Atlantic Fleet Training and Testing (AFTT)

2014 Annual Monitoring Report



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Cuvier's beaked whale (*Ziphius cavirostris*) off Cape Hatteras. Photographed by Danielle Waples, Duke University, taken under NOAA Scientific Permit No. 14809 (Douglas Nowacek) and NOAA General Authorization Letter of Confirmation 16185 held by Duke University.

Tagged green turtle (*Chelonia mydas*) post-release. Photo courtesy of Virginia Aquarium.

Humpback whales (*Megaptera novaeangliae*) off Virginia Beach. Photographed by Brian Lockwood.

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ACRONYMS AND ABBREVIATIONS

AFAST	Atlantic Fleet Active Sonar Training
AFTT	Atlantic Fleet Training and Testing
AMR	Adaptive Management Review
ANOVA	Analysis of Variance
CHSRA	Cape Hatteras Special Research Area
AIC	Akaike Information Criterion
BSS	Beaufort Sea State
CNO	Chief of Naval Operations
DEUO	common dolphins, striped dolphins, and unidentified odontocetes
DMON	digital acoustic monitoring
DMP	Data Management Plan
DNA	deoxyribonucleic acid
DoN	Department of the Navy
DTAG	digital acoustic tag
DPM	detection positive minutes
DUNCOC	Duke-UNC Oceanographic Consortium
EWS	Early Warning System
EAR	ecological acoustic recorder
EIMS	Environmental Information Management System
EST	Eastern Standard Time
FS	Fort Story
GEE	generalized estimating equations
GOMEX	Gulf of Mexico
GPS	global positioning system
HARP	high-frequency acoustic recording/recorder package
HF	high-frequency
HMM	hidden Markov models
hr	hour(s)
ICMP	Integrated Comprehensive Monitoring Program
JAX	Jacksonville
JEB	Joint Expeditionary Base
kHz	kilohertz
km	kilometer(s)
km^2	square kilometer(s)
LC	Little Creek
LFDCS	low-frequency detection and classification system
LF	low-frequency
LMR	Living Marine Resources
m	meter(s)
MARU	Marine Autonomous Recording Unit
MFA	mid-frequency active
min	minute(s)
MINEX	Mine-neutralization Exercise
MSM	Marine Species Monitoring
N45	Energy and Environmental Readiness Division
NAS	Naval Air Station
NAVFAC	Naval Facilities Engineering Command
NEFSC	Northeast Fisheries Science Center
NMFS	National Marine Fisheries Services
NMSDD	Navy Marine Species Density Database
NNB	Norfolk Naval Base
NOAA	National Oceanic and Atmospheric Administration
NSN	Naval Station Norfolk
OBIS-SEAMAP	Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations
OPAREA	Operating Area
PAM	passive acoustic monitoring
PAX	Patuxent River
R/V	Research Vessel
SPOT	Smart Position and Temperature
SERDP	Strategic Environmental Research and Development
U.S.	United States
UNCW	University of North Carolina at Wilmington
UNDET	underwater detonation
USWTR	Undersea Warfare Training Range
VACAPES	Virginia Capes
VAQF	Virginia Aquarium Foundation

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SECTION 1 – INTRODUCTION

This report contains a summary of marine species monitoring activities funded by the United (U.S.) Navy within the Atlantic Fleet Training and Testing (AFTT) Study Area (formerly Atlantic Fleet Active Sonar Training [AFAST]/East Coast and Gulf of Mexico (GOMEX) range complexes) during 2014. The U.S. Navy conducts marine mammal and sea turtle monitoring for compliance with the Letters of Authorization (NMFS 2013a, 2013b) and Biological Opinion (NMFS 2013c) issued under the Marine Mammal Protection Act of 1972 (MMPA) and the Endangered Species Act of 1973 (ESA) for training and testing in the AFTT Study Area. This report also reflects an evolution in the approach to monitoring reports for this area. Concurrent with Phase II of the U.S. Navy's Marine Species Monitoring Program, the U.S. Navy and the National Marine Fisheries Service (NMFS) have agreed to establish compliance based on demonstrated progress towards addressing scientific objectives, rather than on specific monitoring requirements for each range complex from effort-based metrics. This report summarizes the progress, accomplishments, and results from projects currently being conducted in the AFTT Study Area. Additional details on each project are available in individual technical reports linked directly from the corresponding sub-section of this report.

1.1 Background

The AFTT Study Area includes only the at-sea components of the range complexes and testing ranges in the western Atlantic Ocean and encompasses the east coast of North America and the Gulf of Mexico (**Figure 1**). The Study Area covers approximately 2.6 million square nautical miles of ocean area, and includes designated U.S. Navy operating areas (OPAREAs) and special use airspace. The Study Area also includes several U.S. Navy testing ranges and range complexes, as well as Narragansett Bay, lower Chesapeake Bay, St. Andrew Bay, and pierside locations where sonar maintenance and testing occurs.

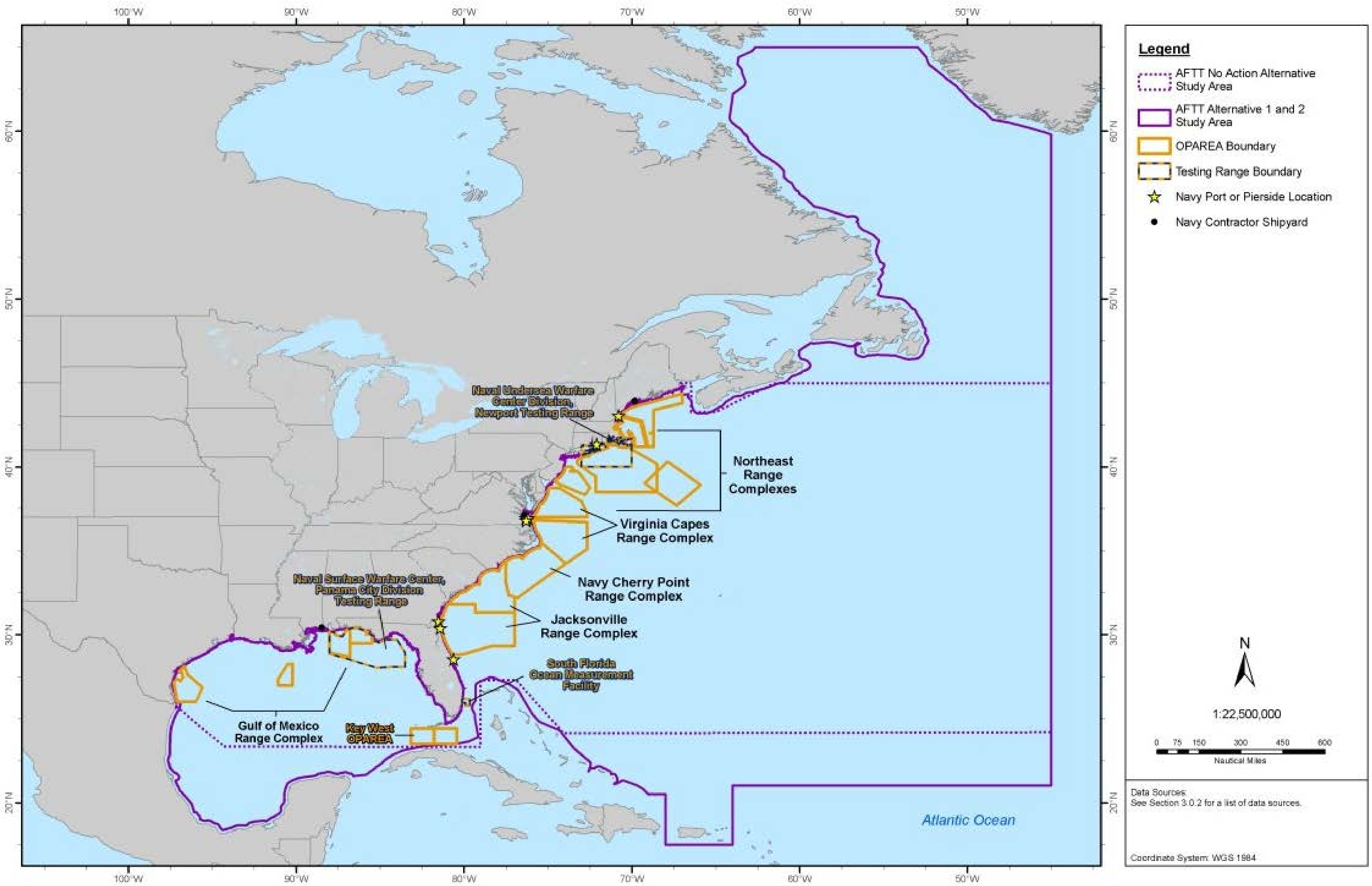

Figure 1. Atlantic Fleet Training and Testing (AFTT) Study Area.

In order to issue an Incidental Take Statement for an activity that has the potential to affect protected marine species, NMFS must set forth "requirements pertaining to the monitoring and reporting of such taking" (50 Code of Federal Regulations [CFR] Part 216.101(a)(5)(a)). A request for a Letter of Authorization must include a plan to meet the necessary monitoring and reporting requirements, while increasing the understanding, and minimizing the disturbance, of marine mammal and sea turtle populations expected to be present. While the ESA does not have a specific monitoring requirement, the Biological Opinion issued in November 2013 by NMFS for the AFTT Study Area includes terms and conditions for continued monitoring in this region (NMFS 2013c).

The U.S. Navy previously submitted annual monitoring and mission activities reports for AFAST and the East Coast/GOMEX Range Complexes to NMFS for 2009 through 2013 (DoN 2009, 2010a, 2010b, 2010c, 2010d, 2010e, 2011a, 2011b, 2011c, 2011d, 2012a, 2012b, 2012c, 2012d; 2013a, 2013b, 2014a, 2014b, 2014c).

The U.S. Navy has invested more than $16 million (**Table 1**) in monitoring activities in the AFTT Study Area since 2009. Additional information on the program is available on the U.S. Navy's Marine Species Monitoring Program website (http://www.navymarinespeciesmonitoring.us). The website serves as an online portal for information on the background, history, and progress of the program, and it also provides access to reports, documentation, data, and updates on current monitoring projects and initiatives.

Table 1. Annual funding for the U.S. Navy's Marine Species Monitoring Program in the AFTT Study Area (formerly AFAST and East Coast/GOMEX Range Complexes) during FY09-FY14.

Fiscal Year (01 Oct-30 Sept)	Funding Amount
FY09	$1,555,000
FY10	$3,768,000
FY11	$2,749,000
FY12	$3,483,000
FY13	$3,775,000
FY14	$3,311,000
Total	**$16,587,000**

In addition to the Fleet-funded monitoring program, the Office of Naval Research Marine Mammals and Biology Program and the Office of the Chief of Naval Operations (CNO) Energy and Environmental Readiness Division (N45) Living Marine Resources (LMR) Program support coordinated Science & Technology and Research & Development focused on understanding the effects of sound on marine mammals, including physiological, behavioral, ecological effects, and population-level effects (DoN 2010f). Collectively, the U.S. Navy has provided over $230 million for marine species research from 2004 to 2012. These programs currently fund several significant ongoing projects relative to potential operational impacts to marine mammals within some U.S. Navy range complexes. Additional information on these programs and other ocean resources-oriented initiatives can be found at the U.S. Navy's Green Fleet – Energy, Environment, and Climate Change website.

1.2 Integrated Comprehensive Monitoring Program

The Integrated Comprehensive Monitoring Program (ICMP) provides the overarching framework for coordination of the U.S. Navy's marine species monitoring efforts (DoN 2010g) and serves as a planning tool to focus U.S. Navy monitoring priorities pursuant to ESA and MMPA requirements. The purpose of the ICMP is to coordinate monitoring efforts across all regions and to allocate the most appropriate level and type of monitoring effort for each range complex based on a set of standardized objectives, regional expertise, and resource availability. Although the ICMP does not identify specific monitoring or field projects, it is designed to provide a flexible, scalable, and adaptable framework for such projects using adaptive management and strategic planning processes that periodically assess progress and reevaluate objectives.

The ICMP is evaluated through the Adaptive Management Review (AMR) process to: (1) assess progress, (2) provide a matrix of goals and objectives for the following year, and (3) make recommendations for refinement and analysis of the monitoring and mitigation techniques. This process includes conducting an annual AMR meeting at which the U.S. Navy and NMFS jointly consider the prior-year goals, monitoring results, and related scientific advances to determine if monitoring plan modifications are warranted to more effectively address program goals. Modifications to the ICMP that result from AMR discussions are incorporated by an addendum or revision to the ICMP. As a planning tool, the ICMP will be routinely updated as the program evolves and progresses. The most significant addition in 2013/2014 was the development of the Strategic Planning Process (DoN 2013) which serves to guide the investment of resources to most efficiently address ICMP objectives and intermediate scientific objectives developed through this process. More details on the Strategic Planning Process are provided in **Section 4**.

Under the ICMP, U.S. Navy-funded monitoring relating to the effects of U.S. Navy training and testing activities on protected marine species should be designed to accomplish one or more top-level goals as described in the current version of the ICMP (DoN 2010g):

(a) An increase in our understanding of the likely occurrence of marine mammals and/or ESA-listed marine species in the vicinity of the action (i.e., presence, abundance, distribution, and/or density of species).

(b) An increase in our understanding of the nature, scope, or context of the likely exposure of marine mammals and/or ESA-listed species to any of the potential stressors associated with the action (e.g., sound, explosive detonation, or expended materials), through better understanding of one or more of the following: (1) the nature of the action and its surrounding environment (e.g., sound-source characterization, propagation, and ambient noise levels); (2) the affected species (e.g., life history or dive patterns); (3) the likely co-occurrence of marine mammals and/or ESA-listed marine species with the action (in whole or part); and/or (4) the likely biological or behavioral context of exposure to the stressor for the marine mammal and/or ESA-listed marine species (e.g., age class of exposed animals or known pupping, calving, or feeding areas).

(c) An increase in our understanding of how individual marine mammals or ESA-listed marine animals respond (behaviorally or physiologically) to the specific stressors associated with the action (in specific contexts, where possible, e.g., at what distance or received level).

(d) An increase in our understanding of how anticipated individual responses, to individual stressors or anticipated combinations of stressors, may impact either: (1) the long-term fitness and survival of an individual; or (2) the population, species, or stock (e.g., through effects on annual rates of recruitment or survival).

(e) An increase in our understanding of the effectiveness of mitigation and monitoring measures, including increasing the probability of detecting marine mammals to better achieve the above goals (through improved technology or methods), both generally and more specifically within the safety zone (thus allowing for more effective implementation of the mitigation). Improved detection technology will be rigorously and scientifically validated prior to being proposed for mitigation, and should meet practicality considerations (engineering, logistic, and fiscal).

(f) A better understanding and record of the manner in which the authorized entity complies with the Incidental Take Authorization and Incidental Take Statement.

CNO-N45 is responsible for maintaining and updating the ICMP, as necessary, reflecting the results of regulatory agency rulemaking, AMRs, best available science, improved assessment methods, and more effective protective measures. This is done as part of the AMR process, in consultation with U.S. Navy technical experts, Fleet Commanders, and Echelon II Commands as appropriate.

1.3 Report Objectives

This report presents the progress, accomplishments, and results of marine species monitoring activities in the AFTT Study Area in 2014 and has two primary objectives:

1. Summarize findings from the U.S. Navy-funded marine mammal and sea turtle monitoring conducted in the AFTT Study Area during 2014, as well as monitoring data analyses performed during this time period. Detailed technical reports for these efforts are referenced throughout this report and provided as supporting documents.
2. Continue the AMR process by providing an overview of monitoring initiatives, progress, and evolution of the ICMP and Strategic Planning Process for U.S. Navy marine species monitoring. These initiatives continue to shape the evolution of the U.S. Navy Marine Species Monitoring Program for 2015 and beyond to improve our understanding of the occurrence and distribution of marine mammals and sea turtles in the AFTT Study Area and their exposure and response sonar and explosives training and testing activities.

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SECTION 2 – MARINE SPECIES MONITORING ACTIVITIES

2.1 Occurrence, Distribution, and Population Structure

In 2005, the U.S. Navy contracted with a consortium of researchers from Duke University, the University of North Carolina at Wilmington (UNCW), the University of St. Andrews, and NMFS's Northeast Fisheries Science Center (NEFSC) to conduct a pilot study and subsequently develop a survey and monitoring plan. The plan included a recommended approach for data collection at the proposed site of the Undersea Warfare Training Range (USWTR) in Onslow Bay off the coast of North Carolina. The identified methods included surveys (aerial/shipboard, frequency, spatial extent, etc.), passive acoustic monitoring (PAM), photo-identification (photo-ID), and data analysis (e.g., standard line-transect, spatial modeling) appropriate to establish a fine-scale seasonal baseline of protected marine species distribution and abundance. As a result, a protected marine species monitoring program was initiated in June 2007 in Onslow Bay. Due to a re-evaluation of the proposed location for USWTR, the preferred location was changed to the Jacksonville Operating Area (JAX OPAREA). Therefore, a parallel monitoring program was initiated in January 2009 at the proposed USWTR site off the coast of Jacksonville, Florida. In 2011, the program expanded beyond the previous Onslow Bay focus site to include a region of high U.S. Navy training activity off the coast of Cape Hatteras to the north. This study area also serves to complement a pilot whale behavioral study initiated in that region at the same time. The overall approach to program design and methods has been consistent with the work that has been performed in Onslow Bay over the past 6 years, and work across the locations continues to evolve in response to the adaptive management response process and changing priorities.

In 2014, the longitudinal baseline study consisted of year-round multi-disciplinary monitoring through the use of aerial and vessel-based visual surveys, photo-identification, biopsy sampling, and passive acoustic monitoring with high-frequency acoustic recording packages (HARPs). Monthly visual surveys were conducted year-round (weather permitting) using established track lines and standard Distance-sampling techniques. A summary of accomplishments and basic results of these monitoring efforts for the reporting period is presented in the following subsections.

All previous annual reports on this component of the baseline monitoring program are available through the U.S. Navy's Marine Species Monitoring Program web portal (http://www.navymarinespeciesmonitoring.us/).

Although the initial intent of the Onslow Bay and JAX monitoring program was to support development of the planned USWTR, the program has evolved into established long-term study sites addressing a number of intermediate scientific objectives within the ICMP framework for AFTT. The intention was to provide robust baseline data—supporting projects designed to examine the potential long-term effects to marine species that may be exposed chronically to anti-submarine warfare training as the USWTR is completed and becomes operational. The monitoring work at these sites provides a longitudinal baseline of marine species occurrence, distribution, abundance, and behavior in key U.S. Navy training areas and serves as a reference for addressing questions concerning exposure, response, and consequences.

2.1.1 Visual Baseline Aerial Surveys

Figure 2 shows the Cape Hatteras and JAX survey areas with established tracklines used for line-transect aerial surveys. Aerial surveys were conducted using standard Distance-sampling protocols. During the current reporting period (January 2014–December 2014), both the Cape Hatteras and JAX sites were surveyed. No aerial surveys of the Onslow Bay survey site were conducted during the reporting period.

2.1.1.1 Aerial Surveys: Cape Hatteras

Researchers from UNCW conducted 15 days of aerial survey effort off Cape Hatteras, North Carolina, during January–December 2014. Monthly surveys were attempted to be flown between January 2014 and December 2014. The goal each month was to conduct at least 2 days of effort, covering a subset of the 26 tracklines over the area. This goal was achieved during 6 months (April, June, July, August, October, and December). In February and May, a single day of effort was completed. During the 4 remaining months (January, March, September, and November) unfavorable weather conditions and/or complications with the plane scrubbed survey effort. A total of 96 tracklines (6,982.1 kilometers [km]) was covered in the Cape Hatteras survey area (**Table 2**). Additional effort on 29 May was conducted at the request of UNCW's colleagues at Duke University to assist in the recovery of a digital acoustic tag (DTAG). Survey conditions were dominated by Beaufort Sea State (BSS) 2 and 3, but some effort occurred in higher sea states.

Table 2. Effort details for aerial surveys conducted in the Cape Hatteras survey area, January 2014– December 2014.

Number of Survey Days	15
Total Hr Underway*	86.2
Total Tracklines Covered	96

* Total hours (hr) underway reported as Hobbs hr = total engine time

Effort-corrected cetacean sighting rates dropped dramatically (from 40.37 to 4.07 per 1,000 km) as the BSS increased (1 to 4, respectively). Ninety-two percent of all cetacean sightings occurred in BSS 1 to 3. A total of 126 sightings of 3,043 individuals of 11 species of cetaceans was recorded (**Table 3** and **Figure 3**), including bottlenose dolphins (*Tursiops truncatus*; 57 sightings of 12,77 individuals), short-finned pilot whales (*Globicephala macrorhynchus*; 21 sightings of 156 individuals), Cuvier's beaked whales (*Ziphius cavirostris*; 13 sightings of 39 individuals), Atlantic spotted dolphins (*Stenella frontalis*; 11 sightings of 579 individuals), unidentified mesoplodont beaked whales (*Mesoplodon* sp.; four sightings of nine individuals), short-beaked common dolphins (*Delphinus delphis*; four sighting of 227 individuals), sperm whales (*Physeter macrocephalus*; four sightings of four individuals), Clymene dolphins (*Stenella clymene,* three sightings of 519 individuals), Risso's dolphins (*Grampus griseus*; one sightings of 25 individuals), striped dolphins (*Stenella coeruleoalba,* one sighting of 160 individuals), True's beaked whale (*Mesoplodon mirus,* one sightings of two individuals), and Gervais' beaked whale (*Mesoplodon europaeus,* one sightings of one individual). There were five delphinid sightings (45 individuals) where species identity could not be established with 100 percent certainty and were listed as "unidentified delphinid." One species previously unrecorded in this area, True's beaked whale, was also observeredthis year. The identification of a new mesoplodont beaked whale reflects increased photo-collection effort, improved photo quality, and continued scrutiny of images of all beaked whales in the lab.

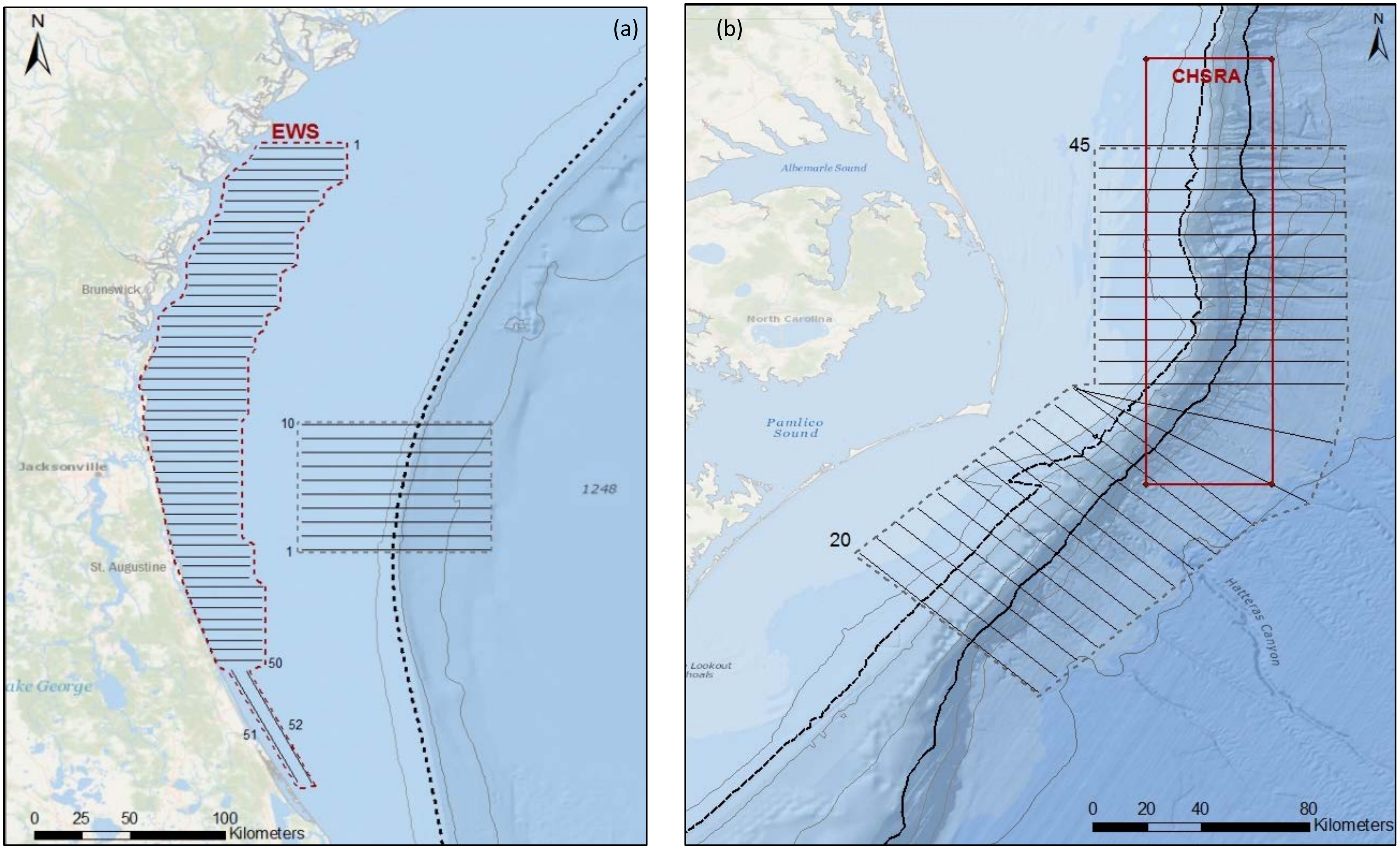


Figure 2. JAX and Cape Hatteras survey areas and established tracklines used for longitudinal baseline monitoring. (2a) Aerial surveys at the JAX location are coordinated with the North Atlantic right whale Early Warning System (EWS, the nearshore lines) surveys to maximize coverage of potential right whale ocurrence within the region. (2b) CHSRA (red box) refers to the Cape Hatteras Special Research Area, which is an area of high rates of pilot whale interactions with the pelagic longline fishery.

Table 3. Sightings from aerial surveys conducted in the Cape Hatteras survey area, January 2014–December 2014. On- and off-effort sightings are represented by #/# (on-/off-effort).

Common Name	Scientific Name	Number of Sightings	Number of Individuals
Short-beaked Common Dolphin	*Delphinus delphis*	4/0	227/0
Risso's Dolphin	*Grampus griseus*	1/2	25/41
Short-finned Pilot Whale	*Globicephala macrorhynchus*	21/6	156/68
Unidentified Mesoplodont Beaked Whale	*Mesoplodon* sp.	4/1	9/4
Sperm Whale	*Physeter macrocephalus*	4/0	4/0
Atlantic Spotted Dolphin	*Stenella frontalis*	11/0	579/0
Clymene Dolphin	*Stenella clymene*	3/0	519/0
Striped Dolphin	*Stenella coeruleoalba*	1/0	160/0
Bottlenose Dolphin	*Tursiops truncatus*	57/10	1,277/150
Cuvier's Beaked Whale	*Ziphius cavirostris*	13/1	39/3
Gervais' Beaked Whale	*Mesoplodon europaeus*	1/0	1/0
True's Beaked Whale	*Mesoplodon mirus*	1/0	2/0
Unidentified Delphinid		5/0	45/0
Loggerhead Sea Turtle	*Caretta caretta*	56/0	66/0
Leatherback Sea Turtle	*Dermochelys coriacea*	5/0	5/0
Unidentified Sea Turtle		4/0	4/0
Unidentified Shark		15/0	22/0
Manta Ray	*Manta birostris*	28/0	57/0
Cownose Ray	*Rhinoptera bonasus*	5/0	340/0
Ocean Sunfish	*Mola mola*	12/0	12/0

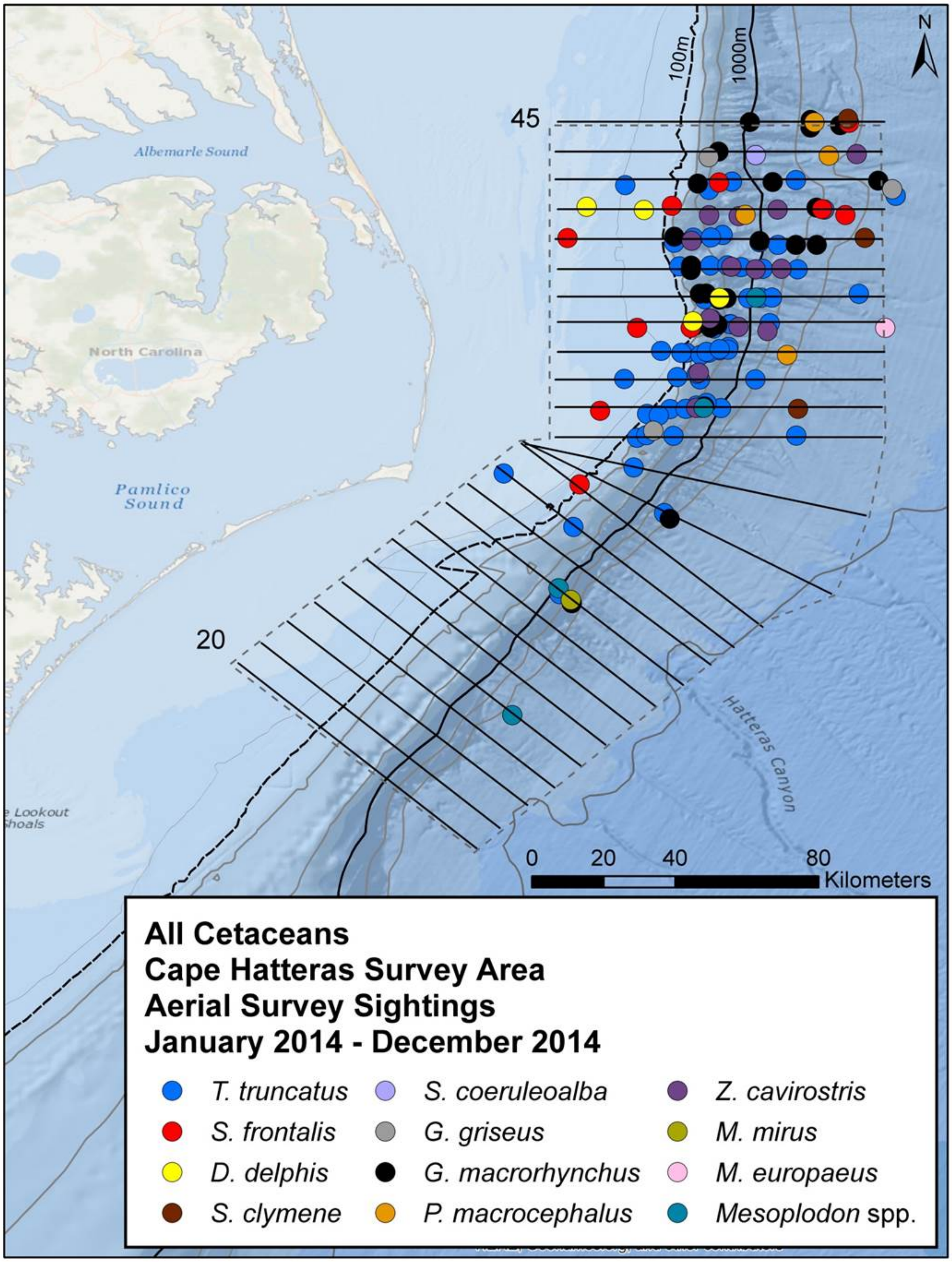


Figure 3. All cetacean sightings during aerial surveys in the Cape Hatteras survey area, January 2014–December 2014. All sightings were made on-effort.

There were 65 sightings totaling 75 individuals of two sea turtle species recorded: loggerhead turtle (*Caretta caretta*; 56 sightings of 66 individuals) and leatherback turtle (*Dermochelys coriacea*; 5 sightings of 5 individuals) (**Table 2** and **Figure 4)**. No species identification could be established for 4 sightings of 4 individuals and these were listed as “unidentified sea turtle.” Sightings were negatively correlated with BSS – sharply declining at higher than BSS 2 (from 47 individuals at BSS 2 compared to 8 at BSS 3).

In addition to cetaceans and sea turtles, other pelagic marine vertebrates were observed (**Table 3** and **Figure 5**). Forty-one sightings of sharks or rays (i.e., *Chondrichthyan* fishes) were recorded during the reporting period, largely inside of the 100-meter (m) isobath. There were 15 sightings of 22 sharks; 12 sightings 18 hammerhead sharks were made, but since identification to a species level could not be confirmed, they are shown in this report as unidentified sharks. Fifty-seven manta rays (*Manta birostris*) were observed during the study period. All five sightings of large groups of cownose rays (*Rhinoptera bonasus*) occurred in June on the northernmost tracklines. Seven sightings of ocean sunfish (*Mola mola)* were recorded, with the majority seaward of the 100-m isobath. A group of 12 bluefin tuna (*Thunnus thynnus*) also was encountered.

For more information on this study, refer to the annual progress report for this project (Cummings et al. 2015).

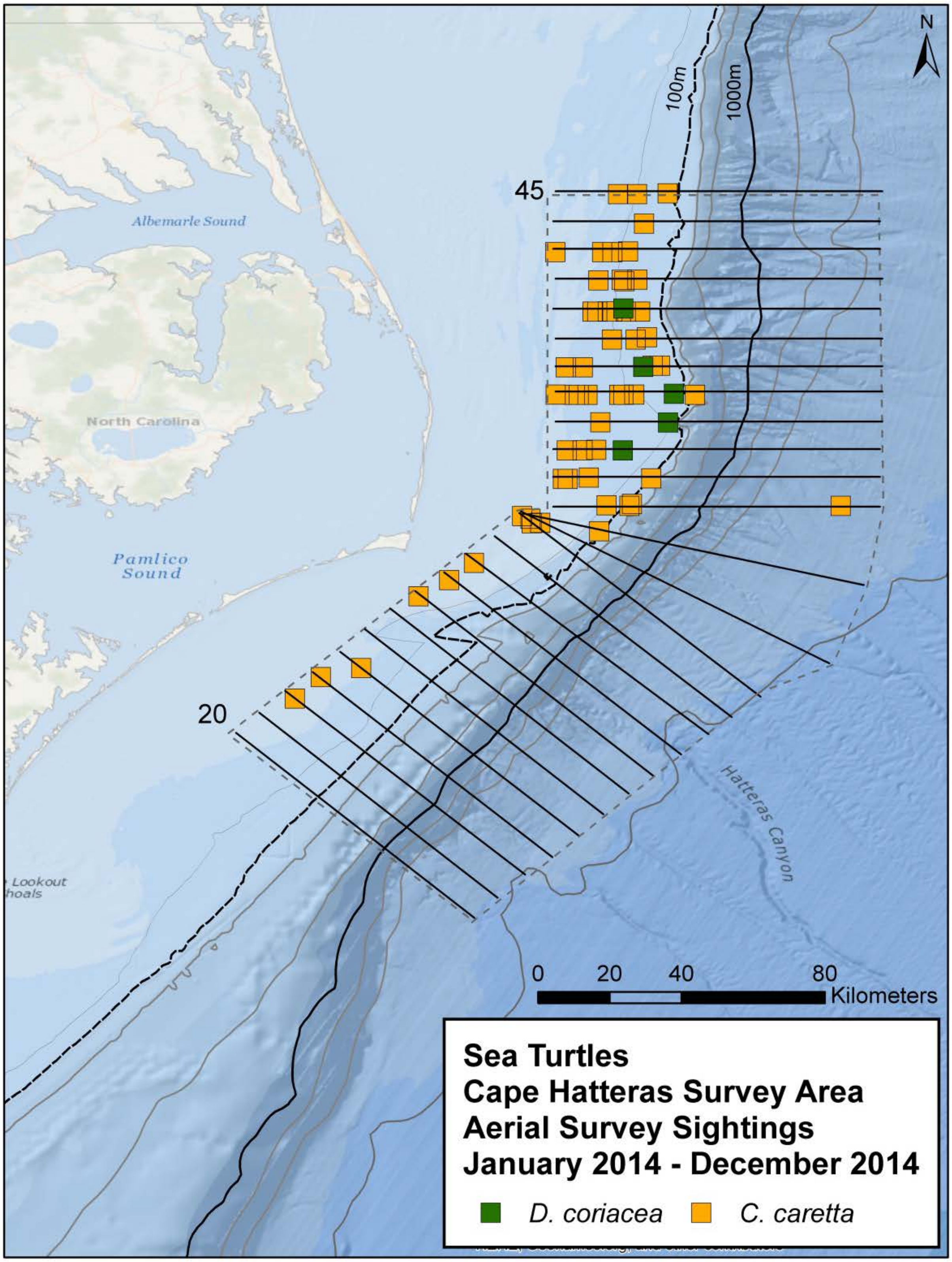


Figure 4. Locations of sea turtle sightings during aerial surveys in the Cape Hatteras survey area, January 2014–December 2014. All sightings were made on-effort.

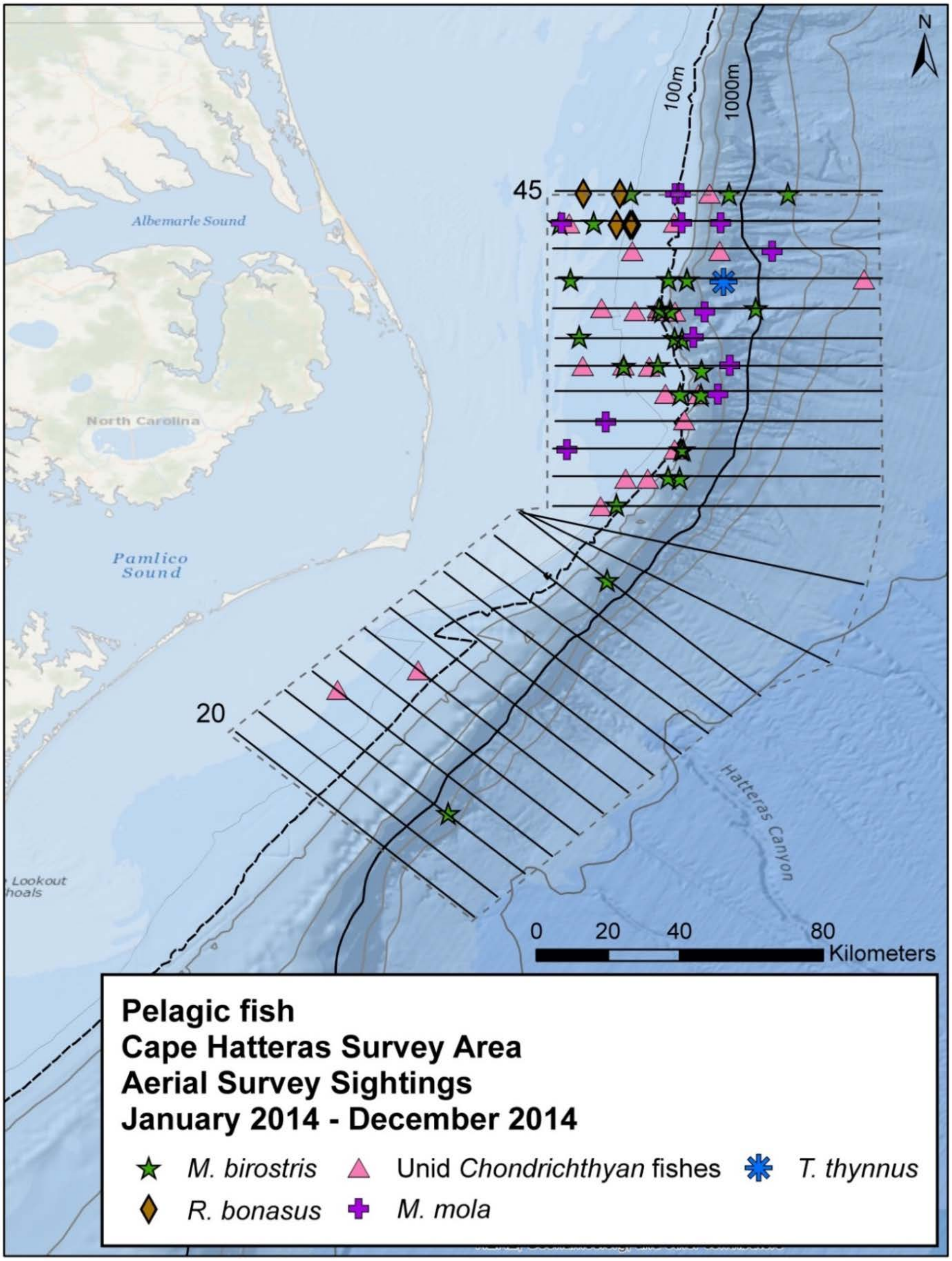


Figure 5. Pelagic fish sightings during aerial surveys in the Cape Hatteras survey area, January 2014–December 2014. All sightings were made on-effort.

2.1.1.2 Aerial Surveys: JAX

Researchers from UNCW conducted 19 days of aerial survey effort off Jacksonville, Florida. Monthly surveys were attempted to be flown between January 2014 and December 2014. The goal was to survey the entire site (10 tracklines) twice per calendar month, which was achieved in four of the nine months surveyed (February, March, May, September). During the months of April, November, and December, no surveys were conducted due to unfavorable weather conditions or plane maintenance issues. Aerial survey coverage was 162 tracklines covering 13,603.5 km **(Table 4**). Survey conditions ranged from BSS 1 to 5, with the majority of the surveys flown in BSS 3 (52 percent).

Table 4. Effort details for aerial surveys conducted in the JAX survey area, January 2014–December 2014.

Number of Survey Days	19
Total Hr Underway*	119.9
Total Tracklines Covered	162

* Total hours (hr) underway reported as Hobbs hr = total engine time

Cetacean sighting rates dropped off dramatically at BSS greater than 3. Lower sighting rates in BSS 1 and 2 are likely the result of limited survey time spent in these conditions rather than decreased detection of cetaceans. A total of 121 sightings of 1,289 cetaceans was recorded while on-effort in the study area (**Table 5** and **Figure 6**). The numbers of cetacean sightings varied by month, with the highest numbers of encounters occurring in February and June. Seven species of cetaceans were observed while on-effort including: bottlenose dolphins (55 sightings of 411 individuals), Atlantic spotted dolphins (42 sightings of 722 individuals), Risso's dolphins (four sightings of 70 individuals), short-finned pilot whales (2 sightings of 25 individuals), rough-toothed dolphins (*Steno bredanensis*; 1 sighting of 20 individuals), humpback whale (*Megaptera novaeangliae*; 1 sighting of 1 individual), and sperm whale (1 sighting of 1 individual). During 15 sightings (totaling 44 individuals) dolphin species identity could not be established with 100 percent certainty (i.e., unidentified delphinids). Seven off-effort sightings were recorded: North Atlantic right whales (*Eubalaena glacialis*) (3 sightings of 5 individuals, including one mother/calf pair); Risso's dolphin (1 sighting of 10 individuals); bottlenose dolphins (1 sightings of 13 individuals); and unidentified delphinids (1 sighting of 2 individuals). A sighting was considered off-effort if it occurred while transiting to or from the survey area or between tracklines. Any cetaceans the survey team encountered while investigating a separate sighting cue were also labeled off-effort. If two species were seen associated with the same sighting cue both were considered on-effort. The off-effort sightings are included in the tables and maps for each species but are excluded from any calculations.

Table 5. Sightings from aerial surveys conducted in the JAX survey area, January 2014–December 2014. On- and off-effort sightings are represented by #/# (on-/off-effort).

Common Name	Scientific Name	Number of Sightings	Number of Individuals
North Atlantic Right Whale	*Eubalaena glacialis*	0/3	0/5
Risso's Dolphin	*Grampus griseus*	4/1	70/10
Short-finned Pilot Whale	*Globicephala macrorhynchus*	2/0	25/0
Rough-toothed Dolphin	*Steno bredanensis*	1/0	20/0
Atlantic Spotted Dolphin	*Stenella frontalis*	42/0	722/0
Bottlenose Dolphin	*Tursiops truncatus*	55/2	411/13
Unidentified Delphinid		15/1	44/2
Loggerhead Sea Turtle	*Caretta caretta*	246/0	296/0
Leatherback Sea Turtle	*Dermochelys coriacea*	30/0	32/0
Unidentified Sea Turtle		23/0	23/0
Unidentified Shark		24/0	24/0
Manta Ray	*Manta birostris*	9/0	15/0
Cownose Ray	*Rhinoptera bonasus*	2/0	255/0
Ocean Sunfish	*Mola mola*	5/0	6/0

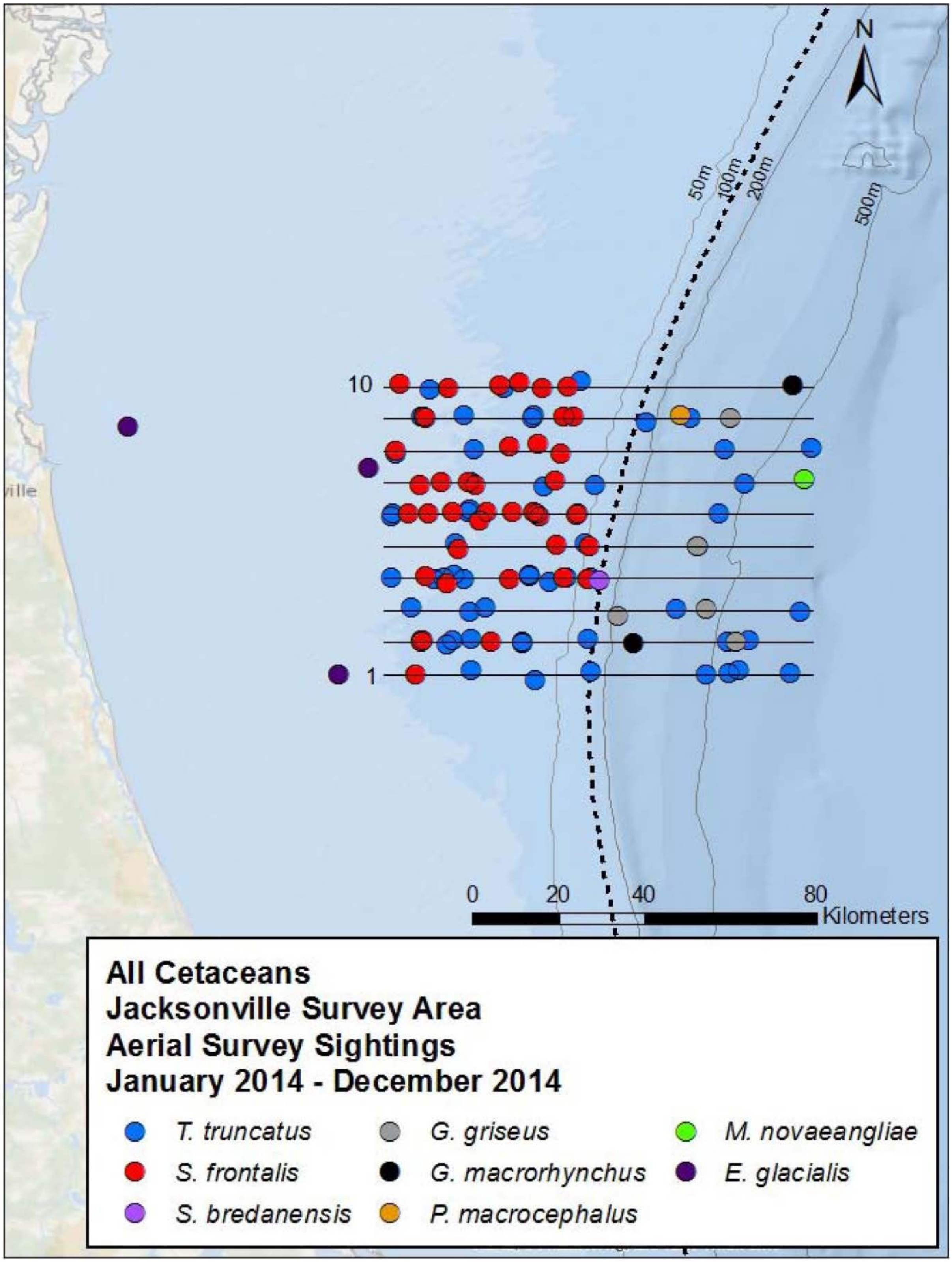


Figure 6. All cetacean sightings during aerial surveys in the JAX survey area, January 2014–December 2014. All sightings were made on-effort.

