B. acutorostrata*), humpback whale (*Megaptera novaeangliae*), North Atlantic right whale, killer whale (*Orcinus orca*), harbor porpoise (*Phocoena phocoena*), and harbor seal (*Phoca vitulina*). All of these species, except for the harbor porpoise and harbor seal, have primary occurrence throughout the Study Area and could occur in the Study Area during any time of year. Based on known distribution and occurrences, North Atlantic right and humpback whales, and some stocks of bottlenose dolphins are most likely to occur seasonally in or near the Study Area (Lefebvre et al. 2001; McLellan et al. 2001; Keller et al. 2006; NMFS 2010a). The area of primary occurrence for the North Atlantic right whale includes known calving grounds and migration routes. North Atlantic right whales may be resident in the portion of the migratory route off northern Georgia and South Carolina based on survey and photo-identification data (Schulte and Taylor 2009).

Harbor porpoise distribution is strongly concentrated in the Gulf of Maine/Georges Bank region; occurrence is more scattered in the mid-Atlantic and extends to coastal waters off North Carolina, particularly during winter (CETAP 1982; Northridge 1996; Waring et al. 2008; NMFS 2010a). Therefore, the primary occurrence for the harbor porpoise in the Study Area includes the waters off North Carolina but not waters farther south. Primary occurrence of the harbor seal also extends to the North Carolina/South Carolina border based on known distributions and consistent stranding data in this region (Harry et al. 2005).

The other 30 species of marine mammals are not expected to have a primary occurrence in the Study Area. Many of these species are associated with deeper, offshore waters. For example, beaked whales normally inhabit continental slope and deep oceanic waters (>200 m) (Waring et al. 2001; Pitman 2002; MacLeod et al. 2004; MacLeod and Mitchell 2006) and are expected to have primary occurrence in offshore waters and only a rare occurrence in the Study Area. Primary occurrence is also limited to temperate cetacean species. Cold-water species such as the Atlantic white-sided dolphin (*Lagenorhynchus acutus*) associates with shallow, nearshore waters but has a primary range of distribution farther north than the Study Area (Testaverde and Mead 1980). In contrast, warm-water species like the West Indian manatee (*Trichechus manatus*) is expected to have a primary occurrence farther south of the Study Area in Florida waters and a secondary occurrence in coastal waters of Georgia and South Carolina due to sighting reports in this region during warm months (Lefebvre et al. 2001).

Table 4. Marine mammal species with known or potential occurrence in the Study Area. ESA status is noted for listed species. Primary occurrence indicates that a species is expected to be found in the Study Area regardless of how abundant it may be.

Common Name	Scientific Name	ESA Status	Primary Occurrence in Study Area
Order Cetacea			
Suborder Mysticeti (baleen whales)			
Family Balaenidae			
North Atlantic right whale	*Eubalaena glacialis*	Endangered	Yes
Family Balaenopteridae (rorquals)			
Humpback whale	*Megaptera novaeangliae*	Endangered	Yes
Minke whale	*Balaenoptera acutorostrata*		Yes
Bryde’s whale	*Balaenoptera edeni*		
Sei whale	*Balaenoptera borealis*	Endangered	
Fin whale	*Balaenoptera physalus*	Endangered	Yes
Blue whale	*Balaenoptera musculus*	Endangered	
Suborder Odontoceti (toothed whales)			
Family Physeteridae			
Sperm whale	*Physeter macrocephalus*	Endangered	
Family Kogiidae			
Pygmy sperm whale	*Kogia breviceps*		
Dwarf sperm whale	*Kogia sima*		
Family Ziphiidae (beaked whales)			
Cuvier's beaked whale	*Ziphius cavirostris*		
Northern bottlenose whale	*Hyperoodon ampullatus*		
Blainville's beaked whale	*Mesoplodon densirostris*		
Sowerby's beaked whale	*Mesoplodon bidens*		
Gervais' beaked whale	*Mesoplodon europaeus*		
True's beaked whale	*Mesoplodon mirus*		
Family Delphinidae (dolphins)			
Rough-toothed dolphin	*Steno bredanensis*		
Bottlenose dolphin	*Tursiops truncatus*		Yes
Pantropical spotted dolphin	*Stenella attenuata*		
Atlantic spotted dolphin	*Stenella frontalis*		Yes
Spinner dolphin	*Stenella longirostris*		
Clymene dolphin	*Stenella clymene*		
Striped dolphin	*Stenella coeruleoalba*		
Short-beaked common dolphin	*Delphinus delphis*		Yes
White-beaked dolphin	*Lagenorhynchus albirostris*		
Atlantic white-sided dolphin	*Lagenorhynchus acutus*		
Fraser’s dolphin	*Lagenodelphis hosei*		
Risso’s dolphin	*Grampus griseus*		
Melon-headed whale	*Peponocephala electra*		
Pygmy killer whale	*Feresa attenuata*		

Table 4 (*continued*). Marine mammal species with known or potential occurrence in the Study Area. ESA status is noted for listed species. Primary occurrence indicates that a species is expected to be found in the Study Area regardless of how abundant it may be.

Common Name	Scientific Name	ESA Status	Primary Occurrence in Study Area
Order Cetacea			
Suborder Odontoceti (toothed whales)			
Family Delphinidae (dolphins)			
False killer whale	*Pseudorca crassidens*		
Killer whale	*Orcinus orca*		Yes
Long-finned pilot whale	*Globicephala melas*		
Short-finned pilot whale	*Globicephala macrorhynchus*		
Family Phocoenidae			
Harbor porpoise	*Phocoena phocoena*		Yes
Order Carnivora			
Suborder Pinnipedia (seals, sea lions, fur seals, walruses)			
Family Phocidae			
Harbor seal	*Phoca vitulina*		Yes
Gray seal	*Halichoerus grypus*		
Harp seal	*Pagophilus groenlandica*		
Hooded seal	*Cystophora cristata*		
Order Sirenia			
Family Trichechidae (manatees)			
West Indian manatee	*Trichechus manatus*	Endangered	

Numerous factors such as demographic, evolutionary, ecological, habitat-related, and anthropogenic factors affect marine mammal distribution (Bjørge 2002; Bowen et al. 2002; Stevick et al. 2002; Stevick et al. 2008). The occurrence of marine mammals in the Study Area may be influenced by any of these factors. Temporal and spatial variation in these associated factors, the behavior of individual animals, or any other of a number of unknown causes may influence the occurrence of any of the species listed in **Table 4** within or near the Study Area.

In addition to the marine mammal primary occurrence layer, the North Atlantic right whale critical habitat (**Figure 5**) is included as a layer in the siting analysis. The waters off Georgia and northern Florida are the only known calving ground for western North Atlantic right whales; this region is designated as critical habitat under the ESA and encompasses waters between 31°15'N (near mouth of the Altamaha River, Georgia) and 30°15'N (Jacksonville, Florida) from the shoreline to 15 NM offshore and the waters between 30°15'N and 28°00'N (Sebastian Inlet, Florida) from the shoreline to 5 NM offshore (NMFS 1994). According to NMFS, there is substantial scientific information to support a revision of the 1994 critical habitat designation for the North Atlantic right whale (NMFS 2010b). A proposed critical habitat rule will likely be submitted to the Federal Register in 2011 and will include expanding the critical habitat for the calving and feeding grounds and adding critical habitat for the mid-Atlantic migratory corridor (NMFS 2010b).

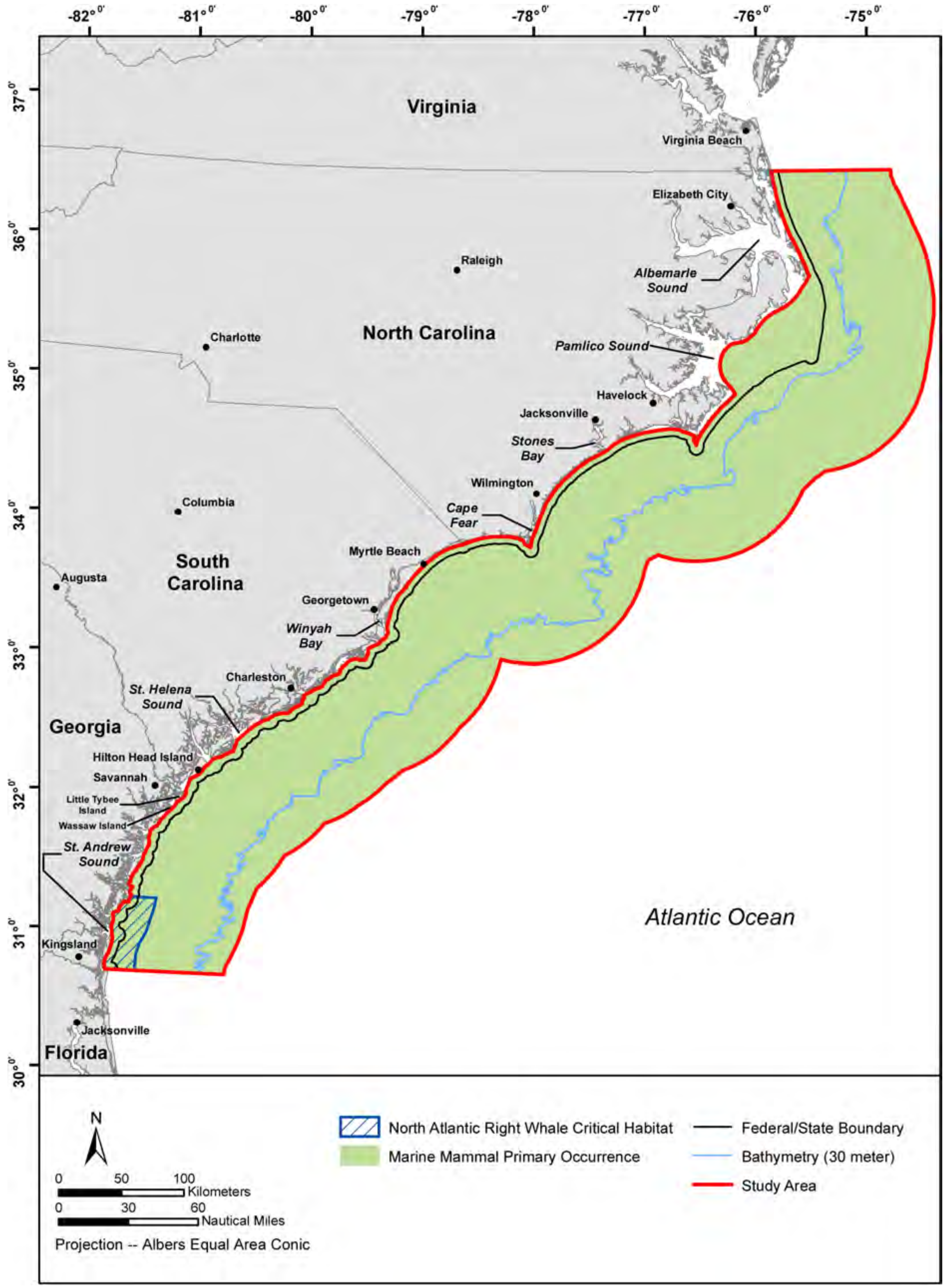

Figure 5. Primary occurrence layer for all marine mammals in the Study Area and designated critical habitat for the North Atlantic right whale.

3.2.2 Sea Turtles

There are six species of sea turtles that may occur in the Study Area (**Table 5**). All species of sea turtles are listed as either T or E under the ESA; the ESA status of each species is given in **Table 5**. There are records of all of these species in or very near to the Study Area (Epperly et al. 1995; Keinath et al. 1995; Sears et al. 1995; Gitschlag 1996; Ruckdeschel et al. 2000; Rabon et al. 2003; Mazzarella et al. 2006; Murphy et al. 2006; Williams et al. 2006). Primary occurrence is defined as the areas where a species is expected to be found regardless of how abundant it may be. Based on known distribution, habitat associations, and available occurrence records (sighting, stranding, and bycatch data), only four of these species have primary occurrence in the Study Area (**Table 5**).

Table 5. Sea turtle species that may occur in the Study Area. ESA status is noted for listed species. Primary occurrence indicates that a species is expected to be found in the Study Area regardless of how abundant it may be.

Common Name	Scientific Name	ESA Status	Primary Occurrence in Study Area
Order Testudines (turtles)			
Suborder Cryptodira (hidden-necked turtles)			
Family Dermochelyidae			
Leatherback turtle	*Dermochelys coriacea*	Endangered	Yes
Family Cheloniidae (hard-shelled turtles)			
Loggerhead turtle	*Caretta caretta*	Threatened[1]	Yes
Green turtle	*Chelonia mydas*	Endangered[2]	Yes
Kemp's ridley turtle	*Lepidochelys kempii*	Endangered	Yes
Olive ridley turtle	*Lepidochelys olivacea*	Threatened	
Hawksbill turtle	*Eretmochelys imbricata*	Endangered	

[1] The Northwest Atlantic population of loggerheads is currently proposed for listing as a distinct population segment and for reclassification to endangered status (USFWS 2010).
[2] The Florida breeding population of green turtles is listed as endangered under the ESA and all other breeding populations in the western North Atlantic are listed as threatened under the ESA. Green turtles in the Study Area should be treated as endangered due to the difficulty in identifying to which breeding population an individual belongs.

These areas of primary occurrence were determined based on known distributions and habitat associations of the species and were combined to provide the sea turtle layer for the siting analysis (**Figure 6**).The four species of sea turtles expected to have primary occurrence in the Study Area include the leatherback (*Dermochelys coriacea*), loggerhead (*Caretta caretta*), green (*Chelonia mydas*), and Kemp's ridley (*Lepidochelys kempii*) sea turtles. These species make seasonal movements along the Atlantic coast of the U.S., moving northward as sea surface temperatures rise during the summer and fall months (Renaud 1995; Hays et al. 2001; Plotkin and Spotila 2002; James et al. 2005; Maier et al. 2005; Eckert et al. 2006; Mansfield 2006). The waters of the Study Area, including inshore of the 30-m isobath, provide year-round habitat for all four species (Peterson et al. 1985; Schwartz 1989a; Epperly et al. 1995;

Figure 6. Primary occurrence of sea turtles in the Study Area. Sea turtles are known to nest regularly throughout the coastal areas adjacent to the Study Area.

NPS 2003; Rabon et al. 2003; Ruckdeschel and Shoop 2006). Loggerhead, leatherback, and green turtles nest on the barrier islands along the southeast U.S. coast, most commonly in Florida but also in North Carolina, South Carolina, and Georgia (Epperly et al. 1995; Plotkin and Spotila 2002; NPS 2003; Rabon et al. 2003; Williams et al. 2006). Juvenile individuals of these species use waters of the U.S. Atlantic coast as nursery and foraging habitats, both in nearshore waters such as estuaries and lagoons and far offshore in the waters of the Gulf Stream (Keinath et al. 1996; Musick and Limpus 1997).

Hawksbill (*Eretmochelys imbricata*) and olive ridley (*Lepidochelys olivacea*) sea turtles are not expected to have a primary occurrence in the Study Area. Both species are tropically-distributed and are not common in nearshore waters north of southern Florida (Foley et al. 2003; Meylan and Redlow 2006; NMFS and USFWS 2007). There are reports of juvenile hawksbill turtles along the eastern seaboard of the U.S., including offshore of the Study Area, but these individuals normally occur well offshore of the 30-m isobath (Parker 1995; Ruckdeschel and Shoop 2006). The primary range of olive ridley turtles is much farther south than the southeastern U.S., and occurrences of this species in mainland U.S. waters are considered exceptional (Foley et al. 2003; Ruckdeschel and Shoop 2006).

Sea turtles are known to nest on the beaches adjacent to the Study Area. Loggerhead turtles nest regularly and in relatively high numbers from Florida north along the U.S. east coast (Hawkes et al. 2005); leatherback and green turtles also nest regularly on the beaches near the Study Area but in fewer overall numbers (Rabon et al. 2003). Kemp's ridley nests have been recorded in all three states adjacent to the Study Area (Williams et al. 2006). Nesting data, including locations, number of nests, species, and seasonality, for the last ten years are available for specific areas in North Carolina, South Carolina, and Georgia at http://www.seaturtle.org/nestdb/.

3.2.3 Coastal and Marine Birds

There are 140 species of marine and coastal birds that may occur in the Study Area (**Table 6**). Of these, 96 species have primary occurrence in the Study Area. Primary occurrence is defined as the areas where a species is expected to be found regardless of how abundant it may be and is based on known distribution, movements, and habitat associations. Three of the species that may occur in the Study Area are afforded protection under the ESA; the ESA status of each species is given in **Table 6**. Three listed species, Wood Stork (*Mycteria americana*), Roseate Tern (*Sterna dougallii*), and Piping Plover (*Charadrius melodus*), may be found in the Study Area but Roseate Tern does not have primary occurrence in the Study Area. There is critical habitat for the wintering population of Piping Plover adjacent to the Study Area in North Carolina, South Carolina, and Georgia (USFWS 2001).

Areas of primary occurrence were determined based on known distributions and habitat associations of the species and were combined to provide the bird layer (**Figure 7**) for the siting analysis. The offshore waters of the Study Area and the adjacent shoreline habitats are a part of the Atlantic Flyway and include the SAB. Many marine and terrestrial birds use the Atlantic Flyway during spring and fall migration (Stokes and Stokes 2010). Seabirds, waterfowl, waders, and shorebirds are known to occur within the Study Area and its adjoining coastal aquatic and terrestrial habitats (Sprunt Jr. and Chamberlain 1970; Fussell III 1994; Beaton 2000). Individual birds' movements within the Study Area may be dictated by numerous factors (Schreiber and Burger 2002), with all being species-specific and many being individual-specific. No truly pelagic species breed in the Study Area, so all such species occur as individuals or flocks moving into the Study Area as they follow dynamic oceanographic features or prey resources.

Table 6. Bird species that may occur in the Study Area. ESA status is noted for listed species. Primary occurrence indicates that a species is expected to be found in the Study Area regardless of how abundant it may be.

Common Name	Scientific Name	ESA Status	Primary Occurrence in Study Area
Order Anseriformes			
Family Anatidae			
Snow Goose	*Chen caerulescens*		Yes
Brant	*Branta bernicla*		
Canada Goose	*Branta canadensis*		Yes
Tundra Swan	*Cygnus columbianus*		
Wood Duck	*Aix sponsa*		Yes
Gadwall	*Anas strepera*		Yes
American Wigeon	*Anas americana*		Yes
American Black Duck	*Anas rubripes*		Yes
Mallard	*Anas platyrhynchos*		Yes
Mottled Duck	*Anas fulvigula*		Yes
Blue-winged Teal	*Anas discors*		Yes
Northern Shoveler	*Anas clypeata*		Yes
Northern Pintail	*Anas acuta*		Yes
Green-winged Teal	*Anas crecca*		Yes
Canvasback	*Aythya valisineria*		
Redhead	*Aythya americana*		
Ring-necked Duck	*Aythya collaris*		
Greater Scaup	*Aythya marila*		Yes
Lesser Scaup	*Aythya affinis*		Yes
Common Eider	*Somateria mollissima*		
Surf Scoter	*Melanitta perspicillata*		Yes
White-winged Scoter	*Melanitta fusca*		
Black Scoter	*Melanitta americana*		Yes
Long-tailed Duck	*Clangula hiemalis*		
Bufflehead	*Bucephala albeola*		Yes
Common Goldeneye	*Bucephala clangula*		
Hooded Merganser	*Lophodytes cucullatus*		
Red-breasted Merganser	*Mergus serrator*		Yes
Ruddy Duck	*Oxyura jamaicensis*		
Order Gaviiformes			
Family Gaviidae			
Red-throated Loon	*Gavia stellata*		Yes
Common Loon	*Gavia immer*		Yes
Order Podicipediformes			
Family Podicipedidae			
Pied-billed Grebe	*Podilymbus podiceps*		
Horned Grebe	*Podiceps auritus*		Yes
Red-necked Grebe	*Podiceps grisegena*		

Table 6 (*continued*). Bird species that may occur in the Study Area. ESA status is noted for listed species. Primary occurrence indicates that a species is expected to be found in the Study Area regardless of how abundant it may be.

Common Name	Scientific Name	ESA Status	Primary Occurrence in Study Area
Order Procellariiformes			
Family Procellariidae			
Northern Fulmar	*Fulmarus glacialis*		
Fea's Petrel	*Pterodroma feae*		
Black-capped Petrel	*Pterodroma hasitata*		Yes
Cory's Shearwater	*Calonectris diomedea*		Yes
Great Shearwater	*Puffinus gravis*		Yes
Sooty Shearwater	*Puffinus griseus*		Yes
Manx Shearwater	*Puffinus puffinus*		Yes
Audubon's Shearwater	*Puffinus lherminieri*		Yes
Family Hydrobatidae			
Wilson's Storm-Petrel	*Oceanites oceanicus*		Yes
White-faced Storm-Petrel	*Pelagodroma marina*		
Leach's Storm-Petrel	*Oceanodroma leucorhoa*		Yes
Band-rumped Storm-Petrel	*Oceanodroma castro*		Yes
Order Phaethontiformes			
Family Phaethontidae			
White-tailed Tropicbird	*Phaethon lepturus*		
Red-billed Tropicbird	*Phaethon aethereus*		
Order Ciconiiformes			
Family Ciconiidae			
Wood Stork	*Mycteria americana*	Endangered	Yes
Order Suliformes			
Family Fregatidae			
Magnificent Frigatebird	*Fregata madnificens*		
Family Sulidae			
Northern Gannet	*Morus bassanus*		Yes
Family Phalacrocoracidae			
Double-crested Cormorant	*Phalacrocorax auritus*		Yes
Great Cormorant	*Phalacrocorax carbo*		
Order Pelecaniformes			
Family Pelecanidae			
Brown Pelican	*Pelecanus occidentalis*		Yes
Family Ardeidae			
American Bittern	*Botaurus lentiginosus*		Yes
Great Blue Heron	*Ardea herodias*		Yes
Great Egret	*Egretta alba*		Yes
Snowy Egret	*Egretta thula*		Yes
Little Blue Heron	*Egretta caerulea*		Yes
Tricolored Heron	*Egretta tricolor*		Yes
Cattle Egret	*Bubulcus ibis*		
Green Heron	*Butorides virescens*		Yes
Black-crowned Night-Heron	*Nycticorax nycticorax*		Yes

Table 6 (*continued*). Bird species that may occur in the Study Area. ESA status is noted for listed species. Primary occurrence indicates that a species is expected to be found in the Study Area regardless of how abundant it may be.

