Comprehensive Exercise and Marine Species Monitoring Report For The U.S. Navy's Atlantic Fleet Active Sonar Training (AFAST) and Virginia Capes, Cherry Point, Jacksonville, and Gulf of Mexico Range Complexes 2009-2012

Submitted To
National Marine Fisheries Service
Office of Protected Resources

Submitted By
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Photos top-to-bottom, left-to-right: DTAG on short-finned pilot whale (Duke University), naval warship in VACAPES (HDR), loggerhead sea turtle (HDR), sperm whale (Duke University), underwater detonation (U.S. Navy), pantropical spotted dolphins (HDR). Photos taken under NOAA Permits 948-1692-00, 808-1798-01, and 14551.

Executive Summary

The United States (U.S.) Navy conducts training operations in a vast region off the U.S. Atlantic and Gulf coasts, known as the Atlantic Fleet Active Sonar Training (AFAST) Study Area, which represents the action area for this report. There are several operating areas (OPAREAs) within this action area that are used for various training purposes by the U.S. Navy. Three areas in particular are used extensively for training operations involving mid-frequency and high-frequency active sonar (MFAS and HFAS, respectively) and explosives: Virginia Capes (VACAPES), Cherry Point (CHPT), and Charleston-Jacksonville (CHAS-JAX) Range Complexes. The U.S. Navy, in association with the National Marine Fisheries Service (NMFS), has developed a program to monitor the impacts of these types of operations on federally protected species—specifically marine mammals and sea turtles.

Section 1 provides background on the U.S. Navy's monitoring program and its various components. The work is conducted under the umbrella of the Integrated Comprehensive Monitoring Program (ICMP), which coordinates similar work in all of the U.S. Navy's training ranges in the U.S. and overseas. A Scientific Advisory Group (SAG) of appropriate experts has been established to provide guidance to the U.S. Navy on how to conduct the monitoring most effectively. Monitoring plans have been developed and designed to pursue a collection of scientific 'studies' that eventually will allow the U.S. Navy to answer a series of monitoring questions related to specific matters of presence, exposure, response, and consequences. The monitoring team is composed of a variety of marine mammal and sea turtle experts from several academic institutions and environmental and scientific research consulting firms, who collectively conduct studies and provide advice on issues related to the impacts of U.S. Navy training exercises on protected species within AFAST. The period of studies encompasses effort from 2007 to 2012.

In **Section 2**, U.S. Navy mission activities during 22 January 2009 to 01 October 2012 are reported. AFAST major training and mitigation events are summarized. Marine mammal sightings are presented and evaluated. The section ends with an overview of the U.S. Navy's compliance with the Monitoring Plans.

Section 3 of the report describes baseline monitoring efforts focused on marine mammals and sea turtles along the U.S. East Coast. Historical longitudinal monitoring efforts using mainly aerial surveys have been conducted since 1998, and have been expanded and enhanced in recent years. Study areas offshore of Cape Hatteras, Onslow Bay, and JAX continue to be monitored with aerial surveys (with higher levels of effort than pre-2007), and recently vessel surveys and passive acoustic monitoring (PAM) methods have been added. Biopsy sampling and photo-ID of individuals have enhanced the types of data being collected, and in 2011 a controlled exposure experiment (i.e., behavioral response experiment) was conducted on short-finned pilot whales (*Globicephala macrorhynchus*). Overall, 20 species of marine mammals and three species of sea turtles were identified. Patterns of habitat use were apparent, with many species of delphinids inhabiting pelagic waters beyond the shelf edge, but with Atlantic spotted dolphins (*Stenella frontalis*) mostly restricted to the continental shelf, and bottlenose dolphins (*Tursiops truncatus*) using the entire study area. The surveys in the Cape Hatteras area showed high diversity and high density of cetaceans, in particular along the shelf edge, where several rarely-observed delphinids were sighted, such as Fraser's dolphin (*Lagenodelphis hosei*), Clymene dolphin (*Stenella clymene*), and melon-headed whale (*Peponocephala electra*). Seasonal occurrence was apparent for baleen whales, but not for most of the toothed cetaceans. The establishment of photo-ID catalogs and matching with existing information has provided preliminary results on movements for bottlenose dolphins and Atlantic spotted dolphins, with some evidence of residency for both of these species in some of the study areas. Photo-ID of short-finned pilot whales and

Risso's dolphins (*Grampus griseus*) has also been possible, although results are not yet available for these species.

U.S. Navy at-sea exercise monitoring efforts, as required under the NMFS-issued Letter of Authorization (LOA), are summarized in **Section 3**. During the 5-year period, 24 visual-monitoring efforts involving training events of the following types were conducted: Anti-Submarine Warfare Exercises (ASWEX), Southeast Anti-Submarine Warfare Integration Training Initiatives (SEASWITI), Mine-Neutralization Exercises (MINEX), Missile Exercises (MISSILEX), and Firing Exercises (FIREX), and Gunnery Exercises (GUNEX). Most of visual monitoring effort involved the use of aerial surveys, and seven species of marine mammals (bottlenose dolphin, Atlantic spotted dolphin, pantropical spotted dolphin [*Stenella attenuata*], Risso's dolphin, short-beaked common dolphin [*Delphinus delphis*], sperm whale [*Physeter macrocephalus*], and short-finned pilot whale) and three species of sea turtles (leatherback turtle [*Dermochelys coricea*], loggerhead turtle [*Caretta caretta*], and Kemp's ridley turtle [*Lepidochelys kempii*]) were identified. Behavioral focal-follows were conducted primarily on Atlantic spotted dolphins, bottlenose dolphins, and pilot whales. PAM devices were used extensively in exercise monitoring. Marine Autonomous Recorders (MARUs—formerly known as 'pop-up' buoys), Autonomous Multi-channel Acoustic Recorders (AMARs), and towed hydrophone systems were used to monitor for marine mammal sounds. This report mostly focuses on vocal events recorded with MARUs deployed in fall (14 September–07 October 2009) and winter (04 December 2009–07 January 2010). A number of different delphinids were recorded, and overall vocalizations were more common at night than during the day, but species identification issues complicated further interpretation of data. North Atlantic right whale (*Eubalaena glacialis*) sounds were detected in both fall and winter months, whereas minke whale (*Balaenoptera acutorostrata*) vocalizations were detected only during winter deployments, which is consistent with what is known about the general migration patterns of these two species along the U.S. East Coast. Obvious behavioral reactions to sonar operations were apparent only for minke whales; vocal events were greatly reduced or completely ceased during sonar transmissions. For other species, data were either insufficient for analysis, or no obvious response was observed. Finally, as part of a larger study, trained marine mammal observers (MMOs) were placed aboard U.S. Navy ships during some exercises to evaluate the effectiveness of the U.S. Navy lookouts (LOs; also called watchstanders) in detecting marine mammals that come within certain mitigation distances (200, 500, and 1,000 yards) of the ship during use of active sonar. A new analysis procedure was devised to determine the probability of animals approaching to within a specified stand-off range without being detected (the 'sneak-up probability'). Results are preliminary, but indicate that the U.S. Navy LOs are not completely effective, and that additional data are needed for more in-depth evaluation.

Data accessibility is described in **Section 4**. Aerial and vessel sighting data from monitoring efforts are periodically submitted to the Ocean Biogeographic Information System-Spatial Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP) site, a geo-spatially-referenced online database available to the public. Data also are contributed to the U.S. Navy's Environmental Information Management System (EIMS). Together, these systems provide accessibility to the data for both the general public and Navy environmental planners, making them available for use in future U.S. Navy effects-analysis modeling efforts. In addition, the Navy's Marine Species Moitoring web site serves as a public portal for accessing reports, publications, and information on the current status of monitoring projects.

Progress during the monitoring program and the feasibility of various monitoring methods are discussed in **Section 5**. Aspects of baseline and exercise monitoring (see **Sections 2 and 3**) are reviewed within the context of a 'lessons learned' perspective and future improvements are discussed.

Finally, in **Section 6**, future directions for the monitoring program is summarized. Baseline monitoring using the visual survey methods described herein is planned to continue throughout 2012 and beyond.

Additional analyses of data collected are currently underway or planned, and several technical publications from these data are in various stages of preparation. Increased effort directed toward developing density estimates from the survey data is considered a high priority. Additional work using passive acoustic methods is ongoing, and future work is aimed at developing better methods of differentiating vocalizations to the species level for delphinids, and in using the resulting data to develop density estimates for species, areas, and time periods of most relevance to U.S. Navy training activities. Further developmental (e.g., theoretical) work is needed in some cases for these types of analyses to be conducted in a manner that provides the kind of information that is needed by the U.S. Navy to achieve its monitoring goals.

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AFAST	Atlantic Fleet Active Sonar Training
AFTT	Atlantic Fleet Training and Testing
AMR	Adaptive Management Review
ASW	anti-submarine warfare
ASWEX	Anti-submarine Warfare Exercise
BACI	Before-After-Control-Impact
CFR	Code of Federal Regulations
CHAS-JAX	Charleston-Jacksonville Range Complex
CHPT	Cherry Point Range Complex
CI	Confidence Interval
CNO	Chief of Naval Operations
DoN	Department of the Navy
DTAG	digital acoustic data-logging tags
EAR	Ecological Acoustic Recorder
EIMS	Environmental Information Management System
ESA	Endangered Species Act
EWS	Early Warning System
FIREX	Firing Exercise
GOMEX	Gulf of Mexico Range Complex
GUNEX	Gunnery Exercise
HARP	High-frequency Acoustic Recording Package
HFAS	high frequency active sonar
Hz	Hertz
hr	hour(s)
ICMP	Integrated Comprehensive Monitoring Program
ITA	Incidental Take Authorization
JAX	Jacksonville Range Complex
kHz	kilohertz
km	kilometer(s)
LMMO	liaison marine mammal observer
LOA	Letter of Authorization
LO	lookout
m	meter(s)
MABDC	Mid-Atlantic Bottlenose Dolphin Photo-Identification Catalog
MARU	Marine Autonomous Recorder Unit
MFAS	mid-frequency active sonar
min	minute(s)
MINEX	Mine-neutralization Exercise
MISSILEX	Missile Exercise
MMO	Marine Mammal Observer
MMPA	Marine Mammal Protection Act
N45	Environmental Readiness Division
NAVFAC	Naval Facilities Engineering Command
NEFSC	Northeast Fisheries Science Center
NMFS	National Marine Fisheries Service
OPAREA	Operating Area
OT	observation team
PAM	passive acoustic monitoring
PMRF	Pacific Missile Range Facility
PTS	permanent threshold shift
ROCCA	Real-time Odontocete Call Classification Algorithm
SAG	Scientific Advisory Group
SEASWITI	Southeast Anti-Submarine Warfare Integration Training Initiative
SEFSC	Southeast Fisheries Science Center
SERDP	Strategic Environmental Research and Development Program
TTS	temporary threshold shift
U.S.	United States
UNCW	University of North Carolina at Wilmington
USWTR	Undersea Warfare Training Range
VACAPES	Virginia Capes Range Complex
VHF	very high-frequency

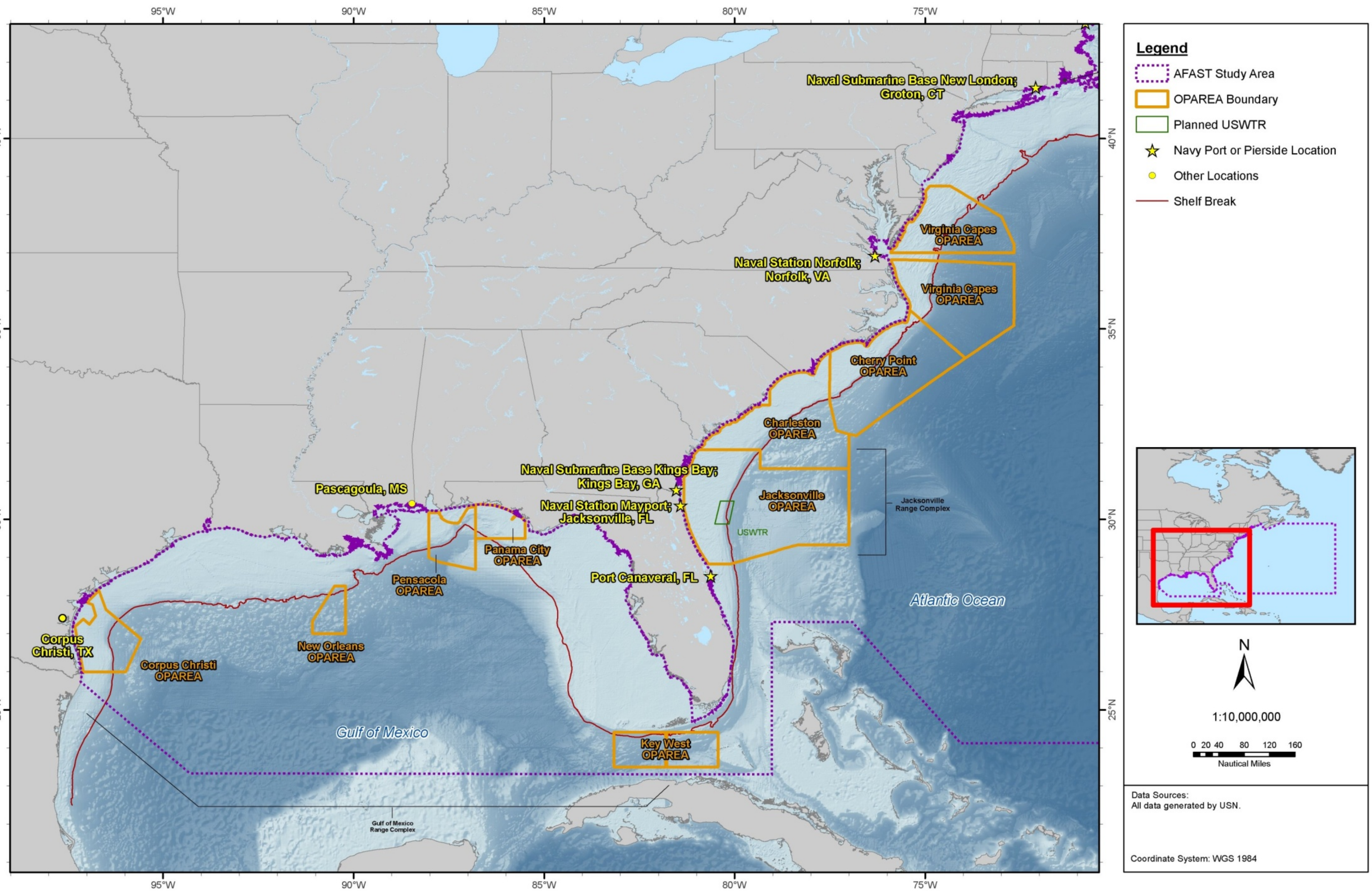
1. Introduction

1.1 Background & History

The United States (U.S.) Navy is responsible for compliance with a suite of Federal environmental and natural resources laws and regulations that apply to the marine environment. The U.S. Navy developed Range Complex monitoring plans to provide marine mammal and sea turtle monitoring as required under the Marine Mammal Protection Act (MMPA) of 1972 and the Endangered Species Act (ESA) of 1973. In order to issue an Incidental Take Authorization (ITA) for an activity, Section 101(a)(5)(A) of the MMPA states that the National Marine Fisheries Service (NMFS) must set forth "requirements pertaining to the monitoring and reporting of such taking." The MMPA implementing regulations at Code of Federal Regulations (CFR), Title 50 (50 CFRFR), Section 216.104(a)(13) note that requests for Letters of Authorization (LOAs) must include the suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species and of the level of takes or impacts on populations of marine mammals that are expected to be present. While the ESA does not have specific monitoring requirements, Biological Opinions issued by NMFS also have included terms and conditions requiring the U.S. Navy to develop a monitoring program. Requirements set forth by issuance of the LOAs necessitate that the U.S. Navy submits a report analyzing and summarizing all of the multi-year marine mammal information gathered during the 5-year period covered within the LOAs.

The U.S. Navy developed monitoring plans (see **Section 3.1**) with specific study objectives for naval training exercises in the Atlantic Fleet Active Sonar Training (AFAST) Study Area; the Virginia Capes (VACAPES), Cherry Point (CHPT), and Jacksonville (JAX) Range Complexes (collectively referred to as the East Coast Range Complexes), and in the Gulf of Mexico (GOMEX) Range Complex as part of the issuance of annual LOAs for training in these areas (**Figure 1**). Monitoring methods used to support the AFAST and East Coast/GOMEX Range Complex monitoring plans include a combination of field methods designed both to support Range Complex-specific monitoring and to contribute information to a larger U.S. Navy-wide science-based monitoring program. These field methods include visual surveys from vessels and airplanes, passive acoustic monitoring (PAM), and marine mammal observers (MMOs) aboard U.S. Navy platforms participating in an exercise or event (see **Section 3**). Each monitoring technique has advantages and disadvantages that vary temporally and spatially, and each method may support one particular study objective better than another. The U.S. Navy uses a combination of techniques so that detection and observation of marine animals are maximized, and meaningful information can be derived to address monitoring objectives within each of the Range Complex-specific monitoring plans and under the monitoring program as a whole. The U.S. Navy submitted annual monitoring and mission activities reports for AFAST and the East Coast/GOMEX Range Complexes to NMFS for 2009 through 2012 (DoN 2009a, DoN 2010a, DoN 2010b, DoN 2010c, DoN 2010d, DoN 2010e, DoN 2011a, DoN 2011b, DoN 2011c, DoN 2011d, DoN 2013a, DoN 2013b, DoN 2012a, DoN 2012b). A multi-year synthesis of data and results is presented in **Section 3**.

Figure 1. AFAST Study Area and East Coast/GOMEX Range Complexes included in the U.S. Navy's marine species monitoring program in the U.S. Atlantic



The U.S. Navy's marine species monitoring program has reached several important developmental milestones since it began. Prior to formal monitoring requirements under the MMPA and ESA, the U.S. Navy identified the need to establish a shallow-water, instrumented Undersea Warfare Training Range (USWTR) off the U.S. Atlantic Coast for anti-submarine warfare (ASW) training, which requires the use of mid-frequency active sonar (MFAS). The original preferred site was offshore North Carolina in Onslow Bay, within the CHPT Operating Area (OPAREA). The U.S. Navy's planned site has since changed from CHPT to a location within the JAX OPAREA. Duke University and the University of North Carolina at Wilmington (UNCW) have jointly carried out a baseline monitoring program aimed at determining the abundance and distribution of cetaceans at both locations (see **Section 3.2**). This program has evolved to address many of the monitoring requirements under current LOAs for AFAST and the East Coast/GOMEX Range Complexes.

The initial LOA for training in the AFAST study area was issued in January 2009 along with authorizations for both the Hawaii and Southern California Range Complexes. These authorizations included the first formal monitoring requirements for U.S. Navy training activities and also prompted the development of the U.S. Navy's Integrated Comprehensive Monitoring Program (ICMP, see **Section 1.2**), which was established in late 2009 to help coordinate monitoring efforts across all of the U.S. Navy's Range Complexes. Each LOA has had individual monitoring requirements based on common objectives.

Since the inception of these Monitoring Plans a series of meetings and workshops has helped to shape the future of the monitoring program, including a program review and planning meeting in 2010 in which many experts from academic institutions and NMFS were invited to evaluate the current objectives of the ICMP and individual monitoring plans. Discussions from that meeting helped establish a way forward for continued refinement of the U.S. Navy's marine species monitoring program including establishment of a Scientific Advisory Group (SAG) to provide expert objective scientific recommendations to guide future monitoring program investments. The SAG was convened in early 2011 and delivered a workshop and recommendations report later that year (SAG 2011). Later in 2011, the U.S. Navy hosted a Marine Mammal Monitoring Workshop with guidance and support from NMFS, which included scientific experts and representatives of environmental non-governmental organizations. The purpose of the workshop was to present a consolidated overview of monitoring activities accomplished in 2009 and 2010 pursuant to the MMPA Final Rules currently in place, including outcomes of selected monitoring-related research and lessons learned, and to seek feedback on future directions. A significant outcome of this workshop was to continue consolidating monitoring efforts from individual Range Complex-specific plans under the ICMP. The result is a Strategic Planning Process that will improve the return on investment by focusing on specific objectives and projects where they can most efficiently and effectively be addressed throughout the U.S. Navy's Range Complexes. The Strategic Planning Process will be incorporated into the ICMP beginning in 2014 (see **Section 6.1.2**).

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 also provides access to reports, documentation, data, and updates on current monitoring projects and initiatives.

In addition to these Fleet-funded monitoring plans, the Office of Naval Research Marine Mammals and Biology (MMB) Program, and the Office of the Chief of Naval Operations (CNO) Energy and Environmental Readiness Division (N45) Living Marine Resources (LMR) Program support basic and applied research and technology development related to 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 projects relative to potential operational impacts to marine mammals ongoing within some U.S. Navy Range Complexes.

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 (DoN 2010g). It has been developed in direct response to permitting requirements for U.S. Navy ranges, which are established in the various MMPA Final Rules, ESA Consultations, Biological Opinions, and applicable regulations. As a framework document, the ICMP applies by regulation to those activities on ranges and in OPAREAs for which the U.S. Navy sought and received ITAs.

The ICMP is intended for use as a planning tool to focus U.S. Navy monitoring priorities pursuant to ESA and MMPA requirements. Top priority will always be given to satisfying the mandated legal requirements across all ranges. Once legal requirements are met, any additional monitoring-related research will be planned and prioritized using guidelines outlined by the ICMP, consistent with availability of both funding and scientific resources. As a planning tool, the ICMP is a "living document" and will be routinely updated, as needed. The initial area of focus for improving U.S. Navy marine species monitoring in 2011/2012 was on development of a Strategic Plan to be incorporated as a major component of the ICMP to guide investments and help refine specific monitoring actions to more effectively and efficiently address ICMP goals and 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 modifications to monitoring plans are warranted to more effectively address program goals. Modifications to the ICMP that result from AMR discussions are incorporated into a revision to the ICMP and submitted to NMFS.

Under the ICMP, monitoring measures prescribed in range-specific monitoring plans and U.S. Navy-funded research relating to the effects of U.S. Navy training and testing activities on protected marine species should be designed to accomplish one or more of the following top-level goals as prescribed in the current revision 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 methodology), 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 MMPA, ITA, and ESA incidental take statement.

CNO-N45 is responsible for maintaining and updating the ICMP, as necessary, reflecting the results of regulatory agency rulemaking, adaptive management, best available science, improved assessment methodologies, and more effective protective measures. The ICMP will undergo a significant update in 2014 following issuance of LOAs for Atlantic Fleet Training and Testing (AFTT) and Hawaii-Southern California Training and Testing.

1.3 Monitoring Team and Performers

The U.S. Navy's marine species monitoring work in the U.S. Atlantic has been performed by a variety of non-U.S. Navy civilian academic, government, and contractor scientists along with participation by U.S. Navy marine species technical experts. The majority of monitoring projects are contracted through HDR Inc., who also provides project coordination, oversight, and management. The HDR team and scientific experts directly support the U.S. Navy's monitoring requirements by conducting field work, collecting data, performing analyses, and providing guidance on the development of the marine species monitoring program in the Atlantic. The following individuals have provided primary guidance in their fields of expertise for much of the U.S. Navy Atlantic monitoring work conducted to date and summarized in this report:

- **Duke University—**Dr. Andrew J. Read, longitudinal baseline monitoring, and Dr. Lynne Williams Hodge, passive acoustic data analysis.
- **UNC Wilmington—**Mr. William McLellan and Dr. Ann Pabst, longitudinal baseline monitoring.
- **Centre for Ecological and Environmental Modelling (CREEM), University of St. Andrews—**Dr. Len Thomas, Distance Sampling and Lookout Effectiveness study.
- **Cornell University, Bioacoustics Research Program—**Dr. Christopher Clark, passive acoustics.
- **Scripps Institution of Oceanography—**Dr. John Hildebrand, passive acoustics.

- **Bio-Waves, Inc.—**Mr. Thomas F. Norris and Dr. Julie Oswald, passive acoustic data analysis.
- **Texas A&M University, Marine Mammal Research Program—**Dr. Bernd Würsig, behavioral analysis.
- **HDR, Inc.—**Dr. Daniel Engelhaupt, marine species monitoring contract Program Manager.

Individuals who participated in data collection, analysis, reporting, and project management for U.S. Navy Atlantic marine species monitoring include (*alphabetized by organization and personnel*):

Elizabeth Ferguson, Tina Yack (Bio-Waves, Inc.); Thomas Jefferson (Clymene Enterprises); Peter Dugan (Cornell University); David Borchers, Louise Burt, Roland Langrock, Charles Paxton, Eric Rexstad (CREEM); Jennifer Dunn, Heather Foley, Ari Friedlander, Patrick Halpin, Dave Johnston, Doug Nowacek, Wendy Dow Piniak, Zach T. Swaim, Kim W. Urian, Danielle M. Waples (Duke University); Catherine Bacon, Melody Baran, Lenisa Blair, Mark Cotter, Brad Dawe, Amy Engelhaupt, Dagmar Fertl, Gregory L. Fulling, Jennifer Latusek-Nabholz, Keri Lestyk, Dana Spontak (HDR, Inc.); Adam Frankel, Ken Hunter, Tom Stewart, Eric Therrien, Kathleen Vigness-Raposa (Marine Acoustics, Inc.); Mellisa Soldevilla (National Narine Fisheries Service, Southeast Fisheries Science Center); Mari Smultea, David Steckler (Smultea Environmental Sciences, LLC); Joel Bell, Anurag Kumar, Deanna Rees, Sarah Rider, Mandy Shoemaker (Naval Facilities Engineering Command Atlantic); Amy Farak, Josh Fredrickson, Stephanie Watwood (Naval Undersea Warfare Center Division, Newport Rhode Island); Brandon Southall (Southall Environmental Associates, Inc.); Erin Cummings, Rachel Hardee, Peter Nilsson, Ryan McAlarney (UNC Wilmington); Alex Bocconcelli, Peter Tyack (Woods Hole Oceanographic Institution).

2. EXERCISE REPORTING SUMMARY

During the period (22 January 2009 to 1 August 2012), the U.S. Navy conducted 35 Major Training Exercises (MTE) within the AFAST Study Area. This section is a summary of these exercises/events and associated marine animal sightings and mitigation events.

2.1 Exercise Reporting Overview

Awareness of environmental stewardship throughout the Fleet has dramatically increased since early 2009. Marine mammal protections have become part of the culture of Fleet Operators. United States Fleet Forces (USFF) Command has developed a comprehensive approach by integrating environmental protective measures during pre-exercise MTE planning that includes: Operational Orders specific to protective measures and stranding reporting; Inclusion of protective measures in pre-exercise Strike Group Planning; Protective measures reporting requirements messages sent to all participating units/commands and Detailed After Action Reporting (AAR) requirements. The Protective Measures Assessment Protocol (PMAP) software program and the Sonar Positional Reporting System (SPORTS) are the keystone programs that allow effective mitigation and compliance reporting for all Fleet commands.

During MTEs Navy collected detailed marine mammal sighting related data that included the number and type of animals sighted, location, range to sighting, and weather data (wave height and visibility). A summary of the MTE sighting related data is included in **Table 1** below. This level of detail requires a significant amount of effort from Navy sailors well above their primary duties of safe navigation. To some degree, this level of effort negatively impacted the quality of training in which they were engaged.

Table 1. AFAST Study Area Major Training Exercise Sighting Data Summary by OPAREA.

Marine Animal Species	# of Sightings (22 Jan 2009 – 1 August 2012)	# of Animals	Mean Range to Sightings (yds)	Mean Wave Height (ft.)	Mean Visibility (nm)
Virginia Capes Range Complex (VCOA)					
Dolphin	4	33	675	1.8	8.5
Whale	7	16	1,000	1.9	7.6
Turtle					
Generic	1	1	Unknown	1.8	8.1
Cherry Point Range Complex (CPOA)					
Dolphin	217	1,199	440	2.5	9.6
Whale	29	61	912	1.8	10
Turtle	18	18	542	1.5	9.9
Generic	1	1	Unknown	1.9	9.6
Jacksonville Range Complex (JAX)					
Dolphin	214	1,279	348	2.7	10.1
Whale	38	90	1,564	2.8	9.4
Turtle	28	37	356	2.2	10
Generic	5	7	150	Unknown	10
Total	**562**	**2,742**	**665**	**2.15**	**9.5**

This sighting data revealed the following:

- Out of 435 dolphin sightings during MTE's, 132 (30.3%) included "bowriding" behavior.
- The mean range to all dolphin sightings was 488 yards.
- The mean range to all whale sightings was 1,159 yards.
- The mean range to all turtle sightings was 449 yards.
- The mean range to all reported sightings was 665 yards.

2.2 AFAST Major Training Event Summary (January 22, 2009 to August 01, 2012)

2.2.1 Composite Listing of AFAST MTEs

There were 35 individual MTEs that took place in the AFAST Study Area from 22 January 2009 to 1 August 2012. These MTEs are summarized in **Table 2** below.

Table 2. AFAST Study Area Major Training Exercise Summary.

Exercise Type	22 Jan 2009 – 1 Aug 2009	2 Aug 2009 – 1 Aug 2010	2 Aug 2010 – 1 Aug 2011	2 Aug 2011 – 1 Aug 2012	Reporting Period Totals
COMPTUEX	3	3	2	3	11
JTFEX	0	1	2	2	5
IAC II	3	3	3	4	13
SEASWITI	1	3	2	0	6
Total	**7**	**10**	**9**	**9**	**35**

2.2.2 Composite Listing of AFAST Mitigation Events

There were 28 total mitigation events (MFAS powered down or shut down) due to the sighting of marine mammals or sea turtles during MTEs from 22 January 2009 to 1 August 2012. These mitigation events are summarized in **Table 3** below. The last column, Excessive Mitigation, is defined as the implementation of powering down or shutting down of MFAS was applied beyond that of mandated safety zones and at ranges beyond what was required. Navy is very concerned when excessive mitigations are applied as this directly contributes to an interruption in training which impacts training effectiveness.

Table 3. AFAST Study Area Mitigation Events.

Marine Animal Species	Range of Detection (Yards, < 200, 200-500, 500-1000, 1000-2000, > 2000)	Mitigation Measure Implemented	Excessive Mitigation (Yes/No)
22 January 2009 – 1 August 2009			
Dolphin	< 200	Sonar shut down	No
Dolphin	< 200	Sonar shut down	No
Dolphin	< 200	Sonar shut down	No
Dolphin	< 200	Sonar shut down	No
Dolphin	Not reported	Sonar powered down	Yes

Marine Animal Species	Range of Detection (Yards, < 200, 200-500, 500-1000, 1000-2000, > 2000)	Mitigation Measure Implemented	Excessive Mitigation (Yes/No)
Dolphin	Not reported	Sonar shut down	Yes
Dolphin	Not reported	Sonar shut down	Yes
Whale	< 200	Sonar shut down	No
Whale	< 200	Sonar shut down	No
Whale	> 2000	Sonar shut down	Yes
2 August 2009 – 1 August 2010			
Dolphin	< 200	Sonar shut down	No
Dolphin	1000-2000	Sonar shut down	Yes
Dolphin	Not reported	Sonar powered down	Yes
Dolphin	Not reported	Sonar powered down	Yes
Dolphin	200-500	Sonar powered down	No
Whale	1000-2000	Sonar shut down	Yes
Whale	> 2000	Sonar shut down	Yes
2 August 2010 – 1 August 2011			
Turtle	< 200	Sonar shut down	No
Dolphin	< 200	Sonar shut down	No
Dolphin	< 200	Sonar shut down	No
Whale	500-1000	Sonar powered down	No
2 August 2011 – 1 August 2012			
Dolphin	< 200	Sonar shut down	No
Dolphin	1000-2000	Sonar shut down	Yes
Dolphin	1000-2000	Sonar powered down	No
Dolphin	1000-2000	Sonar powered down	No
Dolphin	Not reported	Sonar shut down	Yes
Whale	500-1000	Sonar shut down	Yes
Whale	Not reported	Sonar shut down	Yes

2.2.3 Composite Listing of AFAST Marine Animal Sightings

There were 562 reported sightings of at least 2,742 marine mammals and sea turtles during MTEs in the AFAST Study Area from 22 January 2009 to 1 August 2012. These sightings are summarized by MFAS in active or passive mode at the time of sighting in **Table 4** below.

Table 4. AFAST Study Area Sighted Marine Mammals and Sea Turtles.

Marine Animal Species	22 Jan 2009 – 1 Aug 2009	2 Aug 2009 – 1 Aug 2010	2 Aug 2010 – 1 Aug 2011	2 Aug 2011 – 1 Aug 2012	Reporting Period Totals
Animals sighted while MFAS Active					
Dolphin	72	19	23	25	139
Whale	9	10	5	5	29

Marine Animal Species	22 Jan 2009 – 1 Aug 2009	2 Aug 2009 – 1 Aug 2010	2 Aug 2010 – 1 Aug 2011	2 Aug 2011 – 1 Aug 2012	Reporting Period Totals
Pinniped	0	0	0	0	0
Turtle	0	0	1	0	1
Generic	0	0	2	0	2
Subtotal while Active	81	29	31	30	171
Animals sighted while MFAS Passive					
Dolphin	304	273	618	1,177	2,372
Whale	45	22	17	54	138
Pinniped	0	0	0	0	0
Turtle	12	5	20	17	54
Generic	2	0	4	1	7
Subtotal while Passive	363	300	659	1,249	2,571
Total	**444**	**329**	**690**	**1,279**	**2,742**

2.3 Evaluation of Mitigation Effectiveness

The three categories of mitigation measures (Personnel Training, Lookout and Watchstander Responsibility, and Operating Procedures) outlined in the AFAST FEIS/OEIS of December 2008 and approved by NMFS in subsequent LOAs were effective in appropriately mitigating exposure of marine mammals and sea turtles to sonar. During the 35 MTEs in the AFAST Study Area from 22 January 2009 to 1 August 2012 (**Table 2**), prescribed NMFS mitigation zones were either appropriately applied in cases where marine mammals and sea turtles were observed within the applicable zone, or excessive mitigation measures were applied, which is overly conservative, but does not influence evaluating the effectiveness of mitigation. During the entire reporting period, there was only one instance, out of 562 sightings, where a ship neglected to mitigate adequately for a marine mammal sighted within 1,000 yards (99.8% effectiveness). Fleet commanders, aircrews, and ship watch teams continue to improve individual awareness, mitigation execution, and reporting practices. This improvement can be attributed to pre-exercise planning practices, mandatory Marine Species Awareness Training, adherence to required MFAS mitigation zones, and application of lessons learned in marine animal sighting and reporting. In short, Navy personnel have become effective at mitigating marine mammal encounters through increased awareness.

Deep diving animals were not identified during any MTEs. If exposure did occur, the Navy assesses that these animals would not be exposed to significant levels for long periods based on the moving nature of hull-mounted MFAS use, and even less exposure from less-frequent and lower-power aviation-deployed MFAS systems (dipping sonar, sonobuoys). During a one-hour dive by a beaked whale or sperm whale, a MFAS ship moving at a nominal speed of 10 knots could transit up to 10 nm from its original location, well beyond ranges predicted to have significant exposures.

Table 3 lists the 28 mitigation events where sonar was active and ships took action to reduce or eliminate inadvertent exposure of marine mammals and sea turtles to sonar. With or without mitigation, given the rapid relative motion of ships maneuvering at sea and the independent marine mammal movement, the time any given animal would be exposed to MFAS from surface ships is likely to be limited. Of those 28 mitigations listed in **Table 3**, 13 were conducted in excess of mandated safety zones where ships powered down or shut down sonar at ranges beyond what was required. Although 13 out of 28 total events (46%) is a high number of excessive mitigations, the percentage of excessive mitigations for ships in AFAST MTEs has been trending downward, with 9 excessive mitigation events over the first two reporting years and only 4 excessive mitigation events over the past 2 reporting years. This reduction in over-mitigating can be attributed to increased training and familiarity with the mitigation measures and leadership's focus on maximizing realistic active sonar ASW training.

Additionally, there were 15 reported instances of Navy ships proactively maneuvering to avoid marine mammals or sea turtles or to avoid crossing paths with marine animals.

In support of the 35 MTEs during the reporting period, the Navy conducted over 17,590 hours of environmental awareness training, including the Marine Species Awareness Training DVD, for 13,019 Navy personnel prior to these exercises. While at sea, the Navy spent over 184,127 hours of surface ship and aerial visual observation toward the detection of marine mammals and sea turtles. Additionally, over 4,196 hours were spent documenting and reporting marine animal sightings and mitigation events.

2.4 Utility of Marine Mammal Sighting Data

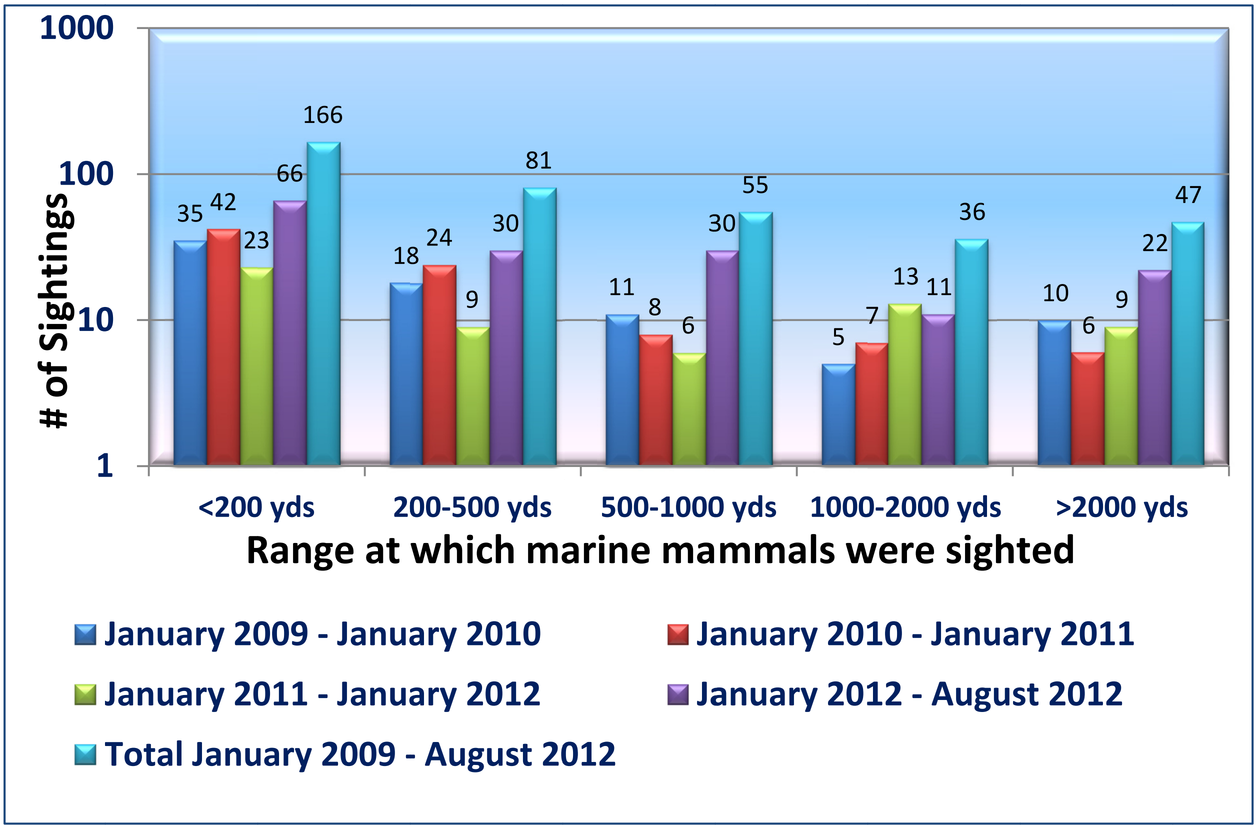
A requirement under the AFAST LOA and BO is to record and report all marine mammal sightings during MTEs. **Figure 2** depicts the reported ranges of all marine mammal sightings (with and without MFAS) from each of the MTEs within the AFAST Study Area by LOA period. The number of sightings is variable by strike group, exercise type, and sea state at the time of the MTE. Instances where a range was not indicated (i.e., passive detections) were excluded from this graph.

