Understanding Impacts of the Sea Scallop Fishery on Loggerhead Sea Turtles through Satellite Tagging

Final Report for 2011 Sea Scallop

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By

Coonamessett Farm Foundation Inc

In Collaboration with

Viking Village Fisheries

277 Hatchville Road

East Falmouth, Massachusetts, USA 02536

508-564-5516 FAX 508-564-5073

cfarm@capecod.net

Project Summary

The focus of this project is to understand the distribution and behavior of loggerhead sea turtles in order to better understand the sea turtle interactions with the scallop fishery in an effort to reduce sea turtle bycatch in scallop fisheries. This entails data collection and analysis of sea turtle distributions and behaviors to identify spatial and temporal "hot spots" on the fishing grounds, as well as turtle behaviors that impact bycatch rates. The information collected will aid in evaluating harvesting strategy options that minimize harm to sea turtles, and better assessing loggerhead abundance.

One concentration was on further developing the methodologies of using a Remotely Operated Vehicle (ROV) as a research tool for observing behavior of loggerhead sea turtles on foraging grounds throughout the Mid-Atlantic. Our pioneering usage of the ROV has allowed us to observe the turtles' behaviors *in situ*, without greatly disturbing the animals. We worked together with Teledyne Benthos to design and construct a High Output MiniROVER ROV that has enabled us to more successfully follow loggerheads in an offshore environment. The ROV is outfitted with a video camera, sonar, and a time-depth-temperature sensor.

Better understanding satellite tag data interpretation and tagging methods were additional goals of this project, with the ultimate objective being to use these data to further analyze the movements and behaviors of the loggerhead sea turtles within areas of possible scallop fishery interactions. Dive profiles and migration patterns received from the satellite will be used in correlation with the ROV imagery. Coonamessett Farm Foundation (CFF) purchased ten Satellite Relay Data Loggers (SRDL) with Argos Fastloc GPS tags through the Sea Mammal Research Unit (SMRU) in 2011. Additionally, the Northeast Fisheries Science Center (NEFSC) received funds for fifteen tags, but no vessel time. Twenty-five turtles were caught and tagged through a joint effort between CFF and the NEFSC in June 2011.

The completed work represents a continuation and evolution of projects conducted since 2004 under RSA funding and NMFS contracts. These projects, besides developing fishing gear that both reduces turtle injury and mortality throughout the scallop fishery, have advanced the ability to locate, track, and observe loggerhead sea turtles through innovative use of dredge and ROV mounted video cameras. Data collected from the video images as well as the satellite tags will continue to build this unique set of observation records and will be used to assess ideas regarding the factors that govern sea turtle distributions and behavior in the Mid-Atlantic Bight (MAB) shelf region.

We originally planned for this project a total of fourteen DAS (Days at Sea) dedicated to ROV work, and seven DAS for oceanographic sampling with aerial over-flights. However, after consultation with our scientific partners at the NEFSC, the work plan was altered to focus on employing satellite tags without oceanographic sampling. The data that the tags provide, including surfacing locations, pressure/temperature/wet/dry sensors, and individual dive (max depth, shape, time at depth, etc.) and haul-out records, are complementary to the ROV work.

Two research trips were completed in 2011. The first trip was dedicated to tagging (seven DAS) which yielded a total of twenty-four tagging takes and nine "missed" takes (attempts that did not result in a capture). While the turtle was aboard, biological samples were also taken. The second trip focused on obtaining ROV data and tagging one turtle with our one remaining tag. After tagging, we began encountering performance issues with the ROV's tether and thruster motors. As a result, the trip was terminated after four DAS. As reported in the 2010 final report, although the ROV underwent repairs and modifications the problems were apparently not resolved. Over the winter we addressed these issues with Benthos and believe the ROV will perform properly in the 2012 field season.

The in-field tagging operation employed two fishing vessels (F/V Kathy Ann and F/V Ms Manya). Both vessels were involved in turtle sighting surveys for the entire cruise. Each vessel was equipped with a zodiac boat, which was deployed to capture the turtles to be tagged. All tagging was conducted on one vessel; the F/V Kathy Ann. The ROV program operated with a single vessel. The ROV's primary tasks involved tracking, observing, and filming loggerhead sea turtles to elucidate their *in situ* behaviors (i.e. feeding, diving, and breathing). The ROV is an excellent tool for validating the location and quantity of sea turtle prey species in the water column and on the sea floor.

During the two research trips (June and July 2011), a total of forty-eight turtles were sighted. All turtles were first observed on the surface or within five meters of the surface. On the ROV trip (July 2011), the crew collected about an hour and a half of footage, with about fifty minutes of that being observations of the behavior of benthic species including sand dollars, hermit crabs, scallops, ocean pout, and jellyfish.

Certain loggerhead turtle behaviors have been consistently observed on tagging and ROV trips over the years, including work completed in summer 2011. These include:

- Extensive feeding on jellyfish within the top 10 meters of water column
- Considerable time spent just under the water surface
- Short excursions to the seafloor through a significant temperature gradient
- Turning the carapace toward a potential threat

Take Summary: Take details can be found in Appendix A, Table A1

Trip	Takes
Kathy Ann 2011 – 1	24 tagging
	9 missed
Kathy Ann 2011 – 2	3 ROV
	1 tagging
	10 missed
Overall total	48 takes

RSA Funding Summary:

2011 Turtle Tagging RSA				**Updated:**	**7/30/2012**	
Income:		**Date:**	**Description:**	**Amount:**		lbs scallops
		8/23/2011	Vvillage/Kathy Ann 8/11	$96,467.78		38219
		9/21/2011	Vvillage/30 Fathom Corp	$51,238.84		19163
		10/2/2011	Vvillage/Ms Manya	$44,643.05		18229
		10/18/2011	MS Manya	$2,102.29		819
		1/30/2012	Celtic Fisheries-F/V Celtic	$63,357.36		21313
			Total:	$257,809.32		**97743**
			Less Expenses:	$155,522.35		
			Balance:	$102,286.97		

Introduction

In 2007, the Coonamessett Farm Foundation (CFF) began using an ROV for various research projects. Efforts were directed towards observing loggerheads in the water column and on the seafloor utilizing the video equipment mounted upon the ROV. In 2007, more than two-dozen loggerheads were recorded at, or near, the surface, although none at the sea bottom. Acquiring video footage of those bottom turtle sightings were impaired by operation difficulties with the ROV. Working with the ROV contractors, improvements were made to the vehicle and its operational procedures, which greatly enhanced its maneuverability and control characteristics.

These developments were successfully tested and utilized in June 2008, August 2008, June 2009, and July 2009. During these trips, over 200 turtles were observed from the vessel and over fifty loggerhead sea turtles were tracked with the ROV. This footage captured their feeding, diving, swimming, and social behaviors. Analysis of that video footage is now providing novel insight into loggerhead behaviors (i.e. the depth ranges occupied, frequency of resurfacing and breaths, feeding behaviors and prey species, shark and predator avoidance, intra/interspecies behaviors, etc.). A number of loggerheads were followed to bottom depths of sixty meters and water temperatures of 7.85°C, and were seen remaining in excess of thirty minutes without exhibiting signs of stress. Loggerheads were also observed feeding on jellyfish in the water column and benthic crustaceans on the seabed. Additionally, the ROV was towed behind actively fishing scallop vessels and physically encountered a loggerhead at ten meters depth in the discard stream of the scalloper.

In 2009, oceanographic sampling from a second vessel was incorporated into this project design. Oceanographic and plankton stations were occupied on a series of cross-shelf transects. A spotter aircraft was hired with a trained pilot and trained observer with the goal to correlate oceanographic data with loggerhead distributions. The aircraft was flown four times over eight transects, for a total of thirty-two runs, recording more than 200 total turtle sightings. This data's intended use was to provide a presence/absence survey of turtles on the sea surface, as opposed to a detailed species assessment. The first survey, conducted in July 2009 and discussed below, established that sea turtle distributions at that time of year were strongly associated with the geography of the "cold pool", a highly oxygenated water mass of temperatures between six and ten degrees Celsius that originates further north on the Scotian Shelf (Houghton et al., 1982). The ROV video confirmed that loggerheads were bottom feeding on crabs and mollusks in those waters, spending as much as thirty minutes in a single dive, and using the warm surface waters (20-22°C) to adjust their body temperature between dives.

A second survey was conducted in September 2009 that repeated the July surveys. Having demonstrated success in acquiring these various data and their value as a means of establishing a factual basis for understanding sea turtle ecology, a great deal of new information about variability in loggerhead distributions and behavior on monthly timescales has been documented, specifically regarding the role of ocean currents in determining that variability.

The goals of the 2010 project continuation included data collection and analysis of sea turtle locations and behaviors, which was done by completing three research trips to sea. A total of fourteen immature sea turtles were captured and satellite-tagged, and the final analysis of the archived tag data will take a considerable amount of time over the next few years. Data collected by CR Environmental, Inc. (CRE) of Falmouth, MA, provided technical support to CFF in the collection of physical oceanographic measurements and biology. Current and CTD profiling and zooplankton tows were completed with the purpose of acquiring an assessment of the water column organisms available for foraging by loggerhead turtles, to determine if the biological community is different in areas where the turtles are observed, compared to areas where they are not. The 2011 project eliminated these oceanographic analyses in favor of satellite tagging, completed ROV dives from surface to sea floor, which gave a better vertical profile of the organisms present.

Methods

Two separate surveys took place from June 1-7, 2011 and July 25-28, 2011, of tagging and ROV operations, respectively. Two commercial vessels were utilized for tagging, and one was used for the ROV operations. Vessel coordination and operations were overseen by Jim Gutowski (Viking Village Fisheries), with whom CFF has successfully interacted in past years' RSA work. For the tagging trip, both vessels conducted turtle sighting transects, with one vessel exclusively conducting tagging and sampling procedures. During the ROV trip, the vessel steamed to areas of reported turtle sightings on the scalloping grounds to conduct operations. Locations of all turtle sightings and takes were logged. The vessel acquired and followed individual turtles, recording behaviors associated with breathing, swimming, and location in the water column.

ROV Operations

The ROV, equipped with video camera, sonar, and a time-depth-temperature sensor, acquired and followed individual loggerheads, recording behaviors associated with breathing, swimming, and location in the water column.

The MiniROVER ROV is outfitted with both a 10X zoom TV camera and a low light black and white TV camera, which are mounted on a tilt mechanism inside an optically clear cast acrylic pressure housing on the bow of the vehicle. The tilt mechanism can tilt at 33 degrees per second up to 90 degrees up and down from horizontal. This tilt function allows for adjustment for the optimum "gazing angle" to represent objects and features in the water column as well as on the sea floor. It also enhances the ROV pilot's ability to collect detailed video of fish objects, and seafloor features. The color zoom camera provides 470 lines of resolution using a single chip CCD and includes auto iris and gain; the black and white TV camera provides 600 lines of resolution. The bow is also equipped with a total of six LED light sources, three per side, each positioned 45 degrees apart, to provide a 240 degree wide fixed beam of light. The lights can be turned on and off, or can be dimmed from the ROV operational hand box.

The Ultra-Miniature Digital Scanning Sonar (model 852-000-100) designed by Imagenex Technology Corporation, were placed upon the ROV as well. The sonar is designed for use upon small ROVs, and is housed within a pressure housing with a fluid filled front. Power consumption is approximately 2.5 watts from 24 VDC. The system produces images with a range resolution of 20mm at a frequency of 675/850 kHz. It has the possibility to scan a full 360° with a range of 150 mm up to 50 meters. The aluminum and polyurethane sonar device weighs less than 0.4 lbs. in water.

All video footage was recorded directly to a hard drive using the Roxio Easy VHS to DVD program and then subsequently burned onto DVDs, while the sonar footage was recorded using its own self-recording program, and then burned to DVDs as well.

The basic procedure for conducting transects was as follows. At approximately 0700, the crew began a transect holding a straight course based on the best sighting conditions (sea state, wind, glare, etc.) at a speed of four knots. A total of five observers were on the lookout for turtles; four CFF scientists, and one NMFS member who was aboard to assist with the deployment of one more satellite tag. Two observers were posted in the masthead crow's nest at an eye height of fourteen meters above the sea surface, and two more were on top of the wheelhouse at an eye height of six meters above the surface. The fifth observer was in the pilothouse, with the Captain, with an eye height of four meters above the sea surface. All observers used binoculars for scanning around the vessel. The masthead observers were equipped with image stabilizing 10x35 binoculars and VHF radios for communications to the captain and ROV operator.

Ronald Smolowitz, CFF Chief Scientist, oversaw operations, assisted by Bill Campbell of Ocean Eye Underwater Inspection for ROV operation. Onshore analysis of the video and data recordings is ongoing but the data is continually being released to collaborating scientists (see Addendums to this report).

Turtle Following Mode

Visually sighting a turtle from a fishing vessel is made difficult by sea state and glare. The sun needs to be a certain distance above the horizon, even on the best weather days, before a successful search pattern can be mounted. During the June to July period, efforts were focused between 0700 and 1800. Sighting conditions varied throughout the day. The masthead position proved to be the most important. Turtles are commonly in the top meter of the sea, just under the surface, and they surface every few minutes to take a breath. Typically, the masthead observer would spot the turtle first and alert the observer on the foredeck and captain in the wheel house. The vessel would be directed towards the turtle; usually the captain would get a visual of the turtle and needed no further guidance from the masthead.

When a turtle was spotted, the vessel was directed to approach by the masthead observer. Some turtles were spotted submerged two to five meters deep, but very close to the vessel, and others were spotted several hundred meters away on the very surface. The vessel was stopped when turtles were in close proximity to the boat; when turtles were spotted further away, the boat was maneuvered to within 50 meters of the animal, attempting to place the turtle windward in relation to the vessel. Positions were recorded and a continuous GPS track maintained. For most of the dives, the ROV was deployed from the port rails of the vessel with two tether handlers on deck to pay out or retrieve the tether as needed. Meanwhile, the captain maneuvered the vessel as close as possible in order to get the turtle to windward and 50 meters out. Careful attention was paid to not allow the vessel to drift over the ROV tether. When everything was ready, the ROV was launched and steered toward the turtle's position. Commonly the masthead observer had the best view and communicated via the VHF radio to the ROV assistant which way the ROV should be heading.

Using an ROV in the open ocean to track a sea turtle is not a simple task. The ROV is a complicated tool with electronic, electrical, mechanical, and optical systems, which are all subject to frequent failure. Even when all systems are functioning well, maintaining a visual on a moving turtle is a difficult task. The ROV operator needs to know the location of the vehicle relative to the vessel while simultaneously knowing the position of the turtle relative to the ROV. Once the turtle is on the video screen, the operator must monitor the video screen continuously but also be aware of the sonar images. All data collected has to be recorded and annotated. While the ROV video was streaming, a scientist took notes of the video events for later review and analysis. The procedures and methods used were developed during previous trips and applied on the ROV trip discussed in this report.

To avoid startling the turtle, which would likely cause the animal to dive, the ROV approached the turtle from its front, when possible. We found it best to stop the ROV about ten meters away from the animal and then approach it slowly until it was acquired. We would then track the turtle, maintaining a distance of three to five meters if possible. If the turtle approached the ROV, we would have the ROV remain still to allow the turtle to investigate the vehicle. When video contact with the turtle was lost, the Imagenex sonar was used to search, as well as visual searches from the vessel. If no contact could be made, we would then proceed to complete a "bottom search," or a general search of the seafloor.

Four of these bottom dives were completed during the July trip. The purpose of these dives was to attempt to record prey species, primarily jellyfish, in the water column. The ROV was equipped with a Onset temperature/depth logger, so we could continuously record temperature on the way down and at the seafloor. Once upon the bottom, the crew operating the ROV would return to searching for turtles while also observing the benthic fauna.

