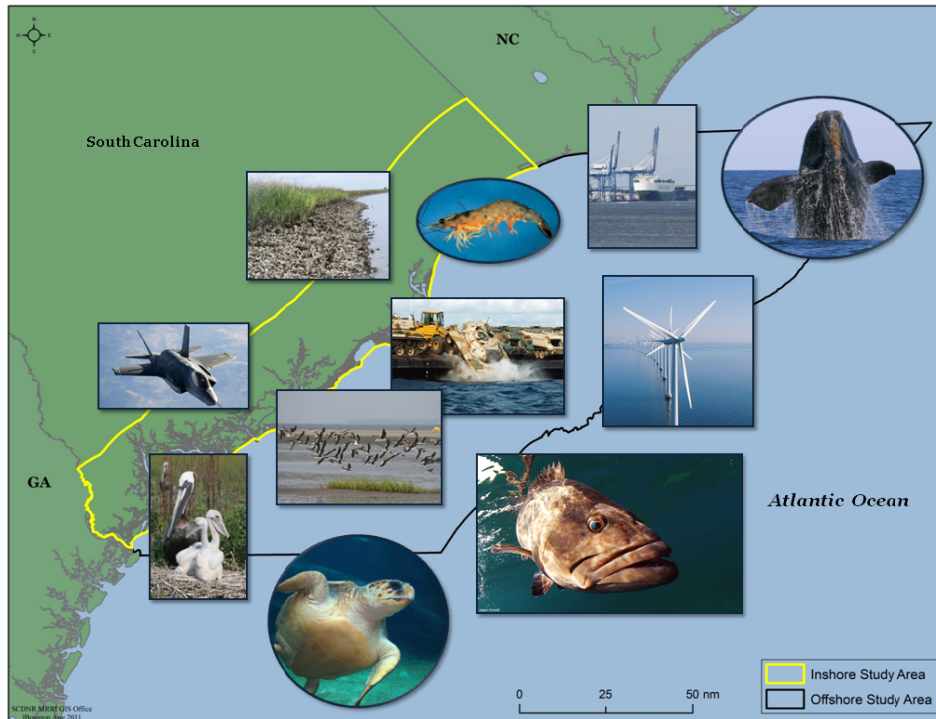


Final Report

A Comprehensive Spatial Mapping Effort of South Carolina's Coastal Resources and Activities



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Introduction:

In 2008, the South Carolina Energy Office received a grant from the U.S. Department of Energy: *South Carolina Roadmap to Gigawatt-Scale Coastal Clean Energy Generation: Transmission, Regulation & Demonstration*. This grant had several cooperative partners to address four major tasks that included 1) an offshore wind transmission study, 2) a wind, wave, and current study, and 3) the creation of a Regulatory Task Force (RTF) for Coastal Clean Energy. This Task Force, which is comprised of the full spectrum of state and federal regulatory and resource protection agencies, universities, private industry and utility companies, has accomplished many activities including developing recommendations for baseline environmental research needs and identifying the need for a comprehensive spatial database on existing resources and activities. Such a database can serve as the precursor for a comprehensive marine spatial planning effort for the state's waters and beyond, but it is critically needed for use in evaluating potential wind energy projects that may be proposed in either state or federal waters off South Carolina. Funds remaining in the above grant were therefore obligated to develop a Geographic Information System (GIS) framework that would provide relevant spatial datasets related to resources and resource use in South Carolina's coastal zone from approximately 30 miles inland to the 200 m depth contour offshore and between the 32° and 34° latitudes. These latitudes fall outside of the state's boundaries, but represent ocean bottom areas that may be relevant to wind energy development.

Specific objectives were to:

- Compile the latest updated spatial data and metadata already available from the SCDNR and other agencies for distribution over the internet.
- Compile and synthesize significant databases maintained by the SCDNR and other agencies on various biological resources, including important fishery species, bottom fauna, sea turtle nesting and coastal juvenile distribution, bird nesting habitats, and marine mammal distribution.
- Compile and synthesize information available from the SCDNR and other agencies on various habitats and habitat features such as wind patterns, bottom habitat characteristics, bathymetry and navigation charts, land cover including protected lands and significant resources such as wetlands and oyster reef habitats, and hydrography.
- Compile and synthesize information available from the SCDNR and other agencies on various uses and protected area of the coastal ocean area, including military restriction zones, shipping activities and routes, sand borrow site locations, ocean disposal area locations, artificial reef zones, areas of commercial fishery activities based on landings, shipwrecks, and various jurisdictional boundaries such as Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) lease blocks, state-federal boundary, etc.
- Upload a zipped file to the SCDNR's web site of all data layers compiled or created in the above objectives that can be downloaded by external agencies and interested entities.
- Work with GIS experts to explore ways that the data could be displayed over the web using an existing framework or one to be developed.

Methods:

The Regulatory Task Force met in September, 2010 to discuss and prioritize existing GIS data layers that could potentially be compiled and analyzed within the time and funding available. These data layers are summarized in Table 1, along with a rating of priority identified by the RTF and probable data source(s).

Many of these data layers and associated metadata already existed either within SCDNR or other state and federal agency databases that were accessible electronically. Other data that were not already available in spatially explicit files (e.g. SCDNR's MARMAP, SEAMAP, Coastal Sea Turtle Surveys, nesting locations), were analyzed and synthesized into GIS files. Project staff worked with experts associated with each of these databases to identify the best format to summarize and display the data. Since fishery and other biological resources are known to vary both temporally and spatially, most of the biological and bottom habitat data were summarized into ocean blocks equal to 1 minute latitude x 1 minute longitude (Figure 1). Some of the data sources were not available for compilation within that scale and a larger block size was used.

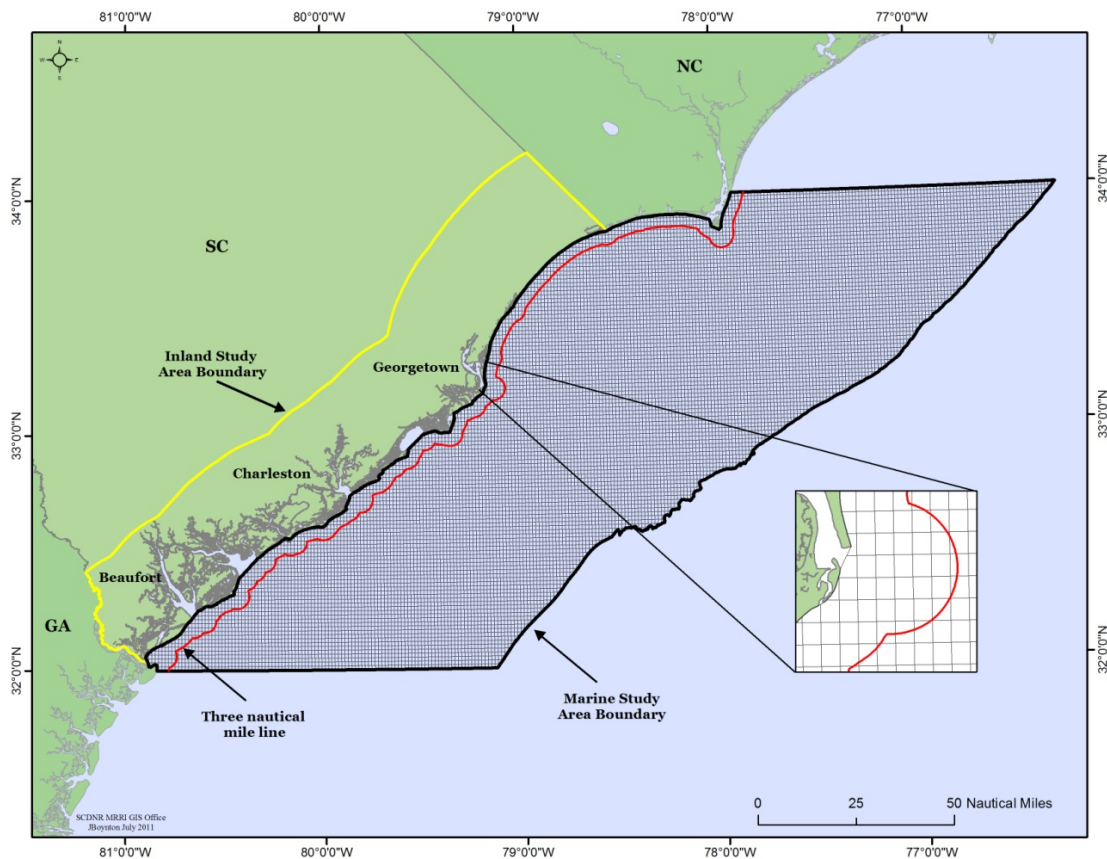


Figure 1. Summary of study area and 1 minute x 1 minute grid cell system used to summarize many of the data layers.

For example, whale survey experts recommended summarization of their whale sighting data into 5 minute x 5 minute blocks due to the rare nature of sightings. Similarly, commercial fishery landings data could only be summarized in 1 degree latitude and longitude blocks since that was the only reporting information required by the National Marine Fisheries Service (NMFS). Additionally, state shrimp landings data are only reported based on a general location along the coast.

For biological resource surveys, program staff agreed that the most valuable dataset would be the most recent five year period, especially for long-term monitoring programs such as SCDNR's MARMAP and SEAMAP programs. These programs have sampling surveys dating back more than 20 years.

Not all of the data layers identified in Table 1 could be developed and compiled in the limited time frame and funding available. Data on avian migration routes and whale critical habitats were not available for the area off South Carolina's coast, updated flood maps were only available for one coastal county, and there is no officially designated shoreline since shorelines change frequently due to erosion or accretion. Electric grid data were not included due to the proprietary nature of those data, and the existing GIS file available on the web is very generalized and dated. The exact location of several ocean outfalls in the Grand Strand area were not available from OCRM and some nearshore coring data that has been collected by the USACE were not available in time for inclusion in this project.

A brief description of each dataset is provided in the following sections to summarize the data source and how the data were analyzed if analyses were required. More complete information is available in the metadata files provided for each dataset and data layers.

Table 1. Summary of the datasets evaluated for this project. Datasets that are not shaded were successfully compiled or developed and are available through the SCDNR web site. Many of the datasets include multiple data layers. Datasets shaded in grey represent information project personnel were unable to obtain in the project timeframe.

<u>Dataset</u>	<u>Source of Dataset</u>	<u>Priority</u>	<u>Data Use</u>
Biological Resources			
Seabird Colonies	SCDNR-Wildlife & Freshwater Fisheries	High	Transmission construction
Benthic Fauna	SCDNR-MRD, NOAA, Coastal Science Association	Low	Platform/transmission construction
Offshore Fisheries (MARMAP): Bank sea bass, black sea bass, gag, grey triggerfish, knobbed porgy, red grouper, red snapper, sand perch, scamp, scup, spottail pinfish, spotted moray eel, tomtate, vermilion snapper, white grunt	SCDNR-MRD	Moderate	Platform construction/operation
Nearshore Fisheries (SEAMAP): Atlantic croaker, bluefish, brown shrimp, Atlantic sharpnose shark, southern kingfish, spot, weakfish, white shrimp	SCDNR-MRD	Moderate	Platform construction/operation
North Atlantic Right Whale	NARWC	Moderate	Platform construction/operation
Sea Turtle Nesting sites	SCDNR-MRD	High	Transmission construction
Sea Turtle In-water	SCDNR-MRD	Moderate	Platform construction/operation
Sea Turtle (SEAMAP)	SCDNR-MRD	Moderate	Platform construction/operation
SC Live and Washed shell Oyster beds	SCDNR-MRD	High	Transmission construction
Seabird/sea duck data	USFWS (unable to obtain within time frame of project)	High	Platform operation
Avian migration routes	Unable to obtain within time frame of project	High	Platform operation
Avian distributions	Unable to obtain within time frame of project	High	Platform operation
Whale critical habitat map	TNC: Excluded due to low resolution	High	Platform construction/operation
Habitat Resources			
Ocean sediment	Multiple sources	High	Platform/transmission construction
Bottom mapping (SEAMAP)	SCDNR, FL Fish and Wildlife Conservation Commission	High	Platform/transmission construction
Modern sediment thickness	USGS	High	Platform/transmission construction
Salamander critical habitat	USFWS	Moderate	Transmission construction
Piping plover overwintering critical habitat	USFWS	High	Transmission construction
Marine protected areas (MPAs)	NOAA	High	Platform construction/operation
Protected Lands	SCDNR; USGS; FWS	High	Transmission construction/operation
Land cover C-CAP 2006	NOAA's Coastal Services Center	Low	Transmission construction
National hydrography dataset (NHD) area	USGS	Moderate	Transmission construction
National hydrography dataset (NHD) flowline	USGS	Moderate	Transmission construction
Bathymetric contours	NOAA	High	Platform construction and transmission
Wind Power: 30, 50, 100 m above sea level	South Carolina Energy Office	High	Platform construction/operation
Wind Speed: 50, 70, 100 m above sea level	South Carolina Energy Office	High	Platform construction/operation
USDA NAIP 2009 1 meter color imagery	USDA	Low	Transmission construction
LIDAR (elevation)	SCDNR	Low	Transmission construction/operation
Wetlands	Available as part of the C-CAP land cover dataset	High	Transmission construction
Flood Maps	Deemed unnecessary	Low	Transmission construction/operation
Shoreline	No official shoreline exists	Low	Transmission construction
Nearshore bottom mapping data	Unable to obtain within time frame of the project	High	Platform/transmission construction
Nearshore coring data	Unable to obtain within time frame of the project	High	Platform/transmission construction
Human Use Resources			
Three mile line	NOAA	High	Platform and transmission construction/operation
Contiguous line	NOAA	High	Platform and transmission construction/operation
Territorial line	NOAA	High	Platform and transmission construction/operation
Outer Continental Shelf (OCS) lease blocks	BOEMRE	High	Platform and transmission construction/operation
8g line	BOEMRE	High	Platform and transmission construction/operation
Shellfish permit boundaries	SCDNR-MRD	High	Platform construction/operation
Aviation airspace	FAA, Military, SCDNR-MRD	High	Platform and transmission construction/operation
Department of Defense (DoD) operation areas	FAA, Military, SCDNR-MRD	High	Platform and transmission construction/operation
Marine Corps Air Station (MCAS) Radar site	FAA, Military, SCDNR-MRD	High	Platform and transmission construction/operation
Military Installations	FAA, Military, SCDNR-MRD	High	Platform and transmission construction/operation
Military Operation Areas	FAA, Military, SCDNR-MRD	High	Platform and transmission construction/operation
Training Routes	FAA, Military, SCDNR-MRD	High	Platform and transmission construction/operation
Warning Areas	BOEMRE, FAA, Military, SCDNR-MRD	High	Platform and transmission construction/operation
Navigational charts	NOAA	High	Platform and transmission
AIS shipping	NOAA's Coastal Services Center	High	Platform and transmission construction/operation
CESAC Channels	US Army Corps of Engineers	High	Platform and transmission construction/operation
National waterways	US Army Corps of Engineers	High	Platform and transmission construction/operation
Jetties	SCDNR-MRD	High	Platform and transmission construction/operation
Marines, piers, docks, boat ramps, bridges, causeways	SCDHEC; OCRM	Low	Platform construction/operation
Artificial reef zones	SCDNR-MRD	High	Platform/transmission construction
Finfish harvest	Atlantic Coastal Cooperative Statistics Program; SCDNR	Moderate	Platform construction/operation
Shrimp trawling locations	SCDNR-MRD	Low	Platform and transmission construction/operation
Ocean dredged material disposal sites (ODMDS)	US Army Corps of Engineers	High	Platform and transmission construction
Shipwreck and obstructions	NOAA, NOS, OCS	High	Platform and transmission construction
Sand borrow sites	SCDNR-MRD, Coastal Science and Engineering	High	Platform and transmission construction
Archeology	Unable to obtain within time frame of the project	High	Platform construction
Electric grid and substation	High resolution electric grid unavailable	High	Transmission construction/operation

Biological Resource Information:

Deep Water Finfish Data:

The Marine Resources Research Institute (MRRI) at the South Carolina Department of Natural Resources (SCDNR) has conducted fisheries-independent research on groundfish, reef fish, ichthyoplankton, and coastal pelagic fishes within the region between Cape Lookout, North Carolina, and Ft Pierce, Florida for over 30 years through the Marine Resources Monitoring, Assessment and Prediction (MARMAP) program. The overall mission of the program has been to determine distribution, relative abundance, and critical habitat of economically and ecologically important fishes of the South Atlantic Bight (SAB), and to relate these features to environmental factors and exploitation activities. While the research and monitoring conducted by this program has varied over the years, the fishery-independent chevron trap survey of reef fish is the most important dataset with respect to the distribution of commercially and recreationally important species in depths ranging from 14-94 m. Details of the specific sampling methodology and gear characteristics are provided in the metadata.