Navy evaluated this data across all MTEs in AFAST, HRC and SOCAL to determine if meaningful conclusions could be derived that contributes to addressing the general goals of the monitoring and reporting requirements. These goals as outlined in the LOA are:

- Increase probability of detecting animals
- Increase understanding of how many animals are exposed to acoustic stressors and the associated effects
- Increase understanding of acoustic stressor impacts to stocks and populations
- Increase knowledge of species
- Evaluate mitigation effectiveness
- Evaluate compliance with LOA and BO ITS

The approach used was to compute sightings per unit effort and determine if the results could potentially address any of these goals. The data was drawn from the MTEs conducted from Jan 2009 through Aug 2012 and only from ships with hull mounted sonars as presented in **Table 4** and summarized in **Table 5** below.

Figure 2. AFAST Study Area ranges for MTE sightings.



Since the actual hours of active sonar use is classified, the following data is presented in a format to ensure protection of the information and still provide the reader with meaningful results. The data showed animals are sighted less than 2% of the time during MTEs, less than 1% while sonar was passive and less than 5% while sonar was active.

Table 5. AFAST Study Area Sighted Marine Mammals and Sea Turtles.

Sonar Active/Passive	Percent of Time Active/Passive During MTE	# of Sightings	Percent of Sightings
January 2009 – August 2012			
Active	9.1%	500	29.3%
Passive	90.9%	1207	70.7%

This data is consistent with the number of mitigation actions as reported in **Table 3**, however, as presented in this analysis or other potential analyses that could be completed with this data set, it does not support any of the six goals stated above. Therefore, Navy recommends that in future LOAs and BOs this reporting requirement either be deleted or significantly revised.

2.5 Compliance Overview

2.5.1 Compliance with authorized annual limits

During the period of 22 January 2009 through 1 August 2012 Navy safely conducted over 10,000 hours of mid-frequency active sonar (MFAS) and over 4000 hours of high frequency active sonar (HFAS), or similar sources, for U.S. Navy anti-submarine warfare (ASW) and mine warfare (MIW) training, maintenance, or research, development, testing and evaluation (RDT&E). During this use Navy successfully employed mitigation measures assessed to be effective at protecting all species of marine mammals and sea turtles. As of 1 August 2012 Navy has remained within the authorized annual limits for all of the sources that are listed in the AFAST Final Rule (50 CFR Part 216) and for each of the four issued Letters of Authorization. Based on the amount of use through this period and scheduled activity through January 2014, Navy projects to remain within the limits of the five year authorization for all sources. In short, Navy is in compliance with AFAST permits overall and among each permitted source.

2.5.2 Need for Flexibility

In August 2009, due to Global Force Management reasons, one of the previously authorized sources (AN/SQQ-32) was determined to be no longer required within the AFAST Study Area. Navy also found that due to adjustments to training requirements to meet ever-changing world events, specifically with MTE requirements and accelerated introduction of new technologies, certain sources (AN/SLQ-25, AN/SQQ-110A and AN/SQQ-125) required the use of more than the originally authorized amounts. When submitting the 2010 Application for Letter of Authorization Navy initiated and entered into consultations with National Marine Fisheries Service (NMFS) on how to best address these two similar issues. Through consultation and public review, an amended AFAST Final Rule (50 CFR Part 216) NOAA (76 FR 6699) was issued that removed the allowance for the source that is no longer being used and increased the amount of use for three other sources. The cumulative results of these changes were qualitatively analyzed and did not result in any increase in the total amounts of "takes" for all sources across all species and in fact these changes lowered the total number of takes overall. Additionally, the cumulative differences did not cause appreciable changes to impacts to any ESA species.

Navy's challenges while protecting the sea lanes of commerce and ensuring the security of the United States are constantly in flux. Enemies change and adapt, new adversaries emerge and world political situations change. The requirement to man, equip and train forces to meet these challenges and ever-changing threats is the primary mission of the United States Navy. The flexibility to meet this commitment while still ensuring that Navy ships and sailors strive to promote environmental stewardship is a must. Regulatory flexibility must allow room for the Navy to continue to remain in compliance but rapidly adjust to changing mission requirements. Navy has a proven track record of environmental compliance; we have been the world leaders in marine mammal research and monitoring efforts; and continue to produce ground-breaking science that supports the ocean environment.

Through the Adaptive Management Process and future environmental planning documents, Navy and NMFS have proposed methods to achieve the flexibility needed while ensuring protection of valuable marine resources.

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3. Marine Species Monitoring Summary

3.1 AFAST and East Coast Ranges Monitoring Overview

As introduced in **Section 1.1**, monitoring plans for AFAST and the East Coast Range Complexes were designed as collections of focused 'studies' to gather data that attempt to address specific questions in relation to the individual study areas. The study questions originally proposed in the AFAST and East Coast Ranges Monitoring Plans (DoN 2009b, DoN 2009c, DoN 2009d, DoN 2011e) relate to both MFAS and explosives use. **Tables 7 and 8** summarize annual monitoring requirements for each LOA. The original study questions were:

1. Are marine mammals and sea turtles exposed to MFAS, especially at levels associated with adverse effects (i.e., based on NMFS' criteria for behavioral harassment, temporary threshold shift [TTS], or permanent threshold shift [PTS])? If so, at what levels are they exposed?
2. If marine mammals and sea turtles are exposed to MFAS in the AFAST Study Area, do they redistribute geographically as a result of continued exposure? If so, how long does the redistribution last?
3. If marine mammals and sea turtles are exposed to MFAS, what are their behavioral responses to various levels?
4. What are the behavioral responses of marine mammals and sea turtles that are exposed to explosives at specific levels?
5. Is the U.S. Navy's suite of mitigation measures for MFAS (e.g., Protective Measures Assessment Protocol) effective at avoiding TTS, injury, and mortality of marine mammals and sea turtles?

The U.S. Navy has invested over $10M (**Table 6**) in monitoring activities in the AFAST and East Coast Range Complex from 2009 through 2012 and has accomplished the following:

- Covered over 150,000 km of visual survey effort;
- Sighted over 30,000 individual marine mammals;
- Monitored 20 individual training exercise events;
- Taken over 23,000 digital photos;
- Collected over 100 biopsy samples;
- Deployed 11 DTags and conducted 6 playback-exposures on short-finned pilot whales;
- Made 23 HARP deployments and collected over 28,000 hours(hr) of passive acoustic recordings;
- Deployed 4 temporary bottom-mounted passive acoustic arrays during training exercises.

Table 6. Annual funding for marine species monitoring in the AFAST study area and east coast range complexes (FY09-FY13).

Fiscal Year (1 Oct-30 Sep)	Funding Amount
FY09	$1,555,000
FY10	$2,794,000
FY11	$2,920,000
FY12	$3,300,000
FY13[1]	$3,300,000
Total	**$13,869,000**

[1] Planned budget for FY13

Overall, similar monitoring commitments and level of effort will continue through 2013 until the re-structuring of the Navy's overall monitoring approach described in Chapter 6.

In addition, 518 sightings for an estimated 2,645 marine mammals were reported by U.S. Navy lookouts aboard U.S. Navy ships within the AFAST Study Area from 2009 to 2012. These observations were mainly during major at-sea training events and there were no reported observations of adverse reactions by marine mammals and no dead or injured animals associated with U.S. Navy training activities. The remainder of **Section 3** provides a comprehensive summary of monitoring efforts and results under the AFAST Study Area and East Coast Range Complexes.

Table 7. Annual monitoring commitments under the AFAST Monitoring Plan for 2009-2012.

Methods	Description	2009	2010[1]	2011[1]	2012[1]
Aerial Surveys – During Training Event (studies 1 and 3)	N/A	30 hours	1 event	1 event	1 event
Aerial Surveys – Before and After Training Event (studies 2 and 4)	N/A	40 hours	1 event	1 event	1 event
Aerial Surveys – Onslow Bay and JAX (study 2)[2]	1) Monthly surveys in Onslow Bay 2) Monthly surveys in JAX	100 hours (Onslow Bay) 100 hours (JAX)	48 days	48 days	36 days
Vessel Surveys – During Training Event (study 3)	NA	100 hours	2 events	2 events	2 events
Vessel Surveys – Onslow Bay and JAX (study 2)[2]	1) Monthly surveys in Onslow Bay 2) 4 days in Cape Hatteras 3) July surveys in JAX	125 hours (Onslow Bay) 125 hours (JAX)	48 days	48 days	24 days
Marine Mammal Observers (studies 1 and 3)	Observers on navy ships during training events	60 hours	2 events	2 events	2 events
Passive Acoustic Monitoring (study 2)	1) Deployment of 4 HARPS (2 in Onslow Bay and 2 in JAX) 2) Use of pop-up buoys for exercise monitoring 3) Use of towed array during vessel surveys	Deploy up to four devices and use pop-up buoys	Maintenance of four devices (HARPS), use pop-up buoys and towed array (when feasible)	Maintenance of four devices (HARPS), use pop-up buoys and towed array (when feasible)	Maintenance of threedevices (HARPS), use pop-up buoys and towed array (when feasible)
MMO/Lookout Comparison (study 5)	Conduct observer comparison trials	N/A	40 hours[3]	40 hours[3]	40 hours[3]
Tagging		N/A	N/A	N/A	JAX in coordination with vessel surveys - study design to be developed.

Notes:
[1] Requirements were changed to reflect training events and survey days
[2] Survey area was expanded to include Cape Hatteras area in 2011
[3] Lookout comparison study requirements apply U.S. Navy-wide
Key: HARP = High-frequency Acoustic Recording Package; JAX = Jacksonville Range Complex; MMO = Marine Mammal Observer; NA = not applicable.

Table 7. Annual monitoring commitments[1] under the East Coast and GOMEX Range Complexes Monitoring Plans for 2009-2012.

Methods	Description	2009-2012 VACAPES and JAX	2009-2012 CHPT	2011-2012 GOMEX[2]
Vessel or Aerial Surveys Before/During/After Event (studies 4 and 5)	Visual surveys before/during/after explosive events.	2 events (1 multiple explosives event)	1 event	1 event
Marine Mammal Observers (studies 4 and 5)	MMOs visually surveying from a U.S. Navy ship before, during and after explosive events.	1 event	1 event	1 event
Passive Acoustic Monitoring (study 4 and5)	Passive acoustic array or monitoring buoys.	Deploy passive acoustic array or buoys during 1 MINEX event.	Deploy passive acoustic array during vessel surveys when feasible.	Deploy passive acoustic array during vessel surveys when feasible.

Notes:

[1] Assumes sufficient monitoring opportunities are available

[2] MMPA authorization for GOMEX began in 2011

Key: CHPT = Cherry Point Range Complex; GOMEX = Gulf of Mexico Range Complex; JAX = Jacksonville Range Complex; MINEX = Mine-neutralization Exercise; MMO = Marine Mammal Observer; MMPA = Marine Mammal Protection Act; VACAPES = Virginia Capes Range Complex

3.2 Longitudinal Baseline Monitoring

3.2.1 Overview of Baseline Monitoring

Initial monitoring of potential sites for USWTR began in 1998 when UNCW conducted aerial surveys for marine mammals and sea turtles off Wallops Island, Virginia, and Onslow Bay, North Carolina (McLellan et al. 1999). These surveys were conducted year-round in 1998 and 1999 and provided baseline data on the occurrence and distribution of marine mammals and sea turtles at these two sites.

In 2005, the U.S. Navy contracted with a consortium of researchers from Duke University, UNCW, the Scripps Institution of Oceanography, and the University of St. Andrews to develop a monitoring program to assess the possible impacts of training activities on marine mammals and sea turtles at a proposed USWTR site in Onslow Bay. Simulation models, parameterized using data from the earlier aerial surveys, indicated that that it would be very difficult, if not impossible, to detect any effects of potentially harmful training activities on populations of marine mammals and sea turtles in Onslow Bay. Model results suggested that, in the absence of daily sampling, traditional surveys would provide insufficient statistical power to detect even the worst possible effects of training activities. Given the results of this simulation exercise, the consortium decided against recommending a Before-After-Control-Impact (BACI) assessment, and instead, designed a monitoring program that would improve scientific knowledge of the occurrence, distribution, and density of marine mammals and sea turtles in Onslow Bay.

The consortium designed a multi-modal survey approach, which included vessel and aerial line-transect surveys for marine mammals and sea turtles, strip-transect surveys of seabirds, and a PAM component. Sightings data collected during vessel and aerial surveys would be used to derive estimates of density, and photographs taken from both platforms would allow confirmation of species identifications. Photographs taken during vessel surveys would also provide information on the residency and movement patterns of identified individual cetaceans. The vessel surveys would employ a towed hydrophone array to obtain ground-truthed recordings of cetaceans, identified to the species level during visual encounters. Two High-frequency Acoustic Recording Packages (HARPs; Wiggins and Hildebrand 2007), designed by researchers at the Scripps Institution of Oceanography, would provide year-round data on the occurrence of vocalizing cetaceans. This program was designed to ensure that even cryptic, deep-diving species, such as beaked whales, would be detected by at least one survey method.

Monthly surveys were initiated at the Onslow Bay site in June 2007 and continued uninterrupted for four years. These surveys were conducted along ten 74-kilometer (km) transect lines (**Figure 3**) encompassing a buffer area surrounding the 46-km by 37-km planned USWTR site. The surveys provided a rich and unparalleled picture of the seasonal occurrence, distribution, and density of cetaceans and sea turtles in Onslow Bay. A comparison across survey periods (1998-1999 versus 2007-2011) has provided a glimpse into possible large-scale distributional shifts of delphinid cetaceans in the western North Atlantic. Analysis of photo-ID images taken during these surveys has produced the first multi-year re-sightings of pelagic dolphins in the Atlantic Ocean and suggests that fine-scale population structure exists for these species. The HARP data yielded a rich trove of information on the occurrence of vocalizing cetaceans and documented the occurrence of several species of mysticetes during winter, possibly including the sei whale (*Balaenoptera borealis*), which would be the first acoustic detection of this species in the western North Atlantic south of New England. The seabird surveys were used to derive habitat models for several species, including the endangered black-capped petrel (*Pterodroma hasitata*).

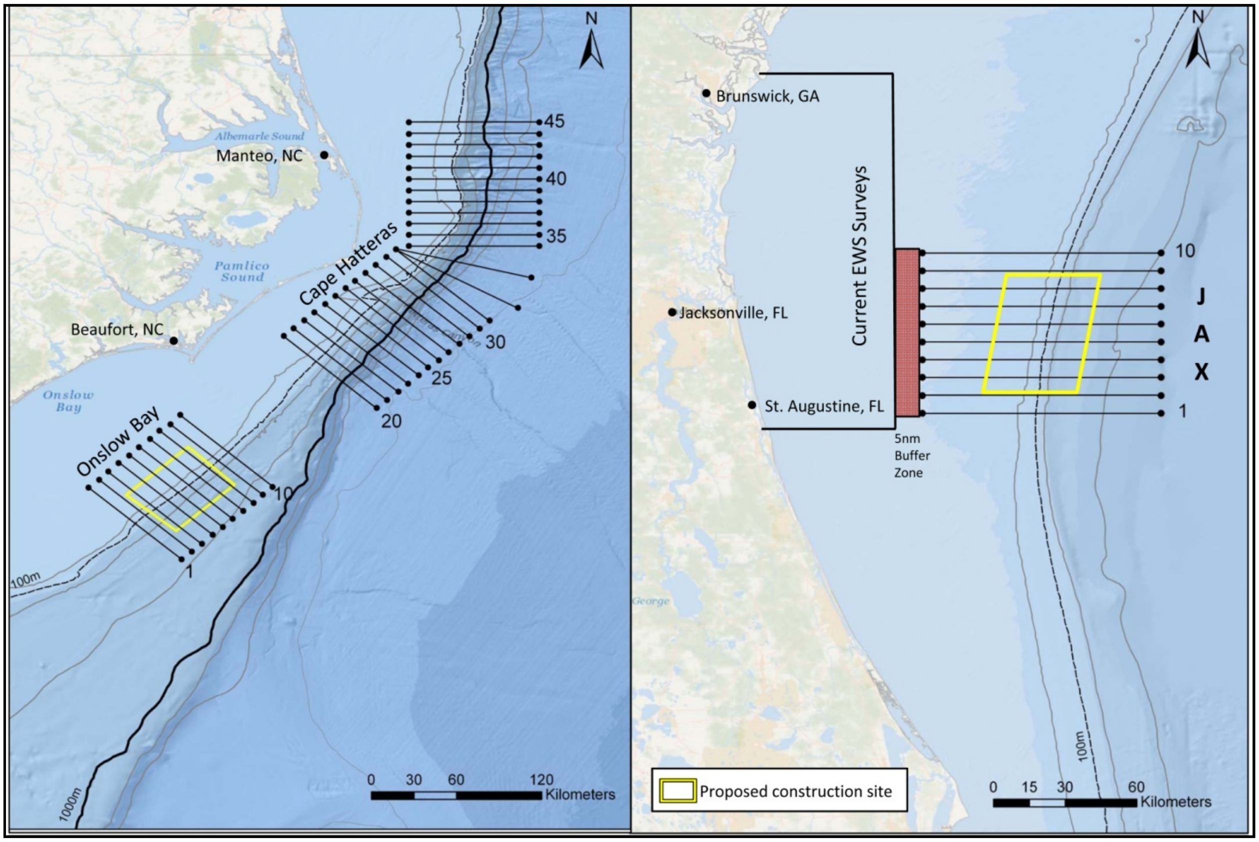


Figure 3. Cape Hatteras, Onslow Bay, and JAX survey areas and established tracklines used for longitudinal baseline monitoring. Aerial surveys at the JAX location are coordinated with the Early Warning System surveys to maximize coverage of potential North Atlantic right whale ocurrence within the region.

Finally, the aerial surveys have documented a significant positive trend in the abundance of loggerhead turtles (*Caretta caretta*) in Onslow Bay, one of the first in-water signals of population recovery for this threatened population. This monitoring program supported the completion of two doctoral dissertations at Duke University, and the program has generated a large number of manuscripts that currently are being prepared for submission to scientific journals (**Appendix A**).

The program was expanded in 2009 to include a similar multi-modal monitoring project at a second potential USWTR site off Jacksonville, Florida. This effort duplicated the approach developed for Onslow Bay, with a similar set of survey tracklines (**Figure 3**). Monitoring efforts continued in Onslow Bay, resulting in concurrent monthly vessel and aerial line-transect surveys at both Onslow Bay and JAX. In addition, two more HARPs were deployed in JAX. Starting in the winter of 2009, aerial surveys in JAX were synchronized with the intensive aerial monitoring of North Atlantic right whale (*Eubalaena glacialis*) calving habitat in the southeast U.S. In March 2010, the JAX aerial survey team documented the birth of a North Atlantic right whale close to the border of the planned USWTR (Foley et al. 2011). This was only the second time a North Atlantic right whale birth has been observed and documented.

In 2011, several additional changes were made to the monitoring program. Vessel-based line-transect surveys were discontinued in JAX and resources were redirected to biopsy sampling and photo-ID efforts. A brief vessel survey in 2009 indicated a high density and diversity of cetaceans off Cape Hatteras. Most aerial and vessel survey effort in Onslow Bay, therefore, was redirected to a third monitoring site, off Cape Hatteras, North Carolina, to improve coverage within the AFAST Study Area. Thus, the current monitoring effort includes: monthly aerial line-transect surveys and vessel photo-ID and biopsy surveys at JAX and Cape Hatteras; year-round deployments of single HARPs in Onslow Bay, JAX, and Cape Hatteras; and a reduced level of vessel and aerial survey effort in Onslow Bay. In addition, a controlled exposure experiment (i.e., behavioral response study) was conducted with short-finned pilot whales (*Globicephala macrorhynchus*) off Cape Hatteras in 2011 (see **Section 3.5**). Cape Hatteras is an area of high density and diversity of cetaceans, particularly deep-diving odontocetes. Aerial and vessel surveys off Cape Hatteras have produced a rich picture of the occurrence, distribution, and density of pelagic odontocetes over the shelf break in this area, including the occurrence of rarely observed species, such as Fraser's dolphin (*Lagenodelphis hosei*), Clymene dolphin (*Stenella clymene*), and melon-headed whale (*Peponocephala electra*). These surveys have also provided the first insight into seasonal patterns of beaked whale distribution along the U.S. Atlantic Coast.

An important component of this monitoring work involves collaboration with other researchers at academic, private, governmental, and non-governmental institutions. Tissue samples and data are routinely provided to other investigators for additional analyses. Examples of such collaboration include the following:

- A sample of every skin biopsy collected from marine mammals is archived with the NMFS Southeast Fisheries Science Center (SEFSC) for their work on population structure and to confirm species identity.
- Acoustic recordings have been provided to investigators at the NMFS Northeast Fisheries Science Center (NEFSC) and Bio-Waves, Inc. to improve automated classification methods.
- Aerial surveys in JAX are coordinated closely with the annual monitoring for North Atlantic right whales off the northeastern coast of Florida.
- Photographs of stranded dolphins are matched against the catalogs of pelagic dolphins.
- Loggerhead turtles were equipped with satellite-linked depth recorders in partnership with the North Carolina Wildlife Resources Commission.

The following sections summarize the multi-modal survey effort conducted at these three survey areas since 2007. Duke University and UNCW have annual review meetings with the U.S. Navy to present results of baseline monitoring efforts and discuss changes for the coming year. Presentations from the most recent review are found in DoN 2012c. Annual reports for the baseline monitoring efforts (DoN 2008, DoN 2009f, DoN 2010h, DoN 2012c) are available through the U.S. Navy's Marine Species Monitoring web portal**.** The picture that has emerged as a result of this monitoring effort is one of the most complete and detailed descriptions of marine mammal and sea turtle occurrence, distribution, and abundance along the U.S. Atlantic Coast and continues to expand and evolve to address questions of residency, stock structure, and movement patterns.

3.2.2 Visual Survey Effort

3.2.2.1 Aerial Surveys

Aerial surveys were conducted over a 47-month period from June 2007 until April 2011 in Onslow Bay, with total trackline coverage of 48,534 km (**Table 9**). Flights were performed during 43 of these 47 months, with a total of 90 effort days. Since April 2011, aerial survey effort has shifted from Onslow Bay to Cape Hatteras, where 17 survey days were conducted over a 13-month period, covering 9,559 km (**Table 10**). Aerial surveys in JAX occurred in 35 of 41 months since January 2009, totaling 87 survey days and covering 55,705 km (**Table 11**).

Table 9. Monthly aerial survey effort in the Onslow Bay survey area, June 2007 through April 2011.

Month & Year	Distance Surveyed (km)	Tracklines (*n*)	Hobbs Hr*	Days (*n*)
2007				
June	147.5	2	3.4	1
July	1,463.5	20	12.2	2
August	1,292.4	20	12.8	3
September	1,424.2	20	13.9	2
October	1,500.0	20	13.2	2
November	1,489.0	20	16.3	3
December	744.0	10	6.8	2
2008				
January	0.0	0	0.0	0
February	740.5	10	13.7	2
March	1,115.0	16	13.4	2
April	1,473.7	20	13.7	2
May	742.6	20	15.2	3
June	1,509.5	20	16.1	3
July	1,367.6	20	14.0	2
August	1,478.1	20	13.6	4
September	0.0	0	0.0	0
October	1,479.0	20	13.8	2
November	935.9	16	9.8	2
December	679.0	10	6.3	1
2009				
January	744.9	10	6.2	1
February	1,470.4	20	12.9	2
March	1,472.6	20	14.2	2
April	742.6	10	9.8	2
May	2,198.2	30	21.5	4
June	1,468.9	20	14.5	2
July	1,486.4	20	12.1	3
August	1,477.7	20	14.6	3

Month & Year	Distance Surveyed (km)	Tracklines (*n*)	Hobbs Hr*	Days (*n*)
September	1,173.1	16	11.3	2
October	1,470.1	20	17.4	3
November	742.7	10	7.9	2
December	741.2	10	6.4	1
2010				
January	1,469.8	20	14.5	2
February	734.8	10	8.0	1
March	1,277.9	20	16.0	3
April	1,485.2	20	13.8	2
May	0.0	0	0.0	0
June	1,479.3	20	13.0	3
July	742.7	10	6.1	1
August	736.3	10	7.1	2
September	908.8	11	8.2	2
October	1,470.1	12	9.7	2
November	813.2	10	9.5	2
December	0.0	0	0.0	0
2011				
January	734.1	10	7.0	1
February	572.9	10	6.7	1
March	894.8	10	9.3	2
April	443.4	6	4.2	1
2007-2011 Total	**48,533.6**	**669**	**490.1**	**90**

*Hobbs hr = total engine time

513 **Table 19. Monthly aerial survey effort in the Cape Hatteras survey area, May 2011 through May 2012.**

Month & Year	Distance Surveyed (km)	Tracklines (*n*)	Hobbs Hr*	Days (*n*)
2011				
May	781.5	10	13.4	2
June	971.5	13	11.1	2
July	1,047.8	11	12.9	2
August	0.0	0	0.0	0
September	0.0	0	0.0	0
October	1,189.3	16	12.6	2
November	1,037.4	13	11.4	2
December	0.0	0	0.0	0
2012				
January	1,341.2	18	15.3	2
February	584.5	8	7.2	1
March	1,439.0	20	15.0	2

Month & Year	Distance Surveyed (km)	Tracklines (*n*)	Hobbs Hr*	Days (*n*)
April	0.0	0	0	0
May	1,167.0	17	14.3	2
2011-2012 Total	**9,559.2**	**126**	**113.2**	**17**

*Hobbs hr = total engine time

Table 11. Monthly aerial survey effort in the JAX survey area, January 2009 through May 2012.

Month & Year	Distance Surveyed (km)	Tracklines (*n*)	Hobbs Hr*	Days (*n*)
2009				
January	851.5	10	6.7	2
February	1,704.6	20	15.0	2
March	431.7	5	3.5	1
April	0.0	0	0.0	0
May	0.0	0	0.0	0
June	1,690.6	20	14.2	3
July	1,709.1	20	13.5	3
August	1,710.1	20	13.9	3
September	2,566.6	30	33.0	4
October	821.5	10	7.6	1
November	1,719.5	20	14.7	3
December	1,898.7	22	15.1	3
2010				
January	3,921.1	46	35.2	5
February	2,545.9	30	22.8	3
March	1,685.3	19	17.2	3
April	2,067.0	26	21.1	3
May	820.3	11	10.0	2
June	3,019.2	36	21.5	4
July	1,021.4	12	8.6	2
August	1,704.8	20	14.8	3
September	1,642.2	20	17.7	3
October	1,535.1	18	12.8	3
November	860.1	10	7.7	1
December	1,872.1	22	18.7	3
2011				
January	1,696.7	20	14.6	3
February	1,183.2	14	14.2	3
March	0.0	0	0.0	0
April	1,541.2	18	14.4	2
May	1,333.7	16	11.1	2
June	1,029.6	12	8.8	2

Month & Year	Distance Surveyed (km)	Tracklines (*n*)	Hobbs Hr*	Days (*n*)
July	1,714.3	20	14.4	2
August	1,650.9	20	15.5	2
September	1,363.0	16	11.3	2
October	846.7	10	7.1	1
November	0.0	0	0.0	0
December	0.0	0	0.0	0
2012				
January	1,658.1	20	16.8	3
February	0.0	0	0.0	0
March	5,51.5	8	6	1
April	1,723.7	20	13.3	2
May	1,614.0	20	14	2
2009-2012 Total	**55,705.0**	**661**	**506.8**	**87**

*Hobbs hr = total engine time

3.2.2.2 Vessel Surveys

Vessel surveys were conducted in Onslow Bay between June 2007 and May 2012. A total of 87 survey tracklines was completed during this period. An additional 525 km of dedicated photo-ID and biopsy surveys were conducted, yielding a total of 6,491 km of survey effort. More than 4,700 photo-ID images were obtained and four biopsy samples were collected to address questions of residency and population structure of dolphins (**Table 12**). Photo-ID analysis has been completed for all sightings, yielding images of 127 individual bottlenose dolphins (*Tursiops truncatus*) and 68 individual Atlantic spotted dolphins (*Stenella frontalis*). Images of bottlenose dolphins were compared to the Mid-Atlantic Bottlenose Dolphin Photo-Identification Catalog (MABDC); this is a collaborative catalog that includes dorsal fin images of 8,329 dolphins (11,345 photos) from 28 contributors conducting photo-ID research from New Jersey to northern Florida (multiple researchers work at some sites), with some images dating back to 1979. To date, no matches have been made to the MABDC.

Table 12. Monthly vessel survey effort in the Onslow Bay survey area, June 2007 through May 2012.

Month & Year	Distance Surveyed (km)	Track Lines (*n*)	Effort (hr)	Days (*n*)	Biopsies (*n*)	Photos (*n*)
2007						
June	444.5	6	29.6	4	n/a	44
July	296.3	4	16.0	4	n/a	40
August	444.5	6	30.5	6	n/a	178
September	148.2	2	26.8	3	n/a	356
October	407.4	7	24.0	4	n/a	14
November	222.2	4	14.5	3	n/a	26
December	0.0	0	0.0	0	n/a	0
2008						
January	0.0	0	0.0	0	n/a	0
February	0.0	0	0.0	0	n/a	0
March	148.2	2	10.0	2	n/a	9
April	0.0	0	0.0	0	n/a	0
May	74.1	1	5.8		n/a	27
June	148.2	2	13.5	3	n/a	183
July	370.4	5	17.8	4	n/a	53
August	426.0	7	28.2	5	n/a	75
September	74.1	1	5.5	1	n/a	0
October	0.0	0	0.0	0	n/a	0
November	74.1	1	4.3	1	n/a	25
December	0.0	0	0.0	0	n/a	0
2009						
January	4.5	1	0.4	1	n/a	0
February	176.0	3	11.4	2	n/a	18
March	74.1	1	4.3	1	n/a	0
April	296.3	4	21.1	4	n/a	321
May	0.0	0	0.0	0	n/a	0
June	246.9	4	16.0	4	n/a	197
July	148.2	2	9.0	2	n/a	10
August	370.4	5	28.1	5	n/a	743
September	222.2	3	14.5	3	n/a	99
October	148.2	2	10.3	2	n/a	146
November	0.0	0	0.0	0	n/a	0
December	0.0	0	0.0	0	n/a	0
2010						
January	148.2	2	9.8	2	n/a	142
February	0.0	0	0.0	0	n/a	0
March	74.1	1	4.6	1	n/a	28
April	296.3	4	19.2	4	n/a	344

Month & Year	Distance Surveyed (km)	Track Lines (*n*)	Effort (hr)	Days (*n*)	Biopsies (*n*)	Photos (*n*)
2010 (continued)						
May	74.1	1	4.4	1	n/a	0
June	74.1	1	5.8	1	n/a	54
July	37.0	1	5.3	1	n/a	0
August	74.1	1	4.7	1	n/a	16
September	148.2	2	10.6	2	n/a	406
October	74.1	1	4.8	1	n/a	45
November	0.0	0	0.0	0	n/a	0
December	0.0	0	0.0	0	n/a	0
2011						
January	0.0	0	0.0	0	n/a	0
February	0.0	0	0.0	0	n/a	0
March	0.0	0	0.0	0	n/a	0
April	0.0	0	0.0	0	n/a	0
May	88.5	n/a	5.5	1	0	566
June	0.0	n/a	0.0	0	0	0
July	102.0	n/a	6.3	1	0	300
August	77.2	n/a	5.8	1	0	0
September	65.8	n/a	5.8	1	2	57
October	0.0	n/a	0.0	0	0	0
November	87.2	n/a	4.8	1	0	10
December	0.0	n/a	0.0	0	0	0
2012						
January	27.0	n/a	4.4	1	2	180
February	77.8	n/a	4.4	1	0	0
March	0.0	n/a	0.0	0	0	0
April	0.0	n/a	0.0	0	0	0
May	0.0	n/a	0.0	0	0	0
2007-2012 Total	**6,490.7**	**87**	**447.8**	**85**	**4**	**4,712**

Key: hr = hour(s); km = kilometer(s); n/a = not applicable.

Line-transect vessel surveys were first conducted off Cape Hatteras in July 2009 (**Table 13**) to obtain sightings to parameterize the probability detection functions used to estimate density of cetaceans in Onslow Bay. In contrast to Onslow Bay, where the density of cetaceans is very low, densities are extremely high in the Cape Hatteras survey area. The surveys in Cape Hatteras employed the same vessel and personnel used in Onslow Bay. Subsequent vessel surveys in Cape Hatteras focused on photo-ID and biopsy sampling and were conducted in May and June 2011, and January through May 2012. Totals of 2,024 km and 285 effort hr have been completed since 2009 (**Table 13**). Over 8,600 photo-ID images were obtained and 61 biopsy samples collected in the Cape Hatteras survey area (**Table 13**). Analysis of the photo-ID data is continuing, and to date has yielded images of 53 individually-identifiable bottlenose dolphins, 19 short-finned pilot whales, and one Risso's dolphin (*Grampus griseus*).

Table 13. Monthly vessel survey effort in Cape Hatteras survey area, July 2009 through May 2012.

Month & Year	Distance Surveyed (km)	Tracklines (*n*)	Effort (hr)	Days (*n*)	Biopsies (*n*)	Photos (*n*)
2009						
July	296.4	n/a	26.3	4	n/a	1,548
2011						
May	577.8	n/a	95.1	6	12	2,850
June	519.6	n/a	84.8	7	12	2,829
2012						
January	0	n/a	0.0	0	0	0.0
February	77.8	n/a	5.9	1	1	276
March	106.5	n/a	6.0	1	2	300
April	0	n/a	0.0	0	0	0.0
May	446.2	n/a	66.5	3	34	878
2009-2012 Total	**2,024.3**	**n/a**	**284.6**	**22**	**61**	**8,681**

Key: hr = hour(s); km = kilometer(s); n/a = not applicable.

Vessel surveys were conducted in JAX between July 2009 and May 2012 (**Table 14**). Totals of 36 tracklines and 853 km of photo-ID and biopsy effort were completed during this period, for a total of 3,339 km of survey effort. Approximately 4,930 photo-ID images were taken and 31 biopsy samples were collected in the JAX survey area (**Table 14**). To date, 21 individual bottlenose dolphins and 43 Atlantic spotted dolphins have been identified.

Table 14. Monthly vessel survey effort in the JAX survey area, July 2009 through May 2012.

Month and Year	Distance Surveyed (km)	Tracklines (*n*)	Effort (hr)	Days (*n*)	Biopsies (*n*)	Photos (*n*)
2009						
July	165.6	2	9.5	2	n/a	0
August	263.1	4	16.0	4	n/a	416
September	227.4	4	14.3	5	n/a	2,097
October	140.3	2	8.4	2	n/a	69
November	0.0	0	0.0	0	n/a	0
December	0.0	0	0.0	1	n/a	0
2010						
January	235.2	3	12.5	4	n/a	150
February	0.0	0	0.0	0	n/a	0
March	145.1	2	8.9	2	n/a	102
April	0.0	0	0.0	0	n/a	0
May	148.0	2	8.7	2	n/a	107
June	313.6	4	18.0	4	n/a	401
July	223.5	3	12.0	3	n/a	342
August	37.0	1	2.3	1	n/a	0
2010 (continued)						
September	0.0	0	0.0	0	n/a	0
October	172.3	3	13.6	3	n/a	420
November	0.0	0	0.0	0	n/a	0
December	68.9	1	3.6	2	n/a	0
2011						
January	139.9	2	7.1	2	n/a	136
February	0.0	0	0.0	1	n/a	0
March	205.8	3	10.7	5	n/a	701
April	0.0	0	0.0	0	n/a	0
May	0.0	n/a	0.0	0	0	0
June	0.0	n/a	0.0	0	0	0
July	0.0	n/a	0.0	0	0	0
August	0.0	n/a	0.0	0	0	0
September	0.0	n/a	0.0	0	0	0
October	0.0	n/a	0.0	0	0	0
November	0.0	n/a	0.0	0	0	0
December	0.0	n/a	0.0	0	0	0
2012						
January	540.5	n/a	33.8	5	21	670
February	0.0	n/a	0.0	0	0	0
March	131.0	n/a	7.3	1	1	20
April	181.9	n/a	10.7	2	9	243
May	0.0	n/a	0.0	0	0	0
2009-2012 Total	**3,338.9**	**36**	**197.4**	**51**	**31**	**5,874**

Key: hr = hour(s); km = kilometer(s); n/a = not applicable.