Jellyfish Dives

To examine how jellyfish are distributed in the water column, we used ROV technology to record the location of the jellyfish, and then to identify them to species level. Most of the jellyfish population that has been researched has been located within and slightly below the thermocline and within the dissolved oxygen maximum layer of the water column. (Alvarez et al., 2009). Therefore, our vertical profiles typically went from the surface to the bottom, throughout the entire water column. Field and experimental studies have shown that jellyfish are light dependent and usually move upward in the water column at dusk and downward at dawn (James et al., 2006). During our research, we noticed that loggerhead turtles spend a high portion of their time at or near the surface during times of high jellyfish abundance. This behavior puts them at risk for collisions with other vessels, and by continuing to investigate loggerhead behavior in conjunction with jellyfish distribution and oceanographic trends, we can begin to identify and address patterns in loggerhead behavior which may be able to reduce takes within the scallop industry in the future. Due to the importance of jellyfish to understanding loggerheads we have included a brief synopsis below.

Jellyfish have evolved over 500 million years and have uniquely adapted to flourish in coastal waters now devoid of many predators due to high fishing pressure. These gelatinous animals consume crustaceans and other marine life that might otherwise be food for commercially important fish stocks (Bailey and Batty, 1984; Moller, 1984; Arai, 1988; Cowan and Houde, 1993; Purcell et al., 1994; Purcell and Arai, 2001). There is evidence to suggest that rather than solely being weak swimmers that passively drift with the water currents, many species of jellyfish can display complicated interactions with their environment (Hamner and Hauri, 1981; Hamner et al,.1994; Albert, 2007). Their behaviors include swimming up in response to somatosensory stimulation, swimming down in response to low salinity, diving in response to turbulence, avoiding rock walls, forming aggregations, and horizontal directional swimming (Albert, 2010). Due to recent work exploring distribution of jellyfish through both vertical profiling in the water column and temporal profiling through their historical ranges, connections between oceanographic trends and jellyfish distribution can now be determined.

In general, it is difficult to measure the abundance and distribution patterns of jellyfish; therefore ecological studies involving large jellyfish have been limited. The few accepted methods used to research jellyfish include video profiles, scuba diving, and aerial and acoustic surveys (Bamstedt et al., 2003; Uye and Shimauchi, 2005; Houghton et al., 2006). Underwater acoustic surveys can give information about the distribution of jellyfish but lack detailed information, and often limit the ability to discriminate between animals with similar physiological composition (Graham et al., 2010). Behavior seen by jellyfish during an aerial survey might reflect a reaction to physical disturbance experienced in rough sea, whereas breaking waves might cause physical damage. For example, aerial surveys have shown that for some species (e.g. *Rhizostoma octopus*), fewer jellyfish are seen on rough days and more on calm days, which would imply they avoid the surface in rough conditions. (Houghton et al., 2006; Graham et al., 2010).

Traditional biomass surveys have used plankton nets to provide semi-quantitative estimates of jellyfish abundance, though using mechanical means to sample produces several issues. Nets cannot sample volumes large enough to accurately determine jellyfish concentration, nor do they account for the ubiquitous patterns of most large jellies. Net sampling techniques are also problematic for estimating jellyfish distribution and abundance because jellyfish become caught in the net, and often, fragile tissue becomes damaged and makes identification inaccurate (Graham et al., 2010).

An alternative to the above mentioned methods is to use an ROV to film jellyfish in their natural environment throughout the water column. Observations made from ROV's can provide information on the abundance and distribution of other members of the ecosystem, as well as real-time recording of environmental information, which can prove to be valuable data. In many situations, vertical video profiles, which can be collected during ROV dives, provide the most detailed information on abundance and distribution (Bamstedt et al., 2003). A video system overcomes the primary faults of other types of surveys for large jellyfish by allowing the researcher to sample large volumes of water without disturbing the behavior and position of large gelatinous zooplankton (Graham et al., 2003).

Tagging Operations

The NEFSC portion of this tagging study is part of the AMAPPS (Atlantic Marine Assessment Program for Protected Species) project, which is a large, multi-agency initiative to provide a comprehensive assessment of marine mammal, sea turtle, and seabird abundance and spatial distribution in US waters of the western North Atlantic Ocean. The goal of the AMAPPS initiative is to develop models and associated tools to provide seasonal, spatially explicit density estimates of marine mammals, sea turtles, and seabirds in the northwest Atlantic. Data will be collected on the seasonal distribution and abundance of these taxa using direct aerial and shipboard surveys conducted by scientists from the National Marine Fisheries Service and the US Fish and Wildlife Service. Concurrently, telemetry studies, passive acoustic monitoring, and development of alternative survey methodologies are also being conducted under AMAPPS. The telemetry data will be used to develop corrections for availability bias in the abundance estimates and to collect additional data on habitat use and life history, residence time, and frequency of use. Data collection for this study are planned to occur over multiple years.

As part of the AMAPPS project, satellite tags were deployed on immature loggerhead sea turtles captured in offshore Mid-Atlantic waters. The US Mid-Atlantic region is an important foraging ground for loggerhead sea turtles, but due to complications involved with locating and capturing these immature turtles on their offshore foraging grounds, relatively little is known about the large, immature turtles that occupy the neritic offshore Mid-Atlantic region.

All tagging operations on this project were operated under the terms of the NEFSC turtle permit. Ronald Smolowitz is a Cooperative Investigator (CI) on this permit and has undergone NMFS training on handling and sampling sea turtles. All sea turtles brought on board that were comatose or inactive were handled in accordance with Sea Turtle Resuscitation Regulations at 50 CFR 223.206(d)(1). The crew of the vessel released sea turtles that were actively moving over the stern of the boat when gear was not deployed and engine gears were in a neutral position, in areas where they were unlikely to be recaptured or injured by vessels.

Tagging Methods

The Northeast Fisheries Science Center (NEFSC) partnered with CFF, with assistance from Viking Village Fisheries (F/V Kathy Ann and F/V Ms. Manya) to provide the vessel, crew, and at-sea scientific personnel of this project. This partnership allowed loggerheads to be sampled in their offshore Mid-Atlantic natural foraging grounds.

In June and July of 2011, the F/V Kathy Ann (a ninety-five foot commercial fishing vessel rigged with a crow's nest, rising sixty feet above the water line) and the F/V Ms. Manya (80 feet long;

crow's nest 50 feet above the water line) were used to locate immature loggerheads in an area known to have overlap between large, immature loggerheads and commercial fishing activity. This area is within the Mid-Atlantic Bight, roughly fifty to one hundred miles offshore of Delaware and New Jersey. After an animal was located, a 14-ft. Zodiac was deployed from the boat closest to the animal to capture the loggerhead using a large dip net, as detailed in the following paragraphs. The SMRU SRDL tags were attached exclusively aboard the F/V Kathy Ann, using epoxy to secure the tag to the second central carapace scute. Captured turtles were also measured (curved carapace length, CCL), photographed, biopsied, and flipper and PIT tagged.

Once in an area of high turtle density, one scientist from the masthead and one crewmember from each boat manned their respective Zodiacs. The Zodiacs are open, fourteen foot Achilles with a soft bottom and a twenty-five horsepower tiller operated motor. The boats are equipped with all required Coast Guard safety/emergency equipment as well as a five-gallon fuel tank and VHF radio. The Zodiac's captain manned the VHF radio in direct contact with the crow's nest and wheelhouse. The scientists positioned in the crow's nest directed the zodiac to the position of the targeted turtle. The Zodiac initially moved at a low speed until both its captain and scientist visually acquired the turtle. Upon sighting the turtle, the captain increased the speed of the zodiac on a heading directly toward the targeted turtle. The net used is a NMFS approved ARC twelve foot Model DN6P dip net constructed of lightweight, durable aircraft aluminum, with a 97 inch circumference hexagonal frame, 38 inch bag depth, and two and a half inch square seamless anti-abrasive knotting (dipped and coated). This net complies with NMFS approved design specifications: twelve foot by one inch aluminum breakdown (with three to four inch sections) anodized pole with sure grip handles. During the capture, the net was attached to the zodiac's bow via a five-foot tether.

Using the guidance from the scientists in the crow's nest, the Zodiac was directed to approach the turtle from behind with the turtle facing away from the boat. The netter was positioned low on the zodiac's bow with net in hand, working to acquire the turtle visually. Once within six feet of the turtle, the netter immediately placed the net directly in front of the turtle to prevent the turtle from diving and escaping. Simultaneously, as the net was deployed, the boat operator put the boat into hard reverse, which assisted in propelling the turtle into the net. The netted turtle, still in the water, was then carefully brought alongside the boat and lifted onboard with the help of the crewmember. The utmost care was taken throughout the capture process, with special attention to not put pressure on the head/eyes, or to allow the turtle to bite the crewmembers or inflatable vessel. The captured turtle was kept safely inside of the net on deck of the Zodiac during the immediate transit back to the F/V Kathy Ann. The captured turtle onboard the collection boat was transferred to the deck of the F/V Kathy Ann using the dip net. The handle of the dip net was removed and the net attached (as a brailer) to a specially rigged winch and boom.

Results & Discussion

A total of twenty five immature loggerhead sea turtles with curved carapace lengths ranging from 61 to 87 cm were captured and satellite tagged, primarily offshore of New Jersey and Delaware (Table 1). Table 2 depicts, according to the SMRU website as of July 31, 2012, the dates and times of the most recent uplink for each tag as well as the initial tagging date. At that time, twelve of twenty-five were still transmitting data. The satellite-relayed data are currently stored in four different locations. Location data are downloaded daily to the publically accessible website:
http://www.seaturtle.org/tracking/?project_id=537.

Figure 1 shows the composite seaturtle.org map of these tags for the entire study period. The detailed GPS location, temperature, and dive data are downloaded daily to a password-protected

SMRU website and an ArgosWeb website, and all data are intermittently uploaded to a NEFSC Oracle database

The loggerheads appeared to be following the same general path. In the fall, they were located throughout the Mid-Atlantic, usually staying within a 2000 mi^2 area. Around November, the turtles began to move south to just off of North Carolina, where they remained for the majority of the winter. One notable "hot spot" that almost each turtle traveled to was the Diamond Shoals area off of Cape Hatteras. Just before springtime, the turtles began their ascent back up the eastern coast, making it back to almost the same areas by mid-summer. Another interesting observation found is periods of time where multiple turtles follow the same track, appearing as they are traveling together. One example of such incidence is depicted in Figure 2.

The Remotely Operated Vehicle (ROV) was used aboard the vessel F/V Kathy Ann out of Barnegat Light, NJ, in July 2011. Four days were spent at sea but due to problems encountered with the ROV, only two days of footage were obtained. Both trips focused on scallop grounds with water depths of fifty to eighty meters, during the months of June and July 2011, when and where turtles are known to be present. Additionally, locations of the previously tagged turtles were taken into account, in an effort to find and archive footage of these tagged turtles. During the two-day period, eleven dives were completed, yielding an hour and a half of footage. During that time, thirteen turtles were sighted. Each turtle was first observed on the surface or within five meters of the surface. The crew collected forty-eight minutes of sea floor video observing the behavior of benthic species, including sand dollars, hermit crabs, scallops, ocean pout, and jellyfish.

For the majority of the dives, the ROV was deployed from the port rail of the boat with two tether handlers on deck. Due to the high level of background noise aboard the vessel, verbal communications between the deck, spotters, and ROV control station was limited, making the usage of VHF radios imperative. While attempting to get video images of the many sea turtles that were spotted throughout the trip, we were repeatedly confounded in our efforts by the high background noise, the drift of the vessel, the poor operation of the sonar system on the ROV, and sea states that bounced the vehicle when it was near the surface.

During the ROV dives, notes were made on the presence of jellyfish within the screen shot, and all were found between zero to sixteen meters. The satellite tag data provides dive profiles of each turtle. When looking specifically at the dive profiles of the tagged turtles from the dates of the ROV trip, it can be inferred that the turtles are completing the majority of their shallow dives within the depth range where jellyfish are most abundant. Figure 3 displays this period of dive data. Depths of the jellyfish locations can be found in Table A2 of Appendix A.

While this project was not a survey effort, we did obtain some useful data on loggerhead abundance. We operated in areas we believed to have the greatest opportunity to locate turtles; these were also known scallop grounds. We searched for turtles by steaming in a line, which we called a "transect". On average, we traveled at a speed of four knots. When we spotted a turtle, we attempted to launch the ROV in an effort to follow the turtle, so there were many interruptions in the transect throughout the course of a day. However, by the end of the day we transited a known distance and typically observed a number of turtles. This transect data can be compared to the abundance estimates derived from aerial surveys.

The massive amount of data being collected by the tagging component of this, and previous efforts, is undergoing continuous use by multiple researchers and resource managers (see Addendum B-F). We are working on a number of peer reviewed papers on the ROV work and its relationship to the interpretation of tagging data.

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Table 1: Curved carapace length (CCL), release date, and location of each captured loggerhead turtle.

Turtle ID	Date	Lat (N)	Long (W)	CCL (cm)
1	6/2/11	38°42.5'	74°08.1'	ND
2	6/2/11	38°38.7'	74°05.7'	67.0
3	6/2/11	38°39.0'	73°59.8'	74.8
4	6/2/11	38°37.1'	73°58.4'	77.0
5	6/3/11	38°02.6'	74°36.5'	69.5
6	6/3/11	37°58.8'	74°38.3'	76.0
7	6/3/11	37°59.5'	74°37.7'	76.0
8	6/3/11	37°59.2'	74°37.3'	73.3
9	6/3/11	37°59.1'	74°37.1'	78.0
10	6/3/11	37°58.9'	74°36.5'	84.0
11	6/3/11	37°58.1'	74°34.5'	69.0
12	6/4/11	37°45.4'	74°42.8'	85.5
13	6/4/11	37°44.0'	74°42.6'	86.5
14	6/4/11	37°43.3'	74°43.4'	78.5
15	6/4/11	37°42.4'	74°43.6'	72.0
16	6/6/11	37°56.9'	74°40.7'	71.5
17	6/6/11	37°58.4'	74°43.3'	61.0
18	6/6/11	37°59.9'	74°44.1'	77.0
19	6/6/11	37°58.0'	74°43.5'	81.0
20	6/6/11	37°58.0'	74°43.9'	69.3
21	6/6/11	37°56.7'	74°43.1'	72.0
22	6/6/11	37°56.7'	74°42.4'	87.0
23	6/6/11	37°56.5'	74°42.2'	74.5
24	6/6/11	37°56.3'	74°41.8'	74.2
25	6/6/11	37°55.0'	74°41.9'	81.6

Table 2: The dates and times of the most recent uplink and initial tagging location for each CFF and NEFSC tag according to the SMRU website.