While many bottom fish species have been collected by this program, the following reef fish were considered by MARMAP staff to be the most abundant and relevant species to summarize distribution and relative abundance: bank sea bass, black sea bass, gag grouper, grey triggerfish, knobbed porgy, red grouper, red porgy, red snapper, sand perch, scamp, scup, spottail pinfish, spotted moray eel, tomtate, vermilion snapper, and white grunt. For any given species, a mean catch per unit effort (CPUE) was calculated using data from all traps sampled within a 1 x 1 minute grid of latitude and longitude within the most recent five-year time frame (2006-2010). All catches used in the calculations were from traps that were soaked between 45 and 150 minutes. CPUE was calculated as the number of a selected species present per trap per hour of soak time. The number of traps, the percent occurrence (the number of positive traps divided by the number of available traps), and coefficient of variance for CPUE were calculated for each 1 x 1 minute grid cell.

The layer (.lyr) files developed for the MARMAP data summarize the relative abundance of each species in every 1 x 1 minute grid cell where that species was collected as follows: Those grid cells where the mean CPUE of a species was high ($> 75^{\text{th}}$ numeric percentile of all grid cell CPUE values observed within the South Carolina study area) were coded as red. Grid cells where the mean CPUE values of a species were moderate ($\geq 25^{\text{th}}$ and $\leq 75^{\text{th}}$ numerical percentile of all CPUE values observed within the South Carolina study area) were coded as yellow, and grid cells where the mean CPUE values of a species were low ($< 25^{\text{th}}$ numerical percentile of all CPUE values observed within the South Carolina study area) were coded as green. An example of the distribution observed for black sea bass within the 1 x 1 minute grid cells where this species was captured is shown in Figure 3.

Shallow Water Finfish Data:

The Southeast Area Monitoring and Assessment Program (SEAMAP) - South Atlantic Coastal Survey, which is funded by the National Marine Fisheries Service (NMFS) represents another long-term fishery independent monitoring program that has been conducted by the South Carolina Department of Natural Resources - Marine Resources Division (SCDNR-MRD) since 1986. Only the most abundant finfish and crustacean species collected by this program were summarized for the shallow water finfish data layers. These species include: Atlantic croaker, Atlantic sharpnose shark, bluefish, southern kingfish, spot, weakfish, white shrimp, and brown shrimp.

SEAMAP provides the only existing long-term fishery independent survey program in coastal waters (30 to 60 ft depth) off the Atlantic coast of the southeastern United States that primarily targets sand bottom finfish and crustacean communities. Field sampling is conducted seasonally: spring (April-May), summer (July-August), and fall (October-November) in established strata

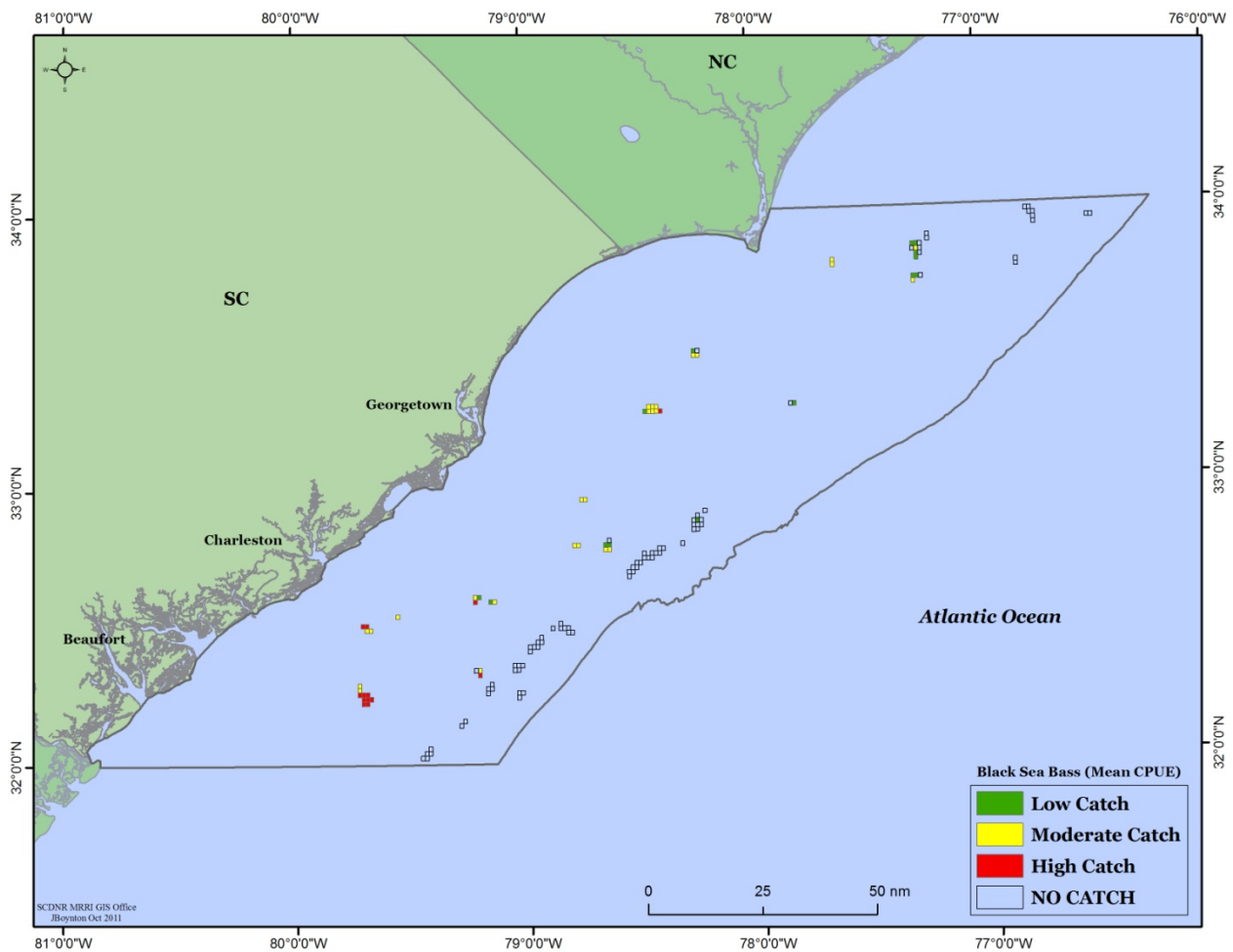


Figure 3. Example of MARMAP data summary of the relative abundance and distribution of black sea bass in deeper waters of the study area.

between Cape Hatteras, North Carolina (35° 13.2'N) and Cape Canaveral, Florida (28° 30.0'N). One hundred and twelve stations in a band delineated by 4.6 and 9.1 meter contours are sampled each season. Stations are allocated to strata according to results of an Optimal Allocation Analysis. Sampling is conducted during daylight hours. Operations at each site include collections with paired 22.9 m mongoose-type Falcon trawls with tickler chains towed for 20 minutes (bottom time) from the R/V Lady Lisa, a 22.9 m St. Augustine shrimp trawler. Nets do not contain TED's or BRD's so that density estimates for all sizes of each species can be calculated, and to maintain comparability with previous survey data. A total of 102 stations were sampled in 2006-2008 (306 stations/year) and 112 stations were sampled in 2009-2010 (336 total).

For each of the dominant species identified above, a mean catch per unit effort (CPUE) was calculated using data from all trawls sampled within a 1 x 1 minute grid of latitude and longitude within the most recent five-year time frame (2006-2010). Mean catch per unit effort within a 1 x 1 minute (latitude and longitude) grid was determined by calculating the number of fish of a specific species caught per net, divided by the total number of nets deployed. Coefficient of variance for the catch per unit effort was determined by dividing the standard deviation of the catch per unit effort by the total catch per unit effort.

The layer files developed for the SEAMAP data summarize the relative abundance of each species in every 1 x 1 minute grid cell where that species was collected as follows: Those grid cells where the mean CPUE of a species was high ($> 75^{\text{th}}$ numeric percentile of all grid cell CPUE values observed within the South Carolina study area) were coded as red. Grid cells where the mean CPUE of a species was moderate ($\geq 25^{\text{th}}$ and $\leq 75^{\text{th}}$ numerical percentile of all CPUE values observed within the South Carolina study area) were coded as yellow, and grid cells where the mean CPUE of a species was low ($< 25^{\text{th}}$ numerical percentile of all CPUE values observed within the South Carolina study area) were coded as green. An example of the distribution observed for Atlantic croaker within the 1 x 1 minute grid cells where this species was captured is shown in Figure 4.

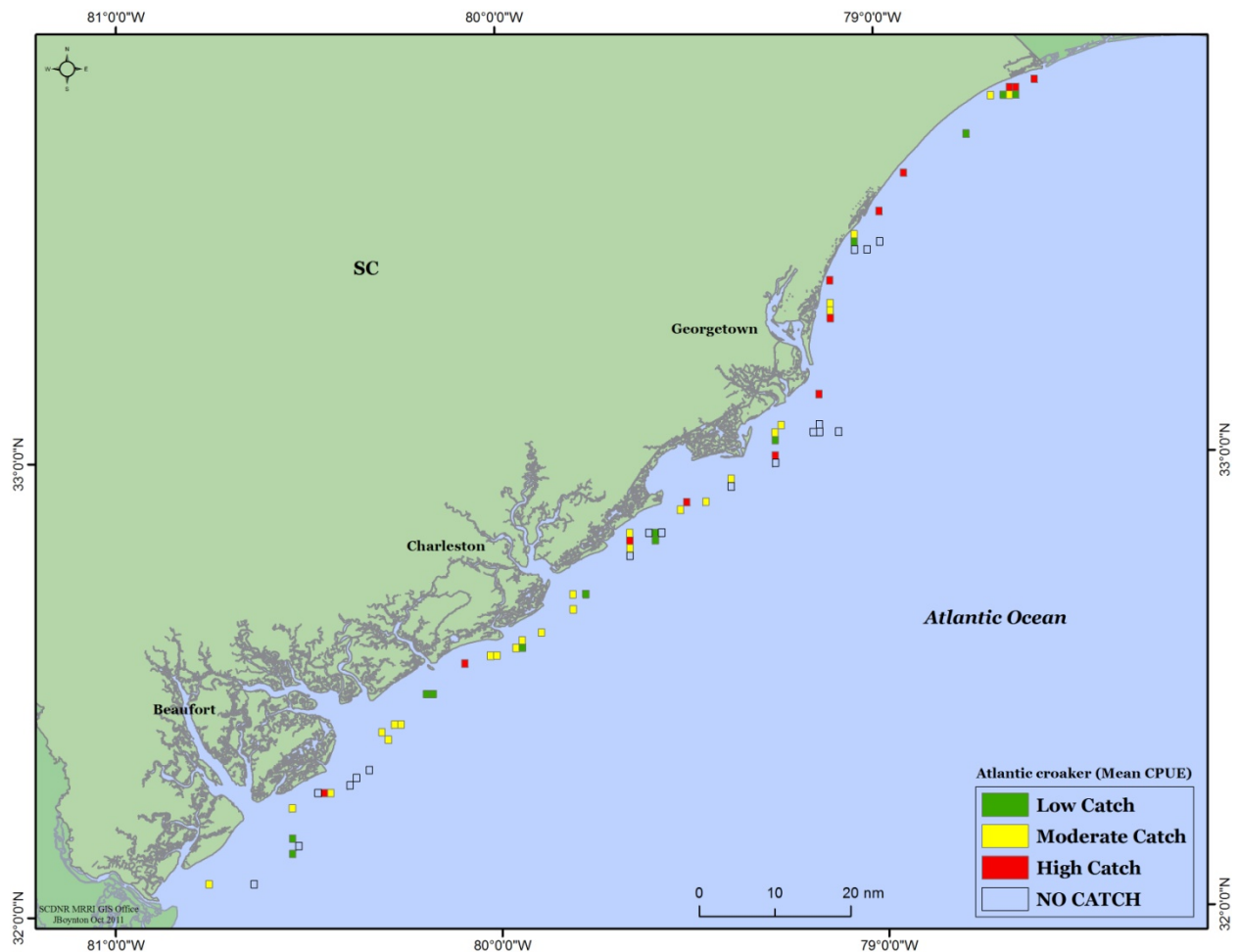


Figure 4. Example of SEAMAP data summary of the relative abundance and distribution of Atlantic croaker in shallower waters of the study area.

Marine Mammal Data:

Marine mammals are of particular concern related to adverse impacts from offshore activities, especially for the endangered North Atlantic right whale (*Eubalaena glacialis*). Right whales have been surveyed by the North Atlantic Right Whale (NARW) Consortium for many years, but only the data collected and provided by the NARW between November and April from 2002-2010 were included in this project. These months were chosen because right whales were rarely or never observed at other times of the year. The longer time period was used (compared to other data sets that were limited to the most recent five years) due to the rare occurrence of this species. Additionally, the scarcity of sightings for this endangered species was not conducive to summarizing the data in 1 x 1 minute grid cells as was done for other data sets. Rather, the data are presented in 5 x 5 minute latitude and longitude grid cells based on the recommendations of NARW experts. The data layer shows the sighting per unit effort (SPUE) of the North Atlantic

right whale in units of 1000 km of valid survey track, which is the effort-adjusted relative abundance index. All sightings came from aerial surveys conducted in sea states of Beaufort 3

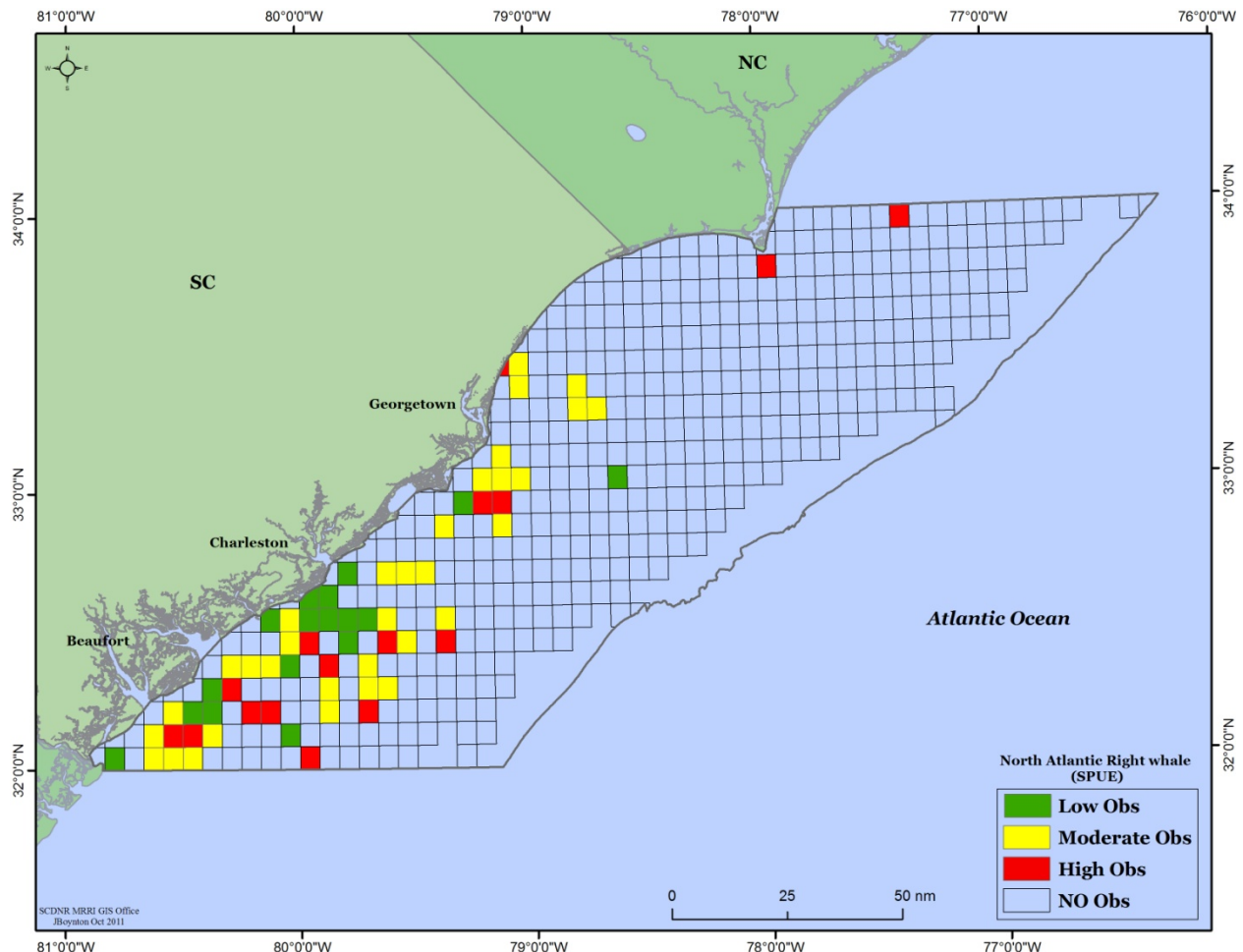


Figure 5. Example of the relative abundance and distribution of North American right whale sightings in the study area.

or lower, with visibility at least two nautical miles, at least one observer on watch, and at altitudes less than 1,200 ft. The spatial data layers summarized the relative abundance of whales sighted over the entire time frame. The layer file developed for the NARW data summarized the relative abundance of each species in every 5 x 5 minute grid cell where that species was observed as follows: grid cells where the whale sightings were relatively high ($> 75^{\text{th}}$ numeric percentile of all whale sightings observed per grid cell within the South Carolina study area) were coded as red. Grid cells where whale sightings were moderate ($\geq 25^{\text{th}}$ and $\leq 75^{\text{th}}$ numerical percentile of all whale sightings per grid cell within the South Carolina study area) were coded as yellow, and grid cells where whale sightings were low ($< 25^{\text{th}}$ numerical percentile of all whale sightings per grid cell within the South Carolina study area) were coded as green. A summary of the whale sightings data is provided in Figure 5. SCDNR personnel were unable to obtain any

other mammal distribution data for South Carolina waters, including counts of dolphins, which are common in SC coastal waters, and manatees, which only rarely occur in SC coastal waters.