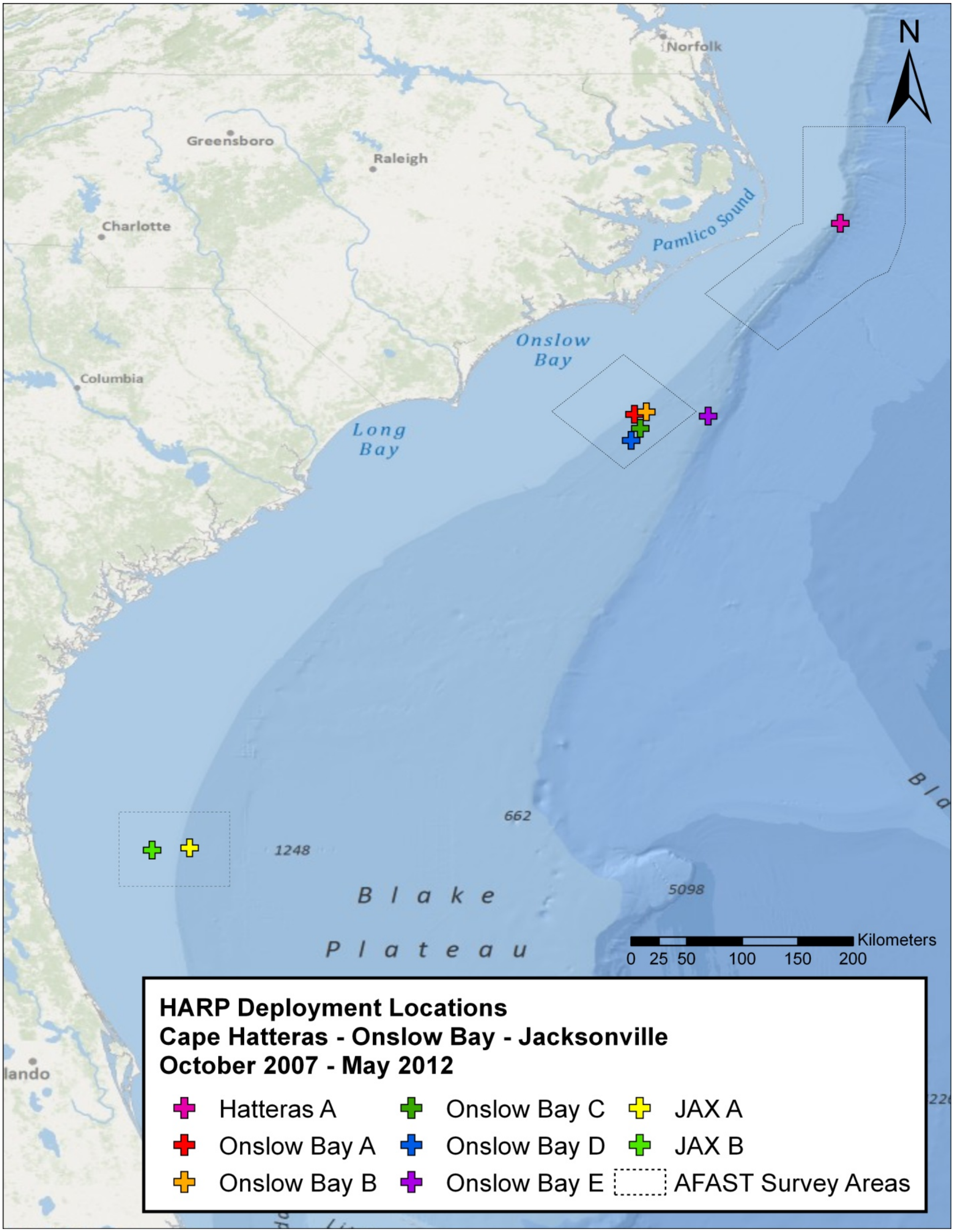
3.2.3 Passive Acoustic Monitoring

As noted in **Section 3.2.1**, HARPs were deployed in Onslow Bay, JAX, and off Cape Hatteras. All HARPs sampled at 200 kilohertz (kHz), providing for useable sound data up to approximately 100 kHz. **Table 15** and **Figure 4** provide information on the deployment locations and depths, recording dates, duty cycles, and status of analysis for each deployment.

Table 15. HARP deployments in the Cape Hatteras, Onslow Bay, and JAX, survey areas.

Location	Deployment ID	Latitude	Longitude	Depth (m)	Recording Start Date	Recording End Date	Duty Cycle (minutes on/off)	Status of Analysis
JAX A	JAX01A	30.2771	-80.1258	82	02APR09	25MAY09	5/10	HF
JAX B	JAX01B	30.2582	-80.4282	37	02APR09	05SEP09	5/10	HF, LF
JAX A	JAX02A	30.28052	-80.21603	83	16SEP09	15DEC09	5/10	HF, LF
JAX B	JAX02B	30.25820	-80.42800	39	No data	No data	5/10	N/A
JAX A	JAX03A	30.28111	-80.21530	89	22FEB10	30JUL10	5/10	HF, M
JAX B	JAX04B	30.25919	-80.42566	38	09MAR10	19AUG10	5/10	HF, M
JAX A	JAX05A	30.26819	-80.20894	91	26AUG10	25JAN11	5/10	IP
JAX B	JAX05B	30.25708	-80.43269	37	27AUG10	01FEB11	5/10	IP
JAX A	JAX06A	30.27818	-80.22085	91	01FEB11	14JUL11	5/10	IP
JAX B	JAX06B	30.25768	-80.42781	37	02FEB11	14JUL11	5/10	IP
JAX A	JAX08A	30.28501	-80.22141	91	27JAN12	N/A	continuous	N/A
Onslow Bay A	USWTR01A	33.79138	-76.52382	162	10OCT07	16JAN08	5/5*	HF, LF
Onslow Bay B	USWTR02B	33.81107	-76.42829	232	30MAY08	10SEP08	5/5	HF, LF
Onslow Bay A	USWTR03A	33.78951	-76.51920	174	24APR09	09AUG09	5/5	HF, LF
Onslow Bay A	USWTR04A	33.78733	-76.52409	171	08NOV09	24FEB10	5/10	HF, LF
Onslow Bay C	USWTR04C	33.67784	-76.47689	335	08NOV09	20APR10	5/10	HF, LF
Onslow Bay A	USWTR05A	33.79316	-76.51620	171	30JUL10	24FEB11	5/5	IP
Onslow Bay D	USWTR05D	33.58065	-76.55015	338	30JUL10	03MAR11	5/5	IP
Onslow Bay E	USWTR06E	33.77794	-75.92641	952	19AUG11	01DEC11	5/5	N/A
Onslow Bay E	USWTR07E	33.78666	-75.92915	914	14JUL12	N/A	5/5	N/A
Cape Hatteras A	Hatteras01A	35.34054	-74.85761	950	15MAR12	N/A	continuous	N/A

Notes: For Status of Analysis: HF = high-frequency (odontocete, > 1 kHz) analysis completed; LF = low-frequency (mysticete, < 1 kHz) analysis completed; M = low-frequency analysis completed only for minke whale pulse trains; IP = analysis in progress; N/A = not applicable, because data is not yet available for analysis. Key: JAX = Jacksonville Range Complex; m = meter(s); USWTR=Undersea Warfare Training Range. * = represents the initial duty cycle, but instrument recorded continuously starting 01 January 2008.



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555 **Figure 4. HARP deployment locations in the Cape Hatteras, Onslow Bay, and JAX survey areas.**

From June 2007 until May 2012, 42 line-transect surveys were conducted with a towed hydrophone array in Onslow Bay, resulting in 193 hr of dedicated acoustic monitoring. Additionally, the towed array was deployed during two photo-ID surveys for an additional 14.4 hr of dedicated acoustic monitoring. During these surveys, 51 odontocete groups were both detected acoustically and visually identified as single-species groups. These visually confirmed encounters (with total duration of recordings in parentheses as hr:minutes [min]) included: 25 bottlenose dolphin groups (15:10), 20 Atlantic spotted dolphin groups (11:18), three Risso's dolphin groups (2:08), two short-finned pilot whale groups (1:06), and one rough-toothed dolphin (*Steno bredanensis*) group (0:40).

Between January 2009 and May 2012, 22 line-transect surveys were conducted with a towed hydrophone array off JAX, resulting in 60 hr of dedicated acoustic monitoring. During these surveys, 21 single-species odontocete groups were both detected acoustically and visually identified. These visually confirmed encounters included: nine bottlenose dolphin groups (3:04), nine Atlantic spotted dolphin groups (3:26), two Risso's dolphin groups (0:40), and one short-finned pilot whale group (0:10).

In May 2008, a towed hydrophone array was used for 1.7 hr of dedicated acoustic monitoring during a research cruise off Cape Hatteras. Recordings were made of one short-beaked common dolphin (*Delphinus delphis*) group (0:31). In July 2009, 4 days of line-transect surveys were conducted with a towed hydrophone array off Cape Hatteras, resulting in 15.3 hr of dedicated acoustic monitoring. During these surveys, 16 single-species and two multi-species odontocete groups were both detected acoustically and visually identified. The single-species encounters included: 12 bottlenose dolphin groups (5:41) and four pilot whale groups (2:19). One multi-species group included bottlenose dolphins and pilot whales, and the other multi-species group consisted of Risso's and bottlenose dolphins.

In April 2012, Bio-Waves, Inc. (Dr. Julie Oswald) began to examine species-specificity in whistles of single species schools of delphinids recorded from the efforts described above and from other studies in the western North Atlantic (see **Section 3.4**). Dr. Oswald is developing semi-automated 'classifiers' in order to identify whistles to the species level. If successful, it will be possible to discriminate whistles from some delphinids that currently are unclassifiable in recordings made in the Onslow Bay, JAX, and Cape Hatteras survey areas.

3.2.4 Species Occurrence

In total, 20 cetacean species and three species of sea turtles were identified at Cape Hatteras, Onslow Bay, and JAX, although the number of species varied among sites (**Tables 16 through 18**, respectively), and few cryptic odontocetes could not be identified to species. Selected photographs are found in **Appendix B**. In the Cape Hatteras survey area, 18 cetacean species were documented, but only 13 and 11 cetacean species were observed in Onslow Bay and JAX, respectively, despite greater survey effort in those two survey areas. Large whales were detected both acoustically and visually in all three areas, but many pelagic odontocete species were observed only off Cape Hatteras. Loggerhead and leatherback turtles (*Caretta caretta* and *Dermochelys coricea*, respectively) occurred at all three sites; Kemp's ridley (*Lepidochelys kempii*) turtles were observed only in JAX. Note that, with the exception of the Risso's dolphin, delphinid cetaceans cannot yet be identified to the species level in the HARP records, and no HARP data have been analyzed yet from Cape Hatteras.

Table 16. Species occurrence list for each survey mode in the Cape Hatteras survey area, May 2008 through May 2012.

Common Name	Scientific Name	Towed Array	HARP[1]	Aerial	Vessel
North Atlantic right whale	*Eubalaena glacialis*				
Humpback whale	*Megaptera novaeangliae*			Y	Y
Minke whale	*Balaenoptera acutorostrata*			Y	
Sei whale	*Balaenoptera borealis*				
Fin whale	*Balaenoptera physalus*			Y	Y
Sperm whale	*Physeter macrocephalus*			Y	Y
Unidentified kogiid	*Kogia* sp.			Y	
Cuvier's beaked whale	*Ziphius cavirostris*			Y	Y
Unidentified beaked whale	*Mesoplodon* sp.			Y	
Rough-toothed dolphin	*Steno bredanensis*			Y	
Bottlenose dolphin	*Tursiops truncatus*	Y		Y	Y
Atlantic spotted dolphin	*Stenella frontalis*			Y	Y
Spinner dolphin	*Stenella longirostris*			Y	
Clymene dolphin	*Stenella clymene*			Y	
Striped dolphin	*Stenella coeruleoalba*			Y	
Short-beaked common dolphin	*Delphinus delphis*	Y		Y	Y
Fraser's dolphin	*Lagenodelphis hosei*			Y	
Risso's dolphin	*Grampus griseus*	Y		Y	Y
Melon-headed whale	*Peponocephala electra*			Y	
Short-finned pilot whale	*Globicephala macrorhynchus*	Y		Y	Y
Loggerhead turtle	*Caretta caretta*			Y	Y
Leatherback turtle	*Dermochelys coriacea*			Y	Y
Kemp's ridley turtle	*Lepidochelys kempii*				

Key: HARP = High-frequency Acoustic Recording Package: Y = confirmed occurrence; [1] data have not yet been analyzed.

Table 17. Species occurrence list for each survey mode in the Onslow Bay survey area, June 2007 through May 2012.

Common Name	Scientific Name	Towed Array	HARP	Aerial	Vessel
North Atlantic right whale	*Eubalaena glacialis*				
Humpback whale	*Megaptera novaeangliae*		Y	Y	
Minke whale	*Balaenoptera acutorostrata*		Y	Y	
Sei whale	*Balaenoptera borealis*		P		
Fin whale	*Balaenoptera physalus*		Y	Y	
Sperm whale	*Physeter macrocephalus*		Y	Y	
Unidentified kogiid	*Kogia* sp.		Y		
Cuvier's beaked whale	*Ziphius cavirostris*				
Unidentified beaked whale	*Mesoplodon* sp.			Y	Y
Rough-toothed dolphin	*Steno bredanensis*	Y		Y	Y
Bottlenose dolphin	*Tursiops truncatus*	Y		Y	Y

Common Name	Scientific Name	Towed Array	HARP	Aerial	Vessel
Atlantic spotted dolphin	*Stenella frontalis*	Y		Y	Y
Spinner dolphin	*Stenella longirostris*				
Clymene dolphin	*Stenella clymene*				
Striped dolphin	*Stenella coeruleoalba*				
Short-beaked common dolphin	*Delphinus delphis*			Y	
Fraser's dolphin	*Lagenodelphis hosei*				
Risso's dolphin	*Grampus griseus*	Y	Y	Y	Y
Melon-headed whale	*Peponocephala electra*				
Short-finned pilot whale	*Globicephala macrorhynchus*	Y		Y	Y
Loggerhead turtle	*Caretta caretta*			Y	Y
Leatherback turtle	*Dermochelys coriacea*			Y	Y
Kemp's ridley turtle	*Lepidochelys kempii*				

Key: HARP = High-frequency Acoustic Recording Package; P = possible occurrence; Y = confirmed occurrence.

Table 18. Species occurrence list for each survey mode in the JAX survey area, January 2009 through May 2012.

Common Name	Scientific Name	Towed Array	HARP	Aerial	Vessel
North Atlantic right whale	*Eubalaena glacialis*			Y	
Humpback whale	*Megaptera novaeangliae*			Y	
Minke whale	*Balaenoptera acutorostrata*		Y	Y	
Sei whale	*Balaenoptera borealis*		P		
Fin whale	*Balaenoptera physalus*				
Sperm whale	*Physeter macrocephalus*			Y	
Unidentified kogiid	*Kogia* sp.			Y	
Cuvier's beaked whale	*Ziphius cavirostris*				
Unidentified beaked whale	*Mesoplodon* sp.				
Rough-toothed whale	*Steno bredanensis*			Y	
Bottlenose dolphin	*Tursiops truncatus*	Y		Y	Y
Atlantic spotted dolphin	*Stenella frontalis*	Y		Y	Y
Spinner dolphin	*Stenella longirostris*				
Clymene dolphin	*Stenella clymene*				
Striped dolphin	*Stenella coeruleoalba*				
Short-beaked common dolphin	*Delphinus delphis*				
Fraser's dolphin	*Lagenodelphis hosei*				
Risso's dolphin	*Grampus griseus*	Y	Y	Y	Y
Melon-headed whale	*Peponocephala electra*				
Short-finned pilot whale	*Globicephala macrorhynchus*	Y		Y	Y
Loggerhead turtle	*Caretta caretta*			Y	Y
Leatherback turtle	*Dermochelys coriacea*			Y	Y
Kemp's ridley turtle	*Lepidochelys kempii*			Y	Y

Key: HARP = High-frequency Acoustic Recording Package; P = possible occurrence; Y = confirmed occurrence.

The numbers of sightings and individuals observed during aerial surveys can be used to illustrate species composition and relative abundance of various species across sites, as this survey mode was employed most consistently in a year-round manner in the three areas. A total of 257 cetacean sightings was recorded in Onslow Bay from June 2007 to April 2011 (**Table 19**). Nine species were identified on-effort in Onslow Bay, in addition to one off-effort sighting of a sperm whale (*Physeter macrocephalus*). In JAX, a total of 607 cetacean sightings was recorded (**Table 20**), including two sightings of North Atlantic right whales on the western side of the survey area. Species composition was very similar in Onslow Bay and JAX, with 8 of 11 species sighted at both locations. In Cape Hatteras, both diversity and density were much greater, with 148 sightings of 18 cetacean species recorded from May 2011 to May 2012 (**Table 21**).

Table 19. Cetacean sightings from aerial surveys in the Onslow Bay survey area, June 2007 through April 2011.

Common Name	Scientific Name	Sightings (*n*)	Individuals (*n*)
Bottlenose dolphin	*Tursiops truncatus*	149	2,635
Atlantic spotted dolphin	*Stenella frontalis*	67	1,745
Unidentified delphinid		22	157
Short-finned pilot whale	*Globicephala macrorhynchus*	9	164
Risso's dolphin	*Grampus griseus*	6	38
Rough-toothed dolphin	*Steno bredanensis*	3	40
Unidentified cetacean		2	9
Minke whale	*Balaenoptera acutorostrata*	2	3
Common dolphin	*Delphinus delphis*	1	20
Humpback whale	*Megaptera novaeangliae*	1	2
Sperm whale	*Physeter macrocephalus*	1	1
Fin whale	*Balaenoptera physalus*	1	1
Total		**264**	**4,815**

Table 20. Cetacean sightings from aerial surveys in the JAX survey area, January 2009 through May 2012.

Common Name	Scientific Name	Sightings (*n*)	Individuals (*n*)
Bottlenose dolphin	*Tursiops truncatus*	263	2,363
Atlantic spotted dolphin	*Stenella frontalis*	230	4,206
Unidentified delphinid		48	171
Risso's dolphin	*Grampus griseus*	33	515
Short-finned pilot whale	*Globicephala macrorhynchus*	13	204
Minke whale	*Balaenoptera acutorostrata*	9	13
Rough-toothed dolphin	*Steno bredanensis*	4	164

Common Name	Scientific Name	Sightings (*n*)	Individuals (*n*)
North Atlantic right whale	*Eubalaena glacialis*	3	5
Humpback whale	*Megaptera novaeangliae*	2	2
Sperm whale	*Physeter macrocephalus*	1	2
Unidentified kogiid	*Kogia* sp.	1	1
Unidentified cetacean		1	1
Total		**608**	**7,647**

Table 21. Cetacean sightings from aerial surveys in the Cape Hatteras survey area, May 2011 through May 2012.

Common Name	Scientific Name	Sightings (*n*)	Individuals (*n*)
Bottlenose dolphin	*Tursiops truncatus*	42	826
Short-finned pilot whale	*Globicephala macrorhynchus*	25	442
Sperm whale	*Physeter macrocephalus*	13	22
Unidentified beaked whale	*Mesoplodon* sp.	9	19
Common dolphin	*Delphinus delphis*	9	975
Atlantic spotted dolphin	*Stenella frontalis*	7	235
Unidentified cetacean		8	9
Unidentified delphinid		6	34
Cuvier's beaked whale	*Ziphius cavirostris*	5	11
Fin whale	*Balaenoptera physalus*	5	8
Striped dolphin	*Stenella coeruleoalba*	4	885
Minke whale	*Balaenoptera acutorostrata*	4	8
Clymene dolphin	*Stenella clymene*	1	70
Risso's dolphin	*Grampus griseus*	1	13
Humpback whale	*Megaptera novaeangliae*	2	2
Melon-headed whale	*Peponocephala electra*	2	395
Fraser's dolphin	*Lagenodelphis hosei*	1	75
Spinner dolphin	*Stenella longirostris*	1	70
Rough-toothed dolphin	*Steno bredanensis*	1	4
Unidentified balaenopterid	*Balaenoptera* sp.	1	1
Unidentified kogiid	*Kogia* sp.	1	1
Total		**148**	**4,105**

3.2.5 Estimation of Density

Monthly estimates of density have been made only for Onslow Bay, although preliminary analyses have been conducted for JAX. No analysis has been conducted yet for Cape Hatteras. In general, the density of cetaceans was relatively very low in Onslow Bay and the numbers of sightings were sufficient to estimate density only for Atlantic spotted and bottlenose dolphins. These density estimates are included in a manuscript that has been submitted to the *Journal of Cetacean Research and Management* .

Aerial and vessel line-transect surveys from the earlier aerial surveys (from 1998-1999) were included to increase the number of observations available for analysis. Estimated abundance of bottlenose dolphins in the Onslow Bay survey area varied between 800 (95 percent confidence interval [CI95]: 100-5,000, August 2007) and 5,200 (1,700-24,300, May 2010) individuals. The maximum value in May 2010 corresponds to a density of 0.972 km^{-2} (CI95: 0.310-4.556). Atlantic spotted dolphins were detected less frequently than bottlenose dolphins and, given the small numbers detected, estimates of abundance were associated with wide CI95. Atlantic spotted dolphins were not observed in the 1998 and 1999 aerial surveys (McLellan et al. 1999). Maximum Atlantic spotted dolphin abundance in the Onslow Bay survey area was 4,200 individuals (CI95: 2,700-30,400) in February 2009, which corresponded to a maximum density of 1.38 km^{-2} (CI95: 0.509-5.703).

3.2.6 Distribution and Seasonality

Quantitative analysis of distribution and seasonality, as described in the aforementioned manuscript submission, has been conducted only for bottlenose and Atlantic spotted dolphins in Onslow Bay. It is, however, possible to draw some qualitative conclusions regarding additional species in the Cape Hatteras and JAX survey areas.

In Onslow Bay, bottlenose dolphins were encountered throughout the survey area, although most frequently at intermediate depths, with maximum values of presence occurring just off the continental shelf break (**Figures 5 through 8**). Abundance of this species varied both across and within years with peak occurrence in spring and, to a slightly lesser extent, autumn. Atlantic spotted dolphins exhibited a very strong preference for waters over the continental shelf (**Figures 5 through 8**) and their presence was not influenced strongly by either water temperature or season. In Onslow Bay, pelagic odontocetes were observed only in deeper waters seaward of the continental shelf break (**Figures 5 through 8**).

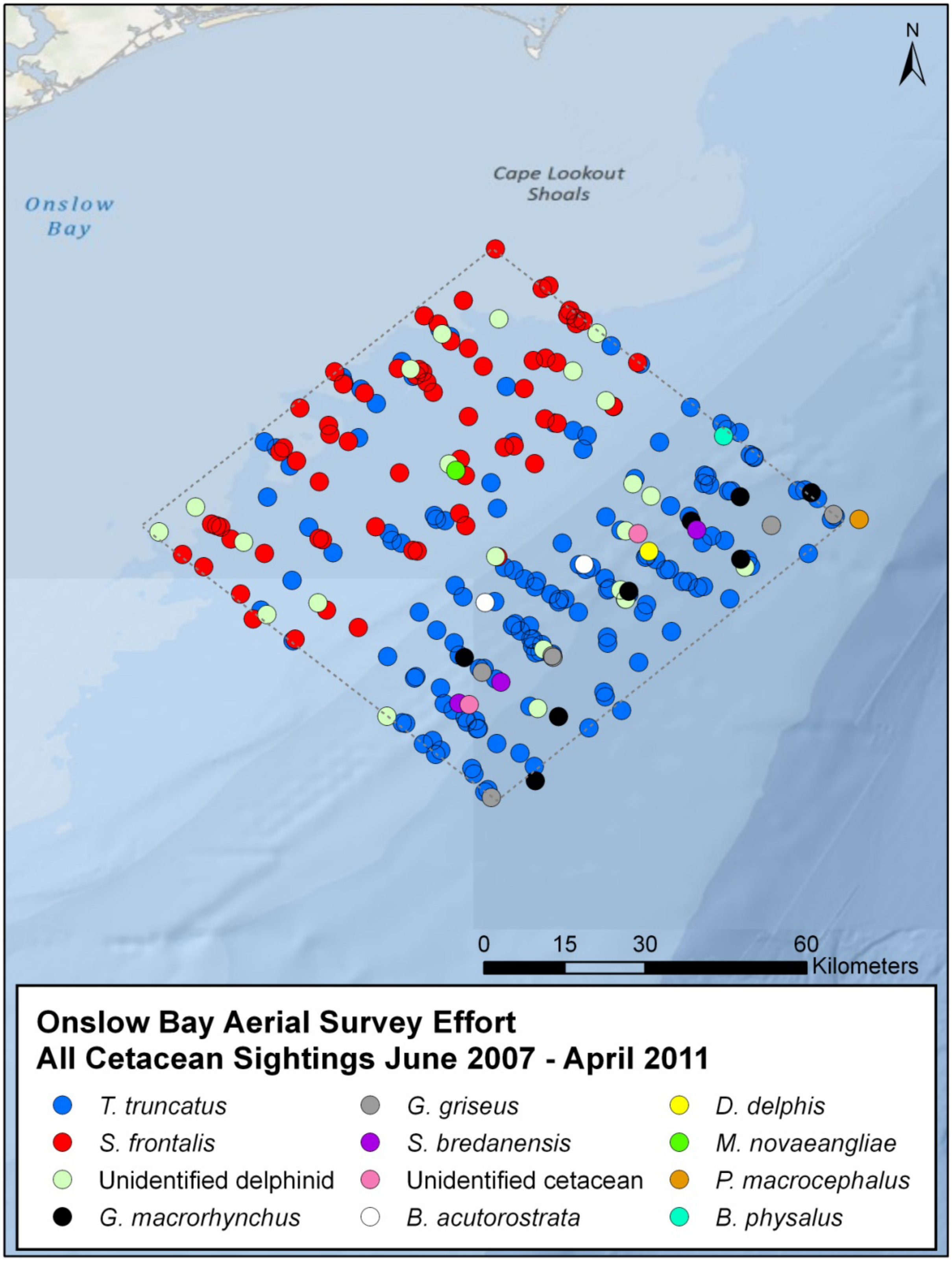


Figure 5. All cetacean sightings from aerial surveys conducted in the Onslow Bay survey area, June 2007 through April 2011.

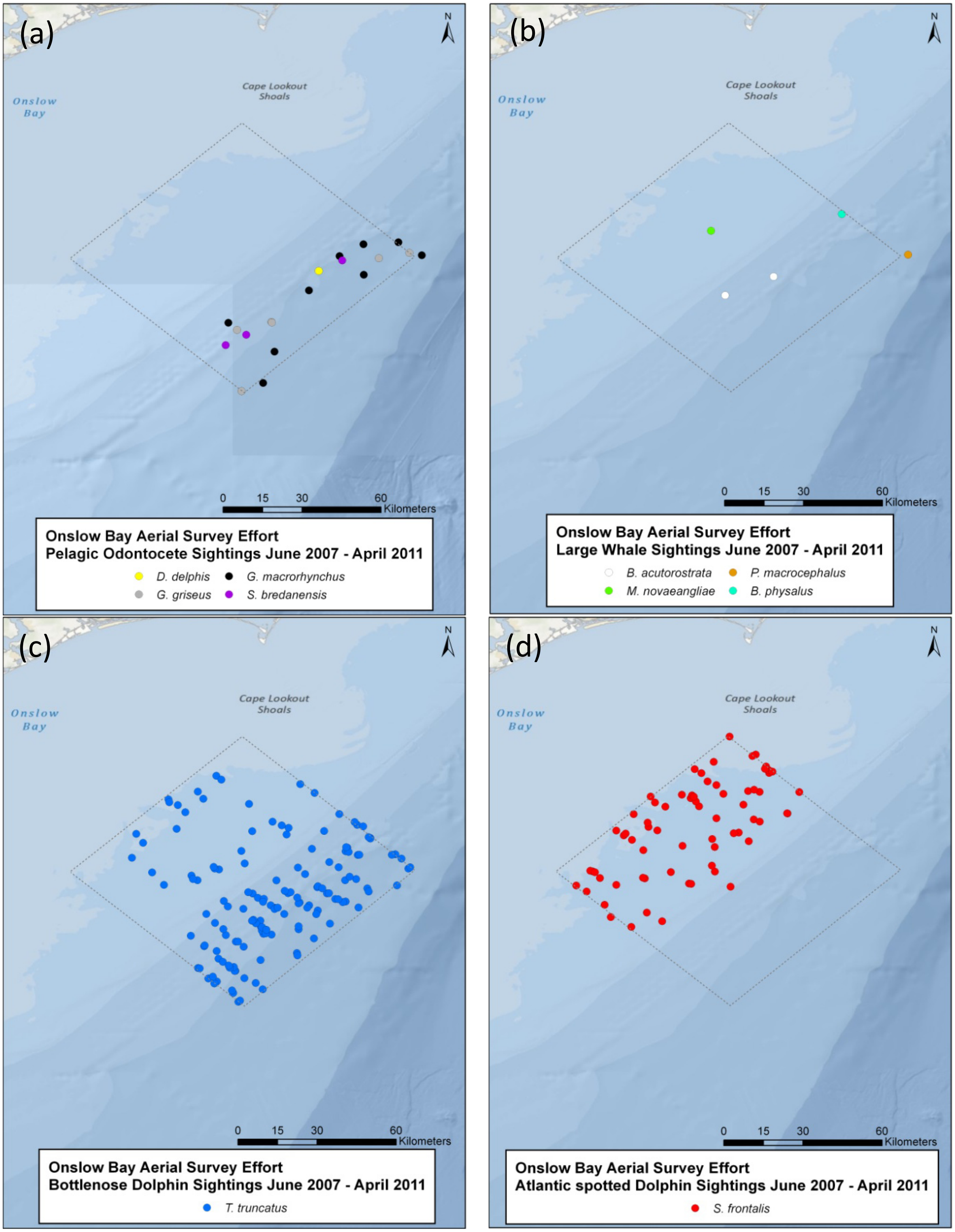


Figure 6. Cetacean sightings from aerial surveys conducted in the Onslow Bay survey area: (a) pelagic delphinids; (b) large whales; (c) bottlenose dolphins; and (d) Atlantic spotted dolphins, June 2007 through April 2011.

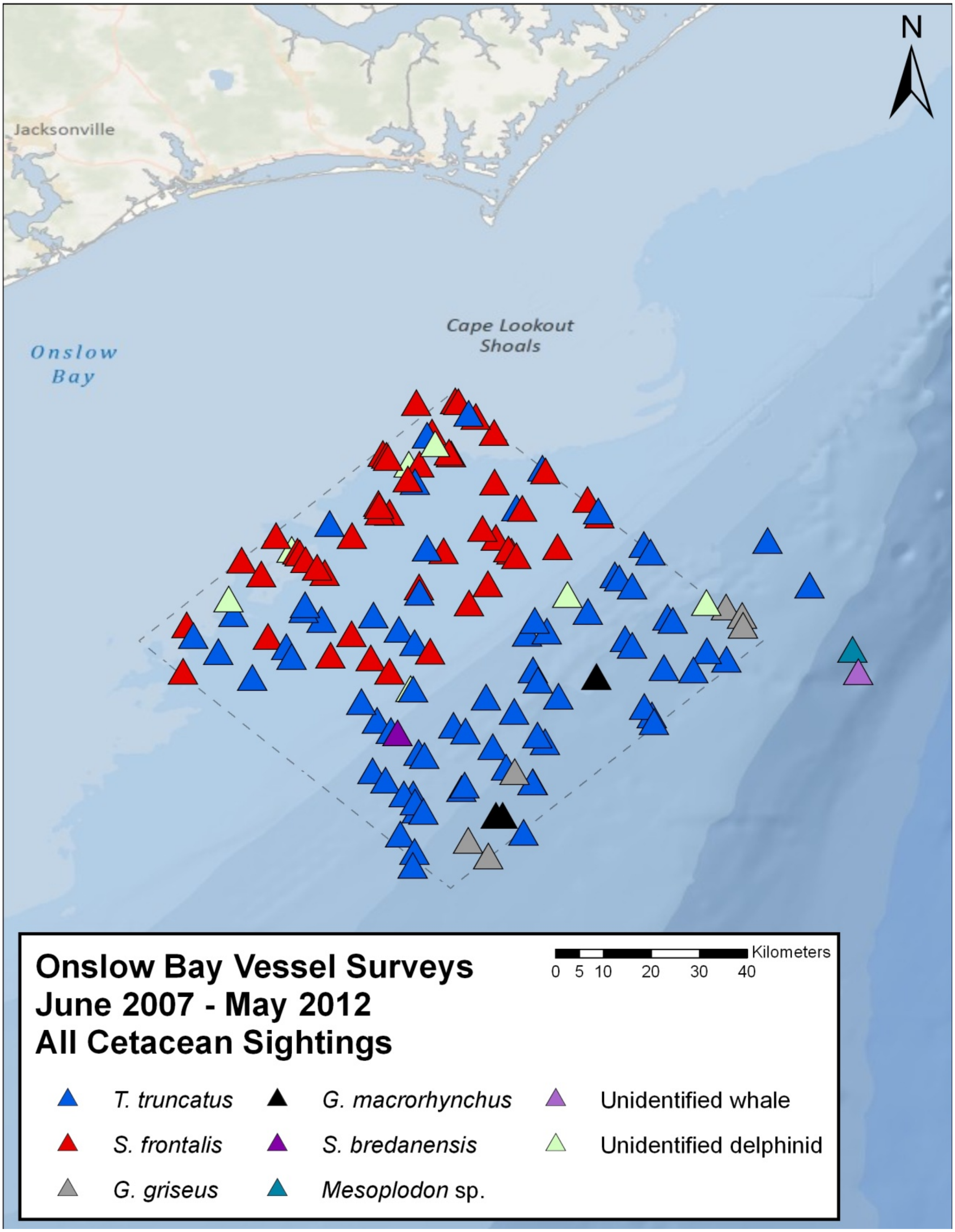


Figure 7. All cetacean sightings from vessel surveys conducted in the Onslow Bay survey area, June 2007 through May 2012.

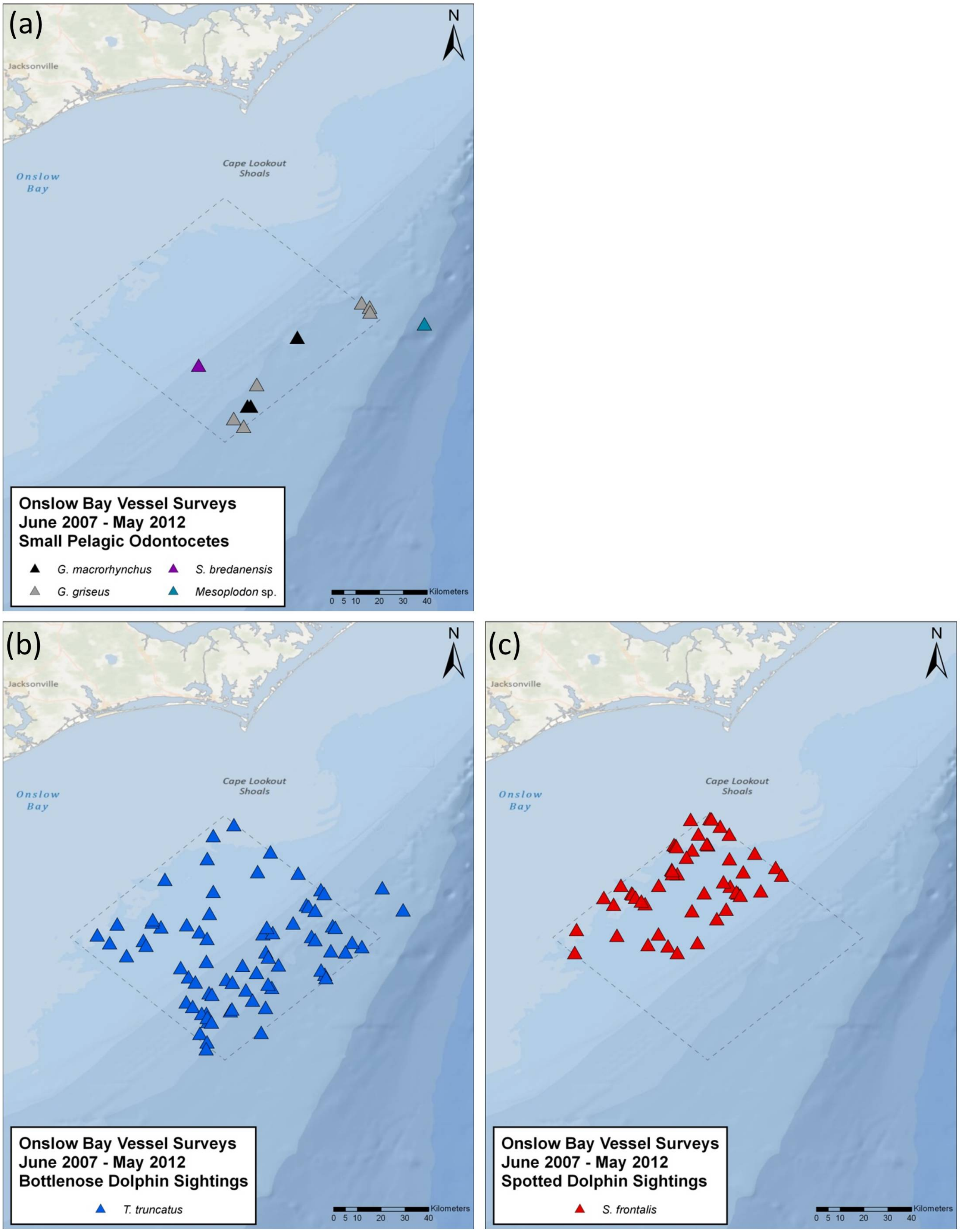


Figure 8. Cetacean sightings from vessel surveys conducted in Onslow Bay: (a) pelagic delphinids; (b) bottlenose dolphins; and (c) Atlantic spotted dolphins, June 2007 through May 2012.

Distribution patterns of cetaceans in the JAX survey area (**Figures 9 through 12**) were, in general, similar to those observed in Onslow Bay, with Atlantic spotted dolphins restricted to shelf waters and bottlenose dolphins observed throughout the survey area. Rough-toothed dolphins were the only other odontocete species routinely observed in waters over the continental shelf; all other odontocetes were observed in deeper waters seaward of the continental shelf break (**Figures 9 through 12**).