Common Name	Scientific Name	ESA Status	Primary Occurrence in Study Area
Order Pelecaniformes			
Family Ardeidae			
Yellow-crowned Night-Heron	*Nyctanassa violacea*		Yes
Family Threskiornithidae			
White Ibis	*Eudocimus albus*		Yes
Glossy Ibis	*Plegadis falcinellus*		Yes
Order Charadriiformes			
Family Charadriidae			
Black-bellied Plover	*Pluvialis squatarola*		Yes
American Golden-Plover	*Pluvialis dominica*		Yes
Wilson's Plover	*Charadrius wilsonia*		Yes
Semipalmated Plover	*Charadrius semipalmatus*		Yes
Piping Plover	*Charadrius melodus*	Threatened[1]	Yes
Killdeer	*Charadrius vociferus*		Yes
Family Haematopodidae			
American Oystercatcher	*Haematopus palliatus*		Yes
Family Recurvirostridae			
Black-necked Stilt	*Himantopus mexicanus*		
American Avocet	*Recurvirostra americana*		
Family Scolopacidae			
Spotted Sandpiper	*Actitis macularius*		
Solitary Sandpiper	*Tringa solitaria*		
Greater Yellowlegs	*Tringa melanoleuca*		Yes
Willet	*Tringa semipalmatus*		Yes
Lesser Yellowlegs	*Tringa flavipes*		Yes
Upland Sandpiper	*Bartramia longicauda*		Yes
Whimbrel	*Numenius phaeopus*		Yes
Long-billed Curlew	*Numenius americanus*		
Hudsonian Godwit	*Limosa haemastica*		
Marbled Godwit	*Limosa fedoa*		Yes
Ruddy Turnstone	*Arenaria interpres*		Yes
Red Knot	*Calidris canutus*		Yes
Sanderling	*Calidris alba*		Yes
Semipalmated Sandpiper	*Calidris pusilla*		Yes
Western Sandpiper	*Calidris mauri*		Yes
Least Sandpiper	*Calidris minutilla*		Yes
White-rumped Sandpiper	*Calidris fuscicollis*		Yes
Baird's Sandpiper	*Calidris bairdii*		
Pectoral Sandpiper	*Calidris melanotos*		Yes
Purple Sandpiper	*Calidris maritima*		
Dunlin	*Calidris alpina*		Yes
Stilt Sandpiper	*Calidris himantopus*		Yes
Buff-breasted Sandpiper	*Tryngites subruficollis*		

Table 6 (*continued*). Bird species that may occur in the Study Area. ESA status is noted for listed species. Primary occurrence indicates that a species is expected to be found in the Study Area regardless of how abundant it may be.

Common Name	Scientific Name	ESA Status	Primary Occurrence in Study Area
Order Charadriiformes			
Family Scolopacidae			
Short-billed Dowitcher	*Limnodromus griseus*		Yes
Long-billed Dowitcher	*Limnodromus scolopaceus*		
Wilson's Snipe	*Gallinago delicata*		
American Woodcock	*Scolopax minor*		
Wilson's Phalarope	*Phalaropus tricolor*		
Red-necked Phalarope	*Phalaropus lobatus*		Yes
Red Phalarope	*Phalaropus fulicarius*		Yes
Family Laridae			
Black-legged Kittiwake	*Rissa tridactyla*		Yes
Bonaparte's Gull	*Chroicocephalus*		Yes
Black-headed Gull	*Chroicocephalus*		
Little Gull	*Hydrocoloeus minutus*		
Laughing Gull	*Leucophaeus atricilla*		Yes
Ring-billed Gull	*Larus delawarensis*		Yes
Herring Gull	*Larus argentatus*		Yes
Iceland Gull	*Larus glaucoides*		
Lesser Black-backed Gull	*Larus fuscus*		Yes
Glaucous Gull	*Larus hyperboreus*		
Great Black-backed Gull	*Larus marinus*		Yes
Brown Noddy	*Anous stolidus*		
Sooty Tern	*Onychoprion fuscata*		Yes
Bridled Tern	*Onychoprion anaethetus*		Yes
Least Tern[2]	*Sternula antillarum*		Yes
Gull-billed Tern	*Gelochelidon nilotica*		Yes
Caspian Tern	*Hydroprogne caspia*		Yes
Black Tern	*Chlidonias niger*		Yes
Roseate Tern	*Sterna dougallii*	Endangered	
Common Tern	*Sterna hirundo*		Yes
Arctic Tern	*Sterna paradisaea*		
Forster's Tern	*Sterna forsteri*		Yes
Royal Tern	*Thalasseus maxima*		Yes
Sandwich Tern	*Thalasseus sandvicensis*		Yes
Black Skimmer	*Rhynchops niger*		Yes
Great Skua	*Stercorarius skua*		
South Polar Skua	*Stercorarius maccormicki*		Yes
Pomarine Jaeger	*Stercorarius pomarinus*		Yes
Parasitic Jaeger	*Stercorarius parasiticus*		Yes
Long-tailed Jaeger	*Stercorarius longicaudus*		Yes

Table 6 (*continued*). Bird species that may occur in the Study Area. ESA status is noted for listed species. Primary occurrence indicates that a species is expected to be found in the Study Area regardless of how abundant it may be.

Common Name	Scientific Name	ESA Status	Primary Occurrence in Study Area
Order Charadriiformes			
Family Alcidae			
Dovekie	*Alle alle*		Yes
Common Murre	*Uria aalge*		
Thick-billed Murre	*Uria lomvia*		
Razorbill	*Alca torda*		Yes
Atlantic Puffin	*Fratercula arctica*		Yes

[1] Piping Plover is listed under the ESA as threatened throughout its range with the exception of the Great Lakes watershed population, which is listed as endangered (USFWS 1985a). Individuals occurring in the Study Area may be from either population but all individuals are considered threatened on their wintering grounds (i.e., within the Study Area).
[2] The interior population of Least Tern is listed under the ESA as Endangered (USFWS 1985b). This population does not occur in the Study Area.
[3] Roseate Tern is listed under the ESA as threatened throughout its range with the exception of the Northeast breeding population, which is listed as endangered (USFWS 1987). The Northeast breeding population occurs within the Study Area, so individuals encountered here should be considered endangered since it is difficult to determine to which population that individual belongs.

Very large numbers of landbird species can be found over open ocean at some point in their migrations between breeding and wintering areas, either by design or by being drifted by offshore winds. Many primarily terrestrial or freshwater species may use the waters and/or airspace of the Study Area in a localized or seasonal manner.

Those species with known or potential occurrence in the Study Area occur in different areas of the Study Area for varying reasons and often on a seasonal basis. The following sections present very general information for species occurrence in broad taxonomic groupings and focus where possible on those species with primary occurrence.

Waterfowl (Anseriformes; e.g., loons, grebes, cormorants) – Few of these species breed on land adjacent to the Study Area and most species found here are present as migrants and wintering individuals from breeding areas farther north and west; however, the inshore portions of the Study Area are important to these species. Huge numbers of these individuals, particularly of scaup, scoters, loons, and Double-crested Cormorants (*Phalacrocorax auritus*), are often present in these waters.

Seabirds (Procellariiformes, Phaethontiformes, Fregatidae, Sulidae, two species of Laridae) – The western Atlantic Ocean waters (Canada, U.S., and Bermuda) support only four species of breeding seabird (Bermuda Petrel [*Pterodroma cahow*], Manx Shearwater [*Puffinus puffinus*], Leach's Storm-Petrel [*Oceanodroma leucorhoa*], and White-tailed Tropicbird [*Phaethon lepturus*]). All other species are of primarily seasonal occurrence, though some species are present in the Study Area at nearly all times of year. Of the seabirds that occur in the Study Area, two arrive from boreal/arctic breeding areas to winter in the Study Area (Northern Fulmar [*Fulmarus glacialis*] and Northern Gannet [*Morus bassanus*]); three arrive from Southern Hemisphere breeding areas to winter during the north temperate summer (Great Shearwater

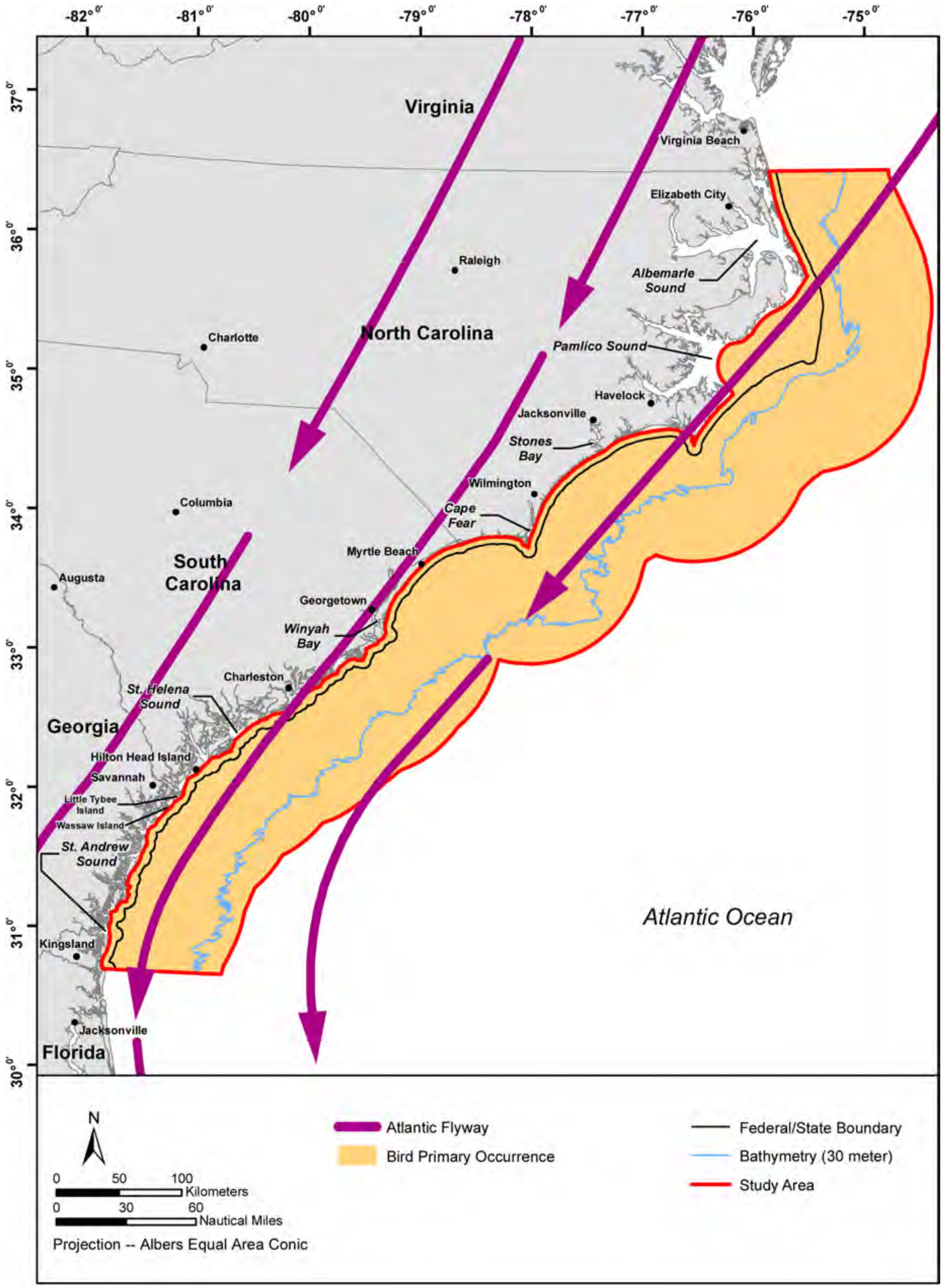

Figure 7. Primary occurrence of birds within the Study Area. The Atlantic Flyway is shown. This flyway represents a general pattern of movement of birds along the eastern seaboard and is not meant to depict distribution.

[*Puffinus gravis*] and Wilson's [*Oceanites oceanicus*] and White-faced [*Pelagodroma marina*] storm-petrels); six are warm-season visitors from tropical breeding range (Audubon's Shearwater [*Puffinus lherminieri*], Red-billed Tropicbird [*Phaethon aethereus*], Magnificent Frigatebird [*Fregata madnificens*], Brown Noddy [*Anous stolidus*], and Sooty [*Onychoprion fuscata*] and Bridled [*O. anaethetus*] terns); one is found as a nearly year-round visitor from its Caribbean breeding area (Black-capped Petrel [*Pterodroma hasitata*]); and the remaining three are visitors from eastern Atlantic Ocean breeding areas. At least 14 other species have occurred in or near the Study Area at least once.

Brown Pelican, herons, gulls, terns – These species are primarily colonial breeders and many are common or abundant as breeders along the inshore edge of the Study Area. Most of these are also primarily piscivorous, depending upon the abundance and diversity of the Study Area's inshore fish resources.

Shorebirds (Charadriidae, Haematopodidae, Recurvirostridae, Scolopacidae) – A wide diversity of shorebirds use the coastal resources adjacent to the Study Area. Though few species use the immediate coastal beaches in any abundance, those that do are found primarily in that habitat (Black-bellied [*Pluvialis squatarola*], Wilson's [*Charadrius wilsonia*], and Piping plovers; American Oystercatcher [*Haematopus palliatus*]; Whimbrel [*Numenius phaeopus*]; Ruddy Turnstone [*Arenaria interpres*]; Red Knot [*Calidris canutus*]; Sanderling [*C. alba*]; Semipalmated [*C. pusilla*] and Western [*C. mauri*] sandpipers; Dunlin [*C. alpina*]; and Short-billed Dowitcher [*Limnodromus griseus*]) and can often be found making local flights out over the ocean, occasionally at some distance from shore. The vast majority of shorebird species are boreal and/or arctic breeders that utilize these areas on migration and during the winter. Many shorebird species utilize the airspace over the Study Area as they move from arctic or boreal breeding grounds to temperate or tropical wintering areas, particularly many long-distance migrants wintering in South America, though these typically travel long distances at high altitudes (>1,000 feet [ft]).

Gulls and terns (Laridae) – Many species of Laridae breed along the coast of the Study Area and forage daily within the Study Area; many of those species' local populations are augmented at other seasons by individuals arriving from farther north or south.

3.2.4 Fishes

The zoogeography of marine ichthyofauna is closely tied to oceanographic processes (e.g., water temperatures and currents) and topographical features on the North Carolina, South Carolina, and Georgia continental shelves (Moyle and Cech 2000). These continental shelves are in the Carolinian Zoogeographical Province (Briggs 1974) which is located within the SAB and the Southeast U.S. Continental Shelf Large Marine Ecosystem (SUSLME) (Shertzer et al. 2009). Due to its high productivity, the SUSLME supports economically important commercial and recreational fisheries (Aquarone 2008) distributed within an estuarine-dependent, coastal (nearshore ocean waters/surf zone), reef-associated (live hard bottom and artificial structures), and epi-/meso-pelagic habitats (Manooch III 1988; Schwartz 1989b). The dynamic interplay of the dominant offshore Gulf Stream Current has a profound effect on the overall ichthyofaunal distribution within these habitats (Gray et al. 1968; Ekberg and Huntsman 1985). The water column of the strong Gulf Stream Current serves as a habitat for marine fish and shellfish during some portion of their larval life history (Leis 1991; Yeung and McGowan 1991; Criales and McGowan 1994; Epifanio and Garvine 2001; Hare and Govoni 2005; Marancik et al. 2005; Hare and Walsh 2007). Depending on temperature tolerances, prey availability, and other environmental/ecological variables (Struhsaker 1969), the temperate, sub-tropical, and highly migratory ichthyofaunal community use this productive ecosystem as a migratory pathway, nursery/foraging area, and major fishery zone (SAFMC and NMFS 2009).

3.2.4.1 Managed Fish/Invertebrate Species

On the continental shelves of the Carolinas and Georgia, fish and invertebrates are managed in inshore waters (0 to 3 NM) by the Atlantic States Marine Fisheries Commission (ASMFC) which coordinates the conservation and management of Atlantic coastal fish species (21) and two species groups (shad/river herring: 4 species] and coastal sharks [40 species]) (ASMFC 2009). In North Carolina, South Carolina, and Georgia offshore waters (3 to 200 NM), South Atlantic Fishery Management Council (SAFMC) manages 90 species of fish and invertebrates (not including the ~300 species of corals and two Sargassum species), Mid-Atlantic Fishery Management Council (MAFMC) manages 12 species, New England Fishery Management Council (NEFMC) manages 28 species, and NMFS manages 47 HMS (SAFMC 1998; NMFS 2001; NEFMC 2003; NCDENR 2008; NMFS 2009).

3.2.4.2 Essential Fish Habitat and Habitat Areas of Particular Concern

Both Fishery Management Councils (FMCs) and NMFS designate EFH and HAPC under the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA). EFH is defined as "...those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (NMFS 2007). "Waters" include aquatic areas and their associated physical, chemical, and biological properties that are used by fish. "Substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities. "Necessary" means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "Spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle (NMFS 2007).

EFH has been designated for 131 fish/invertebrate species (15 temperate, 89 tropical-subtropical [not including the coral species], and 27 HMS). In North Carolina, South Carolina, and Georgia estuarine/marine waters, EFH species include the dolphin-wahoo (**Figure 8a**), shrimp (**Figure 8b**, **8c**, **8d**, and **8e**), coastal migratory pelagic (**Figures 8f**, **8g**, **8h**, and **8i**), spiny lobster (**Figure 9a**), snapper-grouper complex (**Figures 9b**, **9c**, **9d**, and **9e**), coral, coral reefs, and live hard bottom (**Figures 9f**, **9g**, and **9h**), and temperate/HMS (**Figure 10**). These EFH species are classified by the following habitat types: (1) benthic substrates (not including live hard bottom); (2) live hard bottom; (3) structured (artificial reef/biogenic); (4) pelagic *Sargassum*; (5) marine water column; (6) Gulf Stream current; and (7) nearshore (estuarine/marine emergent wetlands, SAV: seagrass, macroalgae], subtidal/intertidal non-vegetated flats, oyster reef and shell banks, unconsolidated bottoms [soft sediments]; state-designated nursery habitats, and sandy shoals of capes and offshore bars (Dooley 1972; Butler et al. 1983; SAFMC 1998; NMFS 2001; SAFMC 2002; NEFMC 2003; Ruebsamen 2005; DeVictor and Morton 2007; NMFS 2009; SAFMC and NMFS 2009; NMFS 2010c).

HAPC are subsets of the EFH that are known "to be important to species which are in need of additional levels of protection from adverse impacts" (NMFS 2007). Areas designated as HAPC receive more of NMFS' and the FMC's attention when providing comments on proposed actions and to engage increased means of protection and restoration. These areas are set aside for one or more of the following reasons: (1) the importance of the ecological function the habitat provides, (2) the level of sensitivity of the habitat to human-induced impacts, (3) the possibility and level of impact current and future development activities stress or will stress the habitat, and (4) the rarity of the habitat type (NMFS 2007).

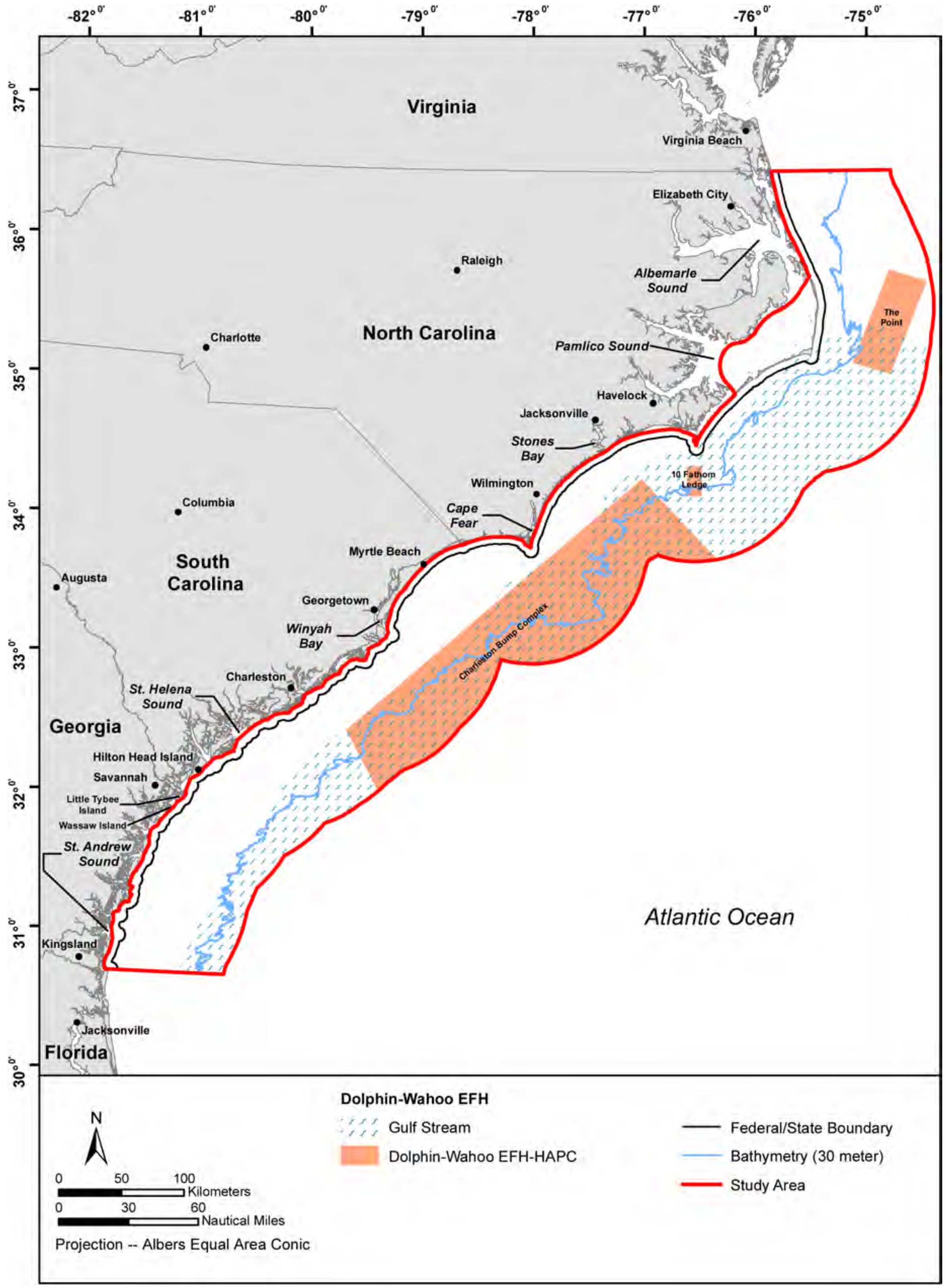

Figure 8a. Designated essential fish habitat (EFH) and habitat area of particular concern (HAPC) for the dolphin-wahoo fishery management unit (MU) in the Study Area. Source data: SAFMC and NMFS (2009).