During January 2014–December 2014, 351 individual sea turtles were recorded during aerial surveys in JAX (**Table 5**). Sighting rates were negatively correlated with BSS, with rates declining at higher sea states. Sea turtles were observed every day of survey effort with the highest sighting rates occurring in May and July. Observation rates ranged from a low of 1.97/1,000 km flown in January to 39.82/1,000 km in July. Loggerhead turtles constituted the majority of sea turtles sighted (84.3 percent; *n*=296), followed by leatherback turtles (9.1 percent; *n*=32). Turtles labeled as unidentified (6.6 percent; *n*=23) were typically either of small size, submerged, or too far away for the observers to make an accurate identification to species (**Table 5**). Loggerhead turtles were predominantly recorded in the shallower waters over the continental shelf, although a small number of individuals occurred beyond the continental shelf break (**Figure 7**). Leatherback turtles were recorded inshore of the 100-m isobath (i.e., continental shelf break) (**Figure 7**).

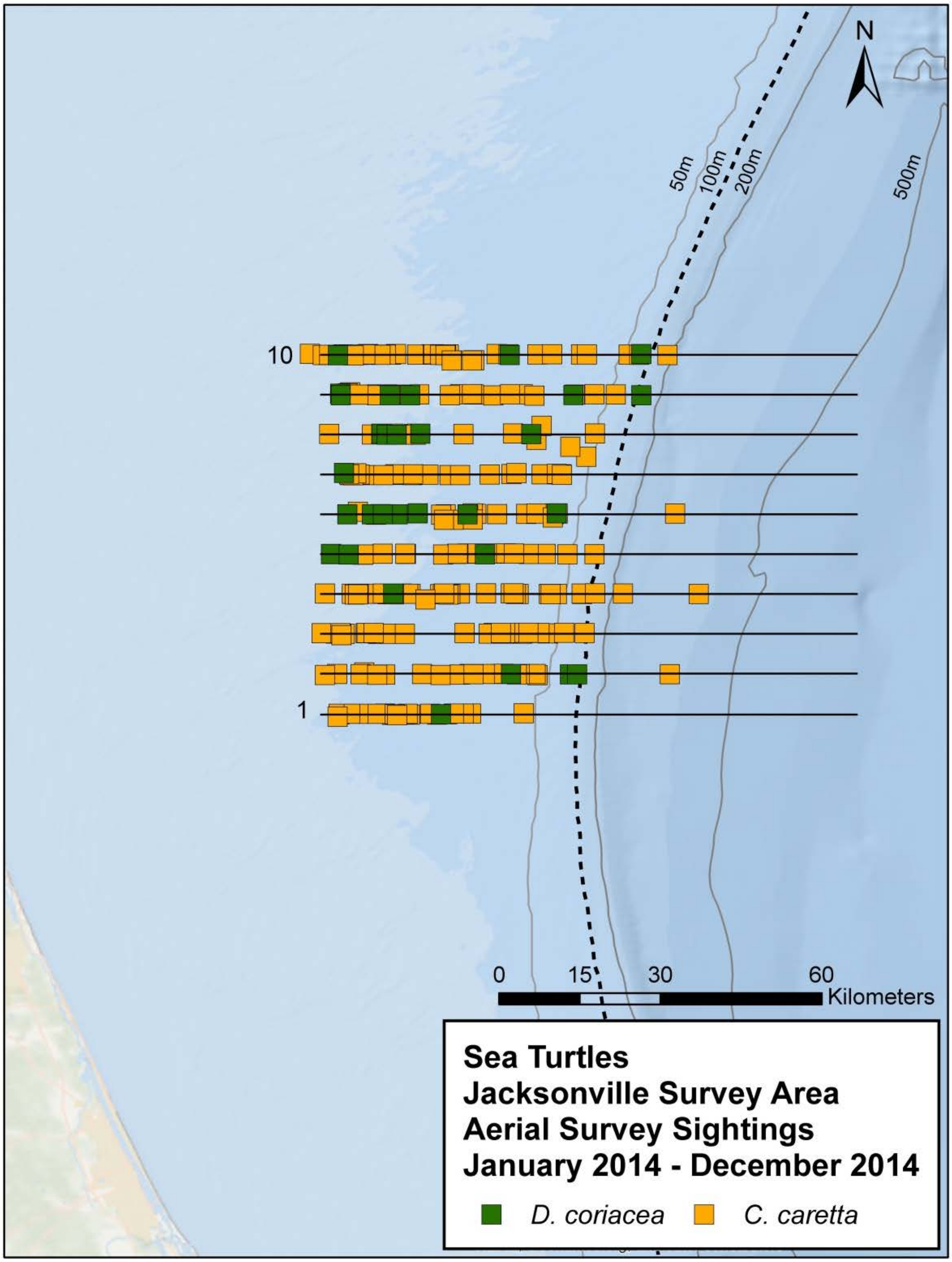
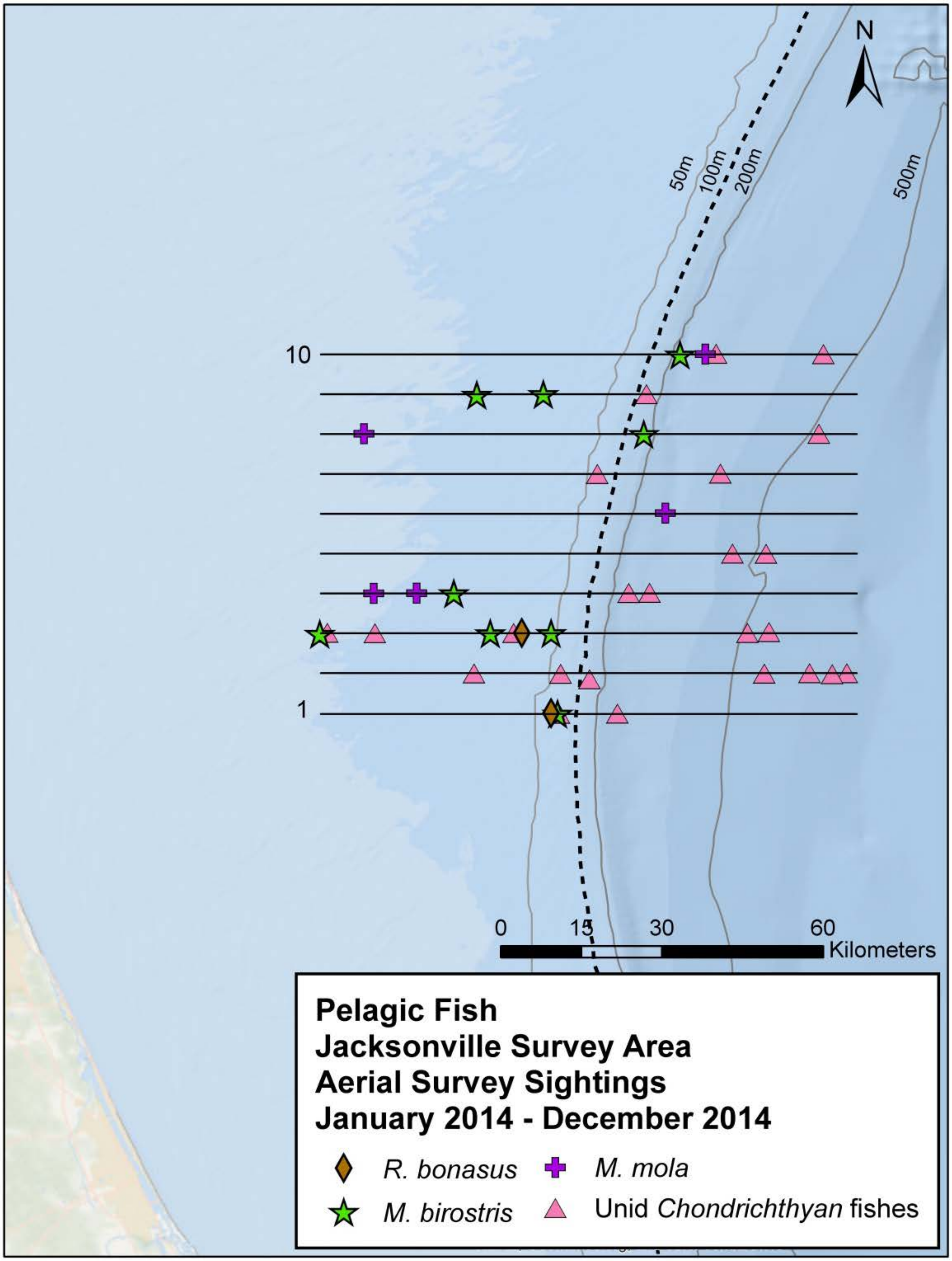


Figure 7. All sea turtle sightings during aerial surveys in the JAX survey area, January 2014–December 2014. All sightings were made on-effort.

In addition to cetaceans and sea turtles, other pelagic marine vertebrates were observed, including sightings of sharks or rays (i.e., *Chondrichthyan* fishes) (**Table 5** and **Figure 8).** Seven ocean sunfish were sighted over the continental shelf in February, March, and June. Fifteen manta rays were observed, with 66 percent of sightings occurring in May. There were only two sightings of cownose rays; both were recorded in June, with a total of 255 individuals. A total of 24 sharks was seen during 2014, 79 percent (*n*=19) were identified as hammerhead sharks, but since identification to a species level could not be confirmed, they are shown in this report as unidentified sharks. Sharks showed no discernable spatial or temporal trends in occurrence.

For more information on this study, refer to the annual progress report for this project (McAlarney et al. 2015).

289 

290 **Figure 8. Pelagic fish sightings during aerial surveys in the JAX survey area, January 2014–December**
291 **2014. All sightings were made on-effort.**

2.1.2 Visual Baseline Vessel Surveys

2.1.2.1 Cape Hatteras Survey Area

Off Cape Hatteras, 4 years of surveys provided information on the complex patterns of distribution and diversity of the marine mammals and sea turtles in this highly productive area. Twenty days of fieldwork were conducted in the Cape Hatteras survey area during January 2014 through December 2014 (between May and October 2014) (**Figure 9** and **Table 6**). Eleven of the 20 days were dedicated to Satellite-Tagging project, eight days to the Deep Diver project, and one day to Strategic Environmental Research and Development Project (SERDP) (**Figure 9**). On 16 June 2014, two survey vessels were used—the Research Vessel (R/V) *Richard T. Barber* and the R/V *Exocetus*. In addition, two field days under the Deep Diver project were used attempting to recover a lost DTAG. Fieldwork conducted during 2014 yielded 921.9 km and 121.7 hr of effort (**Table 6**).

Table 6. Effort details for vessel surveys conducted in the Cape Hatteras survey area, January 2014–December 2014. All sightings were made on-effort.

Number of Survey Days	20
Total Survey Time (hr:min)	227:34
Time On Effort (hr:min)	45:58
Total km Surveyed	921.9

Key: hr = hour(s); km = kilometer(s); min = minute(s)

Seven species of cetaceans were encountered. There were 47 sightings of deep-diving odontocetes: short-finned pilot whale (*n*=26); Cuvier's beaked whale (*n*=16); unidentified beaked whales (*n*=3); and sperm whale (*n*=2). Other species recorded included bottlenose dolphin (*n*=14); Risso's dolphin (*n*=1); short-beaked common dolphin (*n*=4); and Atlantic spotted dolphin (*n*=3); (**Table 7** and **Figure 10**).

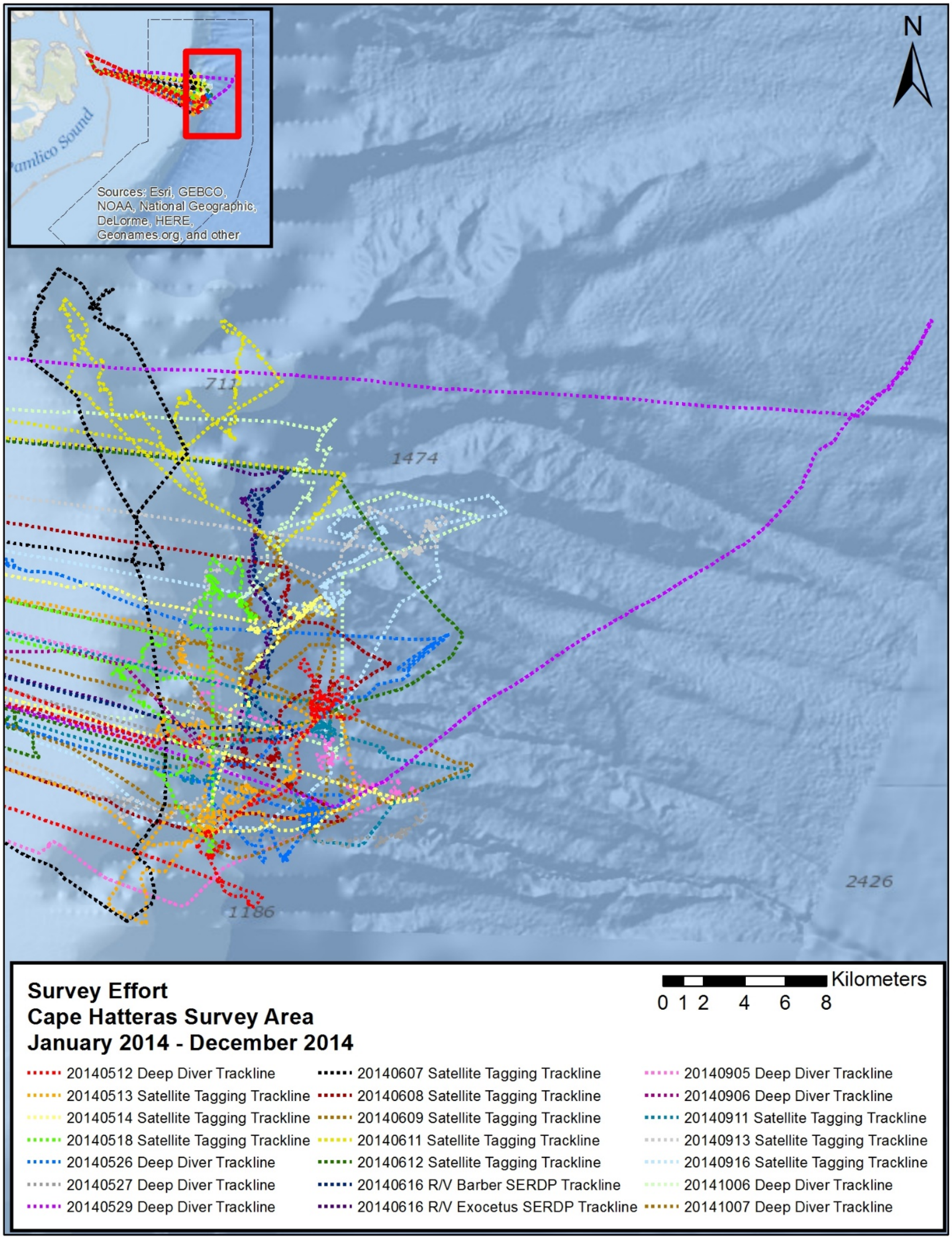
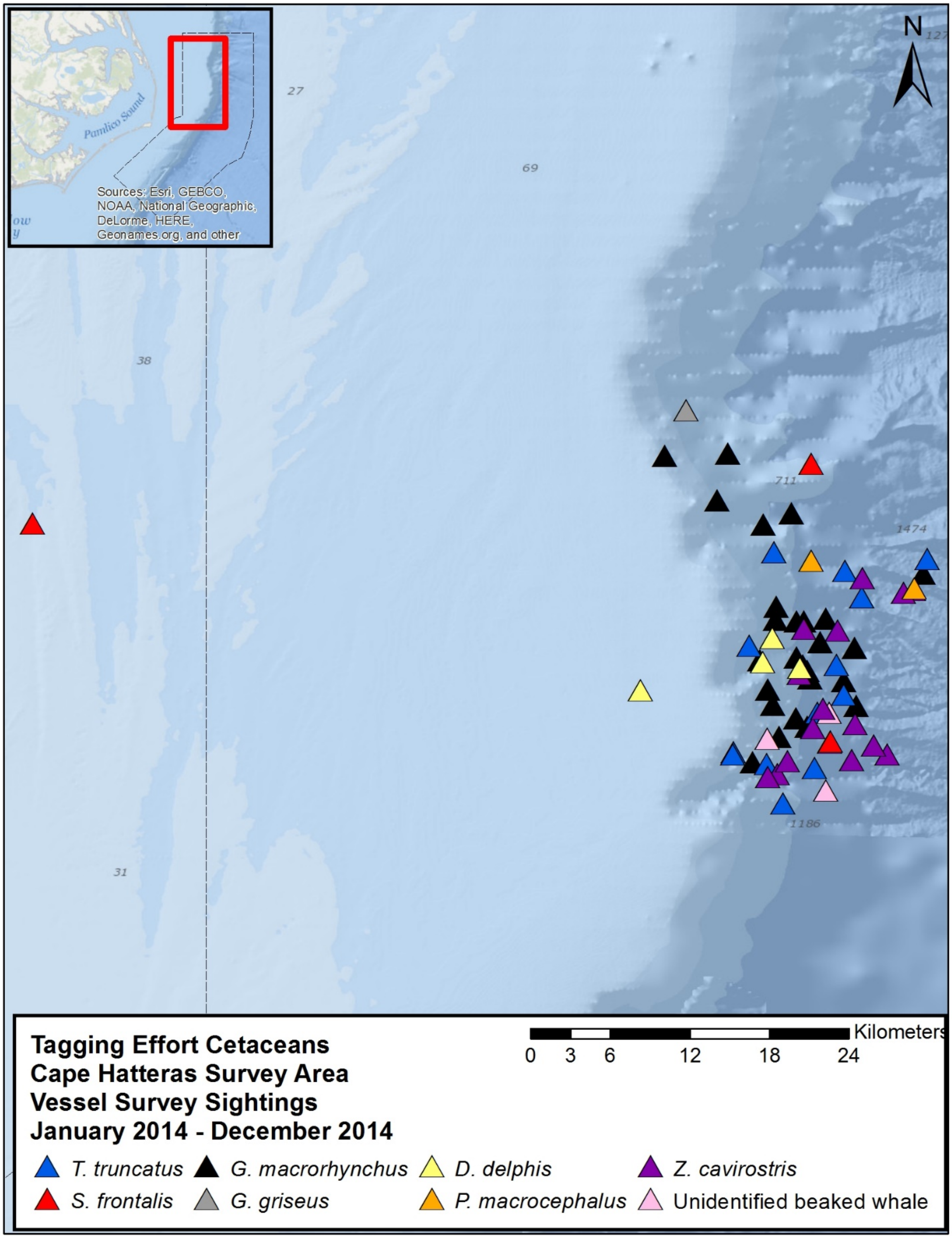


Figure 9. Survey effort in the Cape Hatteras survey area, January 2014–December 2014.

Table 7. Sightings from field work conducted in the Cape Hatteras survey area, January 2014–December 2014. All sightings were made on-effort.

Common Name	Scientific Name	Number of Sightings	Number of Individuals
Short-finned Pilot Whale	*Globicephala macrorynchus*	26	657
Cuvier's Beaked Whale	*Ziphius cavirostris*	16	58
Unidentified Beaked Whale		3	4
Sperm Whale	*Physeter macrocephalus*	2	2
Bottlenose Dolphin	*Tursiops truncatus*	14	
Risso's Dolphin	*Grampus griseus*	1	5
Short-beaked Common Dolphin	*Delphinus delphis*	4	670
Atlantic Spotted Dolphin	*Stenella frontalis*	3	77

313 

314 **Figure 10. Locations of all cetacean sightings observed during fieldwork in the Cape Hatteras survey**
315 **area, January 2014–December 2014. All sightings were made on-effort.**

Thirty-three tags were deployed during the reporting period. Four DTAGs were attached on Cuvier's beaked whales and short-finned pilot whales, while 29 satellite tags were placed on short-finned pilot whales, bottlenose dolphins, Cuvier's beaked whales, and a short-beaked common dolphin in the reporting period (see **Section 2.3.1** of this report for more information).

Ten biopsy samples were collected from four species of cetaceans. Biopsied species included two deep-diving odontocete species: short-finned pilot whale (*n*=5) and sperm whale (*n*=1). Tissue samples also were taken from bottlenose dolphins (*n*=2) and Atlantic spotted dolphins (*n*=2) (**Table 8** and **Figure 11**). Genetic analysis of extracted deoxyribonucleic acid (DNA) from bottlenose dolphin biopsy samples previously collected in the Cape Hatteras survey area between May 2011 and July 2013 confirmed that all of the sampled dolphins were of the offshore ecotype, suggesting that there is limited overlap between coastal and offshore populations in the Cape Hatteras survey area. Voucher specimens of these samples are archived with the NMFS/Southeast Fisheries Science Center in Lafayette, Louisiana.

Table 8. Biopsy samples taken from animals in the Cape Hatteras survey area, January 2014–December 2014.

Common Name	Scientific Name	Samples
Bottlenose Dolphin	*Tursiops truncatus*	2
Short-finned Pilot Whale	*Globicephala macrorhynchus*	5
Atlantic Spotted Dolphin	*Stenella frontalis*	2
Sperm Whale	*Physeter macrocephalus*	1

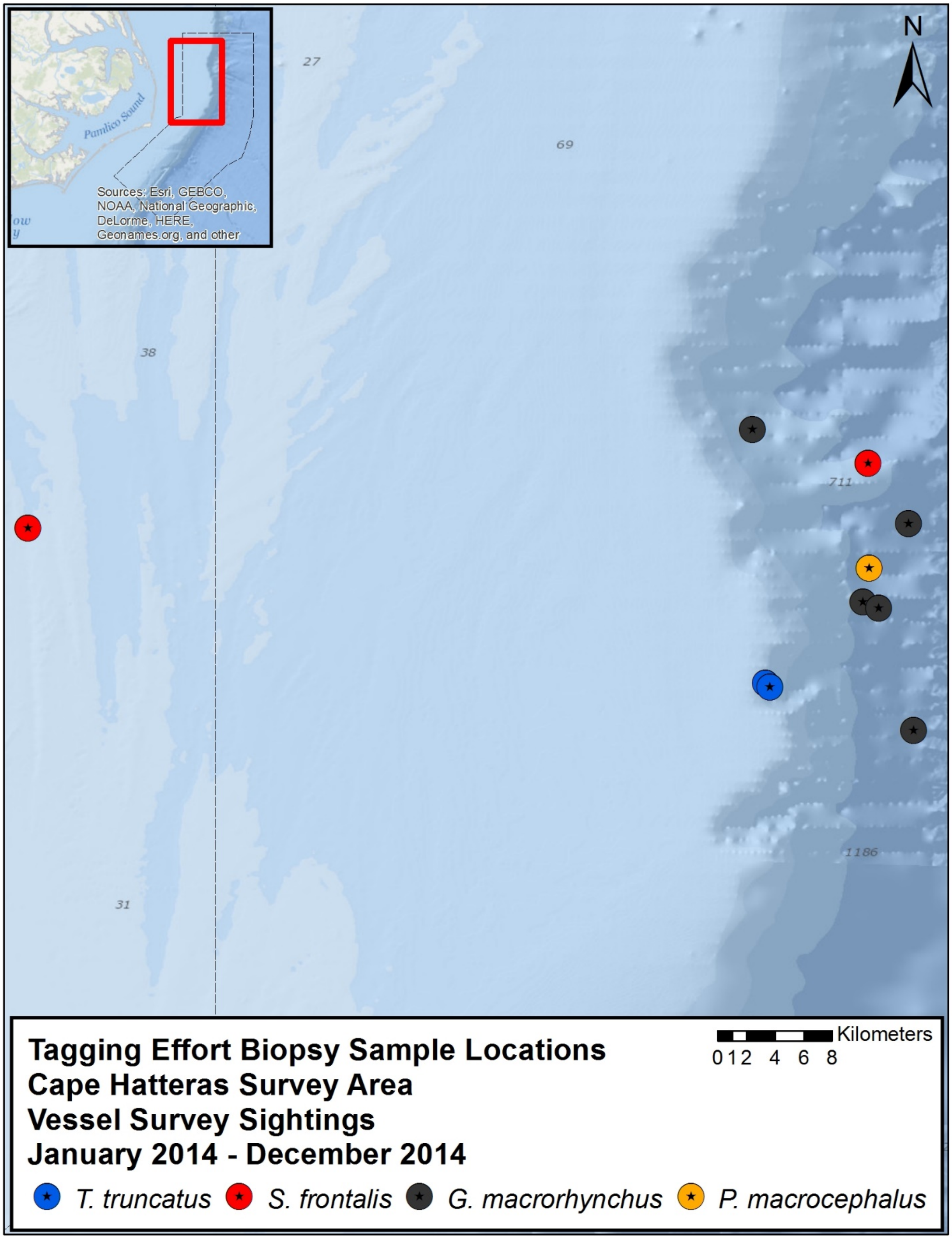


Figure 11. Distribution of biopsy sample locations collected during fieldwork in the Cape Hatteras survey area, January 2014–December 2014.

A total of 4,120 digital images was collected to confirm species identification and identify individual animals during fieldwork in 2014. Images of 130 newly identified animals were added to seven existing photo-ID catalogs of: bottlenose dolphins, Atlantic spotted dolphins, short-finned pilot whales, sperm whales, Cuvier's beaked whales, short-beaked common dolphins, and Risso's dolphins. In 2014, two new photo-ID catalogs were established for humpback whales and fin whales (*Balaenoptera physalus*) that were observed from prior years in the Cape Hatteras study area (humpback whales were previously photographed in 2007 and 2012, and fin whale in 2013). To date, photo-ID catalogs for nine species have been assembled, with nearly 40 individuals re-sighted across all species (**Table 9**). In addition, the photo-ID catalogs of bottlenose dolphins, Atlantic spotted dolphins (through 2013) and short-finned pilot whales (through 2014) from the Cape Hatteras study area have been compared to the Jacksonville and Onslow Bay photo-ID catalogs, but no matches have been identified to date.

Table 9. Comparison of photographs taken of animals in the Cape Hatteras survey area in 2014, with existing photo-ID catalogs, showing matches made so far between this year's photos and the catalogs.

Common Name	Scientific Name	Photos Taken (2014)	Catalog Size to Date	Matches to Date
Bottlenose Dolphin	*Tursiops truncatus*	631	198	9
Short-finned Pilot Whale	*Globicephala macrorhynchus*	2,249	229	25
Risso's Dolphin	*Grampus griseus*	30	7	0
Fin Whale	*Balaenoptera physalus*	0	1	0
Short-beaked Common Dolphin	*Delphinus delphis*	451	27	1
Atlantic Spotted Dolphin	*Stenella frontalis*	22	23	0
Sperm Whale	*Physeter macrocephalus*	16	5	1
Cuvier's Beaked Whale	*Ziphius cavirostris*	721	13	2
Humpback Whale	*Megaptera novaeangliae*	0	3	0

Photo-analysis of the images taken in the Cape Hatteras survey area is ongoing. To date, nine bottlenose dolphins were photographed on multiple occasions, spanning several years (**Table 10**). A single match was made of a short-beaked common dolphin photographed off Cape Hatteras—Dde 7-002 was first photographed on 27 May 2007 and then re-sighted nearly 5 years later on 15 March 2012 (**Table 10**). The first sperm whale and Cuvier's beaked whale matches were made during this reporting period. Pma-004 was observed on 27 and 29 May 2013. Zca_003r, which was satellite-tagged on 13 May 2014 (ZcTag029) was first photographed during satellite tag deployment and again 5 days later. Zca_005r was photographed in May and October 2014 (**Table 10**).

Table 10. Photo-ID matches of odontocete cetaceans in the Cape Hatteras survey area.

ID	2006	2007	2008	2009	2010	2011	2012	2013	2014
Ttr 1-001				X		X^y			
Ttr 6-018^							X	X	
Ttr 6-020						X		X	
Ttr 7-031						X^y			
Ttr 7-038						X^y			
Ttr 7-058								X^y	
Ttr 9-013^							X	X	
Ttr 9-016						X			X
Ttr 9-027 (TtTag015)									X^m
Dde 7-002		X					X		
Pma-004								X^m	
Zca-003r (ZcTag029)									X^m
Zca-005r									X^y

Key: Dde=*Delphinus delphis* (short-beaked common dolphin); m=re-sighted within same month; Pma=*Physeter macrocephalus* (sperm whale); Ttr=*Tursiops truncatus* (bottlenose dolphin); y=re-sighted within same year; Zca=*Ziphius cavirostris* (Cuvier's beaked whale)

There is a high resighting rate for short-fined pilot whales in the Cape Hatteras survey area, suggesting some degree of residency. To date, more than 10 percent (*n*=25 of 229) of the animals in the short-finned pilot whale photo-ID catalog were resighted (**Table 9**). Resightings of this species span up to 6 years, and several individuals were observed on multiple occasions and in different seasons. Three of the 20 short-finned pilot whales equipped with satellite tags in 2014 (see **Section 2.3.1** of this report; Baird et al. 2015) were either resighted or matched to the existing catalog. GmTag087 was tagged on 18 May 2014 and re-sighted on 16 June 2014 during Duke University's SERDP survey (**Figures 12** and **13**). GmTag096, satellite-tagged in September 2014, was previously photo-identified in May and June 2012; this individual was DTAGged in June 2012 during Duke University's SERDP work and also biopsied. Genetic analysis confirms this animal is a female. GmTag097, also satellite-tagged in September 2014, was matched to existing catalog individual Gma 7-016, previously recorded in June 2012 (**Table 11, Figures 12** and **13**).

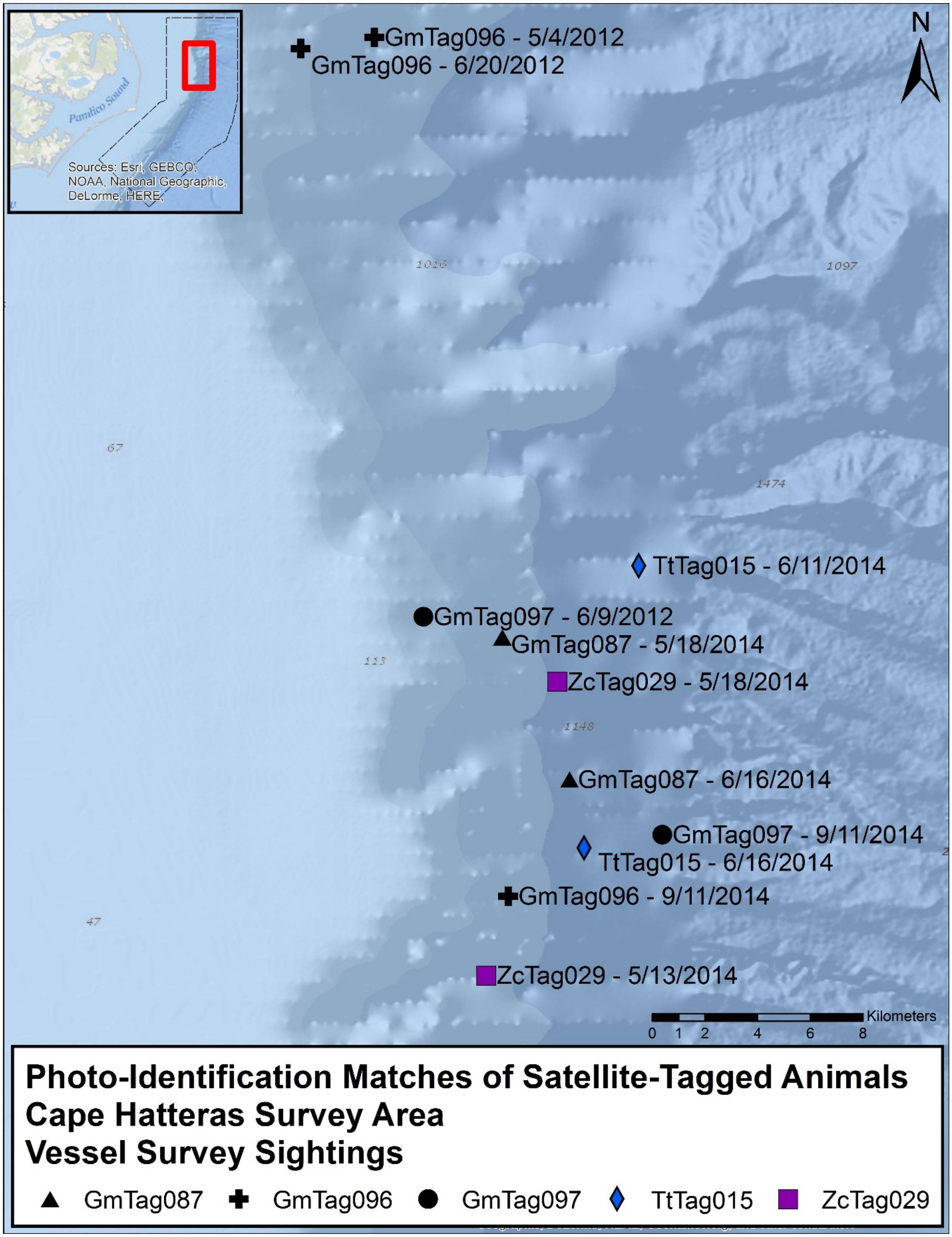


Figure 12. Photo-ID matches of satellite-tagged animals, with dates sighted, observed during fieldwork in the Cape Hatteras survey area.

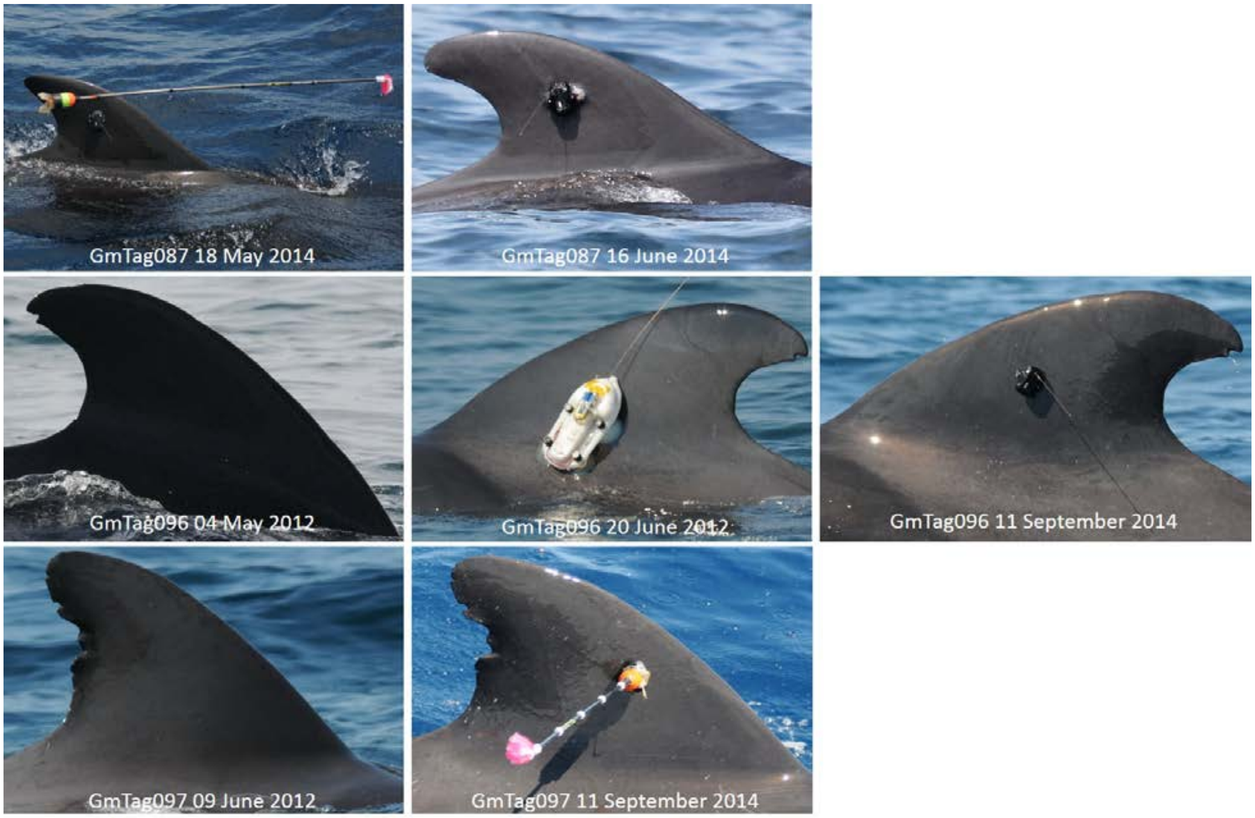


Figure 13. Photo-ID matches of short-finned pilot whales observed in the Cape Hatteras survey area.

Table 11. Photo-ID matches of short-finned pilot whales in the Cape Hatteras survey area.

ID	Sex	2006	2007	2008	2009	2010	2011	2012	2013	2014
Gma_1-001								X^y		
Gma_1-002							X	X		
Gma_6-001	M						X	X		
Gma_6-006	M		X					X		
Gma_6-026	M			X				X		
Gma_6-033	M							X^m		
Gma_7-002	M	X		X				X		
Gma_7-003		X						X^m		
Gma_7-007	M	X^m								
Gma_7-009							X	X		
Gma_7-012								X^y		
Gma_7-014								X^m		
Gma_7-016 (GmTag097)								X		X
Gma_7-017								X^m		
Gma_7-018								X^m		
Gma_7-026								X^m		
Gma_7-027								X^m		
Gma_7-055	F		X^y							
Gma_7-071	M			X				X^m		
Gma_7-084	F							X^y		
Gma_7-085	F							X^y		
Gma_8-007								X^m		
Gma_8-016			X			X				
GmTag087										X^y
GmTag096	F							X^y		X

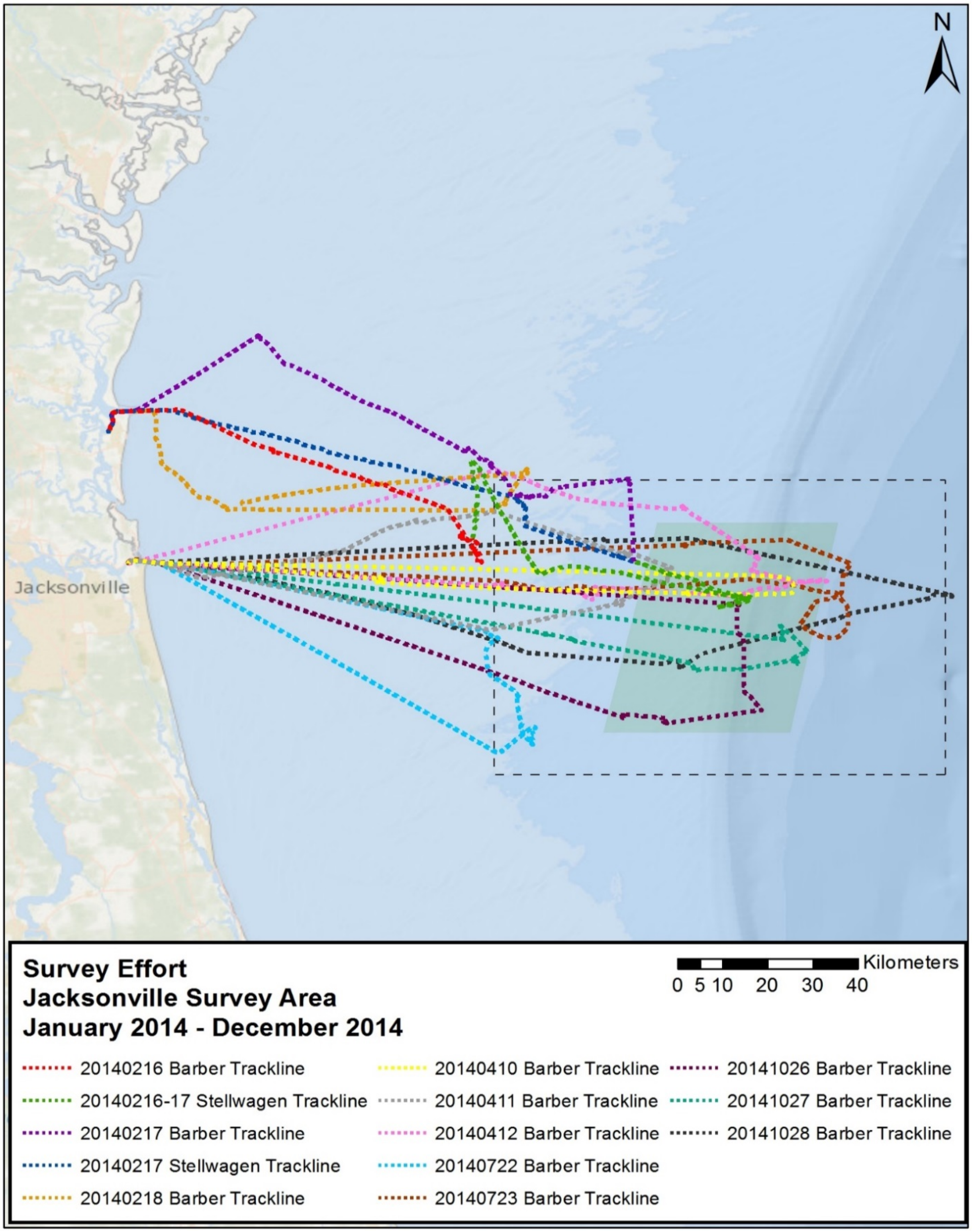
^{m} - re-sighted within same month

^{y} - re-sighted within same year

2.1.2.2 JAX Survey Area

More than 5 years of monitoring in the JAX survey area has yielded a comprehensive picture of the density, distribution and abundance of marine mammals and sea turtles and provided new insights into residency patterns among pelagic delphinid cetaceans in this region.

Eleven biopsy and photo-ID surveys were conducted in the JAX survey area during January 2014 through December 2014 (**Figure 14**). Survey effort occurred during February, April, July, and October 2014. These visual vessel surveys were conducted primarily from the 9-m R/V *Richard T. Barber*, with one day of survey effort also conducted from the 21-m R/V *Stellwagen* following the deployment of a HARP in February 2014. A total of 1,227.4 km and 66.75 hr of trackline effort was conducted (**Table 12**) in BSS 1 to 4.

385 

386 **Figure 14. Survey effort during vessel surveys in the JAX survey area, January 2014–December 2014.**
387 **The dashed line outlines the JAX survey area, while the shaded box is the planned USWTR site.**

Table 12. Effort details for vessel surveys conducted in the JAX survey area, January 2014–December 2014.

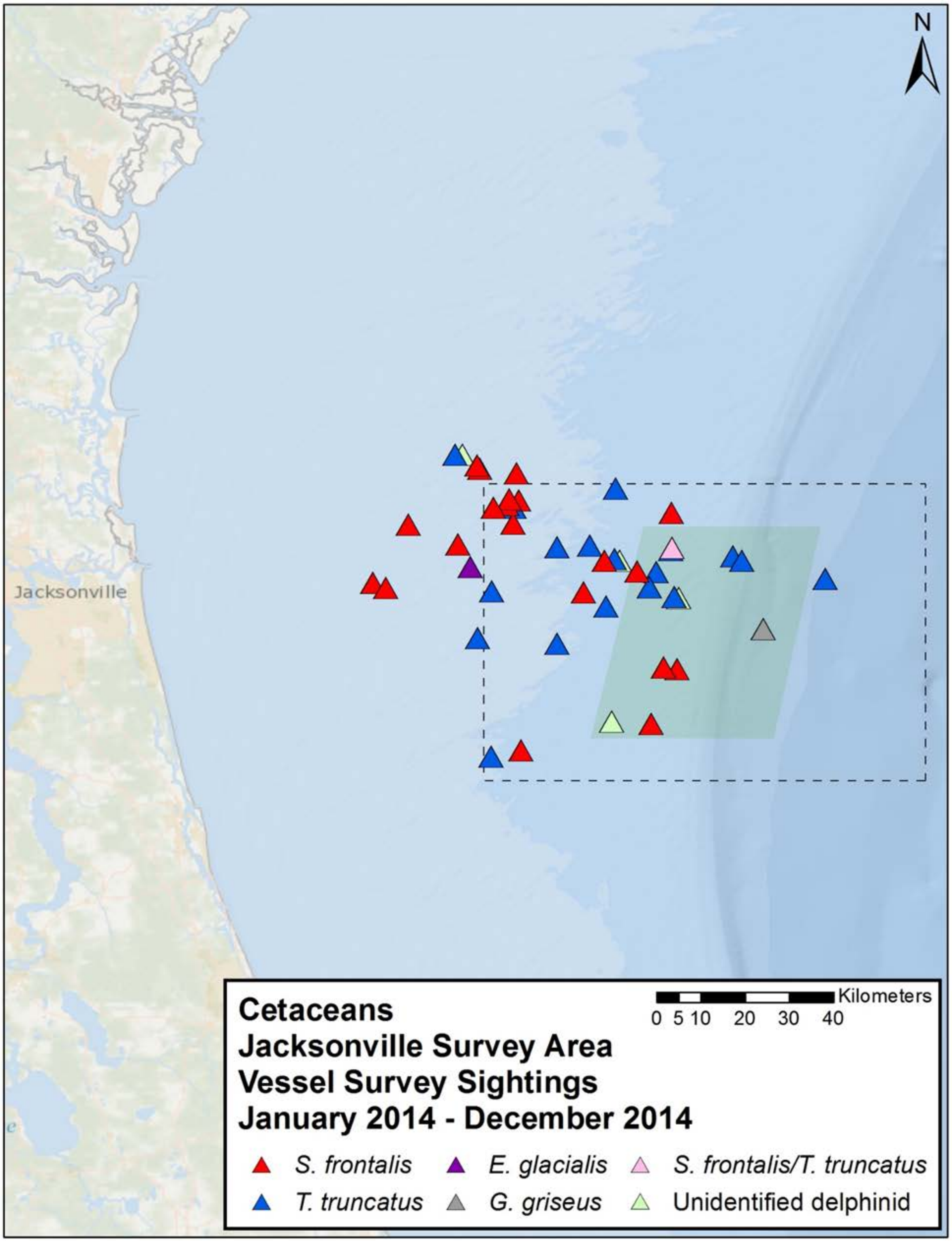
Number of Surveys	11
Total Survey Time (hr:min)	129:30
Time On Effort (hr:min)	66:45
Total km Surveyed	1,227.4

hr = hour(s); km = kilometer(s); min = minute(s)

Forty-five sightings of four cetacean species (North Atlantic right whale, bottlenose dolphin, Atlantic spotted dolphin, and Risso's dolphin) were recorded (**Table 13**). As in previous years, bottlenose (*n*=18) and Atlantic spotted dolphins (*n*=20) dominated the sightings, with single sightings of Risso's dolphins and a solitary North Atlantic right whale. In addition, one mixed group of bottlenose and Atlantic spotted dolphins and four sightings of unidentified delphinids were recorded (**Figure 15** and **Table 13**). Similar to previous years of survey effort (e.g., DoN 2013, 2014), bottlenose dolphins were encountered throughout the JAX survey area, including deeper, pelagic waters (**Figure 15**), whereas Atlantic spotted dolphins were restricted to relatively shallow waters over the continental shelf (**Figure 15**).