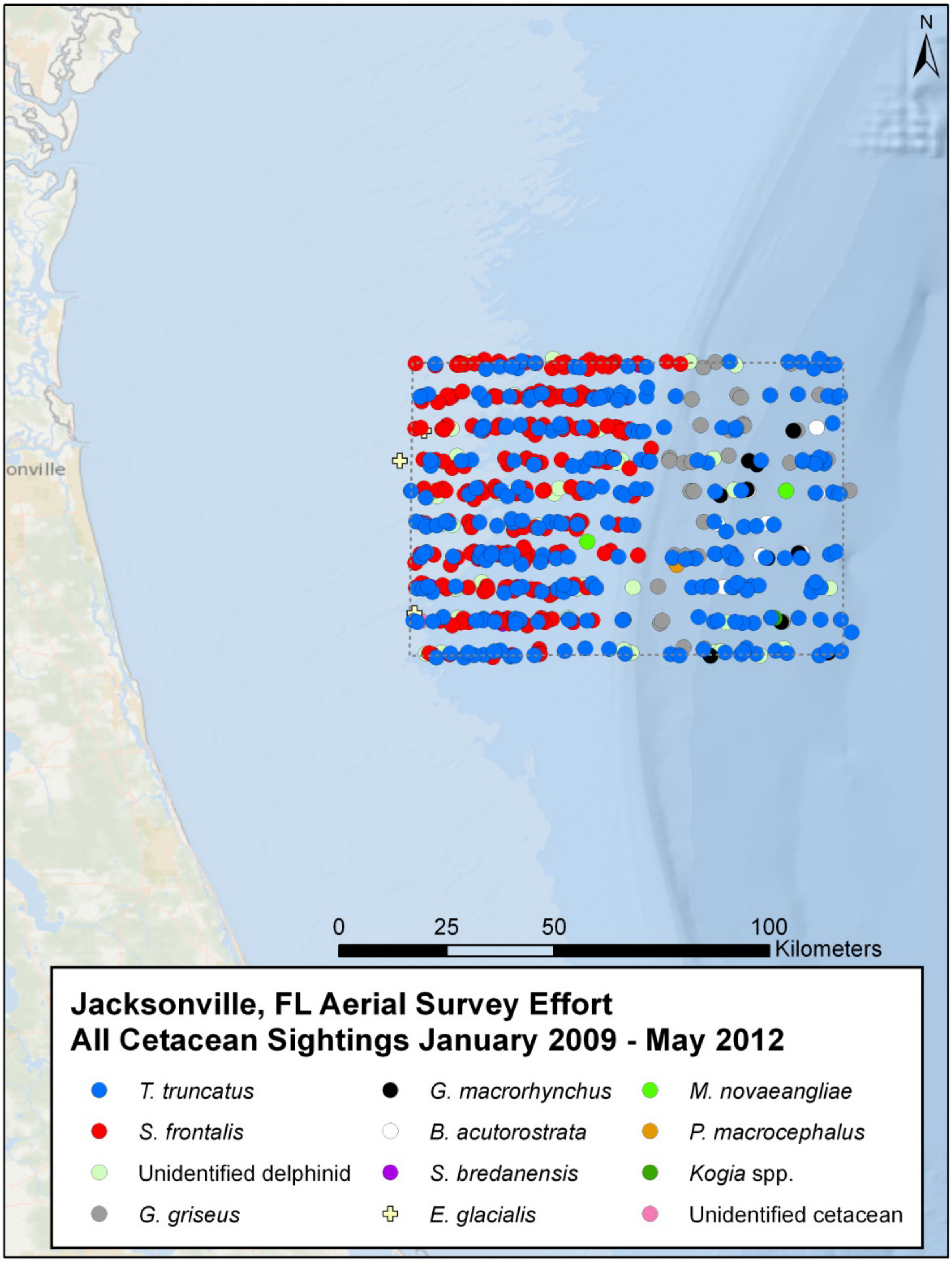


Figure 9. All cetacean sightings from aerial surveys conducted in the JAX survey area, January 2009 through May 2012.

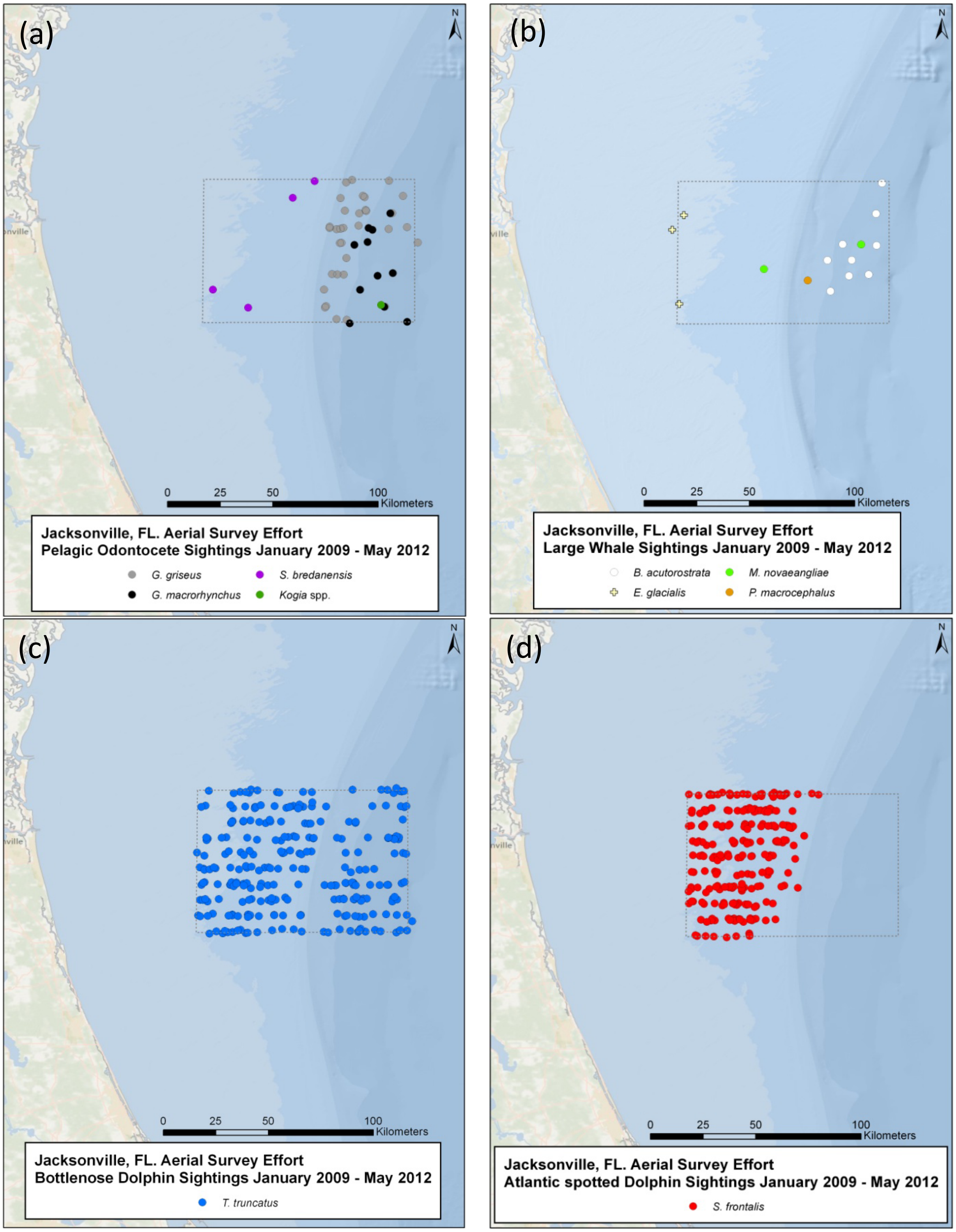


Figure 10. Cetacean sightings from aerial surveys conducted in the JAX survey area: (a) pelagic delphinids; (b) large whales; (c) bottlenose dolphins; and (d) Atlantic spotted dolphins, January 2009 through May 2012.

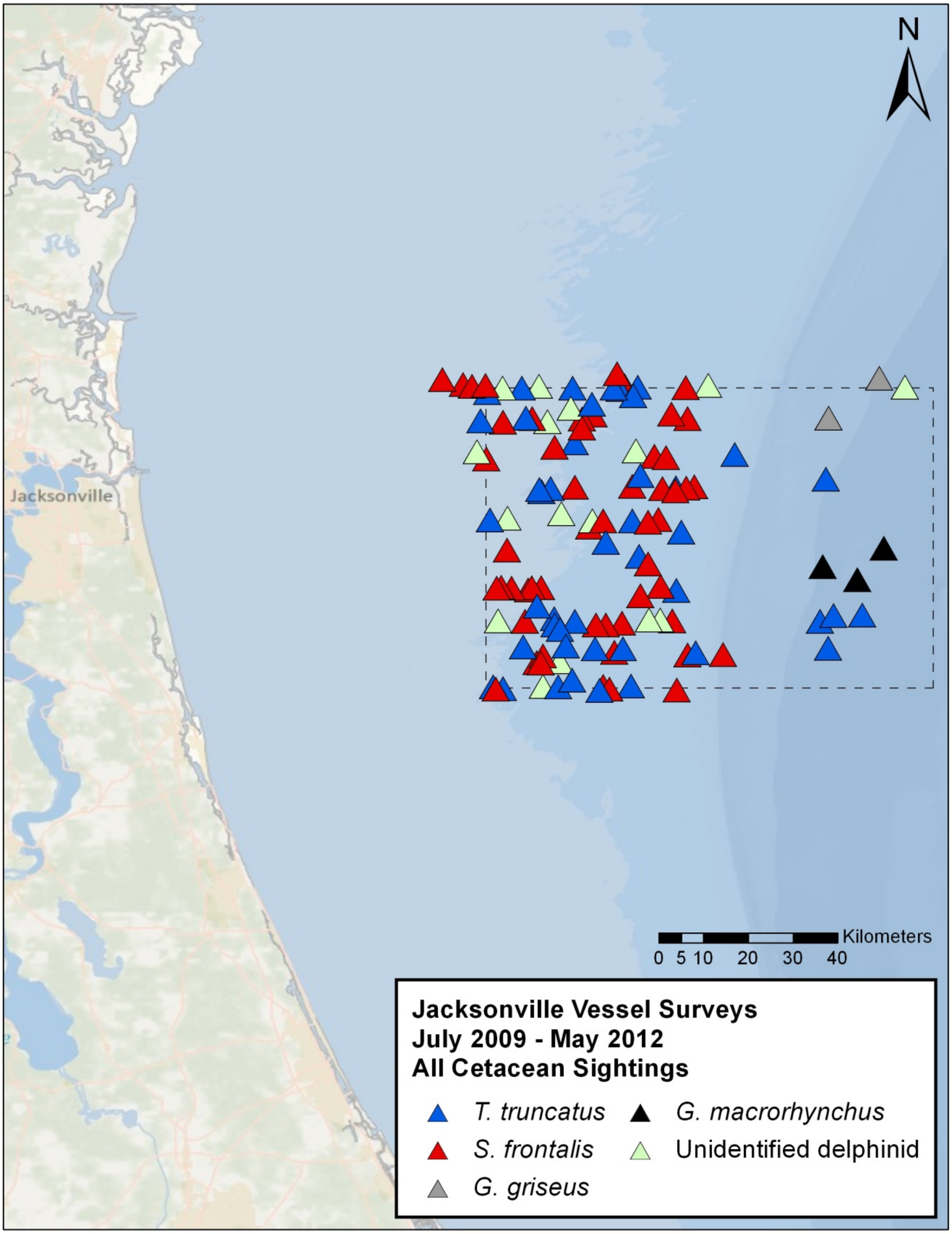


Figure 11. All cetacean sightings from vessel surveys conducted in the JAX survey area, July 2009 through May 2012.

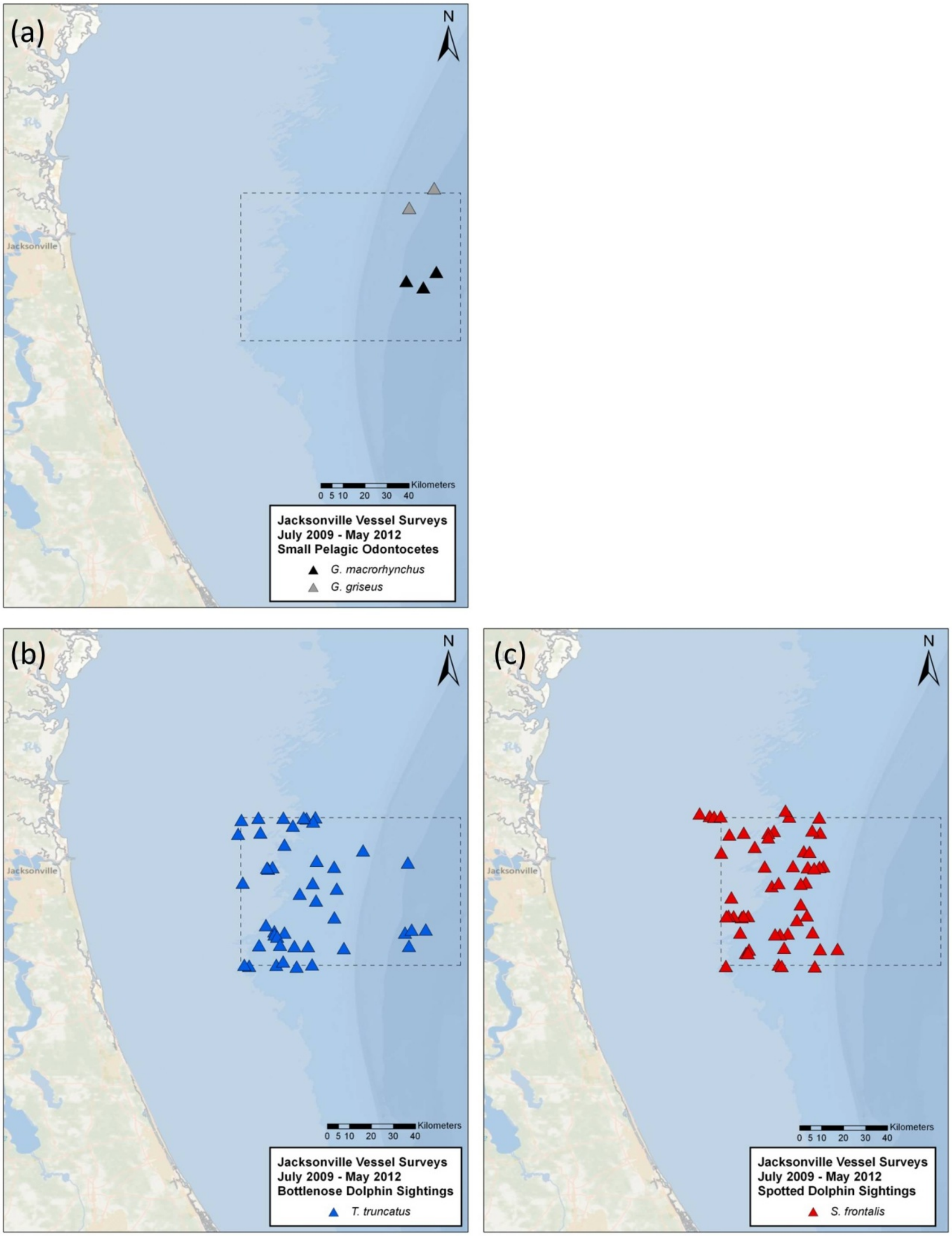


Figure 12. Cetacean sightings from vessel surveys conducted in the JAX survey area: (a) pelagic delphinids, (b) bottlenose dolphins, and (c) Atlantic spotted dolphins, July 2009 through May 2012.

The distribution of cetaceans off Cape Hatteras (**Figures 13 through 16**) was distinct from that observed in Onslow Bay and JAX in several respects. First, as noted above, there was a greater diversity of cetaceans observed in the Cape Hatteras survey area, particularly along the continental shelf break, where several relatively rarely observed delphinids were sighted, including Fraser's dolphin, Clymene dolphin, and melon-headed whale. Furthermore, Atlantic spotted dolphins were observed both over the shelf, as in Onslow Bay and JAX, and also in deeper waters beyond the shelf break, where the small-bodied pelagic form of this species occurs. Unlike the other two areas, short-finned pilot whales form a dominant component of the cetacean fauna off Cape Hatteras, where other deep-diving teuthophagous (i.e., feeding solely on cephalopods) species, such as sperm and beaked whales, also occur with relative frequency. Similar to the other two sites, bottlenose dolphins occurred throughout the Cape Hatteras survey area.

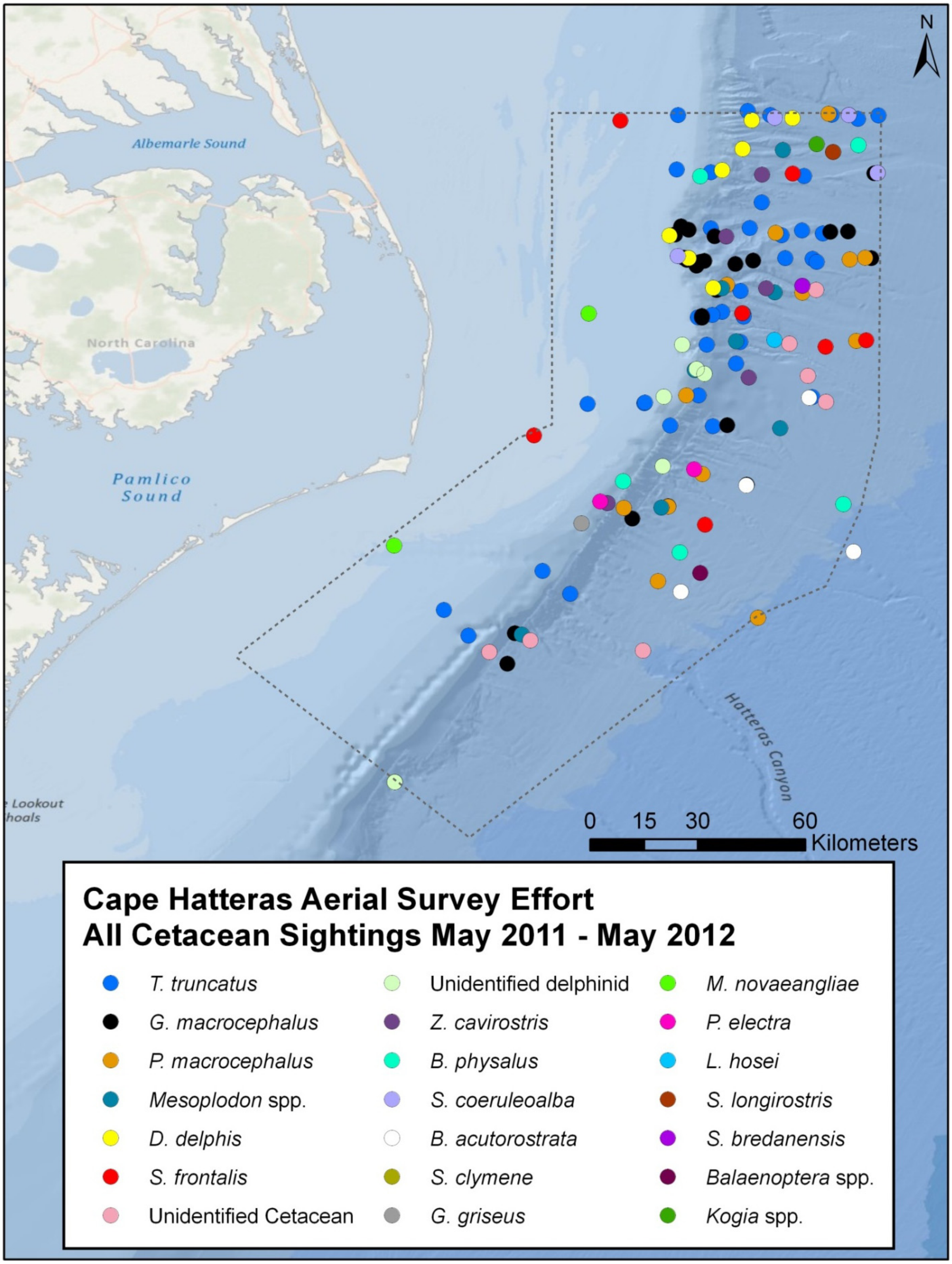


Figure 13. All cetacean sightings from aerial surveys conducted in the Cape Hatteras survey area, May 2011 through May 2012.

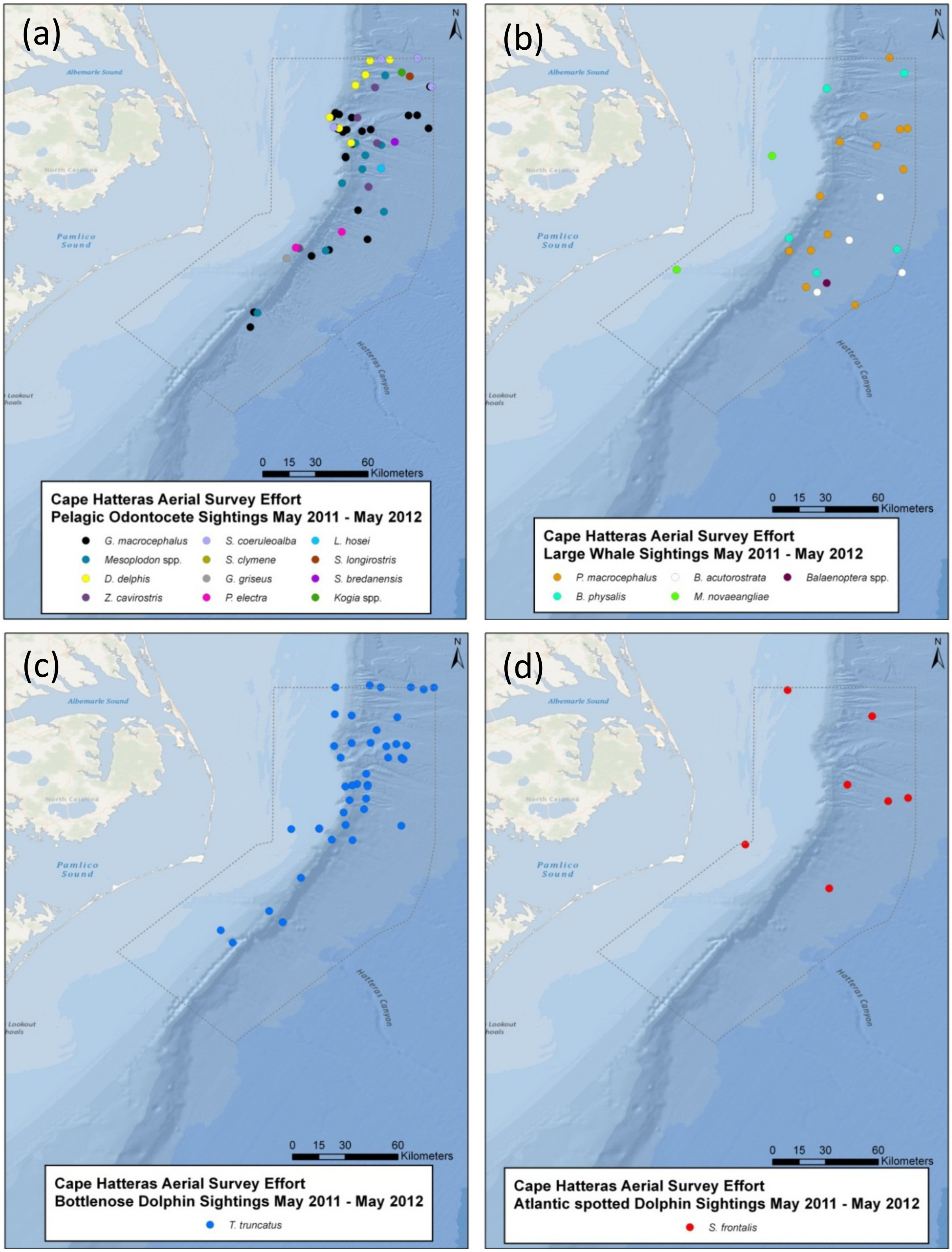


Figure 14. Cetacean sightings from aerial surveys conducted in the Cape Hatteras survey area: (a) pelagic delphinids, (b) large whales, (c) bottlenose dolphins, and (d) Atlantic spotted dolphins, May 2011 through May 2012.

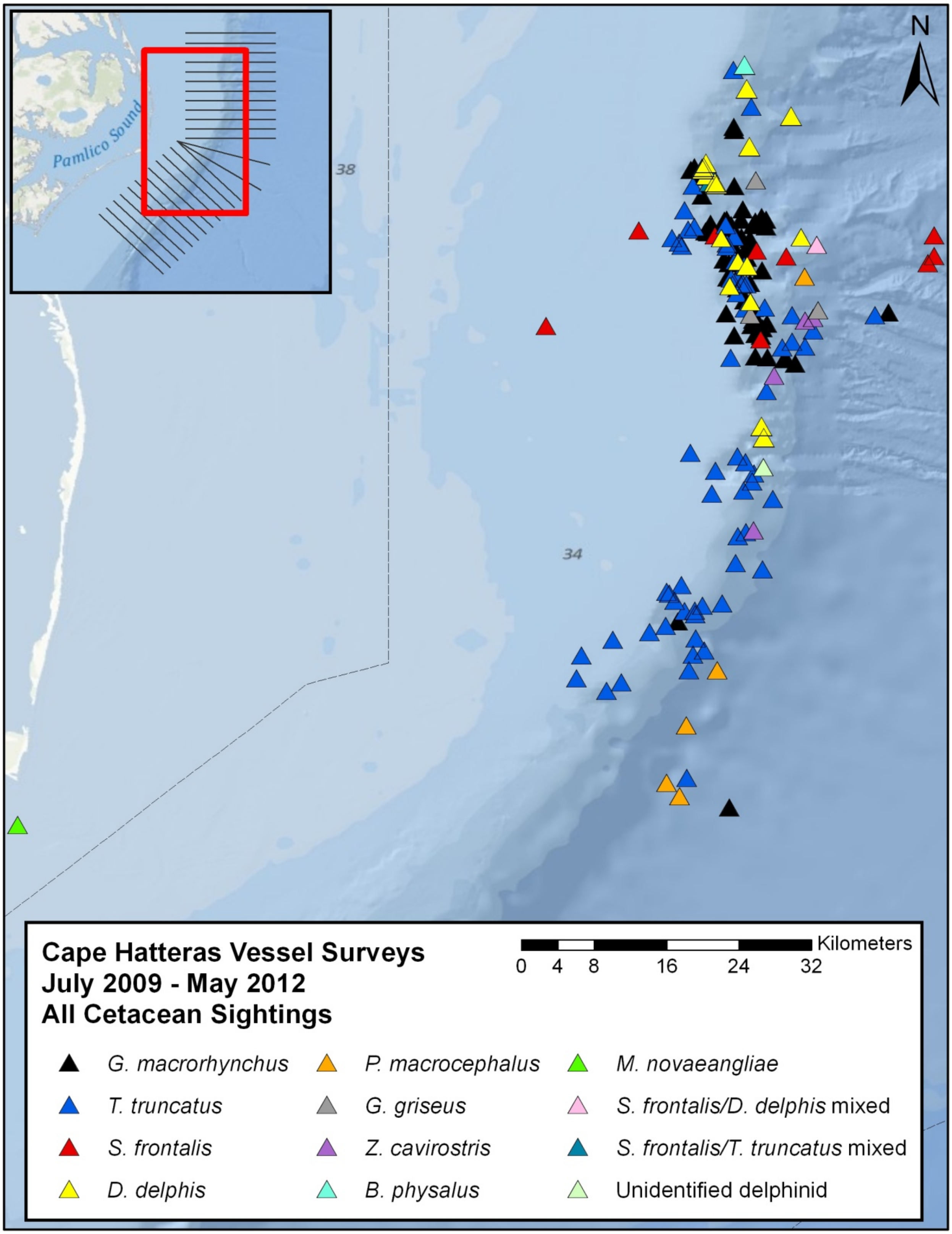


Figure 15. All cetacean sightings from vessel surveys conducted in the Cape Hatteras survey area, July 2009 through May 2012.

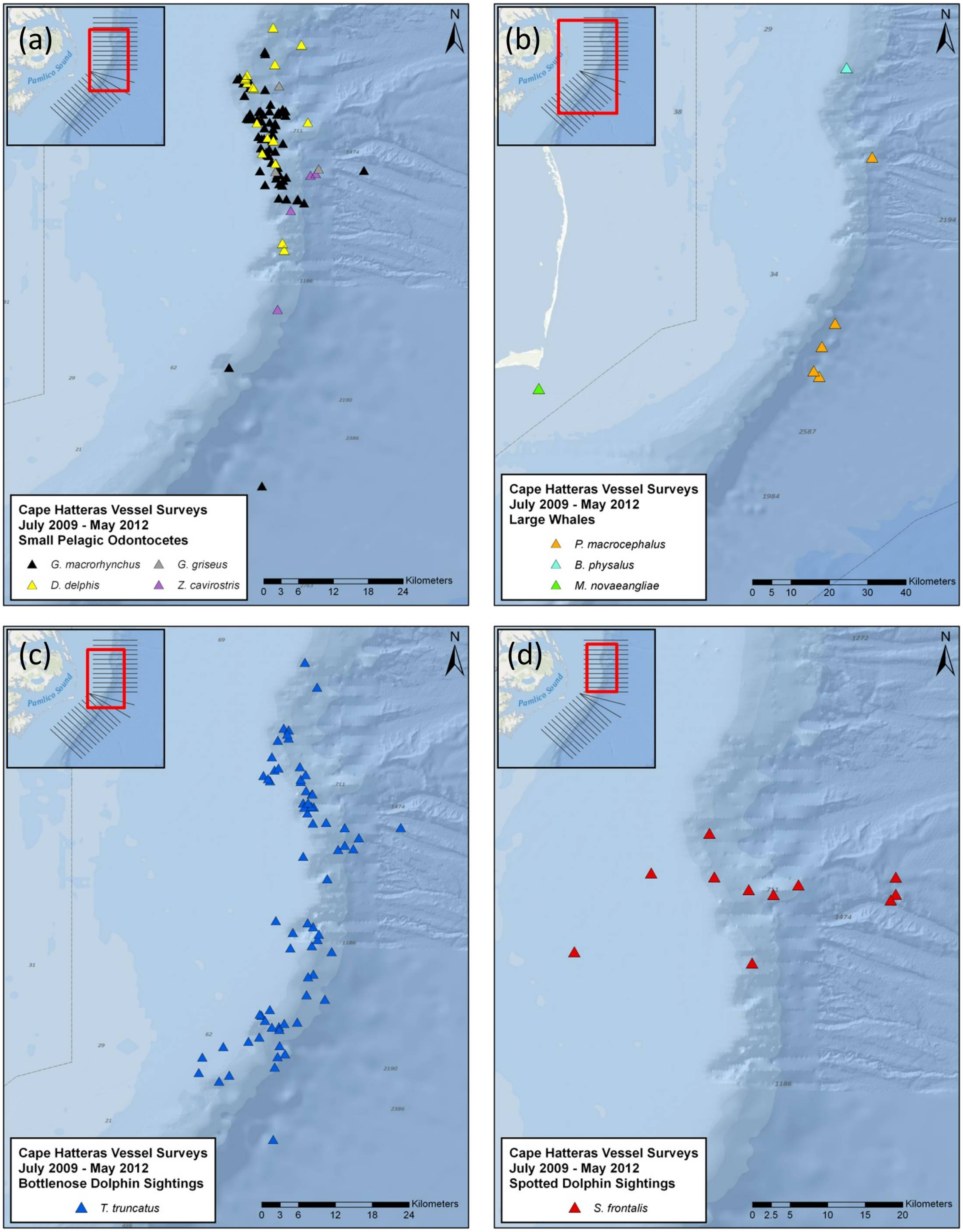


Figure 16. Cetacean sightings from vessel surveys conducted in the Cape Hatteras survey area: (a) pelagic delphinids; (b) large whales; (c) bottlenose dolphins; and (d) Atlantic spotted dolphins, July 2009 through May 2012.

Several aspects of the occurrence and distribution of baleen whales are worth noting. First, the occurrence of vocalizing baleen whales in Onslow Bay was extremely seasonal, as indicated by analysis of HARP deployments 01A-04C, which are the only deployments to be fully analyzed to date. Fin, minke, possible sei, and humpback whale calls were recorded on these HARPs between November and April, but not during other months (**Figures 17 through 20**). Except for the humpback whale calls, which were recorded on a single day in April 2010, all mysticete calls occurred throughout the winter when these species groups are expected to be on breeding grounds. Data from HARP deployments 01B-06B in JAX have been analyzed only for the presence of minke whales. No minke whale calls were detected at the shallow site (Site B), but pulse trains from this species were recorded at the deeper site (Site A), between December and March (**Figure 20**). Although the analysis of the JAX recordings focused on minke whales, sei whale calls were also detected in November and December. Recordings of minke whale calls have been provided to the NEFSC (Denise Risch), for an analysis of seasonality of the vocalizations of this species at the ocean basin level.

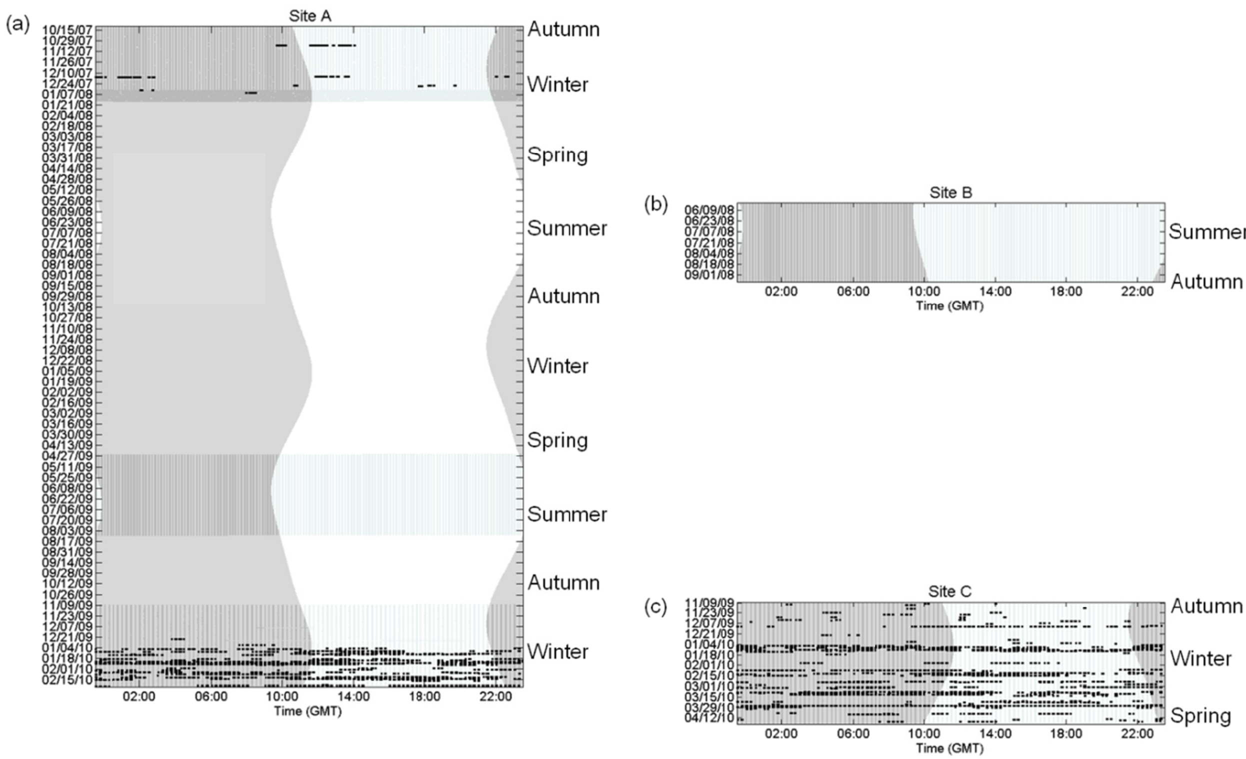


Figure 17. Daily occurrence of fin whale 20-Hz pulse events (black horizontal bars) in Onslow Bay for (a) Site A, (b) Site B, and (c) Site C. Dark shading indicates periods of darkness, determined from the U.S. Naval Observatory. Lighter shading indicates periods of effort.

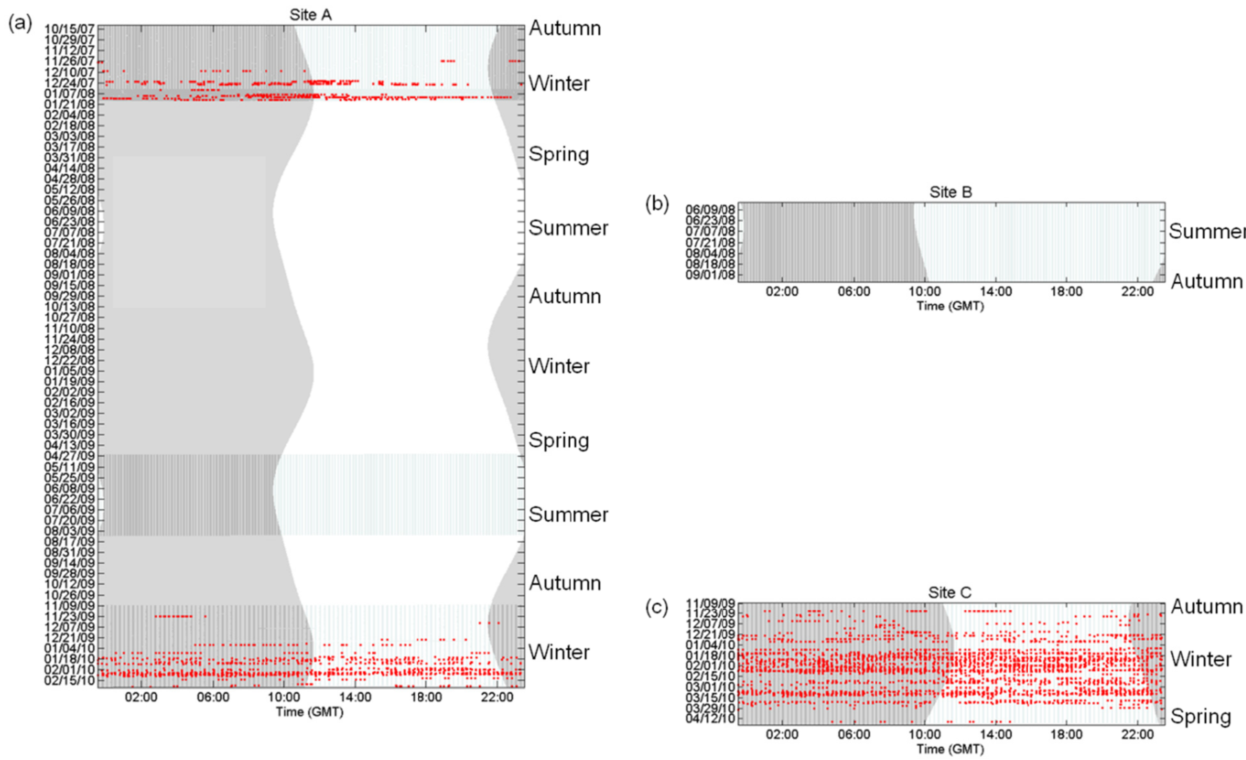


Figure 18. Daily occurrence of minke whale pulse train events (red horizontal bars) in Onslow Bay for (a) Site A, (b) Site B, and (c) Site C. Dark shading indicates periods of darkness, determined from the U.S. Naval Observatory. Lighter shading indicates periods of effort.