Sea Turtle Data:

Loggerhead sea turtles (*Caretta caretta*) have been thoroughly monitored in the southeastern region, both in terms of monitoring nesting density and sampling for juvenile loggerhead turtles in shallow coastal waters. All sea turtle species are globally listed as threatened or endangered species. The loggerhead sea turtle was listed as a "threatened" species in 1978, and since 2008 a debate has ensued regarding whether or not to re-list this species as "endangered" in the NW Atlantic Basin (where the second largest rookery in the world occurs). Advocates of the listing change tout regional declines in nesting data since the late 1990's; however, because sea turtles require approximately 30 years to mature, a greater utility of nesting data is for looking backwards rather than forwards in time. In contrast, in-water surveys collect a wide range of turtle sizes/ages, and therefore provide highly valuable data for gauging potential recruitment of mature individuals into populations.

Sea Turtle Nesting Locations:

The South Carolina Department of Natural Resources (SCDNR) has been monitoring sea turtle nests since the 1970's and authorizes trained participants to survey beaches to locate sea turtle nests. They also relocate nests when necessary, protect nests with predator-proof screening, monitor nests during incubation, and inventory nests after they emerge to determine hatch success. Nest protection project participants include individuals that belong to conservation organizations, federal, state, or local agencies, and universities. All nests are verified by the presence of eggs or hatching activity. Standardized ground surveys are conducted daily starting in May. Participants are required to collect data on all nests including the species of turtle that laid the nest, date laid, and other management information. Additional information can be found at <http://www.seaturtle.org/nestdb/index.shtml?view=2>. All nests reported for this dataset were laid by loggerheads (*Caretta caretta*) between 2001 and 2010. This dataset does not include information for all turtle nesting areas on the coast. Turtles nest on all SC beaches, but only surveys that were completed for at least three years were mapped and used to calculate average annual nest densities. There are five beaches in this dataset that have less than 10 years of data. Waties, Daufuskie and Bull Islands had projects from 2007 to 2010 only. In 2005, South Island daily surveys did not continue through the end of the nesting season. Pritchards Island had a project from 2001 to 2008 only. Two beaches (North Myrtle Beach and Garden City) were not included in the dataset because they were only surveyed in 2010. The remaining 11 beaches not included in this dataset have had partial surveys, but haven't had any completed annual nest surveys. These 11 include: the city of Myrtle Beach, Surfside Beach, North Is., Sand Is., Capers Is., Morris Is., Interlude Beach, Otter Is., Little Capers Is., St. Phillips Is., and Bay Point Island. Nesting data is reported as mean annual density (nest count/length of beach surveyed that year) for each beach and averaged from 2001 to 2010. The length of the beach surveyed varied slightly

over the years, so the length of the beach drawn represents the approximate longest extent of the survey based on beach size in the 2006 imagery.

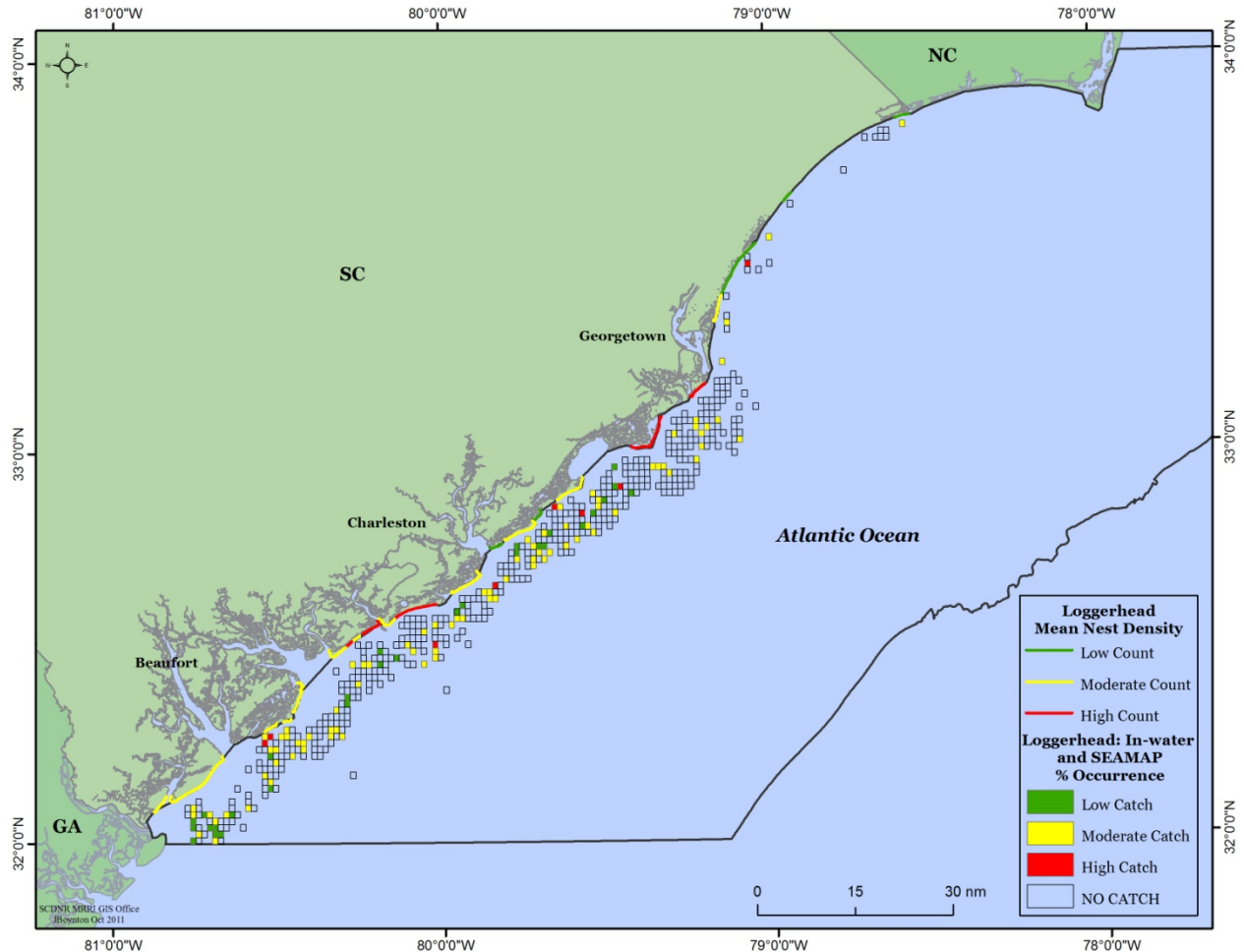


Figure 6. Example of the data summary of the relative abundance (#nests/km) and distribution of loggerhead sea turtle nests along the South Carolina coastline, and juvenile loggerhead sea turtles caught by trawl in the In-Water Sea Turtle Surveys and SEAMAP Trawl Surveys.

The relative abundance of sea turtle nests on the various beaches surveyed have been summarized in the GIS layer files to represent turtle nest densities/km of beach. Those beaches where loggerhead turtle nest densities were relatively high ($> 75^{\text{th}}$ numeric percentile of all beach nesting densities along the South Carolina coastline) were coded as red. Beaches with moderate nest densities ($\geq 25^{\text{th}}$ and $\leq 75^{\text{th}}$ numerical percentile of all beach nesting densities along the South Carolina coastline) were coded as yellow, and beaches where turtle nest densities were relatively low ($< 25^{\text{th}}$ numerical percentile of all beach nesting densities along the South Carolina coastline) were coded as green Figure 6.

Coastal Sea Turtle Trawl Surveys:

The Marine Resources Division of the SCDNR manages a regional trawl survey to assess the relative abundance, distribution, health and demographics of sea turtles. This research endeavor has been funded by the National Marine Fisheries Service via four awards since FY99. The survey is carried out through numerous regional partnerships, notably the University of Georgia Marine Extension Service which conducts trawling aboard their R/V Georgia Bulldog south of the SC/GA border. Trawling off SC is conducted by SCDNR's R/V Lady Lisa. Data have been collected in five phases since inception, but the data summarized for the in-water turtle trawl surveys are limited to the most recent regional trawl surveys conducted from 2008-2010.

Sampling during the previous two years (to create a five year database consistent with many of the other biological data layers) did not include the standardized regional survey. Further, only the sub-set of data collected within the project area for this GIS analysis was included, even though the survey extends into northern Florida. Overall results from the regional trawl survey indicate that 94% of the sea turtles collected are loggerheads (*Caretta caretta*), with Kemp's ridley (*Lepidochelys kempfi*) and Green turtles (*Chelonia mydas*) representing the remaining five and one percent of sea turtle catch, respectively.

Trawling was conducted using NMFS Turtle nets: paired 18.3 m (head rope), 4-seam, 4-legged, 2-bridle nets. Net body consisted of 10.2 cm bar and 20.3 cm stretch mesh, with top's and sides made of #36 twisted nylon and bottom consisting of #84 braided nylon twine. Trawl bottom time was 20 min in 2008-2010 at a target vessel towing speed of 2.8 kts. At the beginning of each annual sampling season, stations were randomly selected from a sampling universe representing the center of 3.4 km² grids of trawl-able bottom in water depths 4.5 to 17.5 m deep. Six research cruises were completed each year with weekly alternation north and south of the vessel homeport (Charleston, SC). Aboard each vessel, daily station sampling order was selected to enable net latitudinal progress while alternating between stations located closer and further from shore in order to diversify longitudinal sampling with respect to time of day and tide stage. In 2008 and 2009, trawling was conducted throughout the SC coast between the SC/GA border and Winyah Bay, SC. (Note: 42 trawling events during sampling at "hot spots" during 12-15 August 2008 were excluded due to the non-random nature of that sampling). In 2010, trawling was only conducted between the SC/GA boarder and Pritchard's Island (SEAMAP strata 41-42) and between the Charleston, SC shipping channel and Bulls Bay (SEAMAP strata 47-48) in order to conduct repeat sampling at randomly selected stations to evaluate sampling design. One thousand five hundred forty-two trawl collections were retained after excluding for years prior to 2008 and the August 2008 "hot spot" sampling. The start latitude and longitude of each trawl were used to assign it to a 1' x 1' grid cell, which resulted in the assignment of these data to 450 SEAMAP blocks. One hundred sixty-four sea turtles were collected during 512 (35%) sampling events, of which 156 were loggerheads (95%), seven were Kemp's ridleys (4%) and one was a Green sea turtle. No loggerheads were collected in 337 (75%) SEAMAP blocks. Only one loggerhead was collected in 77 (17%) of the SEAMAP blocks, two loggerheads were collected in 29 (6%) the SEAMAP blocks and three loggerheads were collected in seven blocks (2%). The percent occurrence (0-100%) of positive sea turtle catch events in each grid cell was used to

display the distribution of turtles among the grid cells sampled in the study area. Those grid cells where the percent occurrence loggerhead turtle occurrence was relatively high ($> 75^{\text{th}}$ numeric percentile of all percent occurrence values observed per grid cell within the South Carolina study area) were coded as red. Grid cells where the percent occurrence of turtles was moderate ($\geq 25^{\text{th}}$ and $\leq 75^{\text{th}}$ numerical percentile of all percent occurrence values observed per grid cell within the South Carolina study area) were coded as yellow, and grid cells where the percent occurrence was low ($< 25^{\text{th}}$ numerical percentile of all percent occurrence values observed per trawl per grid cell within the South Carolina study area) were coded as green (Figure 6). Mean catch per unit effort (CPUE) was calculated as the mean loggerhead count per trawl collection as well, but since turtle densities tend to be very low per trawl (often only 1-2), the percent occurrence in all trawls taken in a grid cell was deemed as a more useful measure to identify where juvenile loggerhead turtles are most frequently captured in the trawl surveys.

By-catch of loggerhead sea turtles is also included in the SEAMAP bottom trawl survey previously described for shallow-water finfish and crustacean catches. These data are included in the summary data shown in Figure 6 since SEAMAP cruises extended further north than the in-water trawl survey specifically dedicated to evaluating the distribution and relative abundance of loggerhead sea turtles (described above), and were coded relative to the percent occurrence per SEAMAP bottom trawl per grid cell.

Avian Fauna Data:

Bird nesting and movements represent a resource of considerable concern related to wind energy development. South Carolina has a diverse array of coastal birds that either nest or forage on our coastal beaches and waters. Since wind energy development is likely to be placed relatively close to land, or could be located in flyways of migrating birds, it will be important to document bird movements and activities in the coastal zone. Unfortunately, relatively little is documented regarding bird fly ways in South Carolina's coastal waters, but information does exist on nesting habitats for several species, overwintering habitats for piping plovers (*Charadrius melodus*), which are listed as both endangered (some states) and threatened (other states including South Carolina), and ocean sightings of sea birds and sea ducks.

Bird Nesting Locations:

South Carolina has a number of transient washover islands that are critical habitat used by seabirds for nesting in South Carolina. Multiple species are typically observed on these islands, including the Eastern brown pelican, black-crowned night heron, great egret, snowy egret, tricolored heron, black skimmer, cattle egret, gull-billed tern, royal tern, sandwich tern, glossy ibis, least tern, and common tern. SCDNR staff survey annually to obtain nest counts or estimates made from counting adults that appear to be incubating or brooding young. Nest counts were conducted by walking through the colony and counting nests with eggs or chicks. The number of wading bird nests at these sites is also included. Wading bird counts were

primarily estimates from counting adults that were assumed to be nesting. Each site was only counted once, thus these numbers may not represent peak numbers of nests at the site. These data do not include all species that nest on a site. For example, laughing gulls, shorebirds, and uncommon species are not included. This dataset also does not include all sites in SC that have nesting seabirds, thus totaling all nests for a species during one year, may not be the total number of nests in SC for that species. All numbers represent the annual average number of nests over the most recent five year period (2006-2010).

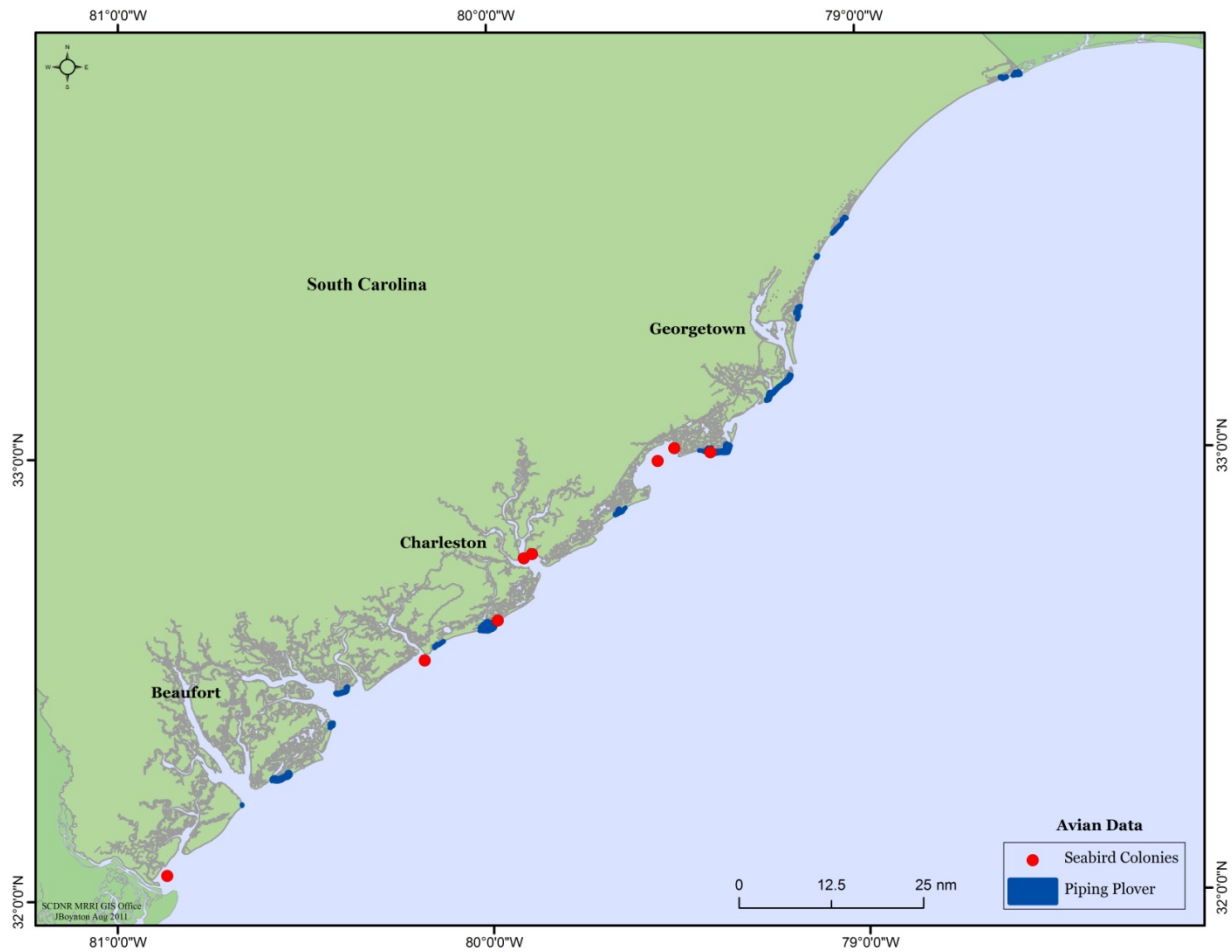


Figure 7. Summary of bird nesting sites and piping plover overwintering grounds along the South Carolina coastline.