Table 13. Sightings from vessel surveys conducted in the JAX survey area, January 2014–December 2014. All sightings were made on-effort.

Common Name	Scientific Name	Number of Sightings	Number of Individuals
North Atlantic Right Whale	*Eubalaena glacialis*	1	1
Risso's Dolphin	*Grampus griseus*	1	50
Atlantic Spotted Dolphin	*Stenella frontalis*	20	164
Bottlenose Dolphin	*Tursiops truncatus*	18	81
Bottlenose Dolphin/Atlantic Spotted Dolphin (Mixed Group)	*Tursiops truncatus/Stenella frontalis*	1	1/7
Unidentified Delphinid		4	5
Loggerhead Turtle	*Caretta caretta*	31	32
Leatherback Turtle	*Dermochelys coriacea*	3	3



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401 **Figure 15. Locations of cetacean sightings from vessel surveys conducted in the JAX survey area,**
402 **January 2014–December 2014. All sightings were made on-effort.**

Thirty-three sightings of two sea turtle species (loggerhead turtle and leatherback turtle) were recorded (**Table 13**). As in years past, the loggerhead turtle was the most frequently recorded species (*n*=30); a small number of sightings of leatherback turtles (*n*=3) also was observed (**Figure 16** and **Table 13**). All sea turtles were found over the continental shelf (**Figure 16**).

Thirty-one biopsy samples were collected from Atlantic spotted dolphins (*n*=19), bottlenose dolphins (*n*=10), and Risso's dolphins (*n*=2) (**Table 14** and **Figure 17**). Skin samples will be analyzed for sex determination.. Voucher specimens of these samples are archived with the Southeast Fisheries Science Center in Lafayette, Louisiana.

Table 14. Biopsy samples collected from animals in the JAX survey area, January 2014–December 2014.

Common Name	Scientific Name	No. Samples
Atlantic Spotted Dolphin	*Stenella frontalis*	19
Bottlenose Dolphin	*Tursiops truncatus*	10
Risso's Dolphin	*Grampus griseus*	2

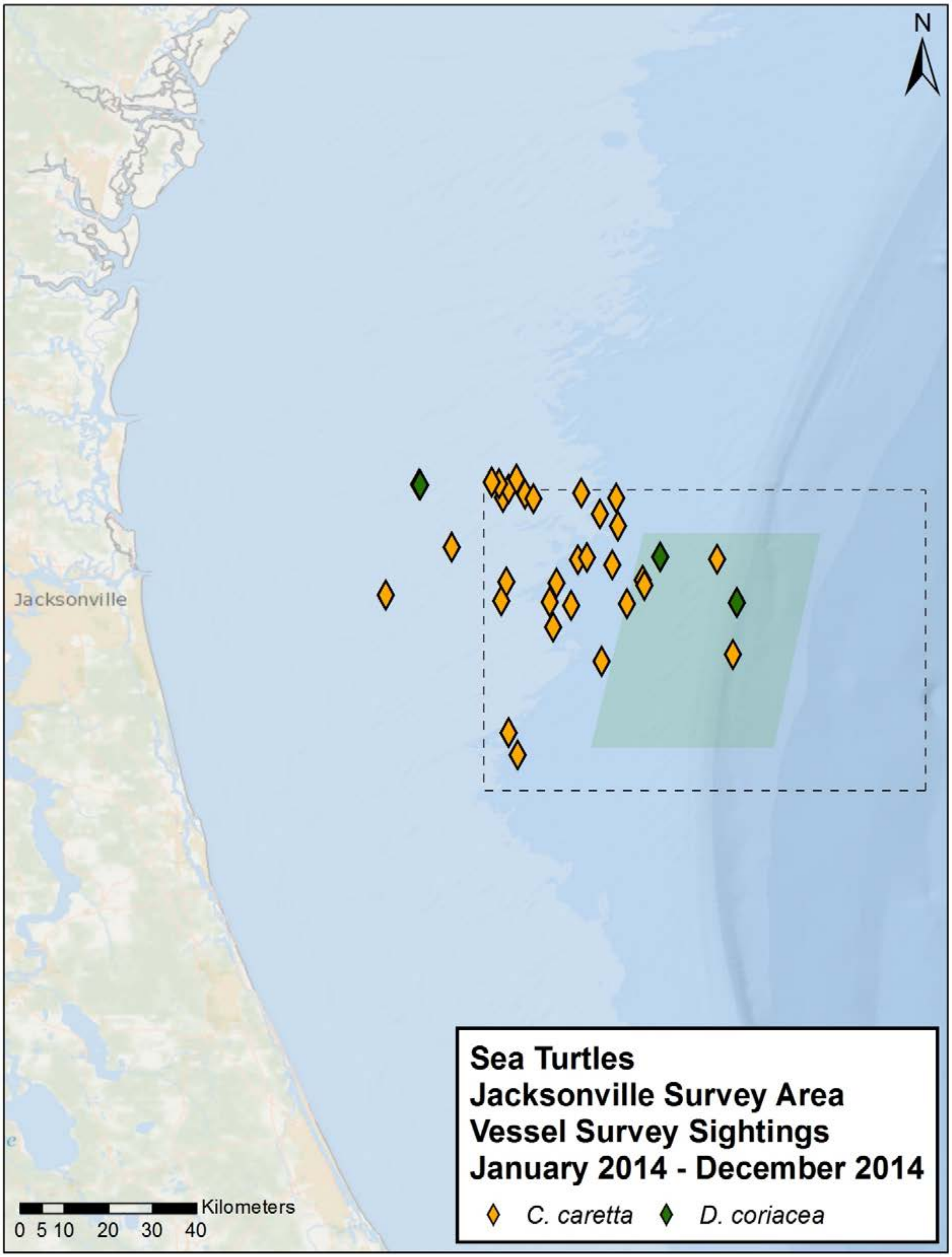


Figure 16. Locations of sea turtle sightings from vessel surveys conducted in the JAX survey area, January 2014–December 2014. All sightings were made on-effort.

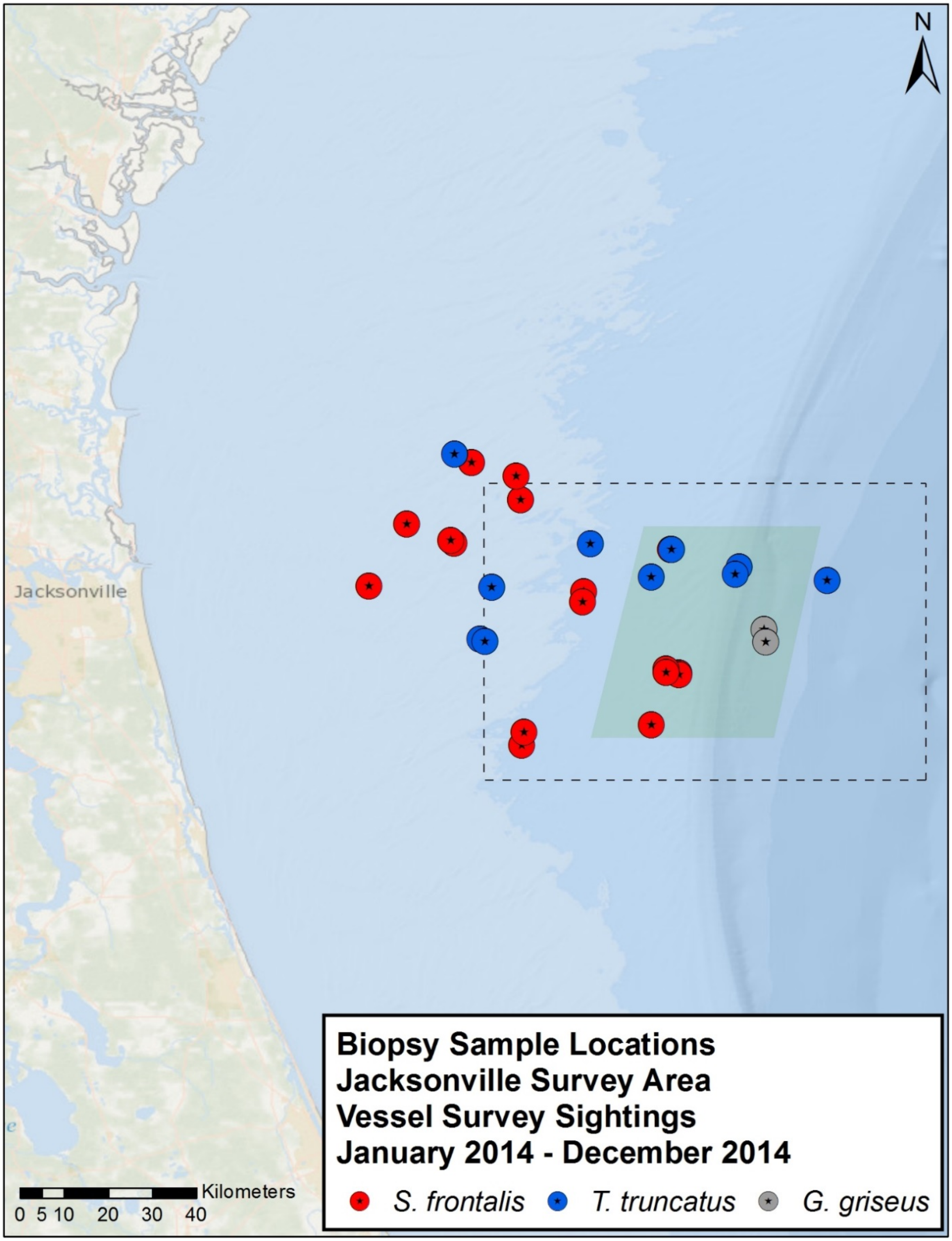


Figure 17. Locations of biopsy sampling of Atlantic spotted, bottlenose, and Risso's dolphins in the JAX survey area, January 2014–December 2014.

A total of 1,688 digital images for species confirmation and individual identification was taken of three species (bottlenose dolphin, Atlantic spotted dolphin, and Risso's dolphin). A total of 77 newly-identified dolphins was added to existing photo-ID catalogs (**Table 15**). Photo-ID catalogues for bottlenose and Atlantic spotted dolphins in the JAX survey area currently consist of 80 and 111 individuals, respectively. Photo-matching efforts revealed resightings of two individual Atlantic spotted dolphins in the JAX survey area (**Table 16** and **Figure 18**). Dolphin Sfr 3-001 was observed first on 10 October 2010 and again on 19 March 2011, while Sfr 8-005 was photographed during surveys on two consecutive days: 18 March 2011 and 19 March 2011. In addition, two bottlenose dolphins were resighted together on 25 January 2012 and 18 July 2013 (**Table 16** and **Figure 18**). The Risso's dolphin photo-ID catalog consists of 22 individuals, with no resighted individuals through 2014. No short-finned pilot whales were sighted in 2014, so the photo-ID catalog remains at its previous size, with no matches for 2014.

Table 15. Summary of photographs taken of animals in the JAX survey area, January 2014-December 2014, with photo-ID catalog sizes and total number of matches.

Common Name	Scientific Name	Photos Taken	Catalog Size to Date	Matches to Date
Bottlenose Dolphin	*Tursiops truncatus*	373	80	2
Atlantic Spotted Dolphin	*Stenella frontalis*	807	111	2
Risso's Dolphin	*Grampus griseus*	312	22	0
Short-finned Pilot Whale	*Globicephala macrorhynchus*	0	12	0

Table 16. Photo-ID matches of bottlenose dolphins and Atlantic spotted dolphins observed in the JAX survey area.

	Jacksonville, FL					
ID	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Ttr 2-004^				X	X	
Ttr 6-010^				X	X	
Sfr 3-001		X	X			
Sfr 8-005			X[m]			

^Observed together in multiple sightings

[m]Resighted within same month

Key: Sfr = *Stenella frontalis* (Atlantic spotted dolphin); Ttr=*Tursiops trunctus* (bottlenose dolphin).

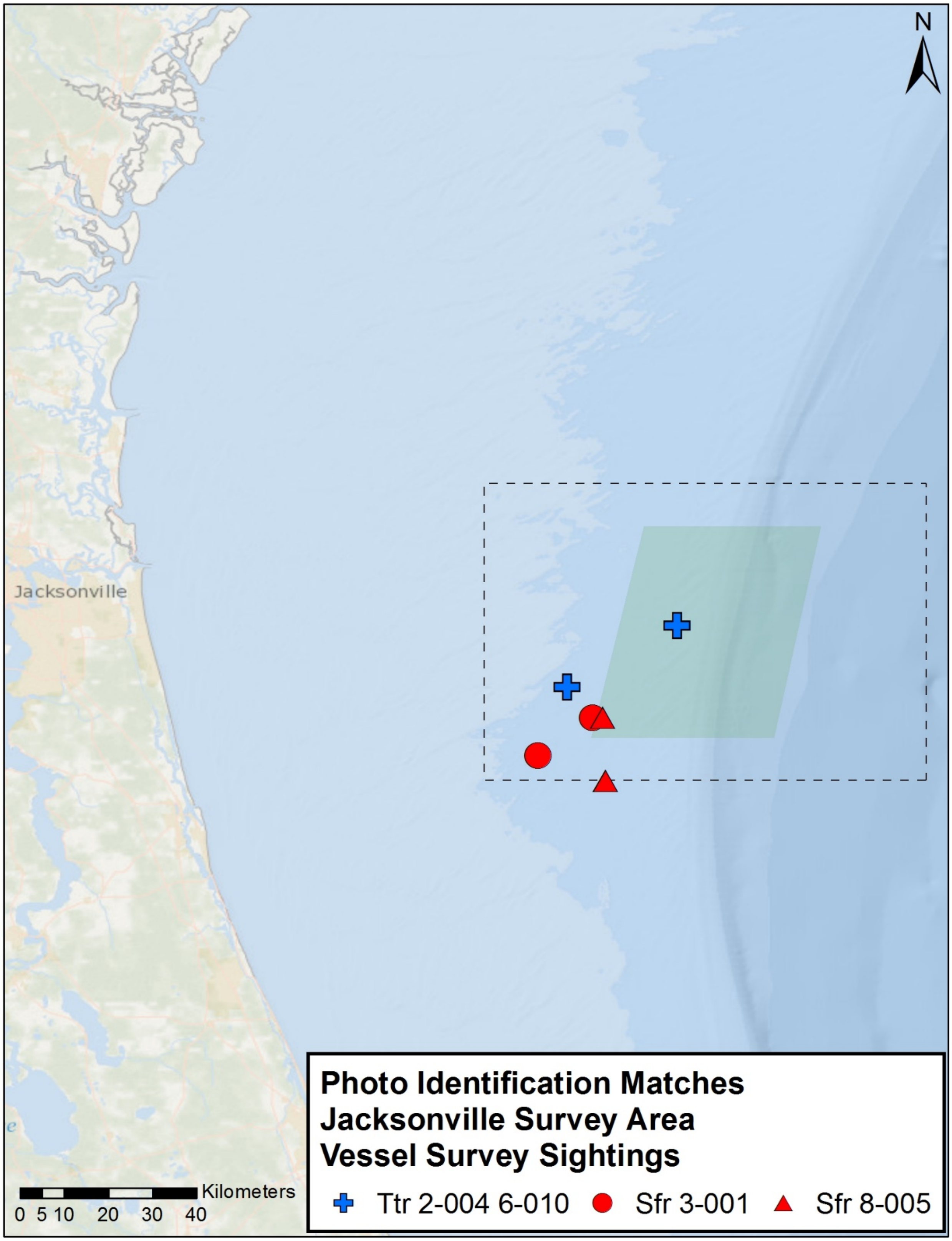


Figure 18. Locations of photo-matched dolphins within the JAX survey area, October 2010–July 2013.

The North Atlantic right whale observed on 16 February 2014 was identified as EGNO 4057, a male born in 2010 (North Atlantic Right Whale Catalog, New England Aquarium, Boston, Massachusetts, http://rwcatalog.neaq.org/). After being partially disentangled on 17 February 2014, the individual was resighted on 12 April 2014 in Cape Cod Bay by the Center for Coastal Studies' (CCS) aerial team. While a line is still present in the mouth of the animal, the entanglement was assessed as not life-threatening.

For more information on this study, refer to the annual progress report for this project (Swaim et al. 2015).

2.1.3 Norfolk Vessel Surveys

2.1.3.1 Coastal/Inshore and Offshore/MINEX Vessel Surveys

HDR, by direction of the U.S. Navy, initiated a monitoring program during August 2012 to provide quantitative data and information on the seasonal occurrence, distribution, and density of marine mammals in coastal waters around Virginia Beach and Norfolk, Virginia. The study area includes waters around Naval Station Norfolk (NSN), Joint Expeditionary Base Little Creek (JEB-LC) and Joint Expeditionary Base Fort Story (JEB-FS), and the Virginia Beach waterfront, including the Virginia Capes (VACAPES) Mine-neutralization Exercise (MINEX) W-50 training range. A combination of monthly line-transect surveys, monthly summer photo-ID surveys, and automated PAM methods were used to gather important baseline information on the occurrence, distribution, and density of marine mammals in this area. Refer to **Section 2.4.4** of this report for presentation of the PAM results.

Prior to initial surveys in 2012, two primary survey zones were established that included a COASTAL/INSHORE zone and an OFFSHORE/MINEX zone. Following supplementary information and input, and taking into account early results from this study, the offshore zone was adjusted in March 2014 to optimize coverage. The COASTAL/INSHORE zone (a 310.4-square kilometer [km^2] area covering a strip extending from the shoreline out to 3.7 km) includes the Chesapeake Bay waters near NSN, extends past JEB-LC and JEB-FS, and extends down the U.S. Atlantic Coast towards the Virginia/North Carolina border). The OFFSHORE/MINEX zone (a 596.6-km^2 area covering Atlantic waters from 3.7 to 25.7 km from shore) includes most of the VACAPES MINEX W-50A and W-50B training areas.

Twenty-six INSHORE line-transect surveys and 21 MINEX line-transect surveys were completed between August 2012 and December 2014. Observers visually surveyed 5,106 km (INSHORE: 2,928 km; MINEX: 2,178 km) of on-effort trackline for 276.45 hr (INSHORE: 158.03 hr; MINEX: 118.42 hr) of on-effort status. Total of 433 sightings of marine mammals and 75 sightings of sea turtles were recorded. The vast majority (96 percent; n=414) of marine mammal sightings were of bottlenose dolphins; the other species sighted included 16 humpback whales, one group of short-beaked common dolphins, and one group of unidentified dolphins (**Figure 19**). The unidentified dolphins had a similar shape to the short-beaked common dolphins, but the observer team was unable to re-sight the group to confirm species identification. Fifty-three marine mammal groups were sighted in the MINEX zone, while 380 were sighted in the INSHORE zone.

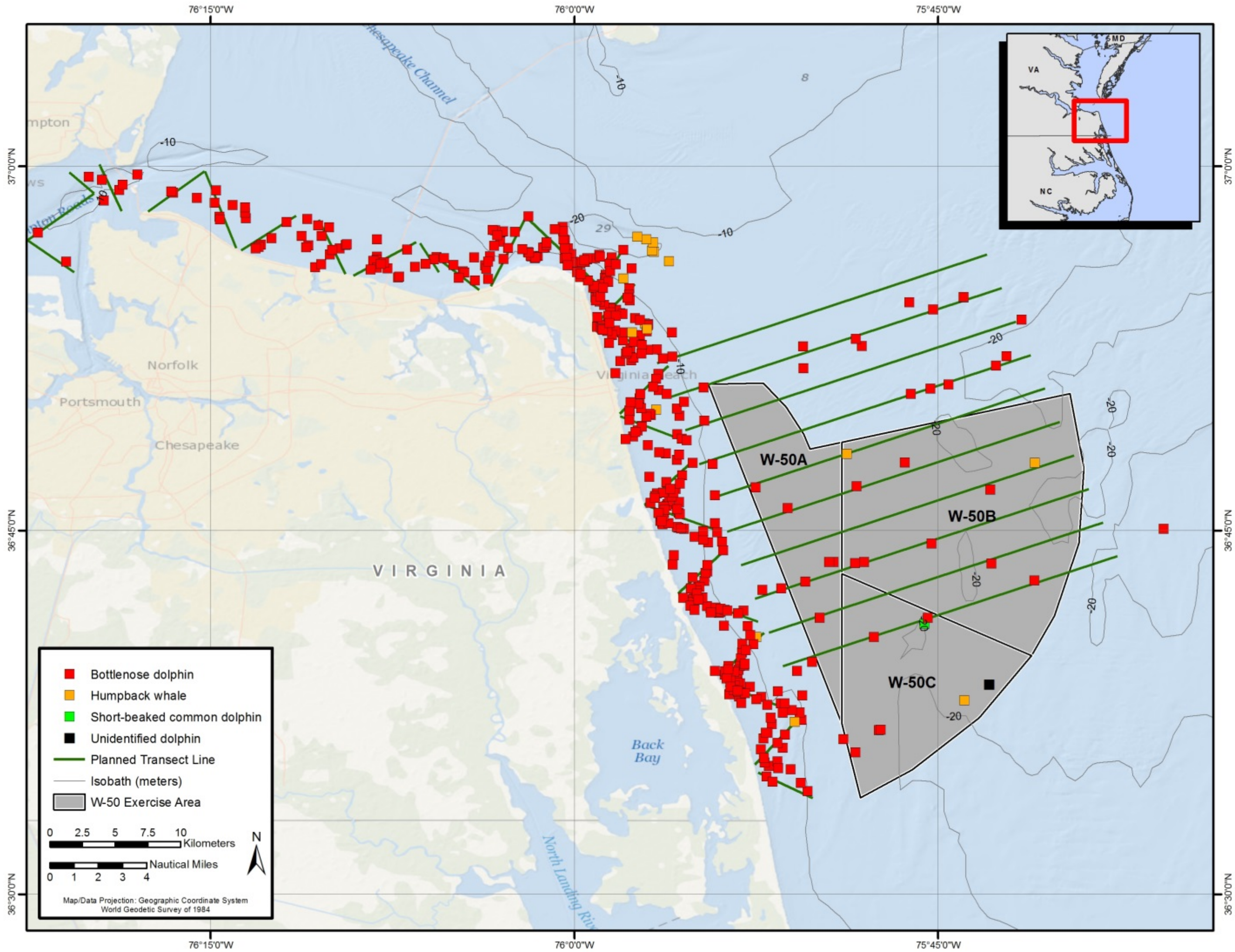


Figure 19. Marine mammal sightings during all line-transect surveys in coastal waters around Virginia Beach and Norfolk, Virginia, August 2012–December 2014.

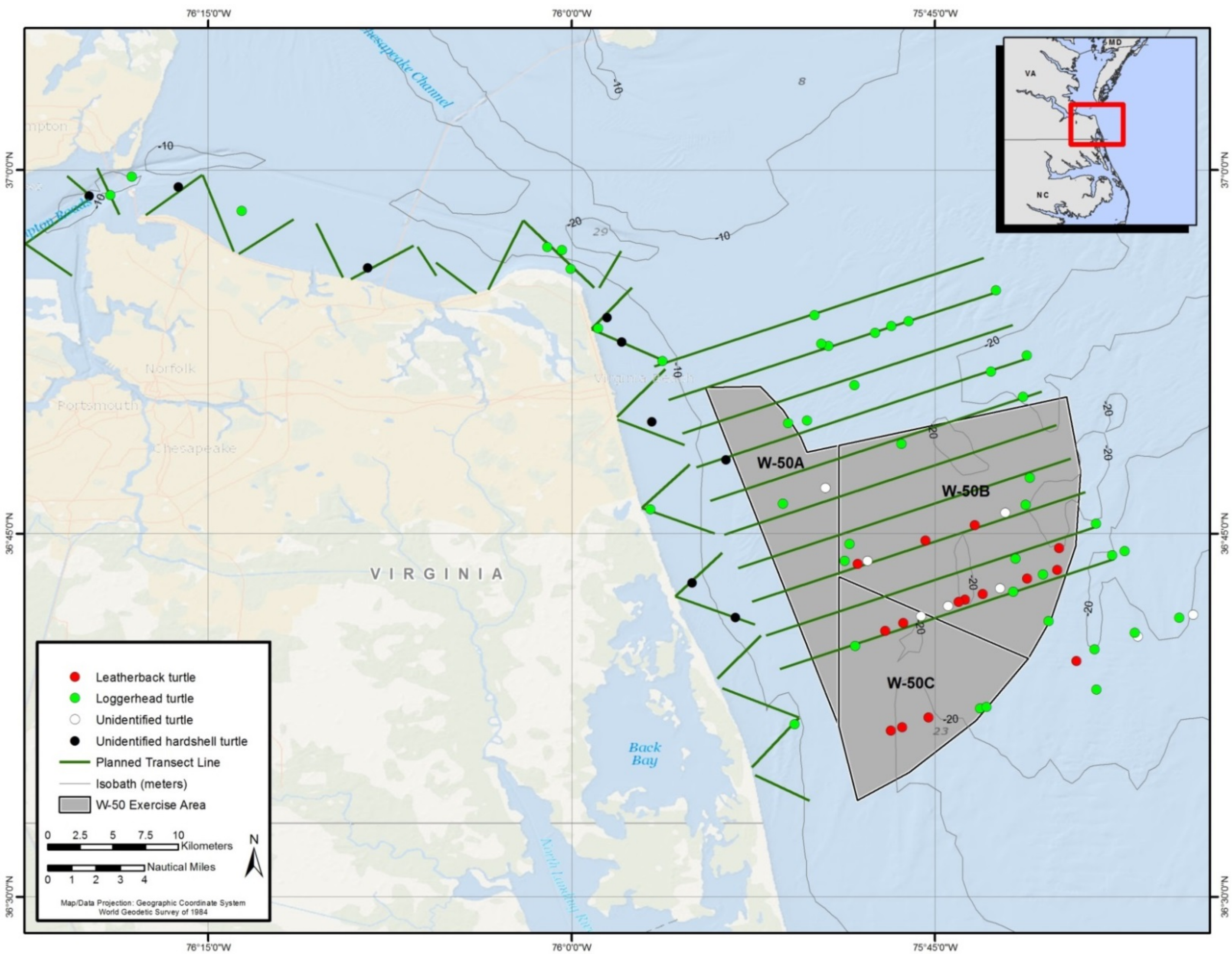


Figure 20. Sea turtle sightings during all line-transect surveys in coastal waters around Virginia Beach and Norfolk, Virginia, August 2012–December 2014.

Forty-three of the sea turtles were identified as loggerhead turtles, 15 as leatherback turtles, 8 as unidentified sea turtles (possible leatherback turtles), and 9 were unidentified hardshell turtles. Fifty-seven sea turtle sightings were made in the MINEX zone and 18 in the INSHORE zone (**Figure 20)**.

Conventional line-transect analysis of bottlenose dolphin sightings showed both spatial and seasonal variation in density and abundance (represented as N), with greatest abundance in the MINEX zone during fall months, followed closely by the INSHORE zone during fall months. Sighting densities in the INSHORE zone were calculated as 4.12 individuals per km^2 (N=1,279) in fall, 0.45 individuals per km^2 (N=138) in winter, 1.02 individuals per km^2 (N=316) in spring, and 2.86 individuals per km2 (N=887) in summer. Densities in the MINEX zone were calculated as 2.23 individuals per km^2 (N=1,333) in fall, 0.06 individuals per km^2 (N=35) in winter, 0.24 individuals per km^2 (N=145) in spring, and 1.19 individuals per km^2 (N=709) in summer. Sightings of humpback whales (*n*=16; across fall, winter, and spring months) and short-beaked common dolphins (*n*=1; spring months only) also were made during the surveys, but the sample sizes were too small for these species to produce reliable estimates of density or abundance.

For more information on this study, refer to the annual progress report for this project (A. Engelhaupt et al. 2015).

Photo-identification Effort

Nineteen photo-ID surveys were completed between August 2012 and December 2014. A bottlenose dolphin photo-ID catalog was created using both photos taken on photo-ID surveys and photos taken on transect surveys. The cataloging effort is currentlyunderway and to date includes all photo-ID and transect photographs taken through September 2013. To date, the catalog contains 456 identifiable individuals. There is no sign of a plateau in the number of identified dolphins in the study area. Re-sighting rates across surveys were low. Following creation of the catalog, there have been 46 matches of cataloged individuals, which includes a second re-sighting of six individuals. All re-sightings in the study area were recorded less than 21 km from the initial sighting. Dolphins sighted in the Chesapeake Bay were not re-sighted along the Atlantic side of Virginia Beach in the southern portion of the study area. More survey and photo-ID effort are required to discern any clear patterns of site fidelity. Photos have been submitted to the existing Mid-Atlantic Bottlenose Dolphin Catalog established by NMFS and curated by Kim Urian of Duke University Marine Laboratory (Urian et al. 1999).

For more information on this study, refer to the annual progress report for this project (A. Engelhaupt et al. 2015).

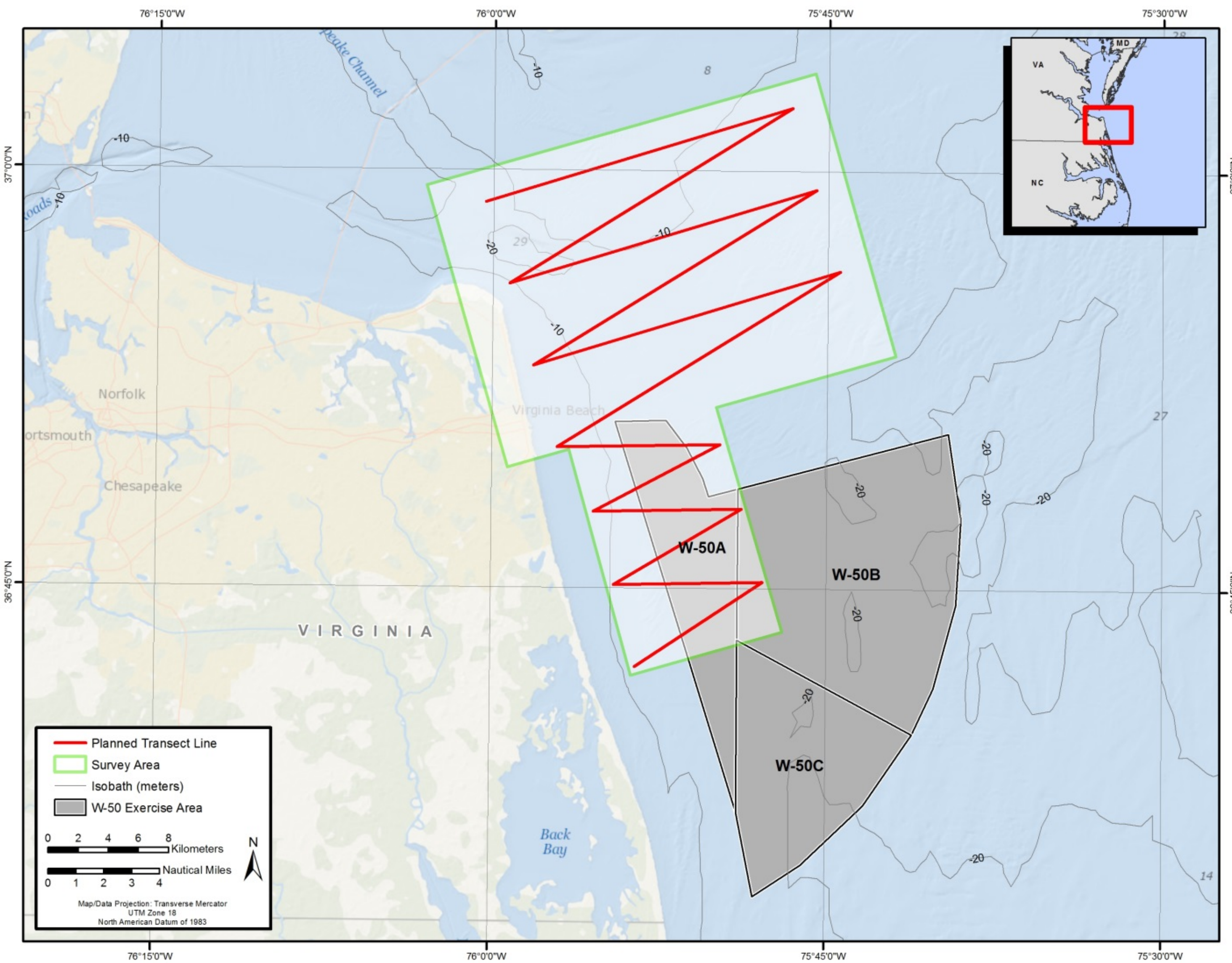
2.1.3.2 Mid-Atlantic Humpback Whale Monitoring

HDR is conducting a pilot project (initiated in January 2015) under the direction of the U.S. Navy to establish baseline occurrence and behavior data for humpback whales in the mid-Atlantic region. Information on the location and movements of humpback whales within this region is very limited. Collection and interpretation of these data are important to assess and mitigate the potential disturbance of humpback whales from U.S. Navy training operations, as well as from the heightened vessel traffic in general that exists throughout the Chesapeake Bay and adjacent coastal waters.

The first year of the project will encompass 20 days of nearshore (**Figure 21**) and 5 days of offshore non-random, non-systematic survey effort (**Figure 22**). While the focus of the project is humpback whales, research will be conducted on other high-priority species of baleen whales (e.g., fin, minke, and North

Atlantic right whales) as they are encountered. The objectives of the project are to conduct photo-ID, conduct behavioral focal follows, and collect biopsy samples.

To date, HDR has conducted 10 inshore surveys for humpback whales and observers have recorded 40 sightings of humpback whales, as well as 3 sightings of fin whales and 1 sighting of bottlenose dolphins (**Figure 23**). Researchers performed focal follows on 21 humpback whales and 1 fin whale (**Figure 24**) during a total effort of 1,413 minutes (min) (**Table 16**). HDR collected 12 biopsy samples and 9 samples contained enough tissue to conduct stable isotope analysis (**Table 17**). Genetic analyses of the tissue samples will be conducted by University of Groningen (The Netherlands) and stable isotope analyses by Duke University.



529 **Figure 21. Nearshore study area for humpback whale surveys.**

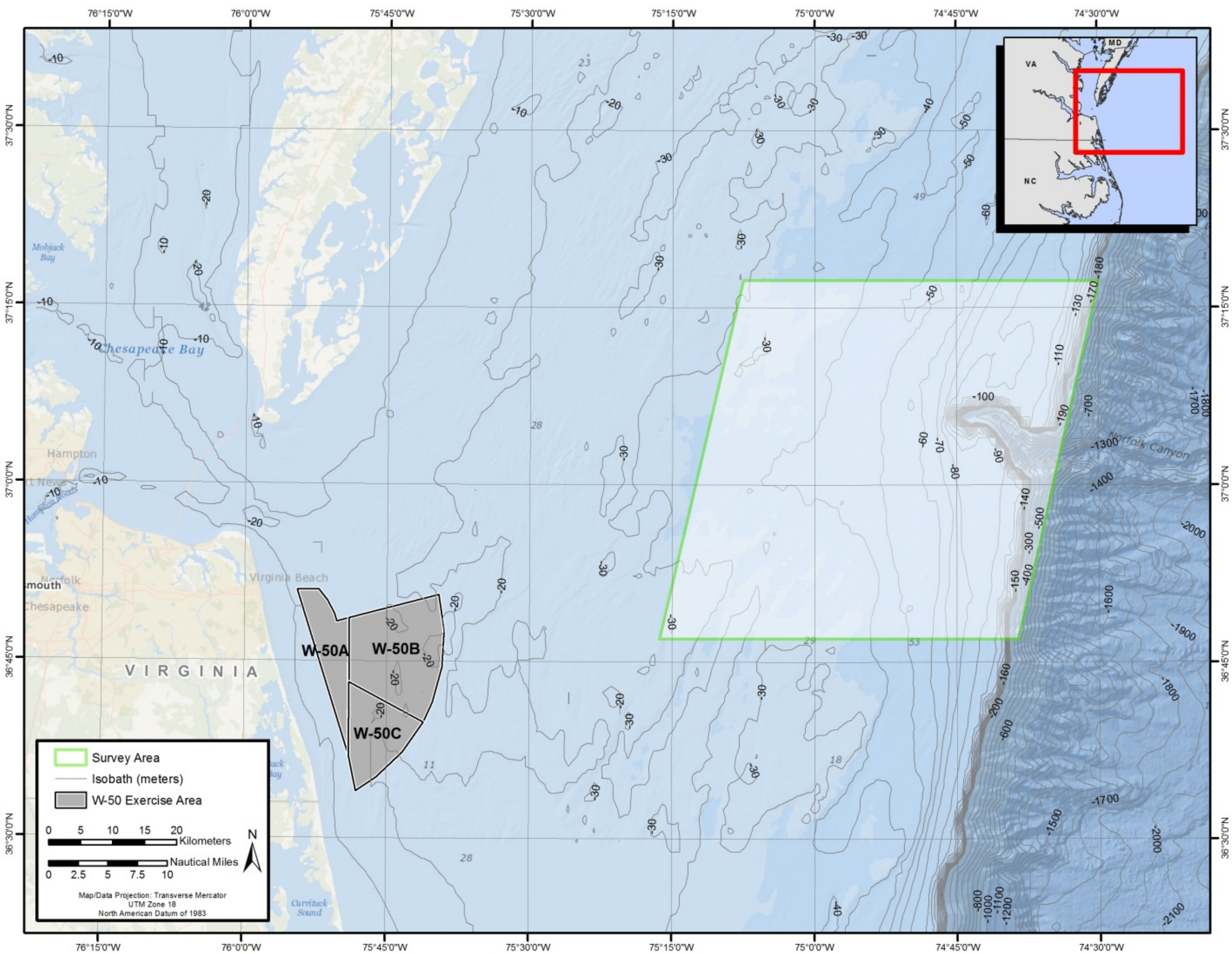
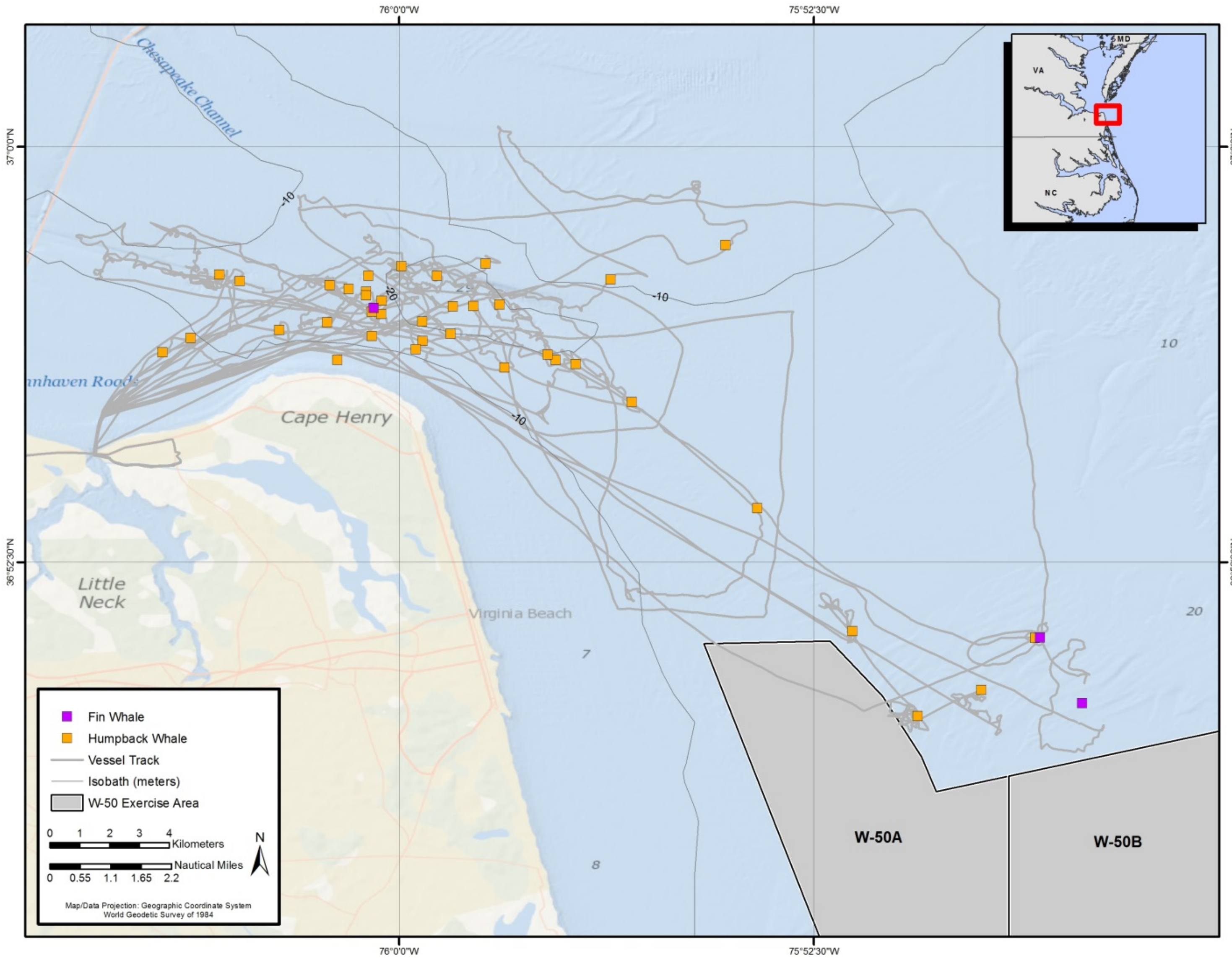


Figure 22. Offshore study area for humpback whale surveys.



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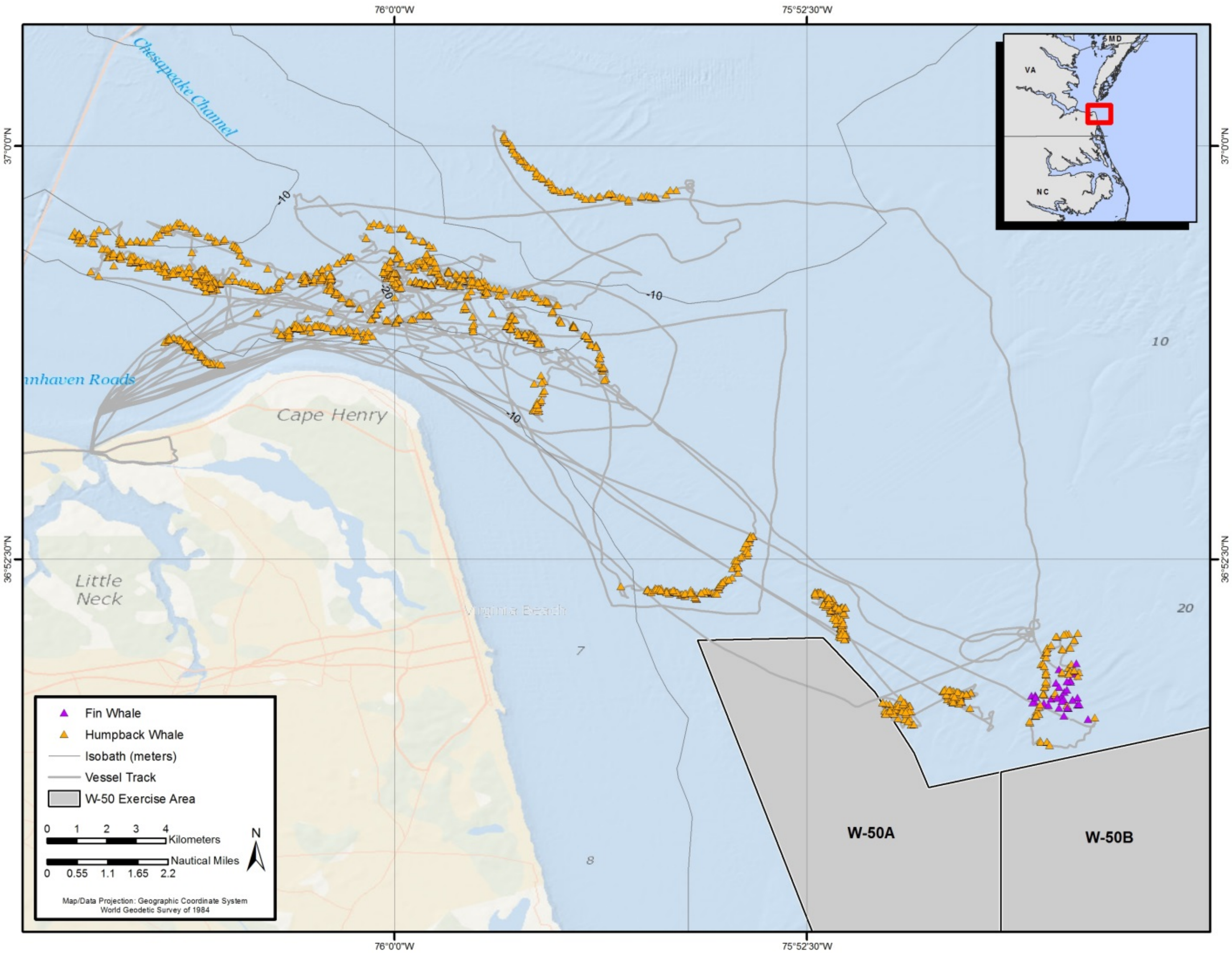
533 **Figure 23. Whale sightings and vessel tracks during humpback whale inshore surveys, 01 January 2015–09 February 2015.**



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535 **Figure 24. Whale focal-follow locations and focal-follow vessel tracklines, 01 January 2015–09 February 2015.**

Table 17. Summary of humpback whale survey effort off Virginia Beach, Virginia, 02 January 2015–09 February 2015.

Date	Survey Time (min)	# Sightings	Total # Individuals	HDR Photo IDs	Focal Follows, ID	Focal Follow (min)	Biopsies (DNA/Stable Isotope), ID
02 January	339	2	2	HDRVA008 HDRVA009	2 HDRVA008 HDRVA009	120	(1/1) HDRVA009
06 January	492	6	6	HDRVA008 HDRVA010 HDRVA011	3 HDRVA008 HDRVA010 HDRVA011	227	(2/1) HDRVA010 HDRVA011
11 January	544	5	8	HDRVA012 HDRVA013 HDRVA014 HDRVA015 HDRVA016	3 HDRVA013 HDRVA014 HDRVA015	170	(3/2) HDRVA013 HDRVA014 HDRVA015
15 January	427	3	6	HDRVA008 HDRVA009 HDRVA011 HDRVA021 HDRVA022	2 HDRVA009 HDRVA011	147	(0/0)
20 January	563	7	10	HDRVA009 HDRVA013 HDRVA023 HDRVA024	4 HDRVA009 HDRVA013 HDRVA023 HDRBp001	262	(1/0) HDRVA023
22 January	510	6	6	HDRVA009 HDRVA012 HDRVA013 HDRVA024 HDRVA025	3 HDRVA012 HDRVA024 HDRVA025	154	(2/2) HDRVA024 HDRVA025
25 January	441	7	11	HDRVA006 HDRVA007 HDRVA008 HDRVA011 HDRVA013 HDRVA014 HDRVA021	2 HDRVA006 HDRVA021	145	(0/0)
29 January	512	5	7	HDRVA005 HDRVA013 HDRVA014 HDRVA022 HDRVA027 HDRVA028	2 HDRVA005 HDRVA027	125	(2/2) HDRVA005 HDRVA027
06 February	311	0	0	-	0	0	(0/0)
09 February	292	2	2	HDRVA007 HDRVA013 HDRVA029	3	63	(1/1) HDRVA029
TOTAL	**4,431**	**43**	**58**		**21**	**1,413**	**(12/9)**

Key: DNA=deoxyribonucleic acid; ID=identification; min=minute(s)

Photo-ID images were processed and included in the HDR catalog, which includes 25 unique humpback whales. The majority (*n*=20, 80 percent) of humpback whales in the catalog include both fluke identification photographs and dorsal fin images. HDR, Inc. submitted images of flukes collected to date to Allied Whale (College of the Atlantic, Bar Harbor, Maine). Although matching by Allied Whale for these images is still underway, preliminary results indicate at least two individuals photographed by HDR have been matched to Gulf of Maine individuals (GOM67 and GOM73), one has been matched to a Newfoundland animal (HWC#7799), and one has been matched to a Saint Pierre and Miquelon animal (HWC#7621/WBR#958).