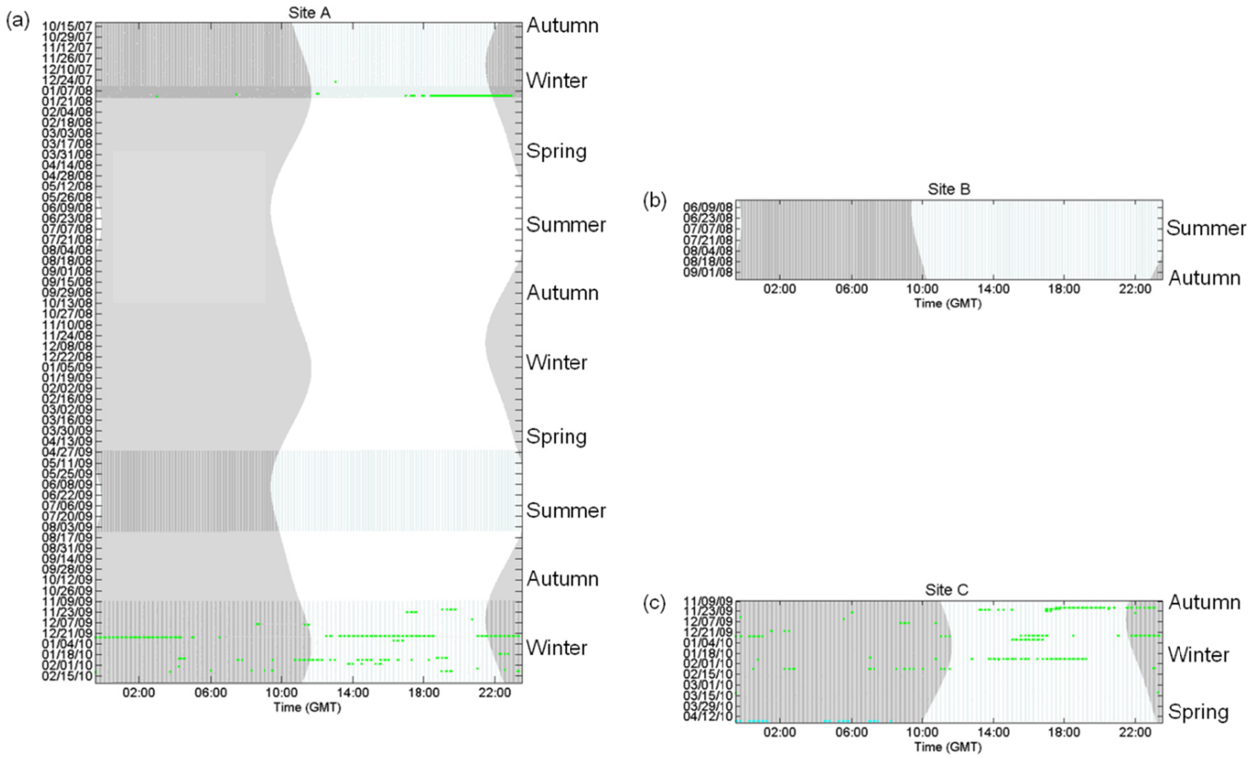


Figure 19. Daily occurrence of low-frequency downsweeps (green horizontal bars) and humpback whale vocal events (blue horizontal bars) in Onslow Bay for (a) Site A, (b) Site B, and (c) Site C. The low-frequency downsweeps are similar to those described by Baumgartner et al. (2008), which were ascribed to sei whales based on the degree of association between visual sightings and call occurrence. Dark shading indicates periods of darkness, determined from the U.S. Naval Observatory. Lighter shading indicates periods of effort.

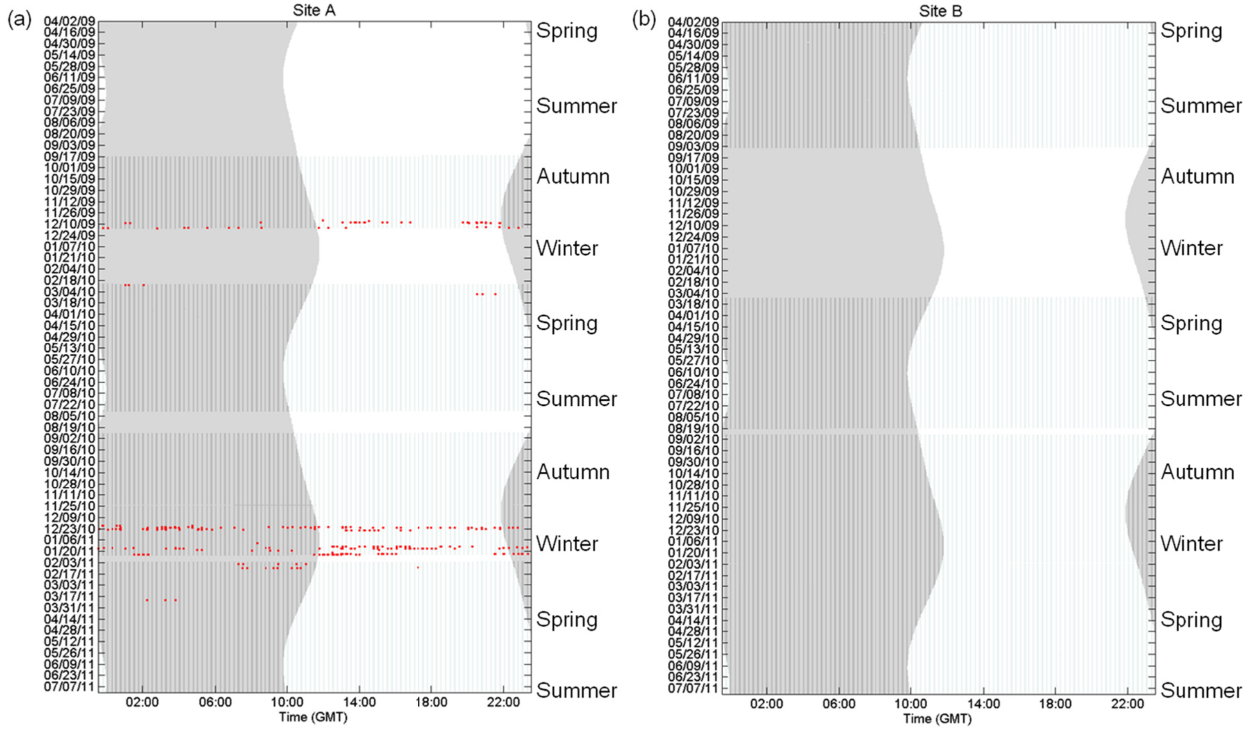


Figure 20. Daily occurrence of minke whale pulse train events (red horizontal bars) in JAX for (a) Site A (deep) and (b) Site B (shallow). Note the absence of pulse trains from Site B. Dark shading indicates periods of darkness, determined from the U.S. Naval Observatory. Lighter shading indicates periods of effort.

The feeding grounds of minke whales in the western North Atlantic have been well-described (Lynas and Sylvestre 1988; Waring et al. 2012), but little information exists on their winter distribution and calving grounds (Waring et al. 2012). In addition to acoustic detections of minke whales, seasonal observations in each of the three survey areas during visual surveys suggest that females with their calves occur in waters beyond the continual shelf break along the southeastern United States. Sightings were recorded from December through March, and consisted of single or paired adults, as well as mother-calf pairs at each site. Minke whales were most abundant in the JAX OPAREA, where they were observed over consecutive winter seasons. Mother-calf pairs comprised the majority of sightings (60 percent: n=9 of 15) in all three survey areas.

The only known calving area for the North Atlantic right whale is located in the shallow waters off the southeastern United States, inshore of the JAX survey area (e.g., Kraus et al. 1988; Garrison 2007). For 16 years, Early Warning System (EWS) surveys have been conducted in this area to monitor right whale distribution and calf production (Brown et al. 2007). Zani et al. (2008) observed a live birth of a right whale calf on 01 January 2005, 31 km offshore Talbot Island, Florida. On 20 March 2010, during a U.S. Navy-funded aerial survey of the JAX survey area, a single right whale was observed 63 km offshore St. Augustine, Florida (Foley et al. 2011; **Figure 21**). The whale was observed for approximately 24 min prior to descending from the surface. Four min later, following the appearance of two blood clouds in the water, a small calf surfaced next to the clouds. The neonate's flukes were limp with ventrally-curled tips, and fetal folds were visible on its flanks. After 34 seconds alone at the surface, during which time the calf was breathing and swimming unassisted, the mother moved to within 10 meters (m) and the pair swam together in a circular fashion. Three min later, after active bleeding ended, the first tactile interactions between the mother and calf were observed. Ten to 13 min after the birth, behaviors interpreted as attempted nursing were observed. The observation of the birth of a North Atlantic right whale offers interesting biological insights into this endangered whale. The location of these two calving events, outside of all current North Atlantic right whale management areas, identify the need for expanding critical habitat and associated management plans vital to the continued recovery of this species. Two other right whale sightings were made in the vicinity of the JAX survey area. On the same day of the observed birth, 20 March 2010, a single adult male (Right Whale # 2303) was observed later in the afternoon. Additionally, a mother-calf pair (Right Whale # 3360 and calf) was observed while transiting to the JAX survey area after refueling on 02 April 2010, a date after that normally surveyed by the EWS flights.

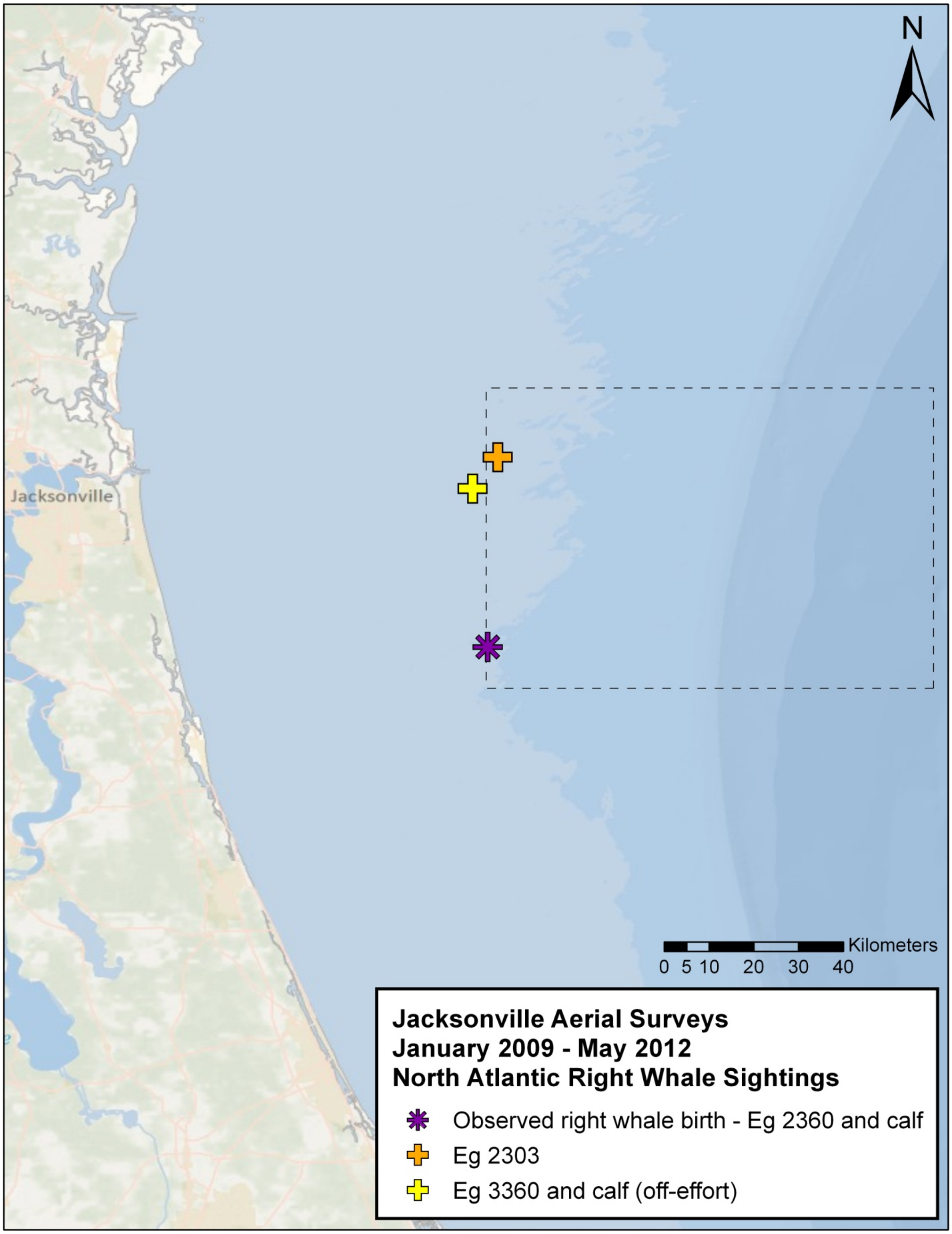


Figure 21. North Atlantic right whale sightings from aerial surveys conducted in the JAX survey area, January 2009-May 2012.

3.2.7 Residency Patterns

Every attempt is made to photograph all animals encountered during vessel surveys, both to validate species identification and to develop photo-ID catalogs. Images taken during these surveys have proven to be extremely helpful in resolving questions of species identity in sightings made from the aerial survey platform. The time-consuming analysis of these images at all three sites is presently ongoing. Photo-ID of dolphins observed from surface vessels during July 2009 in the Cape Hatteras survey area commenced in May 2012. Additions to the catalog are ongoing (**Table 22**). No matches have been made to-date for Cape Hatteras.

Table 22. Individual identifications from images taken during vessel-based surveys in the Cape Hatteras survey area, July 2009.

Common Name	Scientific Name	Sightings (*n*)	Images (*n*)	Catalog Size (*n*)
Bottlenose dolphin	*Tursiops truncatus*	23	824	53
Short-finned pilot whale	*Globicephala macrorhynchus*	9	657	19
Risso's dolphin	*Grampus griseus*	1	58	1

The photo-ID catalogs of bottlenose and Atlantic spotted dolphins from Onslow Bay continue to grow (**Table 23**) and analysis is now complete for all images taken through May 2012. Since the beginning of the monitoring program in 2007, 6 percent (*n*=7 of 127) of bottlenose dolphins in Onslow Bay have been re-sighted, which is surprisingly high despite limited photographic sampling effort. Interestingly, two bottlenose dolphins (Ttr 7-015 and Ttr 8-009) were seen together in both April 2009 and April 2010. Two other dolphins photographed together during January 2012 were matched to the catalog from different days. One of these individuals (Ttr 1-004) has now been photographed on three separate occasions (**Figure 22**). Three biopsy samples have been collected from bottlenose dolphins in Onslow Bay, and two of these were obtained from well-marked individuals included in the photo-ID catalog.

Table 23. Individual identifications of bottlenose and Atlantic spotted dolphins from images taken during vessel-based surveys in Onslow Bay.

Common Name	Scientific Name	Year 1 June 2007-June 2008		Year 2 July 2008-June 2009		Year 3 July 2009-June 2010		Year 4 July 2010-Dec 2011		Year 5 Jan 2012-May 2012	
		Catalog Size (*n*)	Matches (*n*)	Catalog Size (*n*)	Matches (*n*)	Catalog Size (*n*)	Matches (*n*)	Catalog Size (*n*)	Matches (*n*)	Catalog Size (*n*)	Matches (*n*)
Bottlenose dolphin	*Tursiops truncatus*	52	0	78	0	106	5	112	5	127	7
Atlantic spotted dolphin	*Stenella frontalis*	3	0	29	0	49	1	68	2	68	2

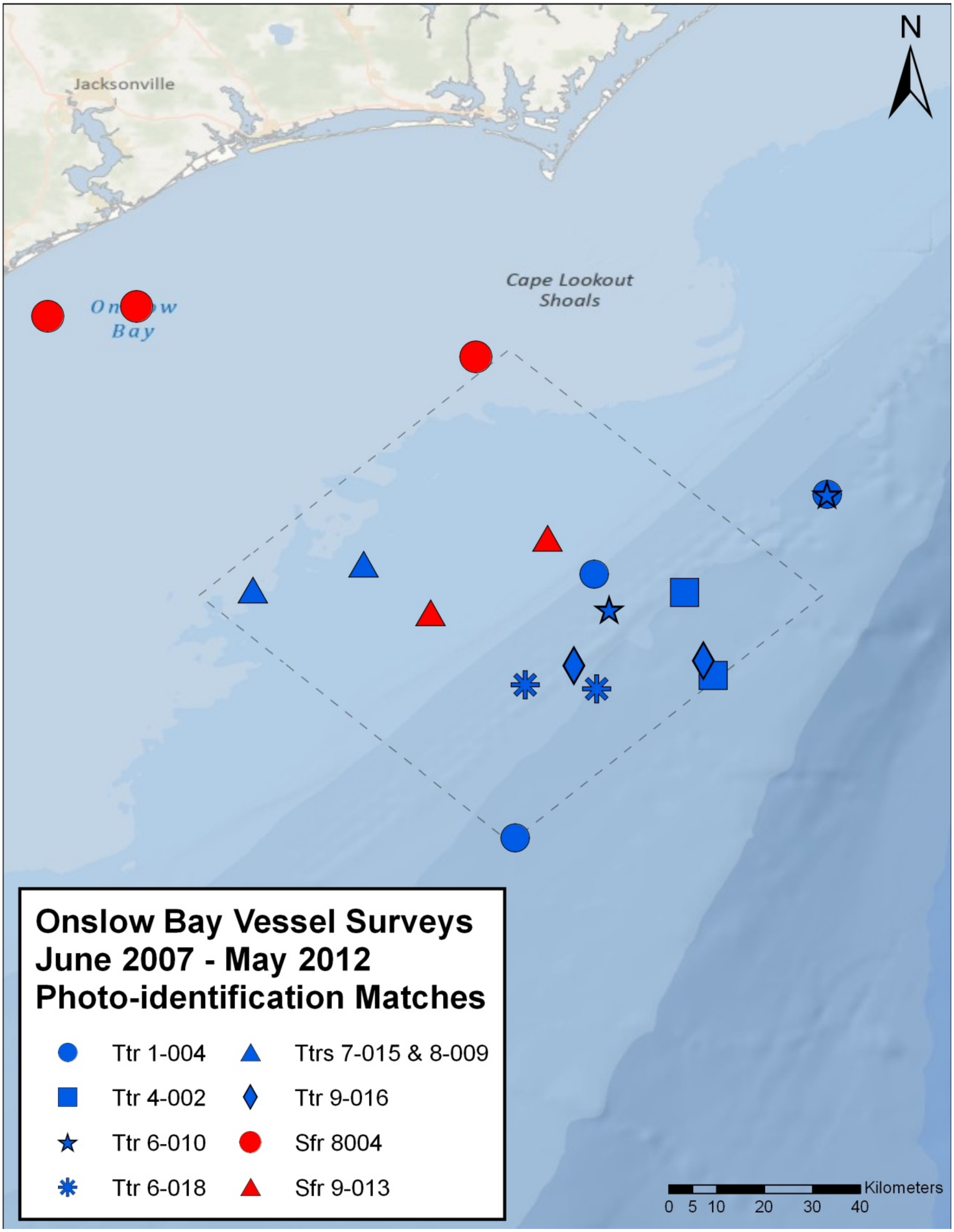


Figure 22. Photo-identification matches of dolphins in the Onslow Bay survey area.

Since the beginning of the monitoring program in 2007, 3 percent (*n*=2 of 68) of Atlantic spotted dolphins identified in Onslow Bay have been re-sighted, despite limited sampling effort (**Table 24**). A biopsy sample was obtained from one of these dolphins. In addition, one Atlantic spotted dolphin (ZTS-11-019) biopsied and photographed on 12 September 2011 was subsequently photographed on 28 June 2001 and on 24 June 2002 (Sf-8004) during other surveys conducted in nearshore coastal waters of Onslow Bay (**Figure 22**).

Table 24. Sighting dates of photo-identification matches of bottlenose (Ttr) and Atlantic spotted (Sfr) dolphins in Onslow Bay.

ID Number	First Sighting (Date)	Second Sighting (Date)	Third Sighting (Date)
Ttr 1-004	01-Oct-09	11-Apr-10	31-Jan-12
Ttr 4-002	15-Sep-09	01-Oct-09	
Ttr 6-010	23-Sep-07	31-Jan-12	
Ttr 6-018	29-Apr-09	10-Oct-10	
Ttr 7-015*	28-Apr-09	20-Apr-10	
Ttr 8-009*	28-Apr-09	20-Apr-10	
Ttr 9-016	25-Jul-08	17-Aug-09	
Sfr 9-013	09-Aug-09	01-Oct-09	
Sfr 8004 (ZTS-11-09)	28-Jun-01	24-Jun-02	12-Sep-11

*These two individuals were seen together on both dates.

Taken together, these re-sightings in Onslow Bay suggest some degree of residency in this survey area (**Table 24**). Matched genetic and photo-ID data will be particularly useful for understanding population structure and site fidelity of odontocetes in Onslow Bay and other U.S. Navy OPAREAs. To date, we have not re-sighted any other species photographed, although the number of sightings and catalog sizes for these species are very small.

Photo-ID of animals from the JAX survey area is ongoing. To date, the catalogs for Atlantic spotted dolphins and bottlenose dolphins consist of 43 and 23 individuals, respectively (**Table 25**). Two Atlantic spotted dolphins have been re-sighted in JAX (**Figure 23**). Atlantic spotted dolphin (Sfr 3-001) was observed first on 10 October 2010 and again on 19 March 2011; Atlantic spotted dolphin (Sfr 8-005) was photographed during surveys on 2 consecutive days: 18 and 19 March 2011 (**Table 26**).

Table 25. Individual identifications from images taken during vessel-based surveys in the JAX survey area.

Common Name	Scientific Name	Year 1 July 2009- June 2010		Year 2 July 2010-Dec 2011		Year 3 Jan 2012-May 2012	
		Catalog Size (*n*)	Matches (*n*)	Catalog Size (*n*)	Matches (*n*)	Catalog Size (*n*)	Matches (*n*)
Bottlenose dolphin	*Tursiops truncatus*	0	0	21	0	21	0
Atlantic spotted dolphin	*Stenella frontalis*	0	0	41	2	43	2

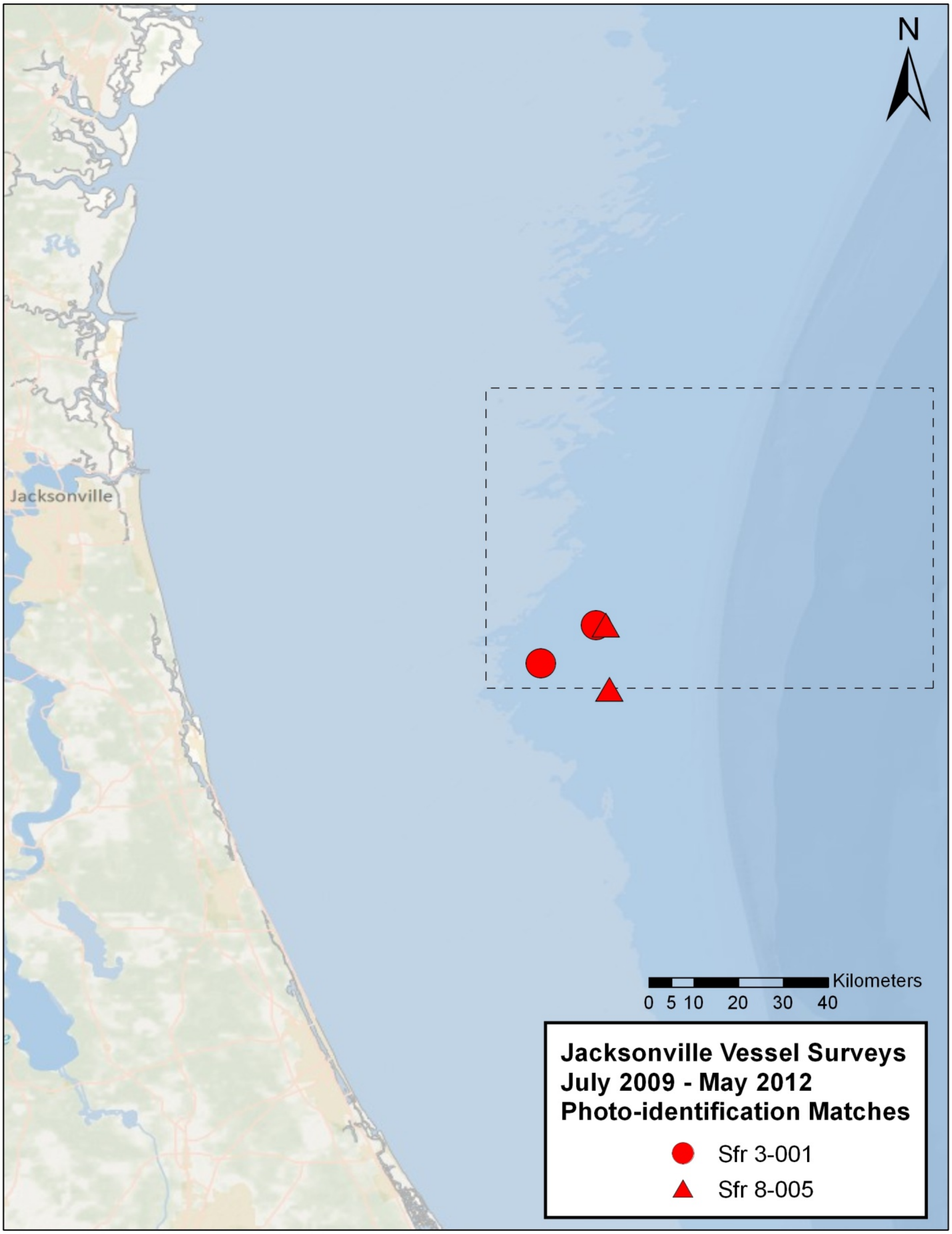


Figure 23. Locations of photo-identification matches for Atlantic spotted dolphins in the JAX survey area.

Table 26. Sighting dates of photo-identification matches of Atlantic spotted dolphins (Sfr) in JAX.

ID Number	First Sighting (Date)	Second Sighting (Date)
Sfr 3-001	10-Oct-10	19-Mar-11
Sfr 8-005	18-Mar-11	19-Mar-11

3.2.8 Sea Turtles

As noted above, three species of sea turtles were observed in the three survey areas. Loggerhead turtles dominated the sightings in all three areas and appear to be particularly abundant in JAX, although quantitative estimates of density have not been made yet. In all areas, loggerheads occur primarily over the continental shelf, but also beyond the shelf break (**Figures 24 through 26**). An initial analysis of aerial survey data from Onslow Bay shows a significant positive trend in loggerhead sightings over multiple years, suggesting an increase in the number of turtles using this area. If confirmed, this will be an important finding for the conservation of this threatened species.

Large numbers of leatherbacks were observed in the JAX survey area (**Figure 26**). Leatherbacks also were observed off Cape Hatteras and in Onslow Bay, but less frequently than in JAX. A small number of Kemp's ridley turtles were sighted in JAX, but not at the other two sites. No other sea turtle species have been observed during this monitoring work to date.

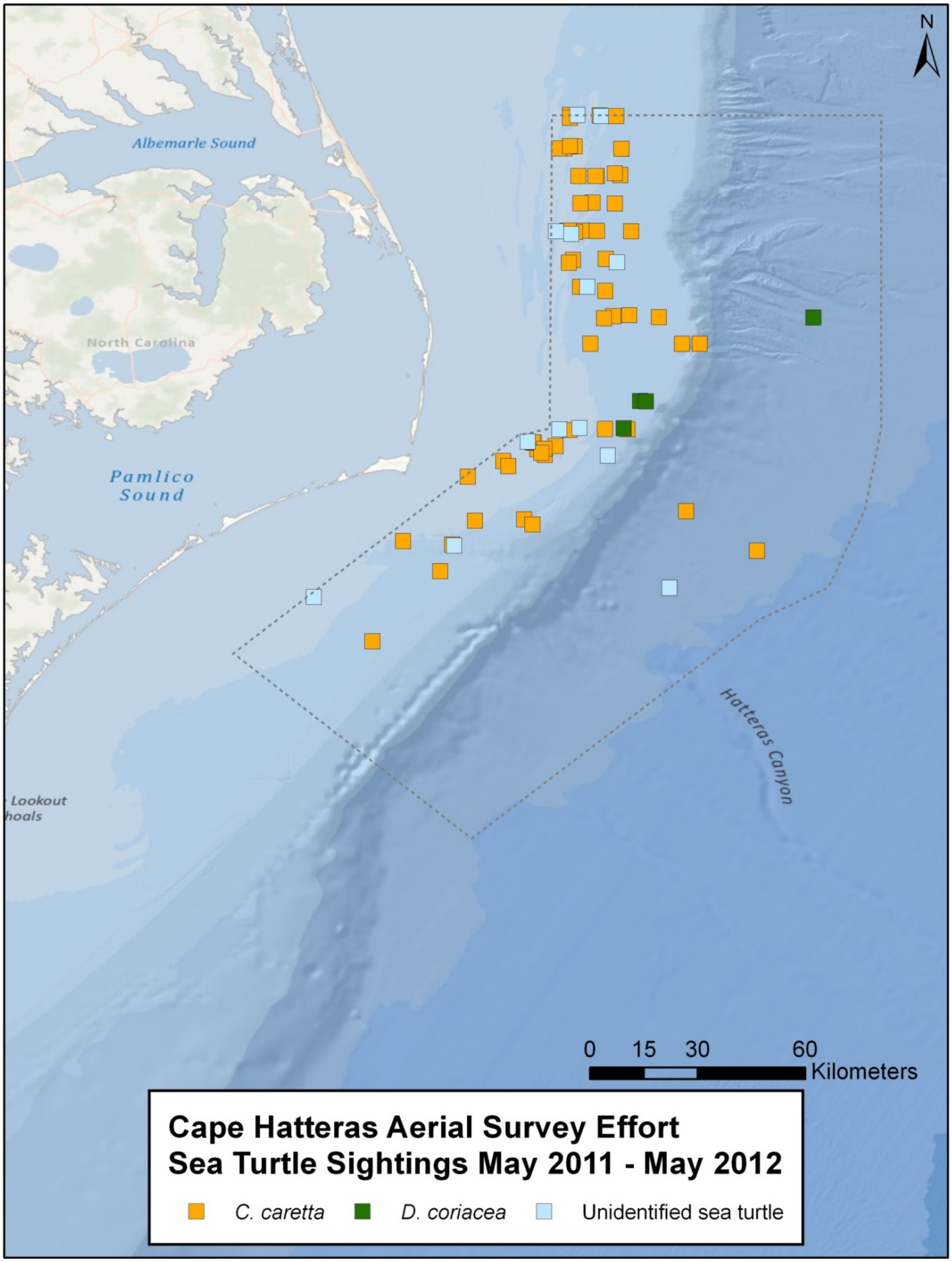


Figure 24. All sea turtle sightings from aerial surveys conducted in the Cape Hatteras survey area, May 2011 through May 2012.

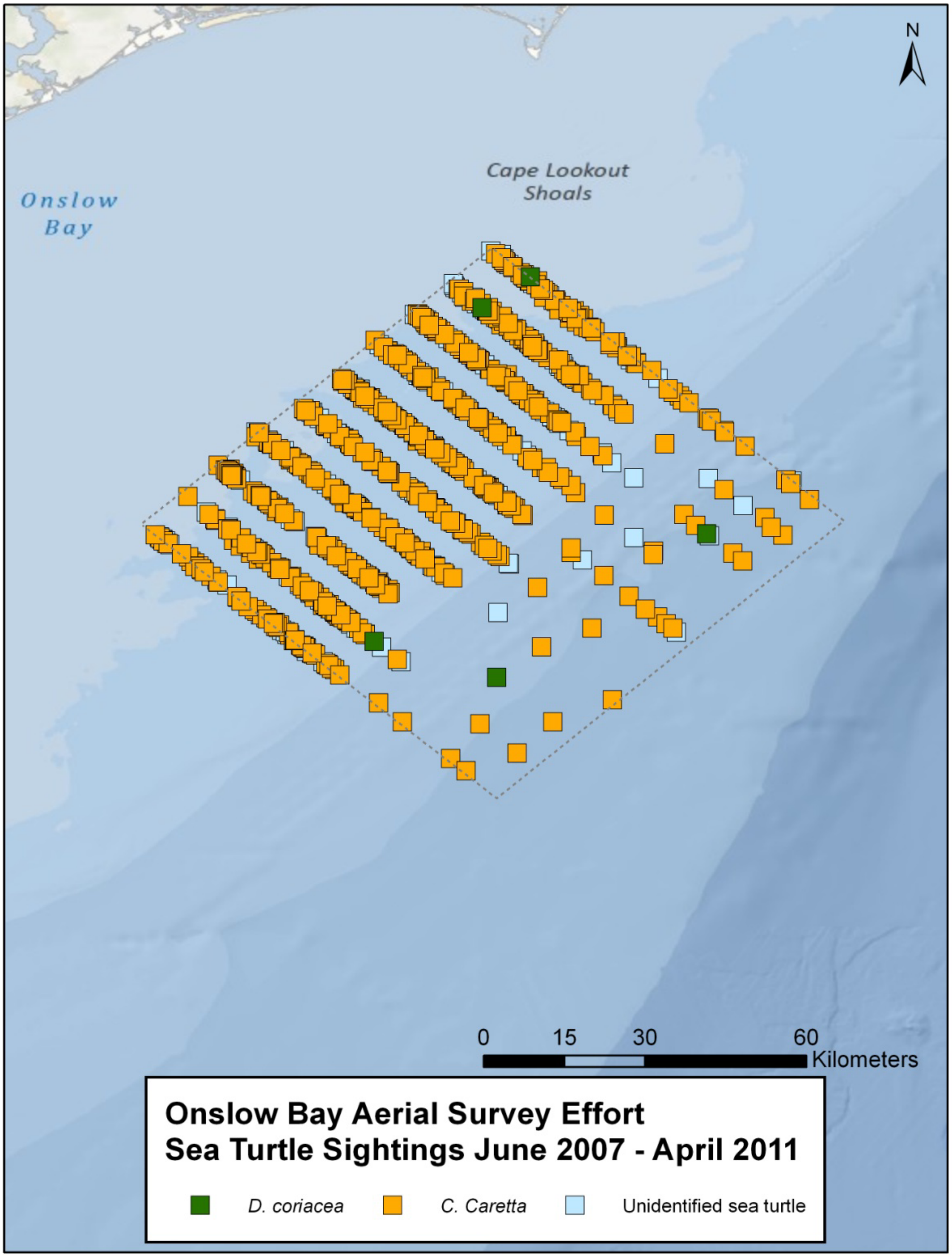


Figure 25. All sea turtle sightings from aerial surveys conducted in the Onslow Bay survey area, June 2007 through April 2011.

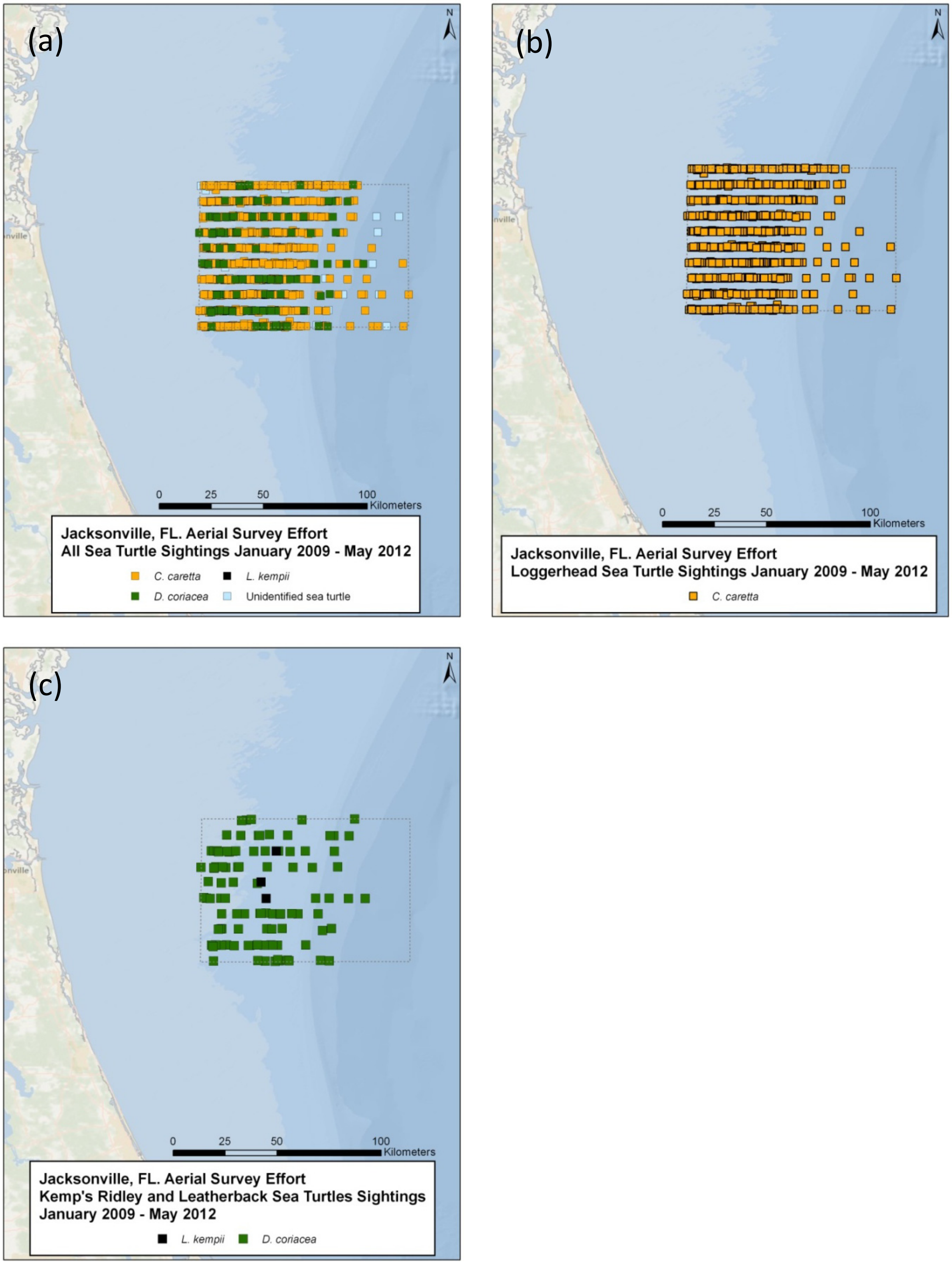


Figure 26. Sea turtle sightings from aerial surveys conducted in the JAX survey area: (a) all turtle sightings; (b) loggerhead turtles; and (c) leatherback and Kemp's ridley turtles, January 2009 through May 2012.