Reference	Latest uplink	Latest location	PTT	Body	Parameters
tu67-R392-11	31-Jul-2012 22:22	30-Jul-2012 00:00	108392	12041	FA_11A
tu67-R393-11	29-Nov-2011 15:06	02-Oct-2011 09:09	108393	12054	FA_11A
tu67-R394-11	31-Jul-2012 22:21	30-Jul-2012 00:00	108394	12046	FA_11A
tu67-R395-11	15-Oct-2011 13:40	18-Sep-2011 16:45	108395	12038	FA_11A
tu67-R396-11	20-Jun-2012 13:27	07-Sep-2011 07:42	108396	12026	FA_11A
tu67-R397-11	22-Jun-2012 13:48	20-Jan-2012 00:00	108397	12036	FA_11A
tu67-R398-11	31-Jul-2012 19:32	30-Jul-2012 00:00	108398	12043	FA_11A
tu67-R399-11	31-Jul-2012 10:55	30-Sep-2011 20:07	108399	12035	FA_11A
tu67-R400-11	29-Jul-2012 22:44	20-Jan-2012 00:00	108400	12042	FA_11A
tu67-R401-11	20-Jun-2012 13:24	20-Jan-2012 00:00	108401	12047	FA_11A

Reference	Latest uplink	Latest location	PTT	Body	Parameters
tu68-H377-11	12-Jul-2012 19:17	29-Sep-2011 02:30	108377	12030	FA_11A
tu68-H378-11	29-Jun-2012 08:31	05-Sep-2011 21:58	108378	12050	FA_11A
tu68-H379-11	10-Jul-2012 18:13	28-Sep-2011 22:04	108379	12051	FA_11A
tu68-H380-11	04-Jun-2012 19:28	02-Oct-2011 05:58	108380	12031	FA_11A
tu68-H381-11	17-May-2012 14:32	02-Oct-2011 04:07	108381	12045	FA_11A
tu68-H382-11	30-Jul-2012 01:43	02-Oct-2011 17:38	108382	12034	FA_11A
tu68-H383-11	31-Jul-2012 15:23	02-Oct-2011 22:33	108383	12049	FA_11A
tu68-H384-11	31-Jul-2012 17:50	24-Sep-2011 18:10	108384	12039	FA_11A
tu68-H385-11	31-Jul-2012 19:08	05-Oct-2011 11:28	108385	12033	FA_11A
tu68-H386-11	28-Jul-2012 06:59	05-Oct-2011 13:25	108386	12066	FA_11A
tu68-H387-11	29-Jul-2012 21:32	05-Oct-2011 11:55	108387	12071	FA_11A
tu68-H388-11	17-Jul-2012 07:15	05-Oct-2011 13:29	108388	12065	FA_11A
tu68-H389-11	21-Jun-2012 20:08	05-Oct-2011 09:09	108389	12072	FA_11A
tu68-H390-11	31-Jul-2012 22:01	03-Oct-2011 19:52	108390	12069	FA_11A
tu68-H391-11	23-Jul-2012 13:49	05-Oct-2011 19:41	108391	12068	FA_11A

Figure 1: Location information as displayed by seaturtle.org on July 31, 2012. The stars indicate the last recorded location.

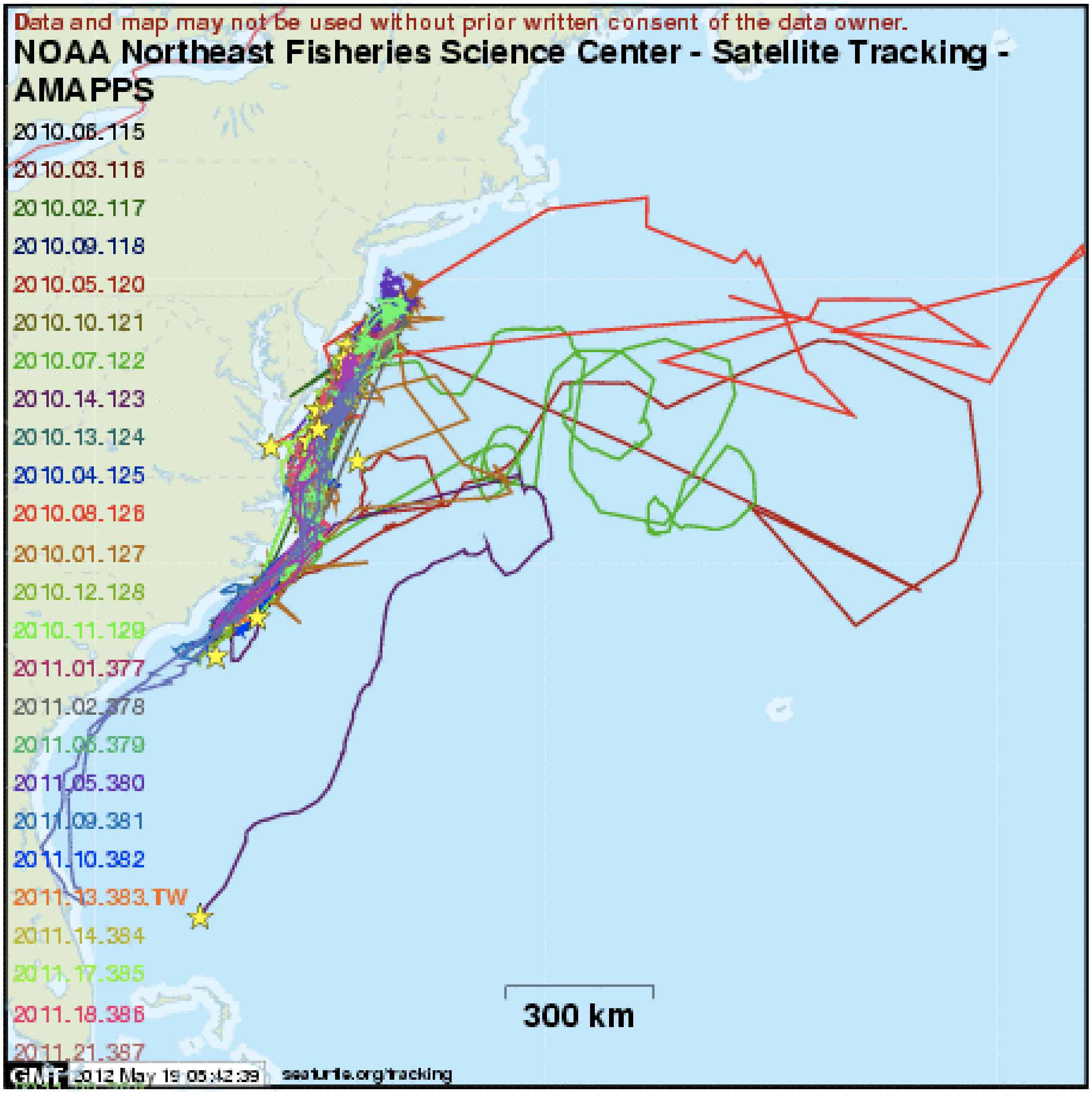


Figure 2: Turtles R393 (light blue), R394 (red), and R400 (dark blue) as they follow the same path from August 25, 2011 through September 1, 2011. The turtles are seen traveling together in frames 1 and 2. The turtles are then seen completing a small counterclockwise loop in frames 3-5. All satellite tagging data were downloaded from the SMRU website and shown in Google Earth.

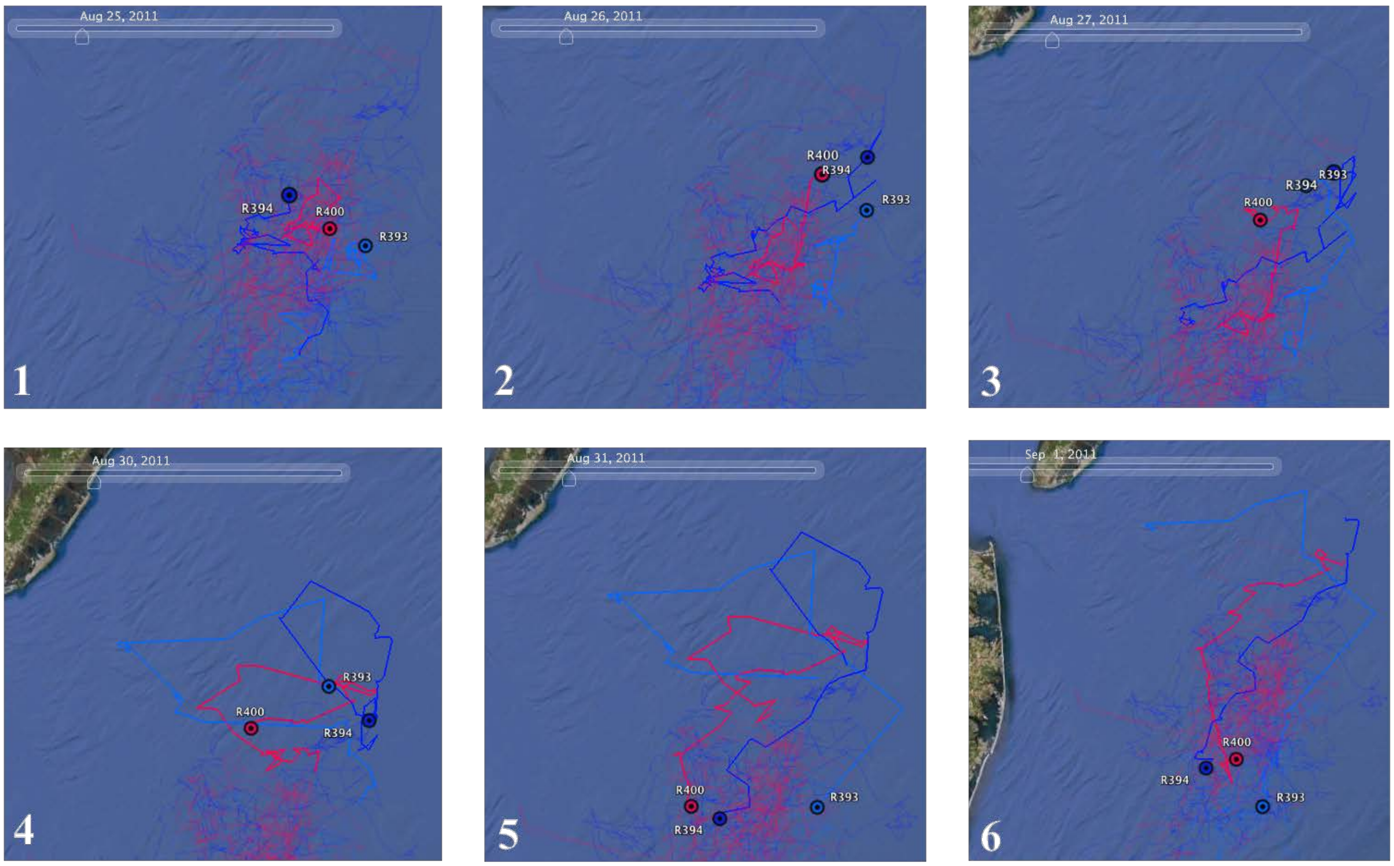
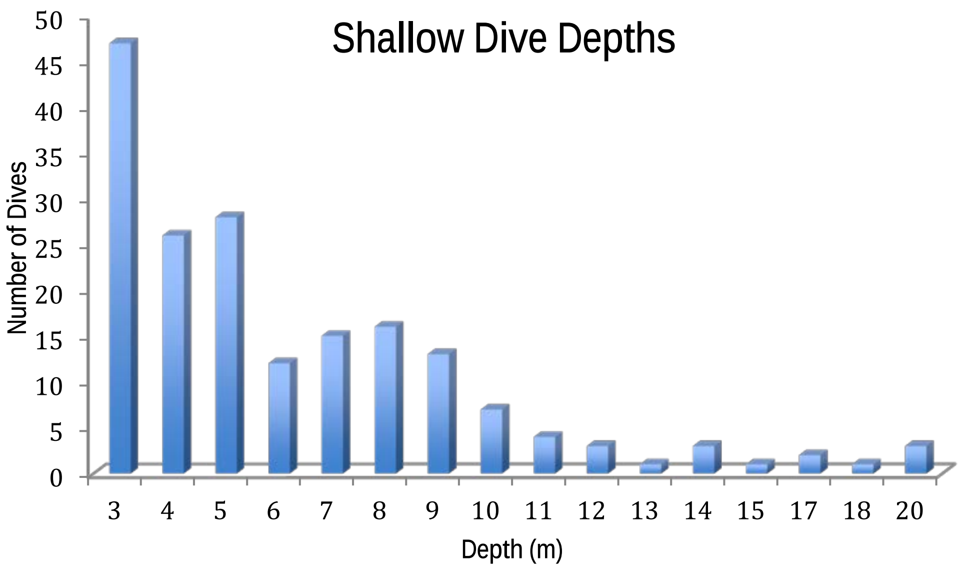


Figure 3: Frequency of the number of shallow (0-20 meter) dives completed by each turtle from July 26, 2011 through July 27, 2011.



Addendum A:

Table A1: Tagging trip turtle take events, Kathy Ann 2011-1

Date	Time	Latitude	Longitude	SST (ºC)	Depth (m)	Turtle #	Take #	Tag #	Tag Boat #
6/2/11	0820	38 45.6	74 07.4	21.6	44.7	m-1	1		1
6/2/11	0935	38 42.5	74 08.1	21.8	52.8	1	2	h12030	1
6/2/11	1154	38 38.8	74 07.8	21.9	50.8	m-2	3		1
6/2/11	1249	38 38.7	74 05.7	22.1	50.4	2	4	h12050	2
6/2/11	1300	38 38.7	74 05.7	22.1	50.4	m-3	5		2
6/2/11	1536	38 39.0	73 59.8	22.3	49.4	3	6	s12026	2
6/2/11	1817	38 37.1	73 58.4	22.3	52.7	4	7	s12041	1
6/3/11	0939	38 02.6	74 36.5	21.2	34.6	5	8	h12031	1
6/3/11	1158	37 58.8	74 38.3	21.5	37.4	m-4	9		1
6/3/11	1159	37 58.8	74 38.3	21.5	37.4	6	10	h12051	1
6/3/11	1245	37 58.5	74 37.7	21.5	40.8	7	11	s12042	2
6/3/11	1400	37 59.2	74 37.3	21.6	38.5	m-5	12		2
6/3/11	1402	37 59.2	74 37.3	21.6	38.5	8	13	s12054	2
6/3/11	1412	37 59.1	74 37.1	21.7	38.5	9	14	h12045	1
6/3/11	1445	37 58.9	74 36.5	21.8	39.7	10	15	h12034	2
6/3/11	1620	37 58.1	74 34.5	21.8	43.5	11	16	s12047	1
6/3/11	1815	37 55.9	74 31.4	20.9	52			plankton	sample
6/4/11	1057	37 45.4	74 42.8	20.9	50.2	m-6	17		2
6/4/11	1105	37 45.4	74 42.8	20.9	50.2	12	18	s12035	2
6/4/11	1256	37 43.9	74 42.6	21.1	49.4	13	19	h12049	2
6/4/11	1605	37 43.3	74 43.4	21.2	49	14	20	h12039	1
6/4/11	1625	37 42.5	74 43.6	21.3	48.1	15	21	s12036	2
6/5/11	0830	37 43.5	74 43.5	21.1	50.1	m-7	22		1
6/6/11	0918	37 56.9	74 40.7	21.4	38.7	16	23	s12043	2
6/6/11	1105	37 45.3	74 43.2	21.5	36.1	m-8	24		2
6/6/11	1119	37 58.4	74 43.3	21.7	36.1	17	25	h12033	1
6/6/11	1140	37 57.9	74 44.1	22.1	34	18	26	h12066	2
6/6/11	1140	37 58.0	74 43.5	22.2	31.9	19	27	s12046	1
6/6/11	1228	37 58.0	74 43.9	22.4	30.7	20	28	s12038	1
6/6/11	1329	37 56.7	74 43.1	23.4	33.1	21	29	h12071	1
6/6/11	1350	37 56.7	74 42.4	23.2	34.5	22	30	h12	1
6/6/11	1400	37 56.7	74 42.4	23.2	34.5	m-9	31		1
6/6/11	1415	37 56.5	74 42.2	23.2	35	23	32	h12072	2
6/6/11	1445	37 56.3	74 41.8	23.1	38.1	24	33	h12069	1
6/6/11	1537	37 55.0	74 41.9	23.1	40.1	25	34	h12068	1

Note: SST taken from vessel hull temperature probe which was out of calibration. We adjusted by comparison with bucket temperature.