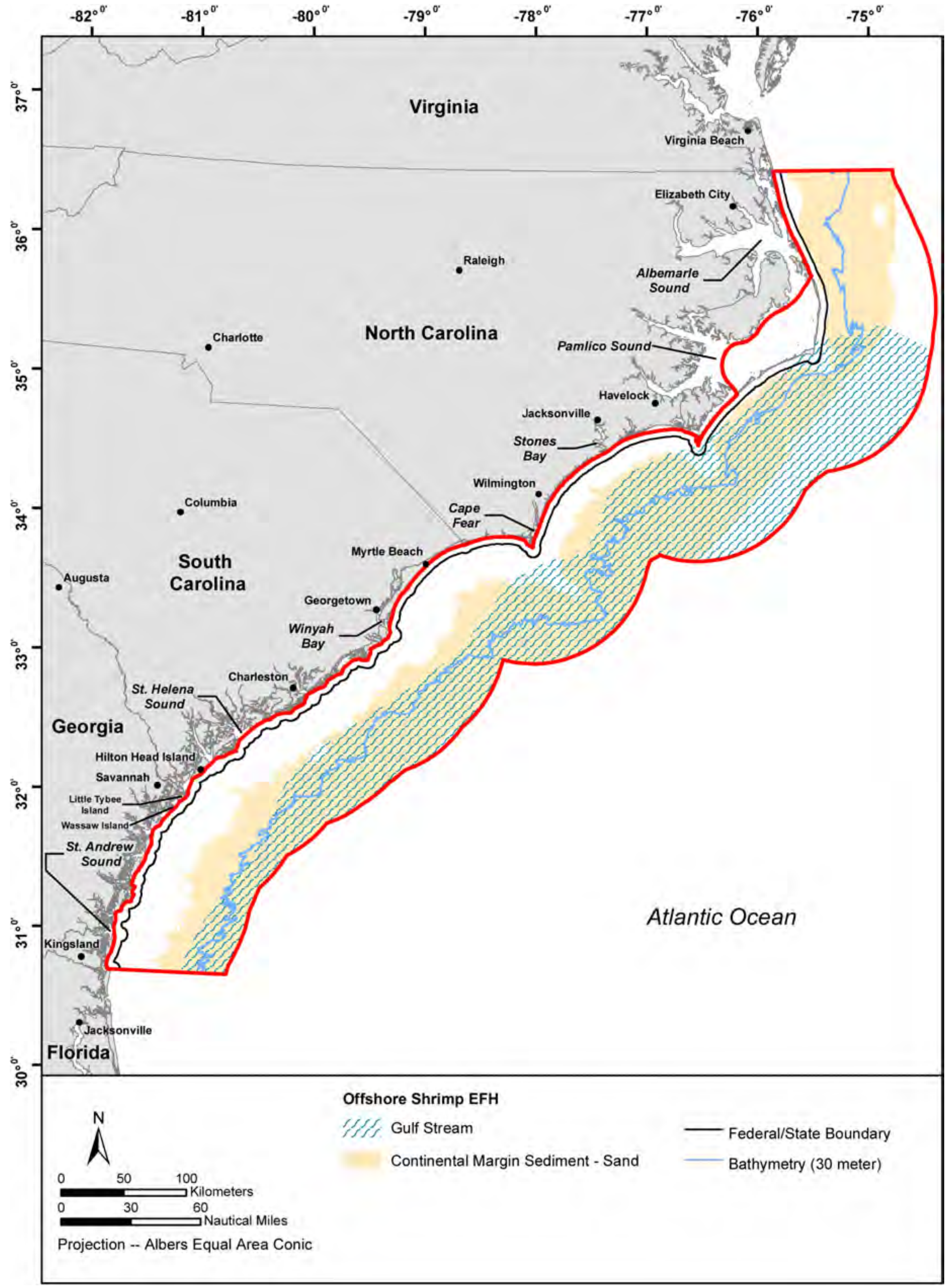

Figure 8b. Designated essential fish habitat (EFH) for the offshore shrimp fishery management unit (MU) in the Study Area. Source data: SAFMC and NMFS (2009).

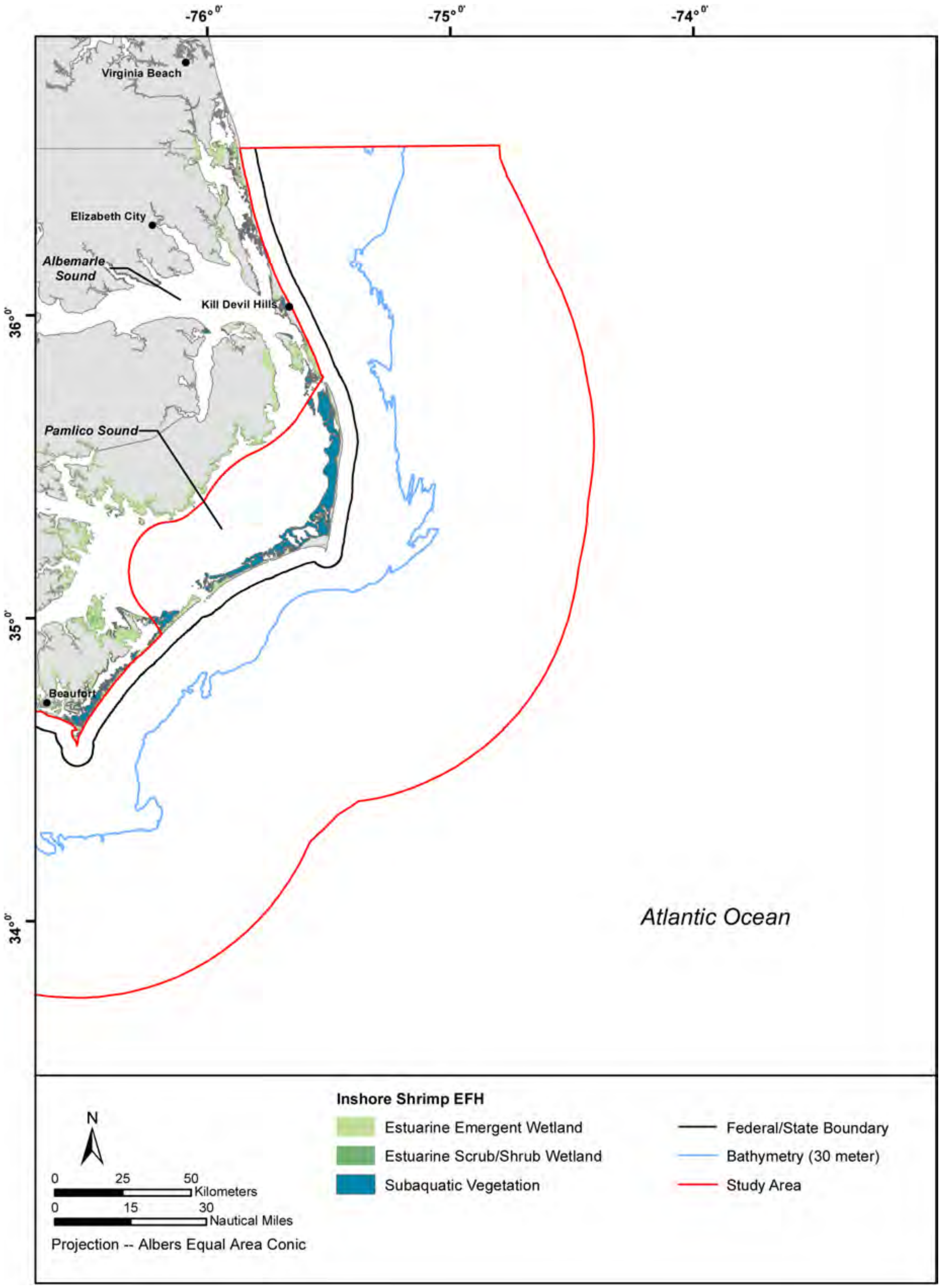

Figure 8c. Designated essential fish habitat (EFH) for the inshore shrimp fishery management unit (MU) in the Study Area off North Carolina. Source data: SAFMC and NMFS (2009).

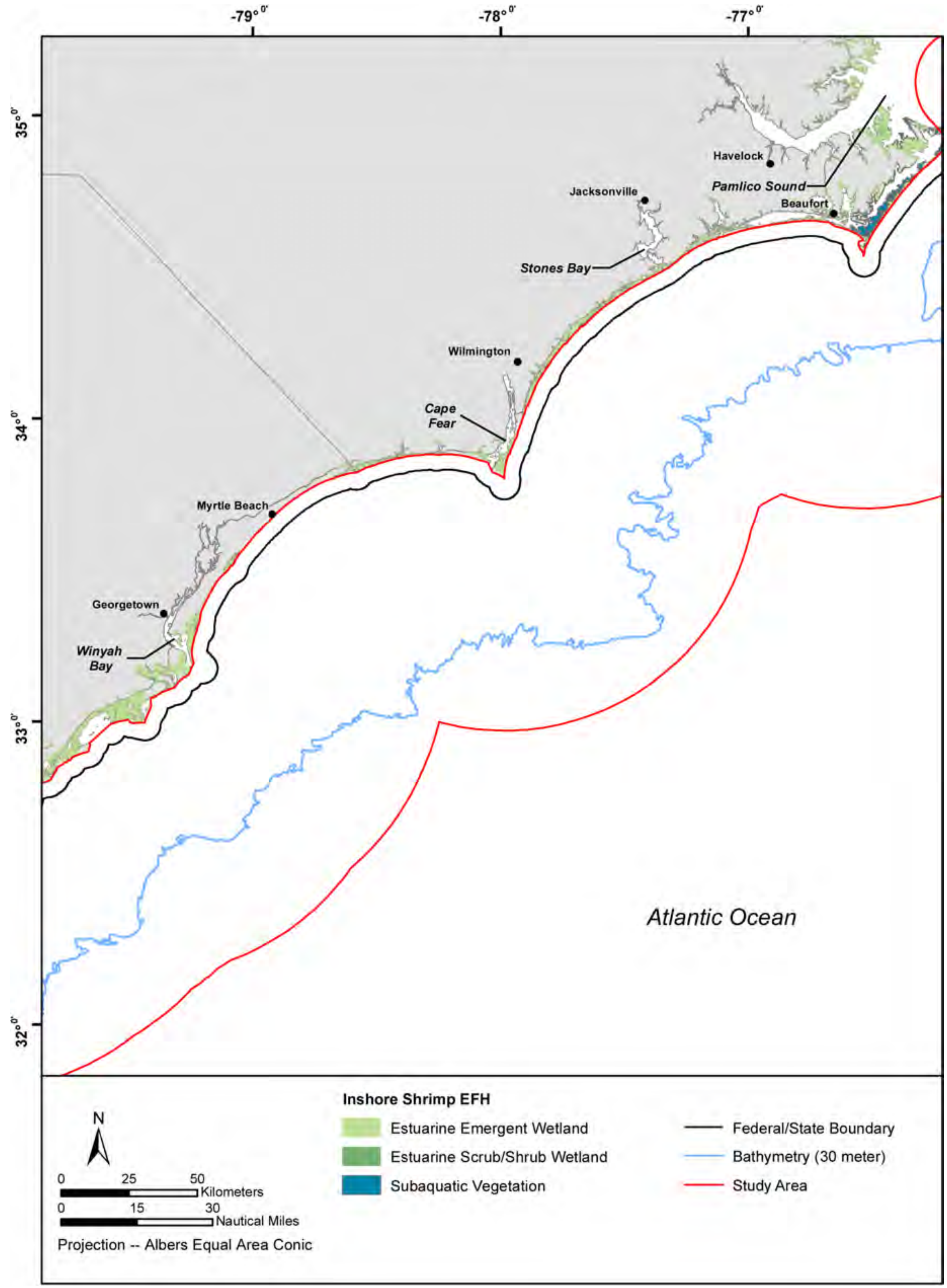

Figure 8d. Designated essential fish habitat (EFH) for the inshore shrimp fishery management unit (MU) in the Study Area off North and South Carolina. Source data: SAFMC and NMFS (2009).

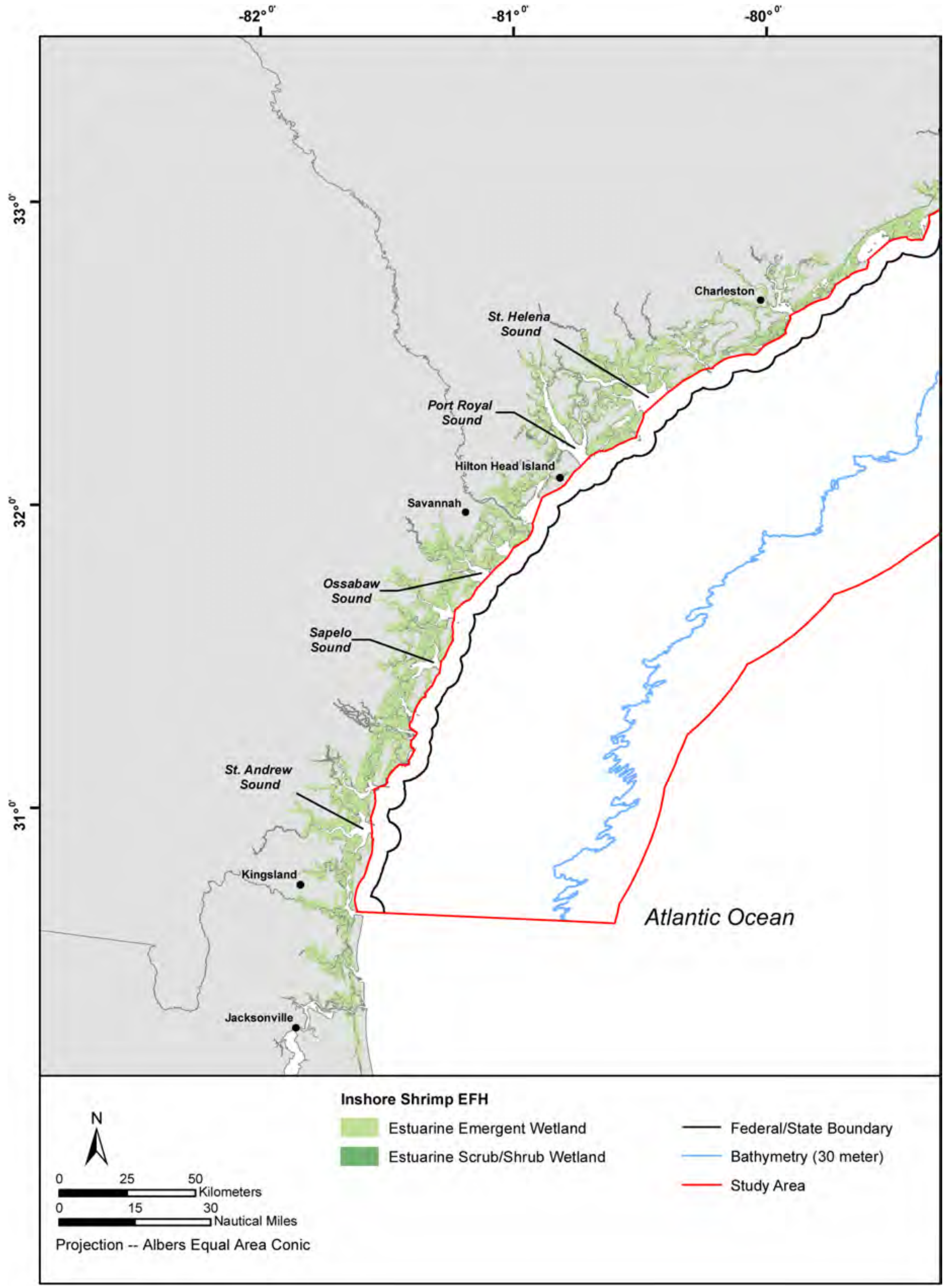

Figure 8e. Designated essential fish habitat (EFH) for the inshore shrimp fishery management unit (MU) in the Study Area off South Carolina and Georgia. Source data: SAFMC and NMFS (2009).

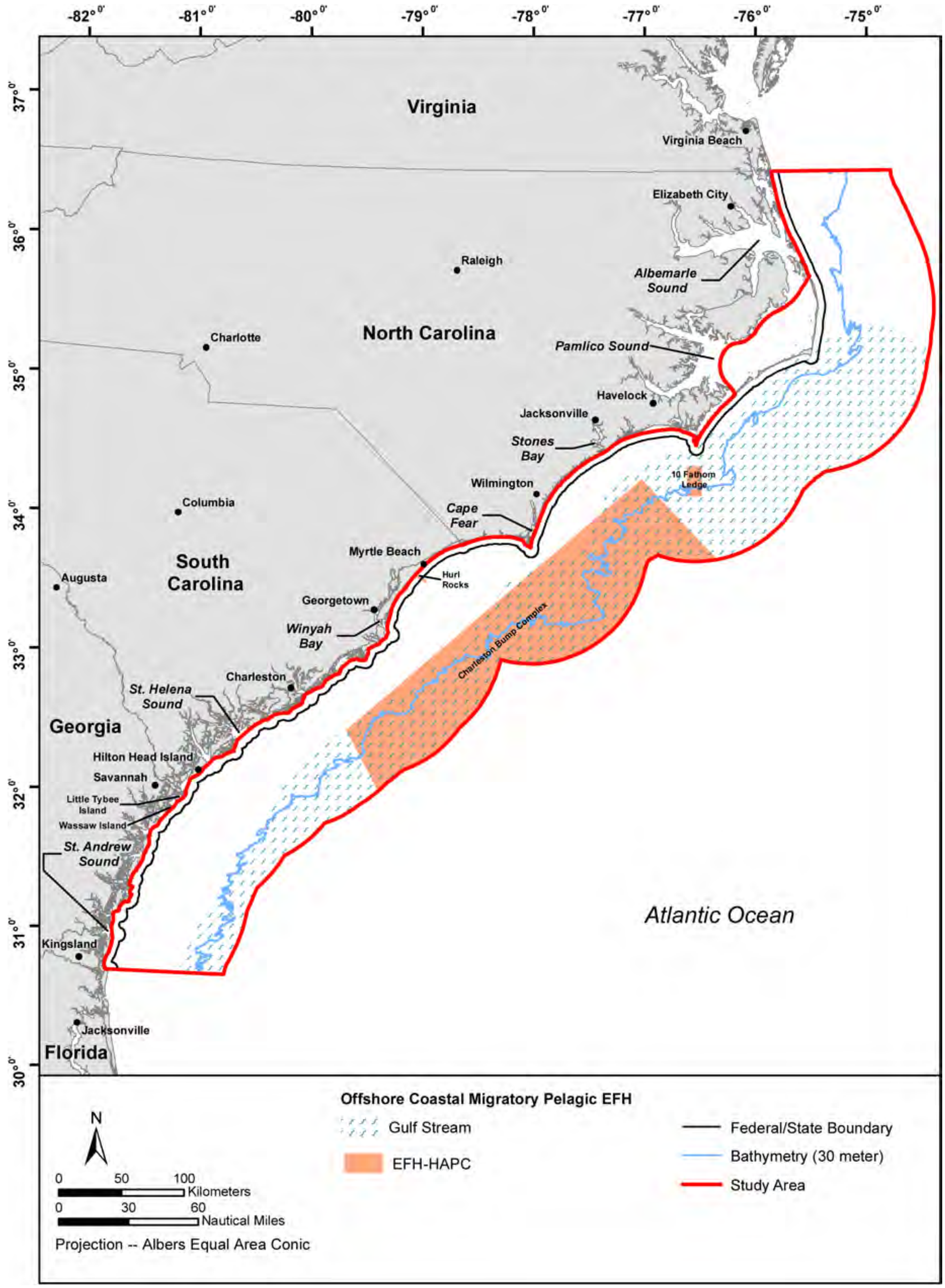

Figure 8f. Designated essential fish habitat (EFH) and habitat area of particular concern (HAPC) for the offshore coastal migratory pelagic fishery management unit (MU) in the Study Area. Source data: SAFMC and NMFS (2009).

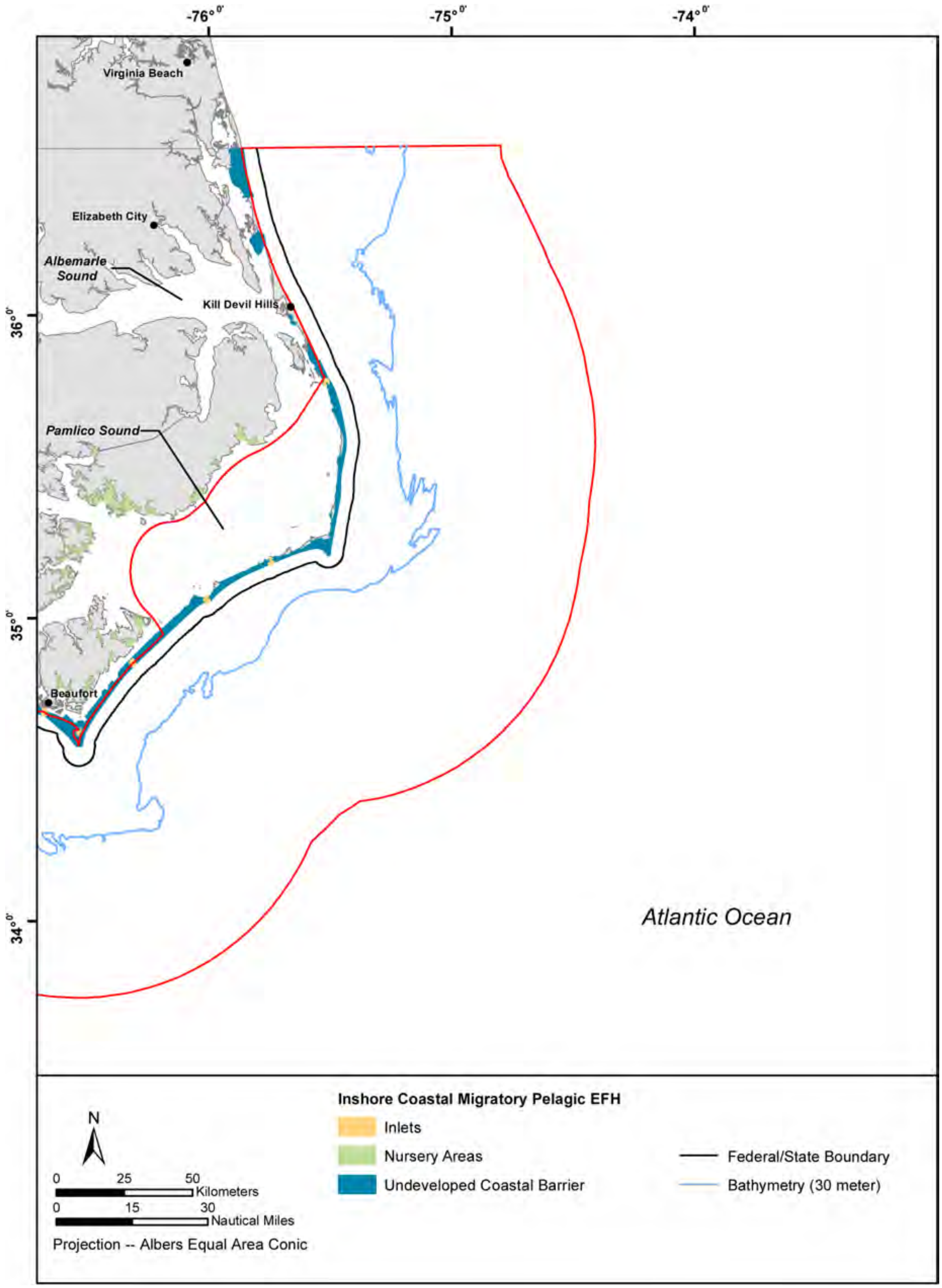

Figure 8g. Designated essential fish habitat (EFH) and habitat area of particular concern (HAPC) for the inshore coastal migratory pelagic fishery management unit (MU) in the Study Area off North Carolina. Source data: SAFMC and NMFS (2009).