Three Wildlife Computer Argos SPLASH satellite-linked time-depth recorders were deployed on adult nesting female loggerhead turtles in North Carolina during the summer of 2010 (details provided in DoN 2011b). This work was conducted in collaboration with the North Carolina Wildlife Resources Commission. The deployments were made to generate data on diving behavior and availability of loggerhead turtles to aerial observers. Such data will be used to generate models used in the estimation of sea turtle abundance and density in Onslow Bay. SPLASH tags provide estimates of location, histograms of time spent at predefined depth and temperature bins, and the amount of time the tag is wet or dry. Interestingly, all three tagged loggerhead turtles migrated south, with two turtles eventually taking up residency in Florida. This southward migration trend precluded data collection from Onslow Bay, but one of the tagged females ('Pointe') was the first adult loggerhead tracked from North Carolina to the Gulf of Mexico (**Figure 27**). The small sample size did not allow for a complete analysis of trends in monthly dive depths or durations, but one turtle increased its dive duration as surface water temperature decreased, suggesting that detection of individuals during aerial surveys could decrease during colder months. These data will be combined with other similar observations from other satellite-tagged turtles when they become available.

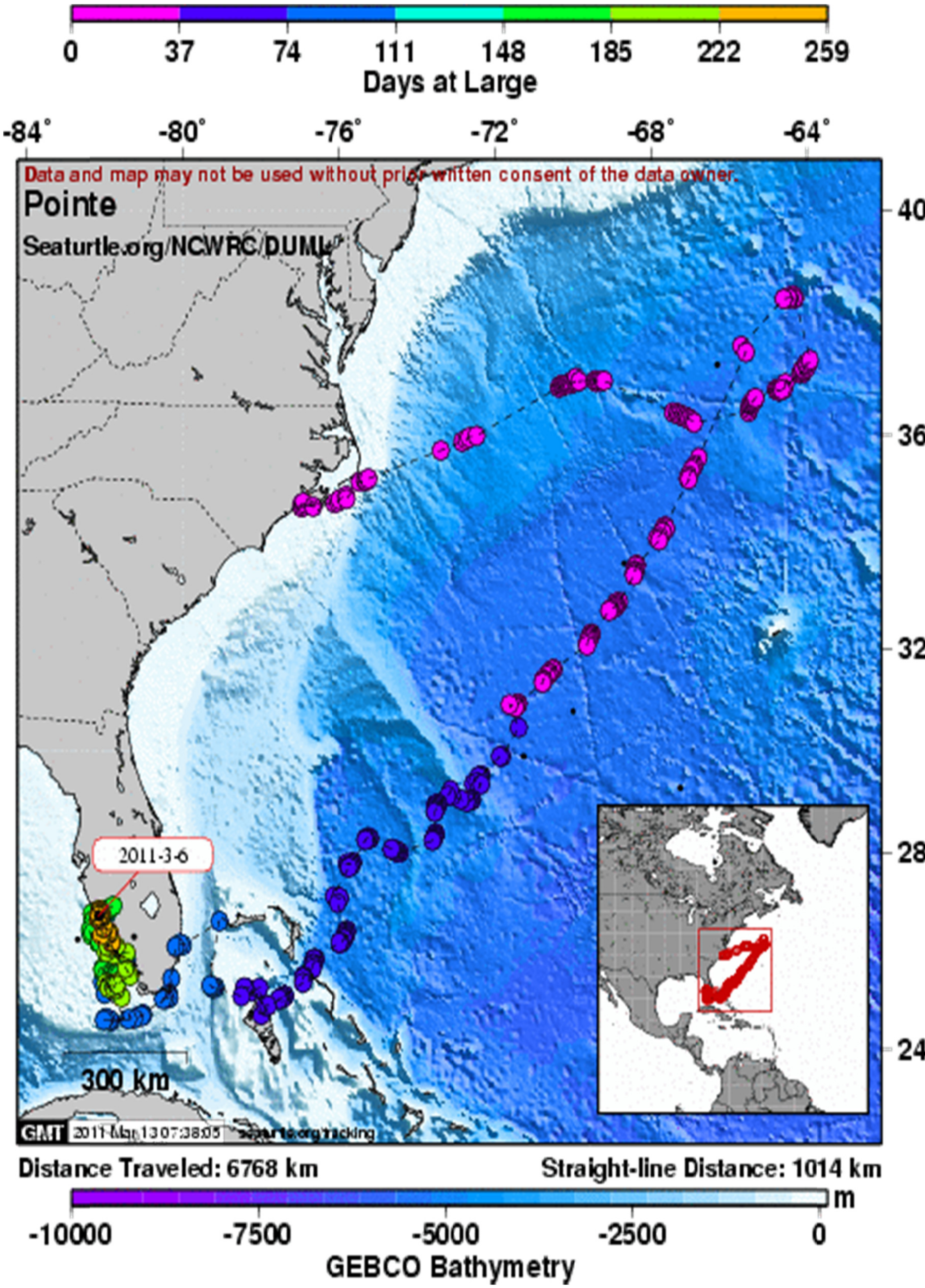


Figure 27. Track of adult female loggerhead turtle 'Pointe' from North Carolina to the Gulf of Mexico. The turtle was tagged during summer 2010 and the last position was obtained in March 2011.

3.3 Visual Exercise Monitoring

3.3.1 Introduction

The U.S. Navy uses various monitoring techniques (PAM and visual [aerial and vessel] surveys) before, during, and after training exercises to record the behavior and movement of marine mammals. Scheduling of protected marine species monitoring that involves civilian aircraft or vessels operating concurrently with multiple U.S. Navy aircraft and ships in the same area requires extensive pre-survey coordination between multiple U.S. Navy commands. The U.S. Fleet Forces operational community provides a critical interface and coordination that is instrumental in allowing researchers to conduct monitoring in close proximity to U.S. Navy assets.

Tables 7 and **8** (**Section 3.1**) summarize the visual survey monitoring requirements for ASW and explosives training, respectively. These requirements are met with a combination of contracted visual surveys and U.S. Navy biologists serving as MMOs on U.S. Navy vessels. Training events monitored off the U.S. Atlantic from 2009 to 2012 include:

- Anti-submarine Warfare Exercise (ASWEX). The primary event involves from one to five surface ships equipped with sonar, with one or more helicopters and P-3 aircraft searching for one or more submarines.
- Southeast Anti-Submarine Warfare Integration Training Initiative (SEASWITI). This is a multi-ship event, utilizing sonar, that occurs only off the coast of Florida.
- Mine-Neutralization Exercise (MINEX). This event involves underwater detonations using explosive ordnance conducted with time-delay firing devices.
- Missile Exercise (MISSILEX). This is a surface-to-air training exercise involving surface combatants firing live missiles (RIM-7 Sea Sparrows, SM-1 or SM-2 Standard Missiles) at target drones. This is an exercise that involves the uses of explosive ordnance.
- Firing Exercise (FIREX). During a FIREX, surface ships use their main-battery 5 ¼-inch guns to fire from sea at simulated land targets in support of military forces ashore. A system of passive acoustic buoys scores the accuracy of shots during U.S. East Coast FIREX training using the Integrated Maritime Portable Acoustic Scoring and Simulation (IMPASS) system.
- Gunnery Exercise (GUNEX). GUNEX operations are conducted by rotary-wing aircraft using explosive ordnance against stationary targets (Floating at Sea Target and smoke buoy).

Monitoring of coordinated ASW exercises is one of the primary components being used to address specific monitoring questions posed in the AFAST Monitoring Plan (DoN 2009b) and associated LOA NMFS 2009a). Monitoring of coordinated exercises using explosives is one of the primary components being used to address specific monitoring questions posed in the VACAPES, CHPT, and JAX Monitoring Plans (DoN 2009c, DoN 2009d, DoN 2009e, respectively) and the NMFS-issued LOAs (NMFS 2009b, NMFS 2009c, NMFS 2009d).

3.3.2 Vessel and Aerial-Based Visual Monitoring

Training exercise event surveys are focused on a specific ASW or explosives training event and typically involve multiple survey flights before, during, and after the event. These surveys often involve focal follows of whales or dolphins to document behavior and group interactions. The monitoring team has conducted 45 individual survey days covering 10 training exercises for over 21,000 km of on-effort trackline throughout the JAX, CHPT, and VACAPES OPAREAs within the AFAST study area since 2009. There were 24 visual-survey monitoring efforts conducted from 2009 through 2012. The majority of these events were monitored by aerial survey due to challenges associated with distance from shore and flexibility with scheduling survey platforms. A 3-day large vessel survey associated with ASW training was conducted in 2010, including use of a passive acoustic array.

Most of the exercise monitoring effort (i.e., number of days) was conducted in JAX (79.7 percent), followed by VACAPES and CHPT (18.9 percent and 1.4 percent, respectively). Monitoring was conducted during July through September in VACAPES, in November in CHPT, and during all seasons in JAX (**Tables 27 and 28; Appendix C**), which is reflective of the training exercise schedules for each area and type of event. There have been no monitoring opportunities available for explosive events in the GOMEX Range Complex. Therefore, there is no monitoring in the GOMEX region to report at this time.

Table 27. Contractor-conducted exercise monitoring effort, April 2009 through September 2012. Source colume refers to Appendix C where additional details are provided.

Survey Date	Range Complex	Exercise Type	Encounter Rate	Platform	Total # Exercise Events	Total # of Survey Days	Total # of Survey Hours (on-effort)	Trackline effort in km	Total # of MM Sightings	Total # MM individ	Total # of ST Sightings	Total # ST Individ	Sp
8-10 Aug 2010	JAX	MISSILEX	Marine mammals: 1 sighting per 1.5 hr, 308 km, and 167 NM; Sea turtles: 1 sighting per 3 hr, 617 km, and 333 NM	Aerial	1	2	3.7 on (6.0 total)	781 on (1,233 total)	4	63	2	2	*T. tru*
9-10 Aug 2010	VACAPES	ASWEX	Marine mammals: 1 sighting per 0.69 hr, 142.42 km, and 76.85 NM; sea turtles: 1 sighting per 0.97 hr, 199.4 km, and 107.6 NM.	Aerial	1	2	1.9 on (4.9 total)	364 on (997 total)	7	503	5	5	*T. tru macr Glob macr atter*
10-11 Aug 2010	VACAPES	FIREX	Marine mammals: 1 sighting per 0.86 hr, 234.2 km, and 126.4 NM	Aerial	1	2	3.7 on (5.8 total)	730 on (1,171 total)	5	105	0	0	*T. tru* delph *grise*
3-7 October 2010	JAX	GUNEX	Marine mammals: 1 sighting per 2.8 hr, 501 km, and 270.5 NM; sea turtles: 1 sighting per 0.4 hr, 88.4 km, and 47.7 NM	Aerial	2	7	14.2 on (16.9 total)	2,803 on (3,006 total)	6	108	34	34	*S. fro*
3-5 December 2010	JAX	ASWEX	Marine mammals: 1 sighting per 12 hr, 2,267 km, and 1,224 NM; sea turtles: 1 sighting per 1.3 hr, 252 km, and 136 NM	Aerial	1	3	10.7 on (12.2 total)	2,156 on(2,267 total)	1	12	9	9	*T. tru D. co*
3-5 December 2010	JAX	ASWEX	Marine mammals: 1 sighting per 6.3 hr, 80.5 km, and 43.5 NM	Vessel	1	3	131.8 on (173.8 total)	1,077 on (1,502 total)	4	31	0	0	*S. fro*
3-5 December 2010	JAX	ASWEX	1 detection per 1.1 hr[1]	PAM	1	3	26.7	367.9 on (total)	30 detections				*P. ma* delph beak
13-15 July 2011	VACAPES	FIREX	Marine mammals: 1 sighting per 0.8 hr, 125.2 km, and 67.6 NM; sea turtles: 1 sighting per 0.07 hr, 10.5 km, and 5.7 NM.	Aerial	1	3	5.4 on (7.6 total)	1,127 on (1,509 total)	9	124	107	108	*C. ca kemp Glob coria*
31 Aug & 10 Sept 2011	VACAPES	ASWEX	Marine mammals: 1 sighting per 0.5 hr, 55.6 km, and 30.0 NM; sea turtles: 1 sighting per 0.19 hr, 22.8 km, and 12.3 NM	Aerial	1	2	4.5 on (7.6 total)	890 on (1724 total)	16	367	39	50	*St. fr Glob caret*
15-20 September 2011	JAX	ASWEX	Marine mammals: 1 sighting per 5.0 hr, 1,041 km, and 562 NM; sea turtles: 1 sighting per 2.2 hr, 446 km, and 241 NM	Aerial	1	5	12.3 on (15.1 total)	2,456 on (3,122 total)	3	48	7	7	*C. ca* sp.

Survey Date	Range Complex	Exercise Type	Encounter Rate	Platform	Total # Exercise Events	Total # of Survey Days	Total # of Survey Hours (on-effort)	Trackline effort in km	Total # of MM Sightings	Total # MM individ	Total # of ST Sightings	Total # ST Individ	Sp
19-21 September 2011	JAX	FIREX	Sea turtles: 1 sighting per 0.64 hr, 119 km, and 64.3 NM.	Aerial	1	3	5.9 on (6.4 total)	1,188 on (2,456 total)	0	0	10	10	*C. ca*
29-30 November 2011	CHPT	FIREX	No sightings	Aerial	1	1	1.0 on (1.4 total)	207 on (291 total)	0	0	0	0	No si
28-29 February 2012	JAX	MISSILEX	Marine mammals: 1sighting per 1.0 hr, 209.7 km, and 113.2 NM; sea turtles: 1 sighting per 0.1 hr, 26.6 km, and 14.3 NM	Aerial	1	2	8.8 on (9.8 total)	1,886.9 on (2,051 total)	14	160	84	88	*S. fro trunc*
05-08 September 2012	JAX	FIREX	Marine mammals: 1.362 sightings per hr and 0.006 sightings per km; sea turtles: not calculated[2]	Aerial	1	4	13 on (15 total)	2,590.3 on (2989.3 total)	20	96	5	5	*S. fro trunc*
26-29 September 2012	JAX	ASW	Marine mammals: 0.647 sightings per hr and 0.003 sightings per km; sea turtles: 4.604 sightings per hr and 0.023 sightings per km.	Aerial	1	3	12 on (14 total)	2,378.1 on (2,776.3 total)	9	69	62	64	*S. fro trunc grise*

Table 28. Navy civilian marine mammal observer exercise monitoring effort from April 2009 through August 2012.

Survey Date	Range Complex	Exercise Type	Encounter Rate	Platform	Total # Exercise Events	Total # of Survey Days	Total # of Survey Hours (on-effort)	Total # of MM Sightings	Total # MM Individ	Total # of ST Sightings	Total # ST Individ	Species Identified
27-30 April 2009	JAX	ASW	Not provided	Vessel	1	4	33.17	20	93	16	18	*Tursiops trunatus, Stenella frontalis, Caretta caretta, Dermochelys coriacea*
5-9 Aug 2009	VACAPES	MINEX	Not provided	Vessel	2	3	12.5	18	49-62	2	2	*T. truncatus*, *Caretta caretta*
15-19 March 2010	JAX	ASW + LOE	Marine mammals: 0.46 sightings per hr	Vessel	1	5	27.9	13	62	1	1	*S. frontalis*
4-9 June 2010	JAX	ASW + LOE	Marine mammals: 0.65 sightings per hr	Vessel	1	6	42.1	20	60-62	1	1	*S. frontalis*
8-10 August 2010	VACAPES	MINEX	Not provided	Vessel	1	3	6.8	3	>2-4	0	0	No identified species
5-6 October 2010	JAX	FIREX	Not provided	Vessel	1	2	9	1	1	0	0	*T. truncatus*
13-14 July	VACAPES	FIREX	Not provided	Vessel	1	1	5.9	0	0	1	1	No identified species
7-9 Aug 2011	VACAPES	MINEX	Not provided	Vessel	3	1	9.2	19	>91-149	5	6	*T. truncatus*, *C. caretta*
29 May - 01 June 2012	JAX	ASW	Not provided	Vessel	1	4	31.5	13	45	11	11	*Stenella* sp., *C. caretta*, *Globicephala* sp.
26-29 September 2012	JAX	FIREX	NA	Vessel	1	2	NA	NA	NA	NA	NA	NA
11-12 September 2012	VACAPES	MINEX	NA	Vessel	3	2	NA	NA	NA	NA	NA	NA

Contractor-conducted Monitoring

A total of 15 exercise monitoring surveys was conducted by contractors for the U.S. Navy starting in Summer 2010 and extending through Fall 2012 (**Table 27**). These efforts included 13 aerial surveys, one vessel survey, and one PAM survey. Ten surveys (66.7 percent) were conducted in JAX, four surveys (26.7 percent) were conducted in VACAPES, and one survey (6.7 percent) was conducted in CHPT. The total on-effort time for all surveys was nearly 256 hr. Of the total on-effort time, 239 total on-effort hr (93.4 percent) were spent conducting monitoring surveys in JAX, 15.5 total on-effort hr (6.1 percent) were spent in VACAPES, and 1.00 total on-effort hr (0.4 percent) were spent in CHPT. The total time (on-effort and off-effort time) for all surveys was over 664 hr. Of the total survey time, 637 total hr (95.9 percent) were spent conducting monitoring surveys in JAX, 25.9 total hr (3.9 percent) were spent in VACAPES, and 1.4 total on-effort hr (0.2 percent) were spent in CHPT. The average duration on-effort was 17.0 hr (standard deviation = 32.4 hr) per survey, 23.9 hr (standard deviation = 38.4 hr) per survey in JAX and 3.9 hr (standard deviation = 1.5 hr) per survey in VACAPES. The total on-effort survey distance for all surveys was 21,002 km. Of the total on-effort survey distance, the majority of the effort occurred in JAX (17,684 km; 84.2 percent), followed by VACAPES (3,111 km; 14.8 percent) and CHPT (207 km; 1.0 percent). The average distance on-effort was 1,400 km (standard deviation = 892 km) per survey overall, 2,177 km (standard deviation = 902 km) per survey in JAX and 1,350 km (standard deviation = 328 km) per survey in VACAPES. The total survey distance covered (on-effort and off-effort time) for all surveys was 27,462.5 km. Of the total survey distance, the majority of the effort occurred in JAX (21,770.5 km; 79.3 percent), followed by VACAPES (5,401 km; 19.7 percent) and CHPT (291 km; 1.1 percent).

The total number of marine mammal sightings recorded during the contractor-conducted exercise monitoring surveys was 128 sightings. There were 91 sightings recorded in JAX and 37 in VACAPES from Spring 2009 through Summer 2012. No marine mammal sightings were made in CHPT. The total number of sea turtle sightings recorded during the MMO surveys was 364 sightings. There were 213 sightings recorded in JAX and 151 in VACAPES from spring 2009 through summer 2012. The total number of individual sea turtles sighted during a single survey ranged from two individuals to 108 individuals.

U.S. Navy MMO Monitoring Efforts

U.S. Navy MMOs were not placed aboard U.S. Navy vessels for every training event or major exercise, but were incorporated during specific opportunities deemed appropriate for data-collection efforts. A total of 11 MMO-monitored surveys (29 survey days) were conducted from vessels starting in Spring 2009 and extending through Summer 2012 (**Table 28**). Monitoring consisted of a combination of MINEX, FIREX, and ASWEX events. Six surveys (55 percent) were conducted in JAX and five surveys (44 percent) were conducted in VACAPES. The total time for all surveys was slightly over 178 hr. Of the total on-effort time, 143.7 total on-effort hr were spent conducting MMO vessel surveys in JAX and 34.4 total on-effort hr were spent in VACAPES. The average duration of MMO surveys spent on-effort was 19.8 hr (standard deviation = 13.8 hr) per survey, 28.7 hr (standard deviation = 12.2 hr) per survey in JAX and 8.6 hr (standard deviation = 9.9 hr) per survey in VACAPES. The total number of marine mammal sightings recorded during the MMO surveys was 107 sightings. There were 67 marine mammal sightings recorded in JAX and 40 in VACAPES from Spring 2009 through Summer 2012. Total number of marine mammals sighted during a single survey ranged from one individual to more than 91 animals. Marine mammal encounter rates were only provided for two surveys (22.2 percent); both surveys occurred in JAX for SEASWITI exercises. The encounter rates were 0.46 marine mammal sightings per hr for the 15 through 19 March 2010 SEASWITI exercise and 0.65 marine mammal sightings per hr for the 4 through 9 June

2010 SEASWITI exercise. The total number of sea turtle sightings recorded during the MMO surveys was 37 sightings. There were 29 sightings recorded in JAX and 8 in VACAPES from Spring 2009 through Summer 2012. Total number of sea turtles sighted during a single survey ranged from one to 18 individuals.

3.3.2.1 Species Occurrence

Seven cetacean species have been observed during visual survey monitoring of training exercises: bottlenose dolphin, Atlantic spotted dolphin, pantropical spotted dolphin, Risso's dolphin, short-beaked common dolphin, sperm whale, and short-finned pilot whale. Unidentified species of spotted dolphins and unidentified species of pilot whales were also recorded. In VACAPES, six cetacean species were identified, with just three cetacean species and one cetacean genus (unidentified pilot whales) identified in JAX, despite extensive monitoring effort. There were no cetacean sightings during exercise monitoring in CHPT.

Species detected during training events were reflective of a species' occurrence in the region (i.e., seasonal in some cases) and the spatial and temporal extent of the training exercise. Additionally, environmental conditions including Beaufort Sea State affected sightings made by the monitoring teams; the majority of sightings were made in Beaufort Sea States ranging from 3 to 6. MINEX training events by their nature are shallow-water and occur close to shore, which is reflected in the U.S. Navy MMO sightings consisting of primarily bottlenose dolphins.

During the December 2010 SEASWITI conducted in the JAX OPAREA over a bottom depth of 40 to 500 m, a towed hydrophone array was used to monitor and record vocal events of marine mammals (**Figure 28**) (HDR 2011). Thirty acoustic detections (i.e., single sounds such as a whistle or click) were made during nearly 27 hr of survey effort. Nine detections of marine mammals were made on the pre-ASW survey day; five detections on the during-ASW survey day; and 16 on the post-ASW survey day. Thirteen detections were classified as sperm whales; five as sperm whales or delphinids; one as sperm whales or possible beaked whales; and 11 as delphinids (including two detections made during sightings of Atlantic spotted dolphins).

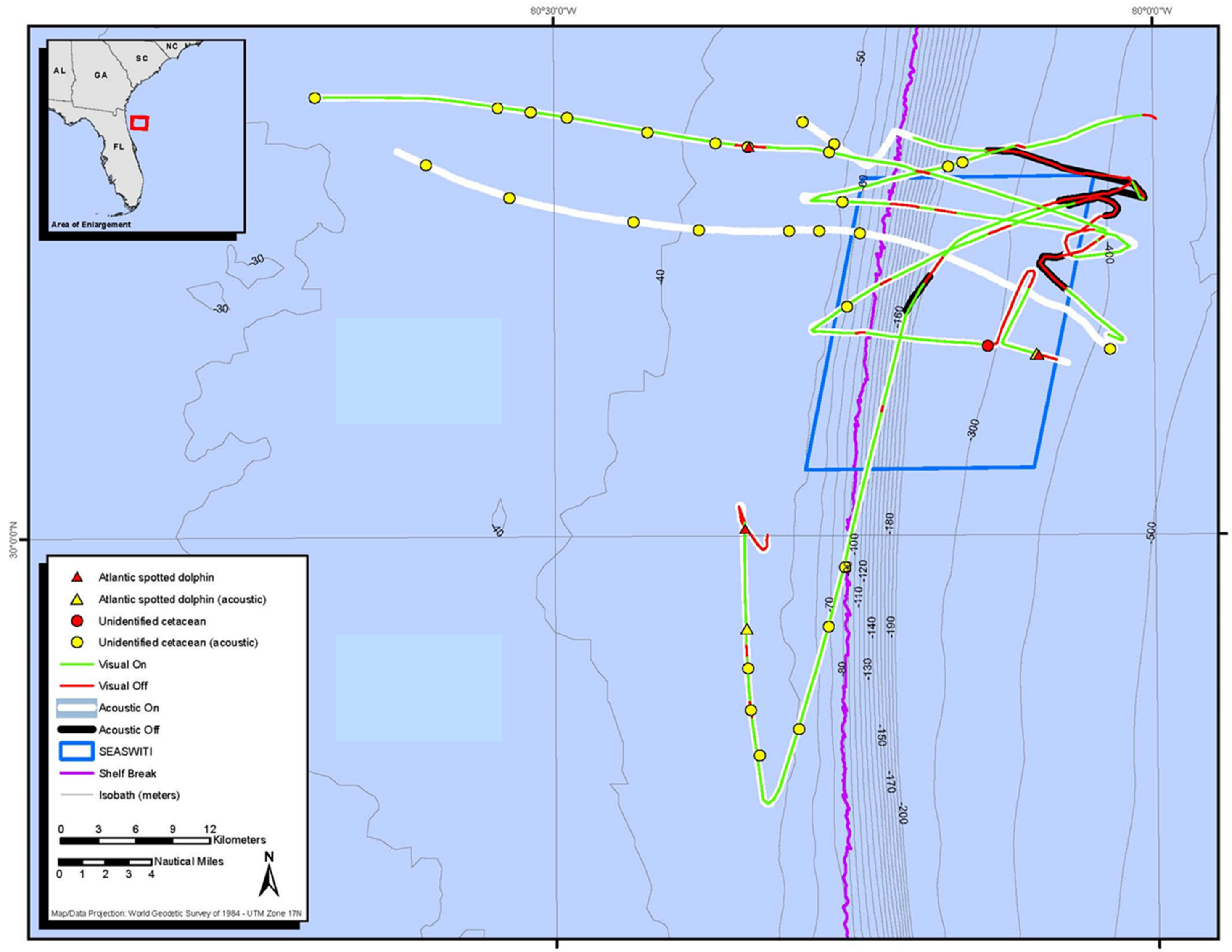


Figure 28. Location of acoustic detections during SEASWITI (03-05 December 2010). Two acoustic detections of Atlantic spotted dolphins were confirmed by visual sighting data.

Three species of sea turtles (leatherback, loggerhead, and Kemp's ridley turtles), as well as many unidentified hard-shell turtles, were recorded in the VACAPES and JAX Range Complexes although the species varied (**Tables 24 and 25**). Loggerhead and leatherback turtles occurred in both VACAPES and JAX; Kemp's ridley turtles were observed only in VACAPES. As with the longitudinal baseline monitoring (see **Section 3.2.8**), loggerhead and leatherback turtles were the most commonly identified turtle species.

Table 29. Species occurrence by survey mode for U.S. Navy exercise monitoring in the VACAPES OPAREA.

Common Name	Scientific Name	Towed Array*	Aerial	Vessel
Sperm whale	*Physeter macrocephalus*	n/a	Y	-
Bottlenose dolphin	*Tursiops truncatus*	n/a	Y	Y
Atlantic spotted dolphin	*Stenella frontalis*	n/a	Y	-
Short-beaked common dolphin	*Delphinus delphis*	n/a	Y	-
Risso's dolphin	*Grampus griseus*	n/a	Y	-
Short-finned pilot whale	*Globicephala macrorhynchus*	n/a	Y	-
Loggerhead turtle	*Caretta caretta*	n/a	Y	Y
Leatherback turtle	*Dermochelys coriacea*	n/a	Y	-
Kemp's ridley turtle	*Lepidochelys kempii*	n/a	Y	-

Key: Y = confirmed occurrence; *n/a = no towed array effort was conducted in VACAPES.

Table 30. Species occurrence by survey mode for U.S. Navy exercise monitoring in the JAX OPAREA.

Common Name	Scientific Name	Towed Array*	Aerial	Vessel
Sperm whale	*Physeter macrocephalus*	Y	-	-
Bottlenose dolphin	*Tursiops truncatus*	-	Y	Y
Atlantic spotted dolphin	*Stenella frontalis*	Y[1]	-	Y
Unidentified pilot whale	*Globicephala* sp.	-	Y	Y
Loggerhead turtle	*Caretta caretta*	-	Y	Y
Leatherback turtle	*Dermochelys coriacea*	-	Y	Y

Key: Y = confirmed occurrence; * = toothed whale occurrence was documented, but not analyzed to the species-level; [1] acoustic detection made during visual sighting of species.

Figures 29 and 30 show marine mammal and sea turtle sightings, respectively, overlaid with survey effort in the VACAPES OPAREA from all exercise monitoring events. Overall, monitoring effort has been concentrated in this OPAREA within offshore areas where exercises have occurred off the coasts of Virginia and northern North Carolina. Marine mammal group sizes have ranged from single individuals to up to 300; turtles were most often sighted as lone individuals, and occasionally in groups of two or three animals. One turtle sighting included seven individuals facing in various directions. During several surveys where sea turtle sightings were high, a random transect line was chosen to represent turtle occurrence for the entire survey so as not to distract the MMO from monitoring for marine mammals in the area.

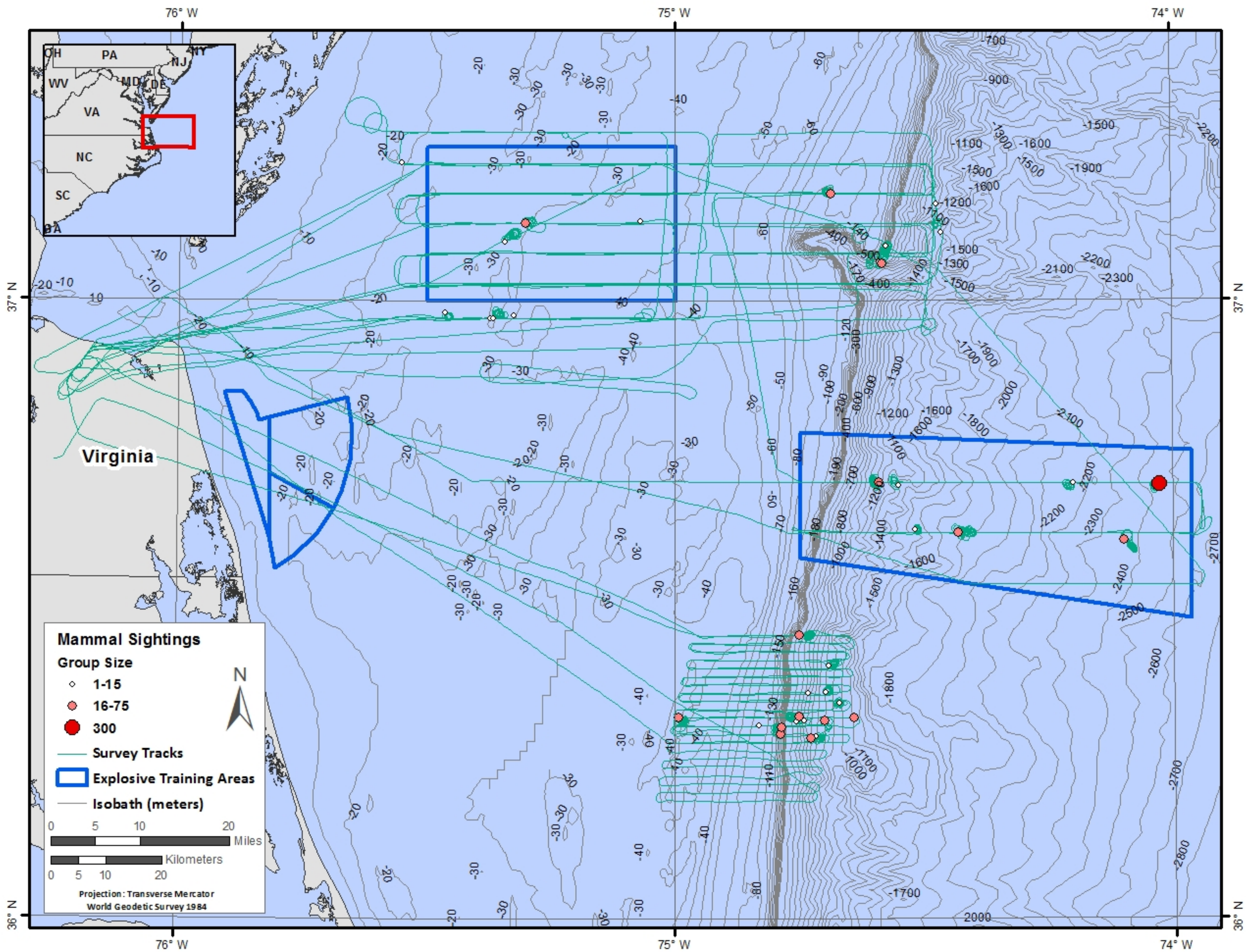


Figure 29. Marine mammal sightings from visual surveys during exercise monitoring events in the VACAPES OPAREA.

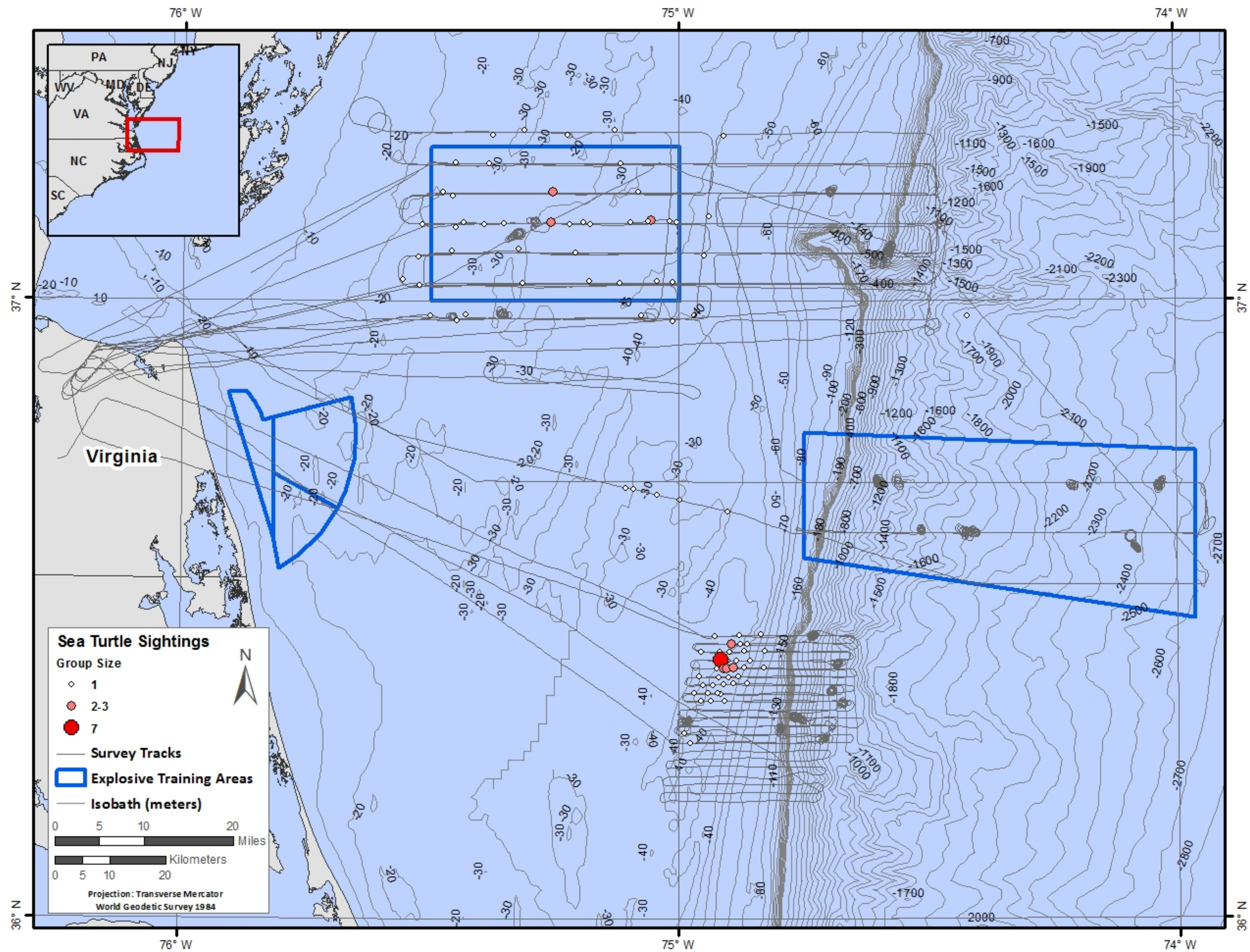


Figure 30. Sea turtle sightings from visual surveys during exercise monitoring events in the VACAPES OPAREA.

Figures 31 and 32 show all marine mammal and sea turtle sightings, respectively, overlaid with survey effort in the JAX OPAREA. Within this area, monitoring effort has been primarily concentrated near the shelf break south of the defined exercise and survey area of JAX. Tracklines have also coincided with exercises within and to the east and northeast of JAX. Marine mammal group sizes have ranged from single individuals to up to 50 animals; turtles were most often sighted as single animals, or in groups with two to three individuals.

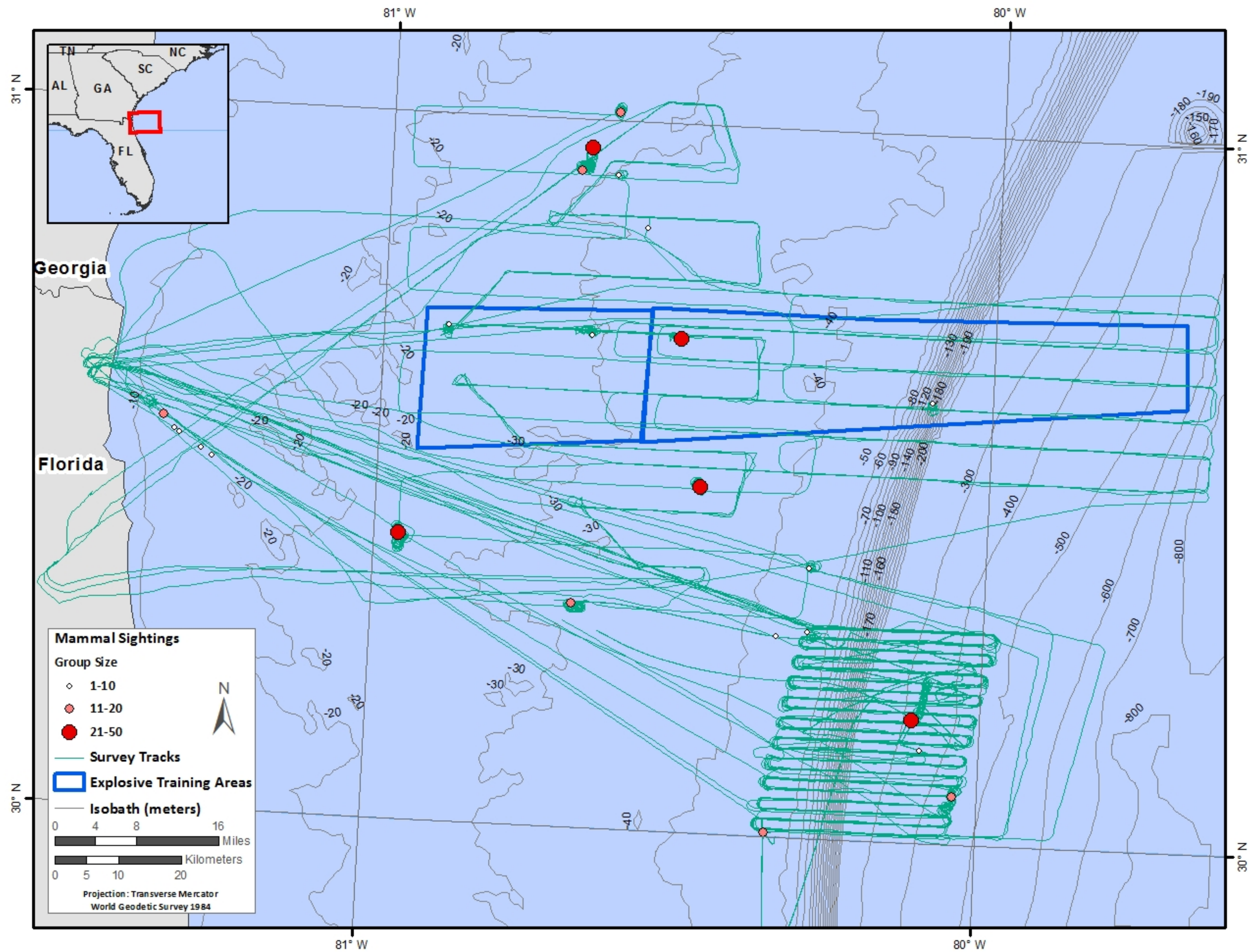


Figure 31. Marine mammal sightings from visual surveys during exercise monitoring events in the JAX OPAREA.