Due to the transient and constantly changing nature of these islands, a single point was used to represent the island. The average nests for all species observed on each island over the most recent five year period (2006-2010) are provided in the GIS database. The locations of known coastal nesting sites available in this GIS layer are shown in Figure 7.

Piping Plover Overwintering Critical Habitat:

The U.S. Fish and Wildlife Service has identified the location of critical habitat units for the Great Lakes and Northern Great Plains populations of piping plover which is a federally listed species. The Great Lakes population is federally listed as endangered, while the Atlantic and Northern Great Plains populations are listed as threatened. Piping plovers are considered threatened on their wintering grounds. In the United States, these populations winter along the Atlantic Ocean from North Carolina south, along the Gulf coast to Texas, and the Caribbean. Piping plovers spend the majority of the year on the wintering grounds. Due to the difficulty of separating out the populations of piping plover (Great Lakes, Northern Great Plains, and Atlantic) when on their wintering grounds, critical habitat was designated for all wintering piping plover. Critical habitats are areas considered essential for the conservation of a listed species. These areas provide notice to the public and land managers of the importance of these areas to the conservation of this species. The locations of those sites are shown in Figure 7.

Benthic Community Data:

Benthic infaunal invertebrate communities represent a critical food resource for many fish and larger invertebrate species. These relatively sessile biota are generally excellent indicators of environmental condition (health) since declines in the relative abundance or diversity of these organisms often indicates the effects of some environmental stress compared to finfish species, which are much more mobile and don't necessarily reflect the health of localized environments. As a result, benthic invertebrate communities have been studied as part of a number of environmental assessments associated with the impacts of beach nourishment projects, or ocean disposal operations. Most of these studies have been conducted by the SCDNR, but studies by others have been completed as well. It should also be noted that there are several historical studies that were conducted in deeper shelf waters, but these data are not included in the benthic community data layer due to time constraints and the relative age of the data (early 1980s). Only one recent study conducted by Cooksey et al. (2010) is available that provides data on benthic community composition across the continental shelf.

Since benthic communities can be quite diverse, it is not feasible to summarize all of the species documented from the various studies summarized in this project. Rather, we have selected two metrics (mean abundance of organisms/0.04m² and mean number of species (taxa)/grab (0.04m²)) as an indication of the productivity of the benthic communities sampled in these studies. Data from all sampling efforts were summarized by 1 x 1 minute grid cells and may have included one or more seasons and multiple studies. Grid cells having a mean values representing >75th percentile of all mean values observed in the study area were coded as red, grid cells with mean values ranging from the 25th to 75th percentile of all mean values were coded as yellow, and grid cells with mean values < 25th percentile were coded as green. An example of the distribution of benthic data based on the mean faunal abundance is shown in Figure 8. Since these data were compiled from a number of different sources, specific point locations of the data are provided as a separate feature class so the user can identify the specific locations of samples collected and

identify the data source. The data source information is included in the database as a separate table titled “BenthicMetadata”.

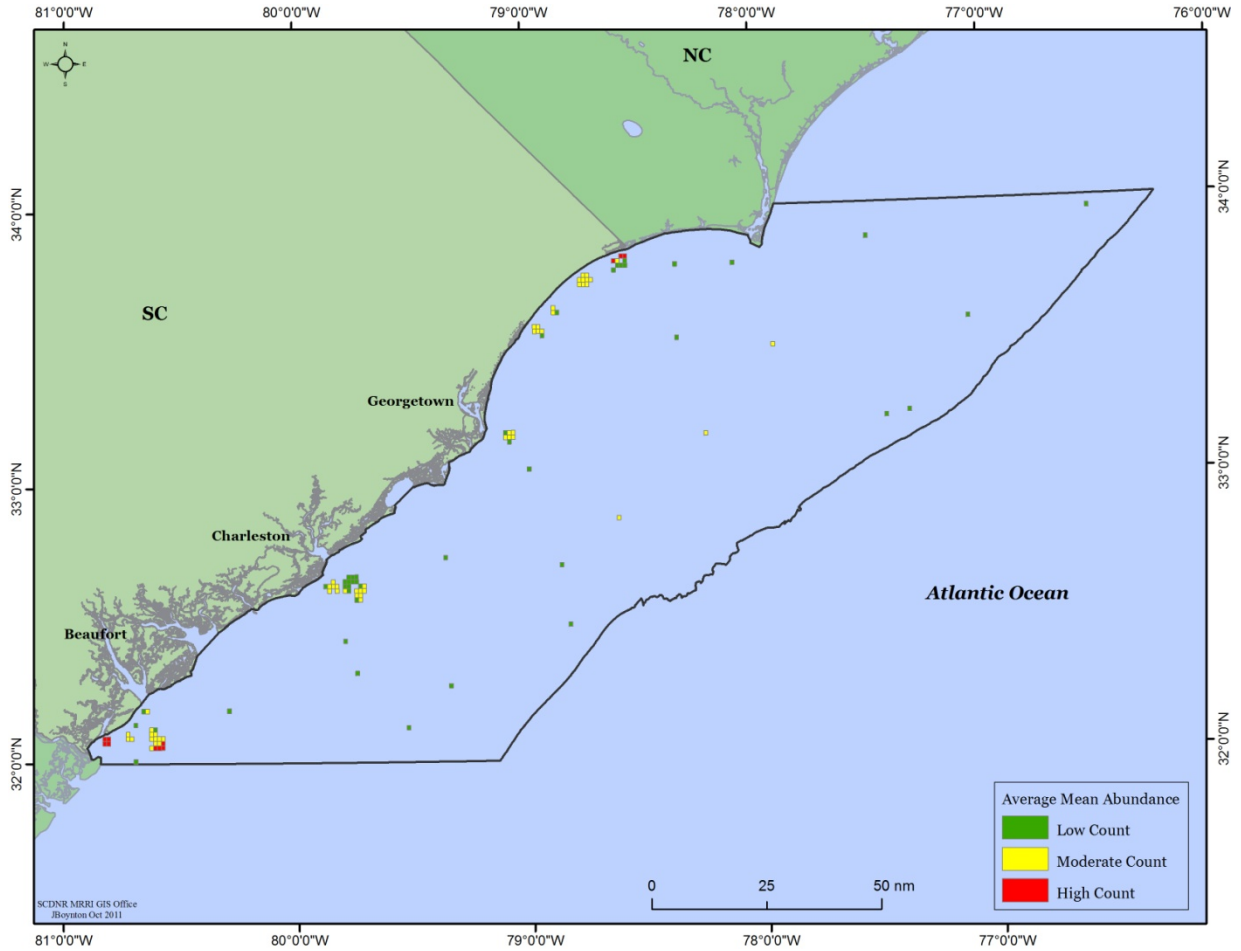


Figure 8. Summary of the distribution of benthic invertebrate community data available from within the project area. Only mean faunal abundance/grid cell is shown as an example.

Habitat Information:

Hard Bottom Reef Habitats:

Hard bottom reef habitats represent an important biological resource in the South Atlantic Bight and are considered by the South Atlantic Fishery Management Council (SAFMC) as a habitat of particular concern (HAPC). Due to the need to protect these habitats, the Southeast Area Monitoring and Assessment Program (SEAMAP) funded a multi-year study effort to mine historical data using a series of standardized protocols (SEAMAP-SA, 2001). Possible bottom types were coded as hard bottom, probable hard bottom, no hard bottom, artificial reef, and

artificial reef on hard bottom. More than 62,000 records were evaluated for bottom type designation. Specific site locations for point and “line” data (e.g. trawl track, side scan sonar segment) are provided in the original database along with data on source and type of record. The records in each 1 x 1 minute grid cell were then compiled and the grid cell was coded as hard bottom (red), probable hard bottom (yellow) and no hard bottom (blue) with priority given to hard bottom, then probable hard bottom where grid cells had multiple records, which was usually the case (Figure 9). Information available for each grid cell includes the total number of records of each bottom type. This is useful since grid cells with only a few records should not be considered very reliable, whereas grid cells with numerous records of a given habitat type provide more confidence. Since priority has been given to hard bottom habitat with respect to how the cell displays in the layer file, it is important to note that only one hard bottom or probable hard bottom record will code that cell as hard bottom, even if there are many more non-hard bottom records in the same grid cell. This is consistent with the SEAMAP Bottom

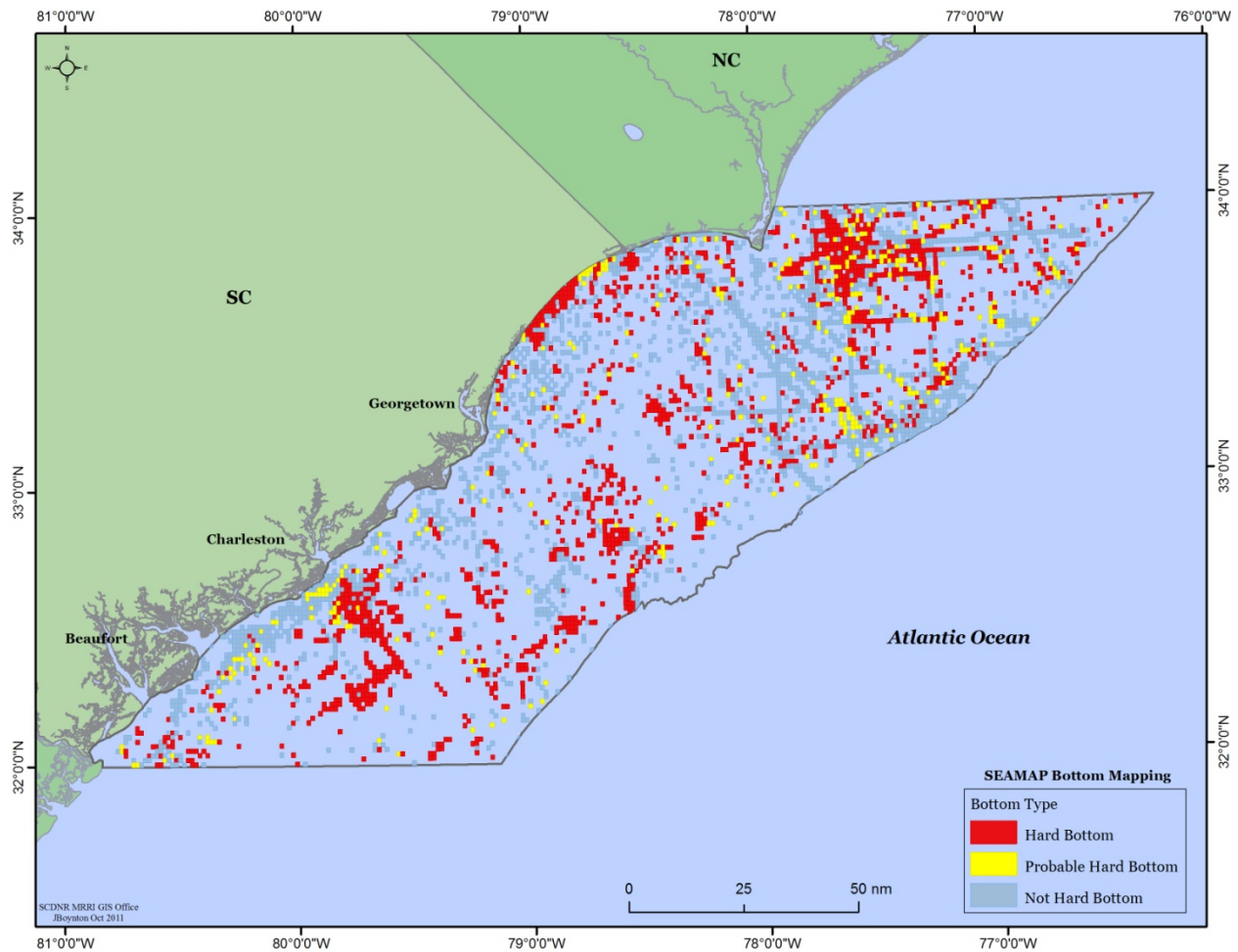


Figure 9. Summary of bottom types identified at the 1 x 1 minute grid cell level in the study area based on the SEAMAP Bottom Mapping Project database.

Project protocols (SEAMAP-SA, 2001). In the Grand Strand area of SC, Coastal Carolina University, in conjunction with the USGS, have completed a detailed mosaic of probable hard bottom locations based on neural net algorithms trained on side scan records taken in conjunction with underwater television. These data are not shown in the 1 x 1 minute grid format, and are available through CCU.

Bottom Sediment Types:

Numerous nearshore studies have evaluated the distribution of sediments for a variety of purposes. These include core and sub-bottom sonar profiling to evaluate the thickness of the surficial sand lens, and studies that have evaluated the characteristics of surficial sediments collected in conjunction with benthic community sampling for various environmental studies. Data from many of these programs (through 1999) were summarized as part of a multi-year effort by the South Carolina Task Force on Offshore Resources through funding from the Minerals Management Service Office of International Activities and Marine Minerals (INTERMAR). Those data were summarized by Weinbach and Van Dolah (2001). Studies

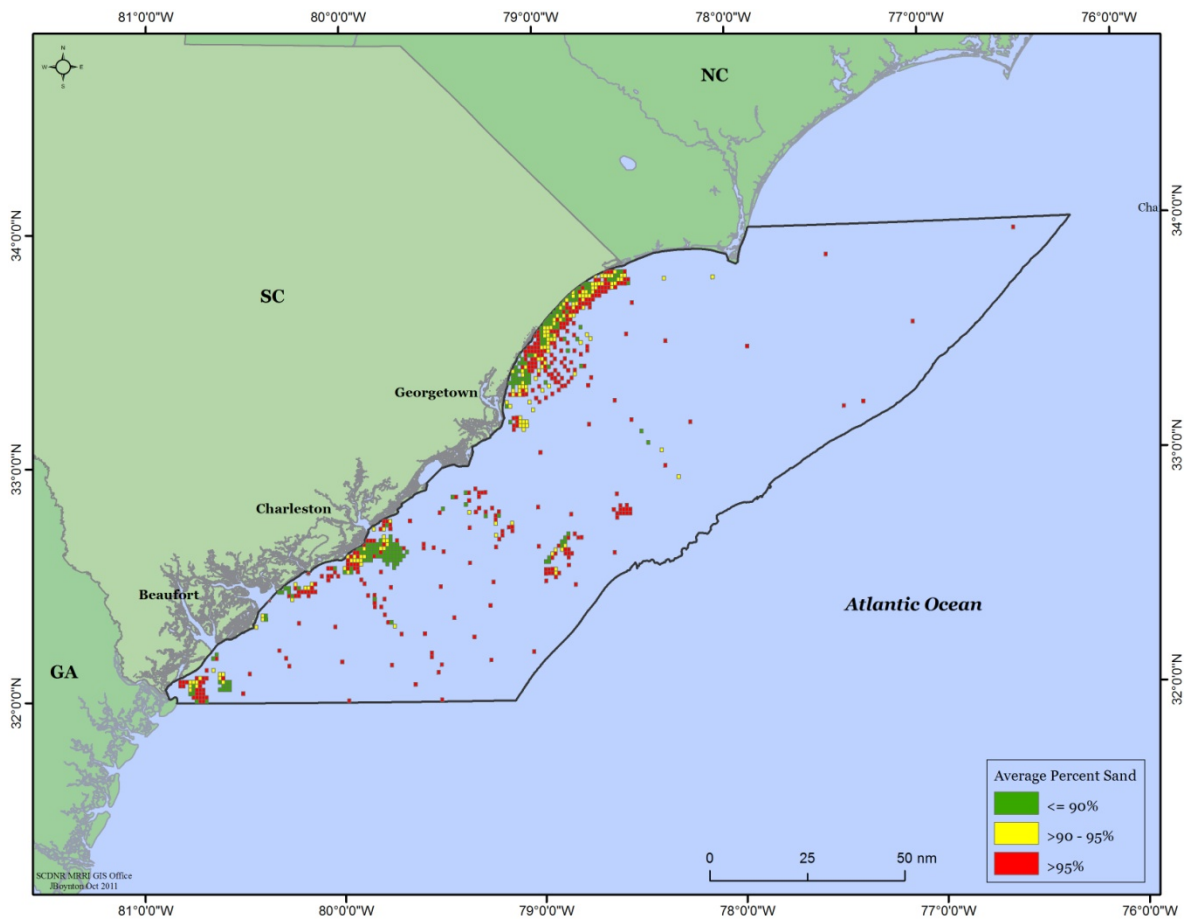


Figure 10. Summary of surficial sediment data describing the percent sand composition at stations sampled in each 1 x 1 minute grid cell.

completed subsequent to that report include numerous additional beach nourishment studies, ocean disposal area surveys, and extensive monitoring of sediment characteristics in the Grand Strand area by USGS and Coastal Carolina University (CCU). Some of those data are included in the database developed for this project, but CCU should be contacted directly for more extensive data that could not be incorporated into this GIS framework in the time available for this project and using the criteria adopted for the project. Three sediment characteristics (percent sand composition, mean phi size, and the depth of the surficial sand lens) were considered for this project. More than 70 studies were reviewed to compile these data.