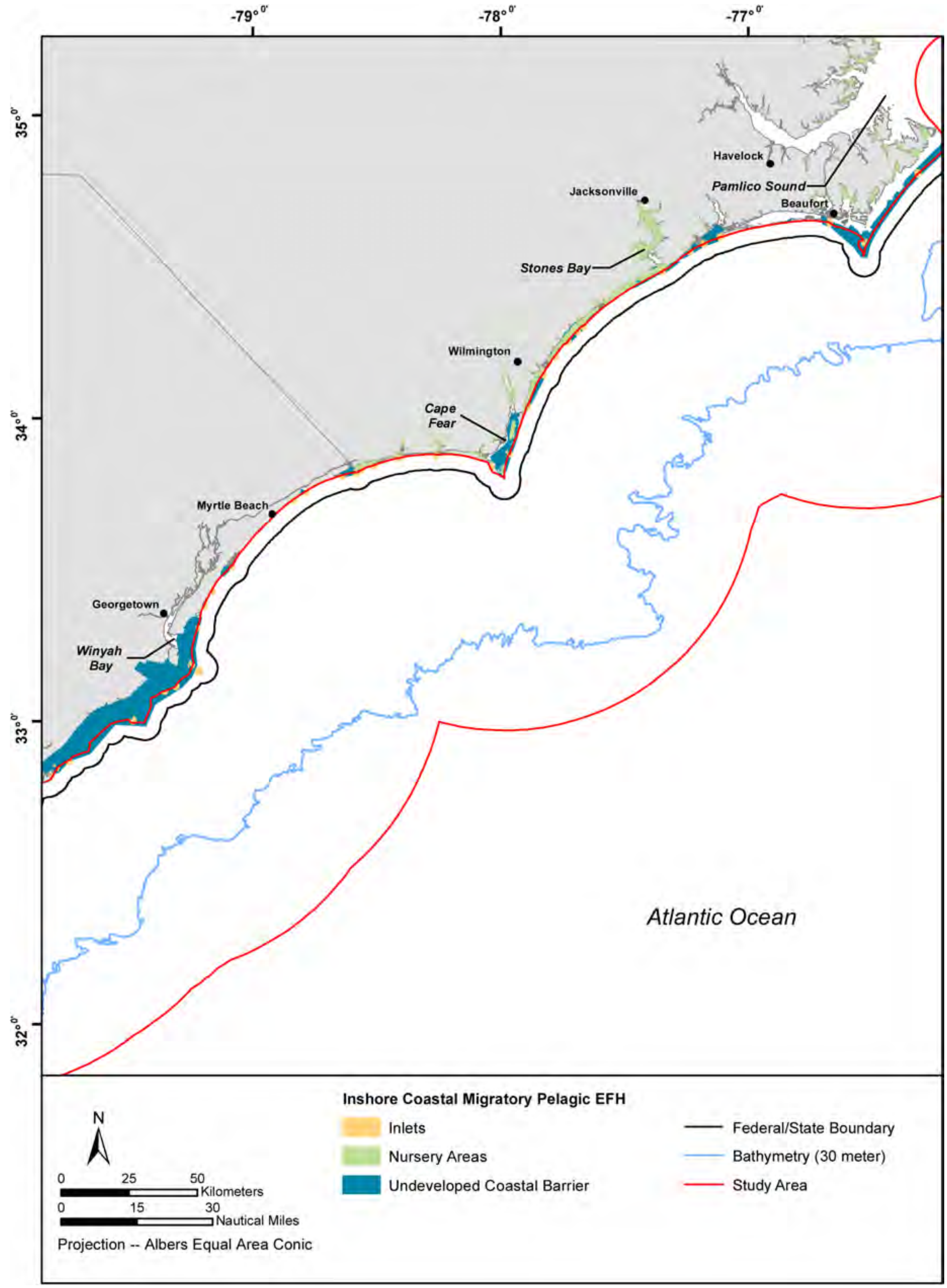

Figure 8h. Designated essential fish habitat (EFH) and habitat area of particular concern (HAPC) for the inshore coastal migratory pelagic fishery management unit (MU) in the Study Area off North and South Carolina. Source data: SAFMC and NMFS (2009).

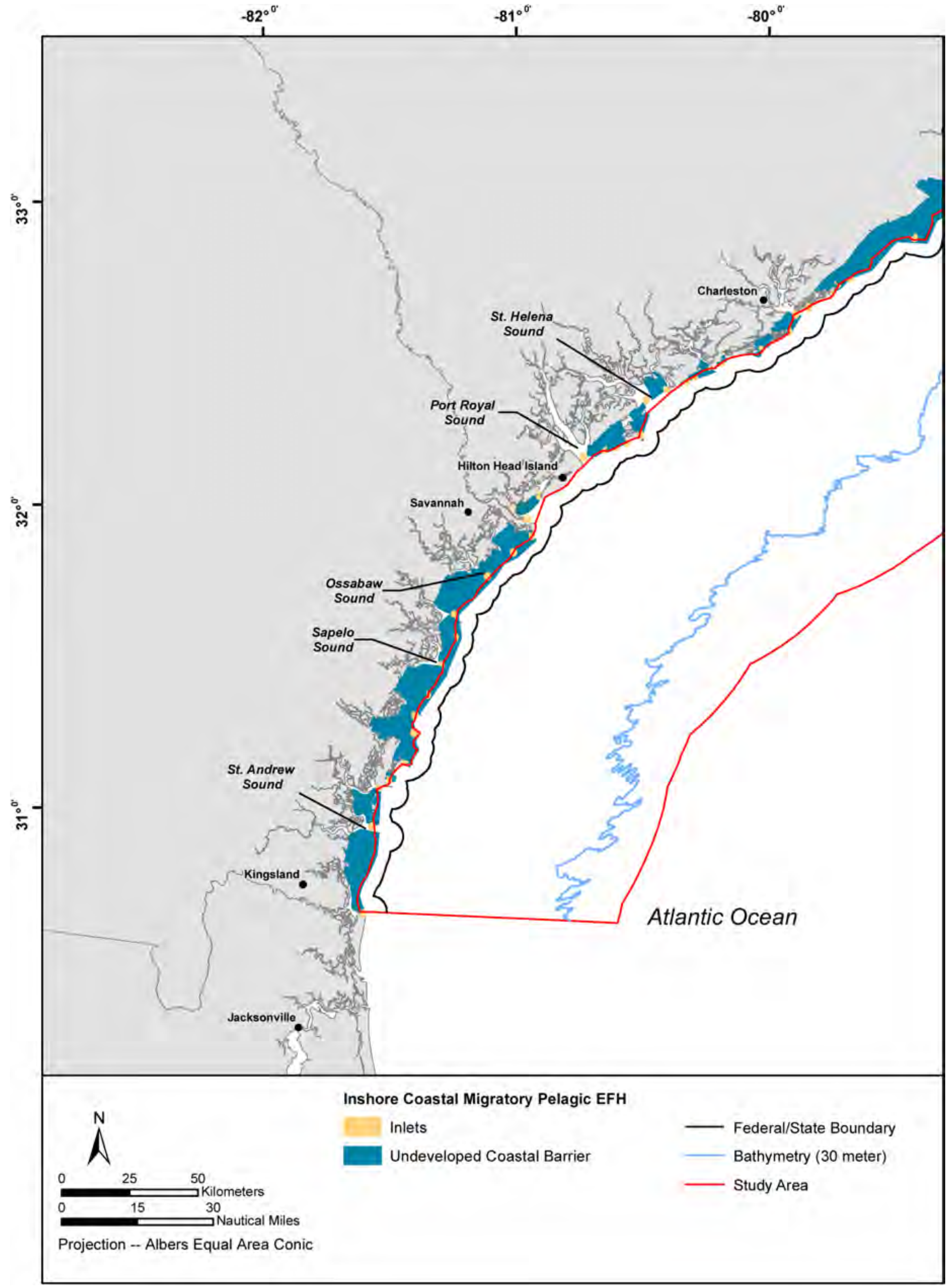

Figure 8i. Designated essential fish habitat (EFH) and habitat area of particular concern (HAPC) for the inshore coastal migratory pelagic fishery management unit (MU) in the Study Area off South Carolina and Georgia. Source data: SAFMC and NMFS (2009).

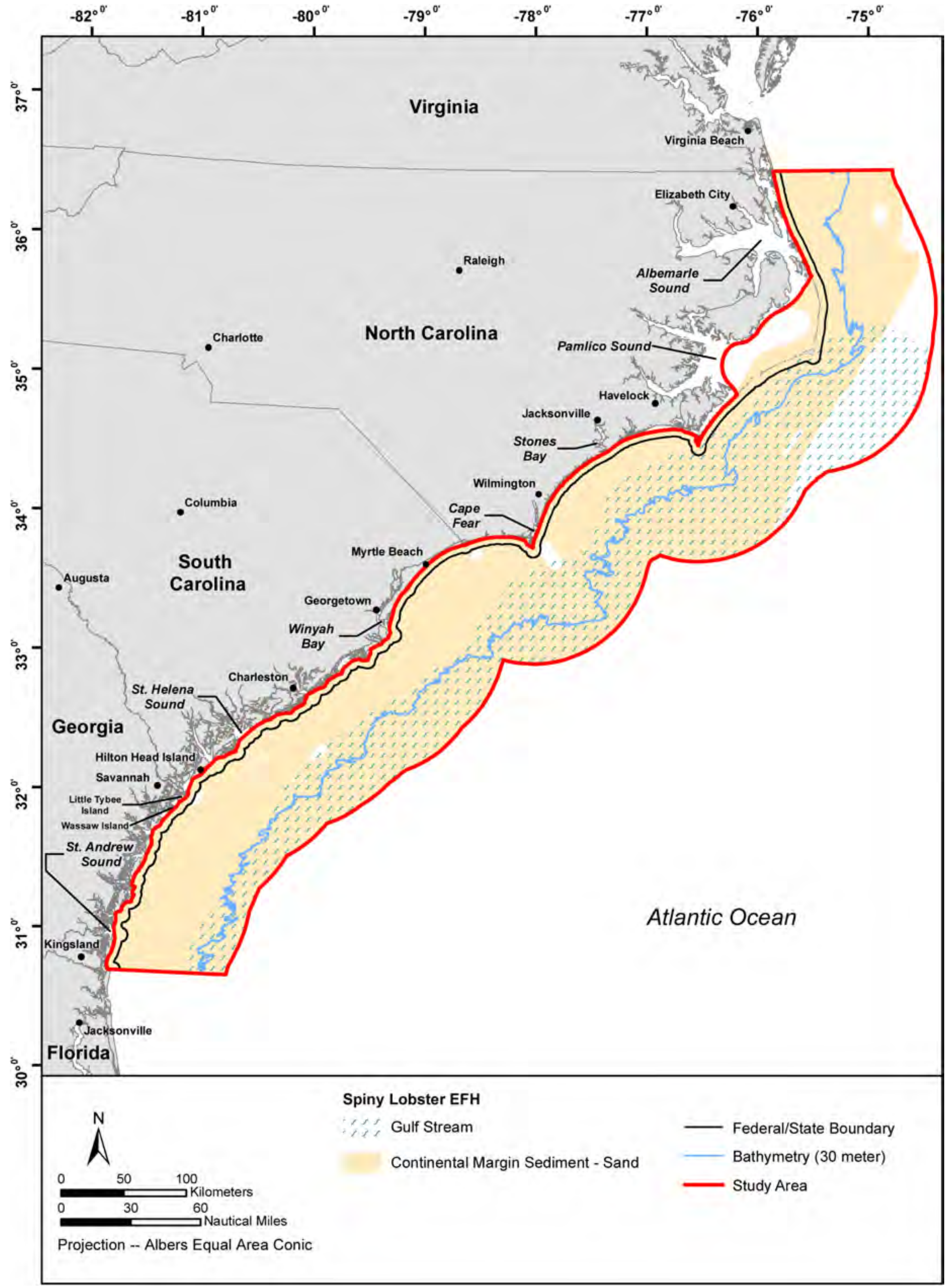

Figure 9a. Designated essential fish habitat (EFH) for the spiny lobster fishery management unit (MU) in the Study Area. Source data: SAFMC and NMFS (2009).

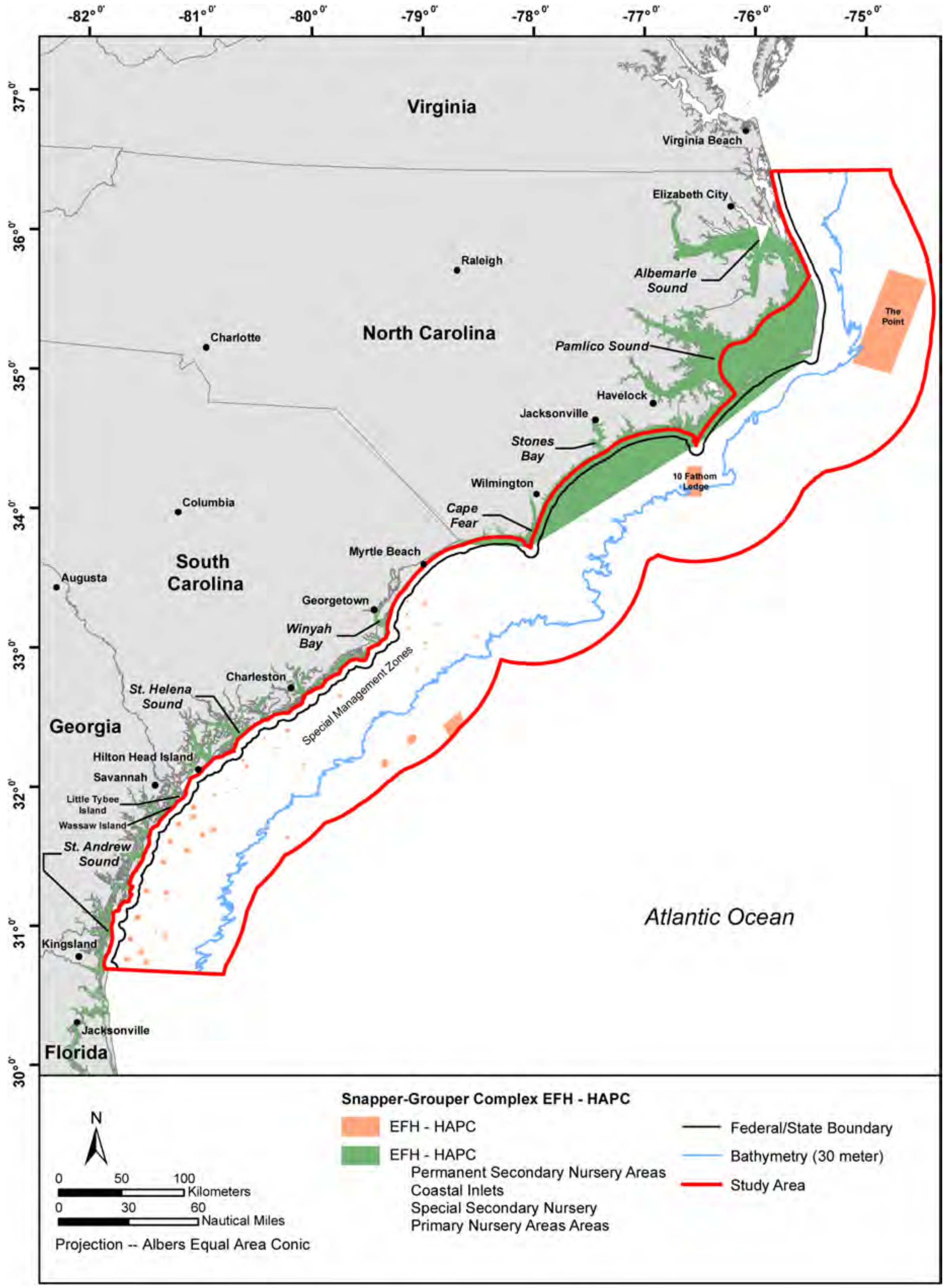

Figure 9b. Designated essential fish habitat (EFH) and habitat area of particular concern (HAPC) for the snapper-grouper complex fishery management unit (MU) in the Study Area. Source data: SAFMC and NMFS (2009).

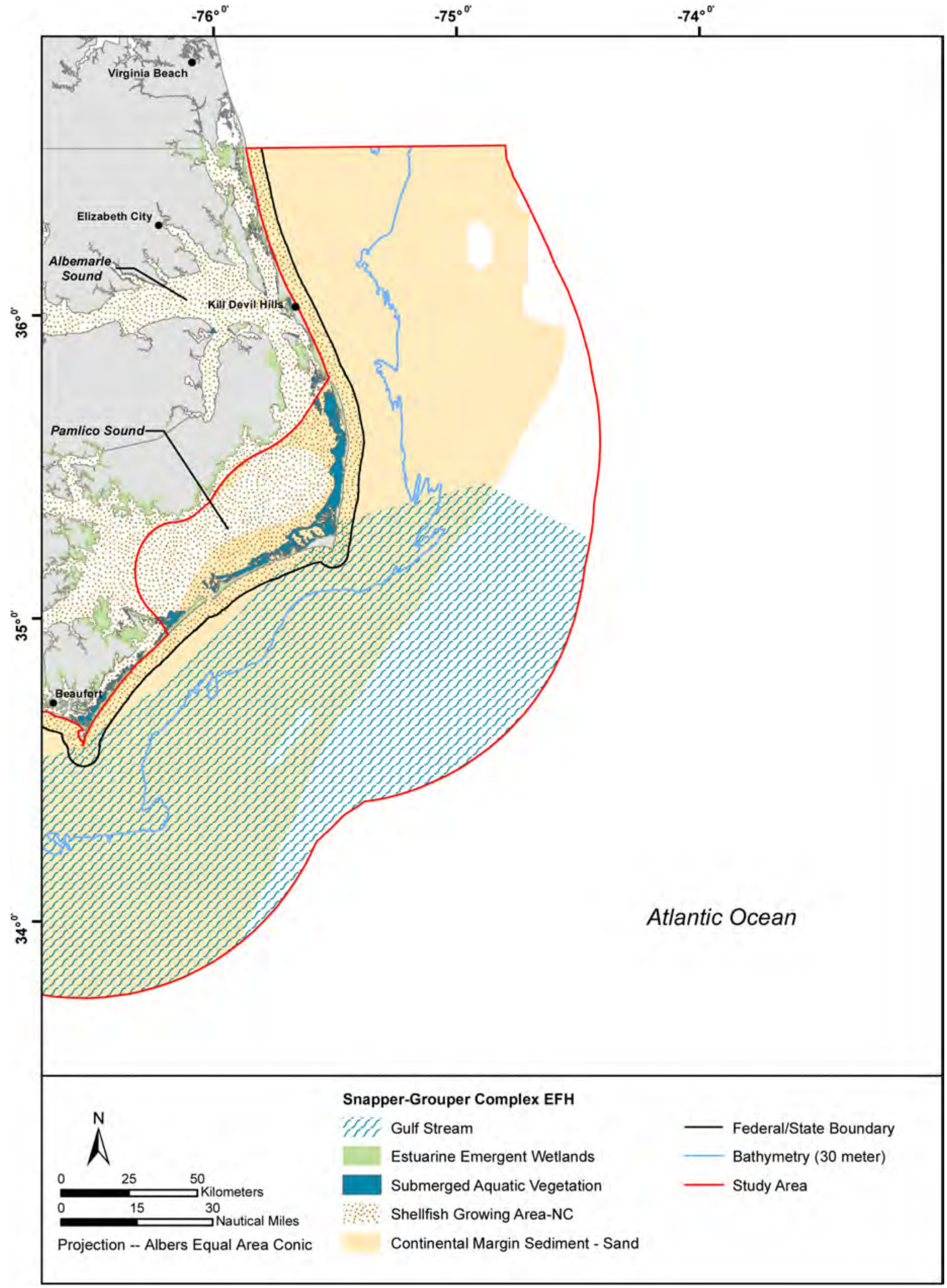

Figure 9c. Designated essential fish habitat (EFH) for the snapper-grouper complex fishery management unit (MU) in the Study Area off North Carolina. Source data: SAFMC and NMFS (2009).

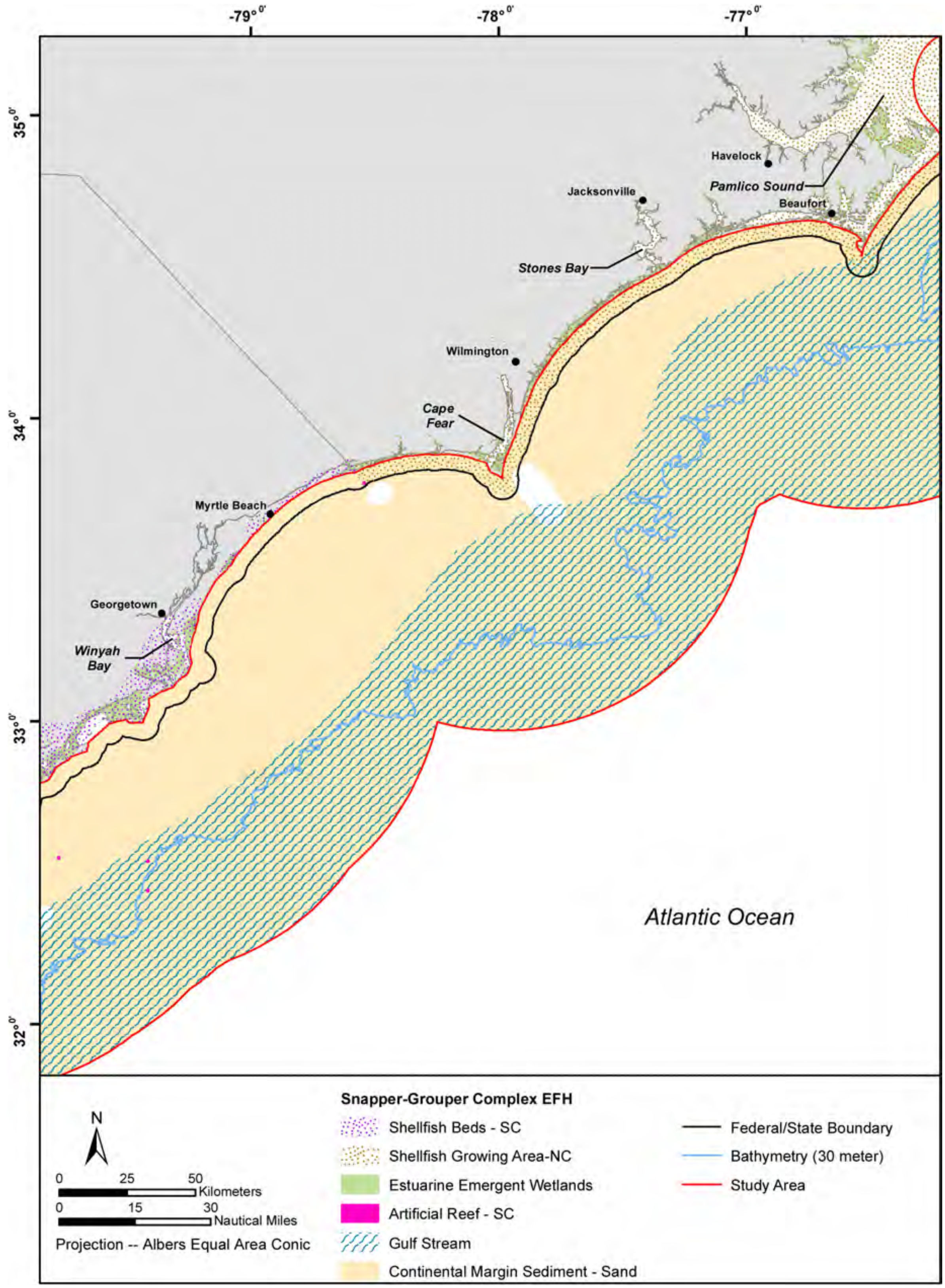

Figure 9d. Designated essential fish habitat (EFH) for the snapper-grouper complex fishery management unit (MU) in the Study Area off North and South Carolina. Source data: SAFMC and NMFS (2009).