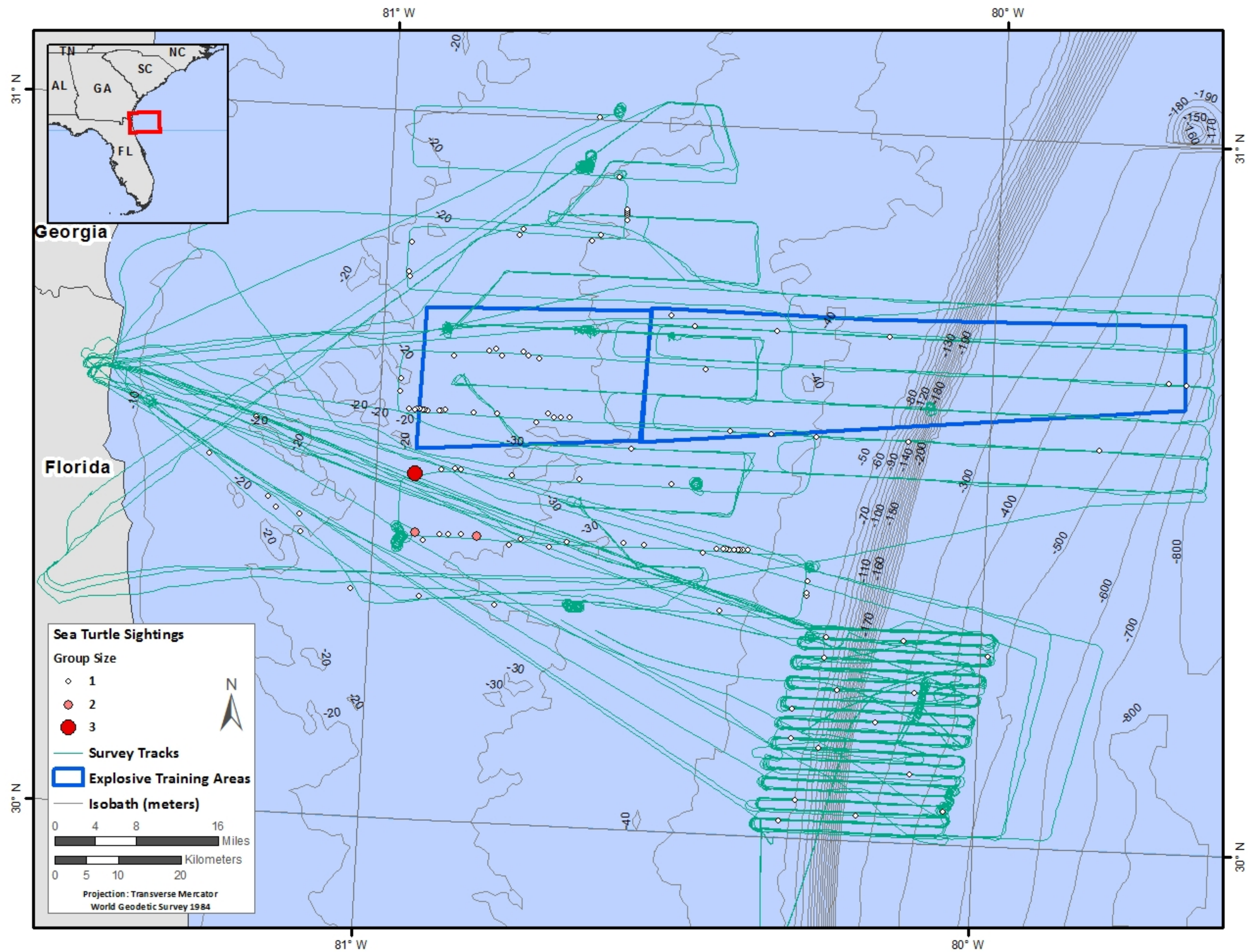


Figure 32. Sea turtle sightings from visual surveys during exercise monitoring events in the JAX OPAREA.

Figure 33 shows all marine mammal sightings, respectively, overlaid with survey effort in the CHPT OPAREA. There were no sea turtle sightings made during CHPT survey report. Overall, monitoring effort has been concentrated in this OPAREA within offshore areas where exercises have occurred, southeast of Cape Lookout, North Carolina. The only sighting was a lone whale sighting made while observers were off-effort. Sighting conditions during the CHPT FIREX monitoring survey were limited by environmental conditions including Beaufort Sea States, which ranged between 5 and 6. There have been no sightings of turtles during monitoring related to U.S. Navy training exercises.

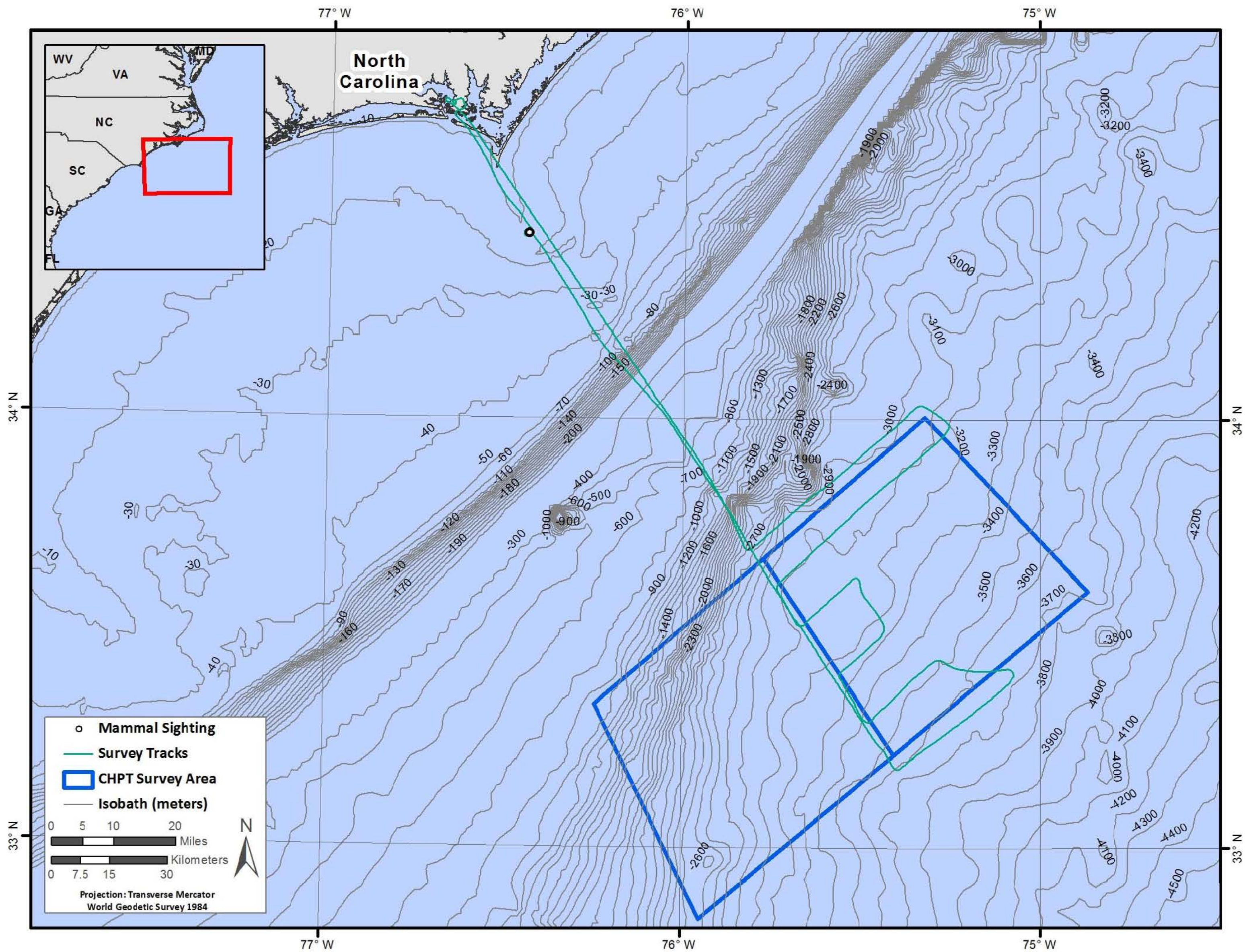


Figure 33. Marine mammal sightings from visual surveys during exercise monitoring events in the CHPT OPAREA.

3.3.3 Focal Follows

There were 30 focal-follow events conducted during aerial survey monitoring associated with nine training events (**Table 31)**. Six of the focal follows were "pre-event" (i.e., day prior to the event), nine were "during-event" (i.e., day of the event), and 15 were "post-event" (i.e., day after the event). Four additional exercises monitored by aerial survey had no focal follows conducted; three in JAX: August 2010 MAVEX, October 2010 GUNEX, and September 2011 FIREX; and one in CHPT: November 2011 FIREX. There were no marine mammal sightings during September and November 2011 monitoring efforts, therefore, no focal follows were possible.

Of the 30 focal-follow events, the Atlantic spotted dolphin (23.2 percent; *n*=7), bottlenose dolphin (20.0 percent; *n*=6), and unidentified species of pilot whale (16.7 percent; *n*=5) were the subject of most focal follows (59.9 percent; *n*=18), followed by unidentified species of dolphin (10.0 percent; *n*=3); Risso's dolphin (10.0 percent; *n*=3); the short-finned pilot whale (6.7 percent; *n*=2); pantropical spotted dolphin (6.7 percent; *n*=2); sperm whale (3.3 percent; *n*=1); and unidentified species of spotted dolphin (3.3 percent; *n*=1) (**Table 26**). Duration of the observation periods ranged from 4 to 35 min (mean=15 min, 8 seconds (sec); standard deviation=8 min, 48 sec). The focal-follow data have not been analyzed for surfacings, dives, approximate speeds, group configuration, general behavior, orientations/re-orientations, or distances among individuals. These behavioral data could shed light on important nuances of behaviors and reactions, in particular for Risso's dolphins (15-min follows of 45 and 18 individuals, and 36-min follow of 16 individuals). Future plans include more focus on collecting this type of information for analyses.

Only one obvious behavioral change was noted during all of the aerial and vessel monitoring. A travel direction shift (considered a mild response to the survey aircraft) was noted from the group of pilot whales during circling attempts in Beaufort Sea State 5 conditions during the July 2011 FIREX in VACAPES.

Table 31. Focal-follow data from ASWEX, FIREX, and MISSILEX training events.

Date	Range Complex	Exercise Type	Platform	Sighting No.	Species	No. Animals	Start Time	Finish Time	BSS	Timing Known Relative to Exercise?
09 August 2010	VACAPES	ASWEX	aerial	1	Bottlenose dolphin (*Tursiops truncatus*)	45	12:21	12:46	2	post-event
09 August 2010	VACAPES	ASWEX	aerial	2	Short-finned pilot whale (*Globicephala macrorhynchus*)	12	12:51	12:59	2	post-event
09 August 2010	VACAPES	ASWEX	aerial	3	Sperm whale (*Physeter macrocephalus*)	2	13:13:00	13:21:06	2	post-event
09 August 2010	VACAPES	ASWEX	aerial	4	Pantropical spotted dolphin (*Stenella attenuata)*	300	13:34	13:50	1	post-event
09 August 2010	VACAPES	ASWEX	aerial	5	Pantropical spotted dolphin (*Stenella attenuata)*	75	14:13	14:25	2	post-event
09 August 2010	VACAPES	ASWEX	aerial	6	UID dolphin (probably pantropical spotted dolphin, *Stenella attenuata*)	65	14:38	14:58	2	post-event
09 August 2010	VACAPES	ASWEX	aerial	7	Short-finned pilot whale (*Globicephala macrorhynchus*)	4	15:05	15:15	2	post-event
10 August 2010	VACAPES	FIREX	aerial	13	UID dolphin (probably common dolphin, *Delphinus delphis*)	12	12:38	12:50	3	during-event
11 August 2010	VACAPES	FIREX	aerial	16	Risso's dolphin (*Grampus griseus*)	6	9:50	10:26	4	post-event
11 August 2010	VACAPES	FIREX	aerial	17	Atlantic spotted dolphin (*Stenella frontalis*)	10	10:49	10:59	3	post-event
03 December 2010	JAX	SEASWITI	aerial	5	UID dolphin	10	15:28	15:32	4	pre-event
03 December 2010	JAX	SEASWITI	aerial	7	Bottlenose dolphin (*Tursiops truncatus*)	12	16:56	17:00	2	pre-event
13 July 2011	VACAPES	FIREX	aerial	4	Bottlenose dolphin (*Tursiops truncatus*)	15	12:19	12:30	2	pre-event
13 July 2011	VACAPES	FIREX	aerial	42	Bottlenose dolphin (*Tursiops truncatus*)	9	14:57	15:04	3	pre-event

Date	Range Complex	Exercise Type	Platform	Sighting No.	Species	No. Animals	Start Time	Finish Time	BSS	Timing Known Relative to Exercise?
15 July 2011	VACAPES	FIREX	aerial	53	Bottlenose dolphin (*Tursiops truncatus*)	50	9:37	9:42	3	post-event
31 August 2011	VACAPES	ASWEX	aerial	3	Atlantic spotted dolphin (*Stenella frontalis*)	60	14:12	14:27	3	during-event
10 September 2011	VACAPES	ASWEX	aerial	4	UID pilot whale species (*Globicephala* sp.)	19	14:09	14:20	3	during-event
10 September 2011	VACAPES	ASWEX	aerial	13	UID pilot whale species (*Globicephala* sp.)	15	14:46	14:55	3	during-event
10 September 2011	VACAPES	ASWEX	aerial	36	UID pilot whale species (*Globicephala* sp.)	13	15:36	15:45	3	during-event
10 September 2011	VACAPES	ASWEX	aerial	45	UID pilot whale species (*Globicephala* sp.)	14	16:07	16:13	3	during-event
10 September 2011	VACAPES	ASWEX	aerial	48	Risso's dolphin (*Grampus griseus*)	30	16:42	16:57	3	during-event
16 September 2011	JAX	ASWEX	aerial	2	UID pilot whale species (*Globicephala* sp.)	24	10:17	10:38	3	during-event
29 February 2012	JAX	MISSILEX	aerial	13	Atlantic spotted dolphin (*Stenella frontalis*)	16	11:31:32	11:51:18	3	post-event
29 February 2012	JAX	MISSILEX	aerial	42	UID spotted dolphin species	25	12:48:47	13:09:30	2	post-event
29 February 2012	JAX	MISSILEX	aerial	50	Atlantic spotted dolphin (*Stenella frontalis*)	23	13:31:18	14:06:24	3	post-event
29 February 2012	JAX	MISSILEX	aerial	112	Atlantic spotted dolphin (*Stenella frontalis*)	16	15:25:05	15:44:42	3	post-event

Date	Range Complex	Exercise Type	Platform	Sighting No.	Species	No. Animals	Start Time	Finish Time	BSS	Timing Known Relative to Exercise?
29 February 2012	JAX	MISSILEX	aerial	113	Atlantic spotted dolphin (*Stenella frontalis*)	35	15:23:13	15:58:16	3	post-event
06 September 2012	JAX	FIREX	aerial	7	Atlantic spotted dolphin (*Stenella frontalis*)	23	16:02:37	16:19:11	3	pre-event
06 September 2012	JAX	FIREX	aerial	9	Risso's dolphin (*Grampus griseus*)	18	16:59:27	17:15:21	3	pre-event
28 September 2012	JAX	MISSILEX	aerial	17	Bottlenose dolphin (*Tursiops truncatus*)	35	9:38:08	9:54:42	4	during-event

Key: ASWEX = Anti-submarine Warfare Exercise; BSS = Beaufort Sea State; FIREX = Firing Exercise; JAX = Jacksonville Range Complex; MISSILEX = Missile Exercise; SEASWITI = Southeast Anti-Submarine Warfare Integration Training Initiative; UID = unidentified; VACAPES = Virginia Capes Range Complex.

3.4 Passive Acoustic Exercise Monitoring

3.4.1 Autonomous Recorder Deployments

A variety of moored autonomous recorders are available for passive acoustic monitoring depending on the required duration and sampling rate. The Navy has used two different autonomous recorder types to deploy small scale temporary monitoring arrays coincident with ASW training exercises in both the JAX and CHPT OPAREAs. These deployments and first results of analyzing this data for potential changes in marine mammal vocal behavior are summarized below. In addition, more in-depth analysis and development of the statistical methods is currently underway.

3.4.1.1 2008 Deployment – Onslow Bay

A pilot project was conducted in July 2008 in Onslow Bay incorporating shipboard and vessel visual-surveys and an array of five Marine Autonomous Recorder Units (MARUs, generically referred to as "pop-up" buoys) developed by Cornell University (www.birds.cornell.edu/brp/hardware/pop-ups). These recorders were deployed at three depths: two in shallow (64 to 73 m), one in medium (236 m), and two in deep (366 m) water (Hodge et al. in press).The MARUs were deployed approximately 10 days prior to the planned 2-day ASWEX and recorded for up to one week following the exercise. The units used in this study sampled continuously at 32 kHz from 06 to 27 July 2008. Habitat influenced the occurrence of odontocete vocalizations, with significantly greater daily vocal activity from delphinids on recorders in deeper waters and sperm whale clicks only on the medium and deep recorders (Hodge et al. in press). These findings suggest that greater diversity and occurrence of animals are located in waters beyond the shelf break in this area, a conclusion supported by visual surveys. An increase was noted in the occurrence of delphinid clicks at night on the shallow and deep recorders, likely reflecting nocturnal foraging activity, and a regular nocturnal occurrence of sperm whale clicks on the medium-depth recorder located near the shelf break suggested that one or more sperm whales moved into that area to feed at night (Hodge et al. in press). This early pilot study provided proof-of-concept data that shaped PAM studies that are discussed in further detail below. More analysis of the data is planned now that a starting point for methodology was developed, based on the 2009 deployments.

3.4.1.2 2009 Deployments – JAX

MARUs were deployed in September (fall deployment) and December 2009 (winter deployment) at the planned JAX USWTR site (**Figure 34**). The MARU deployment sites were selected based on the expected location of planned U.S. Navy training exercises, rather than on habitat preferences or expected distribution of marine mammal species. 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 first exercise and recording for at least 7 to 10 days after the last exercise (Norris et al. 2012). MARUs were deployed for 26 and up to 37 days during the fall and winter deployments respectively, and covered periods before, during, and after ASW training events. The units were deployed in three rows inshore of, just beyond, and offshore of the continental shelf break, in three depth ranges: “shallow” (44- to 46-m depth, on the continental shelf) “mid-depth” (183-m depth, just beyond the shelf break), and “deep” (=305-m depth offshore of the shelf break). Three recorders were deployed at each of the three depth ranges, for a total of nine MARUs for each of the two (fall and winter) deployment periods. Two types of MARUs were deployed: (1) units that recorded using a 32-kHz sampling rate (32-kHz recorders) and (2) units that recorded using a 2-kHz sampling rate (2-kHz recorders). The 32-kHz recorders were deployed at Sites 2, 4, 5, 6, 7, and 9; the 2-kHz recorders were deployed at Sites 1, 3, and 8 (**Figure 34**). Due to the higher sample rates, the 32-kHz recorders sampled for about 2 weeks less total time than the 2-kHz recorders.

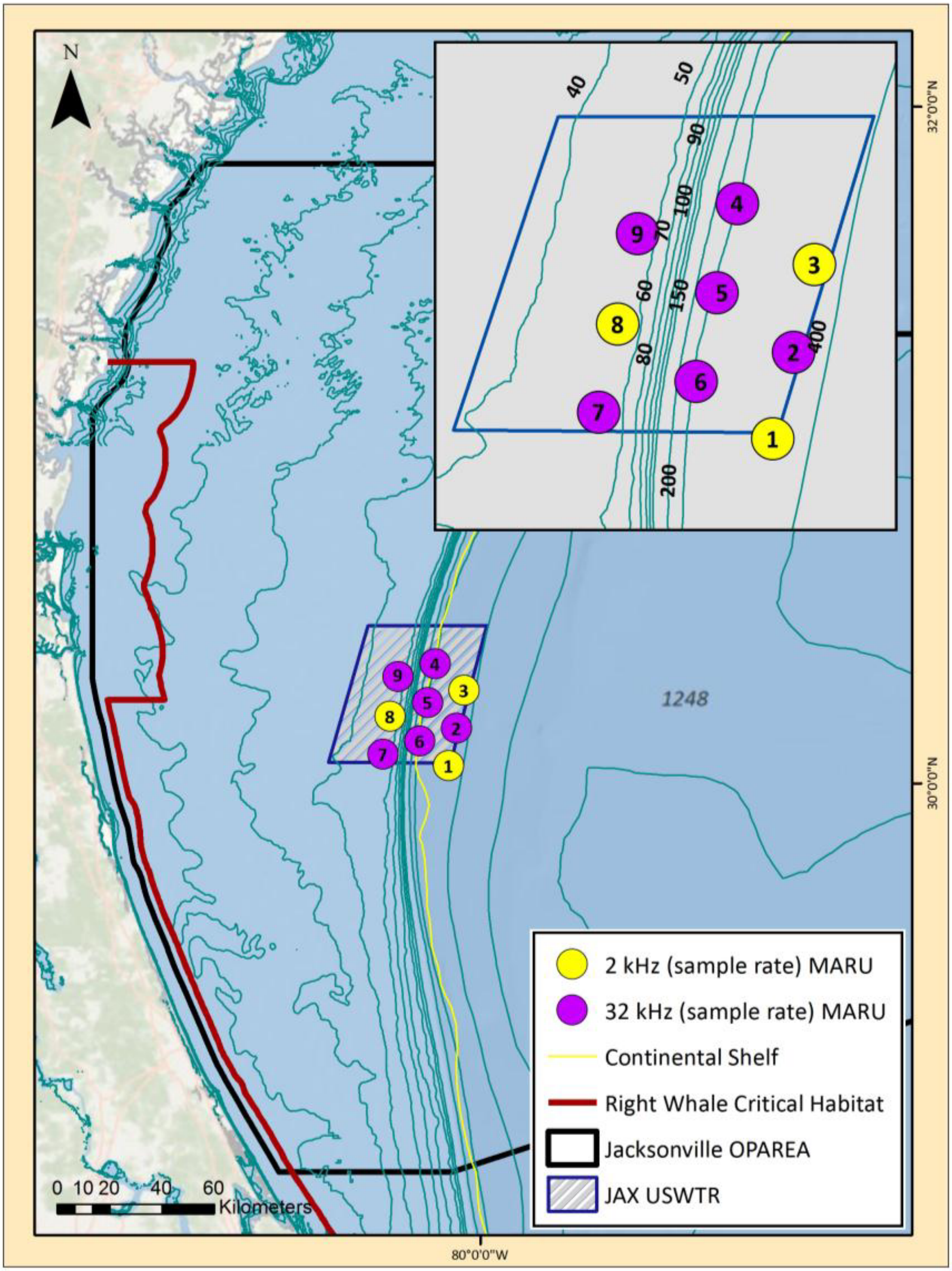


Figure 34. Location of 2-kHz and 32-kHz sample rate MARUs in the planned USWTR of the JAX OPAREA. MARUs labeled 1, 2, and 3 in "deep" sites; recorders labeled 4, 5, and 6 were deployed at "mid-depth" sites, and recorders labeled 7, 8, and 9 were deployed at "shallow" sites.

The 32-kHz units each recorded for approximately 21 days during both fall (13 September–04 October) and winter (04-26 December). The 2-kHz units each recorded for approximately 25 and 33 days during fall and winter (13 September–08 October and 05 December–08 January, respectively). A total of 13,077 hr of recordings was made on all nine MARU deployments. From these recordings, a total of 16,120 hr of data was reviewed and analyzed. The discrepancy between the total hours of recordings made and those reviewed and analyzed is because the 32-kHz data were reviewed twice, once for frequencies below 1 kHz (i.e., data were downsampled to 2 kHz) and once for frequencies between 1 and 16 kHz. Of the 16,120 hr of data reviewed, 10,132 hr consisted of 2-kHz data and 5,988 hr consisted of 32-kHz data. The fall deployment (Deployment 1: September to October 2009) consisted of 7,580 hr (47 percent) of data recorded and reviewed, while the winter deployment (Deployment 2: December 2009 to January 2010) was 8,540 hr (53 percent) of data recorded and reviewed.

Species and species group vocalizations detected included minke whale, North Atlantic right whale, sei whale, (probable) humpback whale, sperm whale, blackfish (melon-headed whale, pygmy killer whale [*Feresa attenuata*], false killer whale [*Pseudorca crassidens*], killer whale [*Orcinus orca*], short-finned pilot whale), and unidentified delphinids (Norris et al. 2012). Based on the percentage of total event duration by species relative to the total recording time available, the minke whale was by far the most commonly detected species, and it was only detected during the winter deployment (**Figure 35**). Sperm whale and the delphinid species group detection events were the next most detected. The remaining species and species-group vocalization events occurred at relatively low percentages (all <1 percent; **Figure 36**).

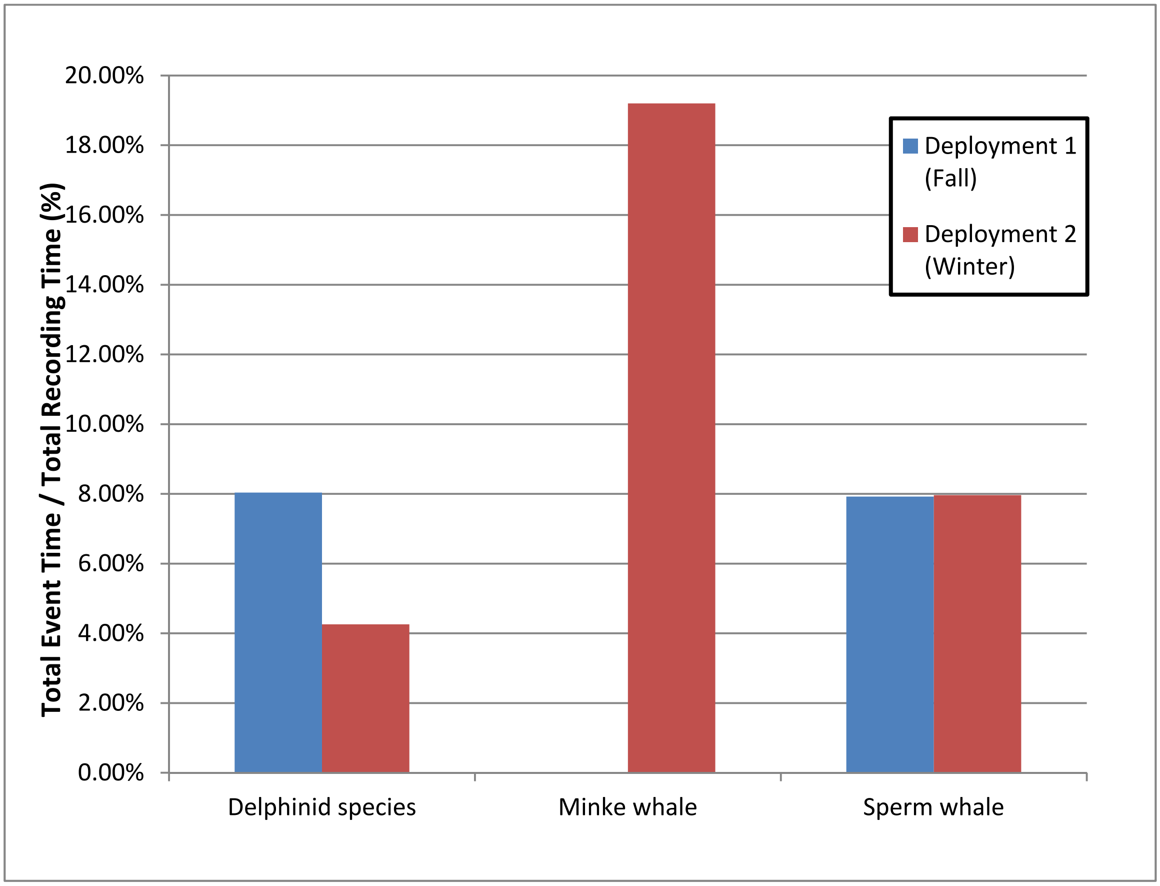


Figure 35. Percentage of total events relative total duration of recordings available for analysis for three species/species groups with values higher than 4 percent. Minke whale events were not detected during the fall deployment.

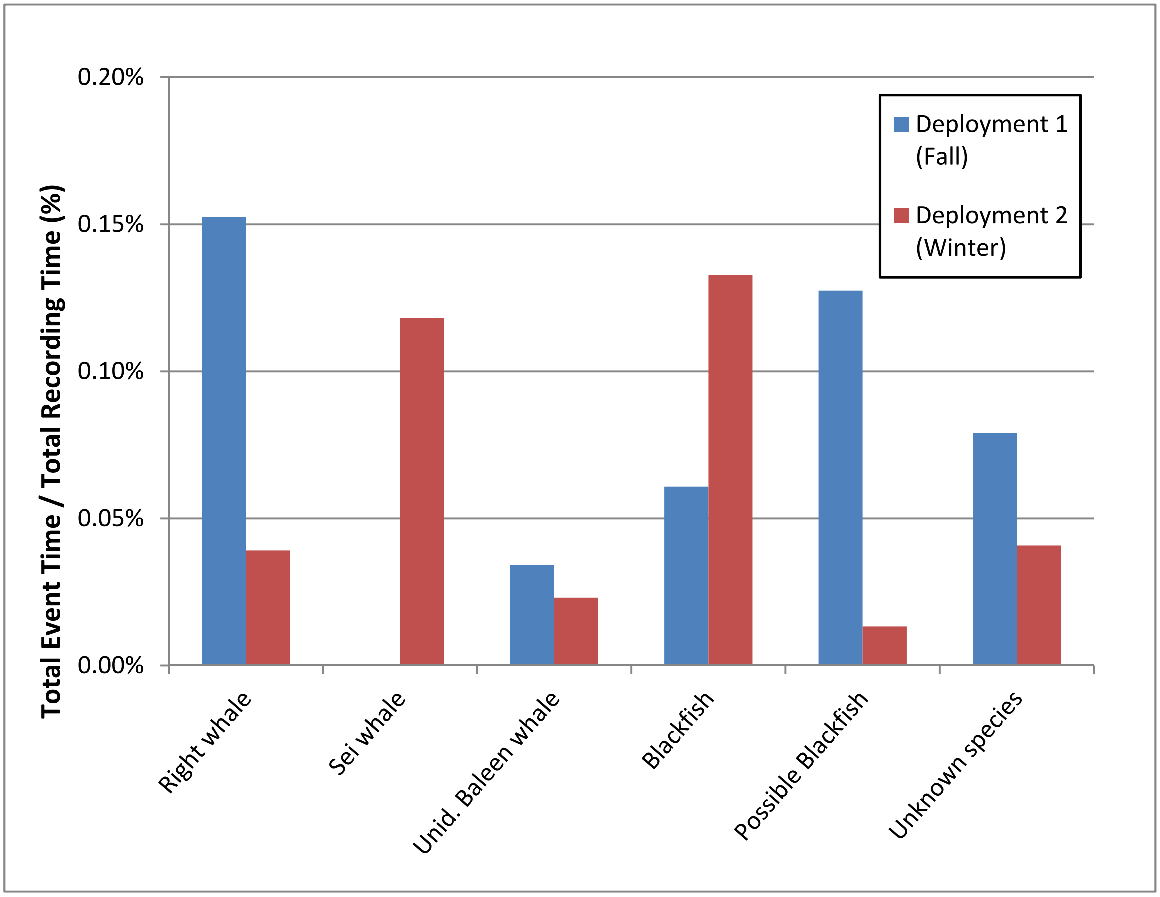


Figure 36. Percentage of total events relative total duration of recordings available for analysis for three species/species groups with values less than 1 percent. Sei whale events were not detected during the fall deployment and 'possible' blackfish were not detected in winter.

Sonar, echosounder, and shipping-traffic events were calculated as percent of total recording time (**Figure 37**). Anthropogenic noise events mostly consisted of ships (7 to 12 percent of total recording duration). MFAS occurred during both deployments, but was much more (>5 times) prevalent in the fall deployment than in the winter deployment recordings, occurring just under 10 percent and 2 percent of the total recording times, respectively (**Figure 37**). Additional details on these vocalization events and patterns are discussed in **Section 3.3.2** and in Norris et al. (2012). The acoustic behavior of species relative to the sonar events is discussed in **Section 3.4.2.**

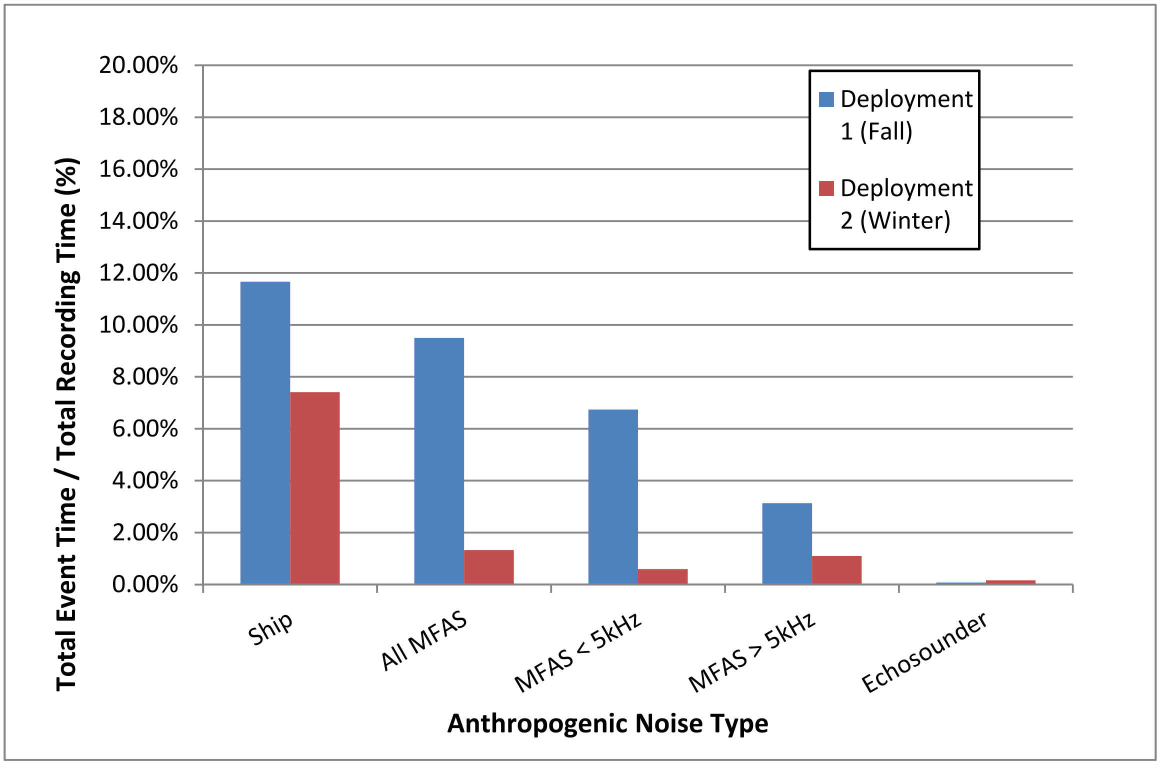


Figure 37. Percentage of total events relative total duration of recordings available for analysis for anthropogenic noise events.

3.4.1.3 2011 Deployment - JAX

Twelve JASCO Autonomous Multi-channel Acoustic Recorders (AMARs; www.jasco.com) were deployed in conjunction with an ASWEX in September 2011. The AMARs were deployed as three individual sub-arrays of four units each (**Figure 38**). Each array included a synchronization pinger located at the approximate center of each sub-array. The AMARs were programmed to record continuously. Data were recorded to memory modules at a sampling rate of 128 kHz with 24-bit resolution. Recordings were made for 27 days including periods before, during, and after the ASWEX (further details on durations of recordings are not currently available). The AMAR units were recovered at the end of the data-collection period. Due to the time-synchronization of the units (and therefore, the ability to locate and track vocalizing animals as well as ships, submarines, and other tactical U.S. Navy assets), these datasets are currently classified and involve the following of specific protocols that can complicate the analysis. A detailed analysis of this classified dataset has been provided to a collection of researchers, including Brandon Southall, Christopher Clark, and Marine Acoustics, Inc. Unclassified results of this analysis are anticipated to be available in late 2013.