Of the 25 unique whales in the HDR catalog, 11 individuals have been seen on only one occasion, while the remaining 14 have been seen on multiple occasions. The most frequently sighted animal has been re-sighted on 10 occasions between 21 December 2014 and 29 January 2015. Observers have recorded this individual, temporarily known as "HDRVA013," within the MINEX W-50 training area as well as inshore waters off Virginia Beach (**Figure 25**). This individual has also been documented separately during the MINEX and INSHORE density surveys (see **Section 2.2.3.1** of this report).

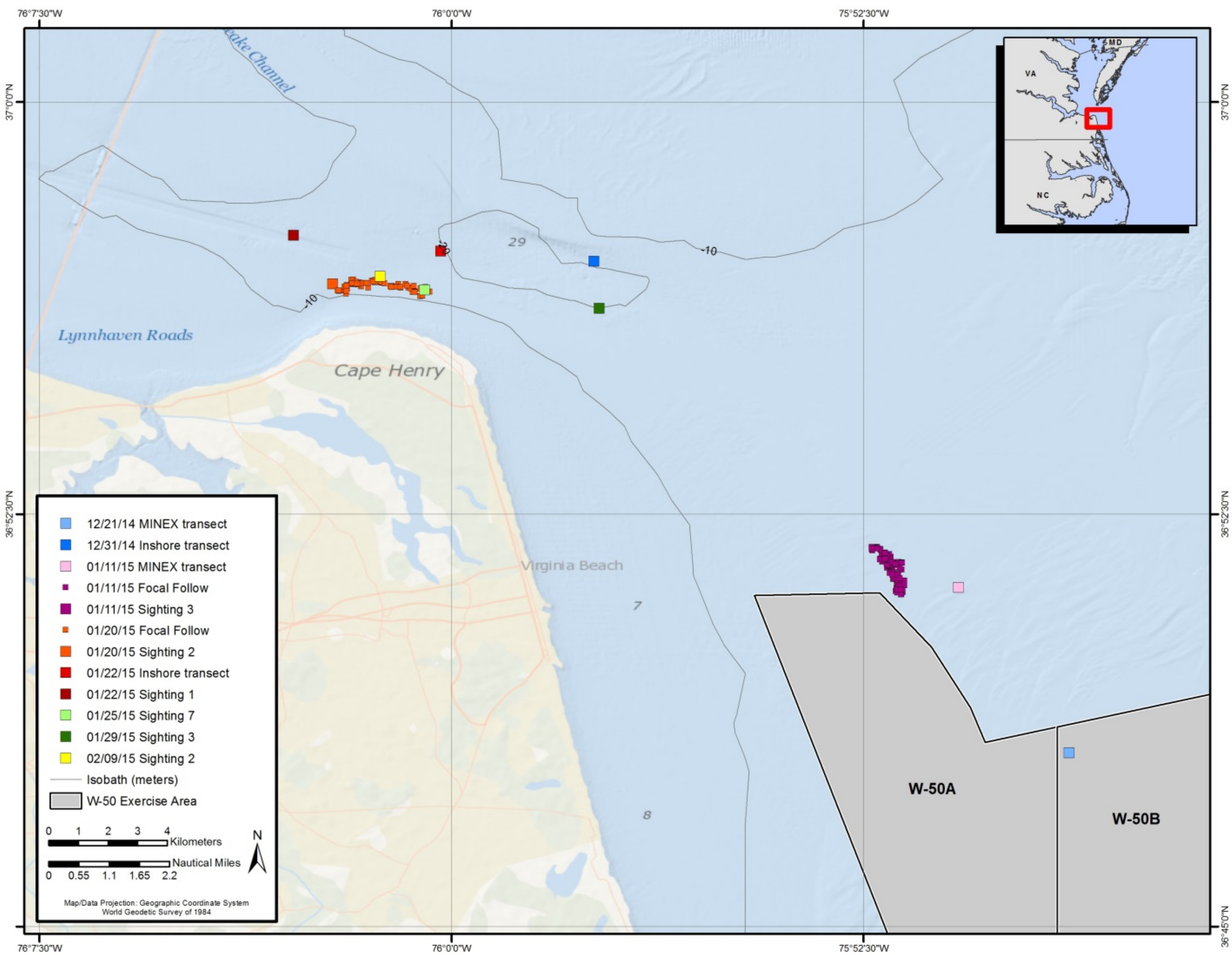


Figure 25. Sightings of humpback whale HDRVA013 off Virginia Beach, Virginia.

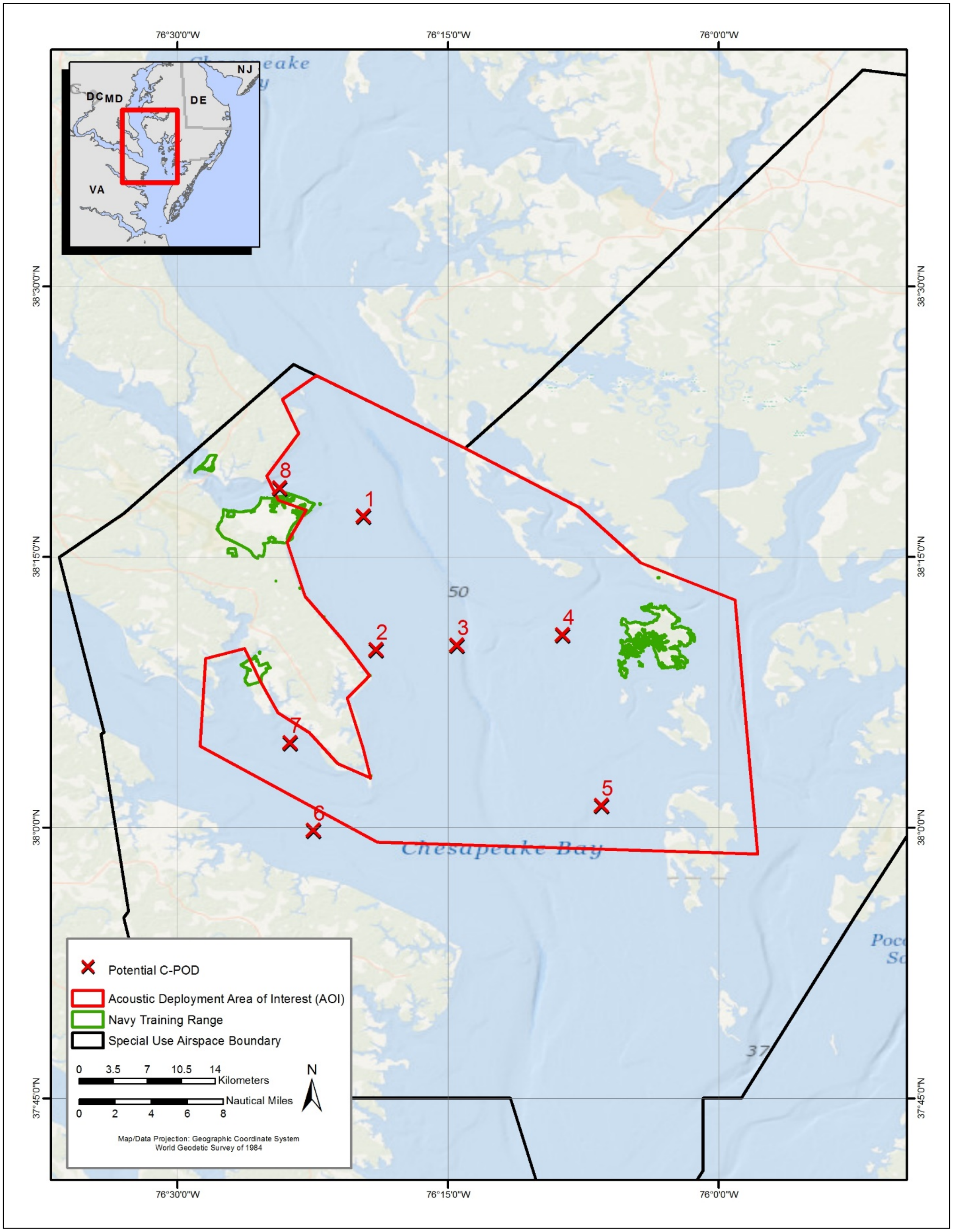
Preliminary results show site fidelity in the study area for some individuals and a high level of whale occurrence within the shipping channels. These lanes are important and highly used by the U.S. Navy and commercial traffic. Some individual whales are also spending time close to the MINEX W-50 training area, presumably within hearing range of U.S. Navy underwater detonation (UNDET) exercises.

The number of sightings of humpback whales and other whale species and the level of interaction between whales and vessel traffic observed to date support continued study in the area, as well as the proposed addition of tagging studies. The use of satellite and other short-term, high-resolution data-logging tags will better document the whales' movements within the study area and departure from this area. This information will better document the occurrence and behavior of humpback whales here and provide a baseline for behavioral response studies in the future.

For more information on this study, refer to the annual progress report for this project (D. Engelhaupt et al. 2015).

2.1.4 Patuxent River Vessel Surveys

A study is being initiated by HDR, that will provide quantitative data and information on the seasonal occurrence, distribution, and density of protected species (marine mammals and sea turtles) in Chesapeake Bay waters near Naval Air Station (NAS) Patuxent (PAX) River, roughly from Drum Point, south to Smith Point along the western shore and over to the coastal waters of the eastern shore (**Figure 26**). An area of interest was determined during discussions with United States (U.S.) Navy Naval Air Systems Command (NAVAIR) personnel, for which more density and occurrence data for marine species was desired for use in environmental planning and regulatory compliance efforts. The University of North Carolina Wilmington (UNCW) will conduct monthly fixed-wing aerial line-transect surveys to document the occurrence and distribution of marine mammals and sea turtles in the study area. HDR will deploy C-PODs (passive acoustic data loggers) to compliment the aerial survey data by assessing the seasonality and occurrence of echolocating cetaceans in the study area. Additionally, HDR will conduct photographic identification efforts opportunistically during C-POD deployments/refurbishments. The Centre for Research into Ecological and Environmental Modeling (CREEM) at the University of St. Andrews will advise on survey design for both the visual data and the passive acoustic data as well as analyze data from the line transect surveys using standard design-based analysis methods. Aerial surveys are expected to begin in March 2015 and C-PODs will be deployed once permits are processed (anticipated June 2015).



585

586 **Figure 26. Patuxent Study Area with proposed locations of C-POD deployments around NAS PAX.**

For more information on this study, refer to the annual progress report for this project (Aschettino et al. 2015).

2.2 Tagging Studies

During the reporting period, the U.S. Navy supported tagging studies of toothed whales (**Section 2.3.1**), baleen whales (**Section 2.3.2**), and sea turtles (**Section 2.3.3**) during the reporting period.

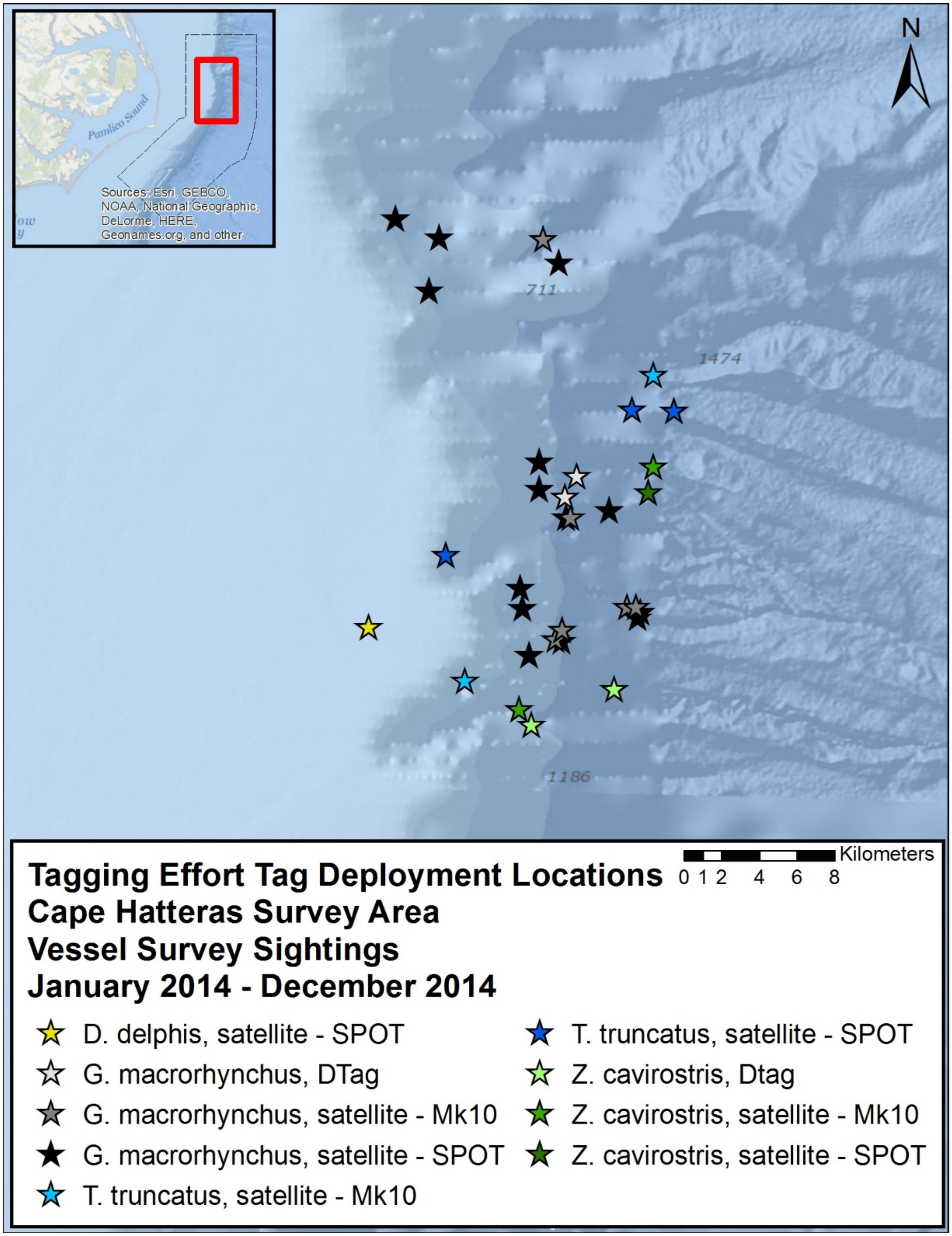
2.2.1 Tagging of Deep-Diving Odontocete Cetaceans – Hatteras

This section builds on this past body of work and describes activities conducted during both the Deep Divers and Satellite-Tagging projects conducted off Cape Hatteras between January 2014 and December 2014. This constitutes the second year of the Deep Divers project, which focuses on the distribution and ecology of several deep-diving odontocete species, including: beaked (Cuvier's beaked whale and *Mesoplodon* spp.), short-finned pilot, and sperm whales. To achieve a more robust picture of the medium-term movement patterns of these and other odontocete cetaceans in the Cape Hatteras survey area, a satellite-tagging project was begun during the reporting period.

Researchers with Cascadia Research Collective and Duke University tagged deep-diving odontocete cetaceans with satellite tags and DTAGs, respectively. Tagging of odontocete cetaceans by Cascadia Research Collective complements ongoing research by Duke University off Cape Hatteras by providing information on the movement and diving behavior of these species over the medium term (weeks to months). Shorter-term dive behavior (i.e., hours to days) can be collected using DTAGs) and longer-term movement information (i.e., months to years) using photo-ID techniques (Swaim et al. 2014) (see **Section 2.3.1.2** of this report; Foley et al. 2015).

2.2.1.1 Satellite-tagging

Tagging efforts by Cascadia Research Collective were conducted in May, June, and September 2014 in the Cape Hatteras survey area. Twenty-nine satellite tags were deployed on four species of odontocete cetaceans: 20 short-finned pilot whales; five bottlenose dolphins; three Cuvier's beaked whales; and one short-beaked common dolphin (**Figure 27**). Ten tags that transmitted dive data (Mk-10 tags, Wildlife Computers) were attached to Cuvier's beaked whales (*n*=2); short-finned pilot whales (*n*=6); and bottlenose dolphins (*n*=2). The remaining 19 tags were tags that relay location-only data (Smart Position and Temperature [SPOT] tags; Wildlife Computers). A summary of these deployments is provided in **Table 18**.

616 

617 **Figure 27. Locations of tag deployments in the Cape Hatteras survey area, January 2014–December**
618 **2014.**

Table 18. Summary of satellite tag deployments in the Cape Hatteras survey area, January 2014–December 2014.

Deployment	Animal ID	Tag Type	ARGOS Id	Last Transmission
13-May-14	Zc029	Mk-10	102465	12-Jul-14
14-May-14	Gm084	SPOT	94808	15-May-14
14-May-14	Gm085	Mk-10	53644	21-Jun-14
14-May-14	Gm086	SPOT	94788	1-Aug-14
18-May-14	Gm087	SPOT	98362	28-Nov-14
18-May-14	Tt014	SPOT	53652	2-Jun-14
7-Jun-14	Gm088	SPOT	102471	24-Sep-14
8-Jun-14	Gm089	Mk-10	94810	Failed immediately
8-Jun-14	Gm090	SPOT	94796	2-Aug-14
8-Jun-14	Gm091	Mk-10	102464	Failed immediately
11-Jun-14	Gm092	SPOT	94817	30-Jul-14
11-Jun-14	Gm093	Mk-10	94805	29-Jun-14
11-Jun-14	Gm094	SPOT	94804	3-Sep-14
11-Jun-14	Gm095	SPOT	53651	3-Sep-14
11-Jun-14	Tt015	SPOT	109822	29-Jun-14
11-Jun-14	Tt016	Mk-10	72534	28-Jun-14
12-Jun-14	Dd001	SPOT	94806	22-Jul-14
11-Sep-14	Gm096	SPOT	94814	12-Sep-14
11-Sep-14	Gm097	SPOT	98369	13-Oct-14
11-Sep-14	Gm098	Mk-10	98358	9-Oct-14
11-Sep-14	Gm099	SPOT	102473	14-Nov-14
11-Sep-14	Gm100	MK-10	53553	6-Oct-14
13-Sep-14	Gm101	SPOT	94794	15-Oct-14
13-Sep-14	Gm102	SPOT	102466	23-Sep-14
13-Sep-14	Gm103	SPOT	94793	5-Jan-15
13-Sep-14	Tt017	SPOT	98359	30-Sep-14
16-Sep-14	Tt018	Mk-10	94797	29-Sep-14
16-Sep-14	Zc030	Mk-10	77246	25-Oct-14
16-Sep-14	Zc031	SPOT	98368	19-Oct-14

Key: Dd=*Delphinus delphis* (short-beaked common dolphin); Gm=*Globicephala macrorhynchus* (short-finned pilot whale); Jan=January; Jun=June; Oct=October; Sep=September; SPOT= Smart Position and Temperature; Tt=*Tursiops truncatus* (bottlenose dolphin); Zc=*Ziphius cavirostris* (Cuvier's beaked whale)

Three bottlenose dolphins were tagged with SPOT tags and two with Mk-10 tags. All but one tagged bottlenose dolphin appeared to spend the majority of their time beyond the continental shelf break (**Figure 28**). Median depths determined at locations of tagged individuals ranged from 305 to 1,899 m, with maximum depths at tagged animal locations ranging from 2,037 to 2,794 m.

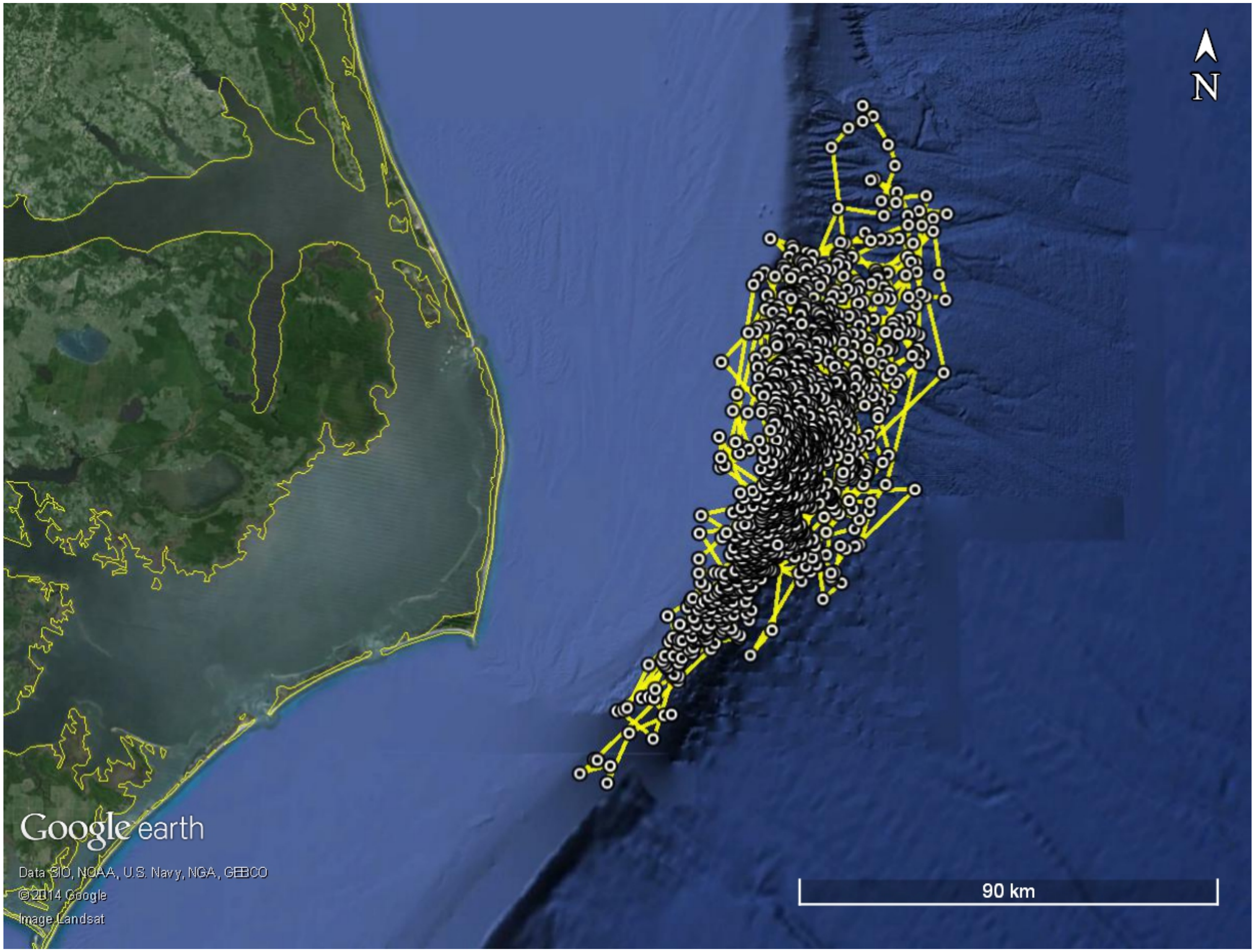


Figure 28. All filtered locations of all five satellite-tagged bottlenose dolphins off North Carolina in 2014, with consecutive locations for each individual joined by a yellow line.

A single location-only tag was deployed on a short-beaked common dolphin, and location data were obtained over a 40-day period (**Table 18**). Over the first 32 days of the 40-day period, the dolphin moved to the north away from the tagging location and back again to the general area of tagging on four occasions, primarily remaining over the continental shelf break and continental slope. For the last 8 days of tag data, the dolphin moved more directionally to the northeast, primarily remaining on the continental shelf (**Figure 29**). The median depth of tagged animal locations over the 40-day span was 297 m.

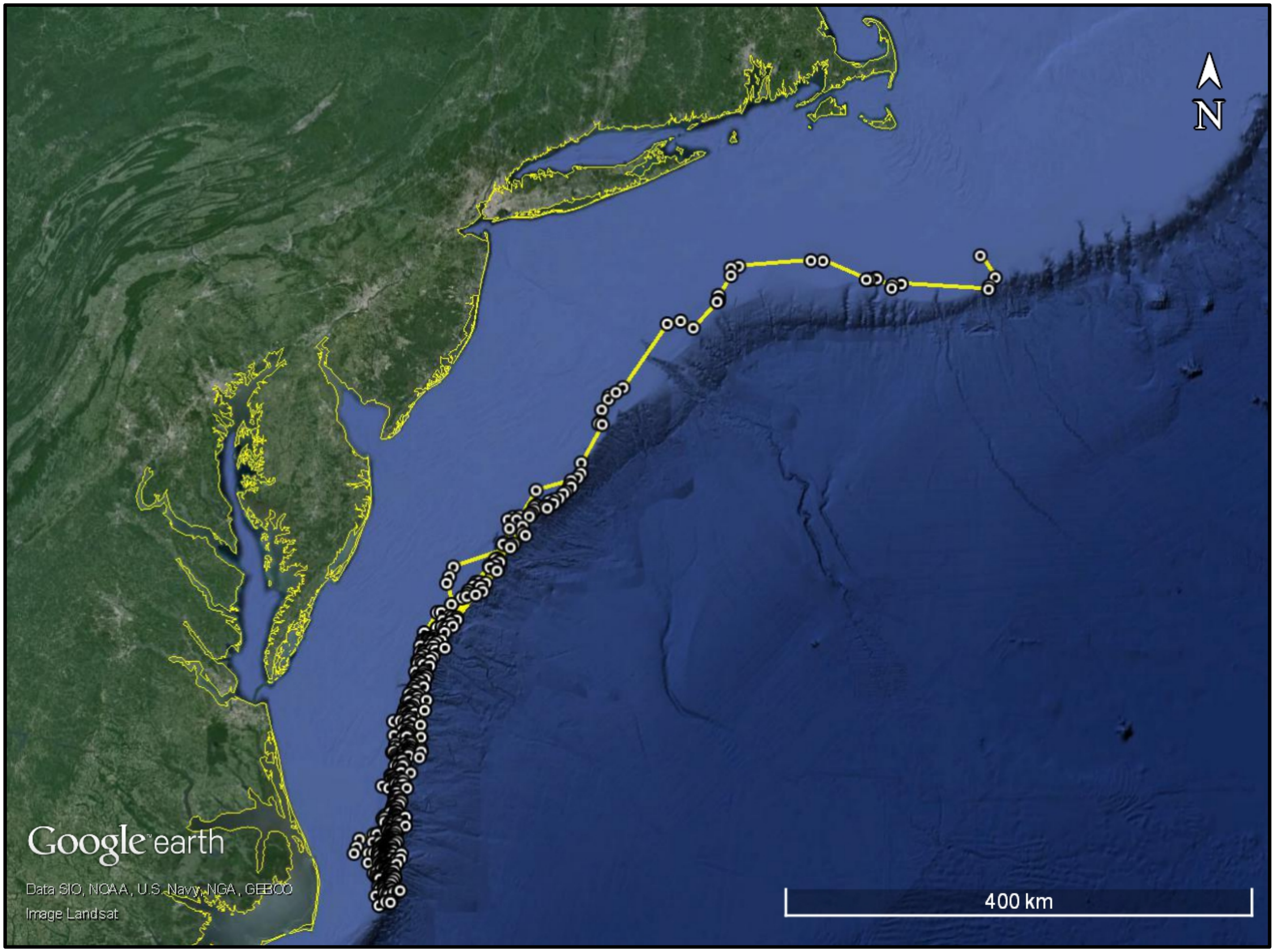


Figure 29. All filtered locations of short-beaked common dolphin tagged off North Carolina over a 40-day period, with consecutive locations joined by a line.

This study provides the first long-distance movement information for Cuvier's beaked whales off the U.S. Atlantic Coast. Tag data were obtained from three Cuvier's beaked whales. Tags were deployed on two individuals in the same encounter in September 2014, although assessment of distance between the two individuals during the period of tag overlap indicates the individuals did not act in concert (median distance apart = 148 km; maximum = 218 km). Movement patterns of the three individuals varied considerably, with one (ZcTag030) remaining an average of 8.6 km from the tagging location, while ZcTag029 and ZcTag031 remained an average of 43.7 and 123.1 km from the tagging locations, respectively. Patterns of movement in relation to the tagging area varied among the three individuals (**Figure 30**), with ZcTag029 and ZcTag031 returning to the general area of tagging after varying periods. Individuals also showed varying patterns of movement north or south of the tagging area (**Figures 31** through **33**). Maximum dive depths and dive durations documented were 2,800 m and 98.0 min for ZcTag029, and 2,160 m and 86.6 min for ZcTag030. Median depths at locations of tagged individuals ranged from 1,725 to 2,274 m (maximum from 2,817 to 3,015 m), suggesting that many of the dives were likely to, or close to, the sea floor.

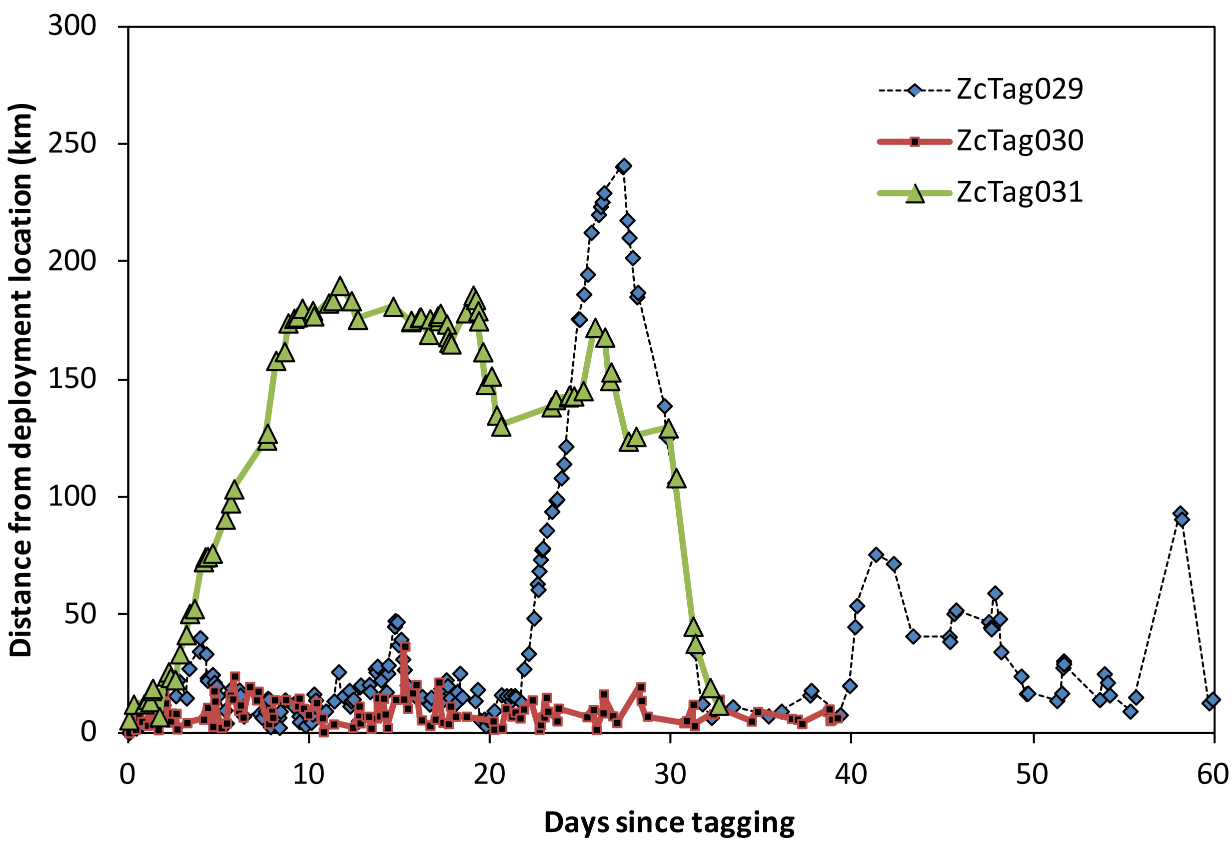


Figure 30. Distance from tagging location for three satellite-tagged Cuvier's beaked whales tagged off North Carolina.

Figure 31. All filtered locations of Cuvier's beaked whale ZcTag029 tagged off North Carolina over a 60-day period, with consecutive locations joined by a line.

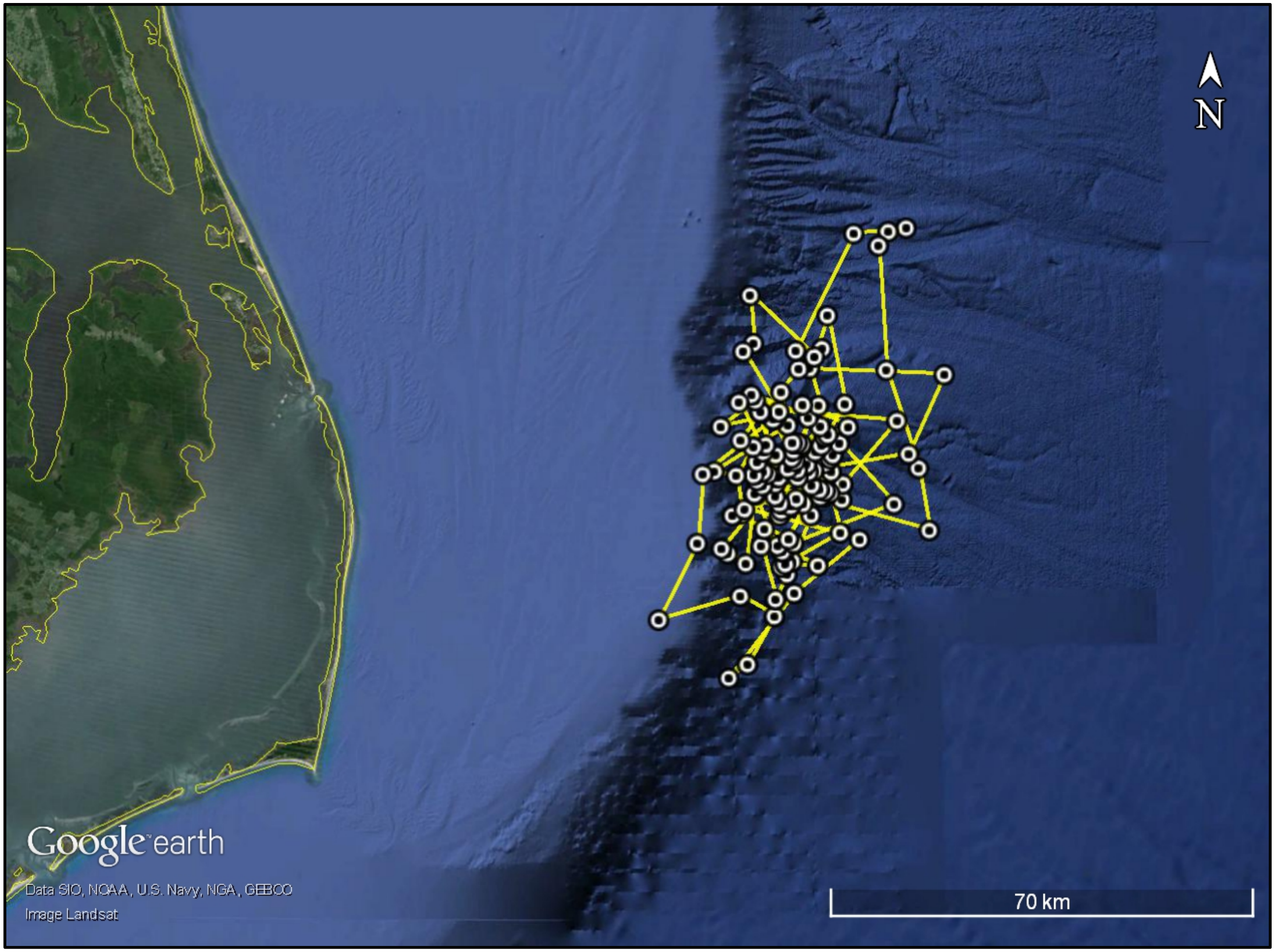


Figure 32. All filtered locations of Cuvier's beaked whale ZcTag030 tagged off North Carolina over a 40-day period, with consecutive locations joined by a line.

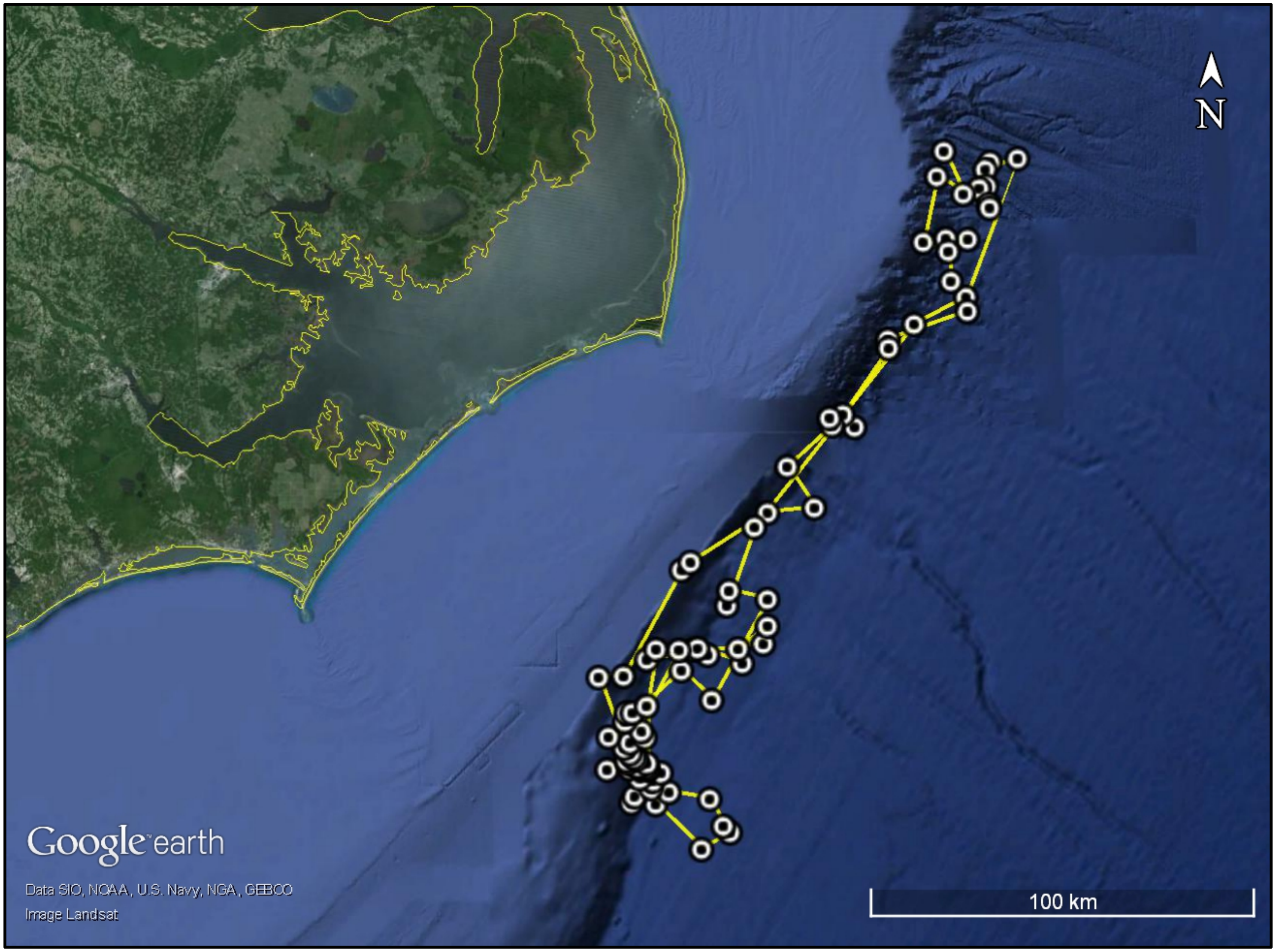


Figure 33. All filtered locations of Cuvier's beaked whale ZcTag031 tagged off North Carolina over a 36-day period, with consecutive locations joined by a line.

This study provides the first information on long-term and long-distance movements of short-finned pilot whales in the area, other than information obtained from tags on previously stranded and rehabilitated individuals. While photo-ID work suggests that short-finned pilot whales display a high degree of residence off Cape Hatteras, satellite tagging demonstrates that these animals cover a significant range up and down the continental slope, from Georges Bank in the north, down to Cape Lookout Shoals in the south, with movements at least occasionally into waters beyond the U.S. Exclusive Economic Zone (**Figures 34** and **35**). There were high concentrations of locations in the canyons along the continental shelf break, including Norfolk Canyon, Washington Canyon, Baltimore Canyon, Wilmington Canyon, and Hudson Canyon. Unlike most of the other pilot whales that stayed along the continental slope, GmTag088 travelled across deep water to the New England Seamount Chain (**Figure 35**). Overall, the distribution of locations of tagged short-finned pilot whales (**Figure 36**) closely matches what is known about the distribution of this species north of Cape Hatteras (see Waring et al. 2014).

For more information on this study, refer to the annual progress report for this project (Baird et al. 2015).

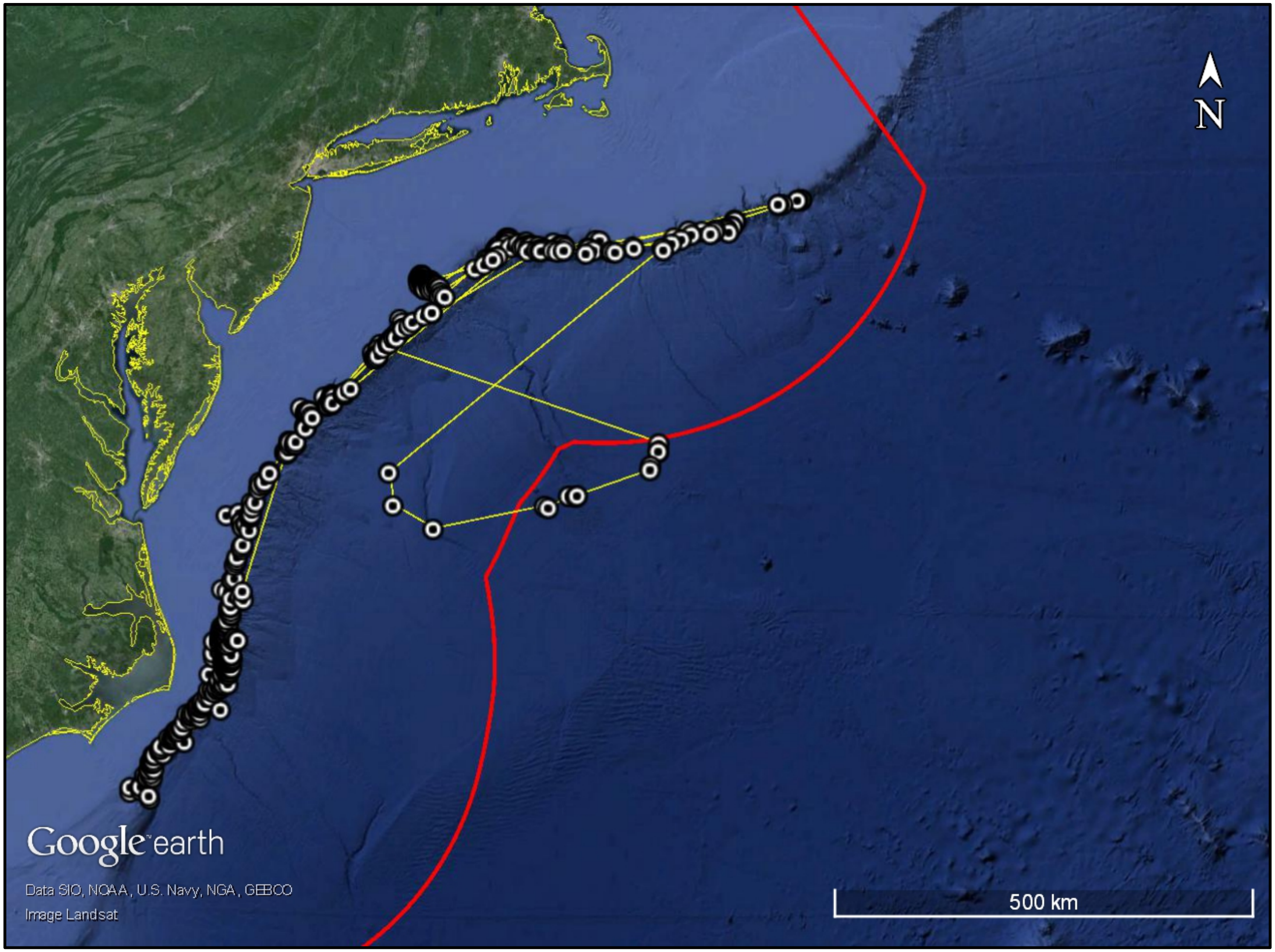


Figure 34. Map showing all filtered locations of short-finned pilot whale GmTag087 tagged off North Carolina over a 194-day period, with consecutive locations joined by a yellow line. The U.S. Exclusive Economic Zone boundary is shown in a solid red line.

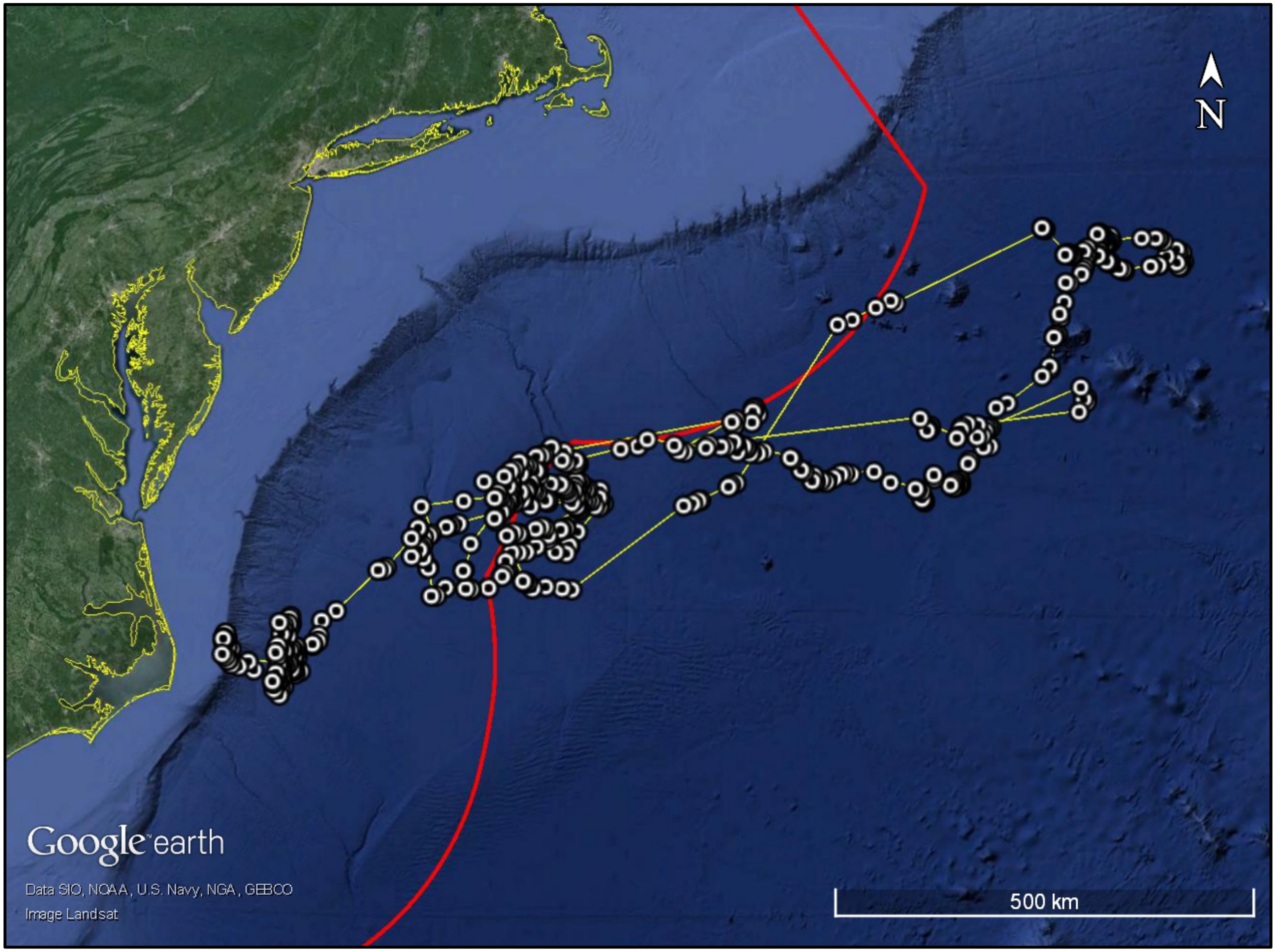


Figure 35. Map showing all filtered locations of short-finned pilot whale GmTag088 tagged off North Carolina over a 104-day period, with consecutive locations joined by a yellow line. The U.S. Exclusive Economic Zone boundary is shown in a solid red line.