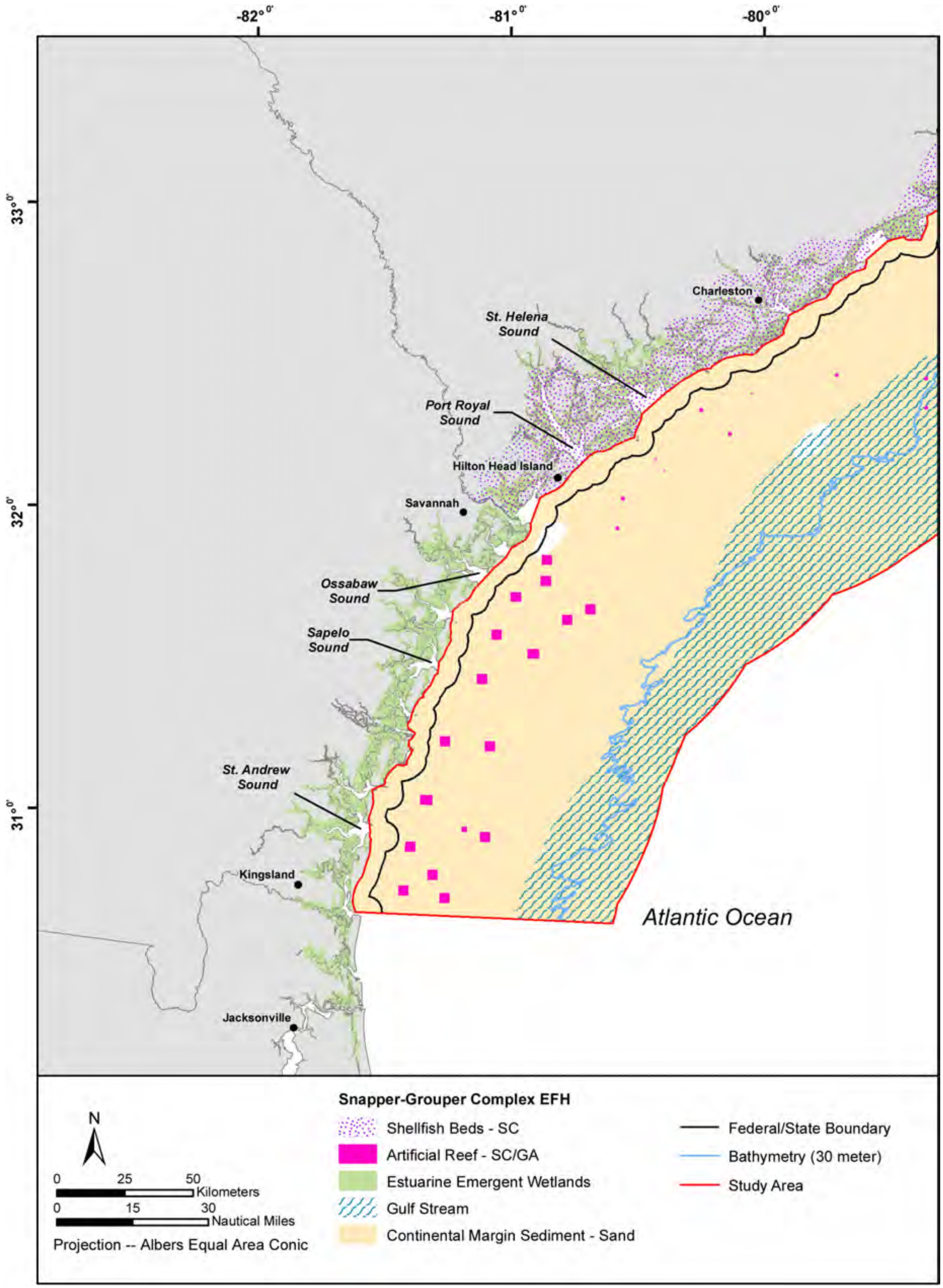

Figure 9e. Designated essential fish habitat (EFH) for the snapper-grouper complex fishery management unit (MU) in the Study Area off South Carolina and Georgia. Source data: SAFMC and NMFS (2009).

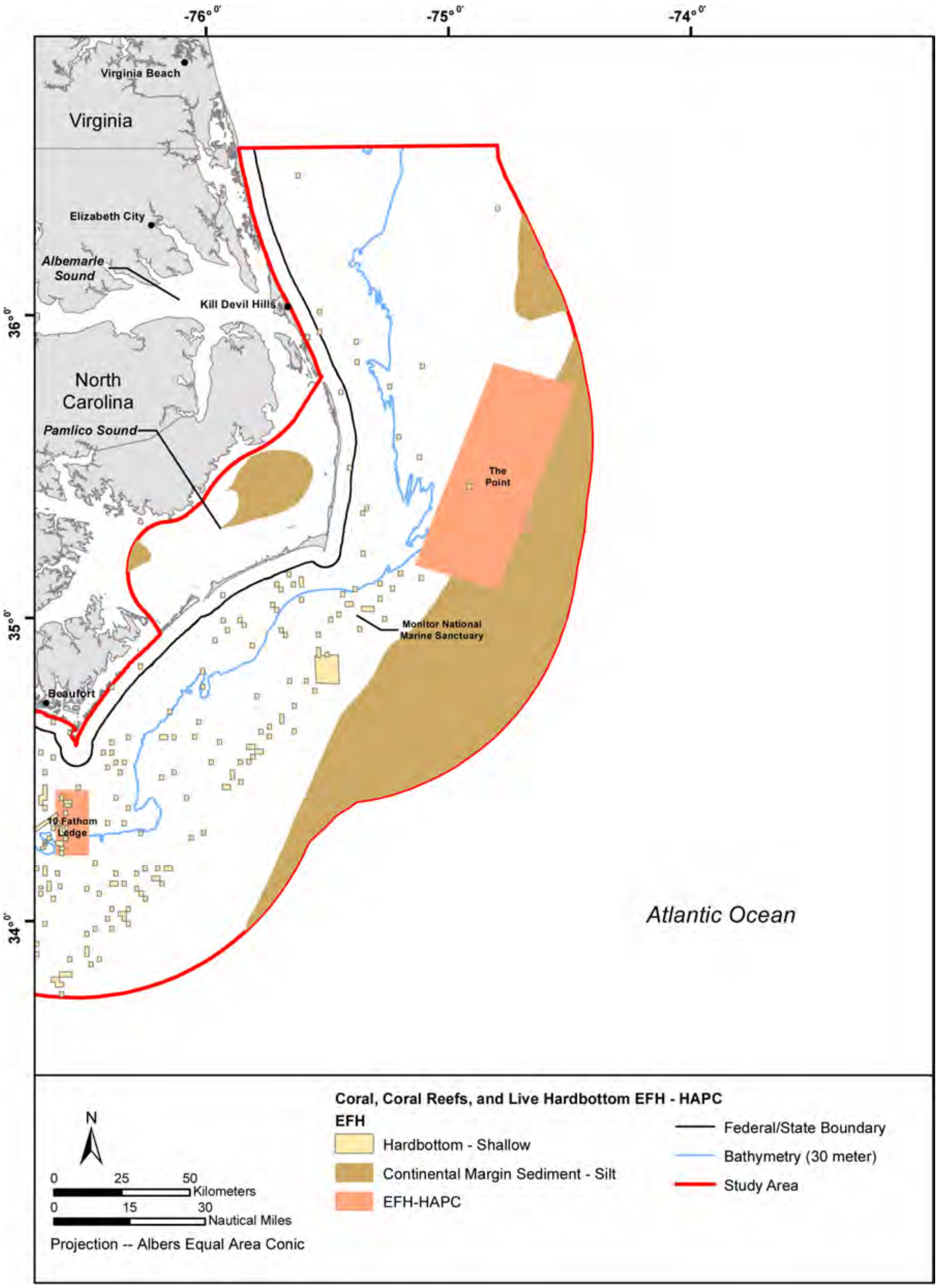

Figure 9f. Designated essential fish habitat (EFH) and habitat area of particular concern (HAPC) for the coral, coral reefs, and live hardbottom fishery management unit (MU) in the Study Area off North Carolina. Source data: BLM (1976), Riggs et al. (1986), Moser et al. (1995), and SAFMC and NMFS (2009).

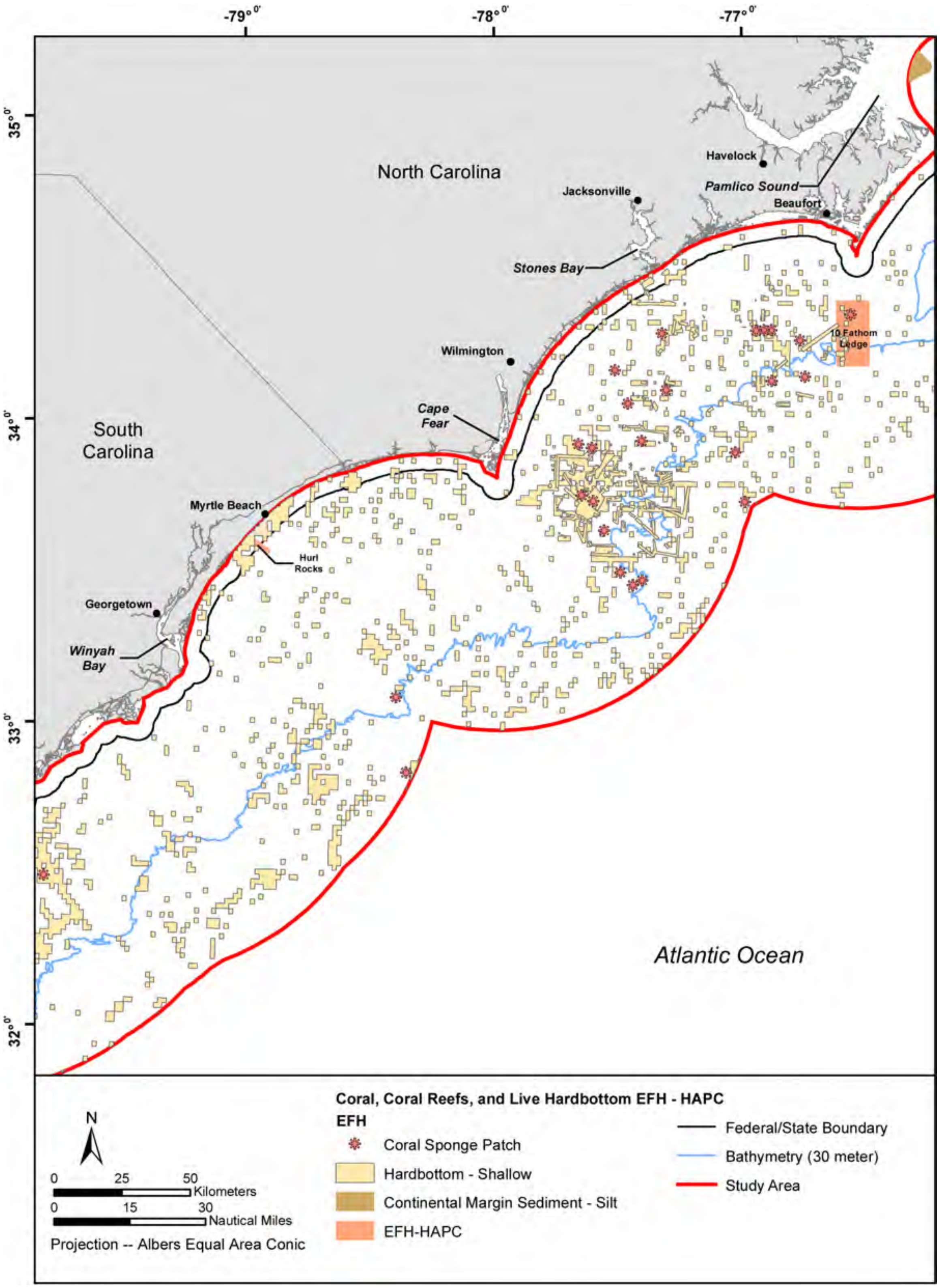

Figure 9g. Designated essential fish habitat (EFH) and habitat area of particular concern (HAPC) for the coral, coral reefs, and live hardbottom fishery management unit (MU) in the Study Area off North and South Carolina. Source data: BLM (1976), Riggs et al. (1986), Moser et al. (1995), and SAFMC and NMFS (2009).

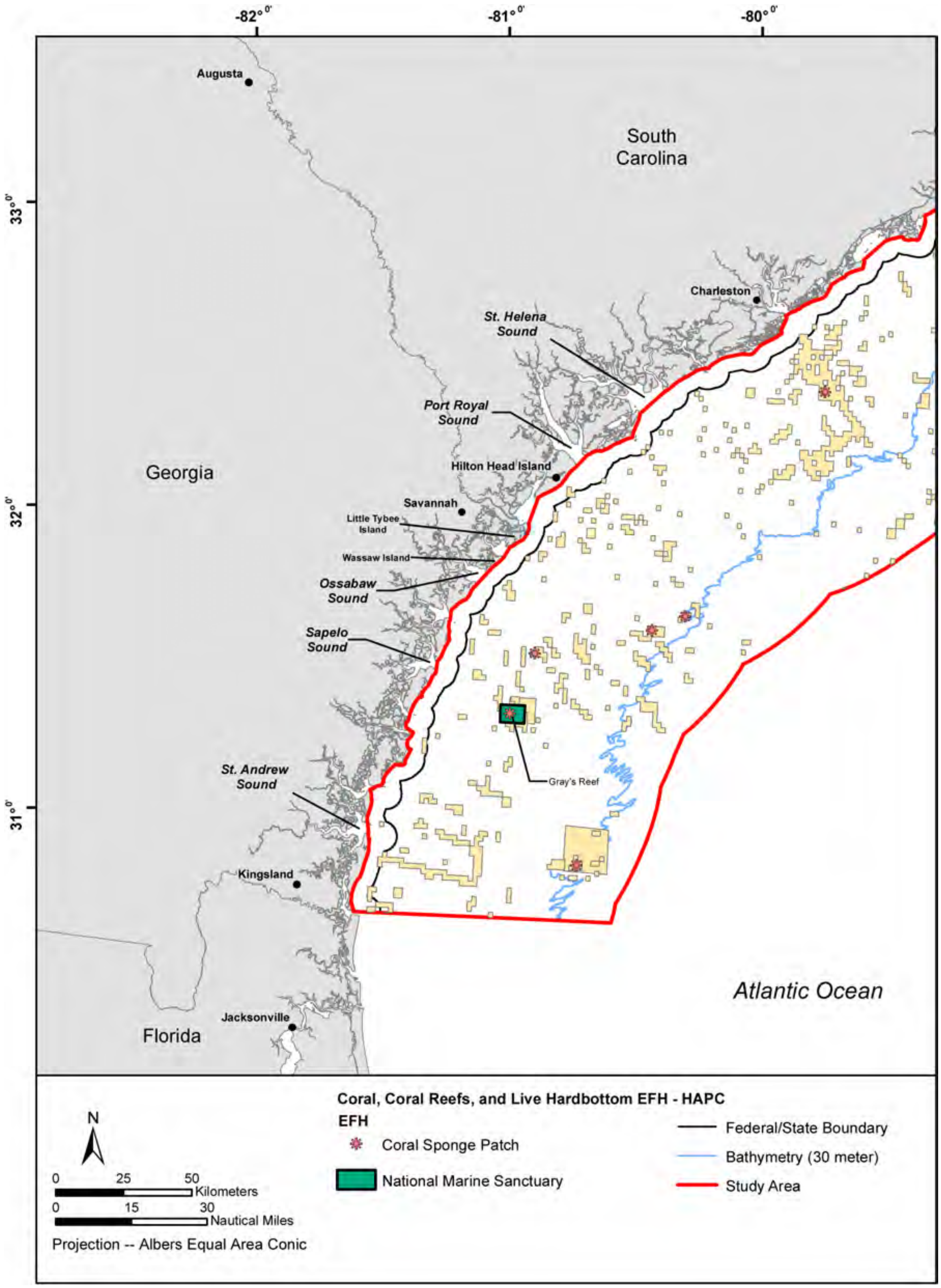

Figure 9h. Designated essential fish habitat (EFH) and habitat area of particular concern (HAPC) for the coral, coral reefs, and live hardbottom fishery management unit (MU) in the Study Area off South Carolina and Georgia. Source data: BLM (1976), Riggs et al. (1986), Moser et al. (1995), and SAFMC and NMFS (2009).

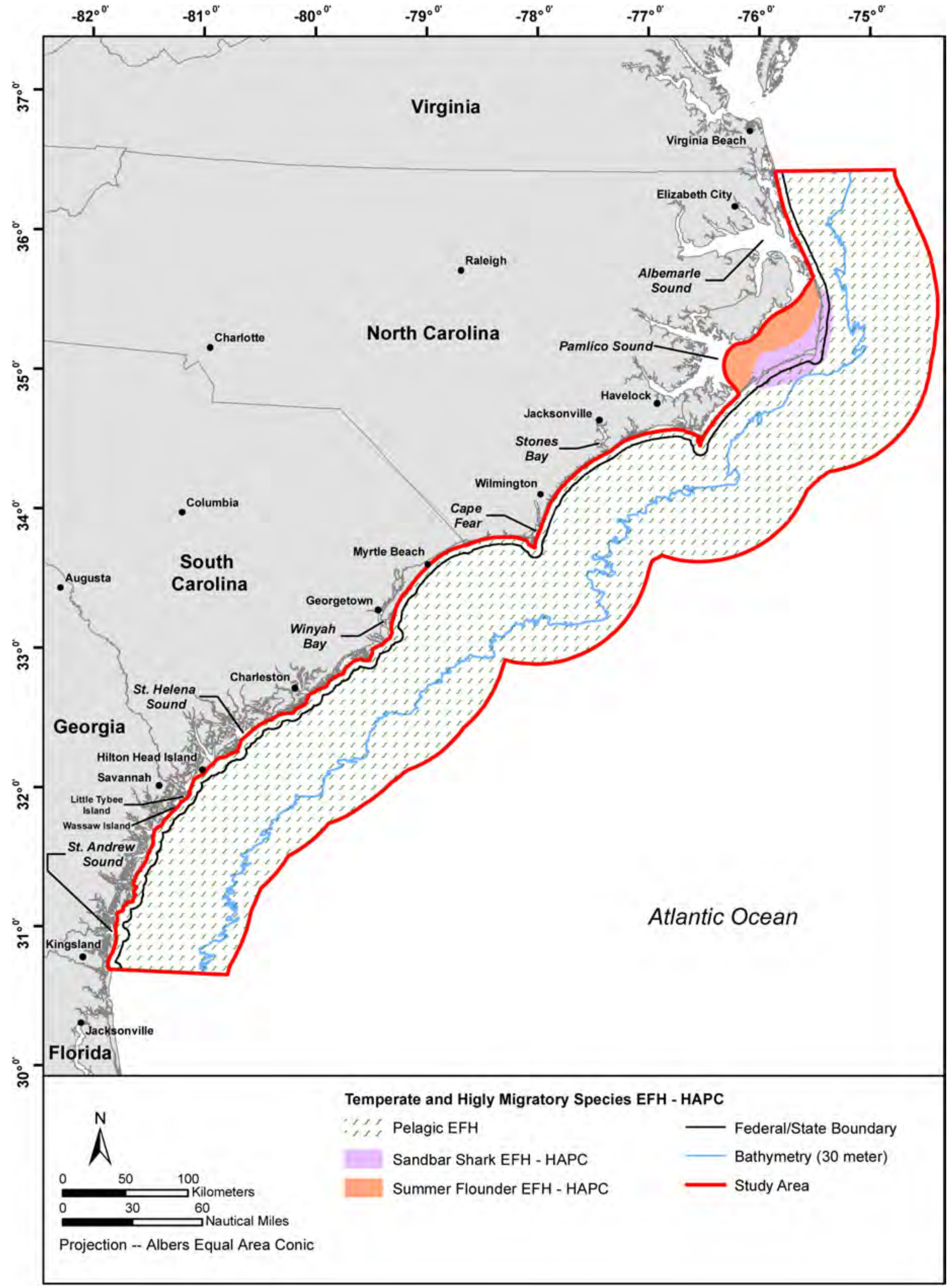

Figure 10. Designated essential fish habitat (EFH) and habitat area of particular concern (HAPC) for the temperate and highly migratory species (HMS) fishery management units (MUs) in the Study Area. Source data: NMFS (2001, 2009).

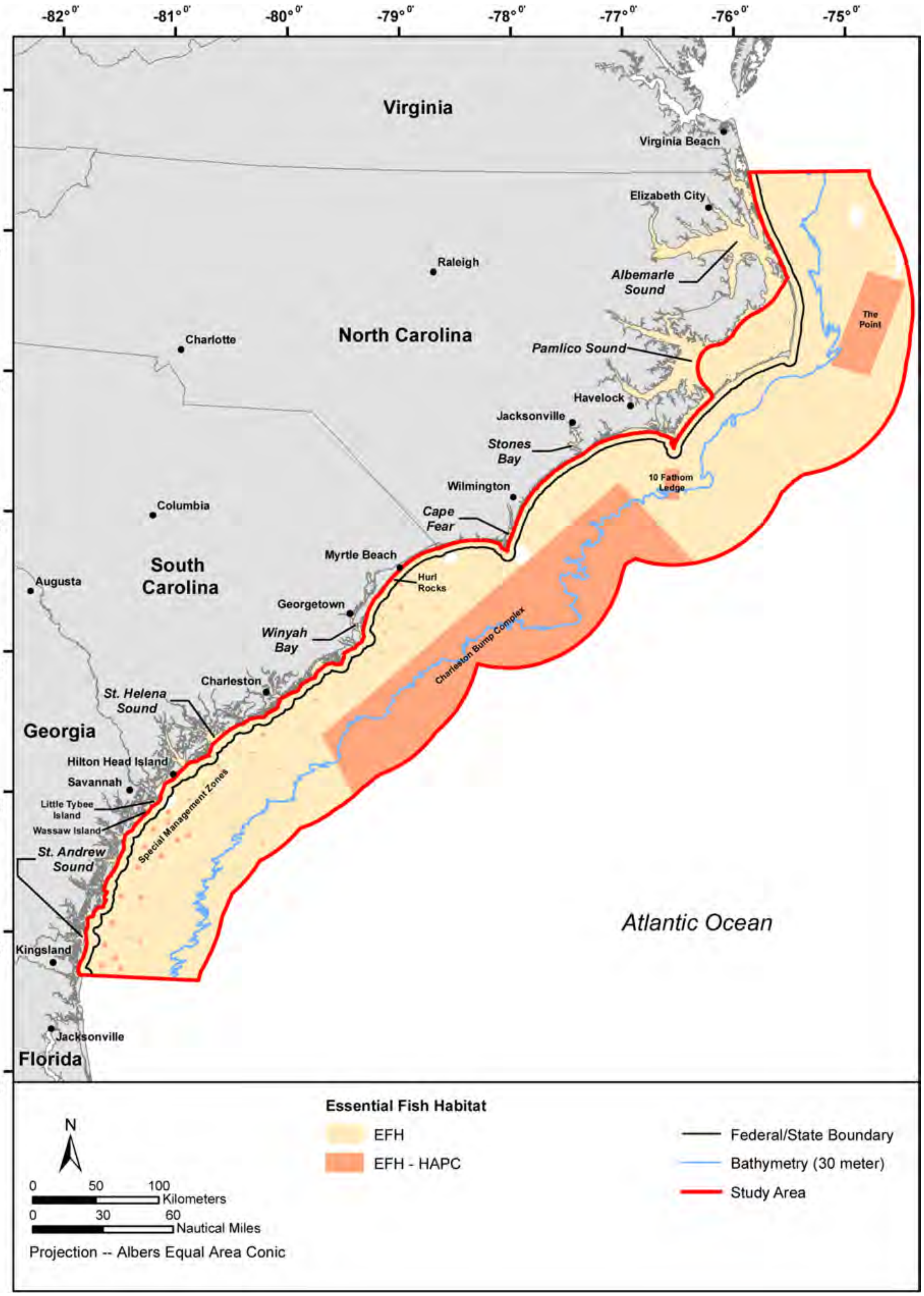

Figure 11. Combined EFH and EFH-HAPC for all managed fish/invertebrate species and species groups within the Study Area.