Data from all samples were averaged for each 1 x 1 minute grid cell for each of these parameters and binned according to their potential value as a sand resource for beach nourishment. An example of the sediment data is shown in Figure 10 that describes how the percent sand data were compiled. Since these data were compiled from a number of different sources, specific point locations of the data are provided as a separate feature class so the user can identify the specific locations of samples collected and identify the data source. The data source information is included in the database as a separate table titled "BenthicMetadata".

Coastal Carolina University scientists, along with investigators from other agencies, have done extensive surveys of the bottom sediment thickness in the Grand Strand Area. They have provided a Modern Sediment Thickness database file to share through the SCDNR site.

Upland and Estuarine Land Cover:

In order to accurately depict upland and estuarine land cover, SCDNR staff recommends using the Coastal Change Analysis Program (C-CAP), which has been developed by NOAA and is updated periodically. C-CAP is designed to monitor change in terrestrial land cover with coastal environments of the United States and classifies a variety of land cover and wetland habitats using remote sensing techniques (primarily satellite imagery and aerial photography). Examples of the land cover and wetland features captured by C-CAP are shown in Figure 11. The most recent C-CAP analysis for South Carolina is 2006 and the area is due for an update since areas are generally re-assessed at 5 year intervals.

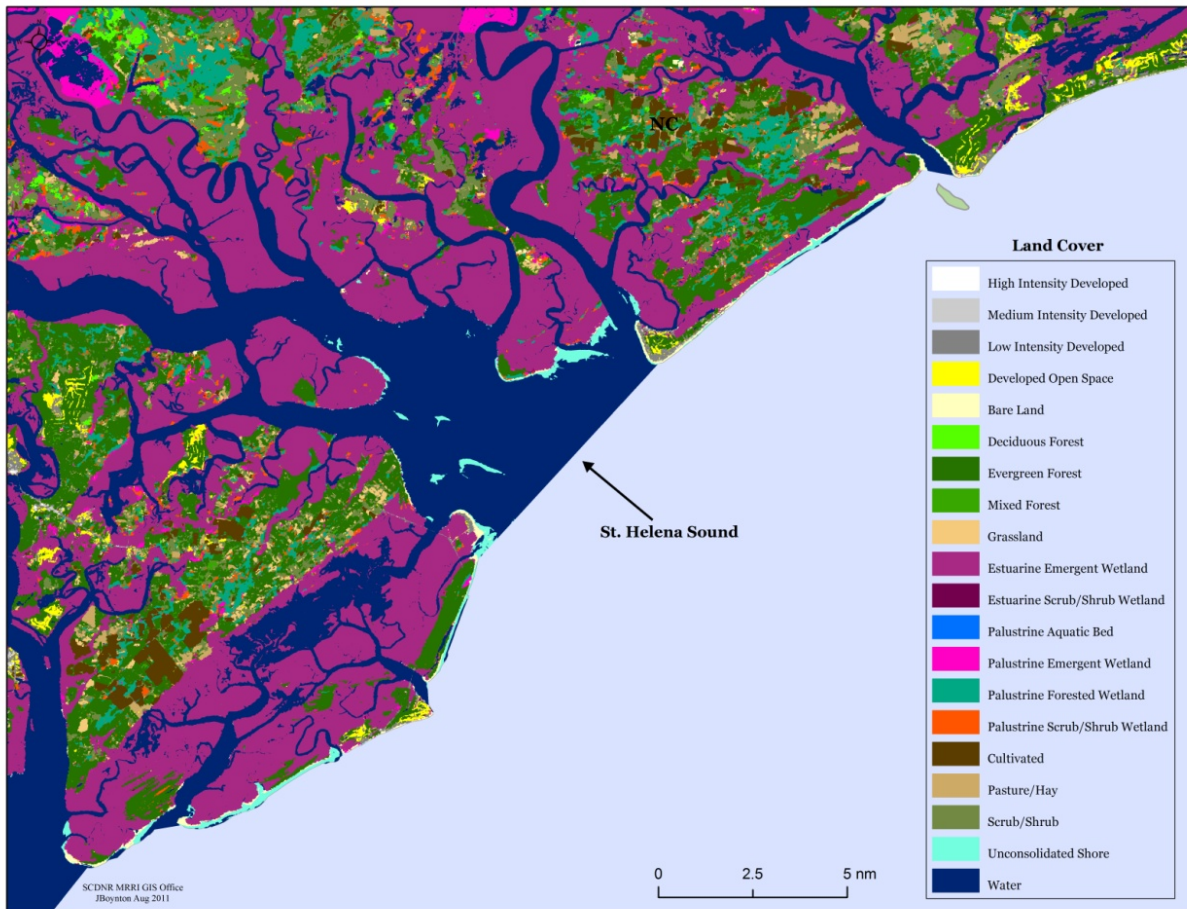


Figure 11. Example of land cover data available for the South Carolina coastal zone. Only a small portion of the state is shown to allow detail to be viewed.

Protected Lands:

South Carolina has a high percentage of its coastal land under some form of protection. These include: the Cape Romain National Wildlife Refuge, the Francis Marion National Forest, state parks and forests, conservation easements, private lands, and other state lands, much of which are owned and managed by the SCDNR. County and city parks were not developed for this dataset since most did not have digital boundaries that could be accessed by SCDNR staff within the project time frame. Many of the protected lands of South Carolina are shown in Figure 12.

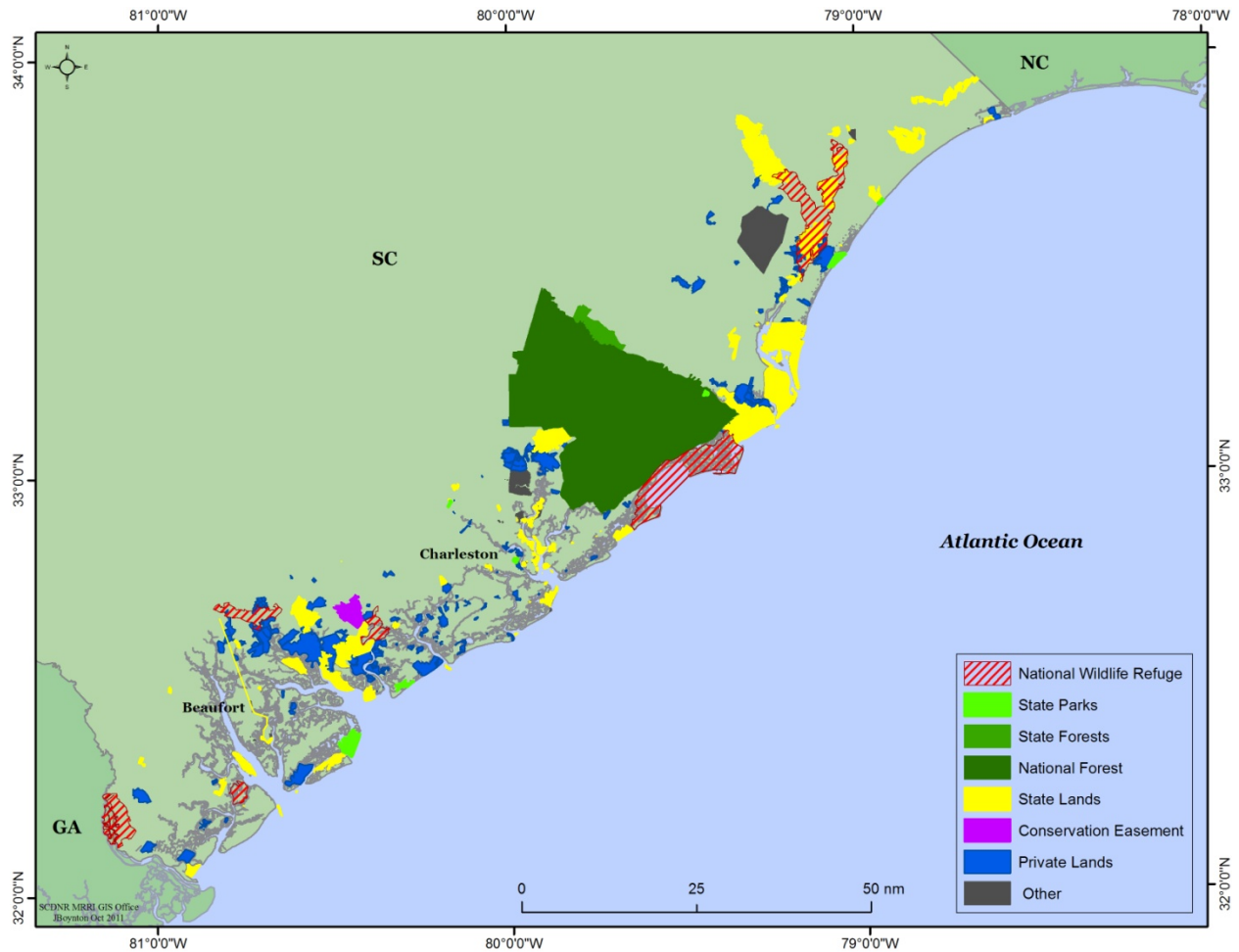


Figure 12. Summary of protected lands in the coastal zone of South Carolina.

Oyster Habitat:

The SCDNR recently completed a detailed oyster reef mapping project which provides updated digitized boundaries of intertidal oyster reefs found along the South Carolina coast. The reefs were digitized through a combination of automated and manual techniques using 4-band (blue, green, red, near-infrared) digital orthophotos with a theoretical ground resolution of 0.25 meters. The photos are dated from 2003 to 2006. The project area was selected specifically to cover those sections of the SC coastal critical zone where oysters had historically been mapped by the SC Department of Natural Resources (SCDNR). The area spans 122 USGS quarter quadrangles (DOQQs). Sixty of the DOQQs were ground-truthed by boat to assess accuracy. Some areas were verified through photographs taken from low-altitude helicopter flights conducted from 2006 to 2008 by SCDNR. The initial digitization process has met with the minimum accuracy requirements of the project (80% correct classification) and was completed through a joint effort between Photo Science Inc. and SCDNR. The entire dataset has been reviewed by SCDNR for quality using all known information through 2010. Updated versions of this dataset will be produced as more information becomes available. Only a small portion of the dataset is shown in Figure 13 so that the detail of oyster bed distribution can be seen along with examples of

shellfish harvesting and permit zones that represent another database provided in the project database files.

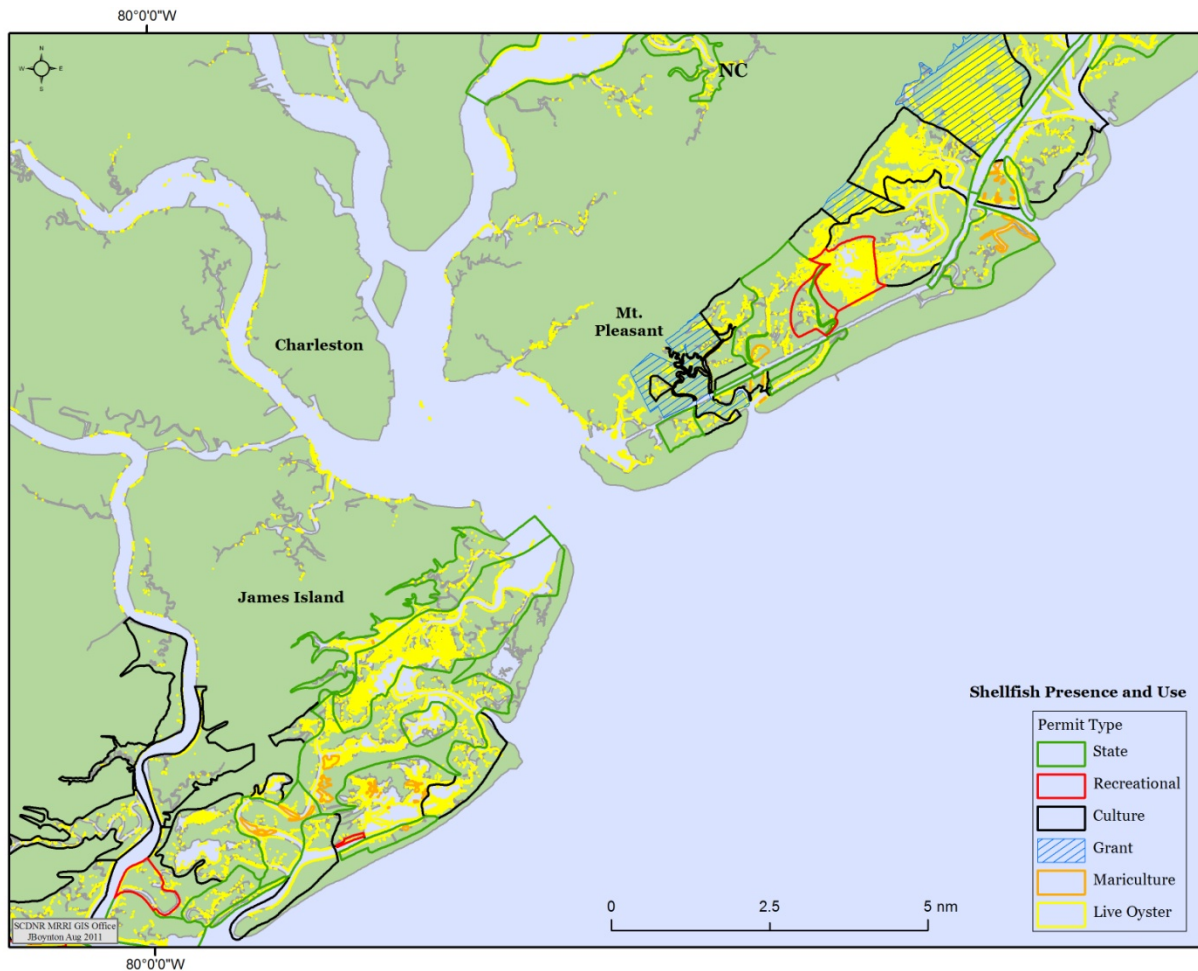


Figure 13. Portion of the state showing the distribution of oyster reefs recently surveyed by the SCDNR and shellfish management boundaries for that portion of the state.

Marine Protected Areas:

The Marine Protected Area (MPA) inventory is a comprehensive catalog that provides detailed information for existing marine protected areas in the study area. The data layer depicts original boundaries as represented by the managing agency(ies). Many of the managed MPAs off South Carolina are located in relatively deep waters of the shelf. Bottom fishing in these areas is restricted by the South Atlantic Fisheries Management Council (SAFMC), and any bottom disturbance activities would also be prohibited. There are other managed areas identified in the region (Figure 14) that are relatively large in scale, such as the Charleston Bump Closed Area, but it is unclear what restrictions might be in effect in those areas that are not related to fishery efforts.