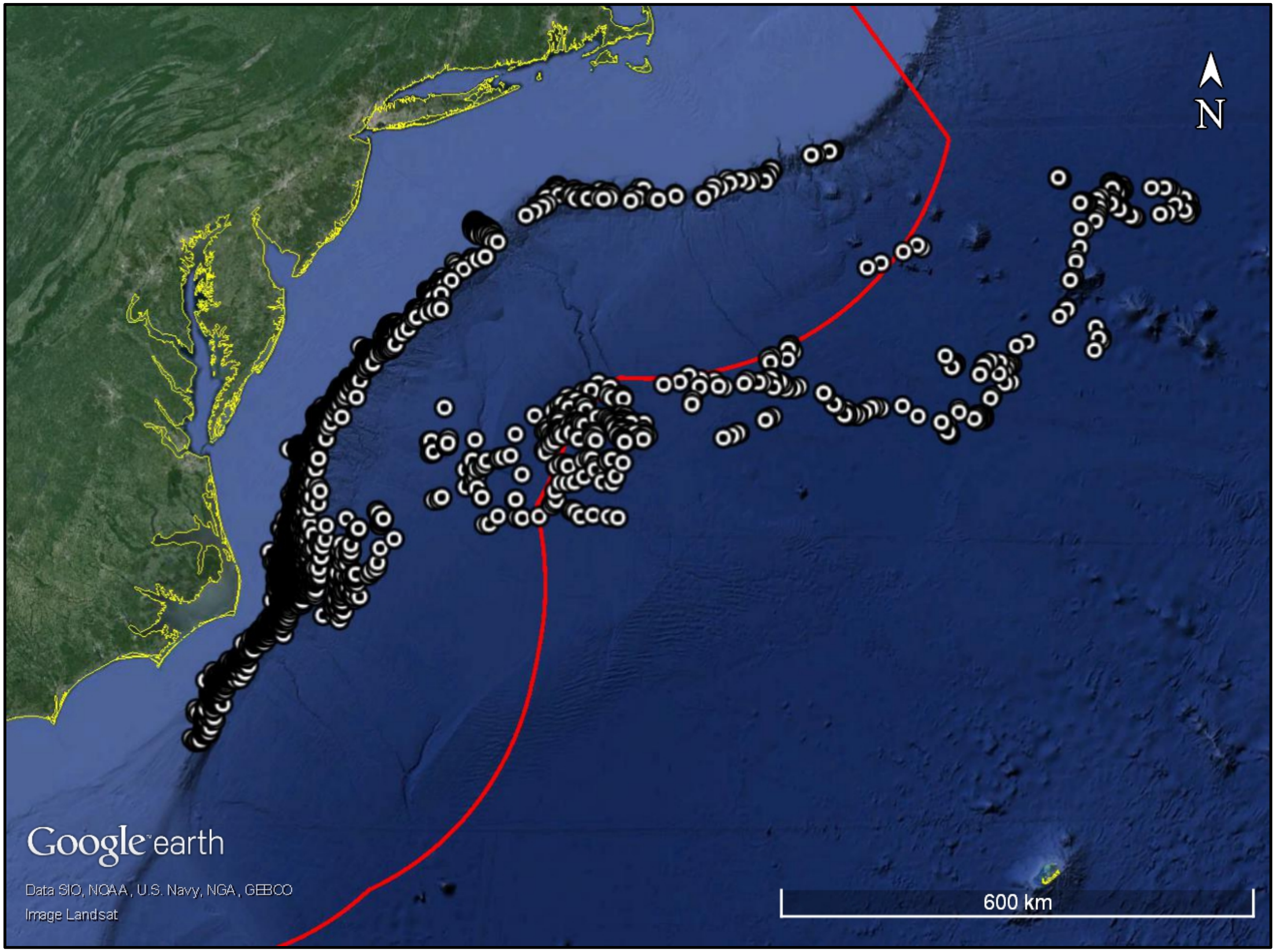


Figure 36. Map showing all filtered locations of all short-finned pilot whales tagged off North Carolina (see Table 18). The U.S. Exclusive Economic Zone boundary is shown in a solid red line.

2.2.1.2 DTAGs

During 2014 in the Cape Hatteras survey area, Duke University deployed four DTAGs: two on Cuvier's beaked whales and two on short-finned pilot whales (**Figure 27**).

Cuvier's beaked whale

On 12 May 2014 at 14:50 Eastern Standard Time (EST), a Cuvier's beaked whale was tagged with a Dtag; however, the tag was immediately shed from the animal.

On 26 May 2014, an adult male Cuvier's beaked whale was tagged at 12:25 EST in waters with a bottom depth of approximately 1,500 (m). The whale was followed through three cycles of deep foraging dives, followed by five dives of shorter duration (<30 min), for nine surfacing bouts. The tag was programmed to jettison from the whale after 4 hr of deployment, or no later than 17:25 EST, but it never detached from the animal. Very high-frequency radio signals were received from the animal at the surface until approximately 18:15 EST, at which point the tagging team returned to shore due to deteriorating weather conditions. On 27 May 2014, the F/V *Samanna* was chartered in an attempt to relocate the tag using the very high frequency radio signal, but no signals were heard. Conditions were very poor, with high winds and heavy seas (BSS 6+). On 29 May 2014, a second offshore fishing vessel was chartered, and a team also searched for the tag from the AFTT survey aircraft equipped with radio-tracking gear. These searches were also conducted in very poor weather conditions. However, neither the vessel nor the plane received any signals, and the tagging team was forced to consider the tag lost. This tag was deployed at the inner front of the Gulf Stream, and the whale was tracked as it foraged along this frontal system. It is assumed that when the tag eventually detached from the whale, the tag entered the Gulf Stream and was advected out of the Cape Hatteras survey area. In discussions with engineers from Woods Hole Oceanographic Institution, Duke learned other researchers had similar problems occasionally with Cuvier's beaked whales, since shedding skin can interfere with the tag release mechanism.

Short-finned pilot whale

DTAGs were deployed on two short-finned pilot whales on 06 and 07 October 2014, respectively. Behavioral focal follows were conducted on both animals, for approximately 3.5 hr and 2.8 hr, respectively. Gm_14_279a completed a series of deep (>500 m) dives throughout the focal follow; the individual was descending when the tag was shed (**Figure 37**). After an initial dive to nearly 100 m, Gm_14_280a executed an extended series of shallow dives for the remainder of the tag's duration (**Figure 38**). Biopsy samples were obtained from each of the tagged individuals, and both tags were successfully recovered. The R/V *Marcus G. Langseth*, a seismic survey vessel from the Lamont-Doherty Earth Observatory at Columbia University, was in the Cape Hatteras study area during both days and relatively close during both tag deployments. An initial review of the acoustic data did not suggest any indication of seismic activity on the tags. These recordings will be compared with the operations schedule of the vessel (data was requested from Dr. Donna Shillington, Lamont-Doherty Earth Observatory, Chief Scientist on this leg of their cruise).

For more information on this study, refer to the annual progress report for this project (Foley et al. 2015).

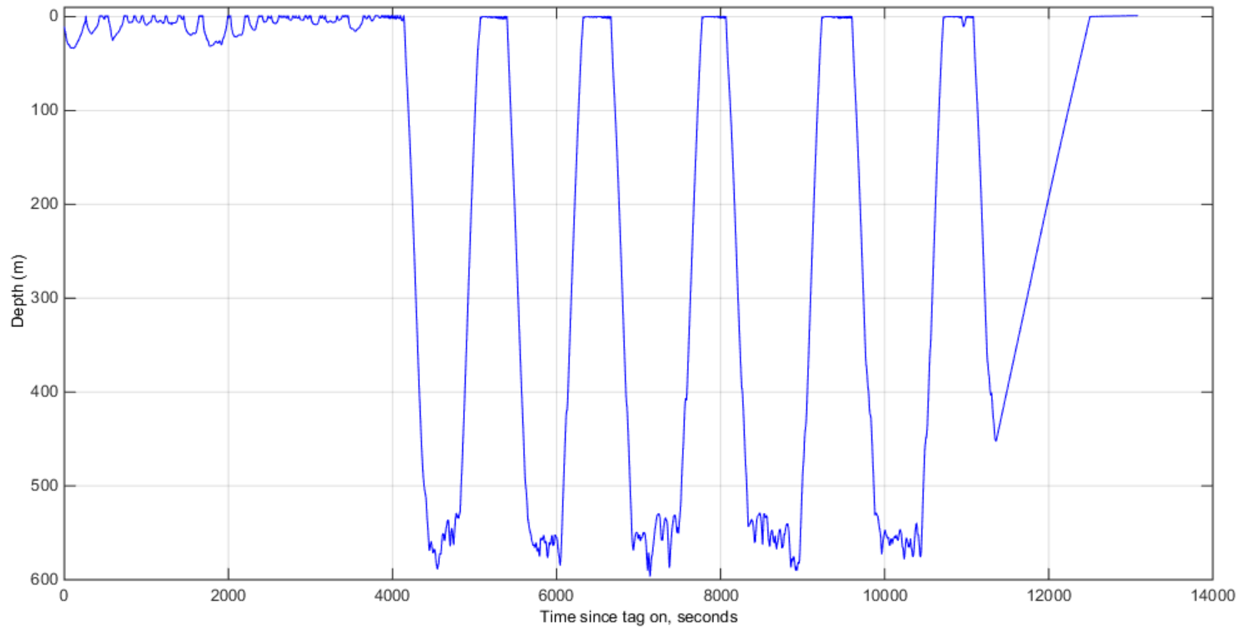


Figure 37. Dive profile of Gm_14_279a from 06 October 2014 DTAG record.

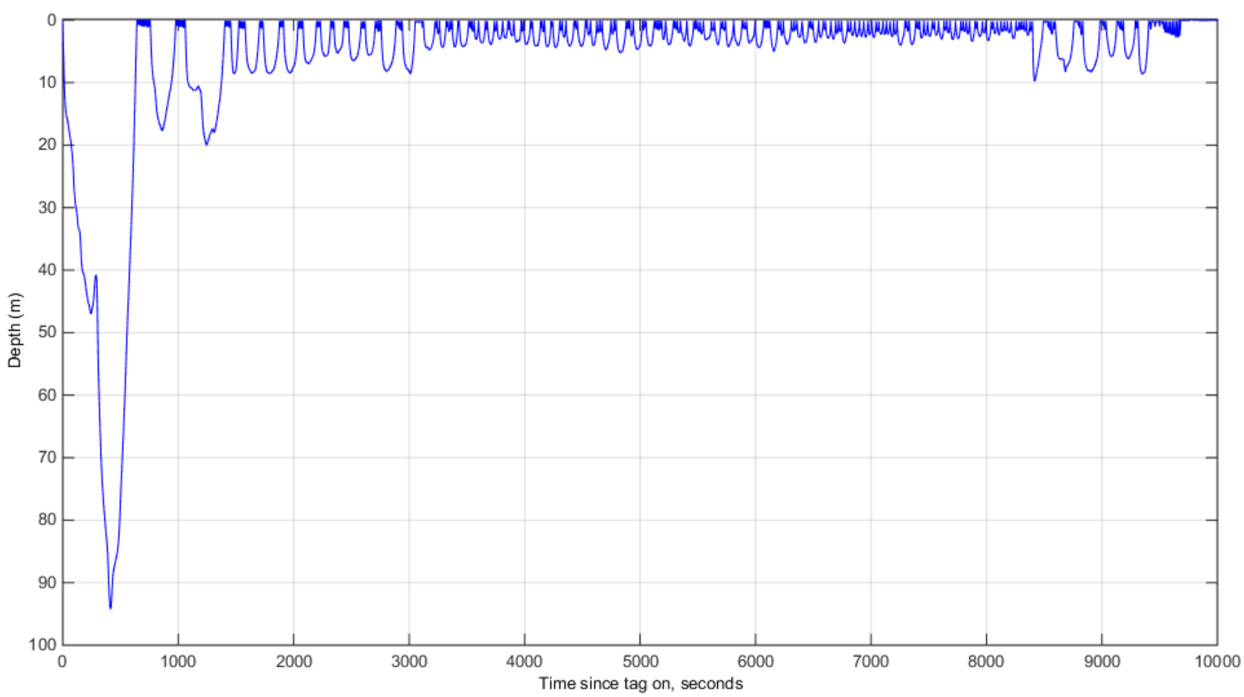


Figure 38. Dive profile of Gm_14_280a from 07 October 2014 DTAG record.

2.2.2 North Atlantic Right Whale Tagging – JAX

Endangered North Atlantic right whales migrate to coastal waters off Florida and Georgia during the winter months. The planned construction and use of the proposed USWTR in the JAX OPAREA may result in interactions with right whales on their winter calving ground. Aerial- and vessel-based visual surveys and PAM are currently being used to detect right whales in the coastal waters of Florida and Georgia, as well as the area of the planned USWTR. These methods give the positions of individual whales, but they only provide information about locations at single points in time. Currently there are few data on the movement patterns of individuals, including movement rates both in north/south and east/west directions, dive depths and durations, or the rates of sound production by individuals on the calving grounds. These data are important to assess the effectiveness of current monitoring techniques and the potential for disturbance to right whales as the proposed USWTR's construction and implementation commences.

A tagging project targeted on North Atlantic right whales was initiated by researchers from Duke University and Syracuse University in February 2014. This study uses non-invasive suction cup tags (anticipated tag duration from 1 to 36 hr) that included Fastloc® Global Positioning System (GPS) technology, time-depth recorders, three-dimensional movement measurements, and acoustic recordings. Tags were successfully deployed on seven right whales during February 2014, including one entangled individual (**Table 19** and **Figure 39**). Tag data collected from six individual right whales off the coast of Florida during a different project in 2006 are being integrated to provide a broader perspective on right whale movement patterns and vocal behavior in this southeastern United States calving area.

Table 19. Summary of data collection from February 2014

Date	No. Tagging Attempts	Tag On?	Whale ID (EGNO)	Mother/Calf	Duration (hh:mm)
03-Feb-14	1	No	2645	X	--
09-Feb-14	1	Yes	2123	X	1:35
10-Feb-14	2	Yes	2040	X	5:30
16-Feb-14	2	Yes	4057	--	3:36
17-Feb-14	3	No	2745	X	--
18-Feb-14	1	Yes	3157	X	11:36
19-Feb-14	2	Yes	2503	X	2:56
23-Feb-14	2	Yes	3546	X	6:41
25-Feb-14	3	Yes	2645	X	5:35

Key: Feb = February; EGNO = North Atlantic right whale catalog number; hh = hour(s); min = minute(s); no. = number.

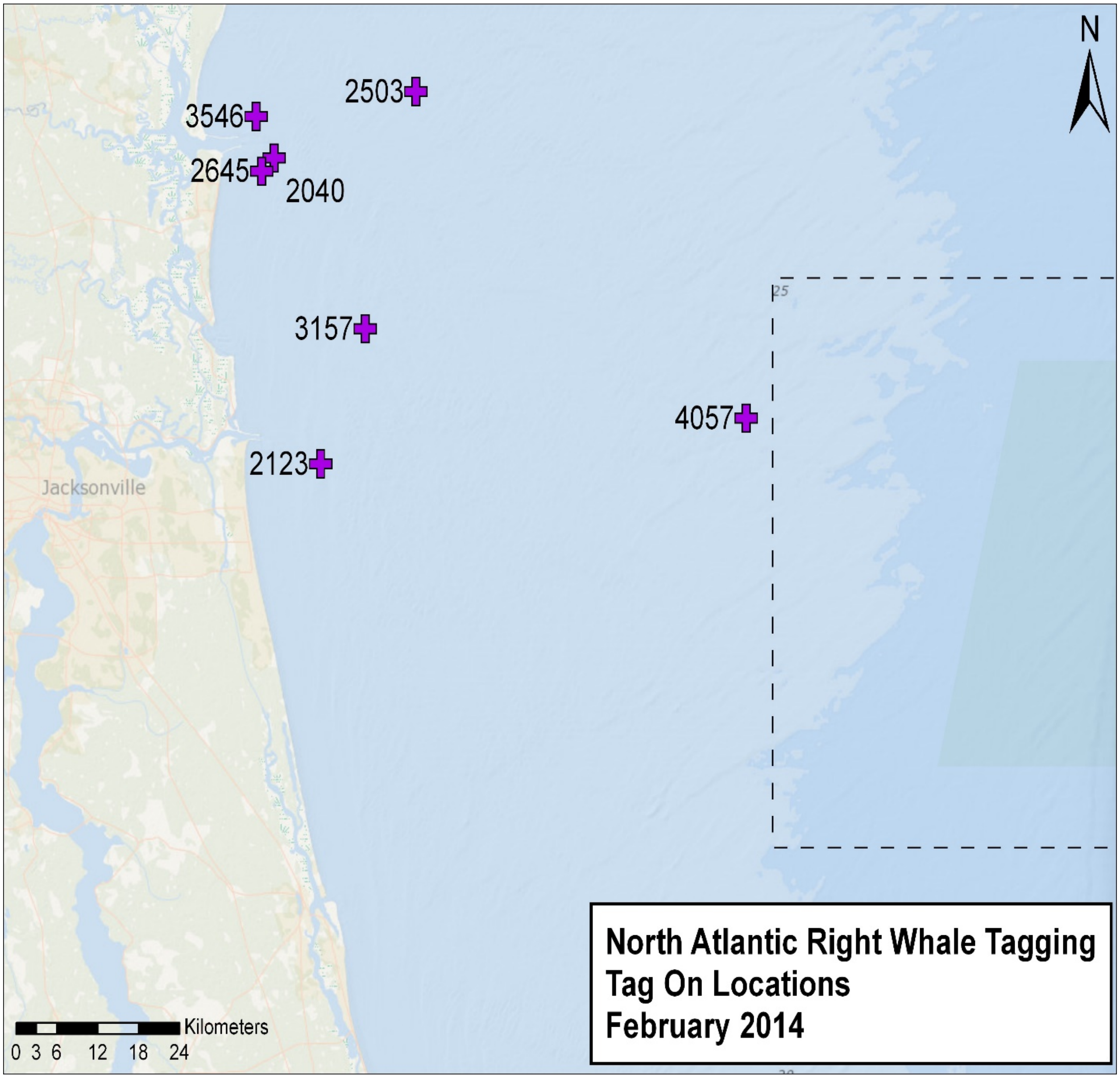


Figure 39. Plotted tag attachment positions in the JAX study area (dashed-line box) and USWTR (shaded box). Each position is marked with a purple plus sign, with the Whale ID (see Table 18) listed next to the point.

A brief summary of the tag data from 2014 indicates that individual whales show variable patterns of movement, both in a north/south and east/west direction (**Figure 40**). The dive profiles indicate that right whales are using the entire water column; however, given the extremely shallow depths in the JAX Study Area, the average maximum dive depth for individuals was <10 m in nearshore waters, with some mother/calf pairs not exceeding 6 m in depth at their maximum point. These data suggest that whales may be just subsurface, where they are difficult to see, in much of the coastal waters off Florida.

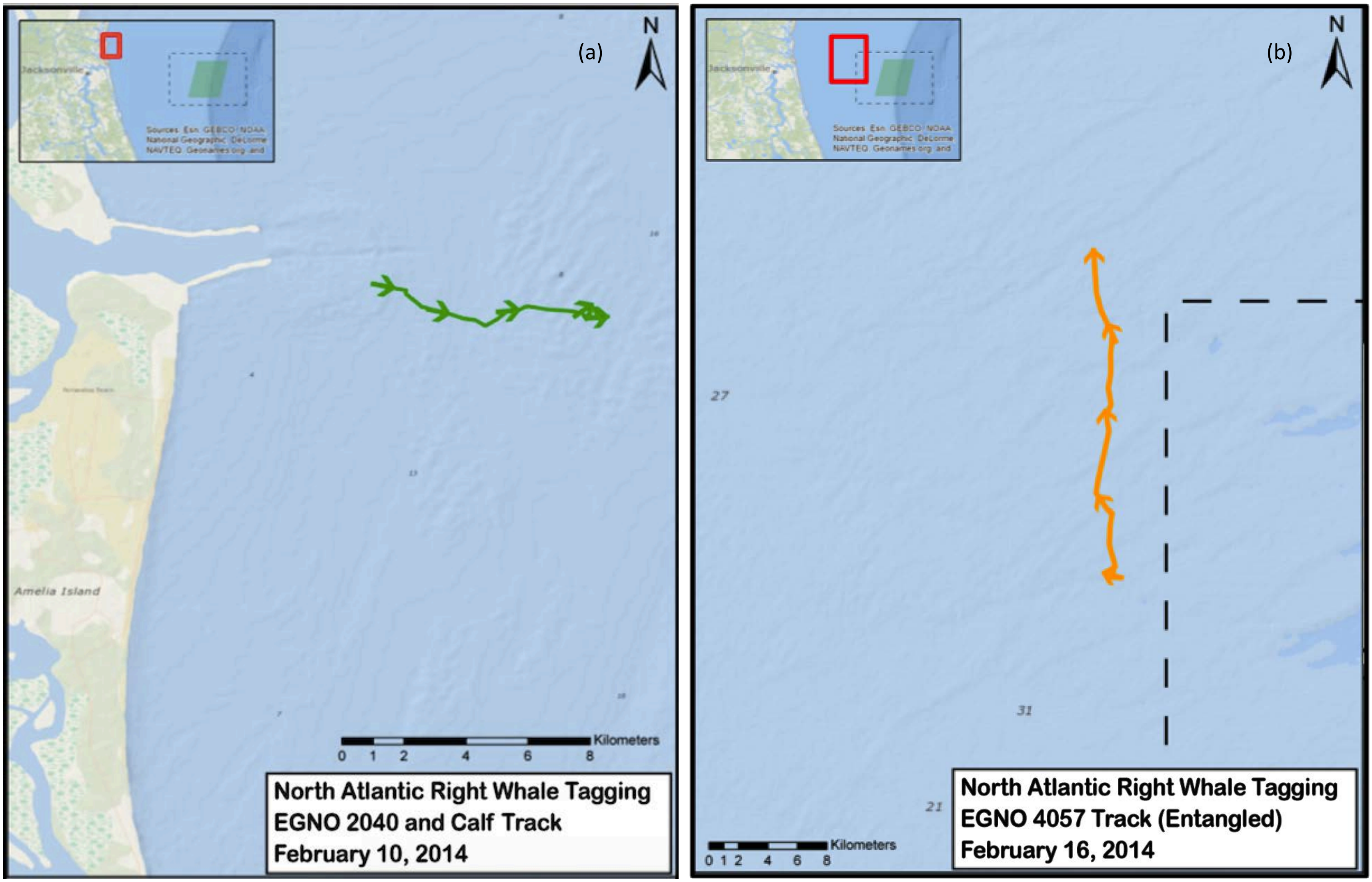


Figure 40. Fastloc GPS tag tracks showing variable movements for North Atlantic right whales tagged off Jacksonville, Florida. Figure 40a shows east-west movements, while Figure 40b shows north-south movements. The inset map shows the position of the enlarged map in red, relative to the planned USWTR (shaded box) in the JAX Study Area (dashed-line box).

Overall, periods with detectable right whale calls were more common than anticipated, with call rates exceeding 100 calls per hour for some individuals. However, call rates were closely associated with the behavioral states of the animals. Call rates from whales involved in social interactions (~90 calls per hour) were significantly higher than rates from a solitary entangled whale that was tagged (0 calls per hour) and two mother/calf pairs with call rates < 2 calls per hour from multiple-hour tag deployments.

Additional fieldwork is planned for 10 February 2015 through 20 March 2015. The emphasis in the second year of data collection will be whales closer to or within the Navy's planned USWTR. An effort to increase the sample size of data collected from whales other than mother/calf pairs also will be made in the second year of data collection.

For more information on this study, refer to the annual progress report for this project (Nowacek et al. 2015).

2.2.3 Sea Turtle Tagging – Chesapeake Bay and Coastal Virginia

In July 2013, the Virginia Aquarium Foundation (VAQF) and Naval Facilities Engineering Command Atlantic initiated a collaborative turtle-tagging project in lower Chesapeake Bay and coastal Virginia waters. The goal of the project is to assess the occurrence, habitat use, and behavior of loggerhead, green (*Chelonia mydas*), and Kemp's ridley (*Lepidochelys kempii*) (turtles in the Hampton Roads region to better assess the impacts U.S. Navy activities may have on these protected marine species. The project includes analysis of historic sea turtle tag data and deployment of satellite and sonic tags on sea turtles captured, incidentally caught, and rehabilitated in Virginia. VAQF gains access to sea turtles in three ways: (1) capture using tangle or dip nets in the vicinity of naval facilities and training areas; (2) incidental capture in Virginia pound nets (fish traps), and (3) rehabilitated turtles from the Virginia Aquarium Stranding Response Program. This project leverages use of the U.S. Navy's existing underwater passive acoustic receiver array. This array records the presence of sea turtles using small sonic (i.e., acoustic) tags attached externally using epoxy. Each tag transmits a specific coded signal that is used to identify the individual as it moves from one location to another. As the turtle moves around areas where receiver arrays are present, the arrays detect the pings from the tag and record the information, which is later downloaded by researchers for analysis. For these turtles, the sonic tag also emits a signal that indicates the approximate depth of the turtle when it is in range of the array.

To build upon 2013 turtle tagging data, turtle tagging was conducted in early summer through fall 2014. Acoustic- and satellite-tagging results and associated statistics were derived from the 2014 turtle tagging data as well as the combined data, and are summarized here.

Twenty-four turtles (15 Kemp's ridley, 7 loggerhead, and 2 green) were tagged with sonic tags during May through October 2014 (**Table 20**). Of these, 5 loggerhead and 3 Kemp's ridley turtles also received U.S. Navy-funded satellite tags (**Table 21**). One loggerhead turtle that received a sonic tag also received a satellite tag as a part of another VAQF project ('non-U.S. Navy' column in **Table 21**). Data from this tag will be available to NAVFAC Atlantic following completion of current projects. Unfortunately, two of the Kemp's ridley turtles stranded dead after being released with tags. They were both too decomposed to determine cause of death, and neither turtle had its acoustic tag attached at the time of stranding.

804 **Table 20. Acoustic (sonic) tag deployments on sea turtles in Virginia during 2013—2014.**

Acoustic Tags	Green	Kemp's ridley	Loggerhead	Total
2013				
Jul	2	0	0	2
Aug	0	1	1	2
Sep	0	0	5	5
Oct	0	0	4	4
Nov	0	0	1	1
2013 Total	**2**	**1**	**11**	**14**
2014				
May	0	1	0	1
Jun	1	7	3	11
Jul	0	3	2	5
Aug	1	2	0	3
Sep	0	1	1	2
Oct	0	1	1	2
2014 Total	**2**	**15**	**7**	**24**
Project Total	**4**	**16**	**18**	**38**

805 **Table 21. Satellite tag deployments on sea turtles in Virginia during 2013—2014.**

Satellite tags	Green	Loggerhead	Kemp's ridley	Total	Non-U.S. Navy Tags
2013					
Aug	0	0	0	0	1
Sep	0	2	0	2	3
Oct	0	3	0	3	1
Nov	0	1	0	1	0
2013 Total	**0**	**6**	**0**	**6**	**5**
2014					
Jun	0	3	0	3	1
Jul	0	0	1	1	0
Aug	0	0	0	0	0
Sep	0	1	1	2	0
Oct	0	1	1	2	0
2014 Total	**0**	**5**	**3**	**8**	**1**
Project Total	**0**	**11**	**3**	**14**	**6**

Thirty-two of the 38 total (2013 and 2014) acoustic tags (84 percent) were detected by an array. There were 4,287 sea turtle detections, 4,196 of which were from U.S. Navy receivers. Detections on the U.S. Navy array were highest in October of each year followed by July–September 2014 (**Table 22**). Tagged sea turtles were detected on 40 of the 62 receivers in the array throughout the lower Chesapeake Bay, James River, Elizabeth River, and Atlantic Ocean. Sea turtles were detected in all military 'zones' (specific zones defined in **Figure 41)**. Green turtles were detected in all military zones except JEB-FS (**Figure 42**). Kemp's ridley turtles were detected in all of the lower Chesapeake Bay and the Atlantic Ocean military zones, with the highest number of detections in the Norfolk Naval Base (NNB) zone (**Figure 43**) The difference in the number of detections between the NNB zone and other zones suggests that the area surrounding NNB may be a foraging area for Kemp's ridley turtles, while this species may only have been transiting through the other zones. Loggerhead turtles were detected in all of the lower Chesapeake Bay and Atlantic Ocean military zones, with the higher number of detections in the NNB and the JEB-LC zones (**Figure 44**). The difference in the number of detections in the NNB and JEB-LC zones and the other zones suggests that loggerhead turtles may be foraging in the NNB and JEB-LC and only transiting through the other zones.

Table 22. Acoustic detections on the U.S. Navy receiver array by month. Detections were highest in October of each year.

Month	Number detections	Number detected	Number deployed*	% Detected
July 2013	23	1	2	50
August 2013	88	1	4	25
September 2013	354	6	9	67
October 2013	1254	3	11	27
November 2013	1	1	5	20
May 2014	80	1	1	100
Jun 2014	286	8	11	73
July 2014	646	5	16	31
August 2014	743	4	7	57
September 2014	721	6	5	120
October 2014	802	3	4	75

* Number deployed 60 days prior to last day of month

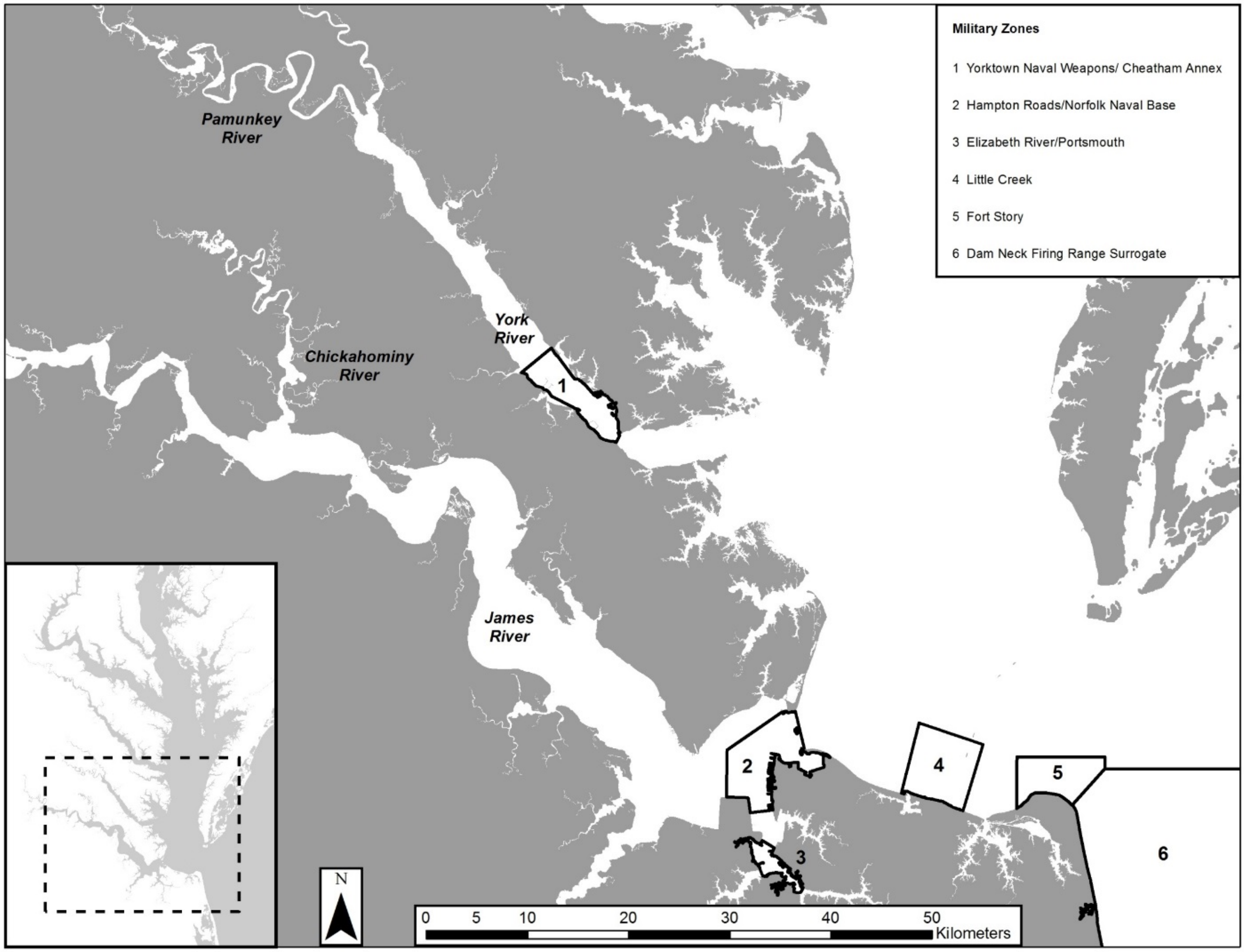


Figure 41. Military zones of interest within Chesapeake Bay where an acoustic receiver array is located (Courtesy of Christian Hager, Chesapeake Scientific).

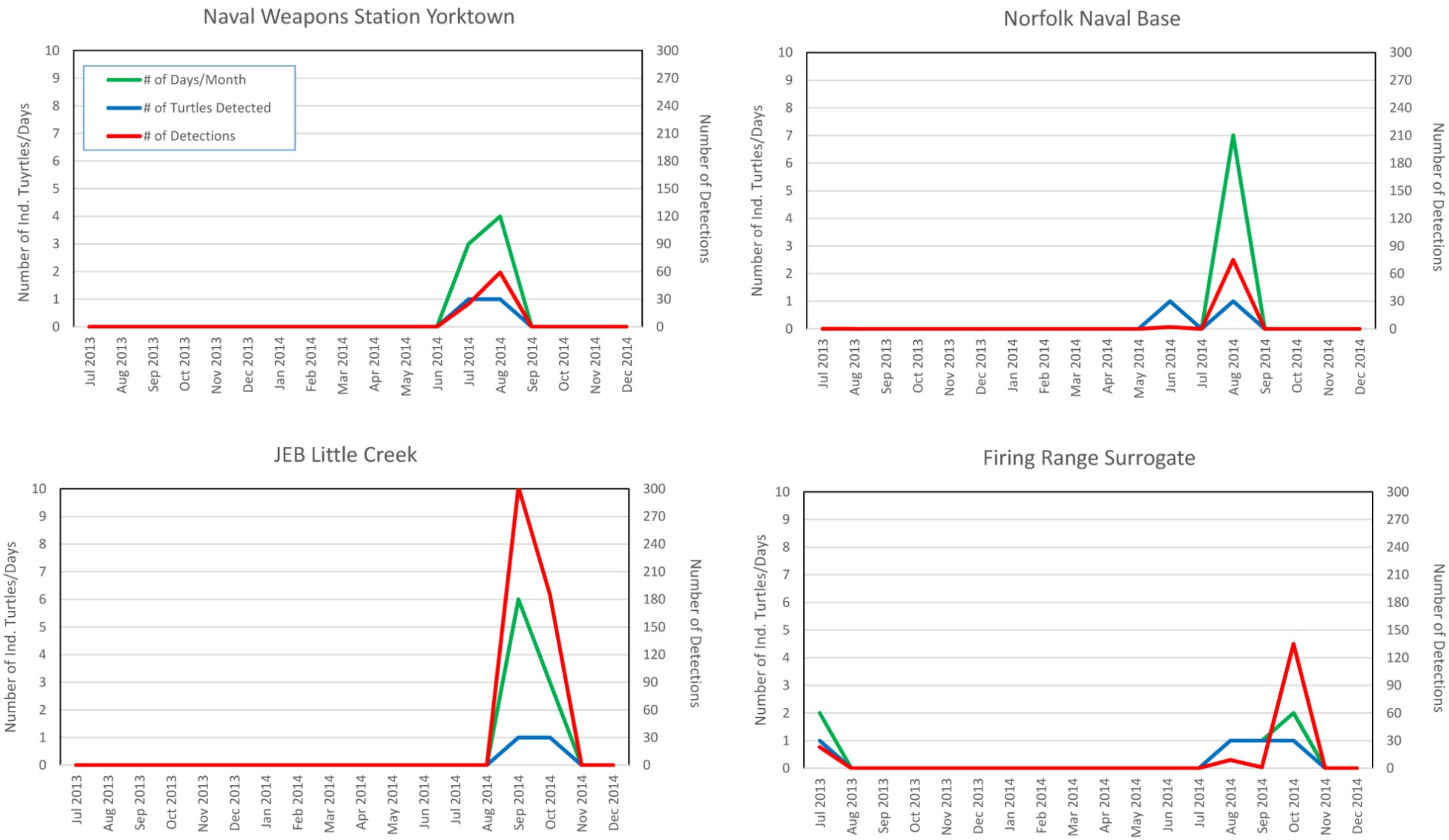


Figure 42. Total number of green turtle detections by month for each geographic zone, July 2013 –November 2014. There were no detections in the JEB-FS zone. Stars indicate green turtle tag deployments.

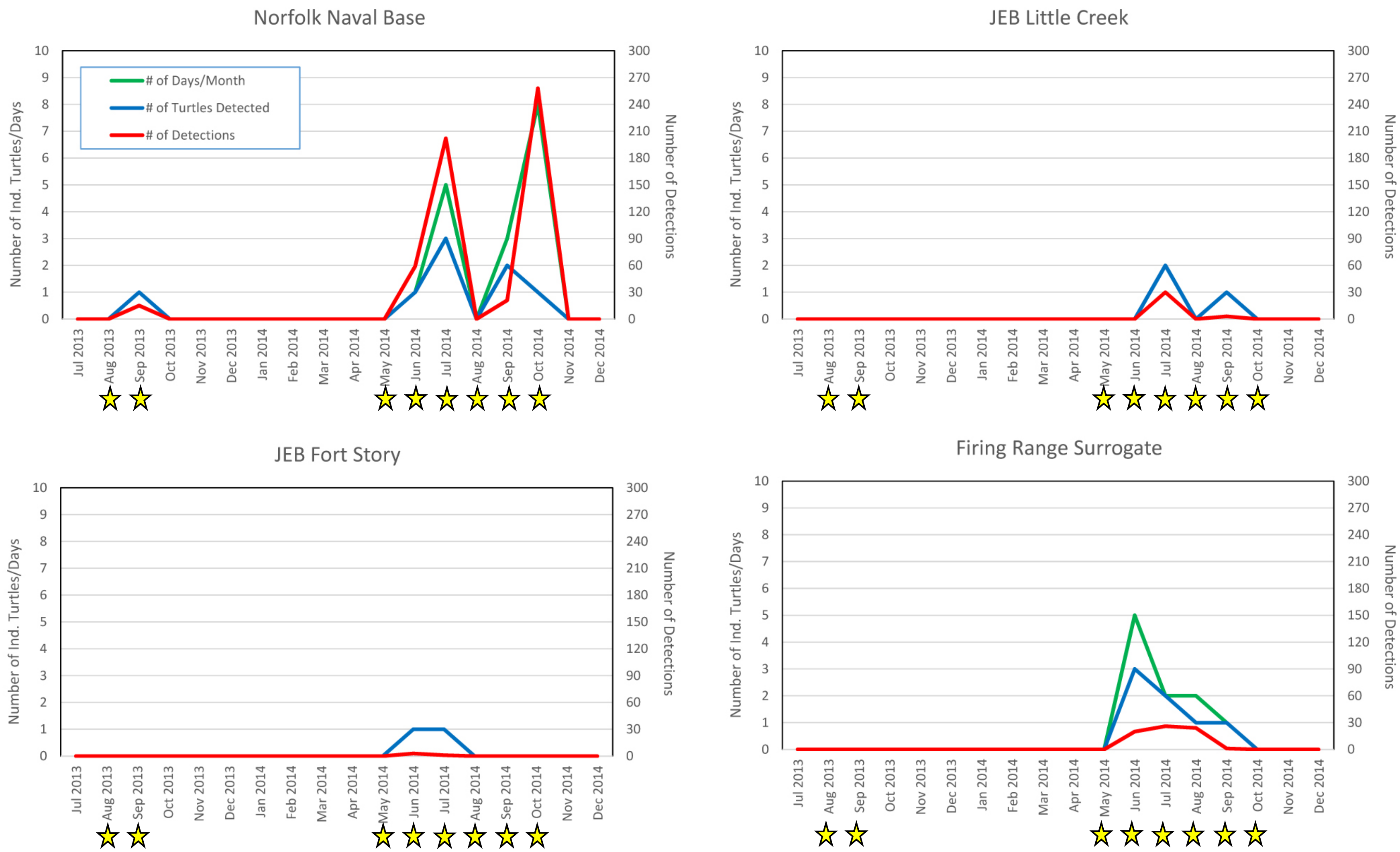


Figure 43. Total number of Kemp's ridley detections by month for each geographic zone, July 2013–November 2014. There were no detections in the Naval Weapons Station Yorktown zone. Stars indicate Kemp's ridley tag deployments.

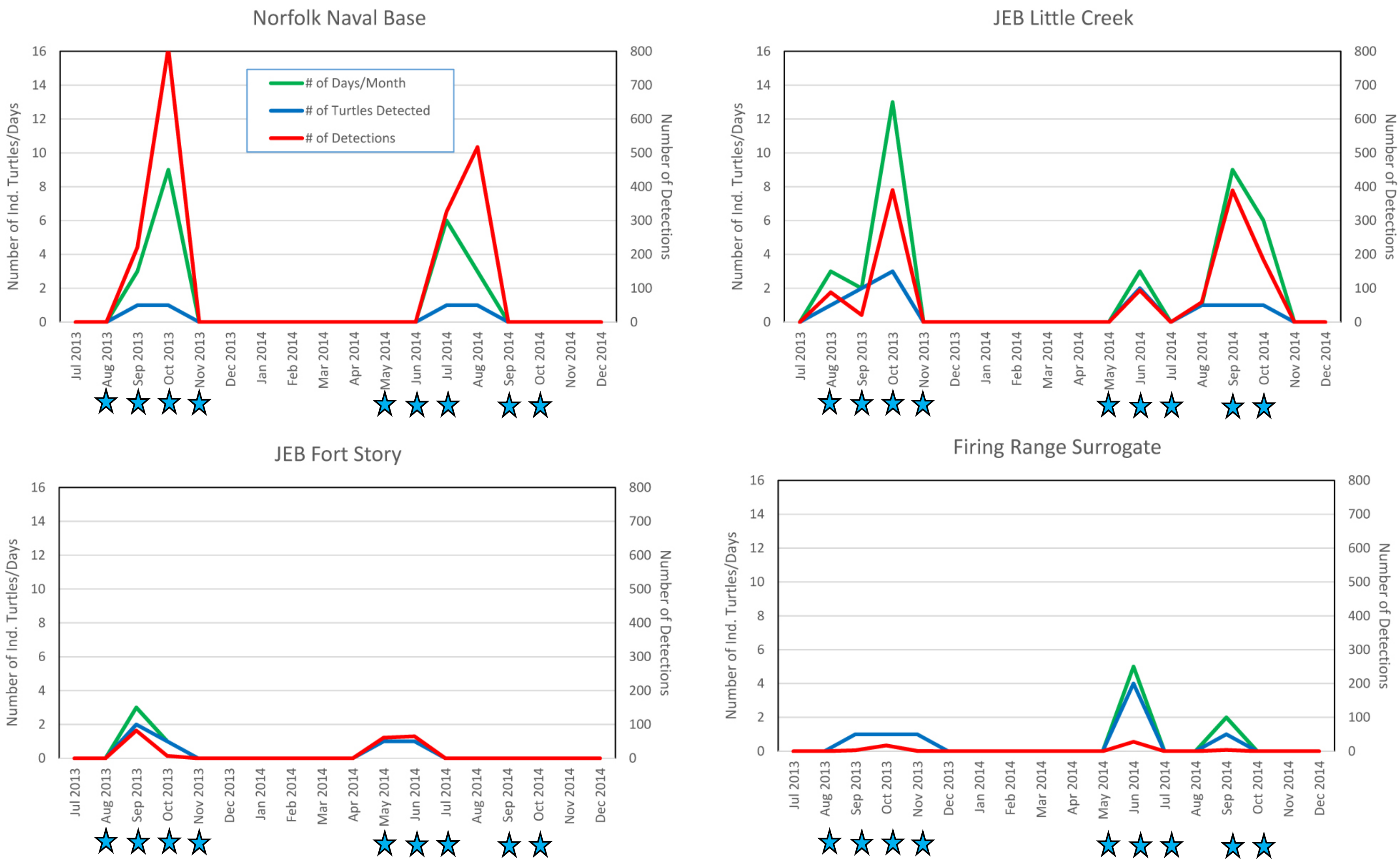


Figure 44. Total number of loggerhead detections by month for each geographic zone, July 2013–November 2014. There were no detections in the Naval Weapons Station Yorktown zone. Stars indicate loggerhead tag deployments.

Given that tag data are still being collected, detailed analyses were not available for inclusion here, but tracks from 37 deployments (including VAQF historical data) of satellite tags are shown in **Figure 45**. Preliminary regional analysis reveals areas of higher use by satellite-tagged individuals include the York River, the upper Chesapeake Bay off Church Neck, the waters just east of the Hampton Roads Bridge Tunnel, waters off the Virginia Beach oceanfront, and the ocean waters outside of Chincoteague Inlet (**Figure 46**). The only area that had greater sea turtle occurrence (61 to 70 days) was off Oregon Inlet.