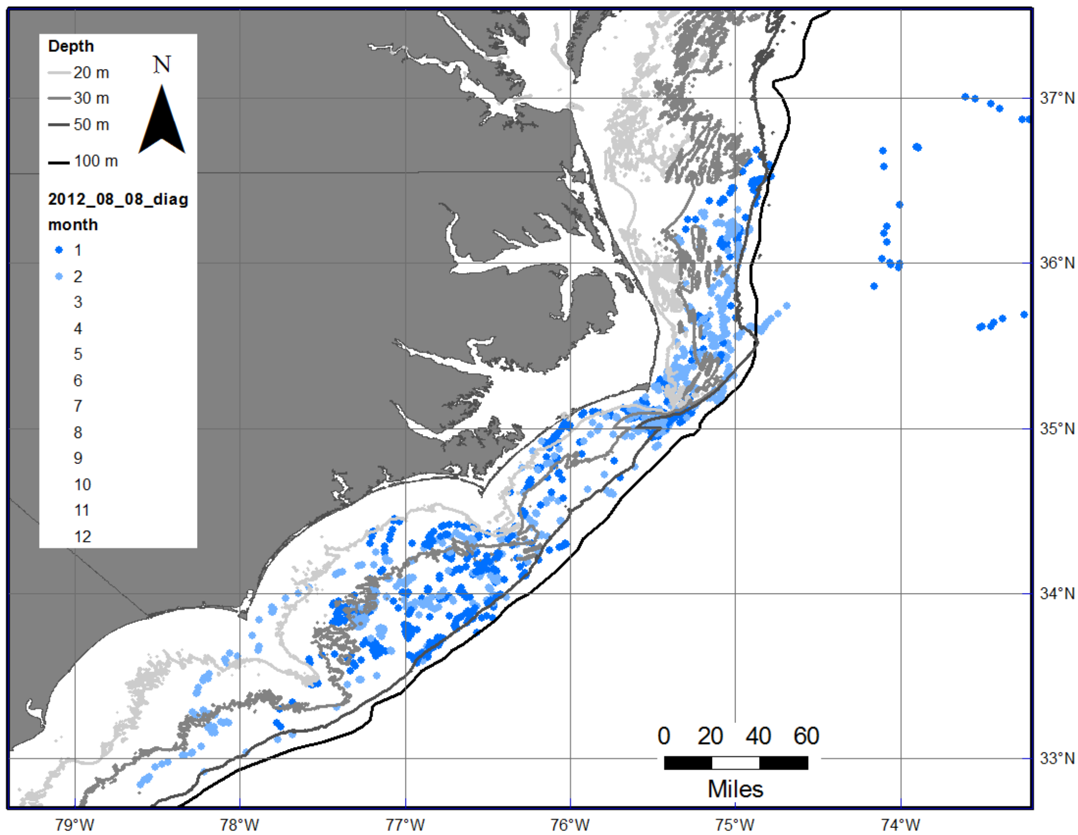
Table A2 – Timeline of ROV video events, Kathy Ann 2011-2

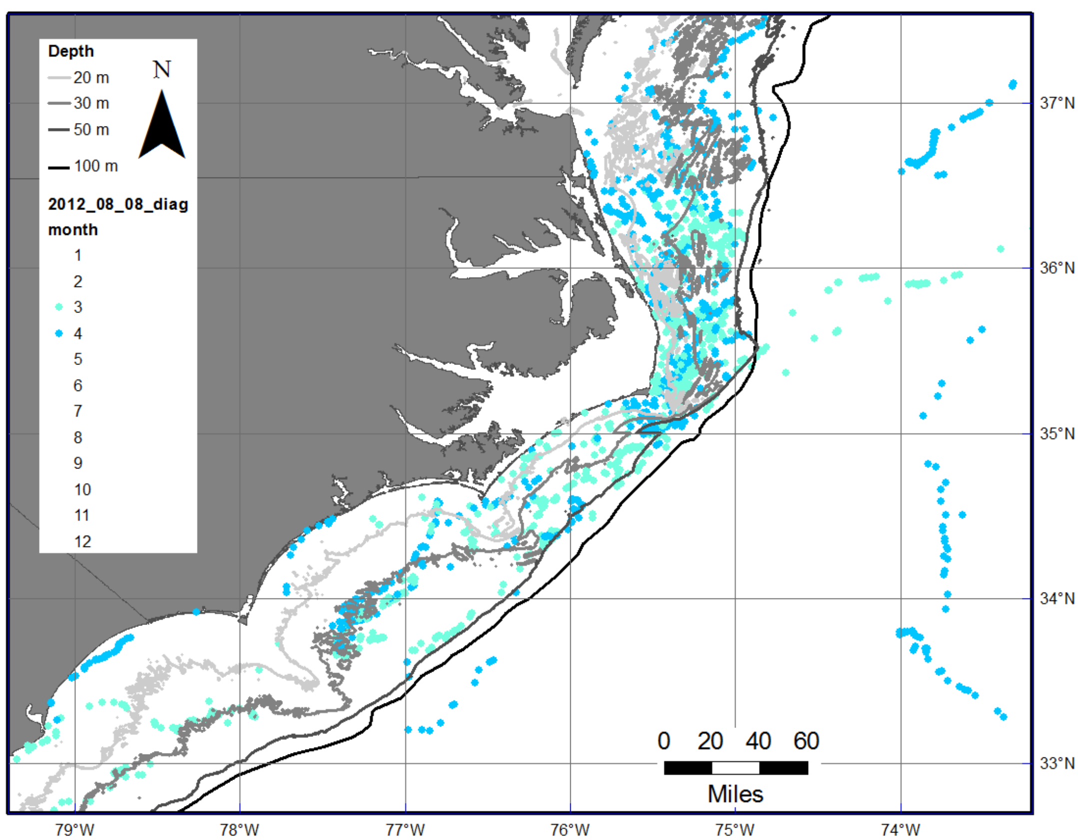
Time Code	Direction	Depth (m)	Acquired	Lost	Clarity	Jellies	COMMENTS
Dive 1							ROV dive began
11:34:35	015	0.5	11:34:45		3		Sighted with ROV for 15 sec but then swam out of sight to about 25 ft away.
11:43:12				11:43:12			Failed to acquire turtle. Retrieved ROV.
Dive 2 Turtle 1							ROV dive began
13:47:55	090	4	13:47:55		5		Acquired turtle
13:50:35	148	2			5	Y	Immediate dive, lost, observed at surface by spotters. Comb jellies.
14:02:08	076	0.5			4	Y	Recovered sight of turtle
14:02:29	081	1		14:02:29		Y	Lost turtle again, still observed by spotters
14:10:51							Failed to acquire turtle. Retrieved ROV.
Dive 3 Turtle 1							ROV dive began, attempting to acquire T1 again.
14:18:52			14:18:52			Y	Short sight
14:21:58				14:21:58			Failed to acquire turtle. Retrieved ROV.
Dive 4 Turtle 1							ROV dive began
14:27:19	031	1.5	14:27:19		5	Y	Acquired Turtle
14:28:11	086	1.5			5	Y	Went to surface, lost, still observed at surface by spotters
14:29:10	042	0.5			5	Y	Recovered sight of turtle.
14:30:55	030	0			5	Y	Breath.
14:31:23	048	0			5	Y	Breath.
14:34:49	052	0			5	Y	Still swimming continuously. Maybe breath about 2 min ago, couldn't view head past shell.
14:35:42	044	0			5	Y	Breath.
14:36:11	045	0			5		Breath.
14:36:40	058	0			5		Breath.
14:37:45	071	0.5			5	Y	Great side-view of turtle.
14:38:43	065	0			5	Y	Breath.
14:39:02	060	0		14:39:02	5		Lost sight of turtle, dove, sight still maintained by spotters.
14:47:41	125	4			3		Shark sighting. Brown, dusty?
14:52:50							Failed to acquire turtle. Retrieved ROV.
Dive 5 Turtle 2							ROV dive began
15:06:34	300	0				Y	Mahi-Mahi
15:06:57	264	1.5	15:06:57		5	Y	Turtle Acquired, 3 Mahi-Mahi in close vicinity.
15:08:05	030	2			5	Y	Lost sight of turtle, still observed at surface by spotters.
15:08:56	057	1.5			5	Y	Turtle sight recovered, mahi-mahi.
15:11:54	165	0			5		Breath.
15:12:22	225	1.5		15:12:22	5	Y	Lost sight of turtle, still observed at surface by spotters.
15:23:18							Failed to acquire turtle. Retrieved ROV.
Dive 6 Turtle 3	***DIVE WAS NOT RECORDED***						ROV dive began
17:17:56	016	0.5	17:17:56		5	Y	Turtle acquired, tons of jellies
					4	Y	Turtle and ROV go under the boat, descending.
17:21:12		8			3		Lost contact with turtle, very bad vis. Still observed from surface by spotters.
17:25:25	299	0			4	Y	Mahi-mahi
17:26:42	237	4			5		ROV wrapped around the rudder, turtle sight was lost

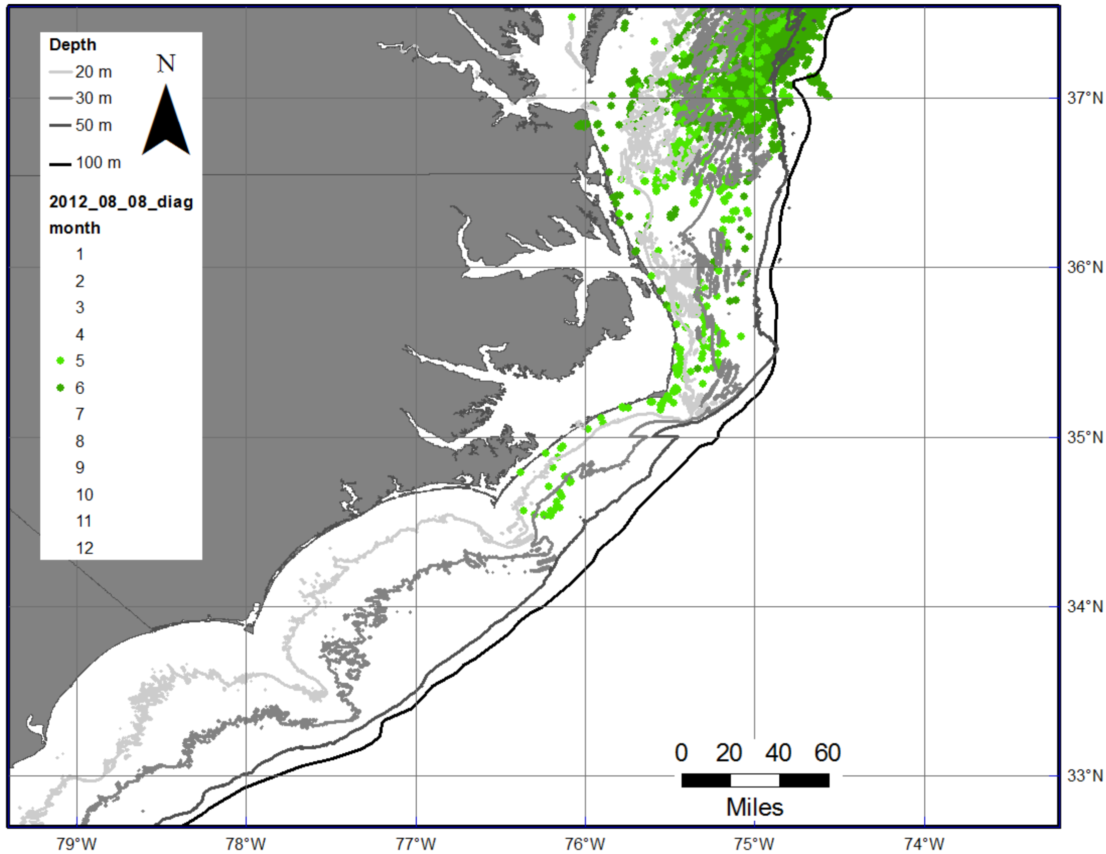
					by spotter, bringing back on board Failed to acquire turtle. Retrieved ROV.
Dive 7 Bottom Dive 1					ROV dive began
17:43:31	332	40	5		Reached bottom
17:45:32	337	40	5		Sand dollars
17:46:20	315	40	5		Small hermit crabs, more sand dollars.
17:47:48	315	40	5		Scallop, small
17:49:23	380	40	5		Un-ID'd fish swam by
17:50:07	000	40	5		Larger cancer crab.
17:52:55	306	40	5		Back to bottom
17:53:19	312	40	5		Medium sized hermit crab
17:53:50	259	40	5		Small hermit crab
17:55:14	281	40	5		Un ID'd fish swam by, lost video for a few seconds.
17:57:38	220	2	4	Y	Jellies
18:01:12					Brought ROV back on board.
Dive 8 Bottom Dive 2					ROV dive began
18:44:50	300	41	5		Reached Bottom
18:45:29	338	40.5	5		Tons of sand dollars.
18:46:25	336	40.5	5		Small hermit crabs
18:48:40	023	40.5	5		Sand dollars!
18:55:30					Brought ROV back on board.
Dive 9 Bottom Dive 3					ROV dive began
7:55:26	068	62	3		Reached Bottom
7:55:41	078	62	3		Ocean pout swam by
7:56:52	062	53	3		Too much current, began ascent.
8:01:24					Brought ROV back on board.
Dive 10 Bottom Dive 4					ROV dive began
8:55:49	303	51	4		Reached Bottom.
8:56:20	048	51	4		Sand Dollars, broken shells.
8:58:31	086	51	3		Began ascent to about 10ft to search for jellies.
8:59:54	023	16	3	Y	Jellies spotted.
9:04:36	340	4	3	Y	Jellies, comb?
9:10:10					Brought ROV back on board.
Dive 11 Turtle 4					ROV dive began
11:04:10					Trouble with ROV, one prop isn't turning. Failed to acquire turtle, returned ROV to deck.

ROV stopped operating, End of Trip.