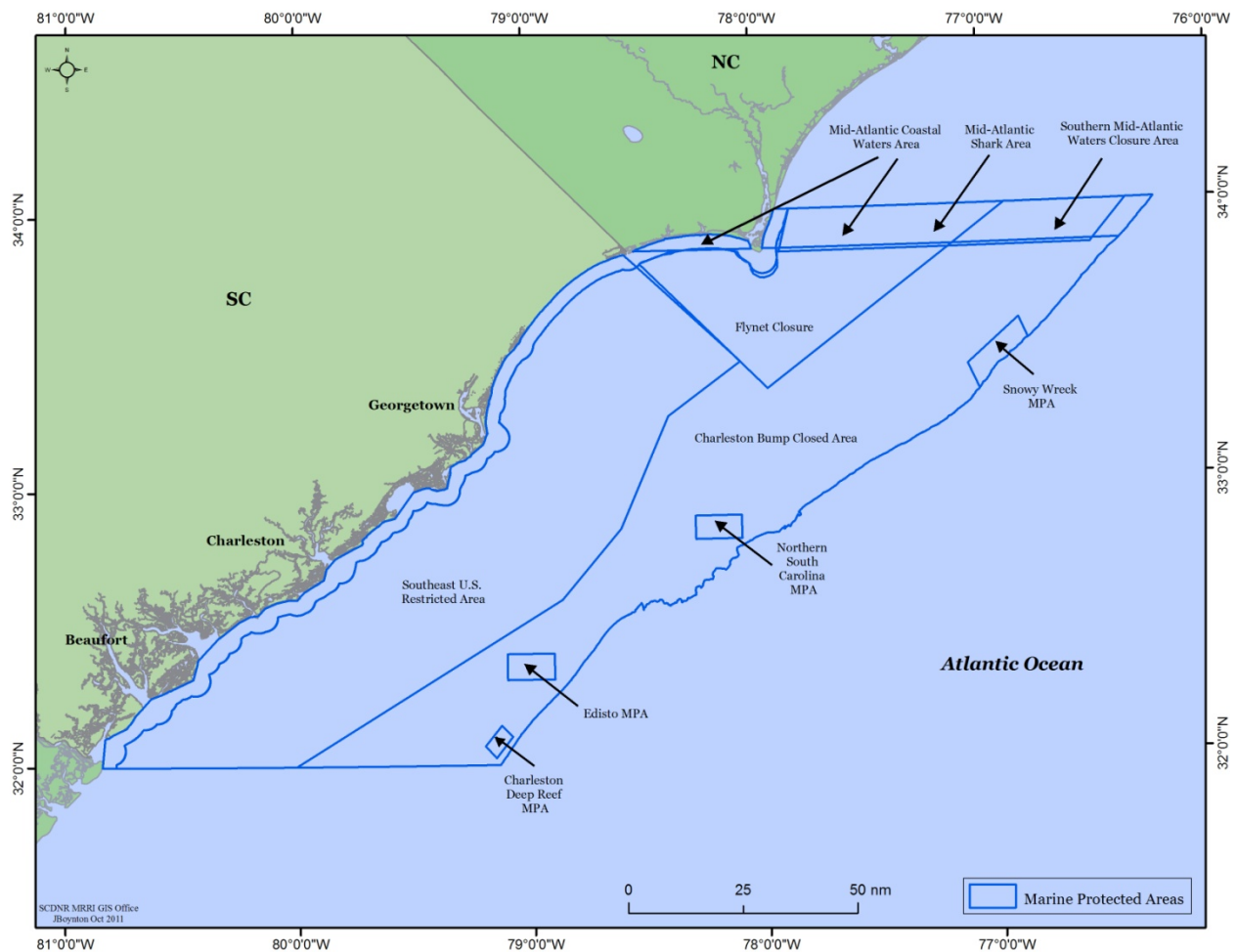


Figure 14. Map of marine protected areas in the study area.

Hydrography:

The National Hydrography Dataset (NHD) is a dataset that shows stream segments or reaches that make up the nation's surface water drainage system. The product was developed by the U.S. Geological Survey (USGS) in cooperation with U.S. Environmental Protection Agency (USEPA), USDA Forest Service, and other Federal, State and local partners. The NHD is a national framework for assigning reach addresses to water-related entities, such as industrial discharges, drinking water supplies, fish habitat areas, and wild and scenic rivers. Reach addresses establish the locations of these entities relative to one another within the NHD surface water drainage network. NHD data was originally developed at 1:100,000-scale and exists at that scale for the whole country. The high-resolution NHD provided for this project was generally developed at 1:24,000/1:12,000 scale and therefore adds detail to the original 1:100,000-scale NHD. Only a small portion of the state's coastal zone is depicted in Figure 15 to show the detail available.

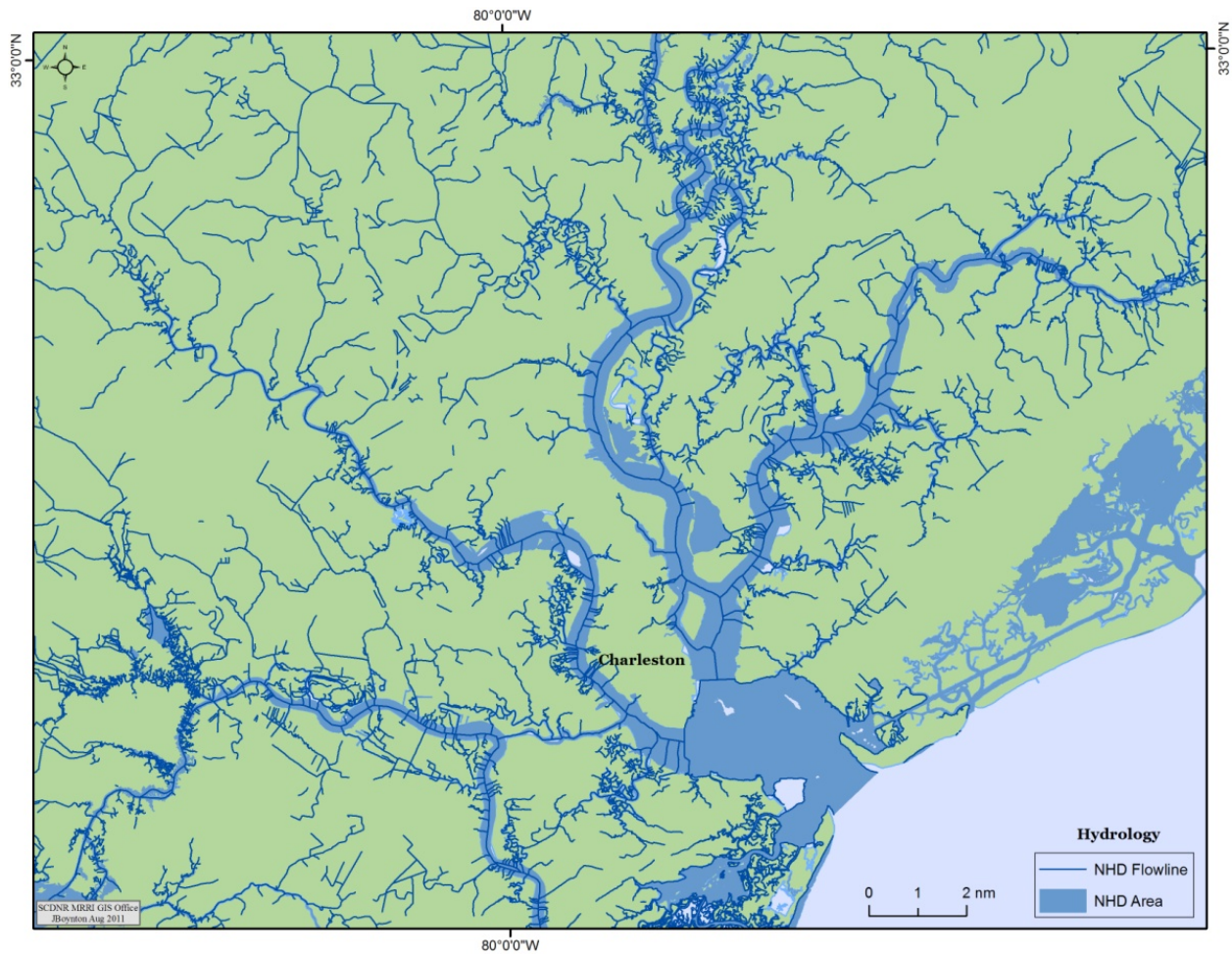


Figure 15. Example of the hydrology layers provided in the hydrology GIS data layer. Only a portion of the state is shown to allow detail to be seen.

Wind:

Wind energy development off South Carolina will be dependent on the presence of sufficient winds to support such activities in areas close enough to the existing power grid system. The South Carolina Energy Office contracted with AWS Truewind to complete a wind mapping project that maps mean annual wind speeds at 30, 50, 70, and 100 m above the ocean surface and mean annual wind power at 50 and 100 m above the ocean surface. Mean annual wind speeds at 70m within the study are shown in Figure 16 as an example of what these datasets depict.

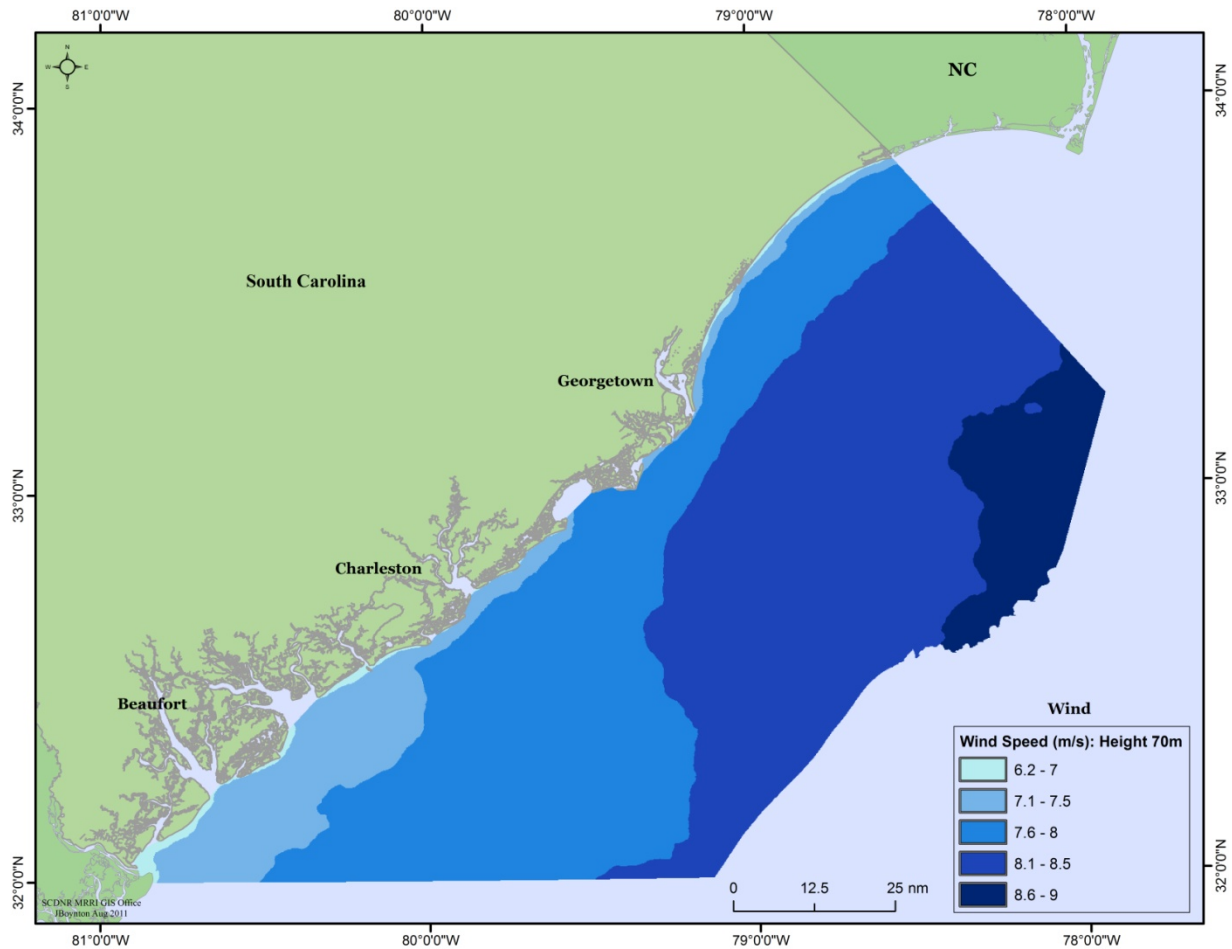


Figure 16. Summary of wind speed at 70 m height in the study area. Wind speeds at other levels are available in the GIS database.

Bathymetry:

Detailed bathymetry is available throughout the study area from NOAA. The GIS data layer provided in this project file shows the 10 m depth contours out to the 200 m limit of the study area. The data were obtained from NOAA at the GEODAS Grid Translator site. No figure is shown for this data layer.

Imagery:

Detailed imagery of South Carolina’s coastal zone is available through the National Agriculture Imagery Program (NAIP). The imagery is acquired during the agricultural growing seasons. A link to the latest imagery files available is provided at the SCDNR’s web site as part of this project’s database listings.

Human Use Information:

Regulatory Boundaries:

The primary land based regulatory boundary that can influence activities in the nearshore coastal zone is the Coastal Barrier Resources System (CBRS) established by the Coastal Barrier Resources Act (CBRA) of 1982. The CBRS is comprised of undeveloped coastal barriers along the Atlantic, Gulf, and Great Lakes coasts. The law encourages the conservation of hurricane prone, biologically rich coastal barriers by restricting Federal expenditures that encourage development, such as Federal flood insurance through the National Flood Insurance Program. Activities that could adversely affect the biological resources or stability of CBRS sites are a concern to the U.S. Fish and Wildlife Service (USFWS). The location of CBRS sites along the South Carolina coast is shown in Figure 17.

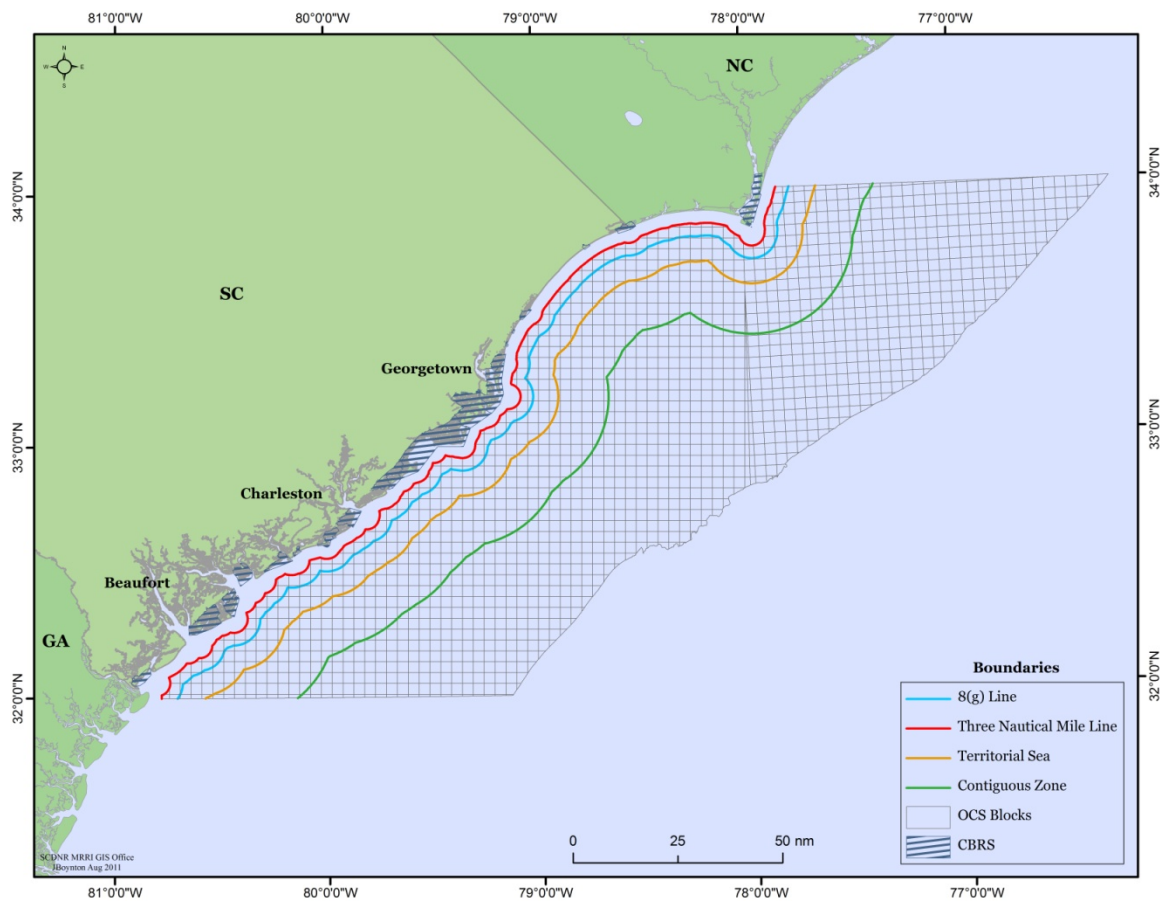


Figure 17. Summary graphic of regulatory boundaries along the coast and in the coastal waters off South Carolina.

In the coastal waters off South Carolina, there are a number of regulatory boundaries that should also be considered when evaluating any proposed ocean activity (Figure 17). These regulatory boundaries are clearly defined at the following web site

<http://www.csc.noaa.gov/mbwg/products.html> and reiterated here. Additional information is available in the metafiles associated with each boundary line. Parallel to the coastline, there is the three mile boundary line that represents the limit of the state's jurisdictions under the Submerged Lands Act (SLA). Approximately three miles seaward of that boundary is the Revenue Sharing Boundary (Section 8(g) of the Outer Continental Shelf Lands Act). The area between the 3 mile and 8(g) lines is provided for states to claim an equitable share of revenues when a federal lease is within that zone. The amendments mandate that 27% of all revenues from production within three miles seaward of the federal/state boundary are to be given to the state, although this may not apply to wind energy projects. The territorial sea boundary is located 12 miles from the state coastline. The U.S. asserts sovereignty over its lands, airspace, seabed and water from the baseline to the 12 nautical territorial sea boundary line. The final boundary line that is most seaward in our study area is the limit of the U.S. Contiguous Zone. This zone is a belt of sea adjacent to the territorial sea over which the U.S. exercises the control necessary to prevent infringement of its customs, fiscal, immigration, or sanitary laws.

Throughout the federal waters and extending beyond the 200 m depth limit of our study area, the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) has defined approved subdivisions of the outer continental shelf (OCS) within federal jurisdiction as lease blocks in support of the federal offshore leasing program. These blocks are approximately 9 sq. nautical miles in size (Figure 17).