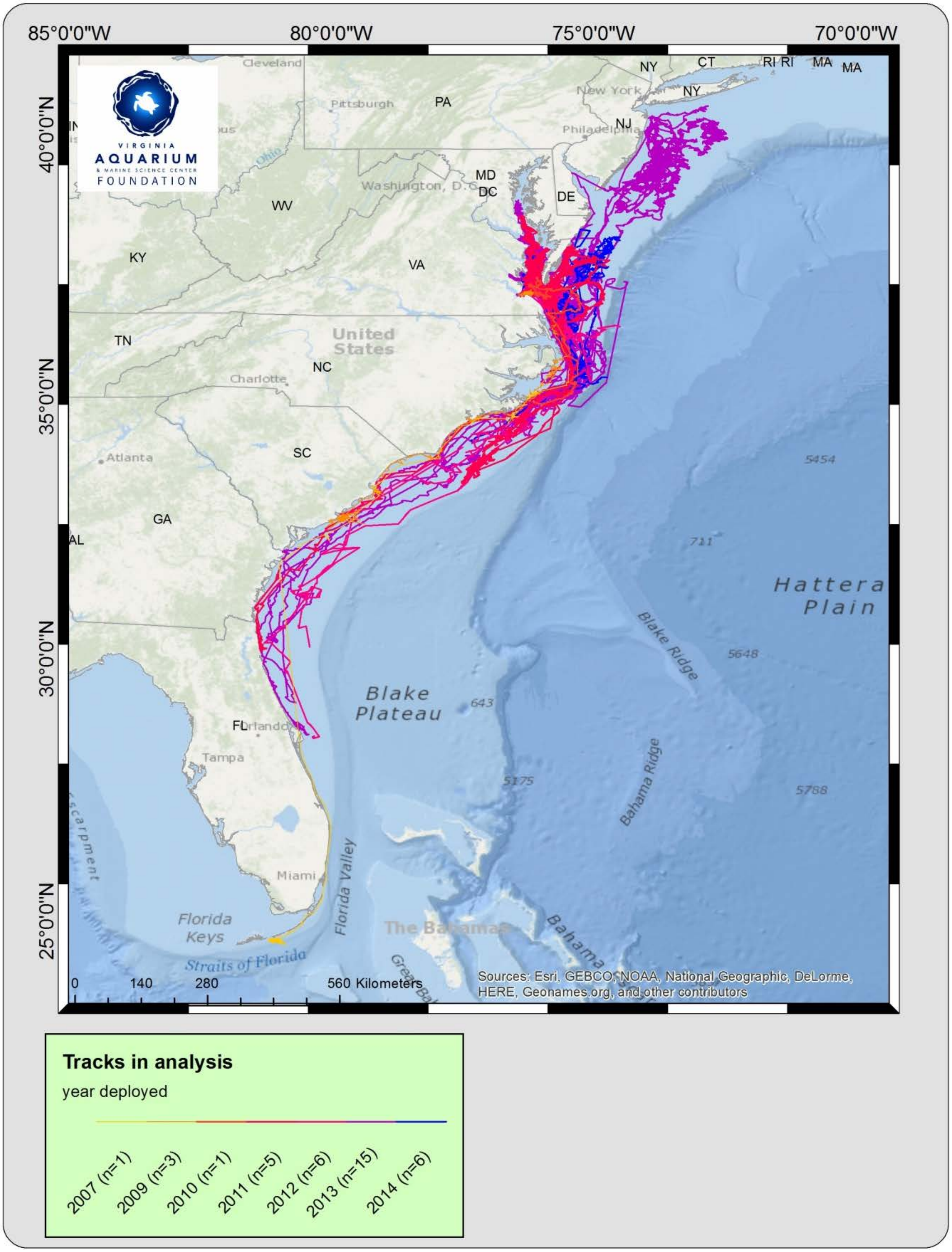
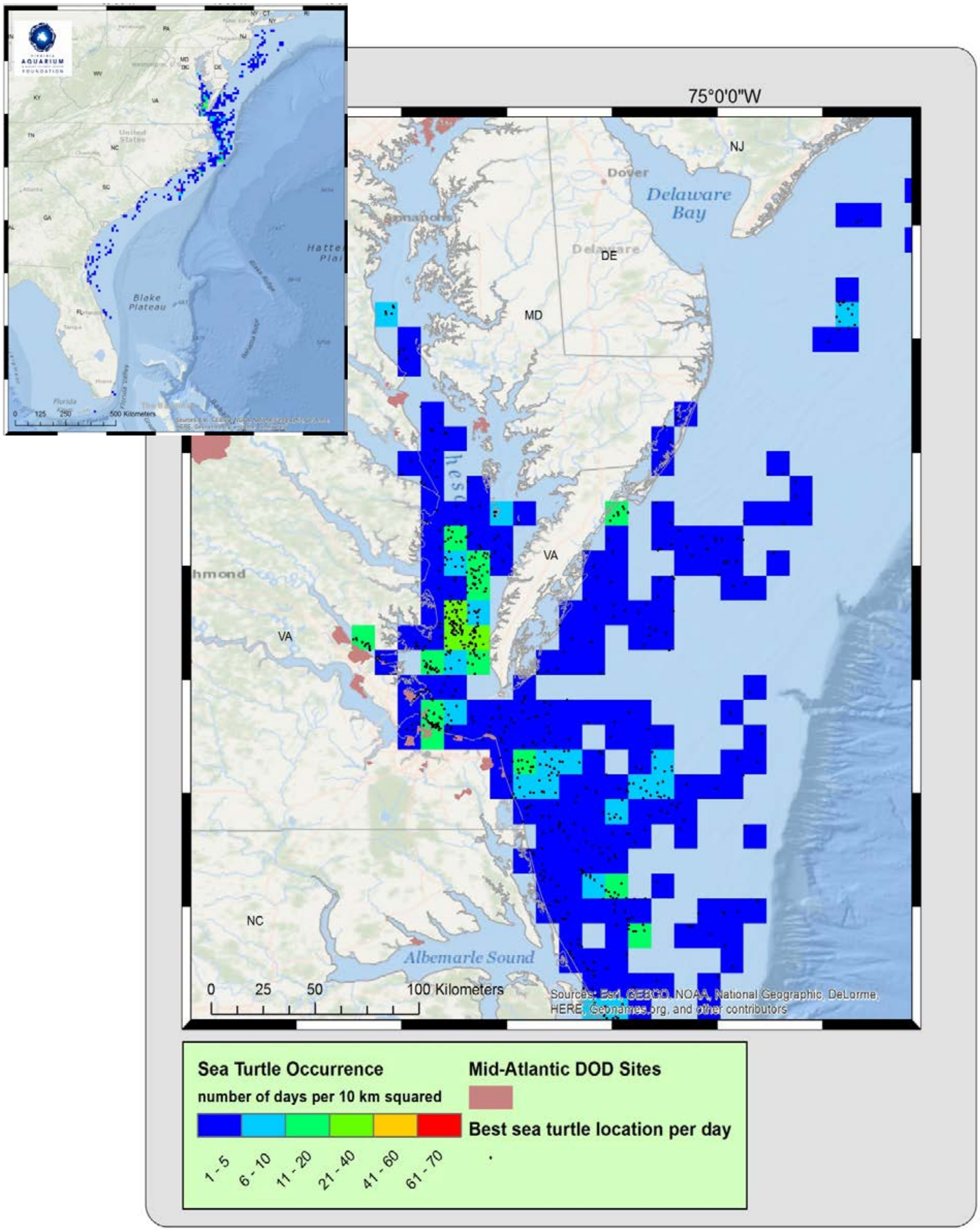


Figure 45. Tracks of 37 satellite-tagged turtles currently being used in analysis.



843 **Figure 46. Satellite-tagged sea turtle occurrence in mid-Atlantic waters.**

The on-going switching state-space analysis of the satellite data will provide a behavioral component (i.e., foraging, migratory) to the detection data provided by the acoustic tags. By identifying foraging versus migratory behavior, VAQF will be able to better understand not only the presence of turtles in military zones but also how they might be using the habitat. These data will provide the U.S. Navy with detailed temporal and spatial data on sea turtle behavior in the vicinity of military facilities and training areas.

Satellite tag data can be viewed online at seaturtle.org (http://www.seaturtle.org/tracking/?project_id=917) and the Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP) NAVFAC collaborative project page (http://seamap.env.duke.edu/partner/NAVY).

In the spring of 2015, VAQF will be conducting detection trials with range-finding tags funded by the U.S. Navy to determine the distance from receivers that turtles must be in order to be detected. These added data will enhance the interpretation of the detection data.

For more information, refer to the annual progress report for this project (Barco and Lockhart 2015).

2.3 Passive Acoustic Monitoring

PAM is conducted in the AFTT study area, both for baseline monitoring and behavioral response studies. As part of a multi-institutional monitoring plan for Onslow Bay, an acoustic monitoring effort was initiated in 2007 by Duke University with assistance from Scripps Institution of Oceanography. In 2008, the preferred USWTR site was moved from Onslow Bay, North Carolina to Jacksonville, Florida. While acoustic monitoring continued in Onslow Bay, it also began in Jacksonville in 2009, once again led by Duke with assistance from Scripps. Later, acoustic monitoring expanded to Cape Hatteras (2012) and Norfolk Canyon (2014), as part of the U.S. Navy's marine species monitoring program for Atlantic Fleet Training and Testing (AFFT). . For all locations, the primary goal of the acoustic monitoring effort has been to determine patterns of occurrence and distribution of cetacean species in the area. In order to determine which species were present, another goal was to identify species-specific characteristics of the vocalizations of marine mammal species in each area. Acoustic monitoring in each area (except for Norfolk Canyon) originally consisted of recordings made by a towed hydrophone array during boat-based surveys and autonomous passive acoustic recorders (e.g., HARPs). Acoustic monitoring by Duke to this day continues to include HARPs. Since 2012, PAM in the mid-Atlantic region has included the use of ecological acoustic recorders (EARs) and C-PODs to monitor baseline occurrence in the region, as well as cetacean behavioral (i.e., acoustic) responses to naval training exercises. Work also continued this year to model predictions of marine mammal vocal behavior in response to mid-frequency active (MFA) sonar exercises by the U.S. Navy.

2.3.1 High-Frequency Acoustic Recording Packages

During 2014, passive acoustic data were collected in Jacksonville, Cape Hatteras, and Norfolk Canyon using autonomous bottom-mounted recorders (i.e., HARPs). Information relating to HARP deployment and data analyses for Norfolk Canyon, Onslow Bay, and the Cape Hatteras and Jacksonville survey areas follows.

2.3.1.1 Norfolk Canyon

One HARP deployment was made near Norfolk Canyon during the reporting period. This HARP was deployed near Norfolk Canyon at a depth of 982 m at 37.16623° N, 74.46692° W (Site A) on 19 June 2014 (**Table 23** and **Figure 47**). The HARP was programmed to sample continuously at 200 kilohertz (kHz); the deployment period will be approximately 10 months and is expected to be recovered during early April 2015. The HARP was programmed to sample continuously at 200 kHz and was also equipped with a SPOT-293A tag as a safety precaution in case the instrument breaks free of its mooring earlier than expected. Table 23. Norfolk Canyon HARP deployment.

Site	Deployment Date	Retrieval Date	Recording Start Date	Recording End Date	Latitude	Longitude	Depth (m)	Sampling Rate	Duty Cycle
01A	19-Jun-14	N/A	19-Jun-14	N/A	37.16623	-74.46692	982	200 kHz	continuous

Key: Jun = June; kHz = kilohertz; m = meter(s) N/A = not applicable

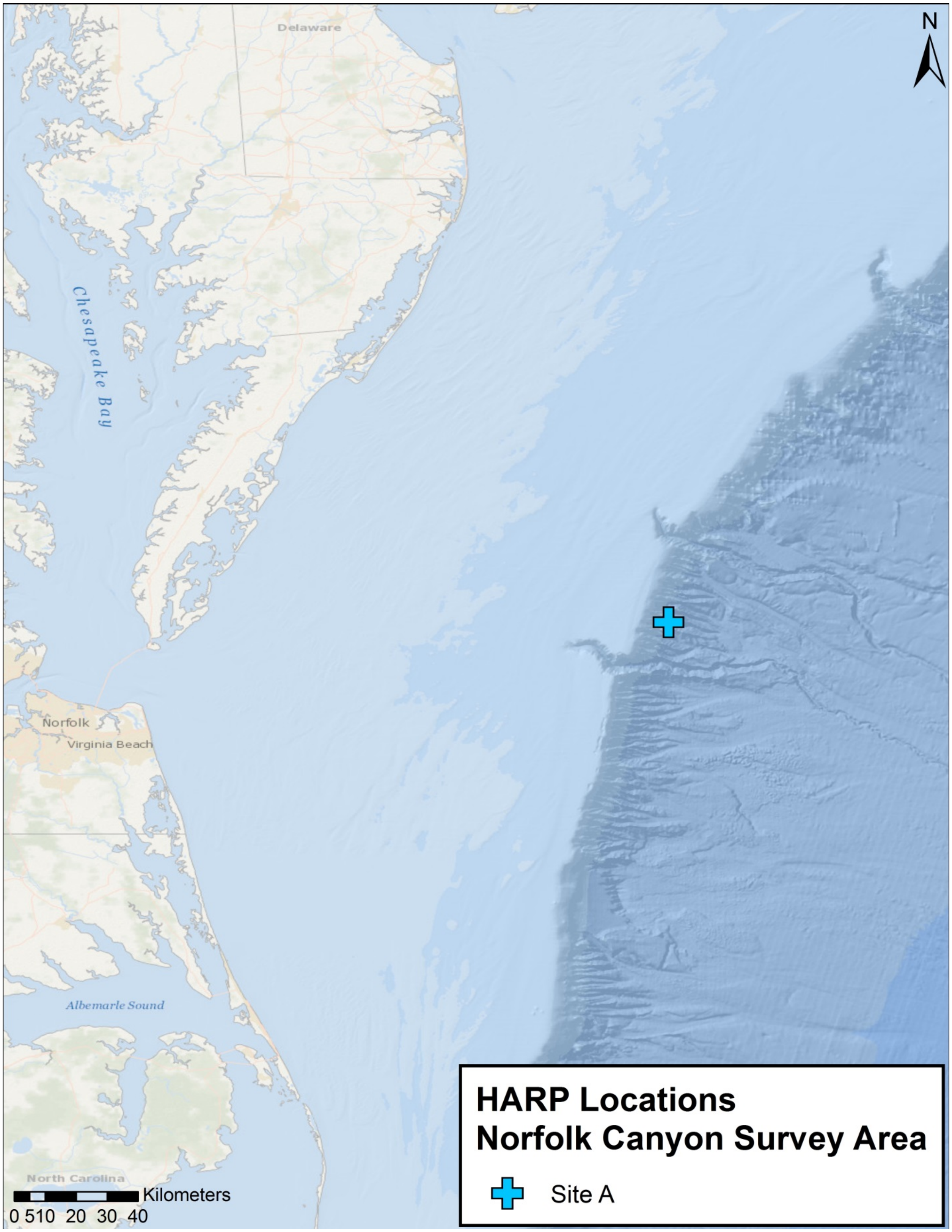


Figure 47. Location of the HARP deployment site in Norfolk Canyon.

2.3.1.2 Cape Hatteras

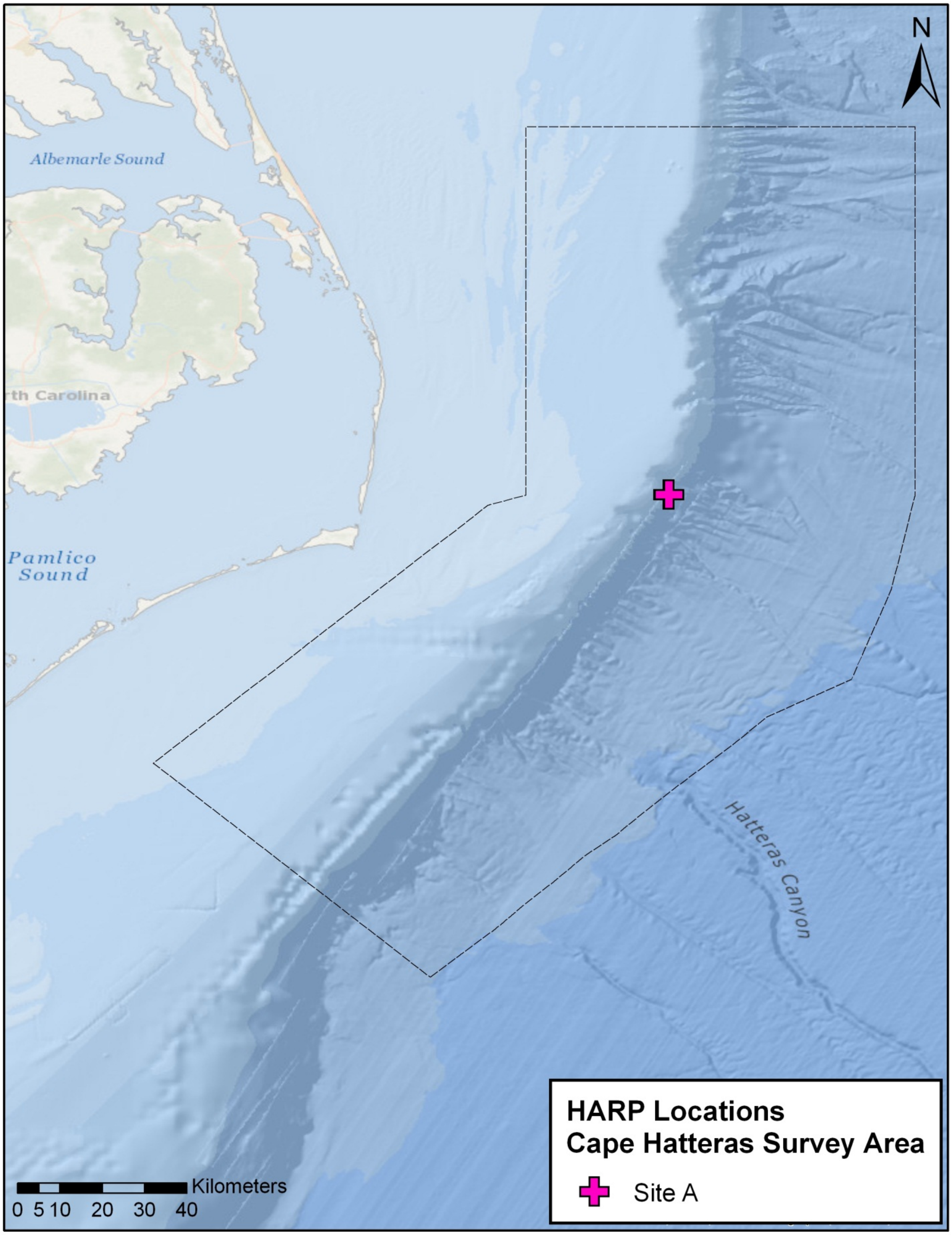
Data Collection (Cape Hatteras)

The HARP initially deployed on 29 May 2013 was recovered and redeployed at a depth of approximately 835 m at 35.34445^{o} N, 74.84805^{o} W (Site A) on 8 May 2014 (**Table 24** and **Figure 48**), yielding a deployment period of 345 days. This instrument is still in the field and is expected to be recovered during early April 2015. The HARP was programmed to sample continuously at 200 kHz for both deployments. The May 2013–May 2014 deployment provided data during 291 days (29 May 2013–15 March 2014).

Table 24. Deployment details for the Hatteras HARPs analyzed and detailed in this report.

Site	Deployment Date	Retrieval Date	Recording Start Date	Recording End Date	Latitude	Longitude	Depth (m)	Sampling Rate	Duty Cycle
01A	15-Mar-12	09-Oct-12	15-Mar-12	11-Apr-12	35.34054	-74.85761	950	100 kHz	continuous
02A	9-Oct-12	29-May-13	09-Oct-12	09-May-13	35.34060	-74.85590	970	200 kHz	continuous
03A	29-May-13	08-May-14	29-May13	15-Mar-14	35.34445	-74.85210	970	200 kHz	continuous
04A	8-May-14	N/A	09-May-14	N/A	35.34677	-74.84805	~835	200 kHz	continuous

Key: Apr=April; kHz=kilohertz; m=meter(s); Mar=March; N/A=not applicable; Oct=October

900 

901 **Figure 48. Location of the HARP deployment site in the Cape Hatteras survey area.**

Data Analysis (Cape Hatteras)

Data from the most recent Cape Hatteras HARP deployment (May 2013–March 2014) are still being analyzed and results are not presented here. Data from the 2012–2013 HARP deployment (09 October 2012–09 May 2013; 4,901.6 hr of recording time) were re-processed. All re-processed 2012–2013 data, as well as original data from the March–April 2012 HARP deployment (15 March 2012–11 April 2012, 636.75 hr of recording time) were re-analyzed for beaked whale echolocation signals using a new automated detection method customized for the Cape Hatteras HARP recordings. This method used the same initial automated detection steps described in detail in Debich et al. (2014).

Table 25 summarizes the updated occurrence of detected and identified sperm whale and beaked whale clicks for the 2012–2013 Site A HARP deployment. Sperm whales were present throughout much of the deployment, with detections on 70.7 percent of days analyzed, and no apparent diel pattern. Sperm whales were detected most frequently during January through March. Cuvier's beaked whale clicks occurred regularly throughout the deployment, with detections on 96.6 percent of days analyzed. These click events were distributed fairly uniformly across both seasonal and diel time scales. Gervais' beaked whale clicks occurred less frequently, with detections on 20.5 percent of days analyzed. Blainville's beaked whale (*Mesoplodon densirostris*) clicks were detected only once, on 03 February 2013.

Table 25. Updated summary of detections of sperm whales and beaked whales at Site A for 09 October 2012–09 May 2013.

Species	Call type	Hours with vocalizations	Percent of total recording hours	Days with vocalizations	Percent of total recording days
Sperm Whale (*Physeter macrocephalus*)	clicks	1157	23.6	145	70.7
Cuvier's Beaked Whale (*Ziphius cavirostris*)	clicks	1485	30.3	198	96.6
Gervais' Beaked Whale (*Mesoplodon europaeus*)	clicks	86	1.75	42	20.5
Blainville's beaked whale (*Mesoplodon densirostris*)	clicks	1	0.02	1	0.49

Table 26 summarizes the updated occurrence of beaked whale clicks detected in the March through April 2012 Site A HARP deployment. Cuvier's beaked whales were detected every day except the last recording day (11 April 2012), which had less than 5 hr of available recording time. Gervais' beaked whales were detected less frequently, on 35.7 percent of recording days.

Table 26. Updated summary of detections of beaked whales at Site A for 15 March 2012–11 April 2012.

Species	Call type	Hours with vocalizations	Percent of total recording hours	Days with vocalizations	Percent of total recording days
Cuvier's beaked whale (*Ziphius cavirostris*)	clicks	257	40.4	27	96.4
Gervais' beaked whale (*Mesoplodon europaeus*)	clicks	22	3.40	10	35.7

2.3.1.3 Onslow Bay

Data Collection (Onslow Bay)

No HARPs have been deployed in Onslow Bay since August 2013. There are no current plans to redeploy in this area. **Figure 49** shows the locations of all HARP deployments that have occurred in this area.

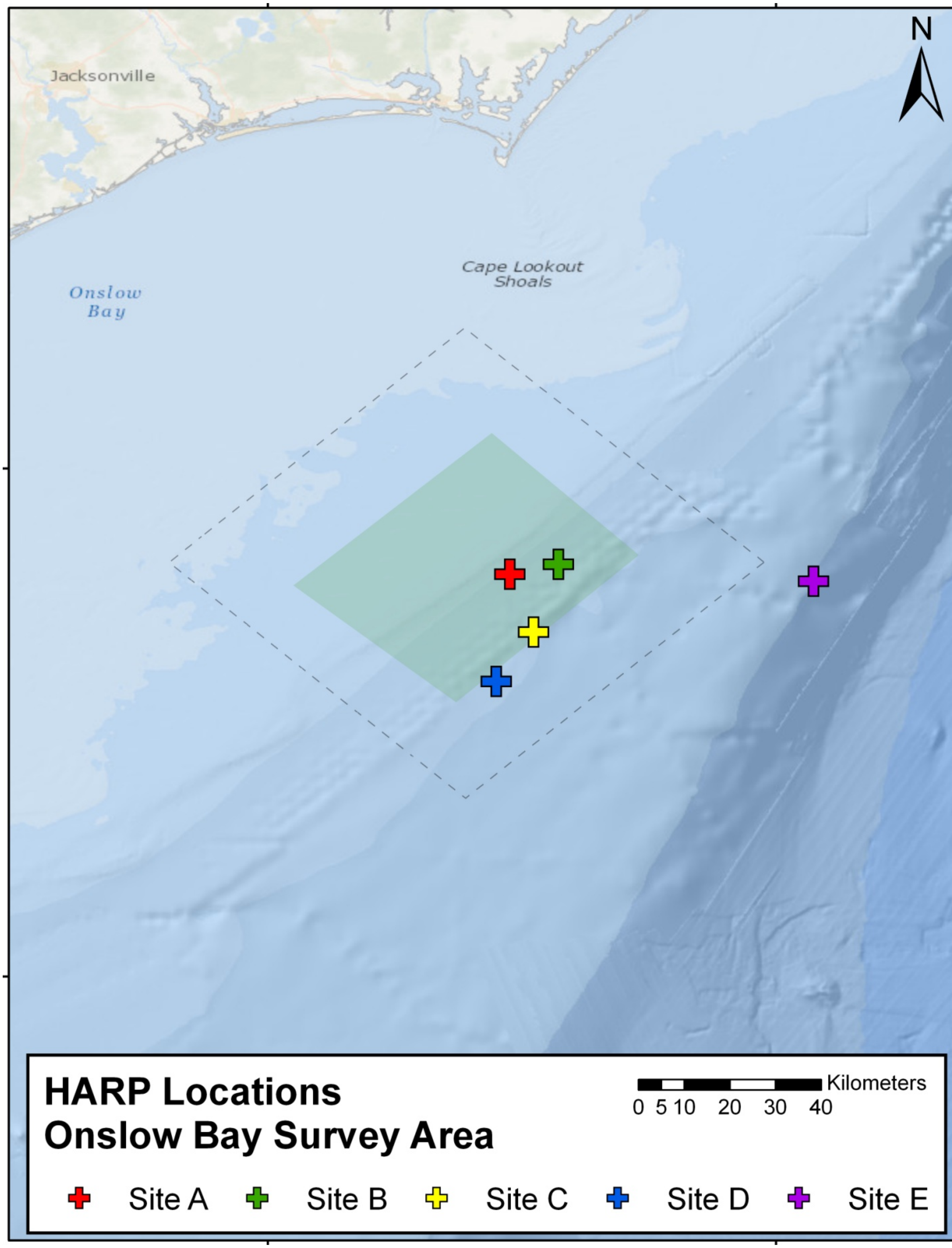


Figure 49. Location of HARP deployment sites in the Onslow Bay survey area.

Data Analysis (Onslow Bay)

Analysis of all datasets from Onslow Bay deployments for marine mammal sounds and MFA sonar are completed. **Table 27** gives details on the datasets analyzed during this reporting period: July 2010–June 2011 site D deployment and October 2012–August 2013 site E deployment.

Table 27. Onslow Bay HARP data sets analyzed and detailed in this report.

Site	Deployment Date	Retrieval Date	Recording Start Date	Recording End Date	Latitude	Longitude	Depth (m)	Sampling Rate	Duty Cycle
05D	29-Jul-10	10-Jun-11	30-Jul-10	24-Feb-11	33.58065	-76.55015	338	200 kHz	5 min on / 5 min off
08E	24-Oct-12	08-Aug-13	24-Oct-12	30-Jun-13	33.78696	-75.92801	853	200 kHz	5 min on / 5 min off

Key: kHz = kilohertz; min = minutes

<u>July 2010–June 2011 Site D Deployment</u>

The July 2010–June 2011 Site D deployment had 2733.9 hours of recording time over 210 days. Mysticete detections included calls from blue whales (*Balaenoptera musculus*), fin whales, minke whales (*Balaenoptera acutorostrata*), and possible sei whales (*Balaenoptera borealis*). Blue whales were present primarily from August 2010 to mid-February 2011, although most detections occurred before the end of December. Fin whale 20-Hertz pulses were present between the end of August and mid-September 2010 and between the end of October 2010 and February 2011. Peaks in detections occurred between December and February, which is similar to previous findings in Onslow Bay of peaks between January and March. Minke whale pulse trains (mainly slow-down pulse trains) were detected between mid-November 2010 and the last day of the recording period, 24 February 2011. Peaks in pulse train calls occurred from the end of December through the end of February, similar to the previous findings in Onslow Bay of peaks between January and March. Downsweeps similar to those ascribed to sei whales by Baumgartner et al. (2008) were detected on 16–17 October 2010 and between 13 November 2010 and 17 February 2011. The general occurrence of this call type is similar to previous findings in Onslow Bay.

Detected odontocete vocalizations included clicks, whistles, and burst-pulses. Most of these detections (93 percent) were assigned to the unidentified odontocete category. Unlike during the 2010–2011 Site A deployment that occurred at the same time as this Site D deployment, there was no pattern of longer-duration and clustered unidentified odontocete vocal events during late night to early morning between November and January. *Kogia* sp. clicks were present on only 3 days, which is consistent with the sporadic occurrence found during previous deployments. Risso's dolphins were detected throughout the deployment with more detections at night, again agreeing with earlier findings. Sperm whales were detected between August and early September and between the end of December and mid-February, during both day and night.

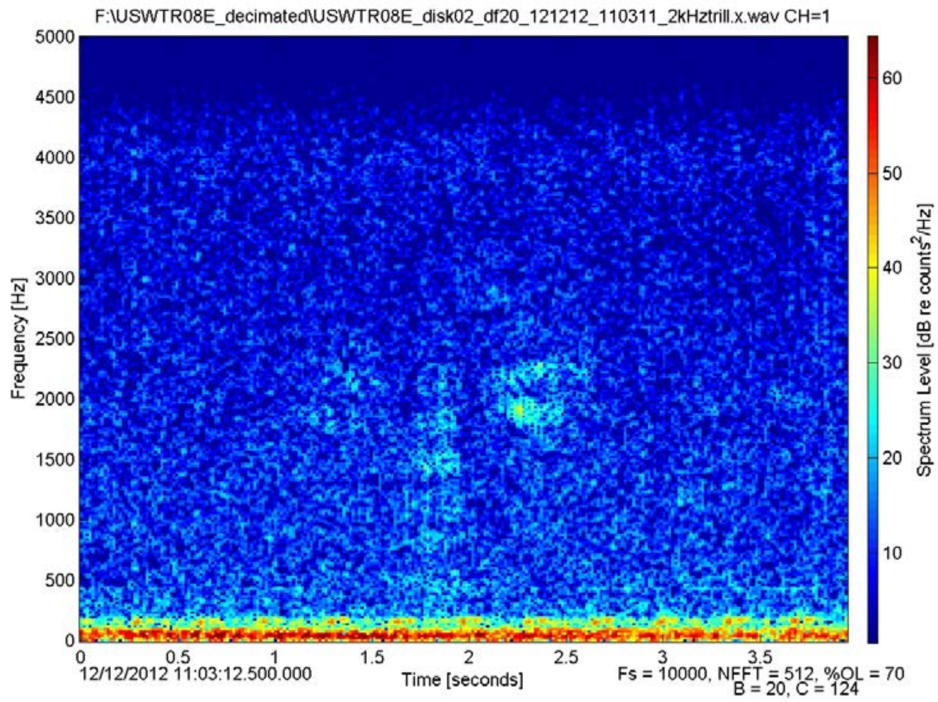
<u>October 2012–August 2013 Site E Deployment</u>

The October 2012–August 2013 site E deployment had 3436.1 hr of recording time over 250 days. Mysticete detections included calls from blue whales, fin whales, minke whales, possible sei whales, and unidentified mysticetes. Blue whales were primarily present from the beginning of the recording period (October 2012) to the beginning of January 2013, with very few detections after that through mid-March. Fin whale 20-Hz pulses were present from the start of the recording period until mid-March.

Minke whale pulse trains (mainly slow-down pulse trains) were detected mainly between mid-November 2012 and mid-April 2013, but detections did continue through 02 May 2013. High levels of pulse train calls occurred from December until mid-April. Downsweeps similar to those ascribed to sei whales by Baumgartner et al. (2008) were detected from the beginning of the recording period until 08 February 2013, with peaks in occurrence in December. The general occurrence of this call type is similar to previous findings in Onslow Bay. Short-duration downsweeps (short in duration compared to possible sei whale downsweeps) were detected from December 2012 through mid-March 2013. Faint upsweeps were detected on three days in 2013 (four calls on 06 February, two calls on 10 February, and two calls on 12 March). These were similar to right whale up-calls (although shorter in duration) but could have been produced by a humpback whale(s) or other species.

One call type that has not been described previously, a three part "2-kHz trill," was detected on 12 December 2012 (34 times) and 16 December 2012 (3 times) (**Figure 50**). The source of the call is unknown at this time. The call was detected mainly at night.

Detected odontocete vocalizations included clicks, whistles, and burst-pulses. Many of these detections were assigned to the unidentified odontocete category. For odontocete detections that could be assigned to species, there were several click detections that were assigned to beaked whales. There were two detections in December 2012 of a click type assigned to an unidentified beaked whale species (BW38). Blainville's beaked whale clicks were detected on several days during this deployment, mainly in April and May 2013. Cuvier's beaked whale clicks were also detected on several days during this deployment, although mainly in November 2012, with a few detections in January and February 2013 and a single detection in June 2013. This peak in November of Cuvier's beaked whale clicks matches what was found previously at Site E for this species. As previously found, there were significantly more Gervais' beaked whale detections than any other beaked whale. While detections occurred throughout the deployment with no specific diel pattern, there were more detections from October 2012 through the end of March 2013. Other detected odontocete clicks included *Kogia* sp clicks, Risso's dolphins, and sperm whales. *Kogia* sp. clicks were present throughout the deployment, with no specific temporal pattern in occurrence. This deployment had more detections of *Kogia* sp. clicks than any other deployment in Onslow Bay. Risso's dolphins were detected mainly from April to June 2013, with no detections from October 2012 through late February 2013 and no detections in March 2013. Unlike in previous deployments in Onslow Bay, there did not seem to be a significant nocturnal click occurrence pattern. Sperm whales were detected without an apparent diel pattern throughout this deployment, with peaks in mid-December 2012–mid-January 2013 and May–June 2013.



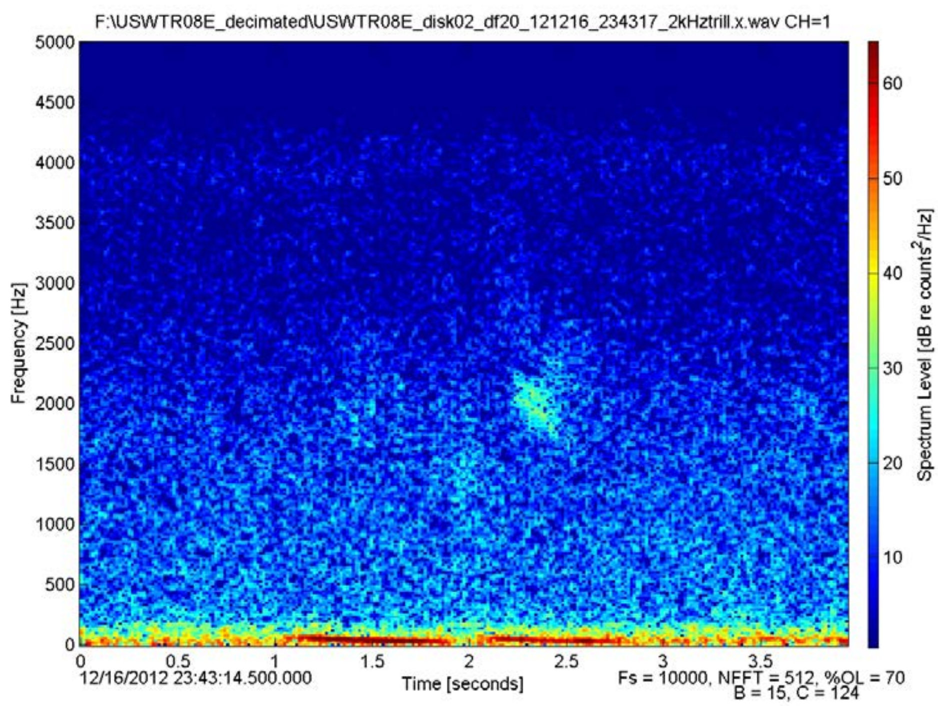


Figure 50. Spectrograms of the three part “2-kHz trill” recorded at Onslow Bay Site E on 12 December 2012 (top) and 16 December 2012 (bottom).

2.3.1.4 JAX HARP

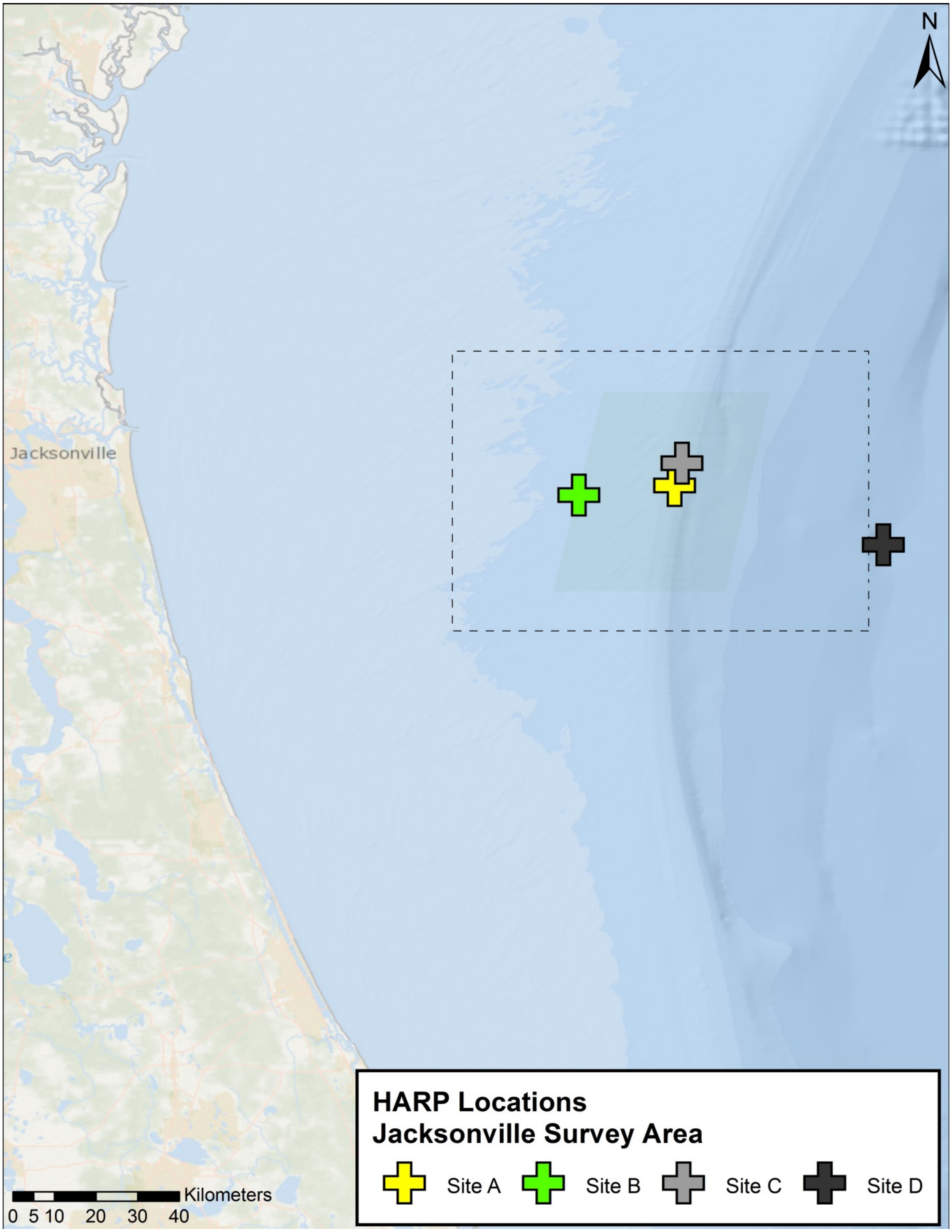
Data Collection (JAX)

The small-mooring HARP deployed in 88 m at 30.32643 N, -80.20493 W (Site C) on 17 February 2014 was recovered on 23 August 2014 (**Table 28** and **Figure 51**). The deployment period was 188 days. The HARP was then deployed that same day (23 August 2014) in approximately 806 m at 30.15060 N, -79.77005 W (Site D) (**Table 28** and **Figure 51**). Both HARPs were set to sample continuously at 200 kHz.

Table 28. HARP data sets from the Jacksonville survey area analyzed and detailed in this report.

Site	Deployment Date	Retrieval Date	Recording Start Date	Recording End Date	Latitude	Longitude	Depth (m)	Sampling Rate	Duty Cycle
9C	12-May-13	17-Feb-14	13-May-13	20-Jun-13	30.33287	-80.20071	94	200 kHz	continuous
10C	17-Feb-14	23-Aug-14	17-Feb-14	23-Aug-14	30.32643	-80.20493	88	200 kHz	continuous
11D	23-Aug-14	N/A	23-Aug-14	N/A	30.15060	-79.77005	~806	200 kHz	continuous

Key: Aug=August; Feb=February; kHz = kilohertz; m = meter(s); N/A = not applicable

1010 

1011 **Figure 51. Locations of HARP deployment sites in the JAX survey area.**

Data Analysis (JAX)

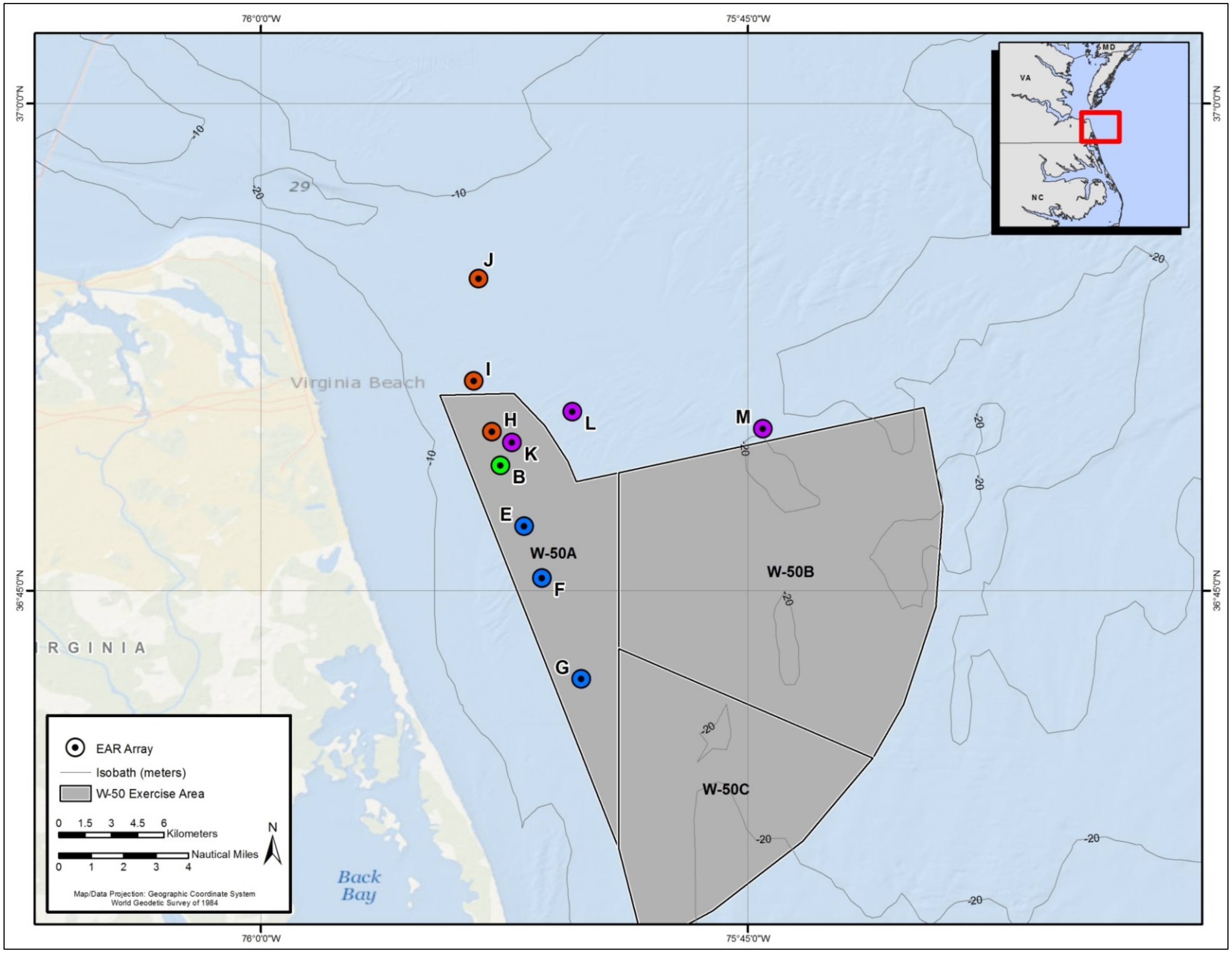
Data from the two deployments at Site C (May 2013–February 2014 and February–August 2014) were analyzed for marine mammal and anthropogenic sounds, but are not yet prepared for a report. These data will be included in next year's annual report.

For more information on this study, refer to the annual progress report for this project (Hodge et al. 2015). Individual technical reports of HARP deployments are available at: http://www.navymarinespeciesmonitoring.us/reading-room/

2.3.2 Passive Acoustic Monitoring of Dolphins in the VACAPES MINEX W-50 Training Range

To better understand the potential impact of MINEX training on marine mammals, an effort was initiated by Oceanwide Science Institute in August 2012 (and is currently still ongoing) to monitor odontocete activity at the MINEX W-50 training range in the VACAPES Range Complex using Ecological Acoustic Recorders (EARs). The initial objectives of the project were to establish the daily and seasonal patterns of occurrence of dolphins in the MINEX W-50 training range, to detect explosions related to MINEX activities, and to determine whether dolphins in the area show evidence of a response to MINEX events.

A second phase of the project began in September 2013 to determine whether the responses observed represent a shift in acoustic behavior or a spatial redistribution of animals. Alternating 2-month deployments in 2013 and 2014 consisted of two different EAR array configurations. In the first configuration (**Figure 52**), four EARs were arranged in a linear coastal array at distances of 1 km (site B), 3 km (sites H & K), 6 km (sites F, I, and L), and 12 km (G, J, and M) from the primary MINEX W-50 training area in order to examine whether animals are redistributing along the coast or offshore in response to training events.