Addendum B: The use of data from this project for determining critical habitat of loggerheads



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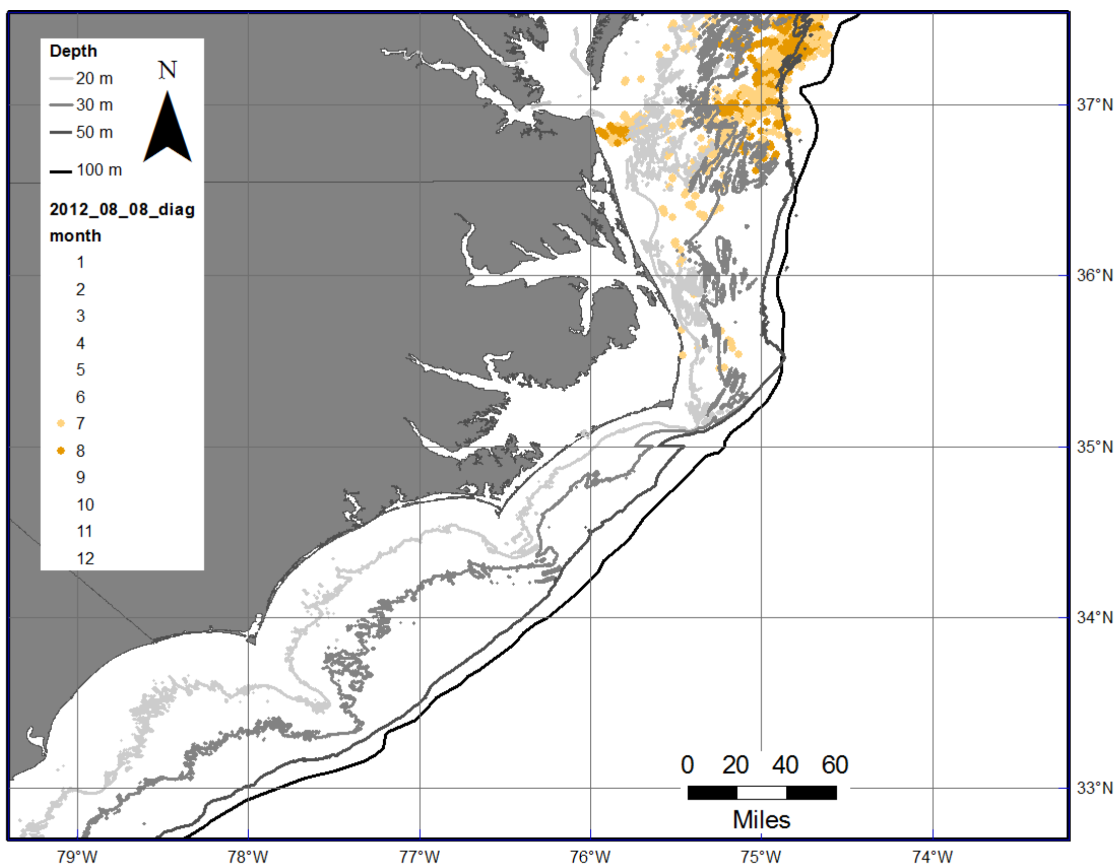
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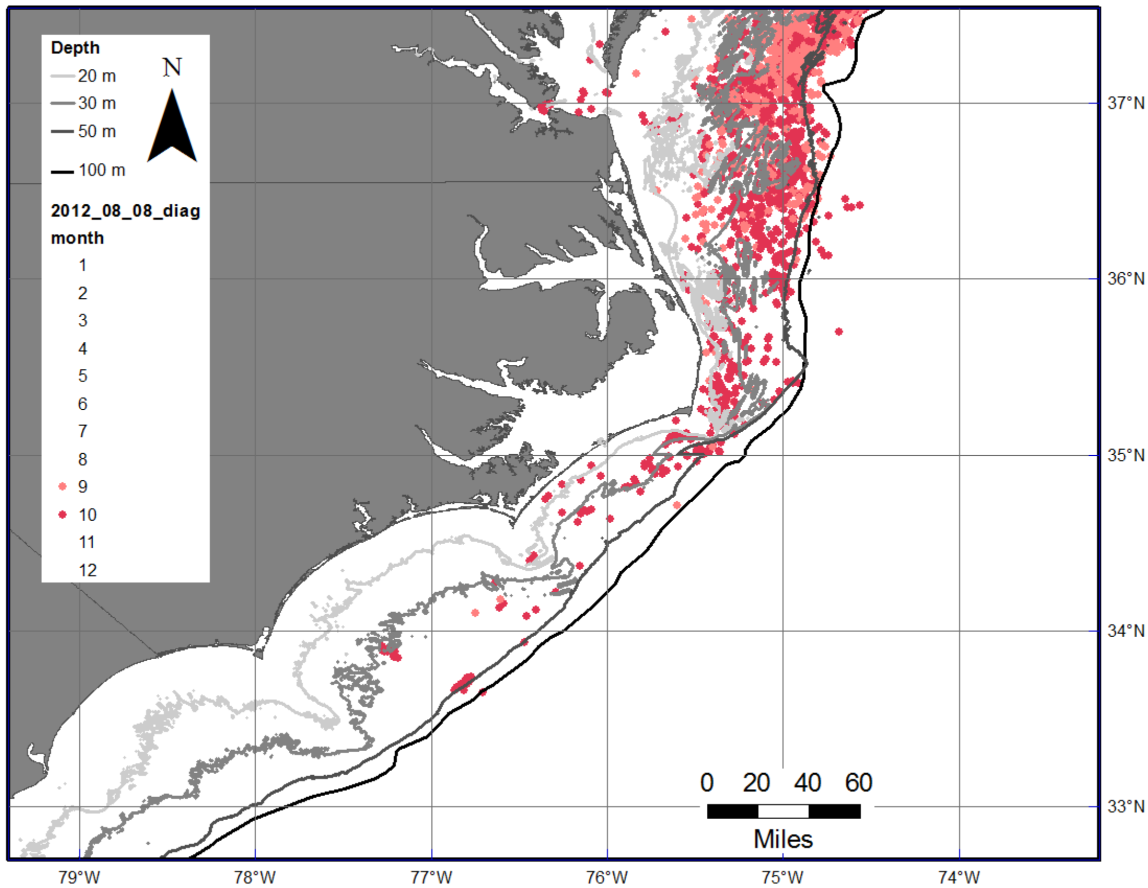
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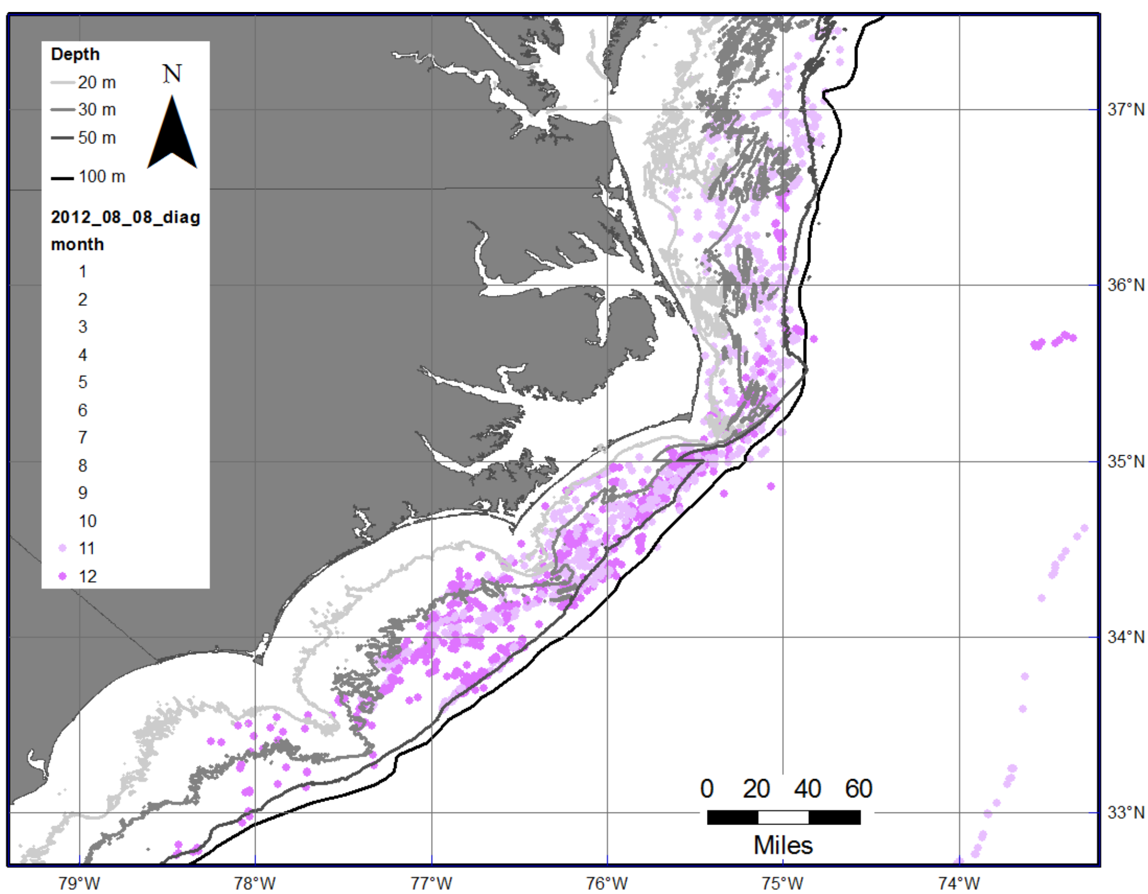
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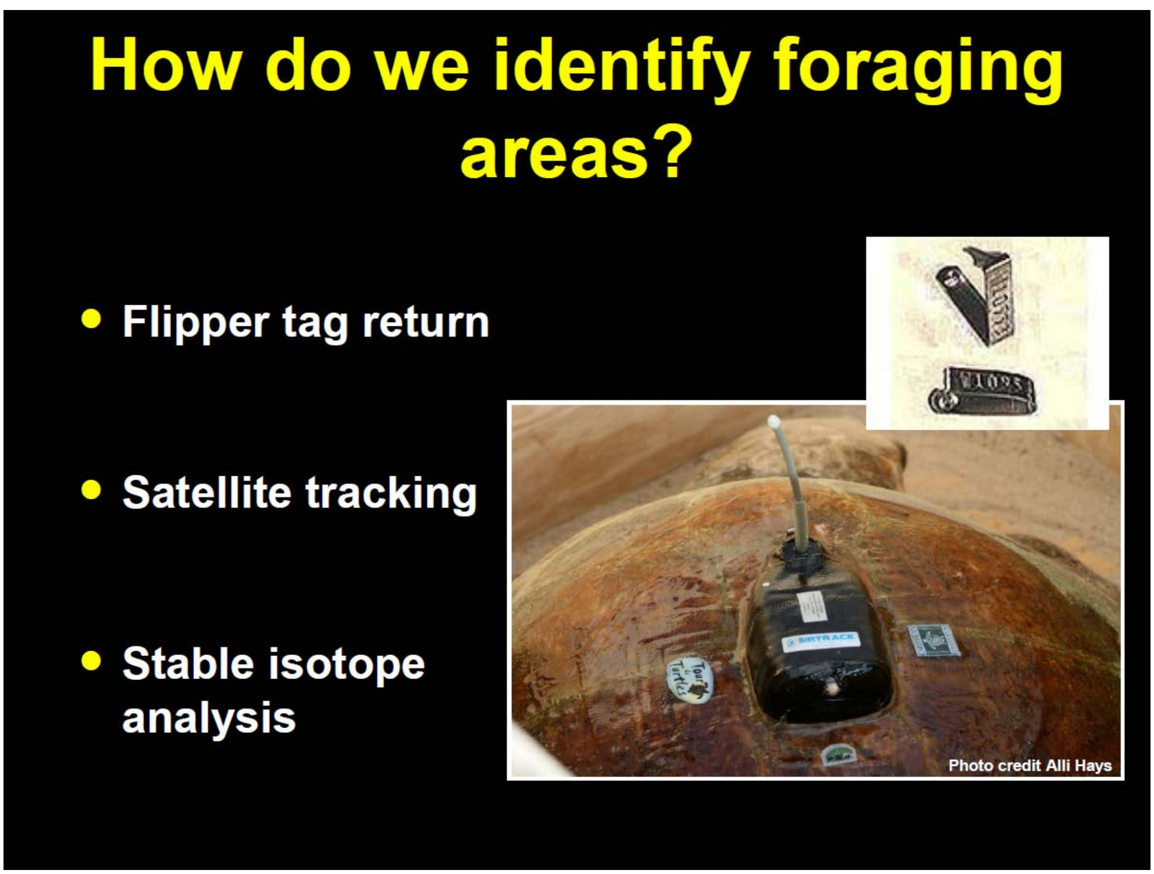
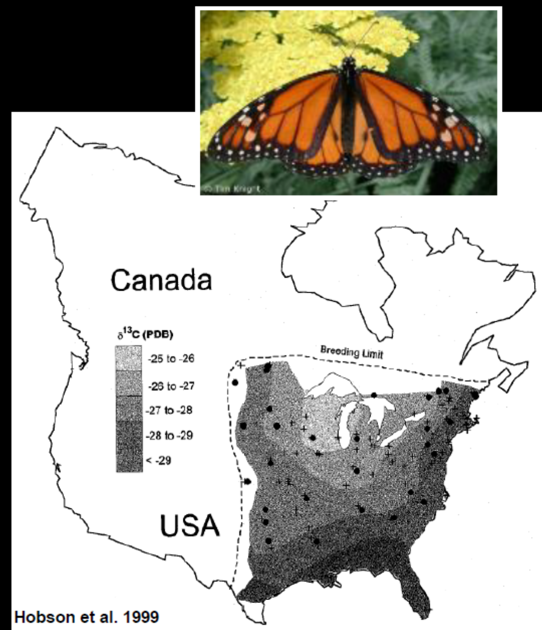
Addendum C: The use of data from this project to define loggerhead foraging areas.



Stable Isotope Analysis

- Ratios of stable isotopes (SI) vary across landscape in systematic ways
- Stable isotope ratios reflect **WHAT** and **WHERE** an animal has been eating/drinking



Hobson et al. 1999

Why Stable Isotopes?

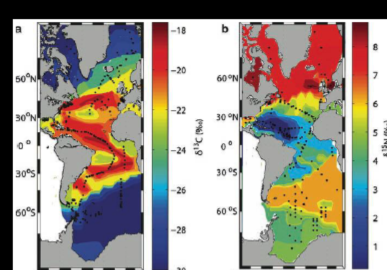
Satellite telemetry

- Precise animal trajectory
- Expensive ($3,000-6,000/turtle)
- Information at the individual level

Stable isotope analysis

- Coarse resolution
- Cheap ($9-20/sample)
- Information at the population level

Powerful combination



Graham et al. 2009

Objectives

1. Identify key foraging grounds used by loggerheads nesting at the Archie Carr NWR, FL
2. Investigate whether SI can be used to infer foraging grounds
3. Develop *isoscapes* for loggerheads along the NW Atlantic coast


Photo credit Alli Hays

Methods

- Combination of satellite telemetry & stable isotope analysis

  - 23 satellite units deployed (2008-2011)

  - several tissue samples/female


Photo credit Alli Hays

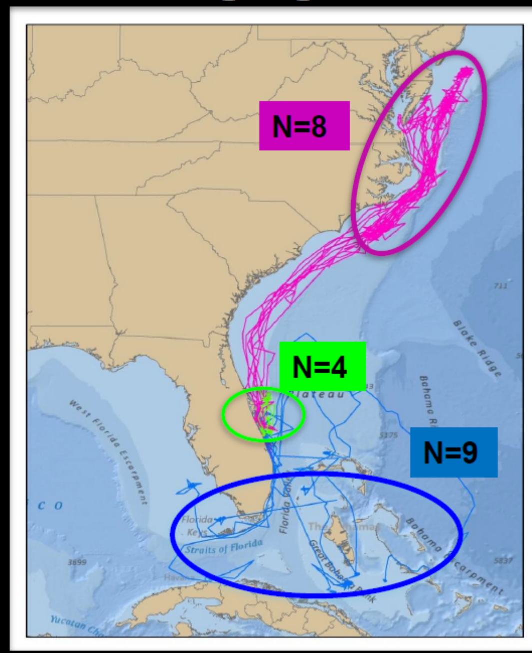
- Only tissue samples

  - an additional 180 females

Results

Telemetry identified 3 major migratory pathways and associated foraging areas:

1. **Seasonal shelf-constrained North-South migratory pattern**
2. **Residency in waters near Central Florida**
3. **Year-round residency in Southern foraging area**



Conservation Implications

- **Mid- and South-Atlantic Bights = important foraging areas**
- **Major difference from previous telemetry studies (n=19)** (Dodd & Byles et al. 2003, Foley et al. 2008)