Figures 8a through **10** depict EFH and HAPC for individual species/species groups. In order to visualize all EFH and HAPC within the Study Area, **Figure 11** shows an aggregate of all layers. Twenty-nine species have designated HAPC for all lifestages encompassing 16 species representing 6 of the 9 families of the 73 species of the snapper-grouper complex MU: medium to high profile, offshore, hard bottom habitat (areas of known spawning aggregation); pelagic/benthic *Sargassum*; all coral habitats/reefs; FMC-designated artificial reef Special Management Zones (SMZs); and areas with fishing gear restrictions or harvest regulations, seagrass and oyster/shell habitats, all coastal inlets, all state-designated nursery habitats (Primary/Secondary Nursery Areas designated in North Carolina), and nearshore hard bottom habitat (<3.96 m [13.1 ft]); 5 coastal migratory pelagic MU: Inner/Outer Hurl Rocks (South Carolina) and pelagic *Sargassum*, dolphin-wahoo MU: 10 Fathom Ledge (North Carolina); 3 penaeid shrimp MU species: all coastal inlets, state-designated nursery areas, and state-identified overwintering areas; 1 temperate MU species (summer flounder, *Paralichthys dentatus*): all native species of macroalgae, seagrasses, and freshwater/tidal macrophytes in any size bed as well as loose aggregations (i.e., Pamlico Sound), and 1 HMS MU species (sandbar shark, *Carcharhinus plumbeus*): near Outer Banks, North Carolina in areas of Pamlico Sound adjacent to Hatteras and Ocracoke islands and offshore of these barrier islands (NMFS 2009; SAFMC and NMFS 2009; NCDMS 2011a).

3.2.4.3 Protected Fish Species

The endangered shortnose sturgeon (*Acipenser brevirostrum*) is the only protected fish species that occurs in various estuarine habitats in North Carolina (Cape Fear River), South Carolina, and Georgia, however, this species is not known to make coastal migrations (Dadswell et al. 1984; NMFS 1998). In addition, there are six species of concern, one candidate species, and one species proposed for listing that occur in coastal waters off North Carolina, South Carolina, and/or Georgia. Species of concern include: alewife (*Alosa pseudoharengus*), blueback herring (*A. aestivalis*), dusky shark (*Carcharhinus obscurus*), sand tiger shark (*Carcharius taurus*), speckled hind (*Epinephelus drummondhayi*), and Warsaw grouper (*E. nigritus*) (NMFS 2011a). Currently, NMFS is preparing a determination on whether to list the Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) or its multiple distinct population segments (DPSs) (i.e., Carolina and South Atlantic) as endangered (NMFS 2010d) and is proposing to list the Atlantic bluefin tuna (*Thunnus thynnus*) as endangered or threatened (NMFS 2010e).

3.2.5 Benthic Habitats: Soft and Live Hard Bottoms

On the southeastern U.S. continental shelf, the benthic habitat consists primarily of two natural communities: soft bottoms (unconsolidated sediments) and live hard bottoms. The soft bottom habitats are virtual aquatic deserts, with shifting sandy topography that prevents the colonization of large plant and animal communities (Lenz 1999). As a result, the distribution of the benthic community may not be uniform but rather patchy (Brooks et al. 2006). The soft bottom communities on the continental shelf provide habitat for many infaunal organisms (macrofauna >0.02 inches [in] and meiofauna = 0.002 to 0.02 in), such as polychaetes (worms), archiannelids (worms), bivalves, amphipods, and asteroids (starfish) (Posey et al. 1998; Hobbs 2002) with abundance and species diversity comparable to nearshore and intertidal areas (Posey et al. 1998). Factors affecting their distribution and abundance include depth, sediment type, grain size, temperature, and salinity (Brooks et al. 2004).

Live hard bottom ledges and reefs are widely distributed in the sub-tropical region off the southeastern U.S. continental shelf (Wenner et al. 1983; Barans and Henry 1984; Sedberry and Van Dolah 1984). Hard bottom areas can support diverse communities of sessile and motile organisms (also known as live hard bottom communities) which can attract sea turtles and fishes (Kirby-Smith and Ustach 1986; Thompson et al. 1999). Known live hard bottom communities within the Study Area exhibit low to high relief (Barans and Henry 1984). The Study Area contained within the 30-m isobath contains primarily low relief live hard bottom the substrate of which consists of relatively flat rock outcrops (<0.5-m relief) colonized by sponges and octocorals. Beyond the 27-m isobath (in a water depth ranging from 28 to 55 m), live hard bottoms tend to have higher reliefs (0.5- to 2-m relief) which are also colonized by sponges and octocorals. Note that not all hard bottom habitats support a live bottom community (Kirby-Smith and Ustach 1986; SAFMC 1998).

There are no true tropical coral reefs within the Study Area or vicinity but there are temperate anthozoans (soft and hard corals) that have developed isolated coral patches or mounds (Huntsman and Macintyre 1971; BLM 1976; Miller 1995; SAFMC 1998; DeVictor and Morton 2007). In fact the Study Area contains numerous locations of hard bottoms and coral sponge patches (see **Figures 9f**, **9g**, and **9h**). In particular, the area off Cape Fear, Onslow Bay, and the area southeast of Charleston Harbor support higher densities of hard bottom habitats compared to the remainder of the Study Area. Onslow Bay also supports the highest density of coral sponge patches within the Study Area. While these coral sponge patches are not true coral reefs as those found in the Caribbean region, they can include the tropical reef-building species *Siderastrea siderea* and *Solenastrea hyades* which occur in isolated patches within the 20- to 40-m water depth range (Macintyre and Pilkey 1969; Huntsman and Macintyre 1971). Other corals found on the shelf in this area are the non-reef building corals *Oculina arbuscula* and *Astrangia danae* which occur as small discrete colonies at various locations on the inner continental shelf within the 3- to 40-m water depth range (Macintyre and Pilkey 1969; Huntsman and Macintyre 1971). Other noteworthy locations in terms of hard bottoms include: the fairly large area of hard bottom found southeast of Charleston Harbor, South Carolina; Gray's Reef located south of Savannah, Georgia; and a fairly large hard bottom area southeast of Gray's Reef (see **Figures 9g**, **9f**, and **9h**). Off the Georgia coast, there are more tropical coral and sponge species than North Carolina and the northern section of South Carolina due to the warmer water temperatures from the Gulf Stream Current (~16 degrees Celsius [°C] in January to ~29°C in August), higher salinities (34.3 to 36.6 parts per million [ppm]), and consistent circulation patterns (northward flowing current) from year to year (Wenner et al. 1984).

Benthic substrates, live hard bottom habitat, biogenic reefs, artificial reefs, and shipwrecks are designated EFH. Areas designated as HAPC for corals, coral reefs, and live hard bottom habitat within the shoreward of the 30-m isobath include the Charleston Bump Complex (South Carolina), Hurl Rocks (South Carolina), and Gray's NMS (Georgia). The area of Gray's Reef, which consists of rock ledges, was designated as a NMS in 1981 considering the rich and diverse assemblage of temperate and tropical fauna and flora associated with the hard bottom area (NOAA 2011). It is located 17.5 NM east off Sapelo Island, Georgia and is one of the largest nearshore live hard bottom areas in the southeastern U.S. Of particular importance are corals and other tropical organisms that dwell at this location. Organisms found at Gray's Reef include bryozoans, hydroids, ascidians, barnacles, tubeworms, sponges, hard corals, sea whips, sea fans, crabs, lobsters, mollusks, diverse fish species (e.g., black sea bass [*Centropristis striata*], snapper-grouper complex, and mackerel), and loggerhead turtles. Gray's Reef lies within the calving grounds of the North Atlantic right whale (NOAA 2011). While certain types of recreational fishing are allowed at Gray's Reef, commercial fishing, mineral extraction, ocean dumping, and the alteration of the seabed are prohibited within the Sanctuary.

3.2.6 Submerged Aquatic Vegetation

SAV, defined as marine, estuarine and riverine vascular plants, is found in nearshore estuarine environments and freshwater systems rooted in unconsolidated sediments but not in the Atlantic Ocean portion of the Study Area. Habitat for SAV in North Carolina includes estuarine waters and freshwater systems. Estuarine SAV species in North Carolina include eelgrass (*Zostera marina*), shoalgrass (*Halodule wrightii*), and widgeon grass (*Ruppia maritima*). Together these three species form seagrass meadows (SAFMC 1998). SAV supports macroalgae including *Ulva, Codium, Gracilaria, and Enteromorpha* in estuarine water and *Chara* and *Nitella* in freshwater. The macroalgae *Ectocarpus* and *Cladomorpha* are found in salt marsh flats in association with SAV (Thayer et al. 1984). The leaves of the SAV can support algae and other living organisms including micro-organisms (protozoans), worms, sponges, mollusks, barnacles, shrimps, and crabs. The abundance and biomass of SAV varies seasonally (Dawes et al. 1995). In the winter and spring, shallow estuarine protected areas support relatively abundant eelgrass whereas shoalgrass will be more abundant in the same area during the summer when water temperature exceeds 25°C. Shoalgrass is also more abundant in cooler water such as deeper habitats and tidal flats exposed to uninterrupted water exchange (SAFMC 1998). The SAV in the Study Area is concentrated along the Outer Banks (Street et al. 2005) (**Figure 12**).

3.2.6.1 SAV Essential Fish Habitat/Habitat Areas of Particular Concern

Within the Study Area, SAV is found in the Pamlico Sound – Albemarle-Pamlico estuarine system which is designated HAPC (**Figure 12**; Street et al. 2005).

3.3 NON-ECOLOGICAL FACTORS

3.3.1 Fisheries

3.3.1.1 Commercial

Commercial fisheries in the southeastern U.S. Atlantic region (North Carolina to Georgia) was a $103 million dollar annual industry in 2009 (NMFS 2011b). Within this three state region, North Carolina ranks first in mass (68.6 million pounds) and dollar (ex-vessel) value (77 million) for 2009 landings (NMFS 2011b). The blue crab (*Callinectes sapidus*) and brown shrimp, followed by the summer and southern (*Paralichthys. lethostigma*) flounders are the most commercially valuable fishery (43.1 million) in North Carolina inshore (Pamlico Sound) and offshore coastal waters. The most extensive fishing activity is bottom trawling for penaeid shrimps and flounders in Pamlico Sound and offshore coastal waters and less commonly for blue crabs in Pamlico Sound (UNC 2010) where they are collected in large numbers by dredge and pot gear types (NCDMF 2011b). In South Carolina and Georgia offshore coastal waters, the white shrimp produced the most revenue (9.7 million) in 2009 (NMFS 2011b). Commercial fisheries taking place in North Carolina, South Carolina, and Georgia waters are managed by a variety of federal agencies including the SAFMC, MAFMC, Gulf of Mexico Fishery Management Council (GMFMC), NEFMC, and NMFS, and state agencies (ASMFC, division of marine fisheries) via several FMPs.

Within this three state region, there are numerous commercial fishery closures (geographic and seasonal) established to protect stocks by reducing fishing pressure. These closures may be seasonal or year-round (i.e., shallow-water grouper and red snapper, *Lutjanus camphechanus*) and some are associated with a specific gear type in order to minimize their impacts on specific habitats in coastal waters (SAFMC 2010) and/or in North Carolina Pamlico Sound/coastal waters (NCMDF 2011c).

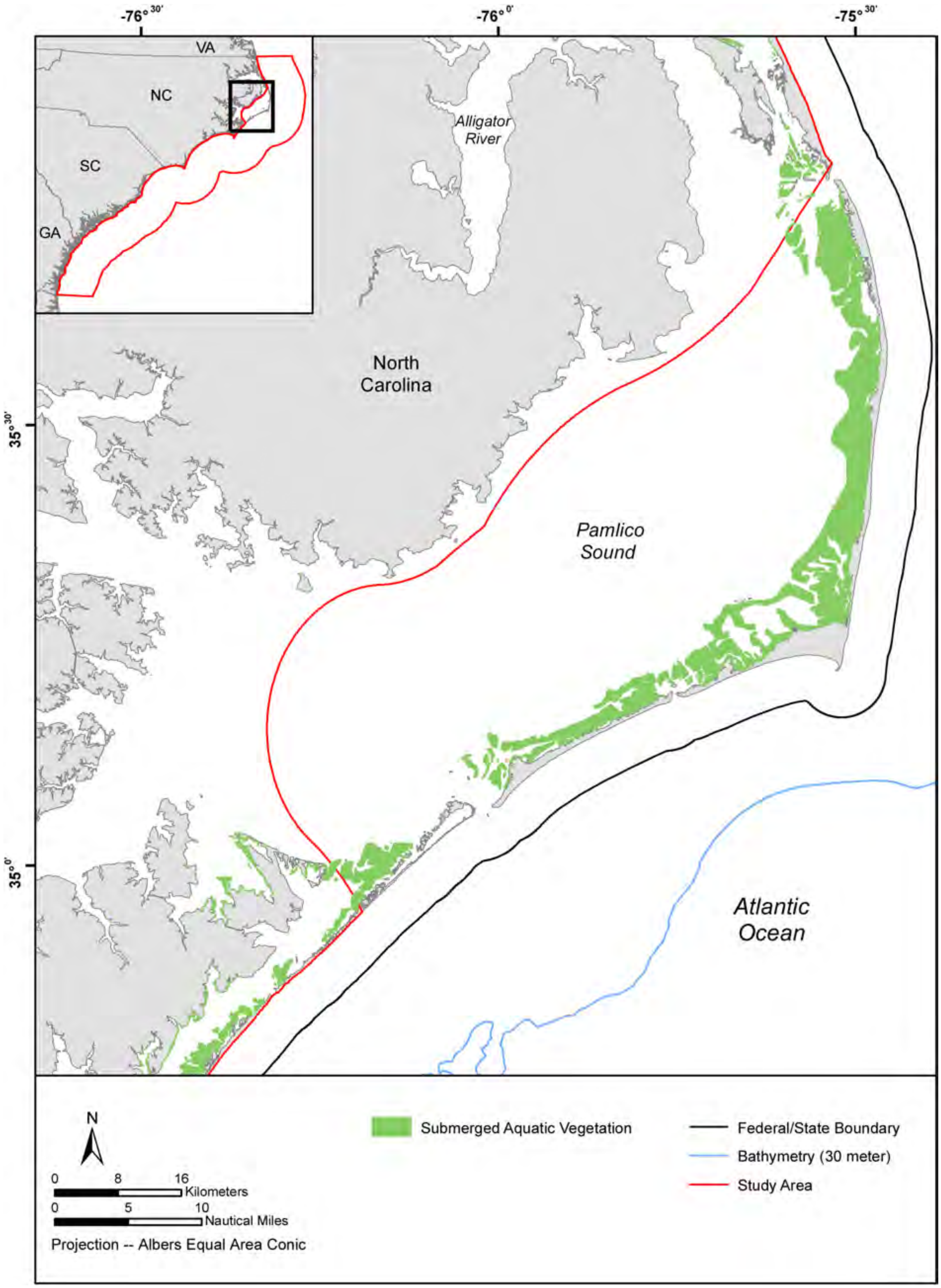

Figure 12. Submerged aquatic vegetation (SAV) located within the Albemarle-Pamlico estuarine system, North Carolina. Source data: NOAA (2000).

Harvest or possession of the red drum (*Sciaenops ocellatus*), several members of the snapper-grouper MU groupers (goliath, *Epinephelus itajara*, Nassau, *E. striatus*, Warsaw, and speckled hind) as well as the harvest of pelagic *Sargassum*, corals, coral reef, and live (wild/aquaculture) rock are prohibited along with various prohibited sharks (sandbar, dusky, etc.) in federal waters of North Carolina, South Carolina, and Georgia (NMFS 2010h; NMFS 2010g; SAFMC 2010). In North Carolina state coastal waters (internal and 0 to 3 NM), it is unlawful to harvest alewife and blueback herring (NCDMF 2010).

The commercial fishing data for North Carolina, South Carolina, and Georgia was acquired from the ACCSP's spatial presentation of commercial landings for South Atlantic species in live pounds and dollar value per NMFS statistical areas (SAFMC 2009a). The commercial fishery dominance in North Carolina compared to South Carolina and Georgia illustrated in **Figure 13** shows that 4,400,000,000 total live pounds caught from 1990 to 2006 in ACCSP statistical fishing blocks 635 and 701 are represented by four species: brown shrimp, spot, bluefish, and Atlantic croaker (SAFMC 2009c). These high totals are further substantiated by mean number of commercial fishing trips conducted from 2000 to 2004 for the following gear types: otter trawls (brown shrimp: 5,380.61 to 8,603.40 in 635/701), gillnets (bluefish: 1,190.01 to 2,658.80 in block 701), and dredges/pots (blue crab: 19,180.61 to 51,458.60/92.01 to 906.40 block 635) (ACCSP 2006a). Distribution of fishing effort relevant to other commercial fisheries using other different gear type: lines, seines, traps, and cast nets is also dominant in these statistical fishing blocks (ACCSP 2006a). The total live catch of white shrimp (2/55 million pounds) in statistical blocks 706/713 and 717/722, respectively from 1990 to 2006, supports its dominance in the South Carolina and Georgia offshore coastal fisheries (SAFMC 2009c), along with the mean number of trawl gear commercial fisheries trips (988.01 to 5380.60/186.61 to 988.00) conducted between 2000 and 2004 (ACCSP 2006a).

3.3.1.2 Recreational

Marine recreational fishing is both a popular and profitable activity along the southeastern U.S. coast. The North Carolina, South Carolina, and Georgia coastal waters offer substantial opportunities for marine recreational fishing due to several physiographic and oceanographic features of the SAB. Small-scale features such as live hard bottom (SEAMAP 2001a) and large-scale features such as shelf/shelf-edge transitions provide spatial complexity, resulting in increased fish diversity in these areas (Huntsman and Manooch 1978). Additionally, extensive bays and estuaries support nursery grounds for juvenile fishes, while artificial reefs and shipwrecks on the continental shelf contribute habitat structure for varied communities of reef fish and invertebrates (Steimle and Zetlin 2000; Street et al. 2005). Currents, such as the Gulf Stream, also contribute to the richness and abundance of fish species, with its warm waters dispersing fish/invertebrate eggs and larvae, as well as southern subtropical-tropical juvenile fishes to the area (Govoni and Spach 1999).

Recreational saltwater fishing in this three state region is either a shore-based or boat-based activity. The boat-based activity is conducted by charter and head boats usually performing full day trips and utilizing several types of fishing gear (rods/reels, trolling, and spearguns) (Abbas 1978). Recreational fishing effort varies seasonally with the majority of boat-based fishing trips occurring from July through August, while the least activity occurs in January and February (Strand et al. 1991). The highest recreational fishing effort is concentrated in inshore/state waters as compared to federal waters (North Carolina: 92.4/7.6%, South Carolina: 95.4/4.6%, and Georgia: 96.9/3.1%) (ACCSP 2006b).

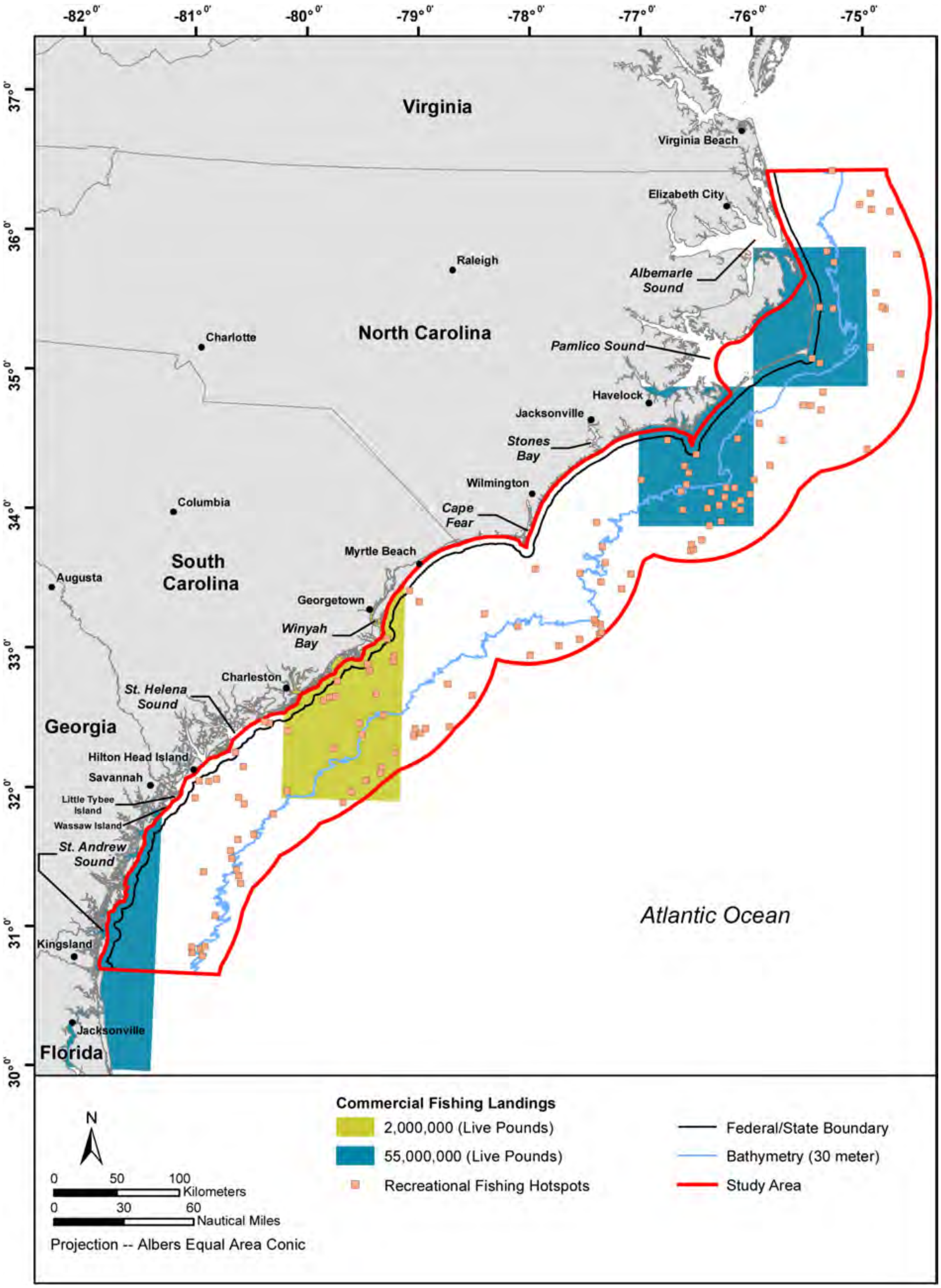

Figure 13. Commercial fishing landings and recreational fishing hot spots within the Study Area. Source data: SAFMC (2009a).

Recreational anglers focus their efforts in specific locations generally associated with subtle habitat features (bottom relief, live hard bottom communities, canyons, artificial structures, and pelagic *Sargassum*) that concentrate fishes (Huntsman and Manooch 1978). Most fishing hotspots are located between the shore and the shelf break in this three state region (**Figure 13**). Favored fishing hotspots may change over time in response to changes in fish populations/communities, changes in preferred target species, or changes in fishing modes and styles (Freeman and Walford 1976a, 1976b). In addition, organized fishing tournaments are popular, occurring from May to December with highest activity centered in the summer months (July through September) (DoN 2009).

3.3.2 Maritime Traffic

3.3.2.1 Commercial Shipping

U.S. navigable waterways are managed by the Marine Transportation System (MTS) and include the oceans and navigable inland and coastal waters, lakes, rivers, and streams (USACE 2004). The U.S. MTS consists of 25,000 mi of navigable channels and more than 3,700 marine terminals (MTS 2011). A determination of navigability, once made, applies laterally over the entire surface of the water body and is not extinguished by later actions or events that impede or destroy navigable capacity (33 Code of Federal Regulations [CFR] 329.4). More than 22,000 NM (40,000 km) of commercially navigable waterways exist within the U.S. transportation system (BTS 2010) (**Figures 14a-c**).

Both domestic and international commercial shipping occurs in the western North Atlantic. The Study Area lies between the major commercial shipping ports of Morehead City and Wilmington, North Carolina to the north, Georgetown and Charleston, South Carolina central to the Study Area, and Savannah and Brunswick, Georgia to the south.