Nautical Charts:

All of the raster-based nautical charts for the study area have been downloaded from NOAA's web site and are available on the SCDNR's web site for this project. No figure on these charts is included in this report since they are a common and well understood dataset.

Commercial Finfish Harvest Data:

The National Marine Fisheries Service (NMFS) requires all commercial fishermen with a permit to harvest finfish collected in federal waters to report their landings and identify the location of harvest within a grid cell of 1 x 1 degree of latitude and longitude. The SCDNR's Office of Fisheries Management has the same requirement for seafood dealers and fishermen to include any harvest from the same grid cells, even if the fish are caught in state waters. The data evaluated for this project was based on the average number of lbs of fish landed from 2005-2009 that included all species reported to the NMFS (landings in NC, SC, GA). Grid cells were only included in the dataset if there were at least three years worth of data within the grid cell. The total number of pounds of fish were summed by year for every grid cell, then averaged weight caught from 2005 - 2009 was computed. For landings in South Carolina only, twenty species comprised 80% (8,591,753 lbs) of the total landings (9,612,937 lbs) with individual species catch totals ranging from a high of 1,306,034 lbs for vermillion snapper to a low of 111,785 for red snapper among the top twenty species. The order of catch landings in decreasing order of

poundage was vermilion snapper, gag, scamp, swordfish, black sea bass, wreckfish, red grouper, triggerfishes, amberjack, dolphin, almaco jack, tilefish (SC Golden), snowy grouper, red porgy, white grunt, sandbar shark, king mackerel, perch-like fish, rock hind, and red snapper. Species totals of fish caught from the same grid cells off South Carolina, but landed in North Carolina and Georgia, are included in the above data; however, individual species numbers were not received from the North Carolina and Georgia landings, so a total ranking of species could not be calculated.

The layer file developed for this dataset summarizes the average total pounds of fish landed in South Carolina, North Carolina, and Georgia from each 1 x 1 degree of latitude and longitude grid cell. Due to the large scale of the reporting grid cells, the grid cells are not coded as high, medium and low, and these data are not likely to be very useful for evaluating potential conflicts between commercial fishing activities and other human uses, such as wind energy development.

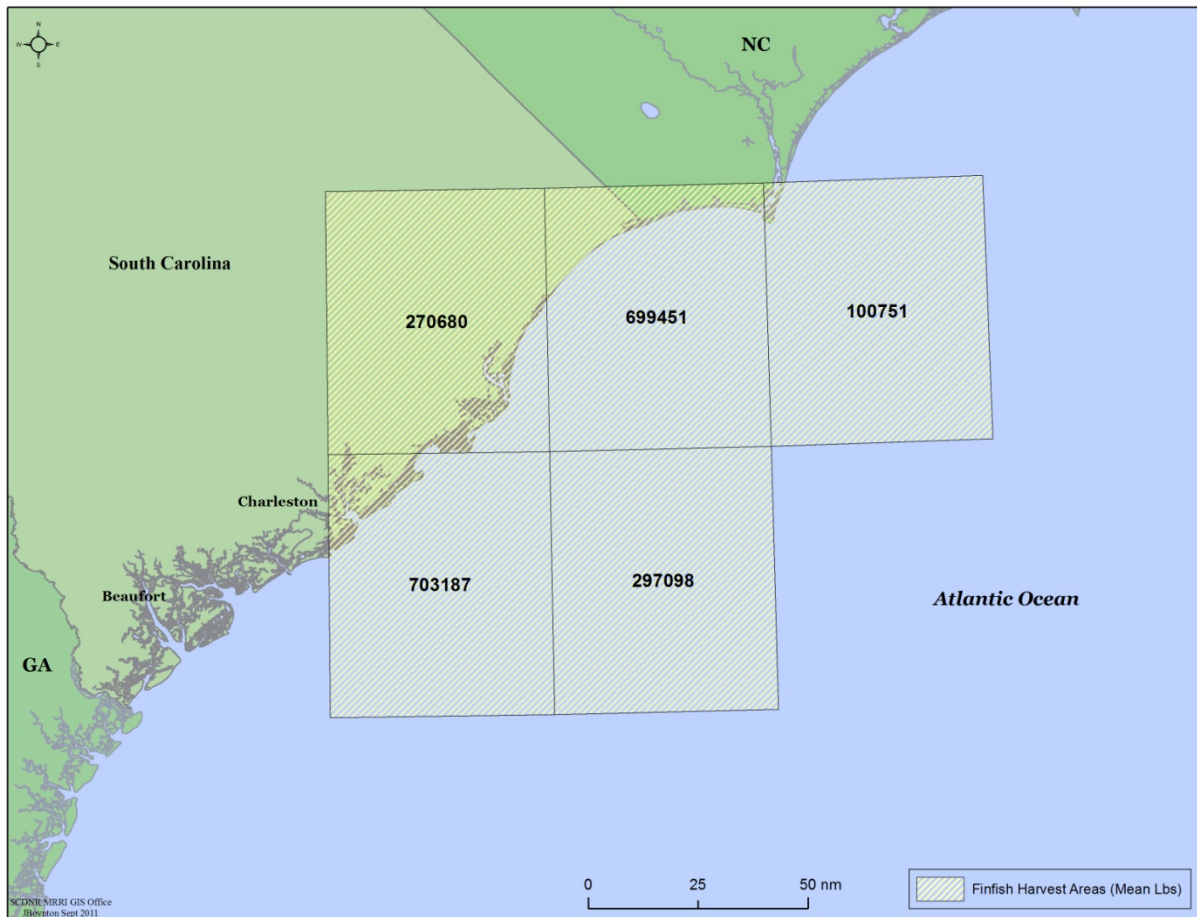


Figure 18. Summary of the NMFS commercial landings data for reporting zones located within the study area.

Commercial Shrimp Harvest Data:

Three species of penaeid shrimp are commercially harvested in South Carolina, with the majority of the catch caught offshore by trawlers working in the nearshore zone. The two most abundant species are brown shrimp (*Farfantepenaeus aztecus*) and white shrimp (*Litopenaeus setiferus*). The third species that is only incidentally caught is pink shrimp (*Farfantepenaeus duorarum*)

Commercial shrimp harvests are reported to the South Carolina Department of Natural Resources (SCDNR) Office of Fisheries Management for 10 trawling areas within the general trawling zone of South Carolina (Figure 19). Shrimp trawling is generally limited to the state's coastal boundary (3 mile limit) although some shrimping activity occurs seaward of that line unless it is closed by the South Atlantic Fishery Management Council. In order to provide summary information on the relative amount of shrimp landings in each zone, the average annual reported weights (lbs heads on) of the commercial trawl landings for both brown and white shrimp, collectively, from 2005-2009, are shown in Figure 19. Areas where landings were relatively high

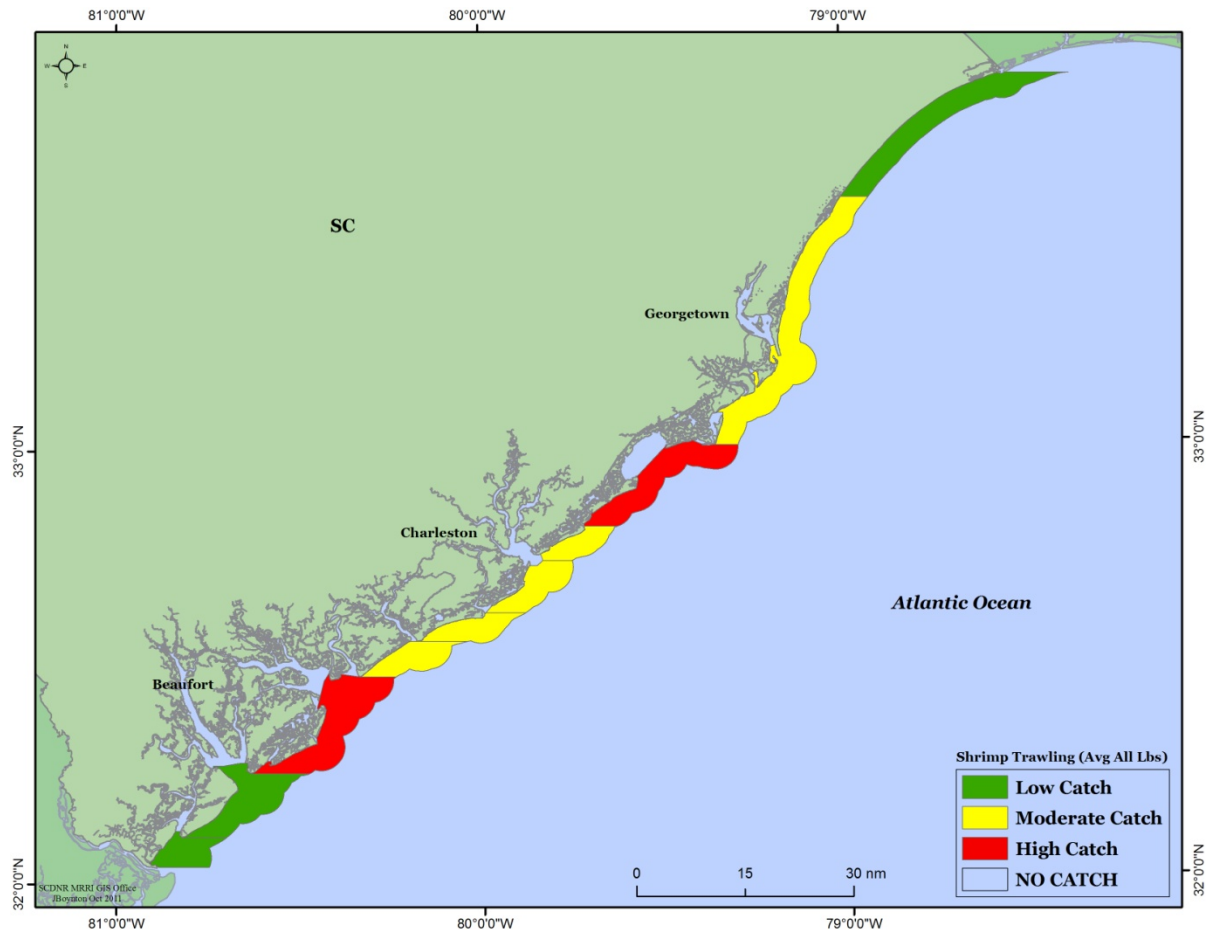


Figure 19. Summary of shrimp trawling activity along the South Carolina coast based on landings data.

(> 75th numeric percentile of all average annual landings data within the South Carolina study area) were coded as red. Areas where landings were moderate ($\geq 25^{\text{th}}$ and $\leq 75^{\text{th}}$ numerical percentile of all average annual landings data within the South Carolina study area) were coded as yellow, and areas where landings were relatively low (< 25th numerical percentile of all average annual landings data within the South Carolina study area) were coded as green. Landings data and the economic value of those landings are also provided for both brown and white shrimp in the GIS data file. The brown shrimp season generally runs from June to August, and the white shrimp season generally runs from August to December.

Artificial Reef Locations:

The SCDNR’s artificial reef program was created to enhance recreational fishing and sport diving opportunities in coastal waters, but future uses may emphasize increasing the amount of productive hard-bottom fish habitat in the form of sanctuaries or reserves. The Department currently maintains 38 artificial reefs zones and has identified 5 known wrecks that are good for

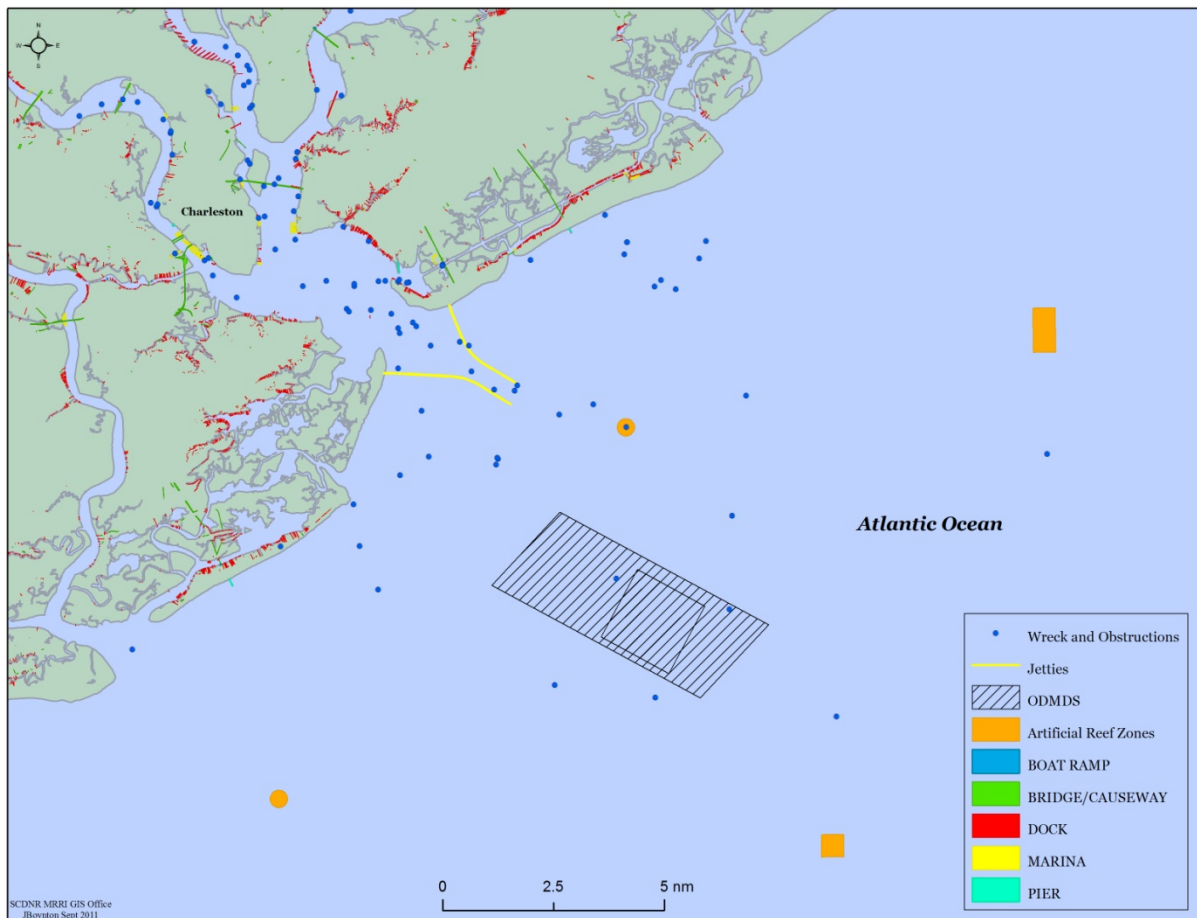


Figure 20. Location of Charleston ODMDS site, jetties, piers, docks, marinas, bridges, boat ramps, and wrecks and obstructions in a portion of the study area.

fishing activities. The data file created for this project contains the location of all public artificial reef zones off the coast of South Carolina. These zones have been permitted for the exclusive use of the SCDNR by the U.S. Army Corps of Engineers (USACE) in federal waters, and by the USACE and South Carolina Department of Health and Environmental Control – Office of Ocean and Coastal Resource Management (SCDHEC – OCRM) in state waters. The actual location of reef material can vary within each zone. The zones mark the potential extent of the reef (Figure 20). These data are only accurate to the date of publication and new zones can be created at any time. Only a portion of the artificial reef locations are shown in Figure 20.

Shipwreck and Obstruction Locations:

NOAA's Office of Coast Survey (OCS) publishes the Automated Wreck and Obstructions Information System (AWOIS) that contains information on wrecks, obstructions, and other significant charted features in the coastal waters of the United States. Items identified in this file are individually catalogued and are accompanied by historic and descriptive information gathered from field observations and government and private publications. AWOIS is not a comprehensive record of wrecks or obstructions in any particular area. Therefore, more detailed surveys of potential wrecks or obstructions, particularly those of historical significance, would need to be completed in any area where offshore energy development is being planned. This can be accomplished through a combination of side-scan sonar and magnetometer surveys. The known wreck and obstructions identified by the AWOIS are shown in Figure 20 for a portion of the study area.

Ocean Disposal Area Locations:

There are three areas in South Carolina's coastal zone that have Ocean Dredged Material Disposal Sites (ODMDS). They are located near Georgetown Harbor, Charleston Harbor, and Port Royal Sound. Ocean dumping occurs under a permit the Marine Protection, Research, and Sanctuaries Act (MPRSA) issued by the U.S. Army Corps of Engineers (USACE) using the U.S. Environmental Protection Agency's (EPA) environmental criteria and subject to EPA's concurrence.

The Georgetown Harbor ODMDS is relatively small and only the outer portion of the historical site is being used. That site is reaching capacity. Therefore, the UACE and EPA have been conducting studies to designate a new site seaward of the current ODMDS.

The historical Charleston ODMDS was originally a much larger site but only the outer portion of that historical site is currently being used for disposal of sediments. That site has a berm of cooper marl material that has been placed around much of the boundary of the smaller site to limit the movement of muddy sediments disposed at the site. The location of this site is shown in Figure 20 as an example of this data layer.