1035 

1036 **Figure 52. Spatial configuration of three linear coastal arrays deployed during the second year of the project. Site B remained constant and**
1037 **north is shown as red (B–H–I–J), east as purple (B–K–L–M), and south as blue (B–E–F–G).**

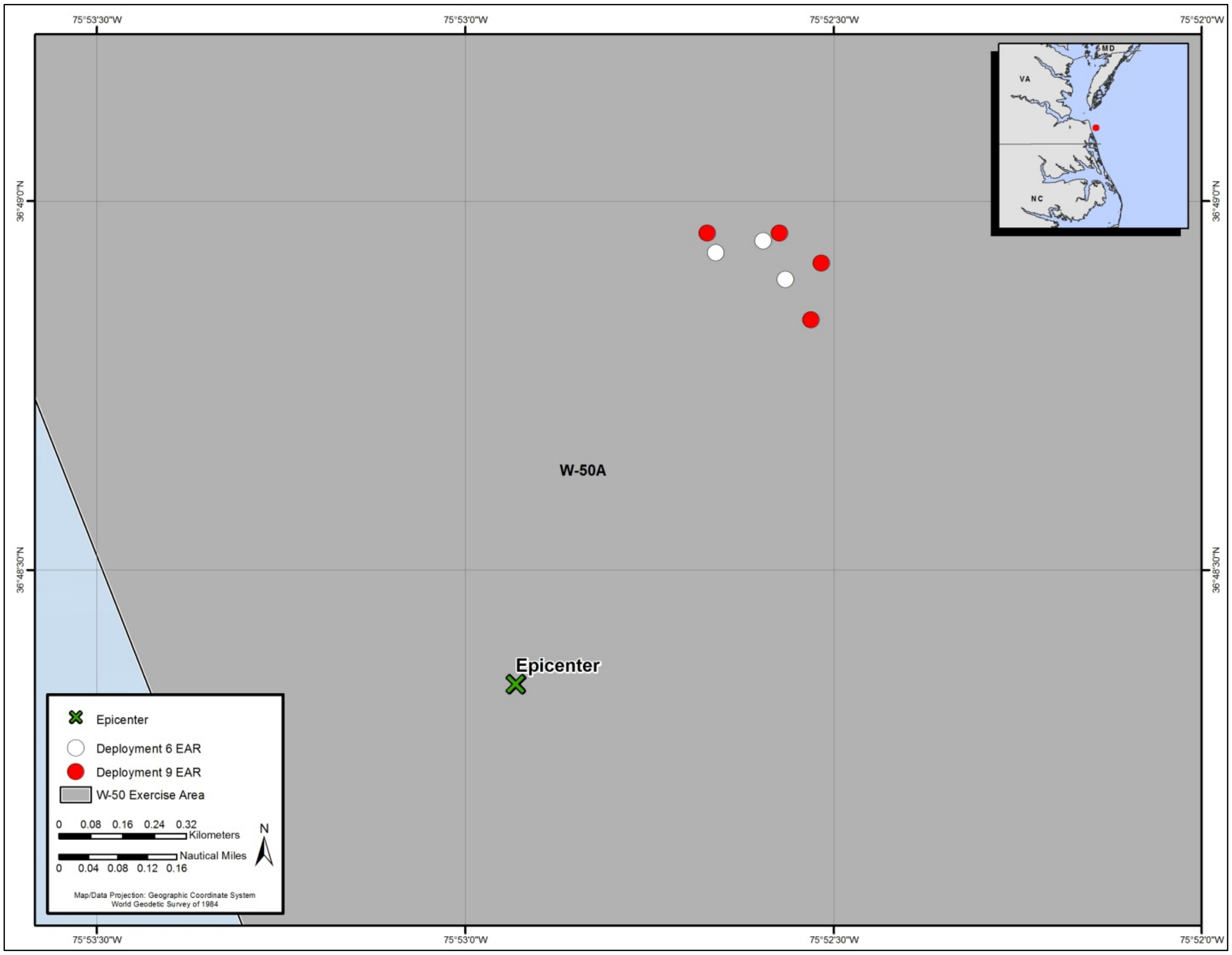


Figure 53. Spatial configuration of the two localization EAR arrays relative to the location of the epicenter of MINEX training activities. The white markers represent deployment 6 and the red markers represent deployment 9.

In the second configuration (**Figure 53**), EARs were arranged in a localization array in an effort to establish the distances that animals occur from MINEX training activities.

The analysis of recordings from site B for the presence/absence of dolphin signals has been completed for the period from 15 August 2012 to 28 July 2014, totaling 530 days of recordings. The findings reveal that dolphins are present daily in or near the MINEX W-50 training range, with detections made on 97 percent of recording days. It can be assumed that the majority of detections are from bottlenose dolphins, which are resident in the area. The data from the second year of work have generally confirmed the findings previously reported (see Lammers et al. 2014). Seasonally, there appears to be a consistent period of 1 to 3 months of low occurrence or reduced acoustic activity centered on February. Dolphin occurrence within some other months of the year also varied from year to year, demonstrating some natural inter-annual variability in the occurrence of dolphins in the area around the 'epicenter' of MINEX training. However, there was more variability overall, with reduced numbers of daily detections during the months of August, September, November, and March. Comparing the differences between months from year to year, there were significantly fewer daily detections in August 2013 (Mann-

Whitney U test, *U*=254, *p*=0.003), September 2013 (Mann-Whitney U test, *U*=75.5, *p*=0.02), and March 2014 (Mann-Whitney U test, *U*=394, *p*=0.001) than the corresponding month the previous year. Conversely, there were significantly more daily detections in December 2013 (Mann-Whitney U test, *U*=394, p<0.001) and January 2014 (Mann-Whitney U test, *U*=685, *p*<0.001) than the corresponding month the previous year.

In total, 46 explosions were detected in the data analyzed to date between 15 August 2012 and 28 July 2014. There were significantly more whistles recorded immediately after an UNDET (Mann-Whitney U-test, *n*=16, *p*=0.02), reflecting a short-term increase in whistle production by the animals. Comparing the mean acoustic activity indices (a metric of relative dolphin acoustic activity defined in Lammers et al. 2015) within the hours before and after an UNDET, a significant decrease in dolphin acoustic signaling was seen during the 2 hr following the event compared to the hour prior to it (One-way Analysis of Variance [ANOVA], *DF*=2, *F*=9.2, *p*<0.001) (**Figure 54**).

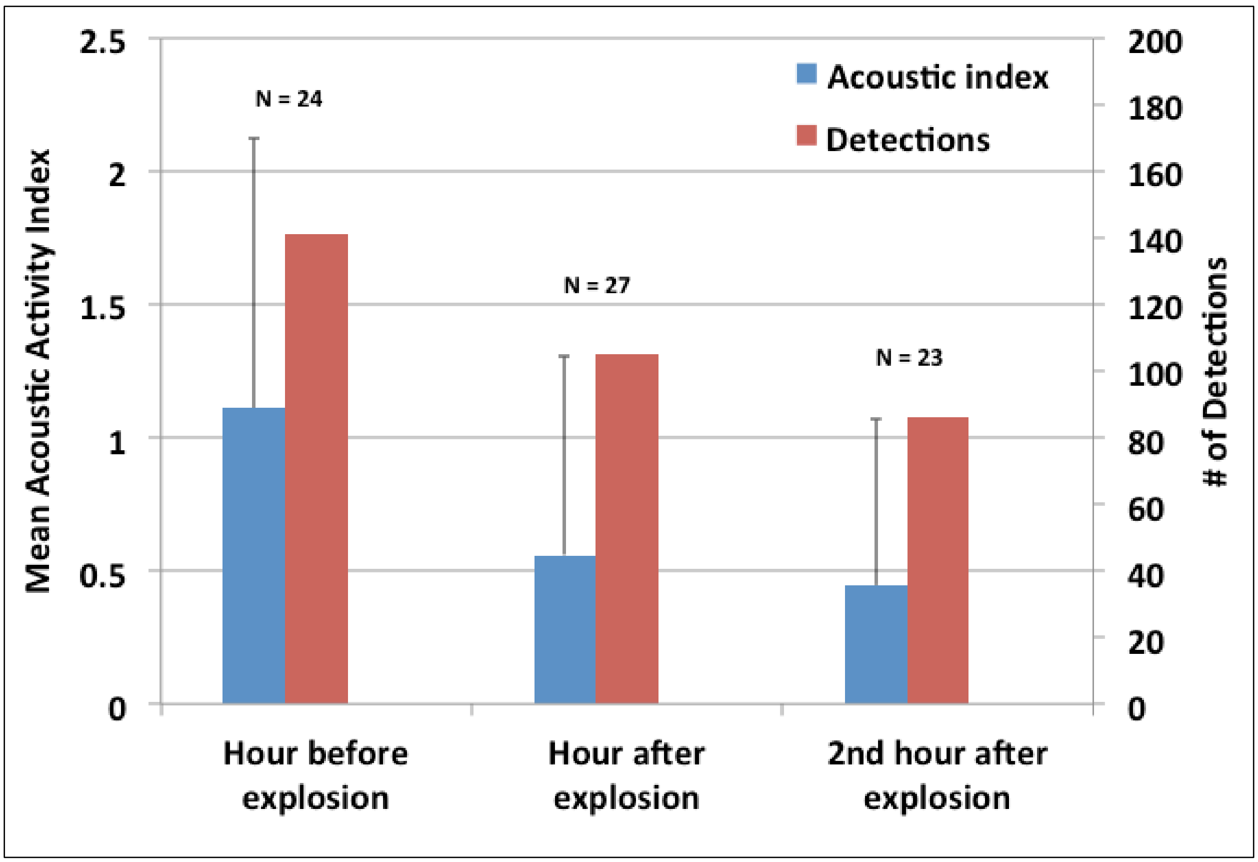


Figure 54. Dolphin acoustic activity observed in the hour before and the first and second hours after an UNDET. The different sample sizes reflect the fact that several UNDETs occurred within minutes or hours of each other and therefore were either treated as a single event or did not have baseline and/or post-UNDET data. Error bars represent one standard deviation.

The hourly sum of acoustic activity of dolphins the day prior, the day of, and the day after MINEX training events is shown in **Figure 55**. During the day prior to an event, dolphins were most active during mid-day (11:00–12:00), late afternoon (15:00), and nighttime hours (19:00–04:00). On the day of MINEX training and the following day, the daytime peak in activity was reduced or absent, although the nighttime peak persisted. The difference between the day before and the day of the exercise was significant for the period between 10:00 and 12:59 (Kruskall-Wallis test, *p*<0.05). In addition, comparing the day before an exercise with the following day also yielded a significant difference, with less overall activity on the day after the training event for the period between 11:00 and 12:59 (Kruskall-Wallis test, *p*<0.05). Interestingly, the nighttime peak in activity persisted following MINEX training events, suggesting that the animals in the area resumed normal activity during these hours. However, this also suggests that the decreased activity observed during daylight hours of the following day might represent avoidance of the area.

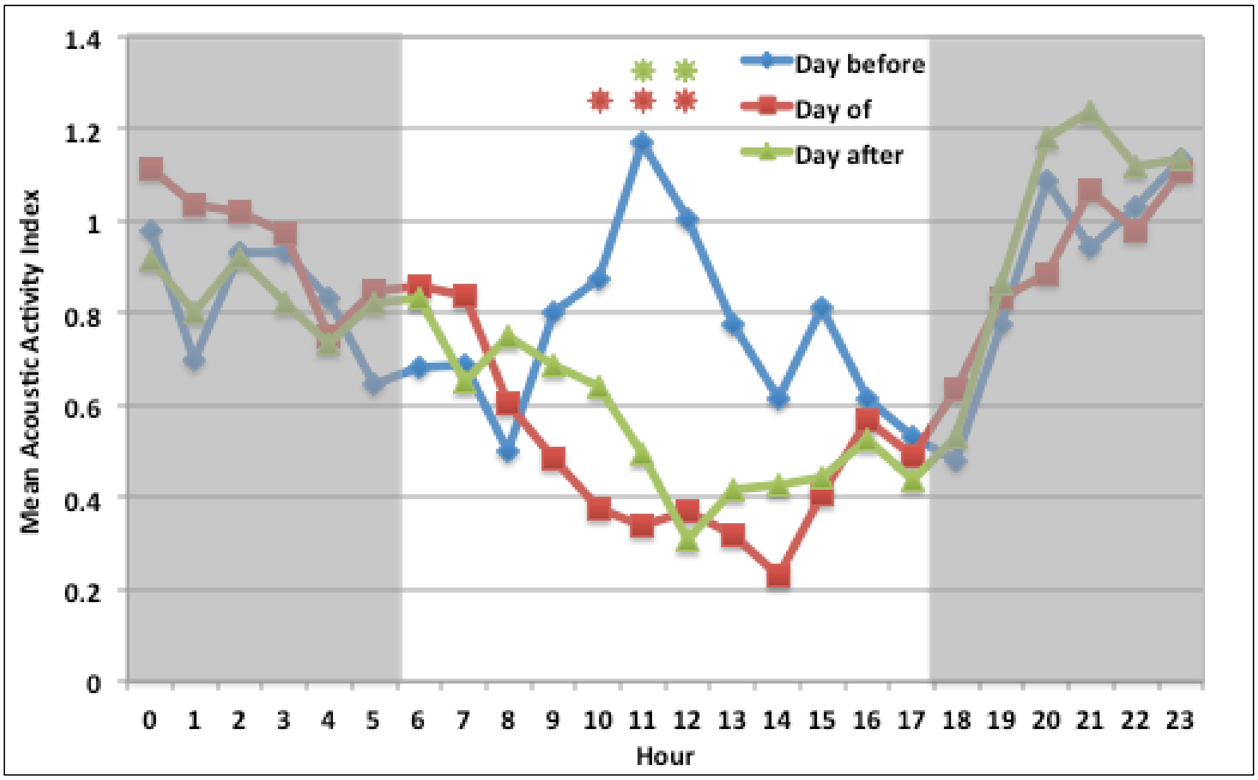


Figure 55. The hourly dolphin acoustic activity observed over the 24-hour period of the days before (*n*=18), the days of (*n*=22) and the days after (*n*=18) a MINEX training event at site B. Red stars indicate a significant difference (Kruskall-Wallis test, *p*<0.05) between the day before and the day of the event. Green stars indicate a significant difference (Kruskall-Wallis test, *p*<0.05) between the day before and the day after the event. Shaded periods represent twilight/nighttime hours.

Figure 56 presents the 24-hr dolphin acoustic activity observed on the linear coast array EARs as a function of their distance from the epicenter of MINEX training for the days before, the days of, and the days after a MINEX training event. For the pooled 3-km data, a significant difference was noted in the acoustic activity between the day before and the day after a MINEX event in the 04:00 time bin (Mann-Whitney U test, *n*=7, *p*=0.015). In addition, the difference was just above the *p*<0.05 level for the 07:00 (*p*=0.084) and 08:00 (*p*=0.084) time bins. No inference was attempted on the pooled data from the 6-km sites because of the small sample size (*n*=3 MINEX events) due to instrument problems at this site during two deployments. For the pooled data from 12-km that comprised seven MINEX events, no statistically significant differences were found between any time bins.

The sample sizes analyzed from the linear coastal EAR arrays are still too small to draw any firm conclusions, but the data examined to date do not suggest dolphins follow a consistent pattern of re-distribution away from the epicenter after a MINEX training event. There is some evidence dolphins may be more acoustically active or abundant 3 km from the epicenter during the early morning hours of the day after an exercise, but this trend may or may not hold as data from additional deployments are collected and/or analyzed.

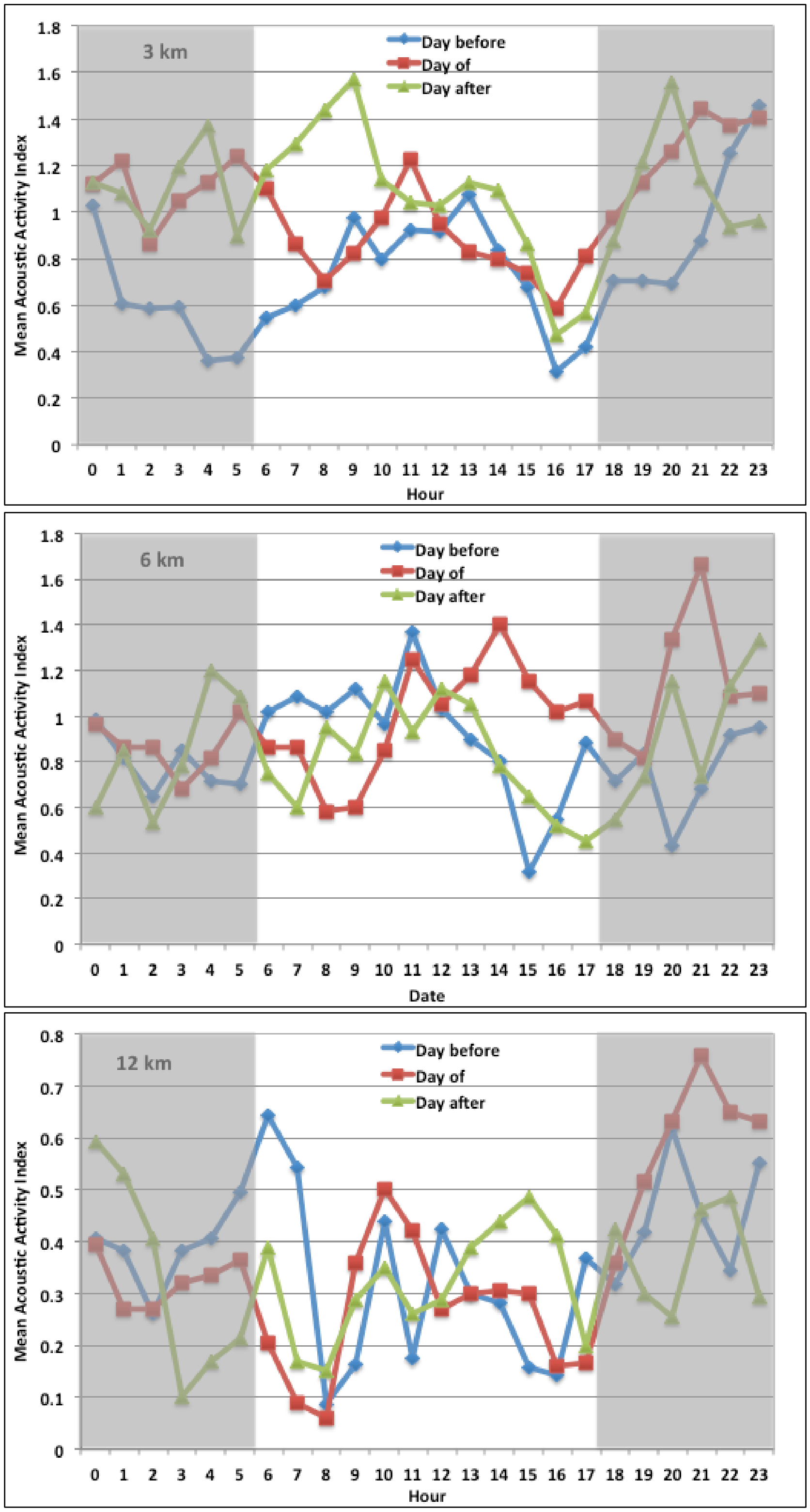


Figure 56. The hourly dolphin acoustic activity observed over the 24-hr period of the days before, the days of and the days after a MINEX training event pooled across sites 3 km (*n*=7), 6 km (*n*=3) and 12 km (*n*=8) from the epicenter of training activities, regardless of directional orientation of array.

Two localization EAR array deployments have yielded data suitable for localizing dolphins. The time-alignment of recordings from the array was made possible by adding a pinger to one of the EAR moorings during the second localization array deployment. Algorithms for localizing dolphin signals have been developed and successfully applied to a subset of data.

For more information on this study, refer to the annual progress report for this project (Lammers et al. 2015). The reader is also referred to **Section 2.4.4** for analyses of C-PODs deployed off the coast of Virginia that provide information complementary to the study using EARs.

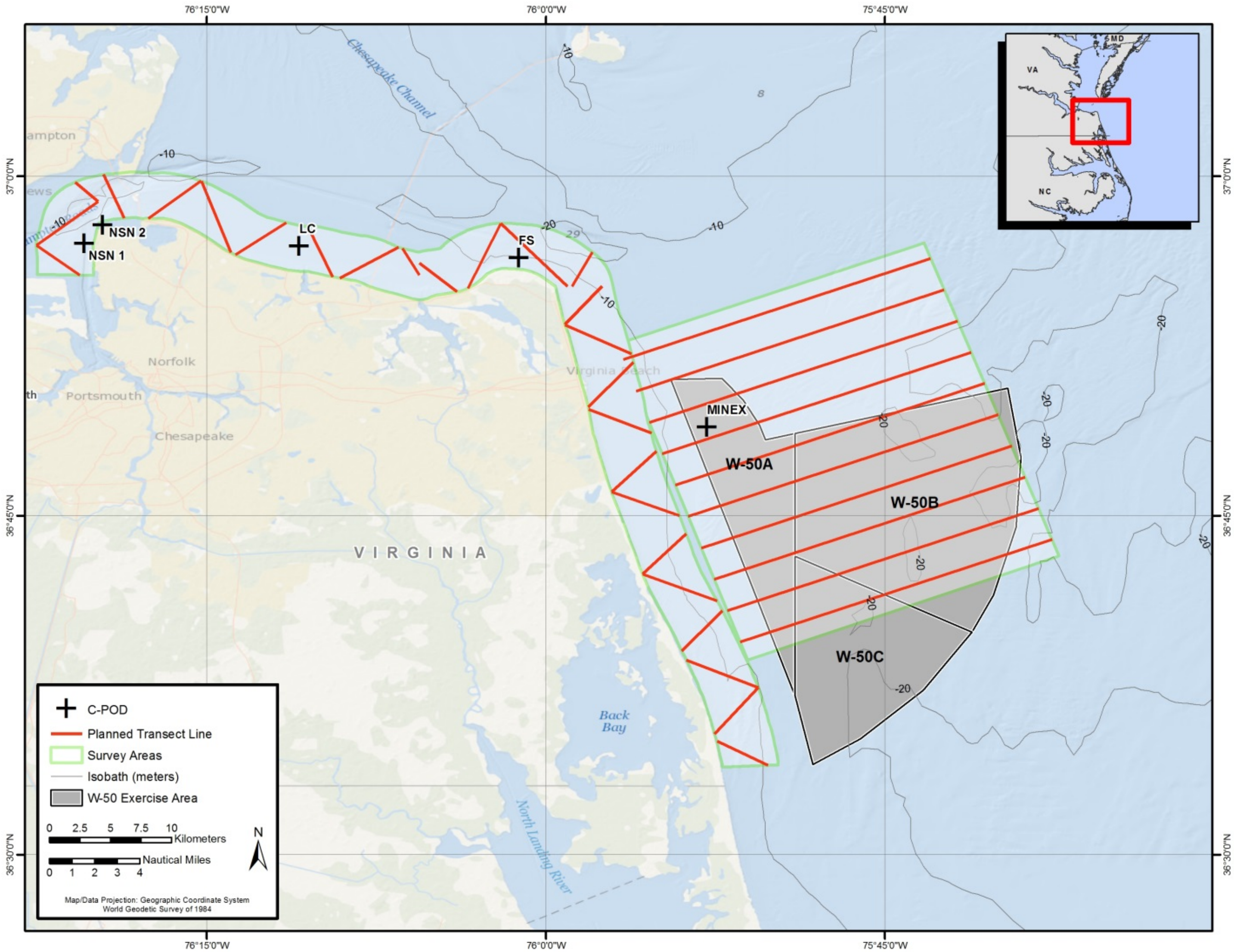
2.3.3 C-POD Monitoring off Virginia Beach

As noted earlier in **Section 2.2.3.1**, a combination of visual and PAM is being used to gather important baseline information on the occurrence, distribution, and density of marine mammals near NSN and adjacent areas. C-POD acoustic data loggers (www.chelonia.co.uk) were deployed at four locations (MINEX W-50 training range, JEB-FS, NSN (2 sites), JEB-LC) (**Table 29** and **Figure 57**). C-POD locations were determined based on the likelihood of overlap between dolphin occurrence and U.S. Navy activities (**Table 29** and **Figure 19**). In 2014, there were two deployments at JEB-LC and one at NSN. In total, during 2012 through 2014, there were four successful deployments at JEB-LC, two successful deployments at NSN, one at the MINEX W-50 training range site, and one moderately successful deployment at JEB-FS.

Table 29. Deployment details of C-POD automated acoustic recorders.

Deployment Date	Location	Coordinates	Total Days Deployed
06 Aug 2012	MINEX	36^{o} 49.905'N, 75^{o} 52.860'W	69
16 Aug 2012	JEB-FS	36^{o} 56.411'N, 76^{o} 01.165'W	53
16 Aug 2012	NSN	36^{o} 57.061'N, 76^{o} 20.444'W	Not recovered
16 Aug 2012	JEB-LC	36^{o} 56.929'N, 76^{o} 10.937'W	59
07 Dec 2012	NSN	36^{o} 57.056'N, 76^{o} 20.498'W	132
07 Dec 2012	JEB-LC	36^{o} 56.940'N, 76^{o} 10.872'W	132
17 Apr 2013	NSN	36^{o} 57.071'N, 76^{o} 20.510'W	Not recovered
17 Apr 2013	JEB-LC	36^{o} 56.936'N, 76^{o} 10.869'W	152
20 Sep 2013	JEB-LC	36^{o} 56.927'N 76^{o} 10.951'W	142
09 Feb 2014	JEB-LC	36^{o} 56.952'N 76^{o} 10.957'W	Not recovered
15 Aug 2014	JEB-LC	36^{0} 56.956'N 76^{0} 10.767'W	Not recovered
29 Sep 2014	NSN	36^{0} 57.900'N 76^{0} 19.700'W	114

Key: ^{o}=degree(s); '=minute(s); Apr=April; Aug=August; Dec=December; Feb=February; JEB-FS=Joint Expeditionary Base Fort Story; JEB-LC= Joint Expeditionary Base Little Creek; MINEX=Mine-neutralization Exercise W-50 training area; N=north; NSN=Naval Station Norfolk; Sept=September; W=west



1130

1131 **Figure 57. Location of C-POD deployments.**

Harbor porpoises (*Phocoena phocoena*) were detected in low numbers near NSN and JEB-LC during winter and spring deployments, and bottlenose dolphins were detected in each deployment location during all deployments from August 2012 to January 2015. Deployments, however, did not provide consistent coverage due to loss of gear.

Bottlenose dolphin detections were common throughout the four deployment sites, and supported the visual survey data in many ways, with a few exceptions. The C-POD at both NSN sites showed some dolphin detections even in the winter months—in contrast to the visual transect survey results, where no dolphin groups were sighted near the NSN deployment sites in winter. The combined dolphin detection-positive minutes (DPM) as percentage of minutes logged at this site was the lowest, but the instrument was deployed during winter months when dolphin presence is expected to be low, which partly explains the reduced number of detections. Further deployments at the new NSN site throughout the year will allow a valid comparison to other sites. NSN houses a large portion of the U.S. Navy's fleet, and potential pier construction in the area means this is one of the sites of greatest interest.

CPODs deployed at JEB-LC were the only deployments spanning a full year, with data collected during all seasons. In general, bottlenose dolphin presence, assessed as DPM, was higher in the summer and fall months. Detections were still made sporadically during the winter, but dolphin presence was only consistent in the summer and fall. Though the number of dolphins in the area cannot be determined using the C-POD detections, the substantial presence of bottlenose dolphins is noteworthy as this location is also a busy port for the U.S. Navy.

The JEB-FS data support the large number of bottlenose dolphin sightings near Cape Henry during visual surveys; however, since the data is compromised by the unit breaking free and traveling, a valid comparison cannot be made. Unfortunately, these data have to be disregarded since the date that it broke free is unknown and the detections are not indicative of dolphin presence around the fixed location of interest.

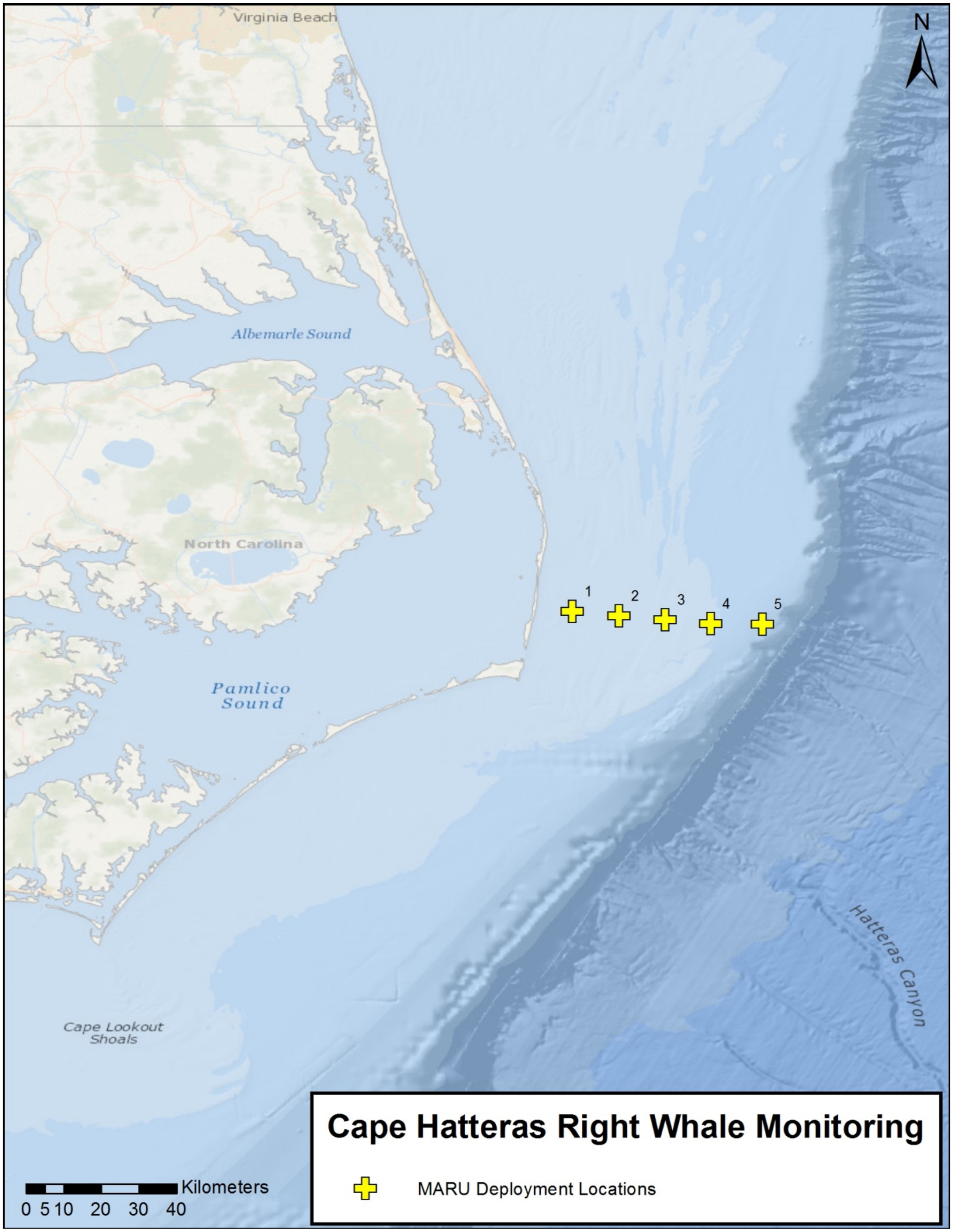
The number of acoustic dolphin detections logged by the MINEX W-50 training range area C-POD (Dolphin DPM percentage = 7.51 percent) supports the updated visual survey results (see **Section 2.2.3** of this report). A strong diurnal trend was evident at NSN, JEB-LC, and MINEX sites, with more echolocation activity occurring during nighttime hours, and is very common for most odontocete species (Klinowska 1986). It is important to note that an increase in acoustic activity at night may not be indicative of an increased number of dolphins, their behavior state (foraging), or group sizes. While whistles are commonly used for intraspecific communication and coordination, echolocation is used for navigation and when it is dark and may also be important as animals travel and acoustically maintain group communication.

For more information on C-POD analyses, refer to the annual progress report for this project (A. Engelhaupt et al. 2015). To better understand the impact of MINEX training on marine mammals, an effort was initiated by Oceanwide Science Institute in August 2012 to monitor odontocete activity in W-50 of the VACAPES OPAREA using passive acoustic methods (refer to **Section 2.4.3**).

2.3.4 Marine Autonomous Recording Units – Right Whales in the Cape Hatteras Survey Area

In fall 2013, a PAM effort was initiated by Duke University and NMFS/NEFSC to detect North Atlantic right whales migrating past Cape Hatteras, during their seasonal movements to and from winter breeding grounds in Florida. The objectives of this project are to investigate the timing of North Atlantic right whale migration through the mid-Atlantic region, as well as the relative distance from shore and acoustic behavior of migrating whales. This effort will help to fill a data gap in the central portion of the migratory corridor, and contribute to a broader understanding of the seasonal occurrence of North Atlantic right whales along the U.S. Atlantic Coast. The project is ongoing, and details are provided here on passive acoustic data collection and analysis between October 2013 and December 2014.

Passive acoustic data were collected using five Marine Autonomous Recording Units (MARUs) deployed in a linear configuration across the continental shelf at Cape Hatteras on 04 October 2013 (**Figure 58** and **Table 30**). MARU 01-1 surfaced prior to recovery during a winter storm on 13 February 2014, activating its ARGOS satellite-tracking unit. It was not possible to recover this unit before it was swept far offshore by the Gulf Stream. The remaining four MARUs were retrieved on 23 February 2014, and five new MARUs were deployed at the same sites (**Figure 59** and **Table 30**). MARUs 02-1 and 02-3 both surfaced during a storm on 07 March 2014. MARU 02-1 was successfully recovered, while MARU 02-3 was swept offshore. It has continued to transmit its position via the ARGOS satellite system, but has not been recovered to date.

1188 

1189 **Figure 58. Locations of the MARU deployment sites off Cape Hatteras.**

1190 **Table 30. MARU deployment at Cape Hatteras.**

Site	Deployment Date	Retrieval Date	In-water Recording Start Date	Recording End Date	Latitude	Longitude	Depth (m)	Sampling Rate	Duty Cycle
01-1	04-Oct-13	N/A	04-Oct-13	N/A	35.39104	-75.40189	21	2 kHz	continuous
01-2	04-Oct-13	23-Feb-14	04-Oct-13	23-Feb-14	35.3805	-75.28949	26	2 kHz	continuous
01-3	04-Oct-13	23-Feb-14	04-Oct-13	23-Feb-14	35.37138	-75.1795	26	2 kHz	continuous
01-4	04-Oct-13	23-Feb-14	04-Oct-13	23-Feb-14	35.3619	-75.07161	32	2 kHz	continuous
01-5	04-Oct-13	23-Feb-14	04-Oct-13	23-Feb-14	35.35806	-74.9517	87	2 kHz	continuous
02-1	23-Feb-14	07-Mar-14	23-Feb-14	07-Mar-14	35.39134	-75.40128	21	2 kHz	continuous
02-2	23-Feb-14	07-Jun-14	23-Feb-14	07-Jun-14	35.38071	-75.28926	25	2 kHz	continuous
02-3	23-Feb-14	N/A	23-Feb-14	N/A	35.3712	-75.17887	27	2 kHz	continuous
02-4	23-Feb-14	07-Jun-14	23-Feb-14	07-Jun-14	35.36169	-75.07072	32	2 kHz	continuous
02-5	23-Feb-14	07-Jun-14	23-Feb-14	07-Jun-14	35.36094	-74.94641	91	2 kHz	continuous
03-1	06-Oct-14	N/A	06-Oct-14	N/A	35.40077	-75.40158	21	2 kHz	continuous
03-2	06-Oct-14	N/A	06-Oct-14	N/A	35.36869	-75.28465	25	2 kHz	continuous
03-3	06-Oct-14	N/A	06-Oct-14	N/A	35.36739	-75.17415	28	2 kHz	continuous
03-4	06-Oct-14	N/A	06-Oct-14	N/A	35.36174	-75.0708	31	2 kHz	continuous
03-5	06-Oct-14	N/A	06-Oct-14	N/A	35.36113	-74.9465	90	2 kHz	continuous

Key: Feb = February; kHz = kilohertz; m = meter(s); Mar = March; N/A = not available; Oct = October

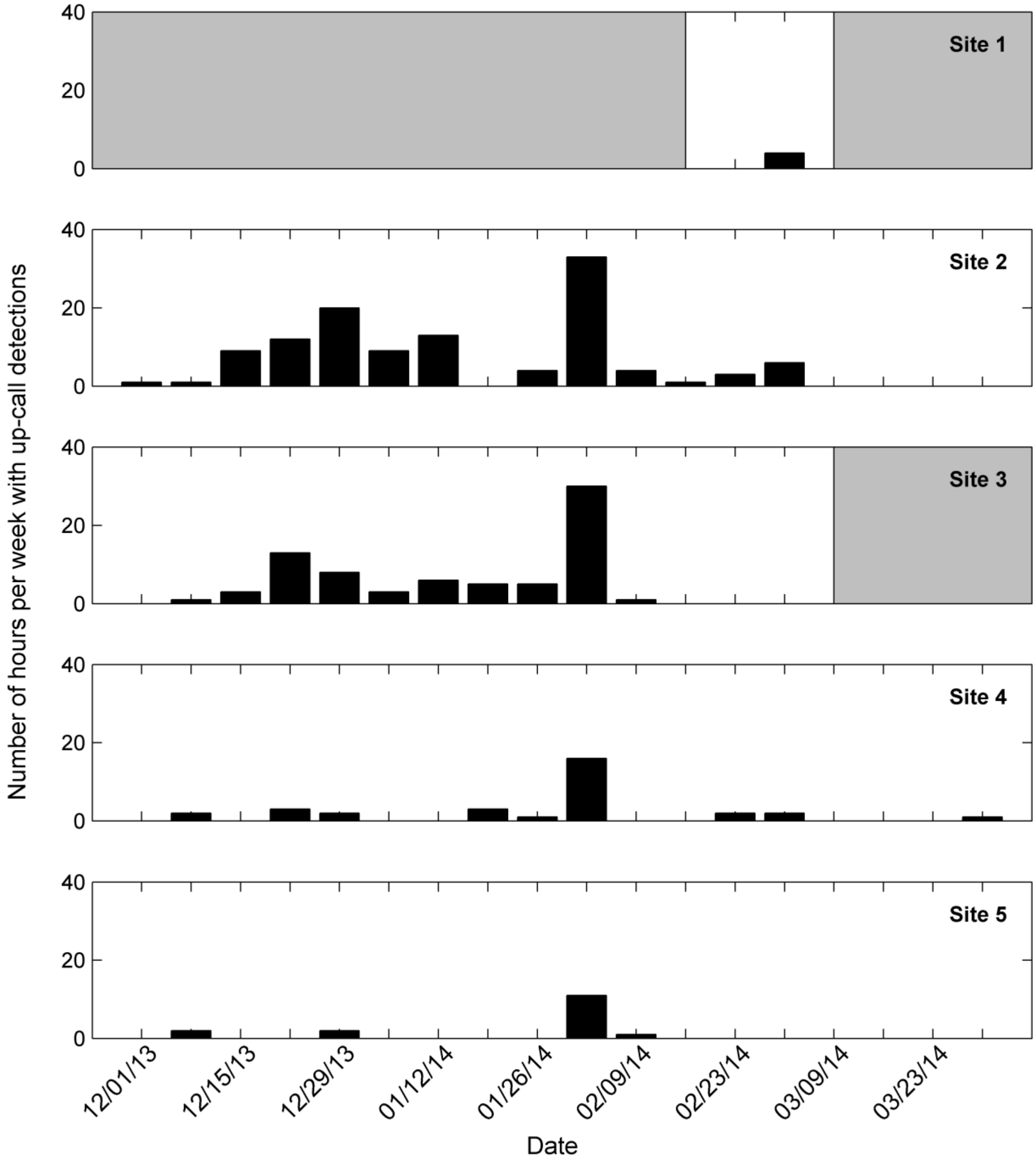


Figure 59. Weekly occurrence of up-call detections across all MARU sites, 04 December 2013–04 April 2014. Gray shading indicates periods of no data.

The Hatteras01 deployment in fall 2013 resulted in 142 recording days on the four recovered MARUs (04 October 2013–03 February 2014). The Hatteras02 deployment in spring 2014 resulted in 12 recording days on MARU 02-1 (23 February–07 March 2014), and 104 recording days on the remaining three MARUs (23 February–07 June 2014).

The second year of the project began in October 2014, with a deployment of five MARUs on 6 October 2014 (**Table 30**). Improvements were made to both the mooring system and the burn wire to strengthen all attachment points. However, the Cape Hatteras study area has continued to be a challenging location for moored instruments, due to the shallow depths and strong winds that frequently occur in this region during the winter. Despite the improved mooring system, another unit, MARU 03-3, surfaced during a storm on 07 December 2014. This unit is still being tracked via the ARGOS system but has not been recovered to date. The remaining four MARUs are scheduled to be retrieved in March 2015, and replaced with a new set for spring 2015.

Data from all recovered MARUs from the Hatteras01 (fall 2013) and Hatteras02 (spring 2014) deployments were analyzed for North Atlantic right whale up-calls. An automated low-frequency detection and classification system (Baumgartner and Mussoline 2011) was used to scan the recordings for potential right whale up-calls. Up-calls were detected on 45 of 246 total recording days (17 percent of days). All detections occurred between 04 December 2013 and 04 April 2014. There was a slight peak in the number of hours per week with up-call detections in December and a higher peak in early February (**Figure 59**). Up-calls were detected across all five sites, with the highest numbers on the sites nearest shore (**Figure 59**). These detections were not independent across sites, and some individual up-calls were detected on multiple MARUs. Analysis of the diel occurrence of detected up-calls showed an increase in calling activity during the late afternoon and evening hours (**Figure 60**).

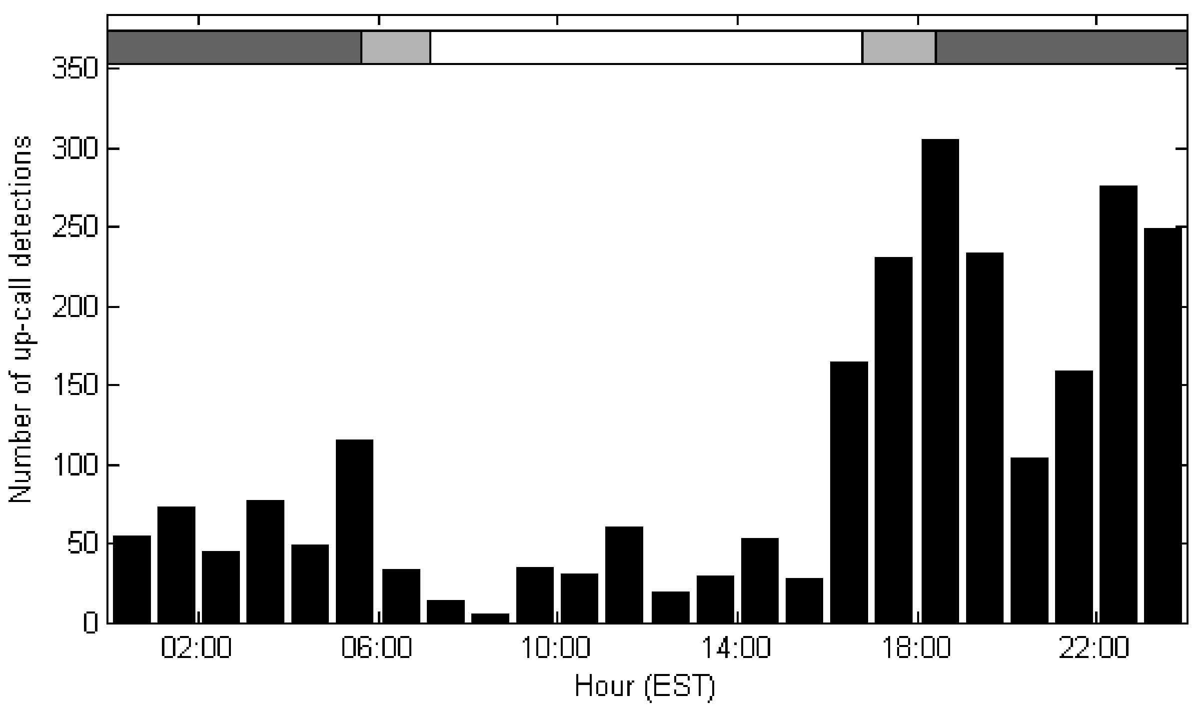


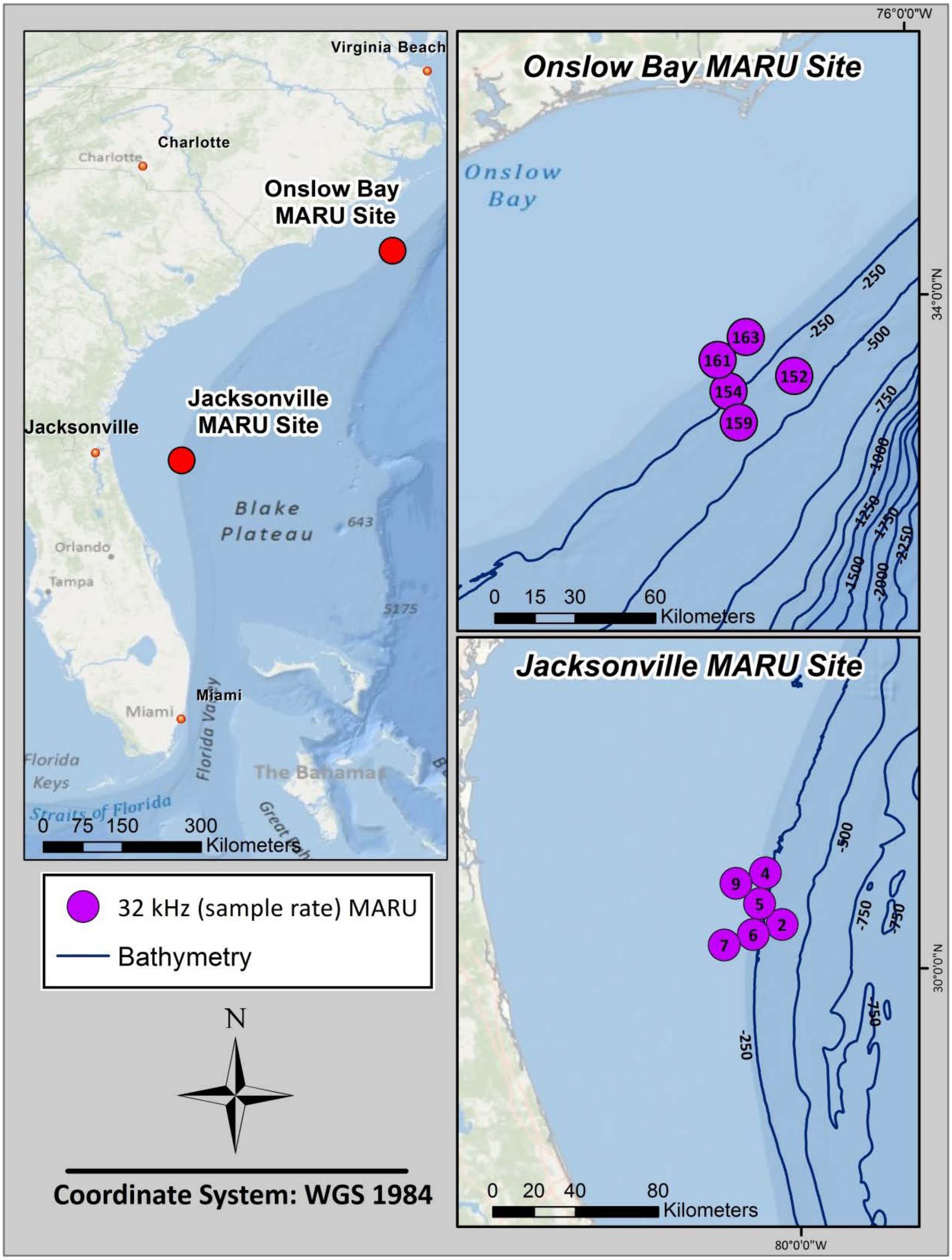
Figure 60. Diel pattern of right whale up-calls detected on all MARUs at Cape Hatteras, 04 December 2013–04 April 2014. Vertical bars represent the summed number of up-calls detected in each hour of

the day. The horizontal bar indicates periods of darkness (dark gray), daylight (white), or either dark or light depending on the time of year (light gray).

For more information on this study, refer to the annual progress report for this project (Stanistreet et al. 2015).

2.3.5 Development of Statistical Methods for Examining Relationships Between Cetacean Vocal Behavior and Navy Sonar Signals

In an effort designed to examine marine mammal vocal behavior before, during, and after MFA sonar exercises by the U.S. Navy, acoustic recordings were made off Jacksonville, Florida (Deployment 1: September–October 2009; Deployment 2: December 2009), and in Onslow Bay (July 2008) using seafloor-deployed MARUs (**Figure 61**). The intent for location and timing of the MARU deployment was to target ASW training exercises, with the units deployed 7 to 10 days prior to the exercise and recording for at least 7 to 10 days post-exercise.