North Carolina ports include Wilmington and Morehead City (Breskin 2005; NCSPA 2011). More than 3,000,000 tons of cargo moved through the Port of Wilmington in Fiscal Year 2010 (July 2009 to July 2010). More than 1,700,000 tons of cargo moved through the Port of Morehead City in Fiscal Year 2010 (July 2009 to July 2010) (NCSPA 2010a, 2010b).

Commercial ports in Georgia include Savannah and Brunswick. The Port of Savannah is one of the largest ports on the East Coast and the sixth busiest international waterborne freight gateway in the U.S. (by value of shipments in 2008; BTS 2011a). Thirty-six million tons of goods moved through the port of Savannah in 2008, which accounted for 2% of all waterborne tonnage shipped in the U.S. (BTS 2011a). The Port of Savannah includes the Garden City Terminal and the Ocean Terminal. The Garden City Terminal is one of the top five, largest container ports in the U.S. and is the largest single-terminal operation in North America. The Ocean Terminal is dedicated to breakbulk and roll-on/roll-off (RoRo) cargo (GPA 2011). The Port of Brunswick includes the Mayor's Point Terminal, Colonel's Island Terminal RoRo Facility, Colonel's Island Terminal Agri-bulk Facility, and Marine Port Terminals (GPA 2011). The Mayor's Point Terminal operates as a distribution center for various solid wood and forestry shipments including woodpulp, linerboard, plywood, and paper products. The Colonel's Island Terminal RoRo Facility is one of the largest automotive facilities in the U.S. The Colonel's Island Terminal Agri-bulk Facility is one of the largest deepwater agricultural bulk operations in the U.S. South Atlantic. The Marine Port Terminal is a deepwater facility managing various bulk and breakbulk shipments (GPA 2011).

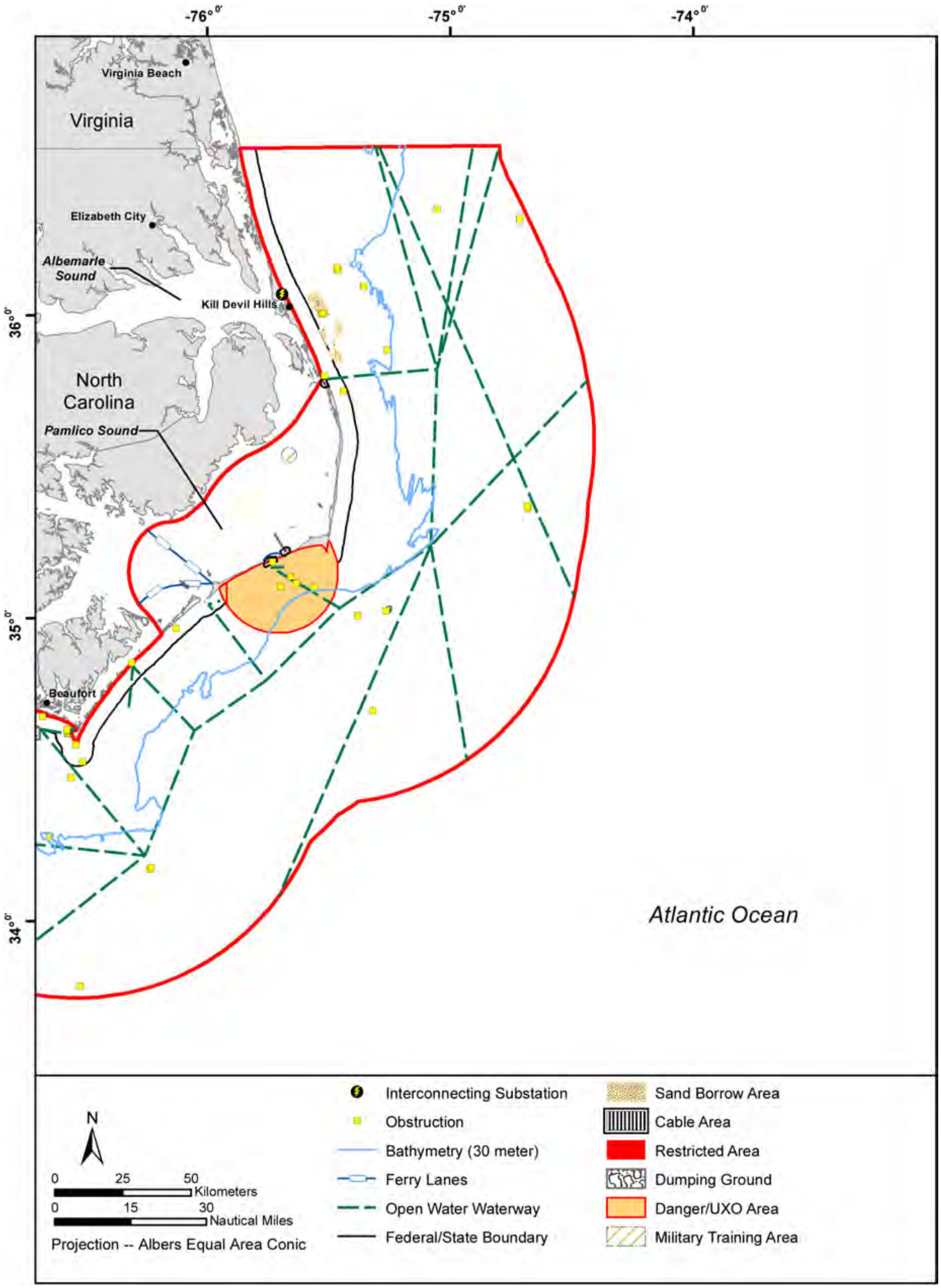

Figure 14a. Obstructions, ferry lanes, open water waterways, submarine cables, restricted areas, danger/UXO areas, military training areas, dumping grounds, and sand borrow areas in the Study Area off North Carolina.

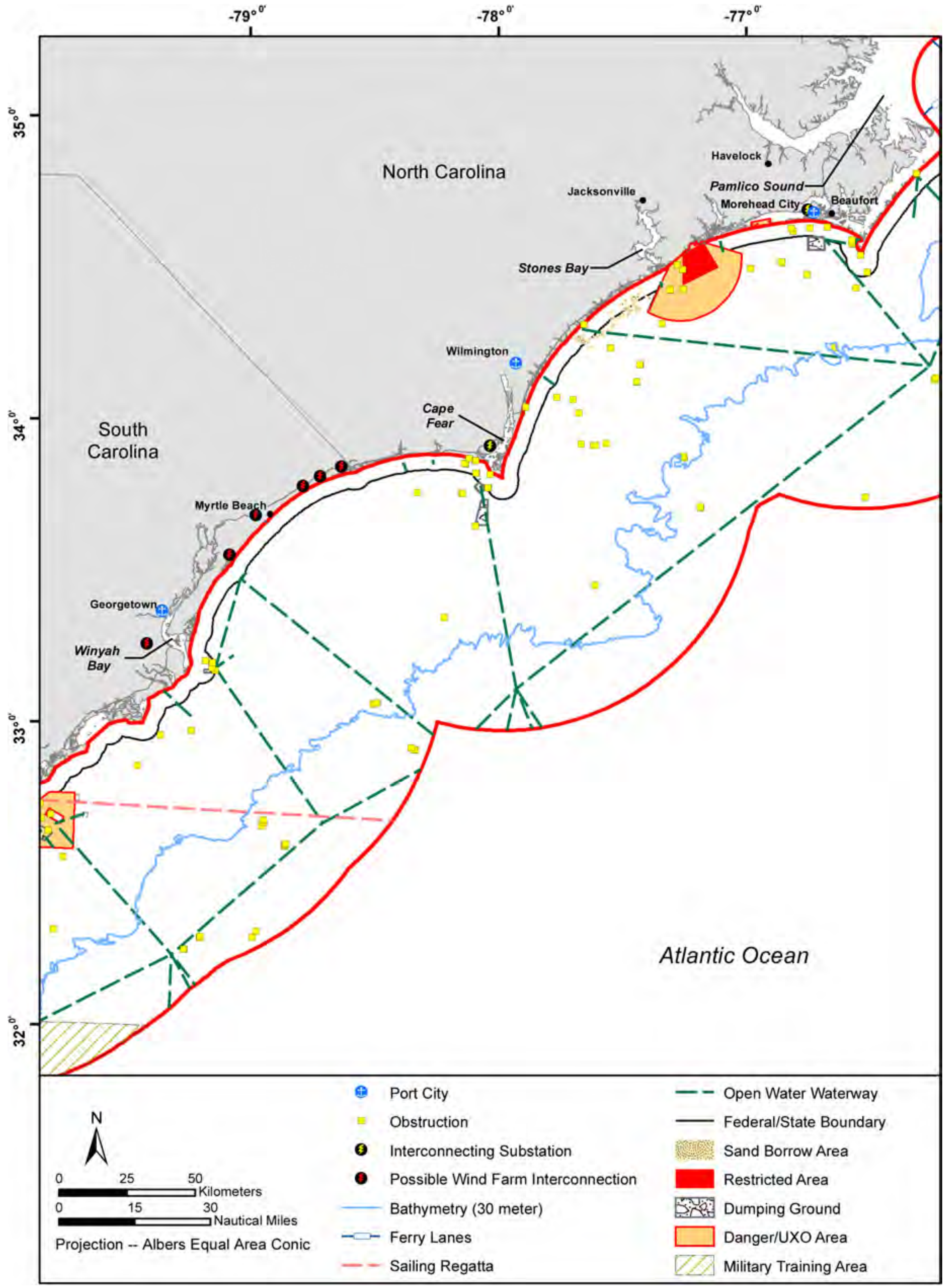

Figure 14b. Obstructions, ferry lanes, open water waterways, submarine cables, restricted areas, danger/UXO areas, military training areas, dumping grounds, sailing regattas, and sand borrow areas in the Study Area off North and South Carolina.

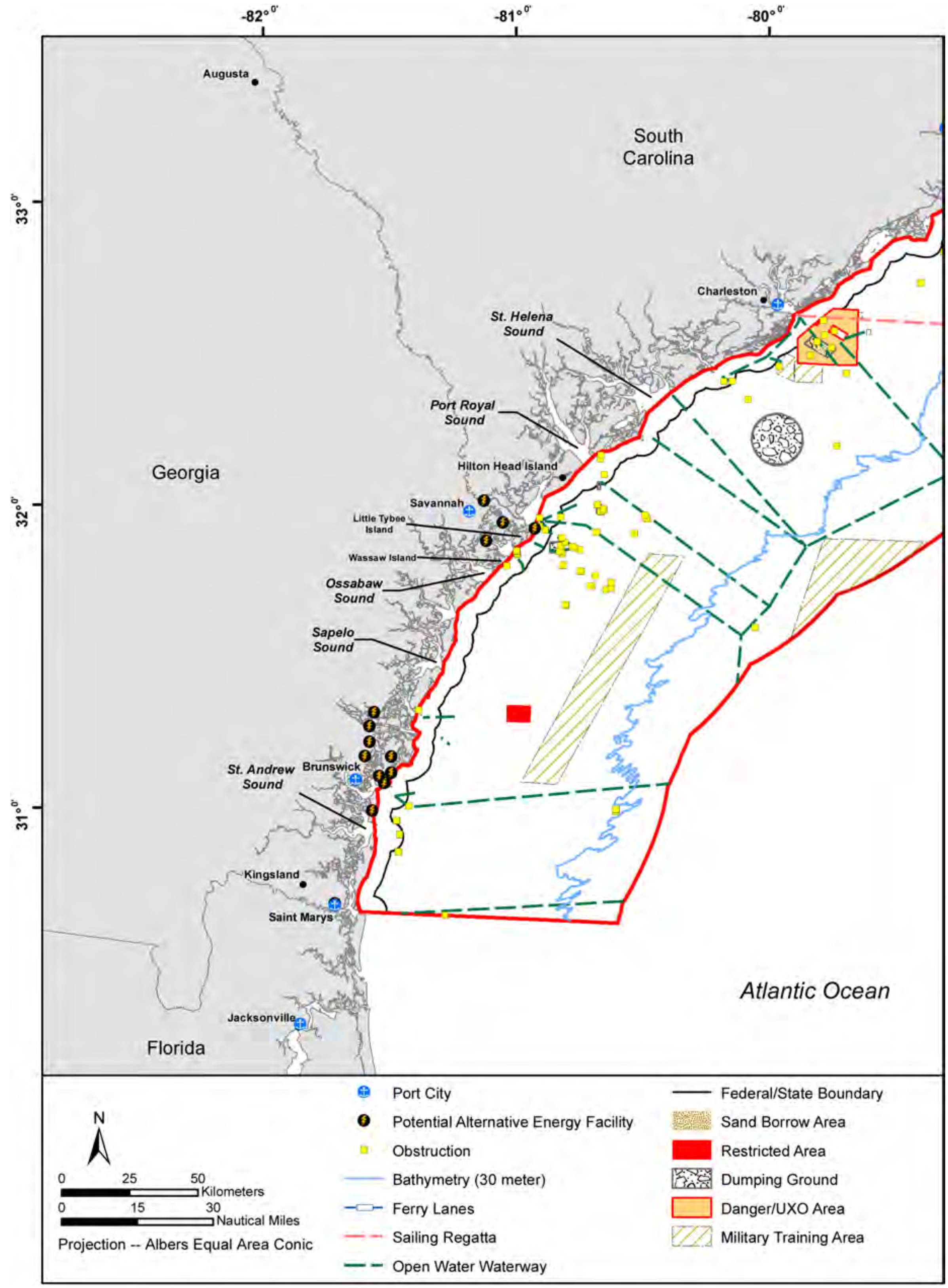

Figure 14c. Obstructions, ferry lanes, open water waterways, submarine cables, restricted areas, danger/UXO areas, military training areas, dumping grounds, sailing regattas, and sand borrow areas in the Study Area off South Carolina and Georgia.

It should be noted that there is the potential for the Ocean Bar Channel for the Port of Savannah to be extended in the near future; however, this action would not impact the potential for offshore wind development in the Study Area because the proposed area for this action would be entirely within an excluded area.

Ports of South Carolina include Charleston and Georgetown. With the deepest water channels in the Southeast, the Port of Charleston provides services for cruise ships as well as for freight-carrying vessels, including freight rail service (SCSPA 2011a). The Port of Charleston is the fifth busiest international waterborne freight gateway, nationally (by value of shipments in 2008; BTS 2011b), and the busiest container port along the U.S. Southeast and Gulf coasts (Breskin 2005). More than 19,000,000 tons of cargo moved through the Port of Charleston in 2008, accounting for more than 1% of all international waterborne tonnage shipped in the U.S. (BTS 2011b). The Port of Georgetown manages bulk and breakbulk cargo (SCSPA 2010) and specializes in handling salt, cement, aggregate, forest products, and ore (Breskin 2005; SCSPA 2011b).

3.3.2.2 Ferry Transit

Ferry transit occurs along the coastline of the Study Area. Ferries are utilized to transport passengers and vehicles, 365 days per year, to and from the barrier islands along the states' coastlines (NC Beaches 2011; SCDPT 2011; St. Marys 2011). North Carolina experiences the most ferry transit activity throughout the year. North Carolina ferries transit seven routes from Knotts Island and Currituck in the north to Fort Fisher and Southport on the southeast coast (NCDoT 2010; NC Beaches 2011; NCDoT 2011).

3.3.2.3 Sailing Regattas

Sailing and yachting (both competitive and recreational) are year-round activities that occur in the waters off the southeast coast. Sailing and yachting activities on inland and coastal waters are regulated by the Georgia Department of Natural Resources, South Carolina Department of Natural Resources, and the North Carolina Wildlife Resources Commission. A multitude of associations and/or clubs for yachting and sailing are linked with the South Atlantic Yacht Racing Association (SAYRA), one of 38 Regional Sailing Associations (RSAs) of U.S. Sailing (national governing body of sailing in the U.S.) (U.S. Sailing 2011). SAYRA is composed of over 40 local sailing associations and yacht clubs, many of which train and compete along various shorelines of Georgia, South Carolina, and North Carolina (SAYRA 2010b). Local sailing associations are sailboat racers who conduct local racing, whereas, yacht clubs are private or public organizations, usually with a specific facility capable of hosting minor and major regattas along the Atlantic coast such as the Deep South Regatta, Charleston Race Week, Harbour Town Cup, U.S. Masters National, McIntosh Cup, Charleston to Bermuda Race, Special Olympics, D-12 Championship Series, Hobcaw Regatta, James Island Regatta, SAYRA Youth Challenge, Lowcountry Regatta, U.S. Sailing Men's Area D Championships, Charleston Yacht Club Regatta, Water Festival Regatta, Carolina Yacht Club Regatta, Rockville Regatta, SAYRA Open Invitational, Leukemia Cup Regattas, Octoberfest Regatta, and the Carolina Ocean Challenge (SAYRA 2010a). The Charleston to Bermuda race is a biennial regatta that began in 1997. The course is 777 NM and requires boats to be at least 30 ft in length. The next race is slates for May 21, 2011 out of Charleston Harbor with participants heading relatively east arriving a week later in Hamilton, Bermuda (Charleston Bermuda Race 2010). **Figures 14b** and **14c** show the recorded tracks of the competitors in the 2009 race. The course should be similar each time.

Regattas that introduce extra or unusual hazards to the safety of life are required to obtain authorization from the local Coast Guard District (33 CFR 100.15). Hazards can include perilous competition, blockage of a navigable channel, and/or presence of commercial, leisure, or spectator craft. Certain applications require special local regulations be administered and overseen by the Coast Guard. The Annual Harborwalk Boat Race on the Sampit River of Georgetown, South Carolina is the only special permit that currently exists in the project area (33 CFR 100.713). Regatta courses with known geographic coordinates can be found in **Figures 14b** and **14c**. Aside from sailing, other recreational uses of the coastal waters include motor boating, jet skiing, waterskiing, surfing, windsurfing, and kayaking.

3.3.3 Military Munitions Training Areas

Along the Study Area, military installations skirt the coasts of North Carolina, South Carolina, and Georgia: the Dare County Bombing Range (southern Virginia Capes [VACAPES] Operating Area [OPAREA]); Marine Corps Air Station (MCAS) Cherry Point and Marine Corps Base (MCB) Camp Lejeune (Cherry Point OPAREA); MCAS Beaufort and part of MCB Camp Lejeune (Charleston OPAREA); Naval Submarine Base Kings Bay (northern section of the Jacksonville OPAREA). These installations often use the adjacent waters for training operations (**Figures 14a-c**). Past and present training exercises and past military conflicts have created known and unknown disposal locations of munitions (such as UXOs) (Greene 2009) and up until the 1970s was an internationally accepted practice (Carton and Jagusiewicz 2009).

3.3.3.1 Virginia Capes Operating Area

Training operations are widely dispersed in the VACAPES OPAREA which includes coastal and offshore waters of Delaware, Maryland, Virginia and North Carolina (total of 27,661 square nautical miles [NM^2]). Pertinent to the Study Area, the southernmost point of the VACAPES OPAREA is at latitude of 34°19’N, 105 NM southeast of Cape Hatteras, North Carolina. The western boundary of the offshore OPAREA lies at the boundary separating state and federal waters (3 NM from shore). Training activities include surface warfare, mine warfare, mine exercises, amphibious warfare, and strike warfare. Depending on the training schedule, no more than 10 vessels are utilized at one time and range in sizes from 362 to 1,092 ft traveling from 10 to 14 knots. Operations can vary from a few hours up to two weeks, logging during an average year 1,400 total vessel days within the VACAPES OPAREA (DoN 2008a).

3.3.3.2 Cherry Point Operating Area

Training operations are widely dispersed in the Cherry Point OPAREA which includes coastal and offshore waters of North Carolina (total of 18,617 NM^2). The offshore OPAREA extends from 3 NM to 130 NM from Point Lookout. Training activities include surface warfare, mine warfare, and amphibious warfare. Depending on the training schedule, no more than 10 vessels are utilized at one time and range in sizes from 362 to 1,092 ft traveling from 10 to 14 knots. Operations can vary from a few hours up to two weeks, logging during an average year 950 total vessel days within the Cherry Point OPAREA (DoN 2008b).

3.3.3.3 Jacksonville/Charleston Operating Area

Training operations are widely dispersed in the Jacksonville/Charleston OPAREA which includes coastal and offshore waters of northern Florida, Georgia, South Carolina, and the southern portion of North Carolina (total of 50,219 NM^2). The western boundary of the offshore OPAREA lies at the boundary separating state and federal waters (3 NM from shore). Training activities include surface warfare, mine warfare, mine exercises, and amphibious warfare. Depending on the training schedule, no more than 10 vessels are utilized at one time and range in sizes from 362 to 1,092 ft traveling from 10 to 14 knots. Operations can vary from a few hours up to two weeks, logging during an average year 1,000 total vessel days within the Jacksonville/Charleston OPAREA (DoN 2008c).

3.3.4 Mining and Dumping Grounds

Currently, no mineral mining operations exist in the South Atlantic region though the resources of phosphate and manganese nodules are present (SAFMC 2009b; Riggs and Manheim 1988). The Carolina Phosphate Province in North Carolina holds the Northeast Onslow Bay and Frying Pan Phosphate districts along with the Aurora Phosphate District in the coastal plain to the north. Extensive drilling and research of these phosphate-rich sediments establishes a connection to the Hawthorn Formation (Florida to South Carolina) and the Calvert Formation (northward through Virginia) (Riggs and Manheim 1988). Concentrations of phosphate in the North Carolina continental shelf beds are theoretically significant enough to be considered potential resources. On the South Carolina continental shelf, the Blake Plateau is considered to be almost entirely underlain by phosphoritic pavements, pebbles, and pellets together with sediments potentially rich in manganese (Riggs and Manheim 1988). With recovery of phosphates comes the potential for uranium resources as a byproduct, though most is not recoverable.

Other than dredged materials regulated by the Environmental Protection Agency (EPA) and U.S. Army Corps of Engineers (USACE), it is illegal for American commercial vessels and all other vessels operating in the contiguous zone and territorial sea of the U.S. to discard toxic and hazardous substances at sea as stated by the Marine Protection Research and Sanctuaries Act (MPRSA) (SAFMC 2009b). The majority of solid matter dumped in nearshore and offshore waters comes from sediment being excavated or removed by dredging (Palmer 1988). Inshore sediment is generally fine and contains some degree of contamination producing potential impacts such as turbidity plumes during removal and/or deposition (SAFMC 2009b) and release of toxic particles (Palmer 1988). As of 2010, offshore dumping sites have been permitted for Morehead City, Wilmington, and New Wilmington, North Carolina (**Figures 14a** and **14b**), Georgetown Harbor, Charleston, and Port Royal, South Carolina (**Figures 14b** and **14c**); and Savannah and Brunswick Harbor, Georgia (**Figure 14c**) (EPA 2010).

3.3.4.1 Sand Borrow Areas

According to BOEMRE, sand deposits of the federal continental shelf could contribute to beach nourishment projects as continuing sources of borrow material. Requests of outer continental shelf (OCS) deposits are increasing as sand is being depleted from state sources (Michel 2004; BOEMRE 2011). Also, the potential development of these OCS sources has grown rapidly with identification of suitable sand resource areas in recent years (SAFMC 2009b). Another need for offshore sand resources stems from concern over urgent repairs to beaches in case of severe storms (Michel 2004). Research suggests that prime sources of sand are the shoals near Cape Fear and Cape Lookout as well as filled channels found seaward from major inlets in North Carolina and South Carolina (Duane and Stubblefield 1988). Large sand volumes from shoals also exist off Cape Hatteras, but the prevalent hard bottom of the South Carolina and Georgia continental shelves limit sizeable resources (Amato 1994). Along the Atlantic coast, some of these major sand mining and subsequent beach nourishment projects are currently in operation (**Figures 14a-c**) (SAFMC 2009b):

- Nags Head and Wrightsville Beach, North Carolina
- Myrtle Beach and Folly Beach, South Carolina
- Tybee Island, Georgia (material was obtained from the Savannah Harbor deepening project as opposed to offshore deposits)

3.3.5 Subsea Pipelines

While no major submarine cables or pipelines lie within the Study Area, there are a few smaller submarine on land line pipelines in estuaries near Nags Head, Jacksonville, and Wilmington, North Carolina; Myrtle Beach, South Carolina; and Savannah and Brunswick, Georgia.