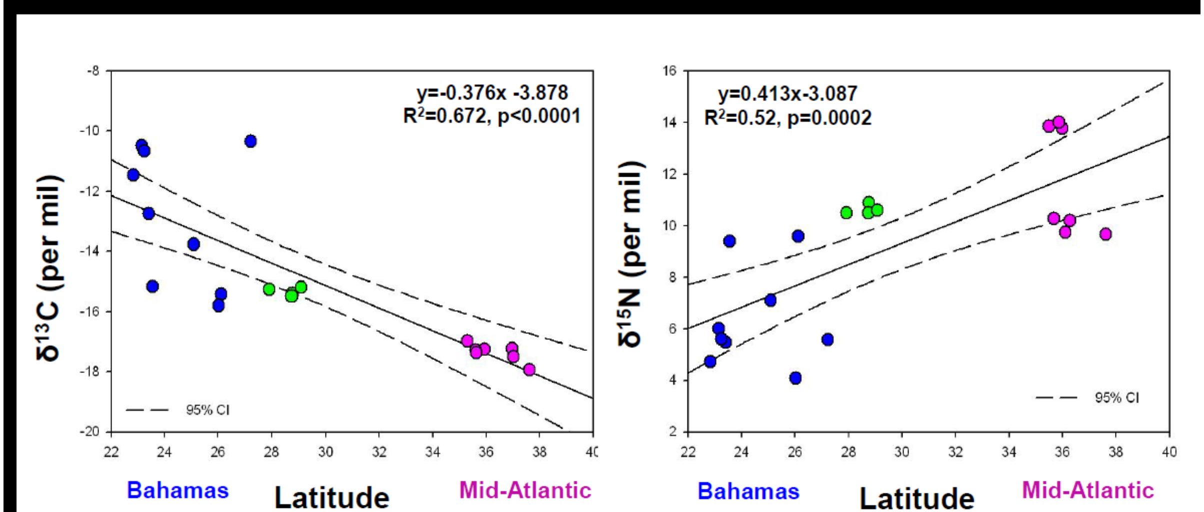
Potential area to prioritize for conservation & by-catch mitigation

Objective 2

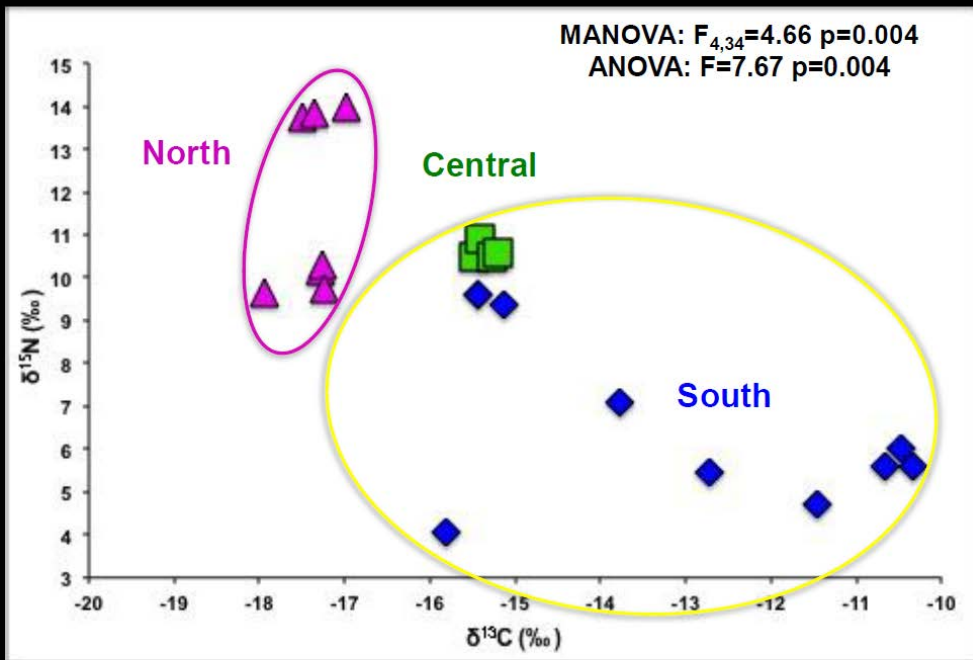
Investigate whether SI can be used to infer foraging grounds

Is there a relationship between latitude and loggerhead isotopic values?

δ13C **δ15N**

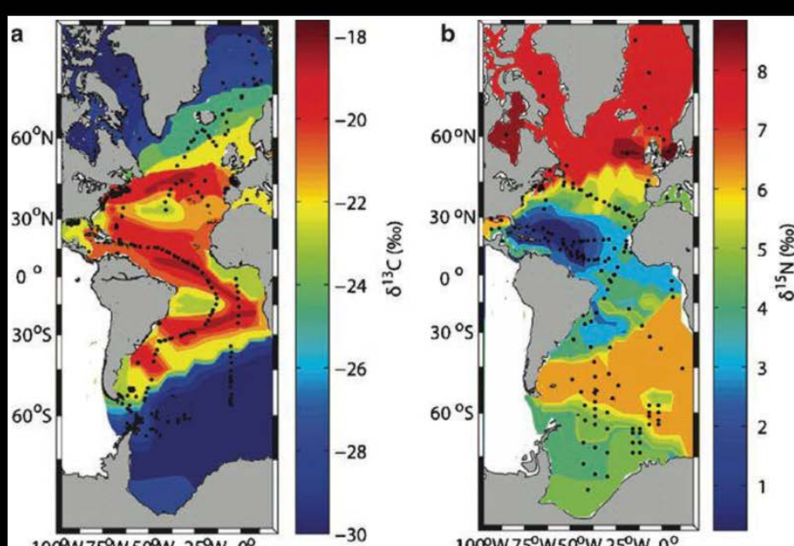


Do loggerheads differ in δ^{13}C among foraging grounds?



Objective 3

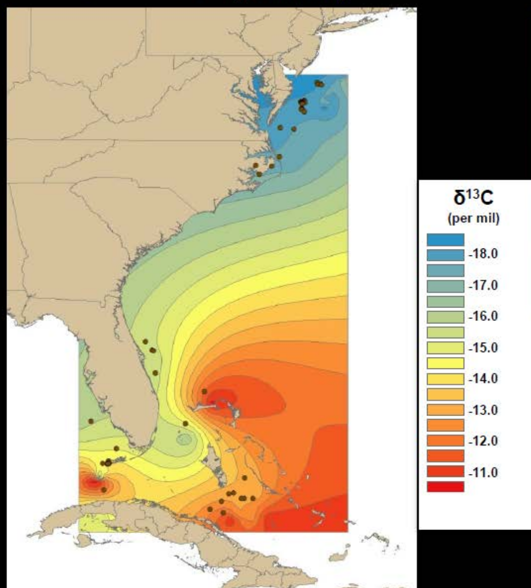
Developing *isoscapes* for loggerheads along the NW Atlantic coast



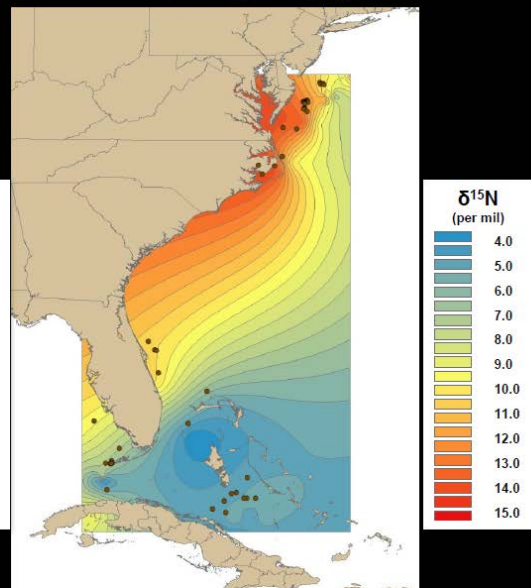
Graham et al. 2009

Isoscapes

$\delta^{13}C$ (per mil)



$\delta^{15}N$ (per mil)



Summary

- Newly identified foraging grounds : Mid- & South-Atlantic Bights
- SI = tool to assign turtles to foraging regions
- First isoscapes for sub-adult and adult NW Atlantic dwelling loggerheads
- We call for collaborations to develop a more robust and predictive model


Photo credit Dave Addison

Thank you!!

Bella Sharma,
Rachael Woods
Jessica Prince
Eric Olson
Melissa Ussa
Fernanda Gusmao
Ciro Amato
Ryan Chabot
Ally Hays
Cheryl Sanchez
Chris Long
Andrew Sterner
Terry Williamson

Anne Savage
Mike Arendt
Catherine McClellan
Kimberly Murray
Mike Bresette
Blair & Dawn Witherington
Jonathan Gorham
Cody Mott
Steve Weege
Dave Clark
Chris Sasso
Katrina Phillips
Kate Mansfield
Meghan Kopersky

Addendum D: The use of data from this project to assess the population size of loggerheads.

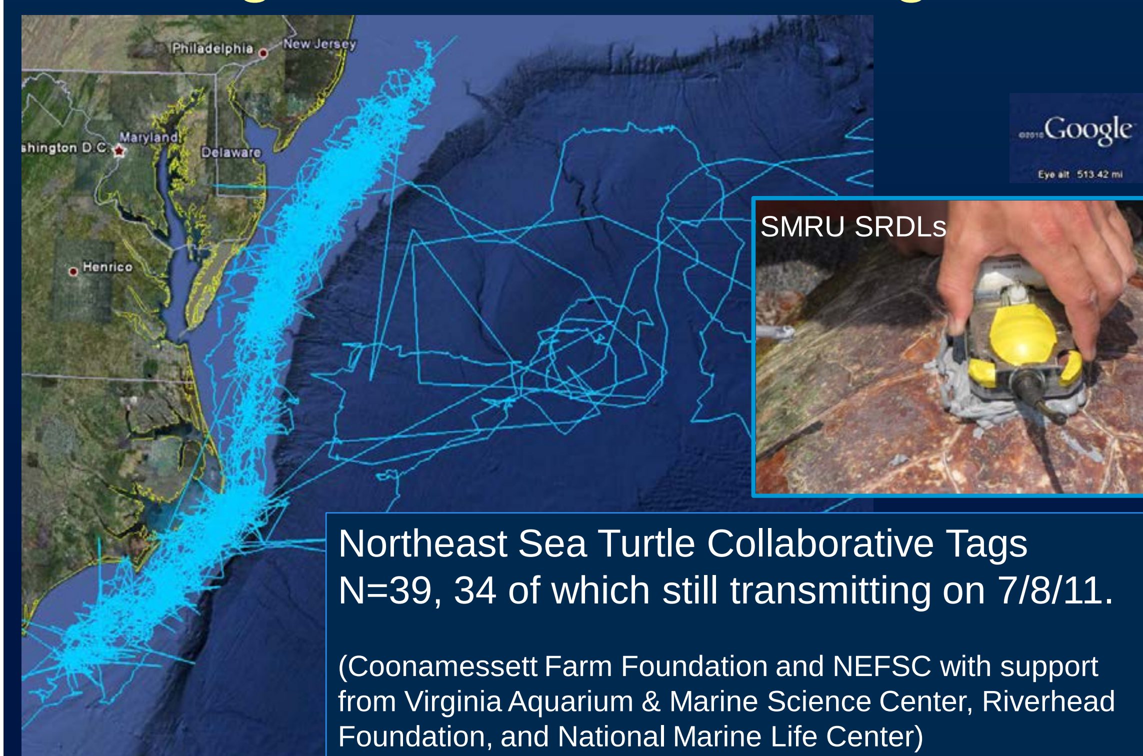
Adapted from

Vertical habitat utilization of immature loggerhead sea turtles in Mid-Atlantic shelf waters

Heather L Haas, Ron Smolowitz, Matthew Weeks, Henry Milliken, Eric Matzen

Tags in Mid-Atlantic Region

2

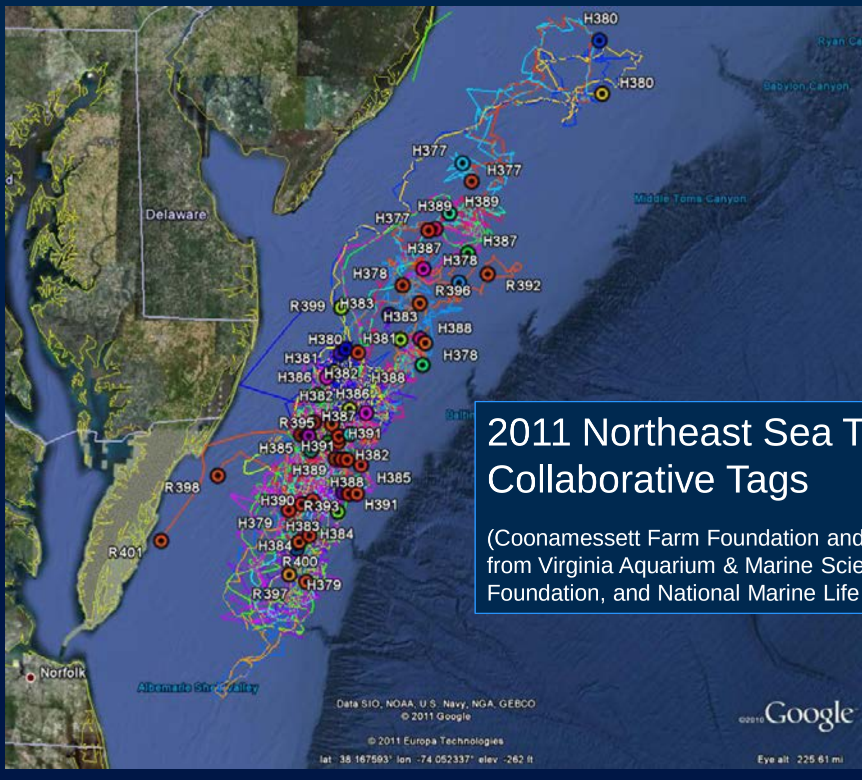


Northeast Sea Turtle Collaborative Tags
N=39, 34 of which still transmitting on 7/8/11.

(Coonamessett Farm Foundation and NEFSC with support from Virginia Aquarium & Marine Science Center, Riverhead Foundation, and National Marine Life Center)

2011 tags

3



2011 Northeast Sea Turtle Collaborative Tags

(Coonamessett Farm Foundation and NEFSC with support from Virginia Aquarium & Marine Science Center, Riverhead Foundation, and National Marine Life Center)

Unique offshore capture

4

Importance of behavior information in abundance estimates

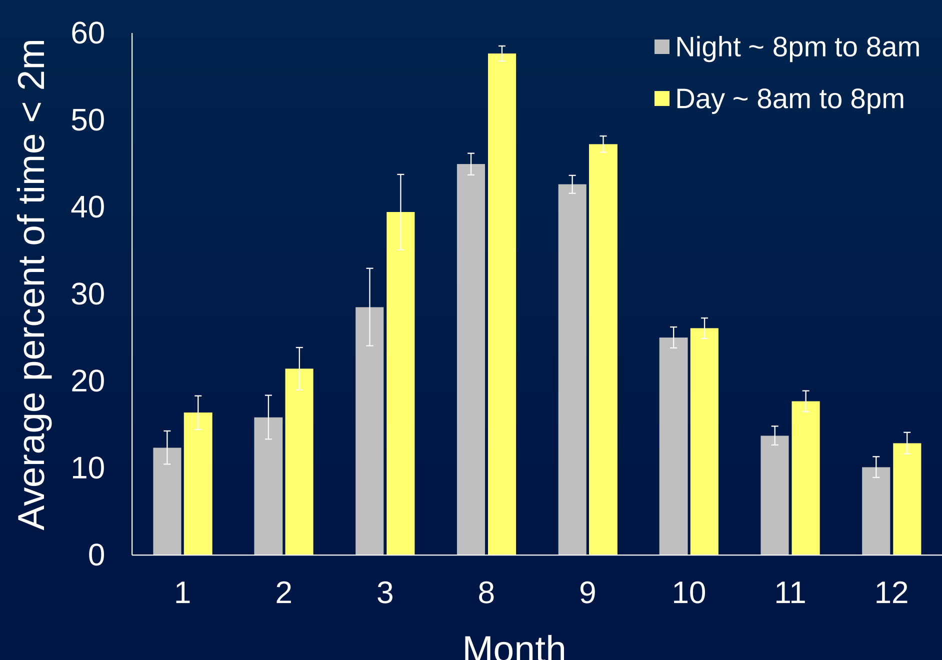
Table 9. Preliminary estimated regional abundance of positively identified loggerheads (*Caretta caretta*) and a portion of the unidentified turtles (loggerheads+) within the northwest Atlantic continental shelf study area when accounting for perception bias (*g(0)*<1) and availability bias (% surface time) – termed adjusted abundance, with associated inner quartile range.