1231 

1232 **Figure 61. Map of MARUs off Jacksonville, Florida, and Onslow Bay, North Carolina.**

Data for JAX were initially analyzed to understand the presence/absence and species of animals within the area during an ASW exercise (Norris et al. 2012). The second stage of the study is a collaborative effort involving researchers at Cornell University, Bio-Waves, Inc., and St. Andrews University to develop robust statistical methods that can be used to analyze vocal behavior before, during, and after MFA sonar events on a species-by-species basis when possible.

MARUs were deployed with two different recording configurations. "High-frequency" (HF) MARUs recorded continuously with a 32-kHz sample rate, resulting in a nominal recording band of 0 to 16 kHz. "Low-frequency" (LF) MARUs recorded continuously with a sample rate of 2 kHz, resulting in a nominal recording band of 0 to 1 kHz. Only HF MARUs were capable of recording MFA sonar signals. Both configurations could record North Atlantic right, fin, and minke whales; sperm whales could be reliably recorded on HF MARUs and in some cases on LF MARUs.

2.3.5.1 Large whales

The passive acoustic data collected by the MARUs were analyzed using automated signal-detection software to detect individual sonar transmissions ("pings"), and sounds of North Atlantic right, minke, fin, and sperm whales. In addition, putative right whale "gunshot" sounds that had been detected by Norris et al. (2012) in the JAX recordings were reviewed further. Sperm whale click trains were detected on every day of recordings from all three deployments. In all deployments, sperm whale click trains occurred almost continuously during hours of darkness, and rarely during daylight hours, with a few exceptions. Minke whale pulse trains were detected only in the winter JAX deployment. There were no confirmed detections of North Atlantic right whale upcalls or fin whale sounds in any of the three deployments. Most of the impulsive sounds previously identified as right whale gunshot sounds were judged most likely to be from sources other than right whales.

Generalized estimating equations (GEEs) were used to build statistical models predicting the presence or absence of minke and sperm whale vocalizations in 1-min periods. The model predictions were functions of seven covariates related to the occurrence and timing of sonar pings, and four sonar-independent covariates related to date, time of day, and recording location. GEEs were also used to model changes in the duration of detected minke whale pulse trains using the same set of covariates. Duration models were not applied to the sperm whale data because frequent overlapping of click trains from multiple individuals prohibited reliable measurement of durations of discrete vocal events.

For the minke whale presence model, the covariate indicating whether a given minute was *before*, *during*, *between*, or *after* sonar transmissions was retained in the final model. For minke whales, the odds of detecting vocalizations were on average higher in the 24 hr after a MFA sonar exercise compared to the 24 hr before the exercise. However, it is likely that inference on this covariate would have been different for minke whales, if different criteria were applied for labelling time periods as *before*, *during*, *between*, or *after* (e.g., using 12-hr rather than 24-hr *before* and *after* periods).

For minke whales, the durations of individual detected pulse trains varied in response to MFA sonar activities. The differences consisted of an increase in duration if approximately 40 to 110 sonar pings were detected in the 4 hr preceding the vocalization and a decrease in duration if approximately 110 to 155 sonar pings were detected in the 4 hr preceding the vocalization. Although these results indicate that MFA sonar had an effect on the detected duration of minke whale vocalizations during this study, the biological cause or significance of the response observed is unclear. However, the sample size of discrete periods with sonar activity was very low; sonar transmissions were only detected on 3 days during the only deployment (JAX2) in which minke whale sounds were recorded. Larger sample sizes are needed for stronger inference. Alternatively, controlled-exposure experiments may allow a wider inference on the vocal responses of the animals to MFA sonar signals.

The best fitting presence model for sperm whales contained the factor covariate *Daynight* and the polynomial spline for *Time* providing evidence that during our study the odds of detecting presences of sperm whale vocalizations varied in a diurnal pattern, increasing at night compared to during the day. None of the covariates related to sonar were included in the best-fitting model, suggesting that sonar activity did not significantly affect the occurrence of sperm whale click trains.

2.3.5.2 Delphinids

A total of 1,259 delphinid acoustic encounters was logged from JAX (deployments 1 and 2) and Onslow Bay. The greater number of encounters was logged from JAX deployment 1 (*n*=550) and fewer encounters were logged from Onslow Bay (*n*=265). All delphinid vocalization encounters that were classified to species using Real-time Odontocete Call Classification Algorithm were classified into one of only three species: short-finned pilot whales (20 percent), striped dolphins (42 percent), or short-beaked common dolphins (38 percent).

Statistical analysis was divided into two approaches. The first approach used GEEs, and the other used hidden Markov models (HMM). Each response variable was related to explanatory covariates. GEEs were used as the model-fitting tool to accommodate potential over-dispersion in the data and correlation in the model errors. A three-step model-selection procedure was used to obtain the best-fitting models for each approach. Due to potentially confounding differences in responses among species and species groups, separate models were built for pilot whale acoustic detections and for the combined detections from the remaining delphinid species (including common dolphins, striped dolphins and unidentified odontocetes [DEUO]). Covariates pertaining to sonar were retained in the best fitting signal-type models for DEUO. Covariates pertaining to sonar were also retained in the best fitting whistle characteristics models for the DEUO species group. However, all potentially important covariates with respect to sonar were not explored. None of the covariates included a cumulative effect (e.g., the number of sonar pings in the 2 hr preceding a 1-min segment for the presence models or sound exposure levels of sonar). Additional analyses are necessary before these cumulative affect covariates can be included.

For the signal-type-given-acoustic-encounter models, predictive power was generally better compared to the presence-of-vocalization models. For this type of model, only the DEUO species group models retained covariates related to sonar. In this model, presence of whistles given vocalization and presence of buzzes given vocalization contained the covariate *Sonar*. These models provided evidence that the expected odds of observing whistles within a vocalization encounter were higher during the emission of sonar pings compared to the 24 hr before sonar. In addition, the odds of observing buzzes within a vocalization encounter were higher during, between and in the 24 hr after sonar compared to the 24 hr before sonar. Furthermore, for the DEUO species group evidence was found that the odds of observing clicks in an acoustic encounter increased during the presence of Type 1-short and Type 3-medium pings. Similarly, the odds of observing buzzes within an acoustic encounter increased during the presence of Type 3-medium sonar pings. Evidence was found that whistle characteristics of common/striped dolphins changed during the emission of sonar and in the 24 hr after sonar when compared to 24 hr before sonar. Further analyses are needed to identify which characteristics changed and in which manner. For pilot whales no change in whistle characteristics in relation to sonar was evident.

In the HMM-based modeling approach, the time series of acoustic encounters (response variable type 1 above) is assumed to be generated by a doubly stochastic process that switches between two different states, corresponding to acoustically active and more silent phases. Hidden Markov models naturally account for the multiphasic nature of the time series, with long periods without any acoustic encounters being recorded, occasionally interspersed with shorter periods that contain at least some acoustic encounters. In contrast to GEEs, in which case the correlation in the residuals is treated as a nuisance (i.e., a feature of the model that is not the focus of inference, but that needs to be accounted for, often in the simplest way possible), HMMs attempt to explicitly model the correlation pattern, at the cost of increased computational complexity. By building separate models for pilot whales and for other delphinids, we investigated the effect of sonar-related covariates on the state-switching dynamics. For pilot whale HMMs, very few vocalizations (and hence also state transitions) occurred during the observation period. As a result, the estimation was numerically unstable in terms of local maxima of the likelihood. Furthermore, no clear pattern was found in the Akaike Information Criterion (AIC) values for the fitted models, likely due to the limited amount of information contained in these time series. For pilot whales in the JAX study area, the model with the covariate pertaining to the standard deviation of the ping interval (i.e., the *SDEV ping interval* covariate) was favored by the AIC, whereas in the Onslow Bay study area the model without any covariates was favored. For the DEUO species group, the model with the *Sonar* covariate affecting the state transition probabilities was deemed best by the AIC, for both the JAX and Onslow Bay study areas.

For more information on this study, refer to the reports for this project (Charif et al. 2015 and Oswald et al. 2015).

2.3.6 Near-Real Time Passive Acoustic Monitoring of Baleen Whales in the Gulf of Maine (Environmental Security Technology Certification Program and LMR funded)

A related project, funded by the Department of Defense's Environmental Security Technology Certification Program and the U.S. Navy's LMR is underway, with the goal of evaluating near real-time detection and classification technology for eventual adoption into the U.S. Navy's Marine Species Monitoring Program. This project was given initial funding in October 2014, and fieldwork is scheduled to begin in March 2015.

This demonstration and validation project will evaluate the performance of the digital acoustic monitoring (DMON) instrument and low-frequency detection and classification system (LFDCS), a combined hardware/software package, on three different autonomous seagoing platforms. Detections will be cross-checked between platforms and visually validated with traditional aerial, shipboard, and land-based survey methods.

The DMON/LFDCS uses dynamic programming to estimate a pitch track for any type of narrowband call. A pitch track is a compact representation of a sound (analogous to a series of notes on a page of sheet music) derived from an audio spectrogram; it consists of a time series of frequency-amplitude pairs that describe the frequency and amplitude modulation of a sound. Attributes of the pitch track (e.g., start frequency, end frequency, duration, slope of frequency variation) can be extracted and compared to the attributes of known call types using quadratic discriminant function analysis. The call library can contain hundreds of these known call types, allowing the LFDCS to efficiently detect and classify many different calls produced by numerous species. Baumgartner and Mussoline (2011) compared the performance of the LFDCS to that of several human analysts for low-frequency sei whale downsweeps and right whale upcalls, and found that the accuracy of the LFDCS was similar to that of an analyst. In addition to right whale upcalls and sei whale downsweeps, Baumgartner et al. (2013) found that the LFDCS performs quite well for fin whale 20-Hertz pulses and several types of humpback whale tonal calls. The system is programmed to look for the calls of these four species (sei, right, fin, and humpback whales) during this test.

This project involves deployment of a single wave glider (Willcox et al. 2009) during spring 2015 to conduct broad scale surveys throughout the Gulf of Maine, west of the Hague Line (i.e., within the U.S. Exclusive Economic Zone) continuously for 1.5 year (**Figure 62**). The survey track is designed to sample across the southward-moving coastal current on the northern and western fringes of the Gulf of Maine using a zig-zag design, and a more conventional straight-track design throughout the central Gulf of Maine where surface currents are more quiescent. Surveying continuously at a nominal speed of 1.5 knot, the glider will complete the 2,700-km circuit in 41 days. However, the glider may be commanded to remain in areas of interest based on the near real-time whale detection information.

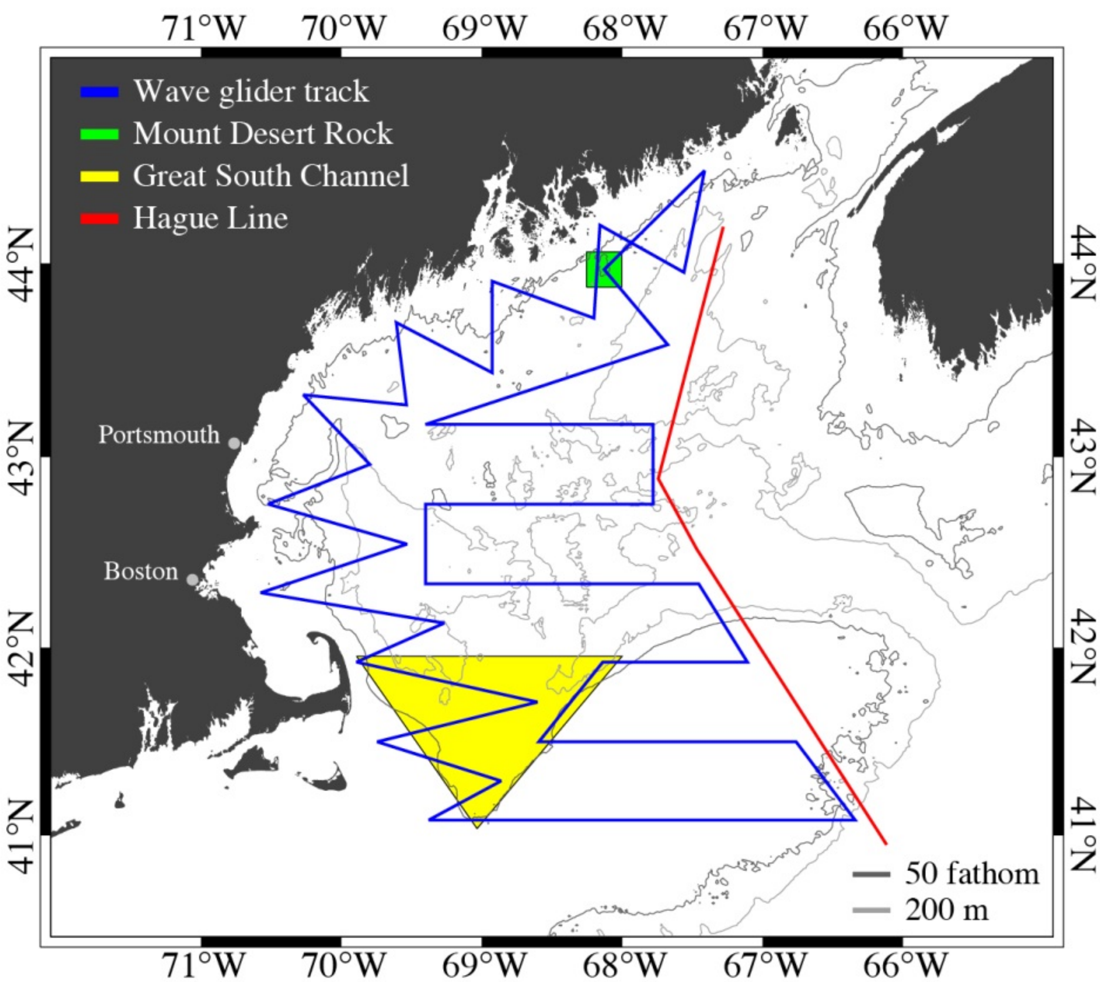


Figure 62. Map of waveglider tracks and Slocum Glider and moored buoy platform locations in the Gulf of Maine. Visual surveys will also be conducted in the Great South Channel (vessel-based) and Mount Desert Rock (shore-based) locations. Aerial surveys will cover the entire region.

To complement the large-scale survey conducted by the wave glider, smaller-scale surveys (tens of kilometers) will be conducted with a Slocum Glider in the Great South Channel (southwestern Gulf of Maine) (**Figure 62**). This region was chosen based on (1) the ability to conduct sustained visual observations in the same area occupied by the two mobile autonomous platforms, and (2) the predictable availability of baleen whales. The Slocum Glider deployment in the Great South Channel will occur during the spring (May) of 2015 and 2016 when right, sei, humpback, and fin whales can be found in this area. This deployment will coincide with the annual large whale cruise conducted by the NMFS/NEFSC aboard a National Oceanic and Atmospheric Administration (NOAA) ship.

A moored buoy will be installed in the waters immediately adjacent to Mount Desert Rock during late early 2015 where fin and humpback whales are commonly encountered, and it will remain in operation for 2 years.

Each platform will be equipped with a DMON/LFDCS capable of detecting, classifying, and reporting calls produced by right, fin, humpback, and sei whales. Detection data (i.e., pitch tracks), summary classification data, and analyst-generated predicted occurrence from each platform will be reported in both graphical and tabular form on a publicly accessible web site (dcs.whoi.edu) as soon as the data are relayed to the shore-side computer.

For more information on this study, please see the project profile on the Environmental Security Technology Certification Program website (RC-201446).

2.3.7 Pile Driving Sound Source Measurement

The potential impacts from pile driving noise on marine mammals are currently a relevant topic driving a number of environmental assessments and MMPA permit applications for different parts of the U.S. Navy. However, there is uncertainty as to whether the existing data on source levels from various types and sizes of piles are applicable to the projects of concern, because most of the data were gathered on the U.S. West Coast, with significantly different bathymetry, sediments, and other environmental conditions. This project was initiated in 2012 to determine whether or not the extensive data library of source levels from pile driving collected on the U.S. West Coast (Caltrans 2012 and Washington State Department of Transportation reports) is also representative of noise levels on the U.S. East coast, and to evaluate existing noise conditions at several U.S. Navy installations on the U.S. East Coast. The project specifies six data collection efforts during pile driving projects at U.S. Navy installations on the U.S. East Coast. To date, three of these efforts have been completed, and planning continues for monitoring future events, with the project completion date set as 31 December 2015.

In May 2013, researchers conducted monitoring on two installations, measuring vibratory installation of steel sheet and H-piles at JEB-LC and impact testing of a single concrete pile at Craney Island. Underwater measurements were made at short- (approximately 10-m) and long-distance (approximately 50- to 200-m) ranges from the piles being driven at both installations. Airborne noise measurements were taken only at JEB-LC. For the steel piles at JEB-LC, the source levels for vibratory driving ranged from 115 to 121 decibels referenced to 1 micro Pascal root mean square. For the impact driving of the concrete pile, source levels averaged between 162 and 169 decibels referenced to 1 micro Pascal root mean square. For more information on this project, see Illingworth and Rodkin, Inc. (2013).

Researchers conducted similar monitoring efforts at the Philadelphia Naval Shipyard and Naval Station Norfolk in fall 2014. At the Philadelphia Naval Shipyard, monitoring included large (48-inch diameter) steel pipe piles, while monitoring at Naval Station Norfolk targeted vibratory driving of small diameter (12 to 16-inches) timber piles and impact driving of 24-inch diameter square concrete piles. For more information on these monitoring projects, please see Illingworth and Rodkin, Inc. (2015a, 2015b).

Analyses of how the recently collected data compare to the U.S. West Coast data points are ongoing at NAVFAC Atlantic. At the conclusion of the project, the interim reports from each monitoring event and the compared data will be published in a single comprehensive report, which will be made available for download.

2.4 Atlantic Undersea Test and Evaluation Center

Passive acoustic methods are being combined with visual observations and satellite telemetry at the Atlantic Undersea Test and Evaluation Center (AUTEC) to document the near and long-term effect of sonar on marine mammals. A Marine Mammal Monitoring on Navy Ranges (M3R) signal processor has been installed at AUTEC as a means of developing marine mammal passive acoustic systems and applying them to long-term monitoring of cetaceans in an area of frequent sonar use.

The AUTEC acoustic range is located in a deep ocean canyon known as the Tongue Of The Ocean (TOTO) which forms the southern branch of the Great Bahama Canyon among the islands of the Northern Bahamas. The range consists of an array of 91 widely-spaced, bottom-mounted hydrophones that are designed to track undersea vehicles. The range is being leveraged for a multi-disciplinary study of cetaceans that combines M3R passive acoustics, expert visual on-water observers collecting individual-based photo-identification data, and the deployment of satellite tags. This work is filling key data gaps to determine the effect of sonar on cetaceans and developing techniques for long-term range monitoring.

The M3R system is being used to monitor the AUTEC hydrophones for vocalizations using real-time passive acoustic tools developed by the program. Trained at-sea visual observers are vectored to vocalizing animals isolated using the M3R system. By combining passive acoustics with visual observations, detected vocalizations are being associated with the species of origin. Significant progress has been made along these lines; however, uncertainty still remains with delphinid species vocalizations. The expert observers provide data on group composition and surface behavior and collect photo-identification data and biopsy samples for analysis. The satellite tags provide direct data on the movement and diving of animals around active sonar operations.

In 2014, analysis of Blainville's beaked whale (*Mesoplodon densirostris*) archives with data spanning over a year's duration was continued. Echolocating Md groups were isolated with and without active sonar present. These data included 53C and 56 surface ship sonar along with dipping helo sonar and DICASS sonobuoys. The results reinforce those reported in McCarthy et al., 2010 which suggested animals move to the periphery of the range during sonar operations. Additional details on M3R progress at AUTEC and associated references can be found in Moretti 2015.

2.5 Lookout Effectiveness Study

The U.S. Navy undertakes monitoring of marine mammals during naval exercises and has mitigation procedures designed to minimize risk to these animals. One key component of this monitoring and mitigation is the shipboard lookouts (LOs, also known as watchstanders), who are part of the standard operating procedure that ships use to detect objects (including marine mammals) within a specific area around the ship during events. The watchstanders are an element of monitoring requirements specified by NMFS in the MMPA LOAs. The goal is to detect mammals entering ranges of 200, 500, and 1,000 yards around the vessel, which correspond to distances at which various mitigation actions should be performed. In addition to the LOs, officers on the bridge search visually and sonar operators listen for vocalizations. We refer to all of these observers together as the observation team (OT). The aim of this study is to determine the OT effectiveness in terms of detecting marine mammals. Of particular interest is the probability of an animal getting within a defined range of the vessel without being observed by the OT, as well as determining the accuracy of the OT (primarily the LO) in identifying the species group (whale, dolphin, etc.), assessing group size, and estimating their position.

A test protocol has been developed for collecting data to assess the effectiveness of the LOs in visually detecting marine mammals (Burt and Thomas 2010). The field protocol for the experiments was developed in consultation with members of the Naval Undersea Warfare Center Division, Newport; USFF; Naval Facilities Engineering Command; Commander, U.S. Pacific Fleet; and NMFS. The basic concept is that trained marine mammal observers (MMOs) are situated onboard a vessel during daylight at-sea exercises, in locations where they can watch for marine mammals and communicate with one another, but not cue the LO. The MMOs then conduct opportunistic trials where they detect a marine mammal and record if/when that OT makes the same observation (a successful trial) or not (an unsuccessful trial).

In parallel with field protocol development, analysis methods using intermittent availability models have been developed and tested that allow estimation of the probability of animals approaching to within a specified stand-off range without being detected (the “sneak-up probability”). Intermittent availability models are appropriate because many marine mammals remain below the surface for significant periods during dives. This method is flexible in allowing for a variety of animal surfacing behaviors: “clustered instantaneous,” where animal surfacings last just for an instant, but where these surfacings are clustered together in time, interspersed between extended periods underwater; “intermittent,” where animals are at the surface for longer periods between dives; and “continuous,” where one or more member of each animal group is always at the surface. The method models detection probability in two dimensions (forward of and perpendicular to the vessel), and can model both LO/OT and MMO detections, although it is also possible to focus just on the LO/OT detection probabilities. This method has been tested on simulated data and found to perform satisfactorily for large sample sizes, however the sample size of real data collected from trials to date is insufficient for reliable inferences to be drawn at this time.

Three data collection embark events were conducted during the 2014 reporting period across the Atlantic and Pacific, and Navy continues to identify opportunities for additional data collection in areas where the number of trials-per-cruise is likely to be maximized.

Shoemaker et al. 2014

MMOs embarked on a U.S. Navy guided missile destroyer (DDG-K) from 25 January through 01 February 2014 during a Koa Kai training event in the Hawaii Range Complex. The MMO team spent approximately 43 hours searching for marine species during the training event. The majority of observation time was spent in BSS of 4 or greater (78 percent), although the majority of the sightings (61 percent) occurred in BSS 3. In total, 60 unique sightings of at least 107 individual marine mammals were recorded during the 7 days of observation. Study ‘trials’ were successfully conducted on all days of the event, with 56 of the 60 sightings (93 percent) available for trials, or an average rate of 1.30 trials per hr of effort across all 4 days. The average of trials per hr was skewed by the considerable increase of sightings on 31 January with 5.19 sightings per hr. Of the 60 sightings, humpback whales were the only species positively identified. Unidentified dolphins were sighted three times, and the rest of sightings were of unidentified cetaceans, the majority noted as large whales. This event was the eleventh aboard a DDG in which data were collected to evaluate lookout effectiveness; data will be combined with future monitoring efforts in order to assess the effectiveness of U.S. Navy lookouts as a whole. (Shoemaker et al. 2014)

Dickenson et al. 2014

MMOs embarked on a U.S. Navy guided missile cruiser (CG-B) from 17 to 21 February 2014 during an Submarine Commander Course event in the Hawaii Range Complex. The MMO team spent approximately 30 hours searching for marine species during training. During the event, BSS ranged from 2 to 5. The majority of observation time was spent in BSS 2 or 3 (31.9 percent and 52.6 percent, respectively) which amounts to favorable environmental sighting conditions, with the majority of the sightings (66.7 percent) occurring in BSS 3. In total, 15 unique sightings comprising at least 45 individual marine mammals and sea turtles were recorded during the four days of observation. Study trials were conducted successfully on all but one day of the event, with 4 of the 15 sightings (27 percent) available for trials, or an average rate of 0.13 trials per hr of effort across all 4 days. Of the 15 total sightings, 12 were identified to species. Visual sightings included one short-finned pilot whale group, six humpback whales, one unidentified whale, one bottlenose dolphin, two unidentified dolphin groups, and four green turtles. The fourth day of the effort had the greatest frequency of unique sightings, with 1.31 sightings per hr of effort. This event was the second aboard a CG in which data were collected to evaluate lookout effectiveness; data will be combined with future monitoring efforts in order to assess the effectiveness of U.S. Navy lookouts as a whole. (Dickenson et al. 2014)

Bort et al. 2014

MMOs embarked on a U.S. Navy guided missile cruiser (CG-C) from 18 August through 23 August 2014 during a Fleet Exercise training event in the Cherry Point and Jacksonville OPAREAs. The MMO team spent approximately 26 hours searching for marine species during the training event. The majority of observation time was spent in BSS of 1 (40.1% percent), and the majority of the sightings (77 percent) occurred in a BSS 1 or 2. In total, 26 unique sightings of at least 58 individual marine mammals were recorded during the 4 days of observation. Study 'trials' were successfully conducted on all days of the event, with 21 of the 26 sightings (87 percent) available for trials, or an average rate of .79 trials per hr of effort across all 4 days. Of the 26 sightings, 5 were identified to the species level, 4 additional to the genus level. Visual sightings included 3 Tursiops truncatus, 1 Stenella frontalis, 4 unidentified Stenella, 10 unidentified dolphin, 4 unidentified whale, 1 unidentified sea turtle, and 1 unidentified cetacean. This event was the third aboard a CG in which data were collected to evaluate lookout effectiveness; data will be combined with future monitoring efforts in order to assess the effectiveness of U.S. Navy lookouts as a whole. (Bort et al. 2014)

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SECTION 3 – DATA MANAGEMENT

The draft version of the U.S. Navy's Marine Species Monitoring (MSM) Data Management Plan (DMP, HDR 2014), outlines procedures related to the collection, quality control, formatting, security, classification, governance, processing, archiving, and reporting of data acquired under the U.S. Navy's MSM program. The DMP provides the necessary framework for the effective management of all data acquired under the U.S. Navy MSM program, from the initial step of data collection through the final step of data archival. The DMP establishes the method by which data flow through the management system and the controls applied to the data during the process. Additionally, the DMP is an important tool that promotes the fullest utilization of the data through data sharing and integration amongst U.S. Navy departments, environmental planners, and researchers. This is achieved in part via the documentation and standardization of data-collection techniques among various researchers. Procedures related to MSM data collection and data management have evolved since 2010, due to refined survey methodologies, improved technologies, and an expanded knowledge base. The DMP is a living document that reflects this evolution, and HDR submitted a revised version of the DMP to NAVFAC in 2014. Revisions were driven by adaptive data management based on maturation of the program, and evolving U.S. Navy guidance on specific data-management procedures, including those outlined in the sections following.

3.1 Data Standards Development

One requirement of the U.S. Navy MSM program is that all data acquired be maintained for ready dissemination to U.S. Navy environmental planners, analysts, and researchers and formatted to ensure compatibility with existing marine databases. This is achieved in part by the application of a *data standard* to all U.S. Navy MSM datasets. A data standard involves listing all potential data elements collected under the program (for example, species, sighting position, environmental variables, etc.), their definitions, required formats for each data element, and any notes, background information, or instructions associated with data collection or data entry for each element. Marine species data are collected under the U.S. Navy MSM program by a variety of researchers, using multiple visual survey platforms (vessel, aerial, shore-based), following a range of survey protocols. Standardization of the multiple data types associated with the MSM program provides a common vocabulary for data collectors and analysis, and allows large datasets to be compiled for analysis and interpretation. Standardization also enables these datasets to comply and be compatible with any applicable Federal data standards and data-management frameworks. Examples include Spatial Data Standards for Facilities, Infrastructure, and Environment; the Department of Defense's Environmental Information Management System (EIMS); the Navy Marine Species Density Database (NMSDD); the Navy Marine Corps Intranet data network and information transfer system; and the Protected Species Observer and Data Management Program currently being developed by the NOAA.

In 2013, the U.S. Navy developed a marine species data standard, applicable to visual survey data acquired under the U.S. Navy MSM program. The standard is also capable of consuming relevant "legacy data" collected prior to the start of the program in 2010. Survey data fall into three broad categories: sightings, effort, and environmental information. Examples of sighting information include species, sighting location, number of animals, presence of calves, and behavioral information. Effort refers to the amount of time spent looking for animals, platform type, number of observers, distance traveled, and effort type (e.g., random, systematic, or transiting). Environmental conditions are also recorded, including sea state, visibility, glare, and cloud cover. The data standard specifies the required field header names for each data variable, units in which the data are expressed, and formats for each field (numeric, text, Boolean, etc.). This consistent data organization across surveys facilitates back-end data processing and analysis, and streamlines reporting and information sharing among various researchers and stakeholders. Although the marine species data standard is designed primarily to accommodate visual survey data, the standard is in the process of being expanded to accommodate marine mammal biopsy (i.e., tissue sample) data collected during cetacean surveys.

3.2 Survey Software Development

In 2014, HDR continued development of a custom iPad® application for the collection of marine species survey data. The application is based on the ArcGIS Runtime Software Development Kit from GIS vendor Esri, and allows observers to document the spatial location of marine species sightings; record behavioral, environmental, and effort characteristics associated with each sighting; and record effort and trackline data in the absence of sightings. Data are then synchronized with an enterprise GIS database where it is available for review, quality control, and mapping activities. The application provides a simple user interface (**Figure 63**), and can be installed on any iPad® device with long-term evolution cellular-networking capability (although data collection can be performed in the field without network capability). The software allows user configuration of data-entry fields, which for the purposes of data output are converted automatically into corresponding standardized data headers specified in the U.S. Navy marine species data standard. This system maintains both attribute and spatial integrity of U.S. Navy MSM data from collection to export, and data-processing and management functions in the application mirror and facilitate the workflows outlined in the DMP. To date, custom templates for field data collection have been created for focal follows, opportunistic photo-ID and biopsy surveys, and for shore-based theodolite surveys. Future developments may include custom templates for line-transect surveys (from both vessel and aerial platforms) and for mitigation monitoring.

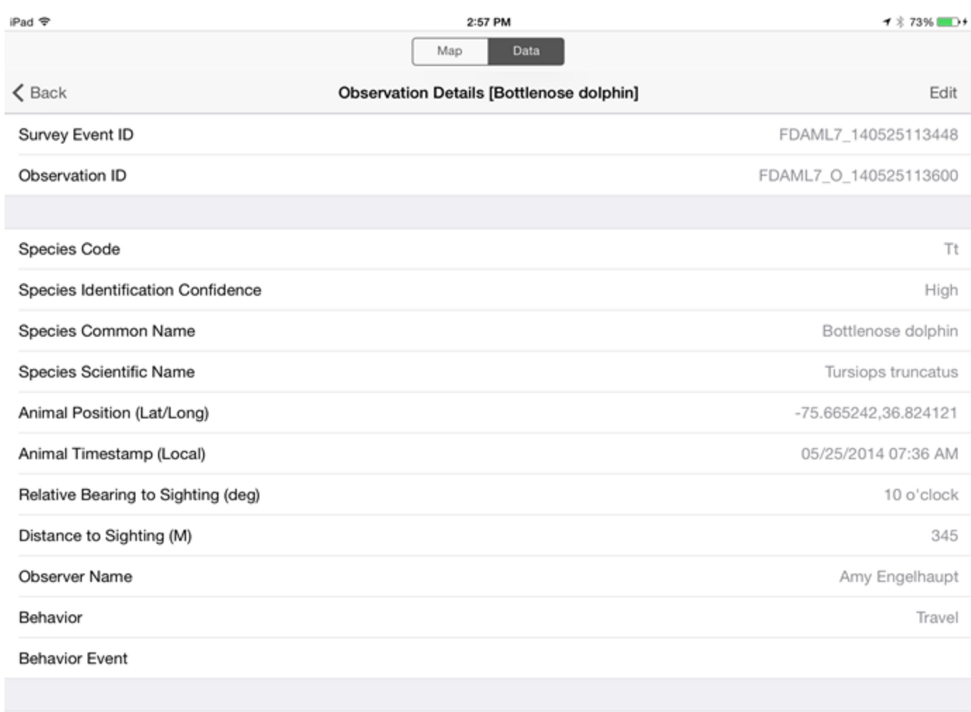

Figure 63. Example of data-collection App user interface.

3.3 Data Archiving and Access

All visual survey data collected under the U.S. Navy MSM program are provided to a Department of Defense environmental data repository called the Environmental Management Information System (EIMS). Data are uploaded to EIMS in the form of personal geodatabase files, containing feature classes for sightings (points) and survey tracklines (polylines). Source data from all surveys also are uploaded for archival purposes, accompanied by all relevant metadata. Marine species data maintained in this centralized location allow the U.S. Navy to track all MSM data collected in various training ranges, and also to use this information to build the Navy Marine Species Density Database (NMSDD). Under U.S. Federal law, the U.S. Navy is required to estimate the impacts of U.S. Navy-generated underwater sound on protected marine species, and calculate the number of animals that might be affected by the sound generated by U.S. Navy training exercises. In order to calculate accurate "take" estimates, the U.S. Navy must take into account marine species density estimates (number of animals per unit area) for all U.S. Navy training ranges. The NMSDD provides the U.S. Navy with data necessary to quantify impacts of sound on protected marine species.

Another important goal of U.S. Navy MSM data management is effective data dissemination that facilitates information sharing among stakeholders, and contribution to general knowledge of marine species distribution and behavior. This information dissemination is achieved in part by the delivery of U.S. Navy MSM visual survey data to the OBIS-SEAMAP database, maintained by researchers at Duke University's Marine Geospatial Ecology and Marine Conservation Ecology Laboratories. OBIS-SEAMAP is a spatially and temporally interactive online archive for marine mammal, sea turtle, and seabird data, and datasets are contributed by researchers all over the world. The U.S. Navy contributes all U.S. Navy MSM survey data via this collaborative effort to help our knowledge of global patterns of marine species distribution and biodiversity. Once MSM datasets are reviewed on EIMS by NAVFAC for accuracy and completeness, these datasets are provided to OBIS-SEAMAP and published at http://seamap.env.duke.edu/partner/NAVY.

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SECTION 4 – ADAPTIVE MANAGEMENT AND STRATEGIC PLANNING PROCESS

Adaptive management is an iterative process of optimal decision-making in the face of uncertainty, with an aim to reduce uncertainty over time via system monitoring and feedback. Within the natural resource management community, adaptive management involves ongoing, real-time learning and knowledge creation, both in a substantive sense and in terms of the adaptive process itself. Adaptive management focuses on learning and adapting, through partnerships of managers, scientists, and other stakeholders. Adaptive management helps managers maintain flexibility in their decisions, knowing that uncertainties exist, and provides managers the latitude to change direction so as to improve understanding of ecological systems to achieve management objectives. Taking action to improve progress toward desired outcomes is another function of adaptive management.

Adaptive management review (AMR) is a process involving NMFS, the Marine Mammal Commission, and non-governmental organizations through technical review meetings and ongoing discussions. Dynamic revisions to the compliance monitoring structure as a result of AMR include the further development of the Strategic Planning Process (DoN, 2013d*)*, which is a planning tool for selection of monitoring projects, and its incorporation into the ICMP for future monitoring. Phase II monitoring addresses the ICMP top-level goals through a collection of specific regional and ocean basin studies based on scientific objectives. The AMR process and reporting requirements serves as the basis for evaluating performance and compliance.

The marine species monitoring program has evolved and improved as a result of the AMR process through changes including:

1. Recognition of the limitations of effort-based compliance metrics
2. Recasting the original generic study questions (DoN 2009b) into a revised conceptual framework
3. Shifting to monitoring projects based on scientific objectives to facilitate generation of statistically meaningful results upon which natural resources management decisions may be based
4. Focusing on priority species or areas of interest as well as best opportunities to address specific monitoring objectives in order to maximize return on investment
5. Increased transparency of the program and management standards, improved collaboration among participating researchers, and improved accessibility to data and information resulting from monitoring activities

As a result, U.S. Navy's compliance monitoring has undergone a transition with the implementation of the Strategic Planning Process under MMPA Authorizations for Atlantic Fleet Training and Testing and Hawaii-Southern California Training and Testing. Under this process, Intermediate Scientific Objectives serve as the basis for developing and executing new monitoring projects across the U.S. Navy's training and testing ranges (both Atlantic and Pacific). Implementation of the Strategic Planning Process involves coordination among Fleets, SYSCOMs, CNO-N45, NMFS, and the Marine Mammal Commission and has five primary steps:

1. **Identify overarching intermediate scientific objectives** – Through the adaptive management process, the U.S. Navy coordinates with NMFS as well as the MMC to review and revise the list of intermediate scientific objectives that are used to guide development of individual

monitoring projects. Examples include addressing information gaps in species occurrence and density, evaluating behavioral response of marine mammals to U.S. Navy training and testing activities, and developing tools and techniques for passive acoustic monitoring.

2. **Develop individual monitoring project concepts** – This step generally takes the form of soliciting input from the scientific community in terms of potential monitoring projects that address one or more of the intermediate scientific objectives. This can be accomplished through a variety of forums including professional societies, regional scientific advisory groups, and contractor support.

3. **Evaluate, prioritize, and select monitoring projects** – U.S. Navy technical experts and program managers review and evaluate all monitoring project concepts and develop a prioritized ranking. The goal of this step is to establish a suite of monitoring projects that address a cross-section of intermediate scientific objectives spread over a variety of range complexes.

4. **Execute and manage selected monitoring projects** – Individual projects are initiated through appropriate funding mechanisms and include clearly defined objectives and deliverables (e.g. data, reports, publications).

5. **Report and evaluate progress and results** – Progress on individual monitoring projects is updated through the U.S. Navy's Marine Species Monitoring Web Portal as well as annual monitoring reports submitted to NMFS. Both internal review and discussions with NMFS through the adaptive management process are used to evaluate progress toward addressing the primary objectives of the ICMP and serve to periodically recalibrate the focus on the navy's marine species monitoring program.

These steps serve three primary purposes: 1) to facilitate the U.S. Navy in developing specific projects addressing one or more intermediate scientific objectives; 2) to establish a more structured and collaborative framework for developing, evaluating, and selecting monitoring projects across all areas where the U.S. Navy conducts training and testing activities; and 3) to maximize the opportunity for input and involvement across the research community, academia, and industry. Furthermore, this process is designed to integrate various elements including:

- Integrated Comprehensive Monitoring Program top-level goals
- Scientific Advisory Group recommendations
- Integration of regional scientific expert input
- Ongoing AMR dialog between NMFS and U.S. Navy
- Lessons learned from past and future monitoring at U.S. Navy training and testing ranges
- Leverage research and lessons learned from other U.S. Navy-funded science programs

The Strategic Planning Process will continue to shape the future of the Navy's marine species monitoring program and serve as the primary decision-making tool for guiding investments. **Table 31** summarizes U.S. Navy monitoring projects underway in the Atlantic for 2015. Additional details on these projects as well as results, reports, and publications will be made available through the U.S. Navy's Marine Species Monitoring Web Portal as they are available.

Table 31. Summary of monitoring projects underway in the Atlantic for 2015.

Project Description	Intermediate Scientific Objectives	Status
Title: Tagging and Tracking of Endangered North Atlantic Right Whales in Florida Waters **Location**: JAX Range Complex **Objectives**: Assess movement patterns of right whales in coastal waters off Florida, rates of travel of individual whales, dive depths, rates of sound production **Methods**: Observational methods combined with short term (ca. 24 hour) non-invasive suction cup attached multi-sensor acoustic recording tags with fastloc GPS **Performing Organizations**: Duke University, Syracuse University **Timeline**: 2014 through 2016 - anticipated 3 field seasons **Funding**: FY13 - $335K, FY14 - $390K, FY15 - TBD	Establish the baseline habitat uses and movement patterns of marine mammals where Navy training and testing activities occur Establish the baseline vocalization behavior of marine mammals and sea turtles where Navy training and testing activities occur Establish the baseline behavior (foraging, dive patterns, etc.) of marine mammals where Navy training and testing activities occur	**First field season - February 2014** 2014 summary report available
Title: Lower Chesapeake Bay Sea Turtle Tagging and Tracking **Location**: Lower Chesapeake Bay (Hampton Roads) **Objectives**: Assess occurrence and behavior of loggerhead, green, and Kemp's ridley sea turtles in the Hampton Roads region of Chesapeake Bay and coastal Atlantic Ocean **Methods**: Satellite, GPS, and acoustic transmitter tags **Performing Organizations**: Virginia Aquarium and Marine Science Center Foundation, NAVFAC Atlantic **Timeline**: 2013 through 2016 - anticipated 3 field seasons **Funding**: FY13 - $180K, FY14 - $195K, FY15 - $70k	Estimate the density of marine mammals and sea turtles in Navy range complexes and in specific training areas Establish the baseline habitat uses and movement patterns of marine mammals and sea turtles where Navy training and testing activities occur Evaluate trends in distribution and abundance of populations that are regularly exposed to sonar and underwater explosives	**Field work summers 2013-15** Technical progress reports available – 2013, 2014

Project Description	Intermediate Scientific Objectives	Status
Title: Assessment of Deep Diving Cetacean Behavior in Relation to Navy Training Activities **Location**: Cape Hatteras **Objectives**: Establish behavioral baseline and foraging ecology. Assess behavioral response to acoustic stimuli and Navy training activities **Methods**: Visual surveys, biopsy sampling, DTags, satellite tags **Performing Organizations**: Duke University, Woods Hole Oceanographic Institute, Cascadia Research Collective **Timeline**: 2013-present - anticipated minimum 3 field seasons **Funding**: FY12 - $275K, FY13 - $250K, FY14 - $510K, FY15 - $150k+	Determine what populations of marine mammals are exposed to Navy training and testing activities Establish the baseline behavior (foraging, dive patterns, etc.) of marine mammals where Navy training and testing activities occur Evaluate behavioral responses by marine mammals exposed to Navy training and testing activities	**Field work spring/summer 2013-15** Technical progress reports available – 2013, 2014
Title: Occurrence, Distribution, and Density of Marine Mammals Near Naval Station Norfolk and Virginia Beach **Location**: Hampton Roads coastal Atlantic Ocean, W-50 MINEX training range **Objectives**: Assess occurrence, seasonality, and stock structure of Tursiops in the coastal waters of Hampton Roads military installations **Methods**: Small vessel visual line transect surveys, photo ID, PAM **Performing Organizations**: HDR Inc. **Timeline**: 2012 through 2015 **Funding**: FY13 - $325K, FY14 - $340k, FY15 - $0	Estimate the density of marine mammals and sea turtles in Navy range complexes and in specific training areas Determine what species and populations of marine mammals and sea turtles are present in Navy range complexes Establish the baseline habitat uses and movement patterns of marine mammals and sea turtles where Navy training and testing activities occur.	**Field work summers 2013-15** Technical progress reports available – 2013, 2014

Project Description	Intermediate Scientific Objectives	Status
Title: Acoustic Monitoring and Evaluation of Tursiops Response to MINEX Training activities **Location**: Hampton Roads coastal Atlantic Ocean, W-50 MINEX training range **Objectives**: Assess occurrence of Tursiops in the vicinity of the W-50 MINEX range. Assess vocal response of Tursiops to underwater explosions **Methods**: PAM **Performing Organizations**: Oceanwide Science Institute **Timeline**: 2012 through 2015 **Funding**: FY12 - $230K, FY13 - $230K, FY14 - $230k, FY15 - $125k	Establish the baseline vocalization behavior of marine mammals where Navy training and testing activities occur Develop analytic methods to evaluate behavioral responses based on passive acoustic monitoring techniques Evaluate behavioral responses by marine mammals exposed to Navy training and testing activities	**Field work 2012 through 2015** 2013 technical progress report available
Title: Baseline Monitoring for Marine Mammals in the East Coast Range Complexes **Location**: Virginia Capes, Cherry Point, and Jacksonville Range Complexes **Objectives**: Assess occurrence, habitat associations, density, stock structure, and vocal activity of marine mammal and sea turtle in key areas of Navy range complexes **Methods**: Aerial and vessel visual surveys, biopsy sampling, photo ID, PAM **Performing Organizations**: Duke University, UNC Wilmington, University of St Andrews, Scripps Institute of Oceanography **Timeline**: Ongoing **Funding**: FY13 - $1.7M, FY14 - $1.5M, FY15 - $300k+	Determine what species and populations of marine mammals and sea turtles are present in Navy range complexes Estimate the density of marine mammals and sea turtles in Navy range complexes and in specific training areas Determine what populations of marine mammals are exposed to Navy training and testing activities Establish the baseline vocalization behavior of marine mammals where Navy training and testing activities occur Evaluate trends in distribution and abundance of populations that are regularly exposed to sonar and underwater explosives	**Ongoing** Began in 2008 as preliminary USWTR baseline monitoring

Project Description	Intermediate Scientific Objectives	Status
Title: Assessment of Marine Mammal Vocal Response to Sonar **Location**: Cherry Point and Jacksonville Range Complexes **Objectives**: Develop analytic methods to evaluate the vocal response of odontocetes and mysticetes to sonar from navy training activities **Methods**: PAM **Performing Organizations**: Bio-Waves Inc, Cornell University, University of St. Andrews **Timeline**: 2014-2015 **Funding**: FY13 - $335K, FY14 - $50K	Determine what behaviors can most easily be assessed for potential response to Navy training and testing activities Develop analytic methods to evaluate behavioral responses based on passive acoustic monitoring techniques Evaluate behavioral responses by marine mammals exposed to Navy training and testing activities	**Initial methods development complete** Final reports available
Title: Mid-Atlantic Humpback Whale Monitoring **Location**: VACAPEs Range Complex **Objectives**: Assess occurrence, habitat use, and baseline behavior of humpback whales in the mid-Atlantic region **Methods**: Focal follow observational methods, photo ID, biopsy sampling **Performing Organizations**: HDR Inc. **Timeline**: 2014 through 2017 - anticipated 3 field seasons **Funding**: FY14 - $300k, FY15 - TBD	Establish the baseline habitat uses and movement patterns of marine mammals where Navy training and testing activities occur Establish the baseline behavior (foraging, dive patterns, etc.) of marine mammals where Navy training and testing activities occur	**New start (FY14)** First field season winter 2015
Title: Sound Source Measurements from Pile Driving **Location**: Navy installations along the US East Coast **Objectives**: Determine the source levels produced by impact and vibratory driving of different size and material piles during construction projects **Methods**: Source measurements and acoustic propagation modelling **Performing Organizations**: HDR Inc., Illingworth and Rodkin Inc. **Timeline**: 2012-2015 **Funding**: FY12 - $450k	Collect data to support impact and effects analyses (e.g. sound source measurements and propagation modelling)	**Field work 2013-2015** Reports available for measurements at JEB Little Creek, NS Norfolk, and Philadelphia Naval Shipyard Additional measurements to be completed at NS Mayport and SUBASE Kings Bay in 2015

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SECTION 5 – REFERENCES

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APPENDIX A

RECENT PUBLICATIONS AND PRESENTATIONS RESULTING FROM AFTT-RELATED MONITORING EFFORTS

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APPENDIX A: RECENT PUBLICATIONS AND PRESENTATIONS RESULTING FROM AFTT-RELATED MONITORING EFFORTS

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Publications and presentations from previous years also are available in the reading room of the U.S. Navy's Marine Species Monitoring Program website (http://www.navymarinespeciesmonitoring.us/reading-room/publications/).

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