The Port Royal ODMDS sites are currently inactive. Only the square site located in the most seaward area is recognized as the official ODMDS by the USEPA (<http://www.epa.gov/region4/water/oceans/sites.html#sitelist>).

Jetties, Piers, Docks, Marinas and Bridges:

The Office of Ocean and Coastal Resource Management (OCRM) within SCDHEC, has compiled an extensive inventory of docks, piers, marinas, and bridges in the state. In addition, the SCDNR has digitized the location of all jetties that extend into the ocean. These features are shown in Figure 20 for a portion of the study area. It should be noted that there are several ocean outfalls that have been constructed in the nearshore zone of the Grand Strand that allow storm runoff to be released away from the beach. The exact locations of these outfalls were not available for inclusion in the data files prepared for this project.

Sand Borrow Sites Used For Beach Nourishment Projects:

Sand resources are extremely important for renourishment projects that are needed for the majority of developed beaches throughout the state. These renourishment projects are either completed by the U.S. Army Corps of Engineers (USACE) in cooperation with local municipalities, or by the municipalities themselves as non-federally funded projects. While many think that sand is an abundant resource off South Carolina, the number of sites that are actually available with sufficient sand resources compatible with the receiving beach and located in areas that can be mined economically is limited. The GIS data layer that shows the location of areas mined for sand (termed borrow sites) for historical projects (Figure 21) is intended to identify areas that either have been used in the past, or sites that can be mined in the future if they have not already been dredged (e.g. Grand Strand borrow sites designated for 50 yr project cycle). Most borrow sites that have been dredged have either not re-filled or have not re-filled with beach compatible sediments. Therefore, they are not likely to be re-dredged in the future, but the sites do indicate that sand resources are likely to be available nearby. The sediment GIS database may also be useful for locating potential sources of sand based on historical data records largely completed by the MMS-INTERMAR Task Force on Offshore Resources (see Bottom Sediment section).

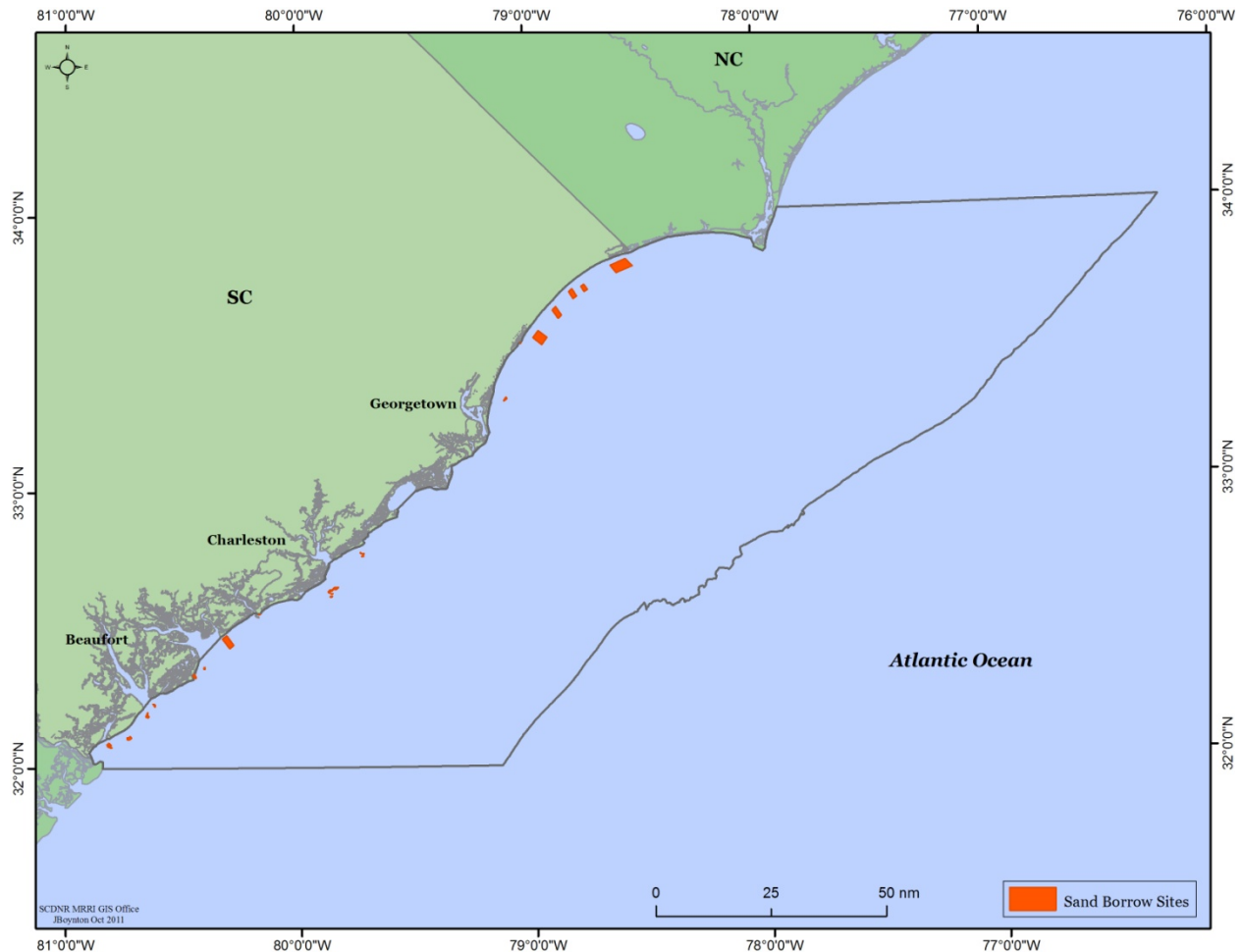


Figure 21. Location of areas that either have been or will be mined for sands used in beach nourishment projects.

Shipping Activities and Shipping Lanes:

Commercial shipping represents one of the major ocean uses off the coast of South Carolina and other states. Therefore, it is essential that any other ocean use activities consider where this activity occurs. The best source of commercial shipping activity is through the Automated Identification System (AIS) that provides both real-time and historical tracking of all commercial vessels greater than a certain size and other vessels that have been voluntarily equipped with the system. It should be noted that most commercial shrimp trawlers and commercial fishing boats in this region are not required to have AIS or other Vessel Monitoring Systems (VMS) that are mandatory in other regions. Additionally, it is unlikely that military vessels are normally providing information on their location. Thus, the data provided for this project should not be considered exhaustive or necessarily sufficient with regard to vessel activity in an area of interest for wind development.

AIS Shipping Activity:

The International Maritime Organization's (IMO) International Convention for the Safety of Life at Sea (SOLAS) requires AIS to be fitted aboard international voyaging ships with a gross tonnage (GT) of 300 or more tons, and all passenger ships regardless of size. It is estimated that more than 40,000 ships currently carry AIS class A equipment. In 2007, the new Class B AIS standard was introduced which enabled a new generation of low cost AIS transceivers. This has triggered multiple additional national mandates from Singapore, China, Turkey and North America affecting hundreds of thousands of vessels. The AIS data available for 2009 originated from the 2009 United States Automatic Identification System Database distributed by NOAA's Coastal Services Center. They are summarized in the AIS GIS data layer using the 1 x 1 minute grid of latitude and longitude for the study area. The summarized data points were derived from position reports, which were pre-filtered to a one-minute time step in the original NOAA database. All data points with a speed greater than zero were summed by grid cell for each month of 2009, and then totaled and averaged for the year and summarized as # of records/month. The data from the month of June was incomplete and therefore not included in the data summary. Even so, there were a total of 2,257,725 data points analyzed for 2009. Data are available for the northeastern section of the study area, but were not provided to the SCDNR for analysis.

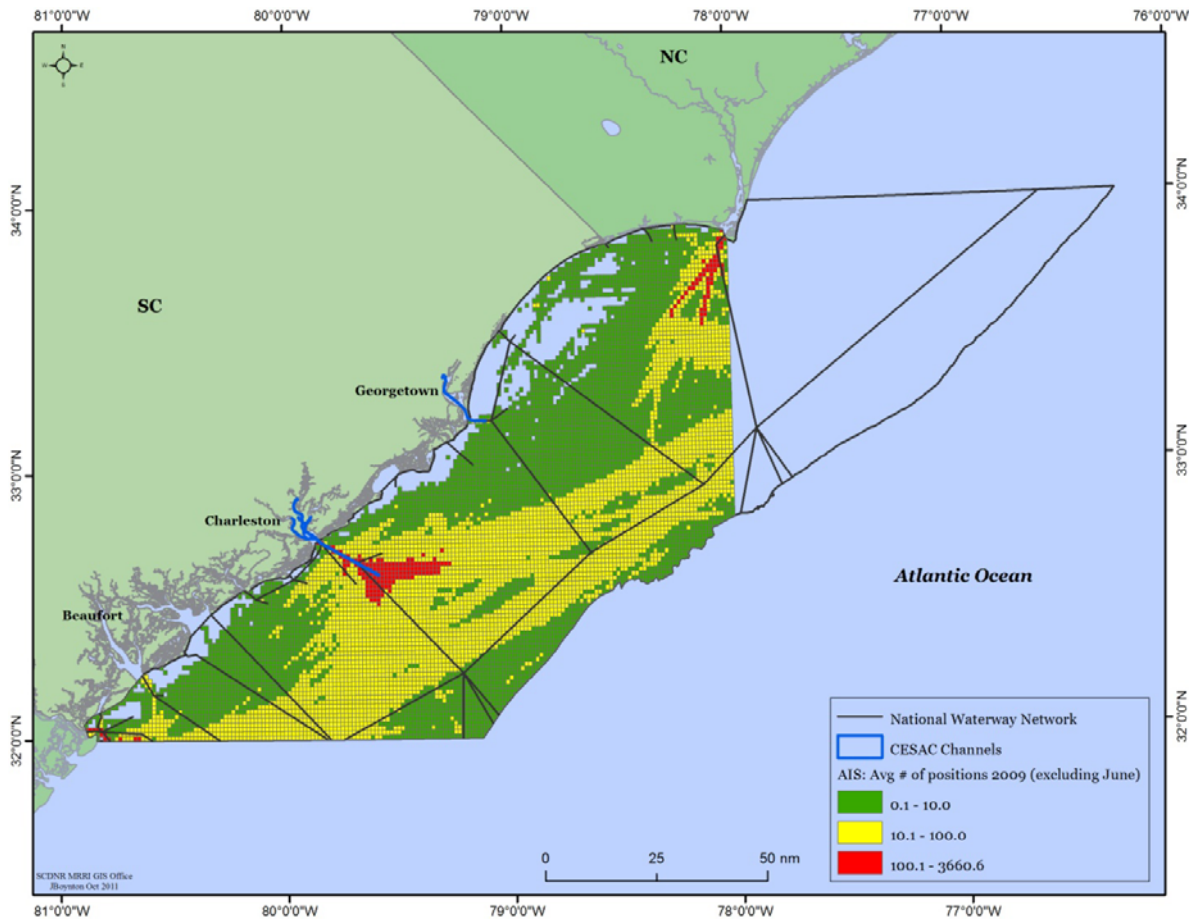


Figure 22. Summary of AIS shipping records for 2009 and documented shipping lanes in the study area. See text for gap in AIS data for northeastern section of the study area.

The data shown in Figure 22 and the provided layer file codes each grid cell by the average number of records observed per month as low (green) if there were fewer than 10 records, moderate (yellow) if there were between 10 and 100 records, and high (red) if there were greater than 100 records.

Shipping Channels and Lanes:

The U.S. Army Corps of Engineers (USACE) maintains the navigable channels associated with the Charleston Harbor and Winyah Bay ports. The CECSAC Channels data layer provided for this project provides detailed information on the horizontal limits of the defined channels. The National Waterway Network is also published by the USACE and represents a comprehensive database on the nation's navigable waterways. Links in the waterway database that represent shipping lanes in the coastal ocean waters serve as representative paths where no defined shipping lanes exist. These are depicted by the black lines in Figure 22. It is interesting to note that the defined shipping lanes do not correspond very well with actual shipping activity as reported by the AIS system.

Military Activities and Restricted Use Areas:

The military has several bases in South Carolina and conducts extensive training activities along South Carolina's coastal zone and further offshore (Figure 23). Some of these activities may conflict with wind energy development in areas where the two activities coincide. The military operations can be separated into training routes for aircraft, warning areas that are primarily located in federal waters and are used for both air and naval training exercises, additional DOD operational areas, and a radar zone identify by the Beaufort Marine Corps Air Station where any conflicts with radar activity should be avoided.

In addition to military operations, there are several additional controlled air spaces around airports. These often extend into coastal waters and may or may not pose a conflict with wind energy development. Wind generating towers have been demonstrated to cause problems in accurately tracking aircraft since the turbine blade movements create a signal that is detected by the radar.

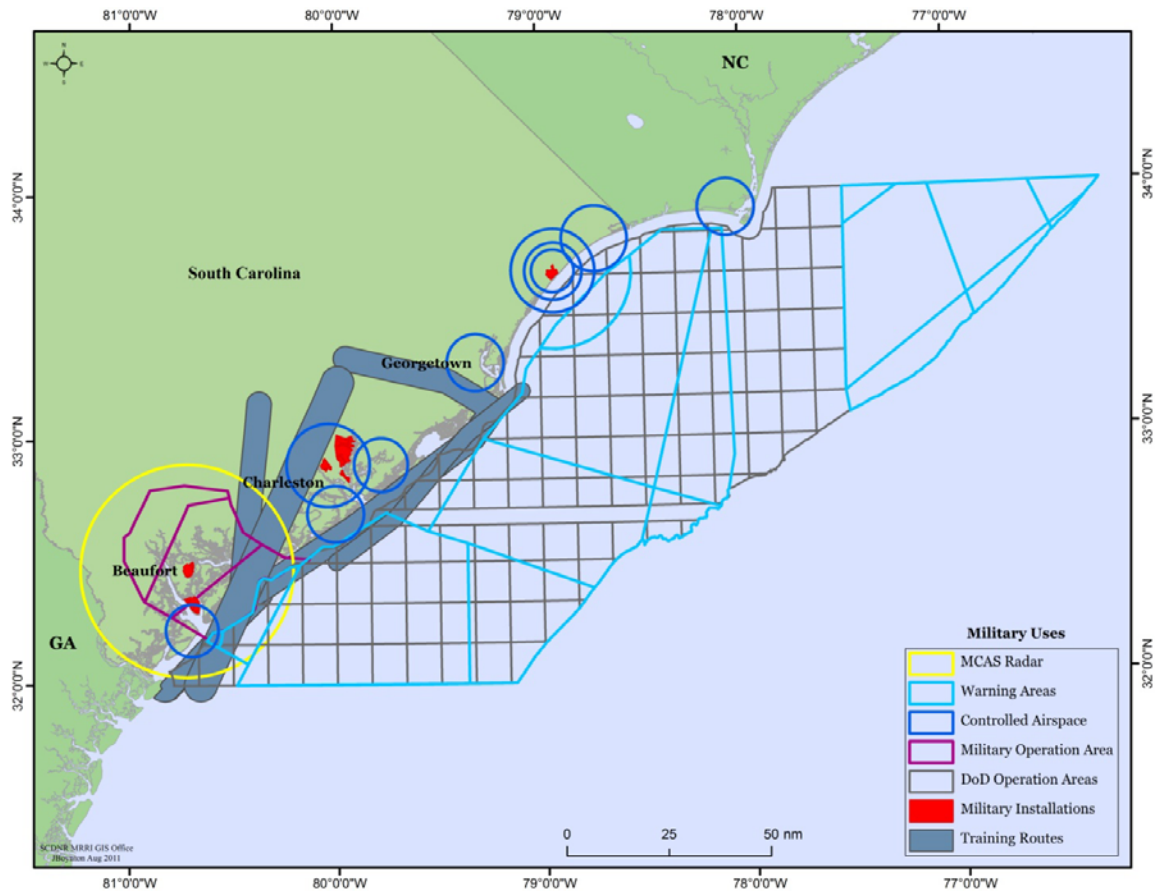


Figure 23. Summary of military training areas and other controlled space in the South Carolina study area.

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References:

Cooksey, C., J. Harvey, L. Harwell, J. Hyland, J.K. Summers. 2010. Ecological Condition of Coastal Ocean and Estuarine Waters of the U.S. South Atlantic Bight: 2000 – 2004. NOAA Technical Memorandum NOS NCCOS 114, NOAA National Ocean Service, Charleston, SC 29412-9110; and EPA/600/R-10/046, U.S. EPA, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Gulf Ecology Division, Gulf Breeze FL, 32561. 88 pp.

Southeast Areas Monitoring and Assessment Program – South Atlantic (SEAMAP-SA). 2001. Distribution of Bottom habitats on the Continental Shelf from North Carolina through the Florida Keys. SEAMAP-SA Bottom Mapping Workgroup, Atlantic States Marine Fisheries Commission, Washington, DC. 166p.

Weinbach, P.R. and R.F. Van Dolah. 2001. Spatial Analysis of Bottom Habitats and Sand Deposits on the Continental Shelf off South Carolina. Final Report to Minerals Management Service, INTERMAR Program. 21 p. + Appendices.