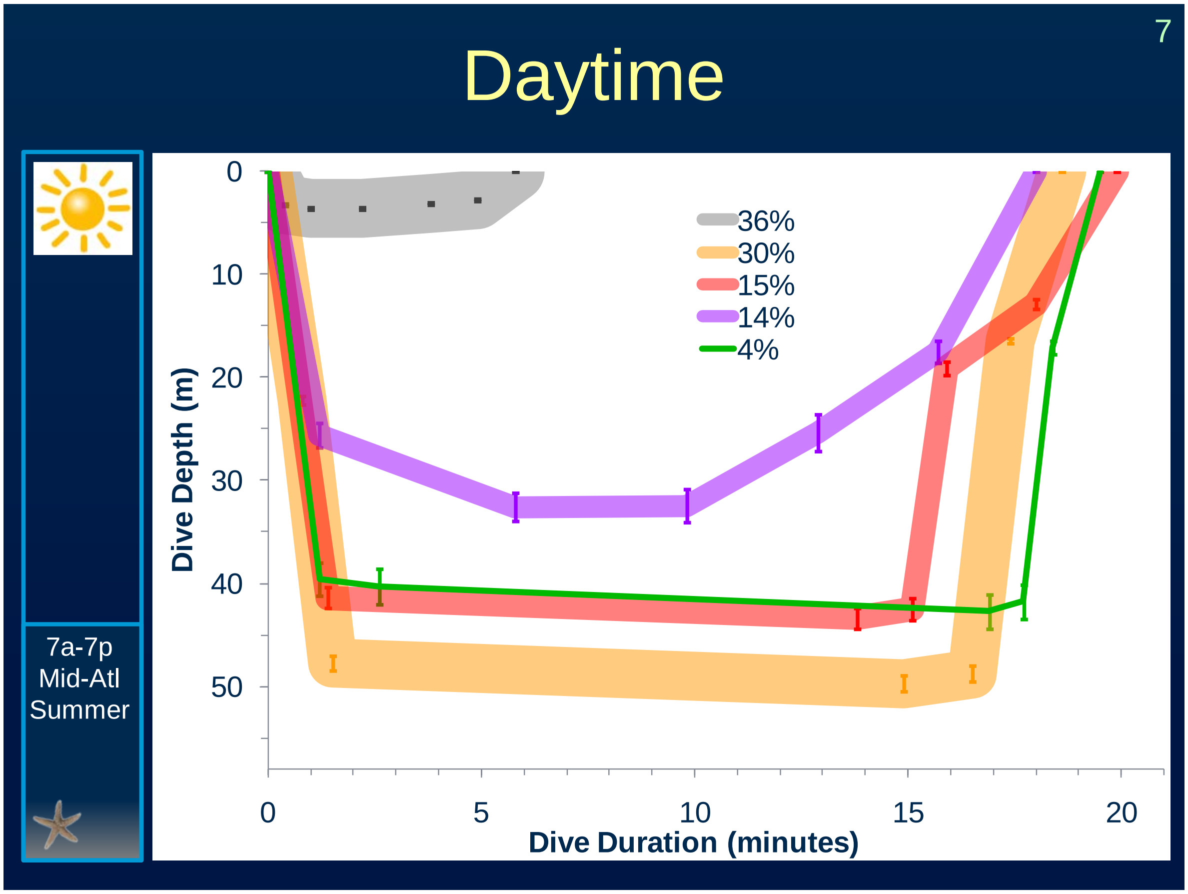
Strata	Abundance loggerheads+, *g(0)*<1	Median %surface time	1st Quartile %surface time	3rd Quartile %surface time	Adjusted loggerheads+ abundance	Lower quartile range of adjusted loggerheads+ abundance	Upper quartile range of adjusted loggerheads+ abundance
South Atlantic	52,650	7.0	5.0	11.0	752,143	478,636	1,053,000
Mid-Atlantic South	28,196	67.1	56.6	76.9	42,021	36,666	49,816
Mid-Atlantic North	4,489	67.1	56.6	76.9	6,690	5,837	7,931
North Atlantic	0	67.1	56.6	76.9	0	0	0
TOTAL	85,335				800,854	521,139	1,110,747

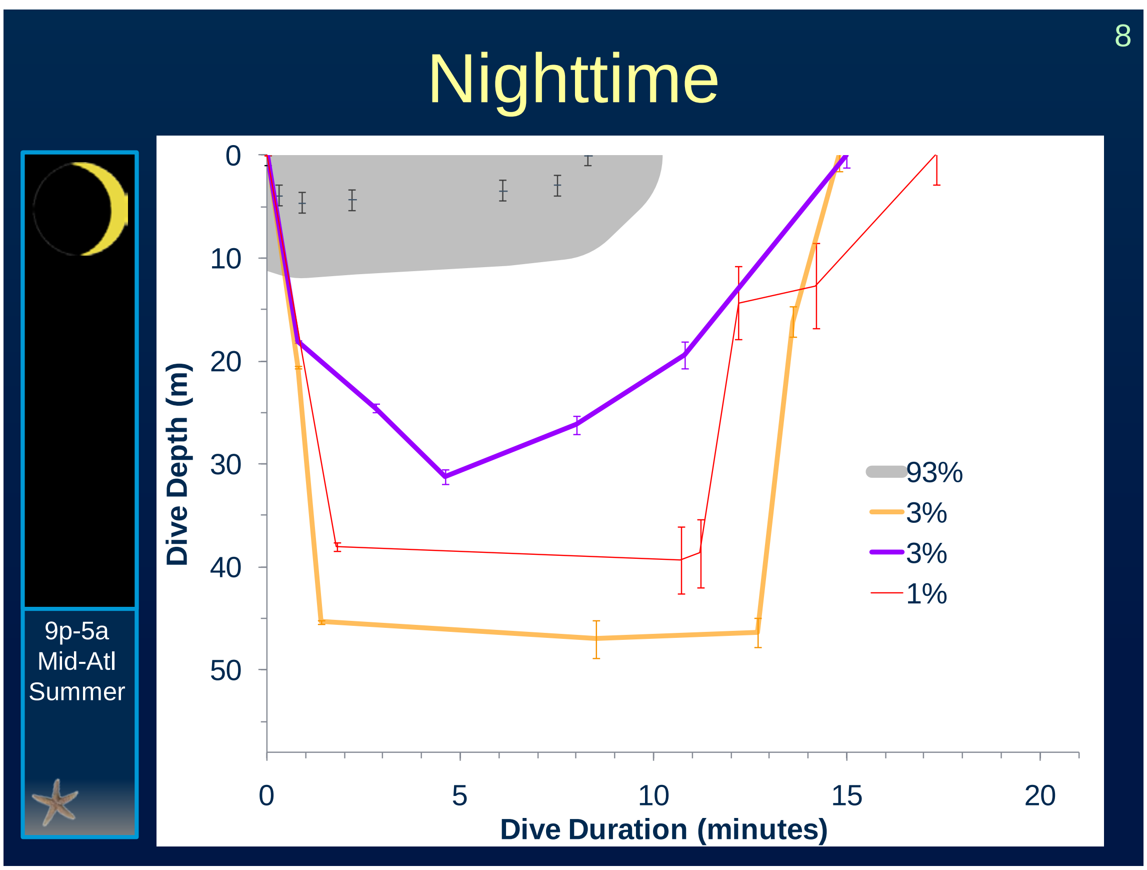
NEFSC & SEFSC 2011

6

(near) Surface

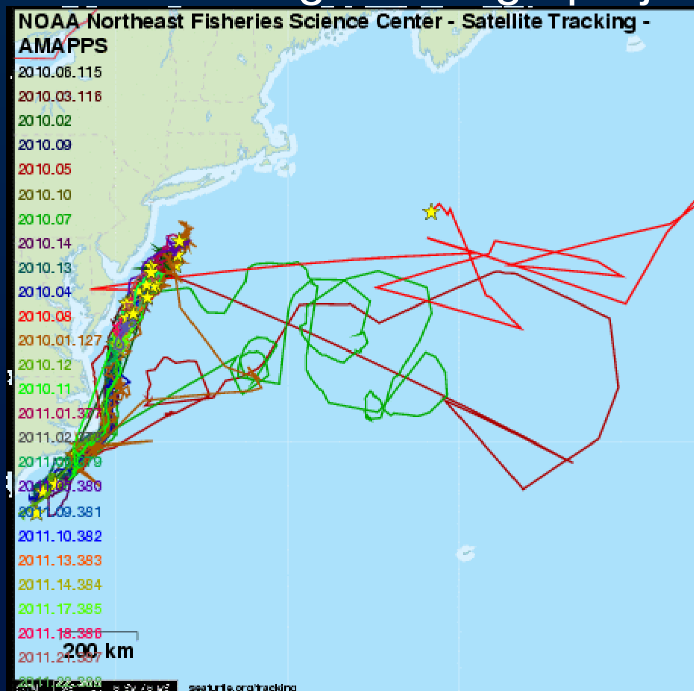



7
Daytime
7a-7p
Mid-Atl
Summer
36%
30%
15%
14%
4%
Dive Depth (m)
0
10
20
30
40
50
0
5
10
15
20
Dive Duration (minutes)


8
Nighttime
9p-5a
Mid-Atl
Summer
93%
3%
3%
1%
Dive Depth (m)
0
10
20
30
40
50
0
5
10
15
20
Dive Duration (minutes)

Online Access

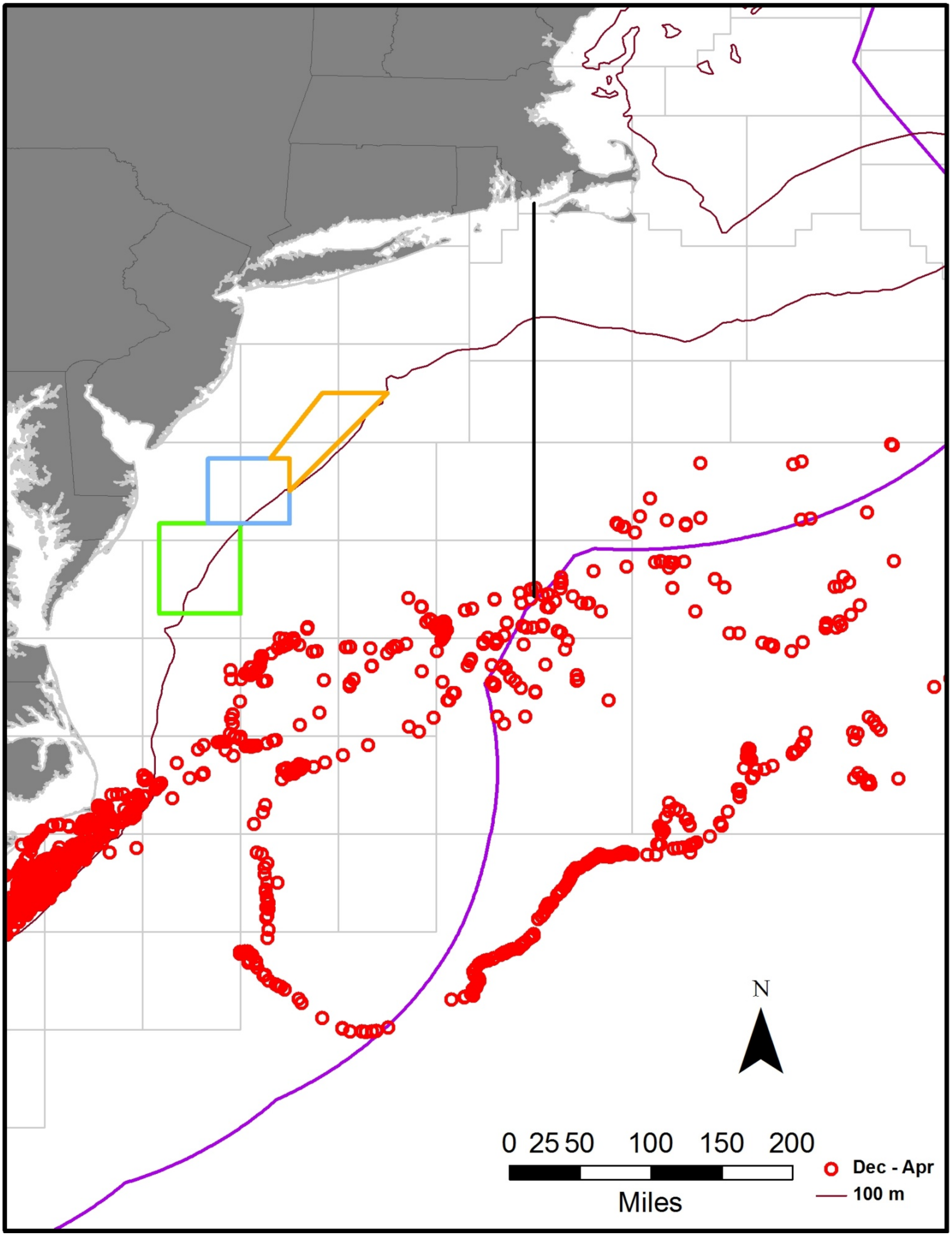
http://www.seaturtle.org/tracking/?project_id=537