3.3.6 Onshore Interconnecting Facilities

In order for energy generated by offshore wind power facilities to be useful, they must be able to connect to the onshore power grid. In the states adjacent to the Study Area, there are existing facilities in North Carolina and South Carolina and potential sites in Georgia (Girgis et al. 2010). The existing sites, interconnecting substations, are shown on **Figures 14a** and **14b**. There are no existing interconnecting substations in Georgia. Instead, sites for potential alternative energy facilities that would accompany the development of offshore renewable energy are shown (**Figure 14c**). The sites for South Carolina are approximate.

3.3.7 Shipwrecks

The maritime history of the U.S. southeast coast is associated with natural and anthropogenic disturbances. These disturbances including convergence of strong currents, high winds and seas from hurricanes, and vessel traffic and war (Civil War and World War II [WWII]) are all causes of numerous shipwrecks (**Figures 15a-c**) (Newton et al. 1971). The North Carolina, South Carolina, and Georgia coasts are subjected to hurricanes every fall and strong currents colliding from the Gulf Stream Current flowing north and the Labrador Current flowing south. These two currents collide around Frying Pan Shoals off the coast off Wilmington, North Carolina, and the Diamond Shoals near Cape Hatteras, creating hazardous conditions for mariners (TWP 2006). Frying Pan Shoals has claimed various warships from World War II such as the tanker *ESSO Nashville.* The *Papoose*, *WE Hutton*, and *EM Clark* are other examples of shipwrecks located near Frying Pan Shoals in North Carolina (TWP 2006). The Diamond Shoals extend 17 NM seaward creating hazardous sea conditions for vessel traffic due to their shallow depths (Newton et al. 1971). The Civil War Union battleship, the *USS Monitor*, lies near the Diamond Shoals in 71 m of water, southeast off Cape Hatteras. The *USS Monitor* was designated the first NMS in 1975 (NOAA 2004). Other shipwrecks located near Diamond Shoals are the *SS Liberator* and *Dixie Arrow.* Off the northern end of North Carolina near Nags Head, the *USS Huron* has been designated a Historic Shipwreck Preserve (HSP) in less than a 15-m water depth (AWEX 2006). Some of the shipwrecks date to colonial times, including the first recorded shipwreck along the coast of North Carolina (Beaufort Inlet, Cape Lookout) in the past four centuries, *The Queen Anne's Revenge*. The *Queen Anne's Revenge* is in the only Shipwreck Protected Area in the vicinity. There are over 50 shipwrecks off the coast of North Carolina alone (Veridian Corporation 2001; AUE 2006). Numerous wreckages can be found on the shoals (Diamond, Lookout, and Frying Pan) and capes (Hatteras, Lookout, and Fear) found throughout the North Carolina coast. Off the coast of Charleston, South Carolina there are various Civil War sunken ships (i.e., *Housatonic*, *Palmetto State*, the *Norseman*, the *Stonewall Jackson*, *Raccoon*, *Keokuk*, *Weehawken*, *USS Patapsco*, *HMS Acteon*, and the *Ruby*) (NUMA 2006). Offshore Georgia possesses at least four sunken warships: *CSS Georgia*, *CSS*

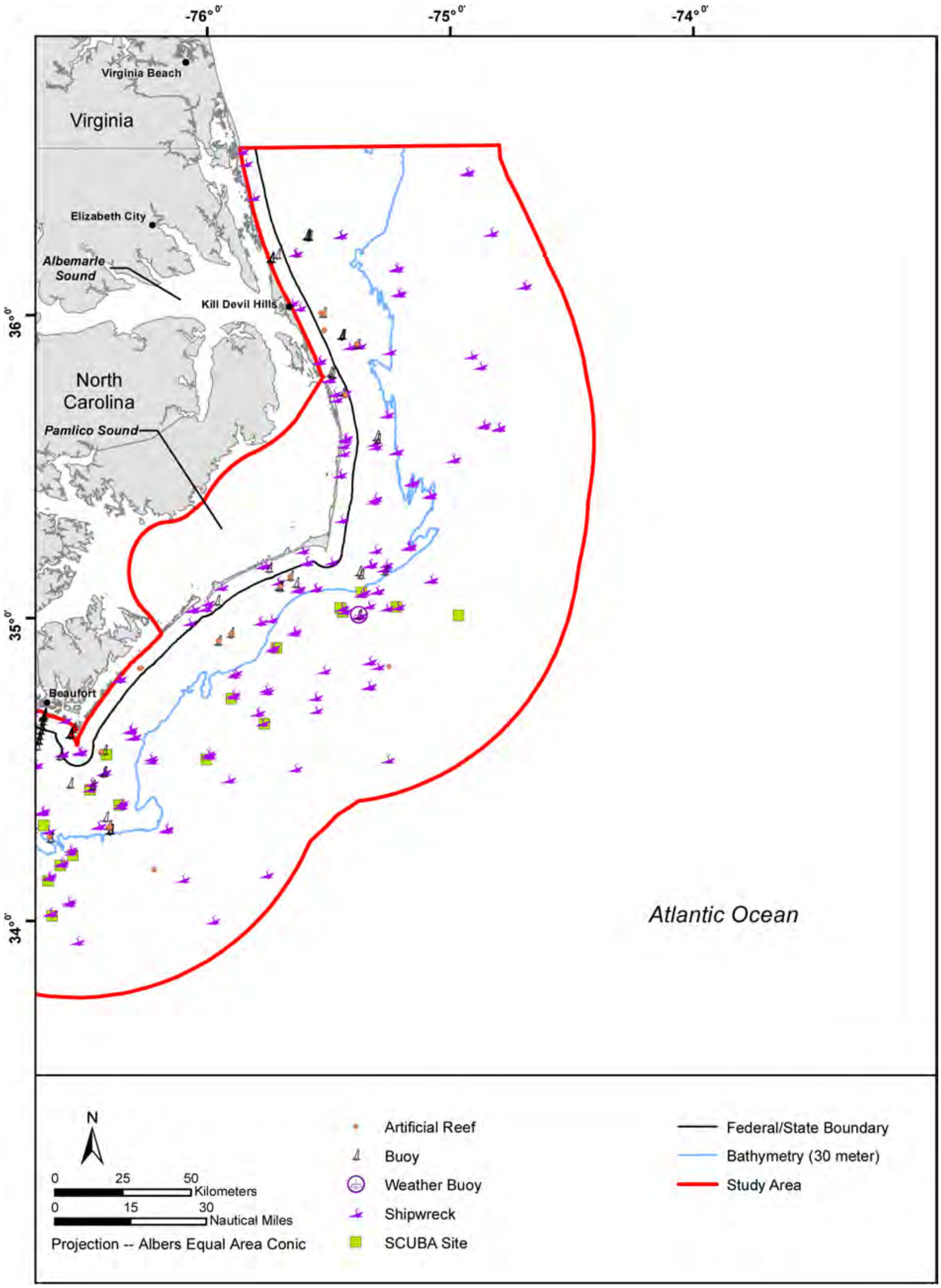

Figure 15a. Artificial reefs, buoys, weather buoys, shipwrecks, and SCUBA sites in the Study Area off North Carolina.

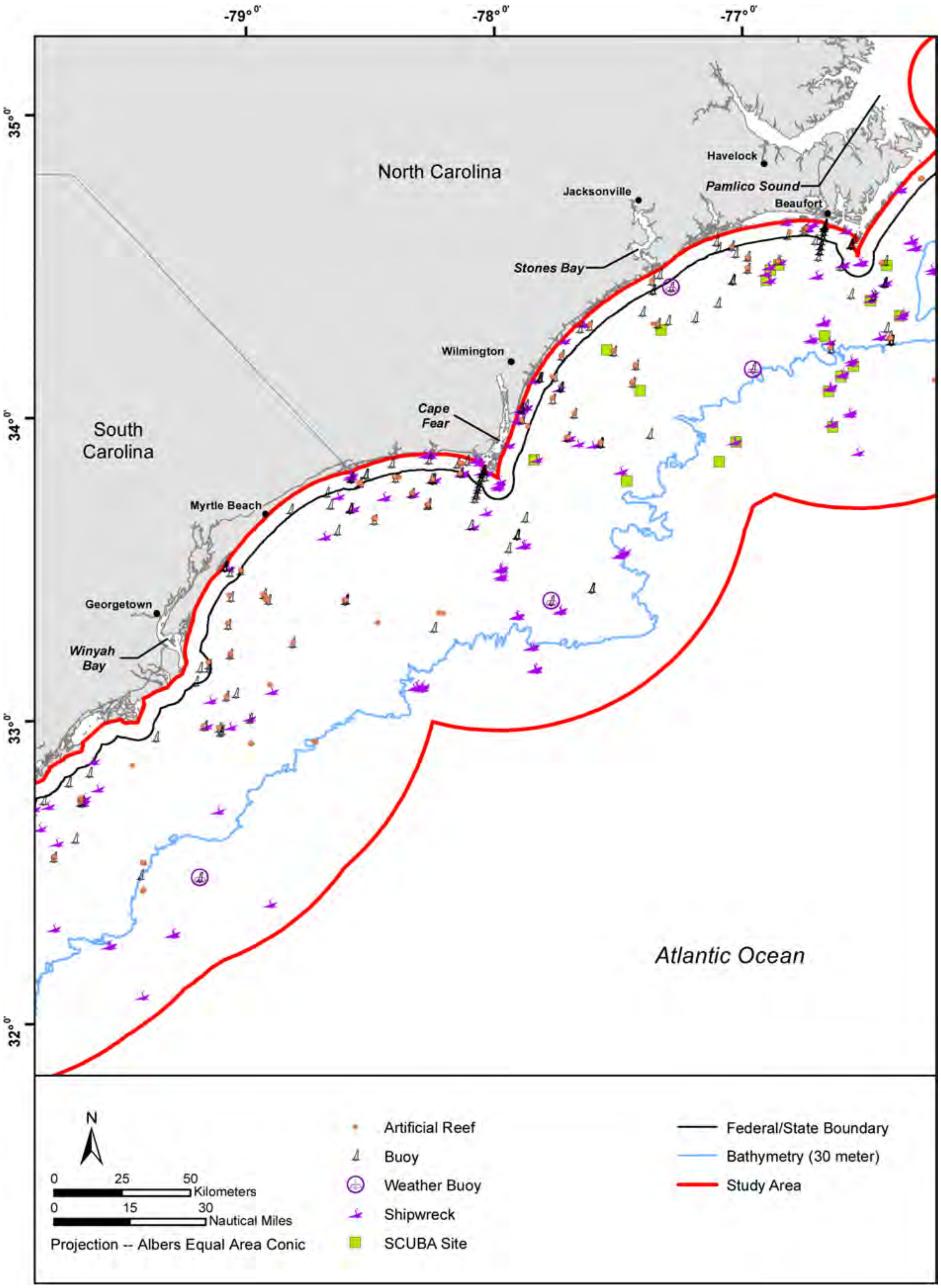

Figure 15b. Artificial reefs, buoys, weather buoys, shipwrecks, and SCUBA sites in the Study Area off North and South Carolina.

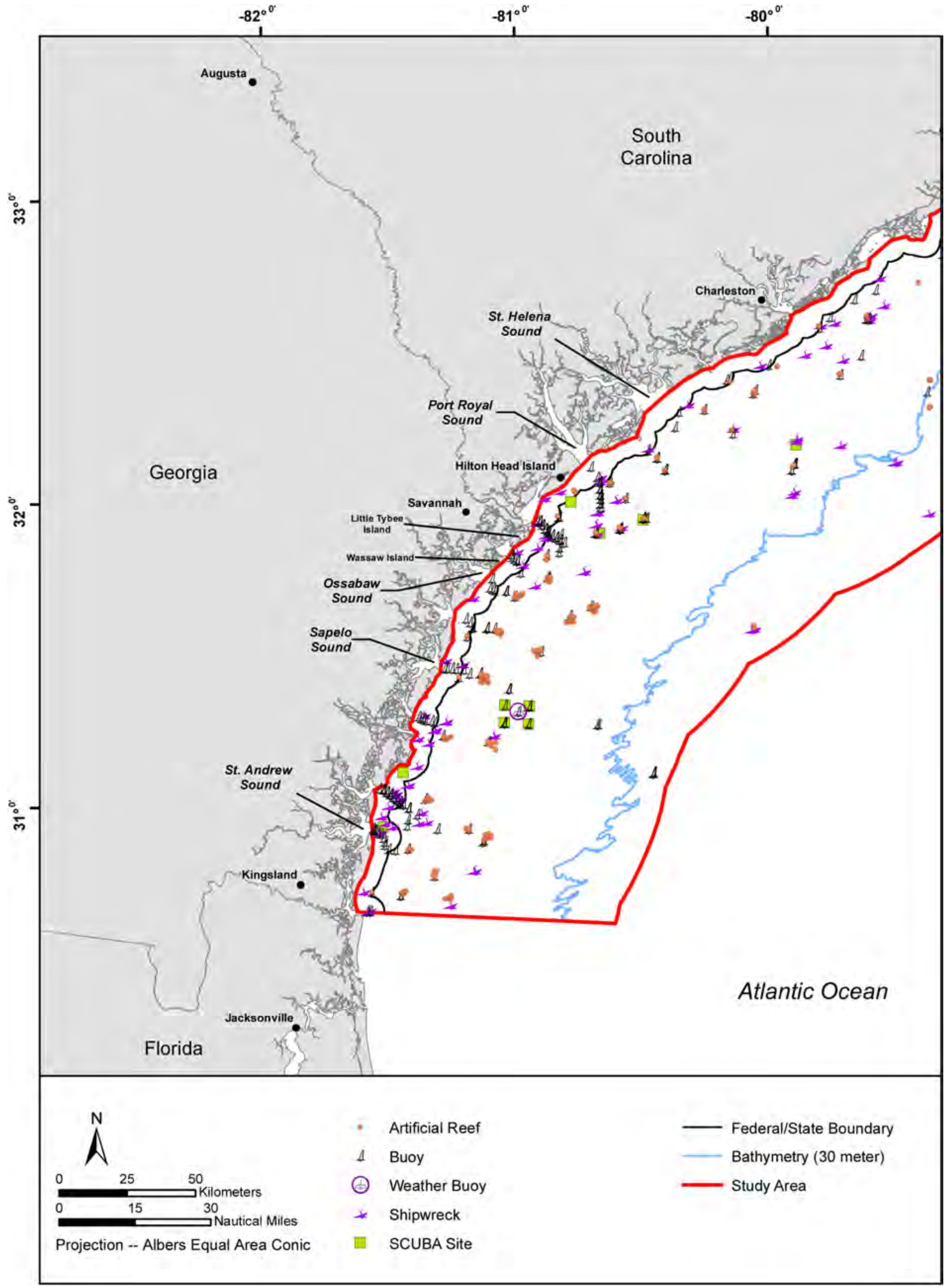

Figure 15c. Artificial reefs, buoys, weather buoys, shipwrecks, and SCUBA sites in the Study Area off South Carolina and Georgia.

Rattlesnake, *SS Republic*, and *USS Water Witch* (GHPD 2006). These wreckages have created artificial hard bottom that has become colonized by sessile organisms (hard and soft corals, sponges, bryozoans, and macroalgae), and wreck fish (black sea bass, gag, and snapper [*Lutjanus* sp.]) essentially creating artificial reefs (NCDMF 2005).

3.3.8 SCUBA Sites

The North Carolina, South Carolina, and Georgia continental shelves contain a vast number of popular sites for both recreational scuba diving and snorkeling (**Figures 15a-c**). Dive sites in the area are typically associated with artificial habitats, such as live hard bottom (i.e., natural reefs), artificial reefs (i.e., reefballs), and shipwrecks. These structures range widely in size, type, and architecture. The entire continental shelf has considerable hard bottom that can support sessile fauna, flora, and demersal species (Jones et al. 1985; Cahoon et al. 1990). Examples of hard bottom substrates within the area include rock outcroppings of mudstone, fossilliferous limestone, sandstone off North Carolina, natural reef (e.g., Gray's Reef off Georgia), limestone outcroppings, and artificial reefs scattered throughout the area (Jones et al. 1985; Riggs et al. 1998; SEAMAP 2001b). Gray's Reef is a NMS located off the coast of Georgia and is 17 NM east of Sapelo Island. Its depth ranges from 18 to 22 m (Sedberry et al. 1998). Its bottom topography consists of low to moderate rock outcroppings and ledges that are situated in a northwest to southwest direction (Hunt 1974; Sedberry et al. 1998). It has an abundant amount of coral and sponge coverage as well as numerous tropical fish species. The artificial reef program in North Carolina supports commercial and recreational fishermen as well as the dive community; diving occurs throughout the year, but the most popular recreational season is during May and June and at depths between 25 and 38 m (Seldon 2004). Many shipwrecks open to recreational diving can be found along the coast and offshore of all three states (**Figures 15a-c**). The offshore waters of North Carolina have some of the most shipwrecks on the east coast due in large part to its three treacherous capes: Cape Hatteras, Cape Lookout, and Cape Fear. A number of shipwrecks are found in Onslow Bay, between Cape Lookout and Cape Fear, and around the point of Cape Fear (AUE 2006). Many divers are also attracted to North Carolina waters because it's a congregating site for sand tiger sharks which are especially abundant around shipwrecks (TDP 2006). Shipwrecks along the Outer Banks in North Carolina, and in particular Nags Head, include sunken WWII-era U-boats, freighters, and liberty ships (OBDC 2006).

3.3.9 Buoys and Weather Stations

There are six oceanographic weather buoys moored and maintained by NOAA's National Data Buoy Center (NDBC) located in or near the coasts of North Carolina (**Figures 15a** and **15b**), South Carolina (**Figures 15b** and **15c**), and Georgia (**Figure 15c**). The weather buoys were established by the NDBC to serve as data gathering sites for the National Weather Service (NWS). The moored oceanographic buoys maintained by the NDBC monitor barometric pressure, wind direction, speed, gusts, air and sea temperatures, and wave energy spectra which allow the calculation of wave height, dominant and average wave period, and in some cases, the direction of wave propagation (NOAA 2002). Off the Georgia coast, the Navy also maintains eight offshore platforms outfitted with observational oceanographic and meteorological equipment that are used for flight training, which are collectively called the South Atlantic Bight Synoptic Offshore Observational Network (SABSOON) (SIO 2006).

4.0 FUTURE CONSIDERATIONS

This siting analysis considers the spatial distribution of the ecological and non-ecological factors that may affect the suitability of certain areas for commercial wind farm development; however, there are myriad other factors that may influence the siting of wind power facilities in the Study Area. This section discusses briefly some examples of those factors that may need to be considered for future planning.

A major consideration for the siting and construction of any offshore wind facility is leasing and permitting. This is a complex process that includes consultation with numerous Federal and state agencies on both non-ecological and ecological aspects of the project area. The Federal leasing process for offshore wind development requires the developer to submit information on the proposed construction activities as well as a review of the environmental factors which may be impacted. Major environmental legislation, including take permitting for T&E species, often requires a quantitative estimate of how many of a given species may be affected by proposed activities. These consultation, planning, and permitting requirements mean that it is critical to have as much current and useful data prior to beginning this process to mitigate potential problems and ensure that the process is completed as efficiently as possible.

In order to make the siting, planning, and construction process go as smoothly as possible, it is essential to recognize data gaps that may slow the permitting process and to anticipate and account for any issues or factors that may affect the Study Area in the foreseeable future. Complete ecological data are critical to fully evaluate potential development sites in the Study Area. This report provides a preliminary gross overview of suitability of the offshore environment by geographically visualizing known areas of high ecological value or areas that are entirely unsuitable based on competing use, logistical constraints, and areas that have already been deemed infeasible. In order to further narrow down and identify suitable areas, a fine-scale evaluation is necessary to fully evaluate the resources present in the Study Area. In addition to the areas evaluated for development, the areas where transmission cables are laid both on the seafloor and at areas where they come onshore should be evaluated. This will help to mitigate or eliminate unnecessary consultations or permitting constraints by ensuring that the data used to evaluate the site are as current and complete as possible.

One of the most important considerations for future work is the availability and coverage of ecological data, especially for species groups that may be impacted by any development. Marine mammals, sea turtles, and birds are important marine resources found in the Study Area; however, the seasonal distribution patterns and abundance estimates of these resources in the Study Area are not well known. Seasonal abundance estimates, in particular, would provide a better assessment of the occurrence of these resources in the Study Area. An ecological baseline study similar to the baseline study conducted off New Jersey in 2008 and 2009 (GMI 2010) and Rhode Island (2009 and 2010) could be conducted to collect the necessary sightings data via dedicated survey effort throughout the Study Area. The sightings data can be used in conjunction with spatially-indexed environmental covariates to generate abundance/density estimates at a fine spatial resolution via spatial modeling (Thomas et al. 2010). These data provide regulators with the information they need to evaluate the potential impact of any development project and allow the developers to comply with relevant environmental legislation such as the ESA.

When considering future planning efforts for offshore wind development in the Study Area, it is important to anticipate management actions that have been proposed. Although they are not law yet, there are several pending actions that could affect the Study Area in the near future.

For example, the Federal NMFS has decided that there is substantial scientific information to support a revision of the 1994 critical habitat designation for the North Atlantic right whale (NMFS 2010b). A proposed critical habitat rule will likely be submitted to the Federal Register in 2011 and will include expanding the critical habitat for the calving and feeding grounds and adding critical habitat for the mid-Atlantic migratory corridor (NMFS 2010b). This area of critical habitat could include much of the Study Area and may influence the way that any offshore construction is permitted or carried out. Similarly, the SAFMC is expected to undertake a five year review of its existing EFH areas that may alter or expand current EFH. There are also several species that are being considered for protected species status under the ESA, including the Atlantic sturgeon, Atlantic bluefin tuna, and Red Knot (NMFS 2010d, 2010e). Once these species are listed under the ESA, they will have to be more closely considered during the siting and planning process.

Finally an important factor in determining where to develop offshore wind facilities is the likelihood that it will impact or affect an existing use. As of March 2010, the offshore areas of the mid- and Southeast Atlantic coasts were opened to oil and gas exploration; however, the area has been excluded from leasing activities until 2017. There are numerous commercial fisheries, both foreign and domestic, that operate in these waters and that fall under a variety of jurisdictions. Federal and state protected areas exist in numerous coastal and offshore areas along the eastern seaboard, often with varying levels of permissible use. Recreational uses such as SCUBA diving and charter fishing are often very economically valuable to coastal states and must be evaluated during the consultation process. There are large swaths of the offshore environment on the U.S. east coast that are military OPAREAs that also must be considered. Finally, each state adjacent to the Study Area has the right to evaluate any use of its offshore environment (in either state or Federal waters) that may impact its coastal zone.

The spatial distribution of ecological and non-ecological factors that may influence the siting of offshore wind facilities is a valuable starting point for evaluating potentially suitable areas; however, the process of planning and permitting for offshore development is complicated and relies upon having current data and a thorough understanding of the resources that may be influenced by an offshore wind facility. An anticipatory approach to data collection and site evaluation will help to streamline the planning and permitting process, which will ideally increase efficiency and reduce overall costs.

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