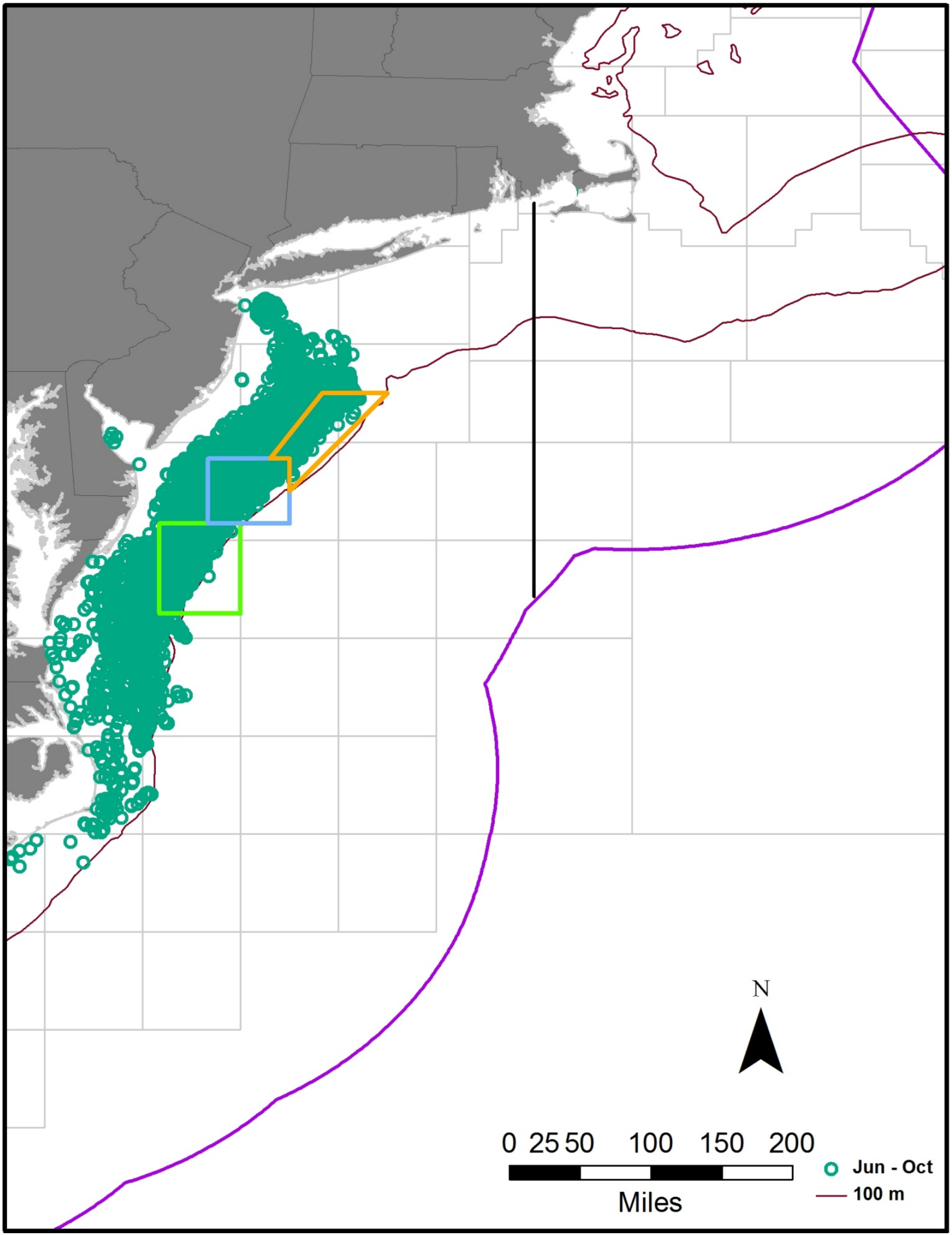


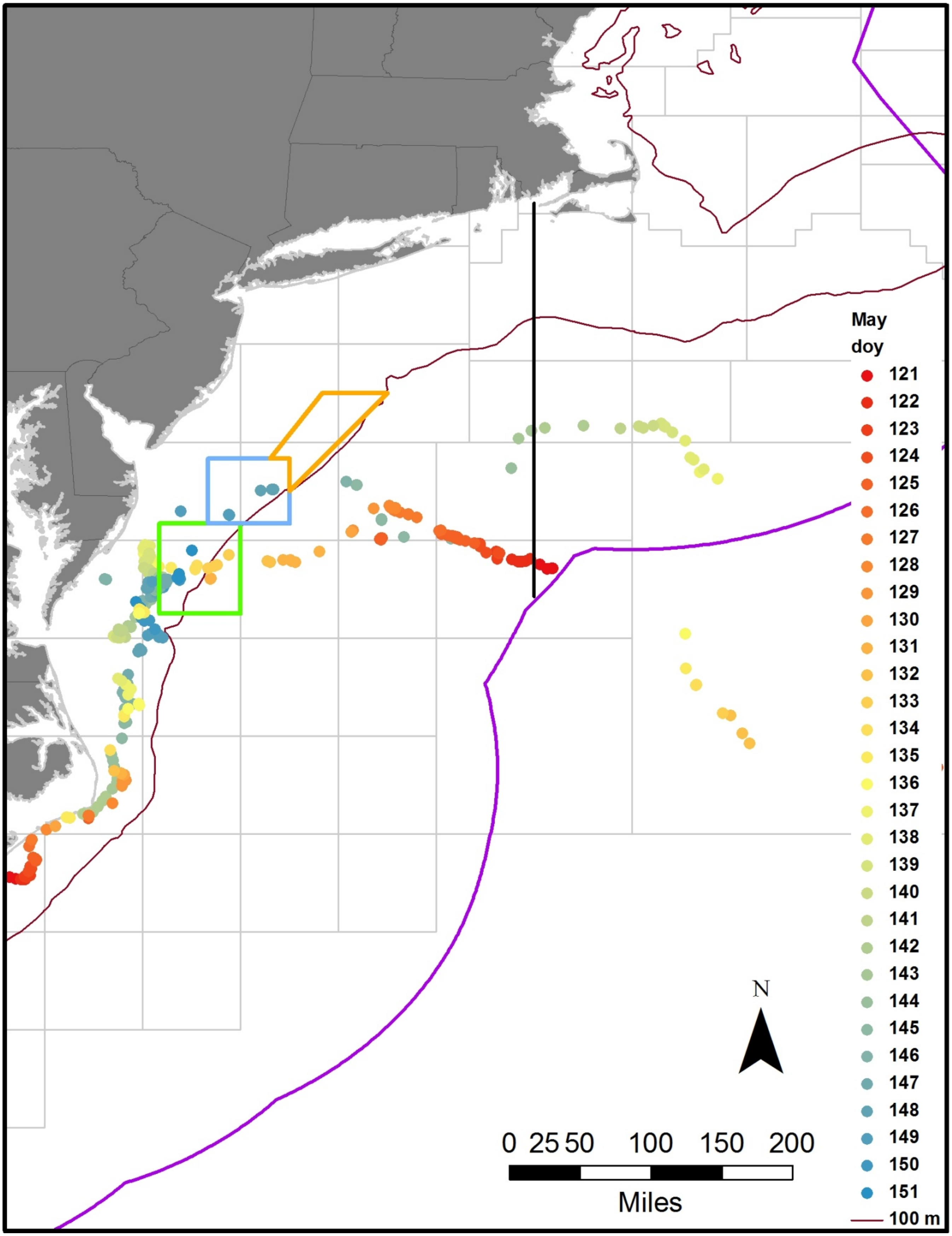
Acknowledgements

This research is part of a joint AMAPPS (Atlantic Marine Assessment Program for Protected Species) project between the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) Southeast Fisheries Science Center (SEFSC) and Northeast Fisheries Science Center (NEFSC), the Bureau of Ocean Energy Management, Regulation, and Enforcement (BOE; formerly the Minerals Management Service), the U.S. Fish and Wildlife Service (FWS), the U.S. Navy. We thank Dr. Jeffrey Seminoff for his help with our initial satellite tagging and the US commercial sea scallop industry (with the assistance of Viking Village Fisheries and the F/V Kathy Ann) for their support through their research set aside program.

Addendum E: The use of data from this project to define area and seasons for the Coonamessett Farm Turtle Deflector Dredge.




N
0 25 50 100 150 200
Miles
Jun - Oct
100 m


May
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137
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139
140
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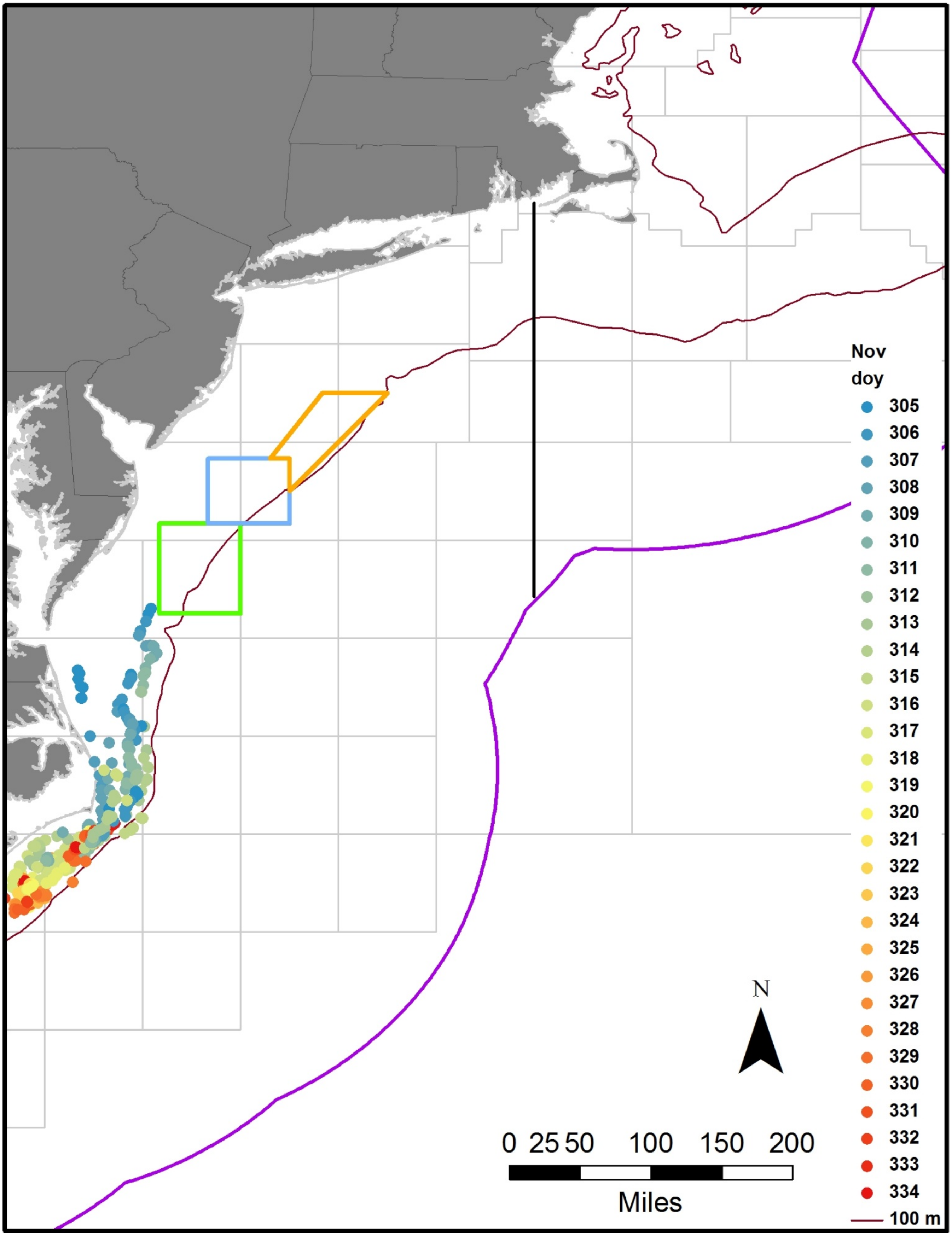
146
147
148
149
150
151
100 m
N
0 25 50 100 150 200
Miles


Nov
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322
323
324
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326
327
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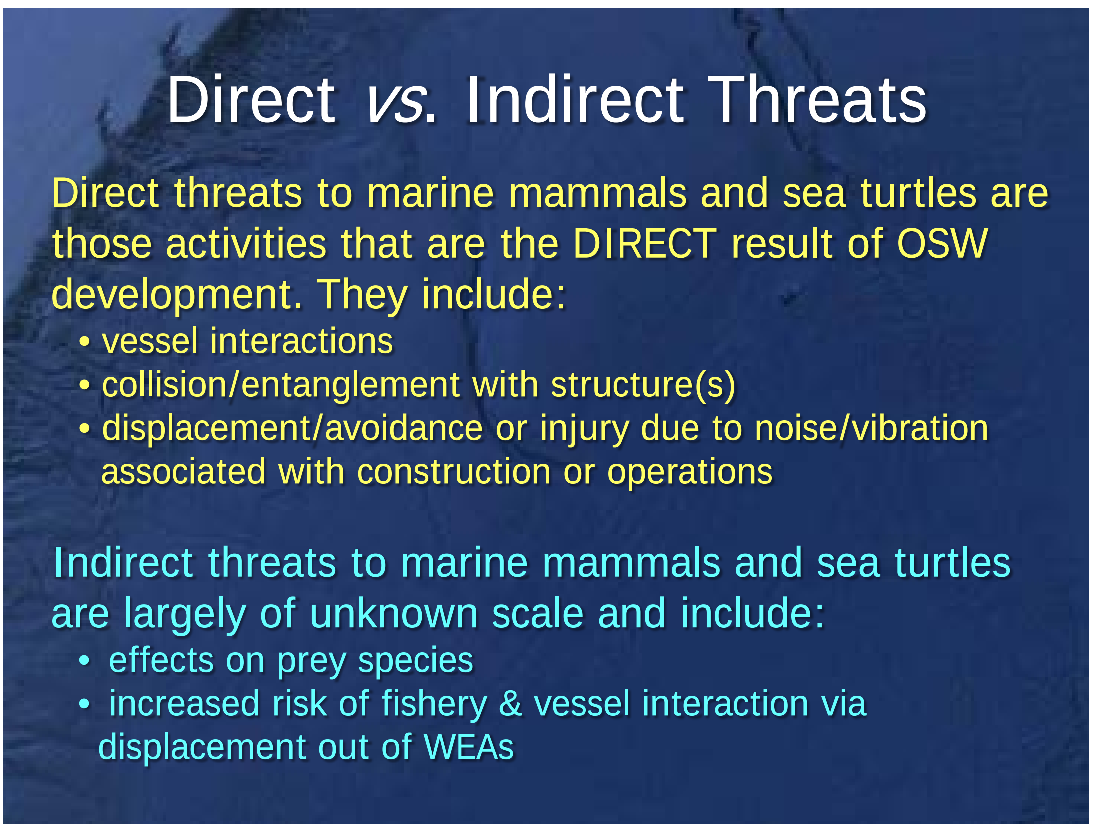
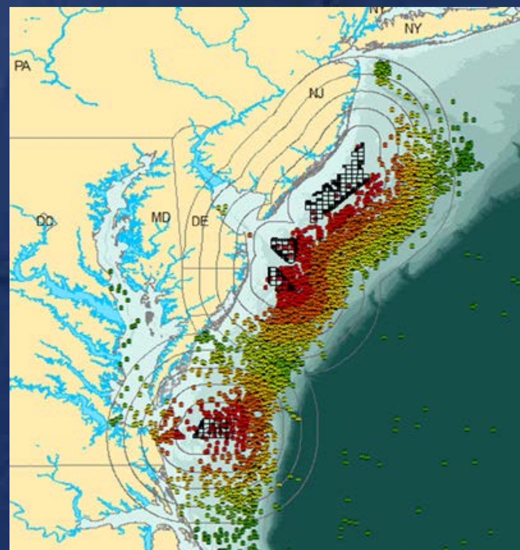
329
330
331
332
333
334
100 m
N
0 25 50 100 150 200
Miles

Addendum F: The use of project data to understand the impact of offshore projects on loggerheads.



Sea Turtle Satellite Telemetry April to November 2011

- 49 tags
- Filtered for maximum of one point-per-day for each animal
- 62% of all points were within 30nm of a mid-Atlantic wind energy area.



Map created using telemetry data from transmitters purchased by NMFS, Coonamessett Farm Foundation, and VAQF

Priorities

1. The continuation of Agency support for regional inter-annual marine animal surveys
2. The devolvement of methods to reduce bias associated with marine animal abundance estimates.
   - Current sighting data, used in NEPA analysis documents, does not account for perception and availability bias in density calculations- resulting in an underestimation of some animals in study area.
3. The acquisition of spatial data for anthropogenic activity such as fishing and military activity
4. Inter-organizational cooperation and data sharing protocols need to be developed so that agencies have all available information prior to action implementation.