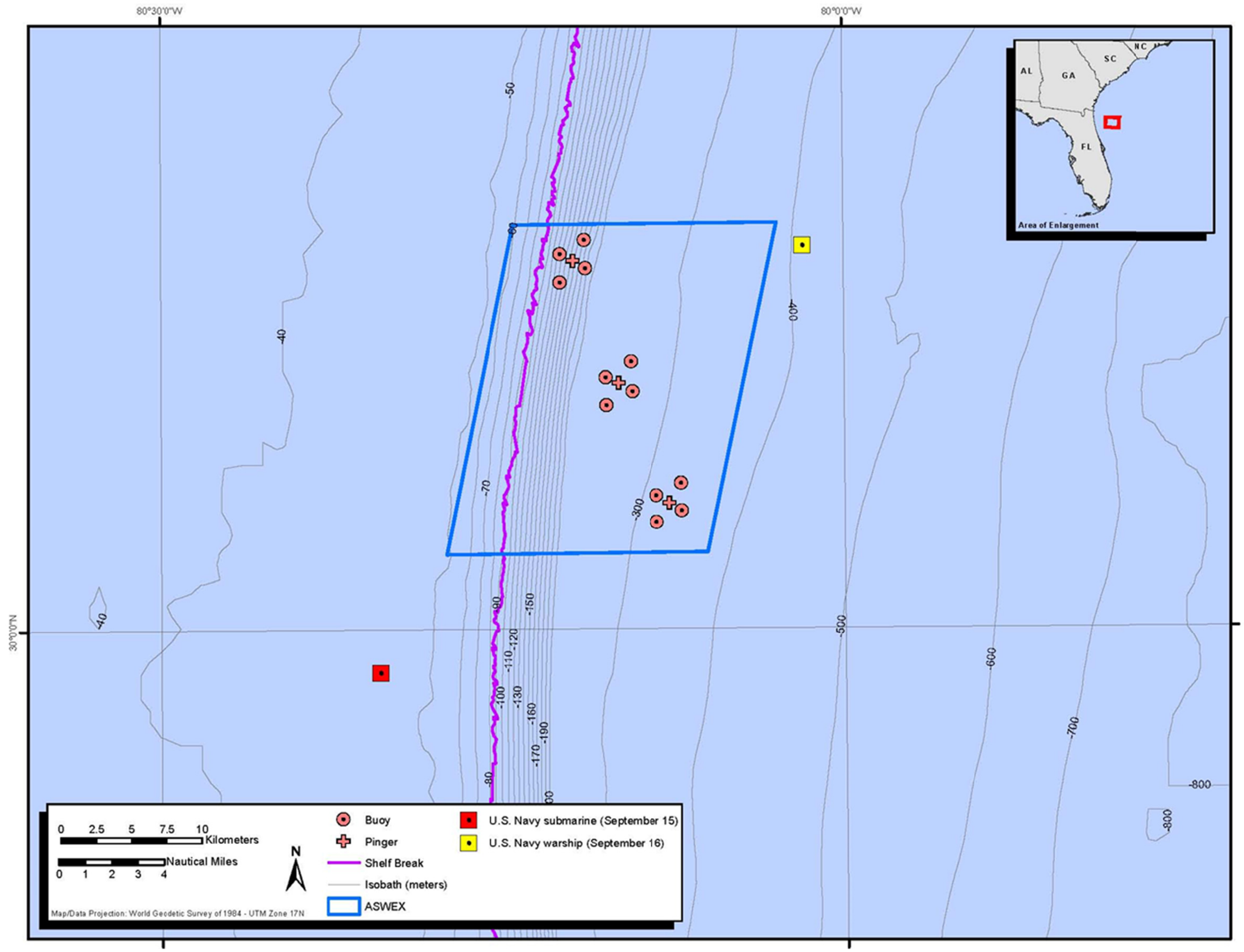


Figure 38. Locations of deployed AMARs and U.S. Navy vessels and submarines sighted from awerial surveys in conjunction with the September 2011 ASWEX training in JAX.

3.4.2 Behavioral Responses

Insights on species-specific vocal responses to sonar events were based exclusively on the MARU data collected from the JAX study site during a ASWEX events (see **Section 3.4.1.2**). Potential response to sonar was examined by calculating the probability of a vocal event occurring simultaneously with sonar events, and without sonar events, using 10-min 'event' bins. This approach was modeled after Melcón et al. (2012), who looked at the probability of blue whale calls with and without MFAS. The probability of a vocalization event was then calculated for each condition and plotted graphically, with the number of bins used presented as a horizontal bar (e.g., **Figure 39)**. Results of the MFAS analysis are presented in Norris et al. (2012) and summarized below.

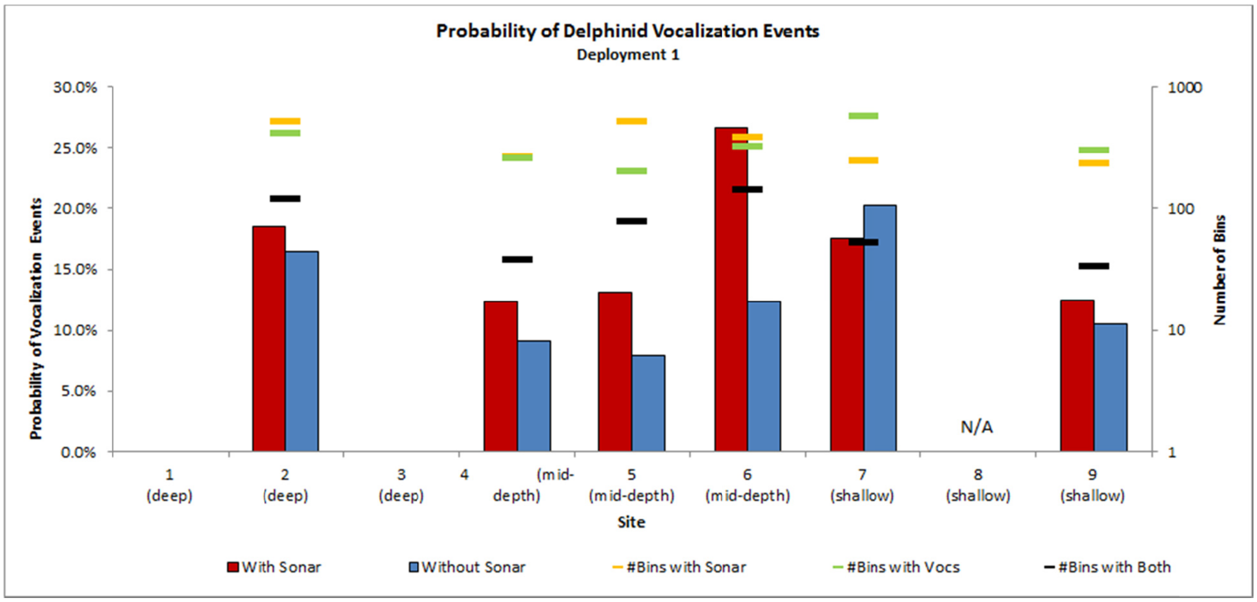


Figure 39. Probability of occurrence of delphinid vocalizations in the presence of sonar (red bars) and in the absence of sonar (blue bars) for Deployment 1 (fall). Probabilities were calculated based on the number of 10-min bins containing sonar only, vocalizations only, and both sonar and vocalizations. The numbers of 10-min bins containing sonar only are shown as yellow lines, the numbers of bins containing vocalizations only are shown as green lines, and the numbers of bins containing both sonar and vocalizations are shown as black lines

Over 630 hr of MFAS were logged during the combined JAX-MARU deployments (see Section 3.4.1 for more details on the deployments), with significantly more sonar occurring during the winter deployment than fall deployment (approximately 535 and 108 hr, respectively) (**Table 32**). During the fall deployment, MFAS occurred in just under 10 percent of total time recorded, but less than 2 percent of the total time recorded during the winter deployment—almost a five-fold difference (**Figure 38**). The following is a brief synopsis of the findings presented in Norris et al. (2012).

Table 32. Acoustic detection duration by deployment.

Acoustic Detection Type	Deployment 1: Total Event Duration (hr:min:sec)	Deployment 2: Total Event Duration (hr:min:sec)	Summed 1 & 2: Total Event Duration (hr:min:sec)
Blackfish	2:17:07	6:35:15	8:52:22
Possible Blackfish	0:36:04	0:39:30	1:15:34
Probable Blackfish	4:11:09	-	4:11:09
Delphinid Species	301:57:01	235:18:16	537:15:17
Possible Delphinid Species	2:21:25	0:27:55	2:49:20
Possible Humpback Whale	-	0:01:24	0:01:24
Minke Whale	-	1429:04:04	1429:04:04
Sperm Whale	297:29:41	395:10:54	692:40:35
Right Whale	8:35:33	2:54:43	11:30:16
Sei Whale	-	8:47:26	8:47:26
Unidentified Baleen Whale	1:55:17	1:42:58	3:38:15
Ship	659:09:51	551:41:08	1210:50:59
Echosounder (active sonar)	4:11:06	12:22:35	16:33:41
MFAS < 5kHz (active sonar)	379:41:59	44:24:28	424:06:27
MFAS > 5kHz (active sonar)	155:24:51	54:36:39	210:01:30

Key: hr = hour(s); min = minute(s); sec = second(s); MFAS = Mid-frequency Active Sonar.

3.4.2.1 Delphinids

The probability of delphinid vocalization events was higher with sonar than without sonar during the fall deployment and the opposite situation was true during the winter deployment (**Figures 39 and 40**). The differences in probabilities of vocalization with and without sonar were small (i.e., less than 5 percent) in most cases, with the exception of mid-depth Site 6 during the fall deployment and Sites 5 and 9 (mid-depth and shallow-water sites, respectively) during the winter deployment (**Figures 39 and 40,** respectively). It is possible that these opposing fall and winter patterns evident in **Figures 39 and 40** are due to different behavioral reactions to sonar by different species or differences in social structure or social contexts (e.g., females and groups with dependent calves may have stronger reactions than sub-adults or male groups), or in the case of the winter deployment (when there was much less sonar) due to chance. It is possible, even likely, that any differences in the probabilities of delphinid vocal events were confounded by the fact that all delphinid species were lumped together for this analysis. For example, if one species responds to sonar by increasing its vocalization rate and another responds to sonar by decreasing its vocalization rate, then the two responses will potentially offset each other and it would appear that there is little or no response to sonar. It is also possible that there was no consistent effect for any species. Classification of sounds to species level, and more data, will be required to elucidate any effects from these autonomous recorder data.

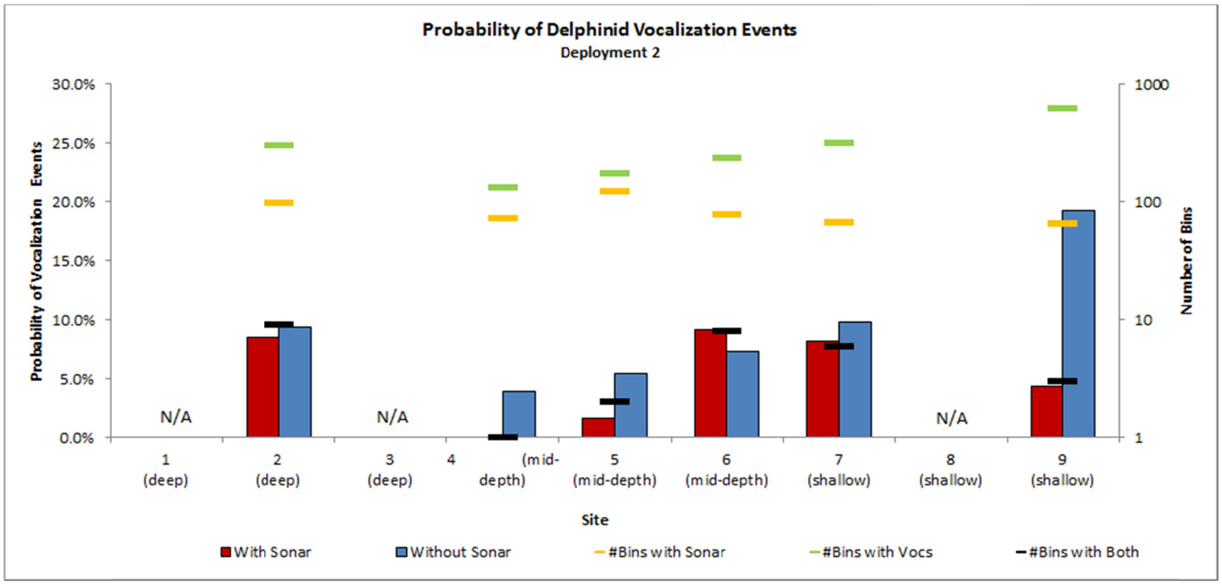


Figure 40. Probability of occurrence of delphinid vocalizations in the presence of sonar (red bars) and in the absence of sonar (blue bars) for Deployment 2 (winter). Probabilities were calculated based on the number of 10-min bins containing sonar only, vocalizations only, and both sonar and vocalizations. The numbers of 10-min bins containing sonar only are shown as yellow lines, the numbers of bins containing vocalizations only are shown as green lines, and the numbers of bins containing both sonar and vocalizations are shown as black lines.

3.4.2.2 Blackfish

Because the sample size for blackfish vocalization events in the JAX-MARU dataset was so small, the probability analysis results were inconclusive. It is possible that there were effects, but until more data and samples can be obtained from autonomous recorders, these data should not be used to assess impacts of sonar on this species group. Refer to Section 3.5 for details on the behavioral response study conducted by Duke University, which was a controlled exposure experiment to determine short-finned pilot whale responses to an echosounder (another type of sonar).

3.4.2.3 Sperm Whale

Results of the probability analysis for the fall deployment did not indicate any consistent differences in the probabilities of call events occurring with or without sonar (**Figure 41**). During the winter deployment, there were consistently lower probabilities of call events occurring with sonar relative to call events without sonar (i.e., all three mid-depth recorder sites had lower, or zero, probabilities of vocal events occurring with sonar than without) **(Figure 42**). It is possible that the reduced probability in winter was mostly coincidental, because more sonar use occurred during the day versus at night. Although the JAX-MARU data do not provide support for strong reactions (e.g., a cessation of vocalizations) by sperm whales to sonar, as was observed for the minke whale, more subtle effects (such as reduced foraging success or a change in dive durations) could be occurring that were not detectable with the preliminary analyses conducted as part of the analysis effort.

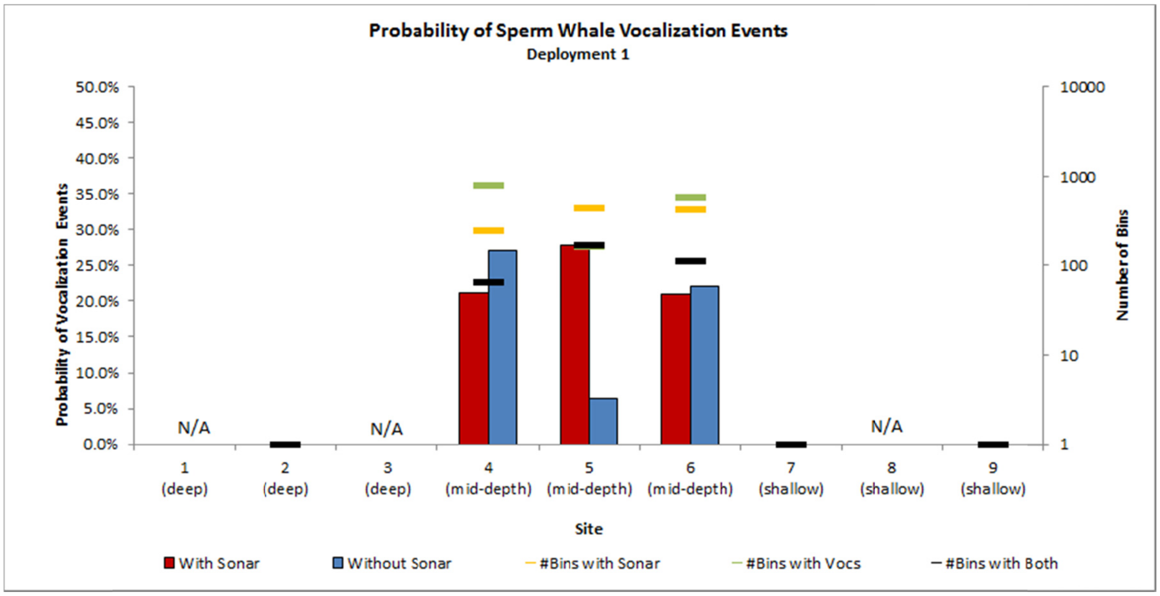


Figure 41. Probability of occurrence of sperm whale vocalizations in the presence of sonar (red bars) and in the absence of sonar (blue bars) for Deployment 1 (fall). Probabilities were calculated based on the number of 10-min bins containing sonar only, vocalizations only, and both sonar and vocalizations. The numbers of 10-min bins containing sonar only are shown as yellow lines, the numbers of bins containing vocalizations only are shown as green lines, and the numbers of bins containing both sonar and vocalizations are shown as black lines.

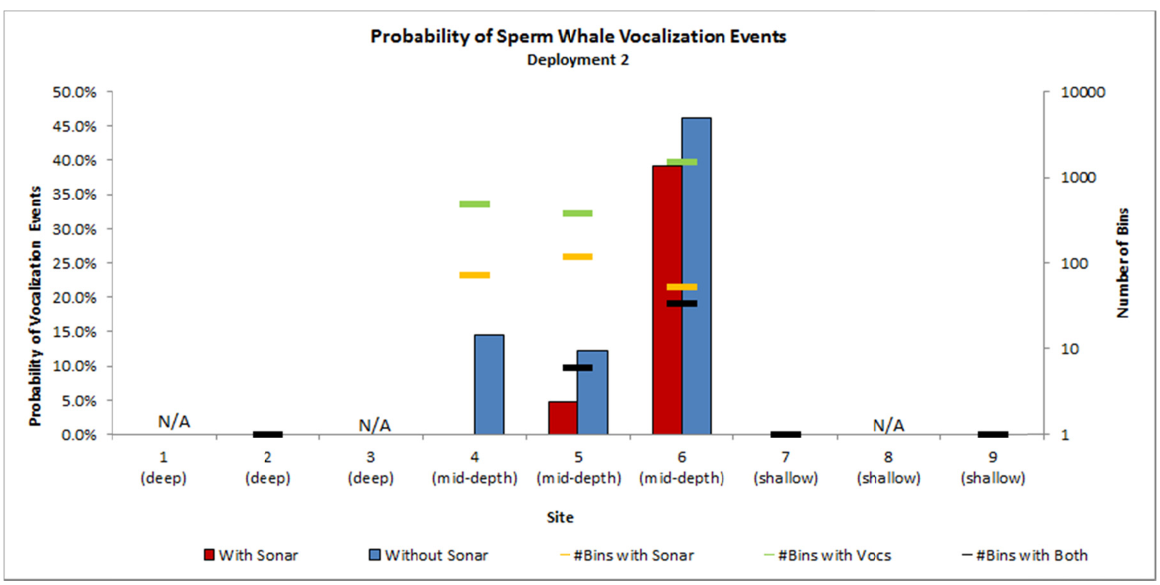


Figure 42. Probability of occurrence of sperm whale vocalizations in the presence of sonar (red bars) and in the absence of sonar (blue bars) for Deployment 2 (winter). Probabilities were calculated based on the number of 10-min bins containing sonar only, vocalizations only, and both sonar and vocalizations. The numbers of 10-min bins containing sonar only are shown as yellow lines, the numbers of bins containing vocalizations only are shown as green lines, and the numbers of bins containing both sonar and vocalizations are shown as black lines.

3.4.2.4 North Atlantic Right Whale

Right whale vocalization events either were not present, or were not always inversely correlated with sonar events (**Figures 43 and 44**). Due to low vocalization rates by right whales, it is not possible to say if sonar resulted in cessation of right whale vocalizations, or if individuals were not vocalizing when sonar was present. These results must be interpreted with consideration of the low rates of right whale vocalization, and low numbers of MFAS events in general, within the winter JAX-MARU recordings (which resulted in a limited ability to detect meaningful changes in vocalization events from these data) (see **Section 3.3.2.3**). Due to the expected shallow-water distribution of right whales and the deep-water location of the ASW events, right whales could have been exposed to relatively lower sound levels of sonar than animals occurring in deep water, or inside the planned USWTR. Consequently, any effects on right whale vocalizations might be expected to be more subtle, and therefore, difficult to detect. The study design and analysis used were not intended to pick up such subtle effects. Furthermore, acoustic characteristics of the right whale sounds were not measured for responses such as shifts in durations, call frequencies, or spectral characteristics of right whale sounds as have been documented in other studies of the effects of man-made noise on right whales (Parks et al. 2007, Parks et al. 2011).

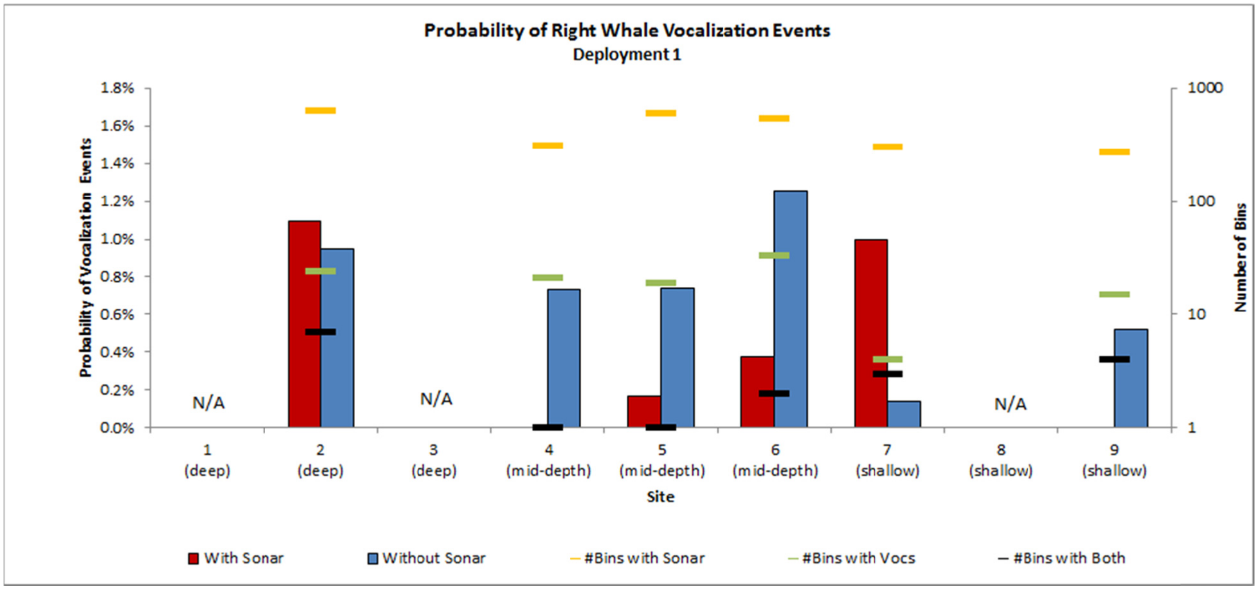


Figure 43. Probability of occurrence of right whale vocalizations in the presence of sonar (red bars) and in the absence of sonar (blue bars) for Deployment 1 (fall). Probabilities were calculated based on the number of 10-min bins containing sonar only, vocalizations only, and both sonar and vocalizations. The numbers of 10-min bins containing sonar only are shown as yellow lines, the numbers of bins containing vocalizations only are shown as green lines, and the numbers of bins containing both sonar and vocalizations are shown as black lines.

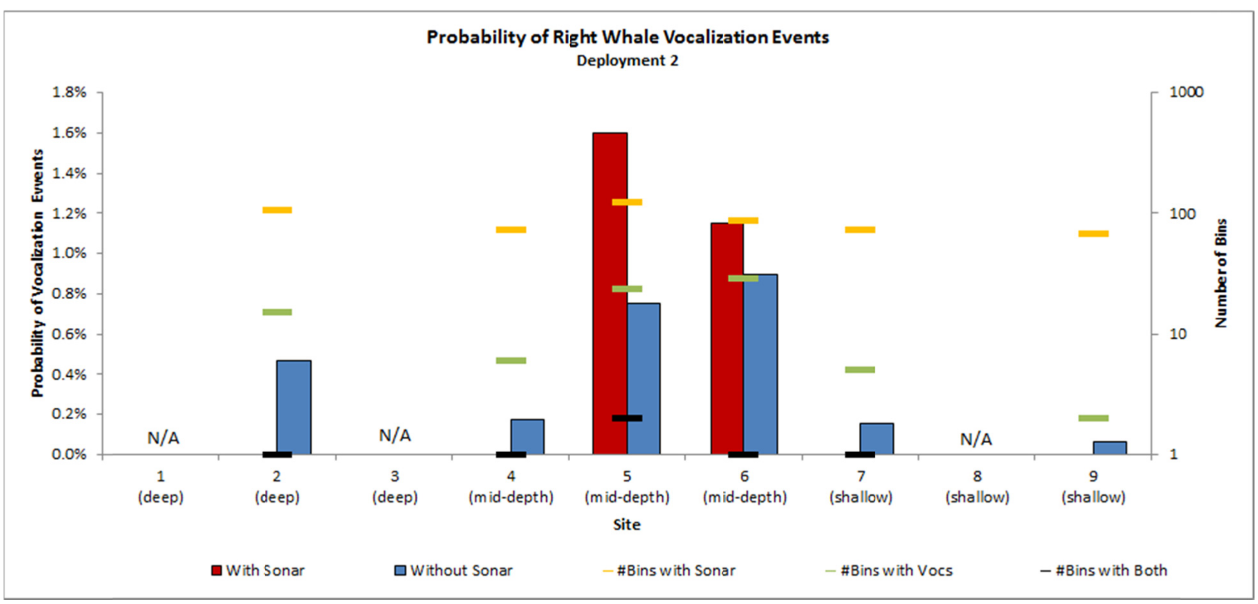


Figure 44. Probability of occurrence of right whale vocalizations in the presence of sonar (red bars) and in the absence of sonar (blue bars) for Deployment 2 (winter). Format as in Figure 43.

3.4.2.5 Minke Whale

Minke whale vocal events were greatly reduced or completely absent during most days during which sonar events occurred (**Figure 45**). Results of the probability analysis of vocal events, with and without sonar, suggest a very strong response to sonar, as indicated by the greatly reduced probabilities of vocalization events occurring during sonar relative to when sonar was not present (**Figure 46**). In fact, for Sites 4, 5, and 6 (mid-depth recorders), there were no vocalization events that coincided with sonar during the entire deployment period. It cannot be determined with certainty from these data whether minke whales ceased vocalizing or moved away from the area, or if it was some combination of both factors. PAM of minke whales in other regions with frequent sonar activity (for example, the Pacific Missile Range Facility [PMRF] off Kauai; Martin et al. 2013) has not produced similar results, however, call characteristics for minke whales in the North Pacific are extremely different than those recorded for minke whales in the North Atlantic.

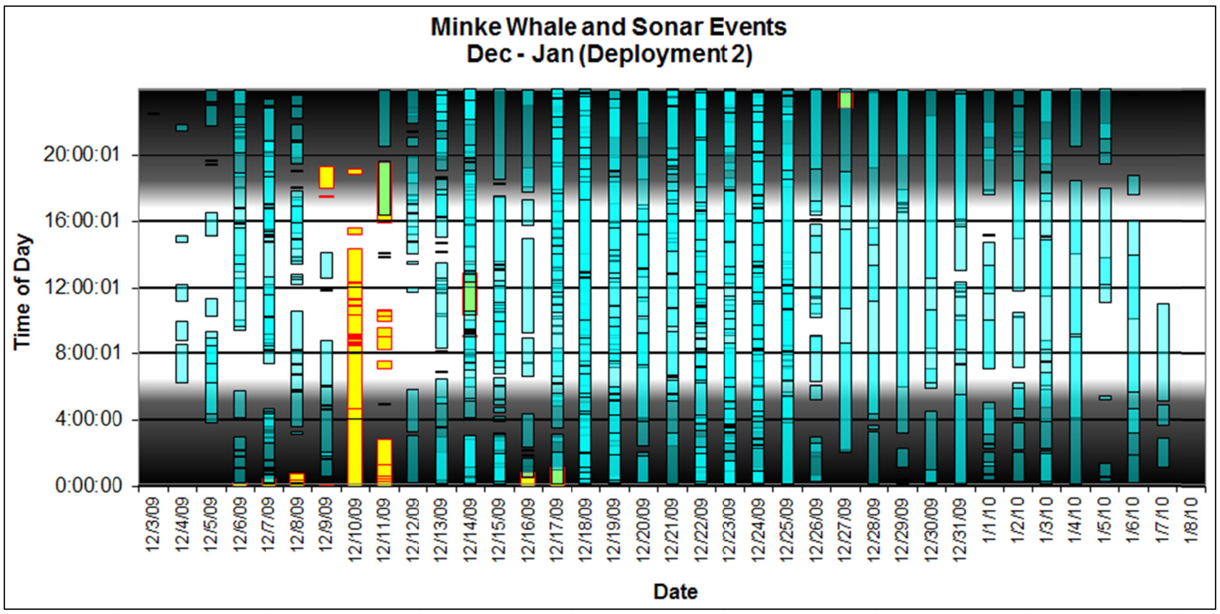


Figure 45. Deployment 2 (winter)—Minke whale vocal and sonar events by day and time. Minke whale vocal events are shown in teal (shading is representative of event overlap [i.e., an event occurring at multiple sites] with time of day on the y-axis and date on the x-axis. Sonar activities are shown in yellow with the same axes. Shading represents average daylight (white) and darkness (black) for the deployment period.

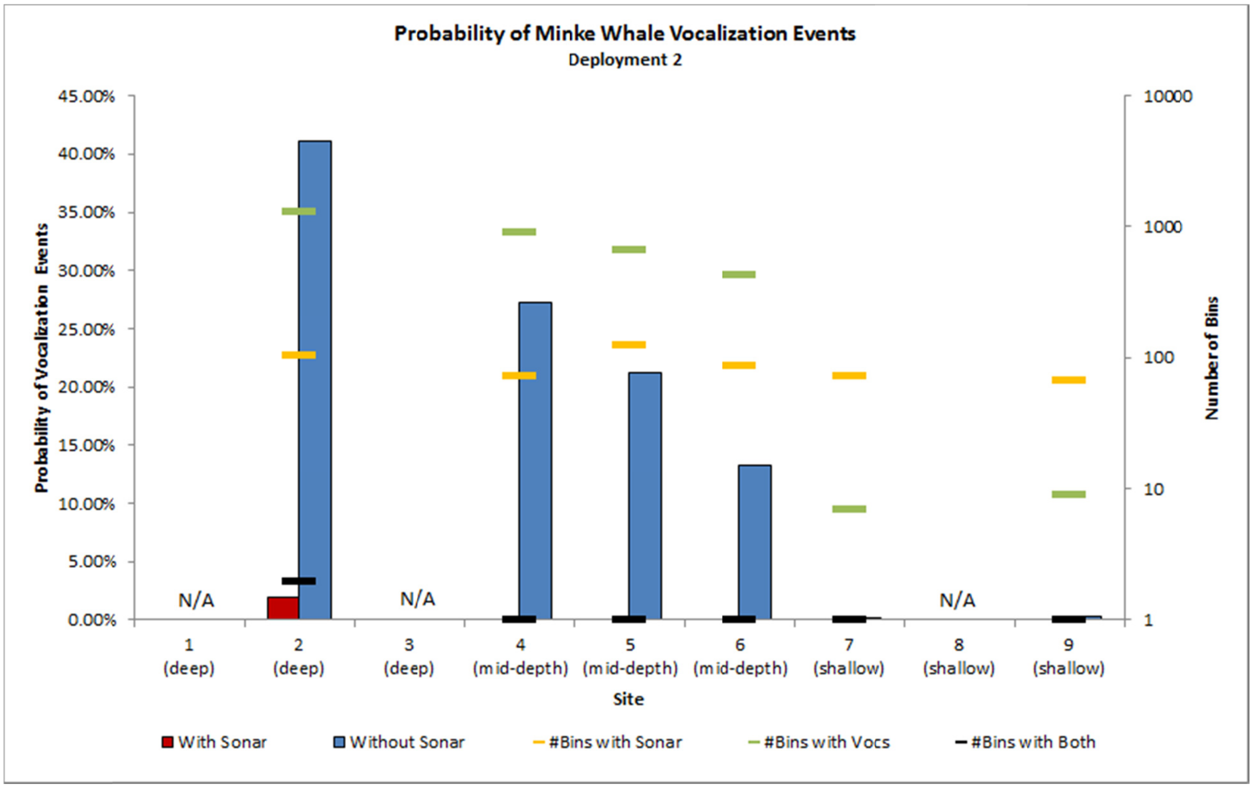


Figure 46. Probability of occurrence of minke whale vocalizations in the presence of sonar (red bars) and in the absence of sonar (blue bars) for Deployment 2 (winter). Probabilities were calculated based on the number of 10-min bins containing sonar only, vocalizations only, and both sonar and vocalizations. The numbers of 10-min bins containing sonar only are shown as yellow lines, the numbers of bins containing vocalizations only are shown as green lines, and the numbers of bins containing both sonar and vocalizations are shown as black lines.

3.4.2.6 Other Baleen Whales

There were insufficient (or, in some cases, no) acoustic detections to examine the effects of sonar on other baleen whale species (e.g., humpback whale [*Megaptera novaeangliae*] and sei whale [*Balaenoptera borealis*]).

3.4.2.7 General Comments Regarding Passive Acoustic Data Analysis Findings

The analysis and results presented here are a preliminary effort to examine the effects of sonar on the calling behaviors of marine mammals. When considering the effects of sonar on marine mammals, it is important to note that hearing sensitivity varies greatly across marine mammals (Richardson et al. 1995), with baleen whales most sensitive in the lower frequencies and odontocetes (with possible exception of mature sperm whales) more sensitive to sounds in the higher frequencies (Ketten 1998). We did not attempt to address the lack of responses based on (low) hearing sensitivities; however, it is worth noting that Melcón et al. (2012) detected a reduction in the probability of vocalizations of blue whales (which are extremely low-frequency signalers) during MFAS transmissions. This detection implies that at least some species can detect MFAS (or vessel noise associated with the occurrence of MFAS) that is well outside the frequency range of their calls. More detailed analyses of the potential effects of sonar on calling rates, call structure, and other aspects of marine mammals calls and echolocation behaviors are needed to better understand how sonar affects marine mammal acoustic behaviors.

3.5 Pilot Whale Behavioral Response Experiment

In May and June 2011, a behavioral response experiment was conducted with short-finned pilot whales in the Cape Hatteras survey area. This was the first phase of a planned multi-year study examining the responses of pilot whales and other odontocetes to a variety of acoustic stimuli, including the sounds of predators (see below). Part of this work relies on an understanding of the prey field around these animals, which is measured with a scientific echosounder.

In the 2011 study, pilot whales were exposed to the sounds of a 38-kHz EK-60 scientific echosounder in an experimental protocol designed to determine whether the surface and foraging behavior of the whales was affected by the sounds produced by the echosounder. The echosounder system is used to map the prey of pilot whales and other odontocetes during surveys and behavioral studies off Cape Hatteras.

Individual pilot whales were tagged with digital acoustic recording tags (DTAGs; Johnson and Tyack 2003), designed by researchers at the Woods Hole Oceanographic Institution (**Figure 47**). These tags each contain 12 gigabytes of flash memory, in which digital recordings (sampled at 192 kHz) and detailed records of depth and three-axis acceleration are collected. The tag is attached with suction cups and programmed to jettison from the whale at a pre-determined time and float to the surface, where it is recovered with the aid of a very high-frequency (VHF) radio beacon. In the current experiment, the tags were programmed to stay on each whale for four hr, including a 1-hr period of pre-exposure, two 1-hr-long exposure periods (alternated randomly between active exposure with the echosounder operating and a control period with the echosounder off), and a 1-hr post-exposure period (**Figure 48**). Five additional pilot whales were equipped with DTAGs, but not exposed to the echosounder, to provide control data on surface and diving behavior.

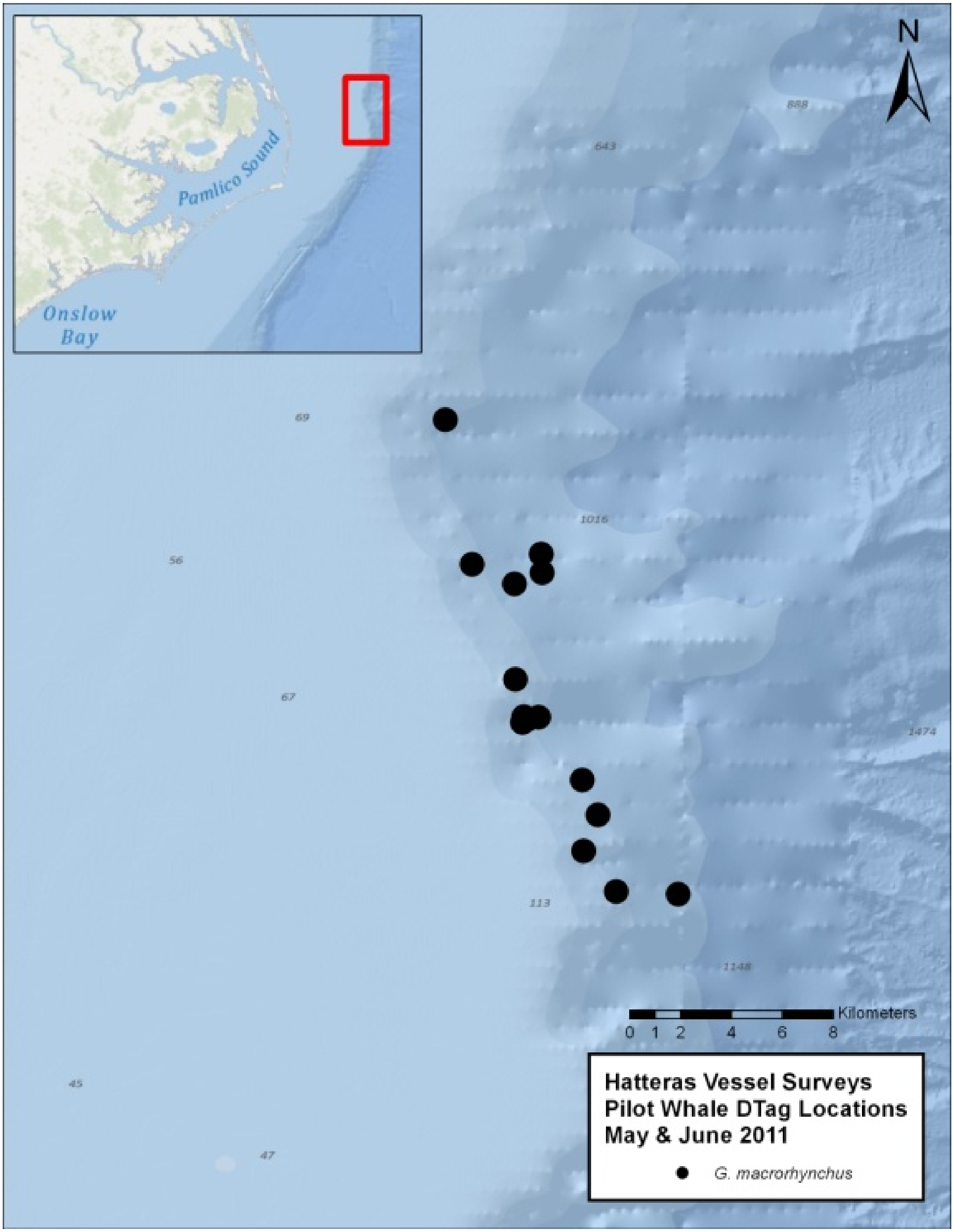
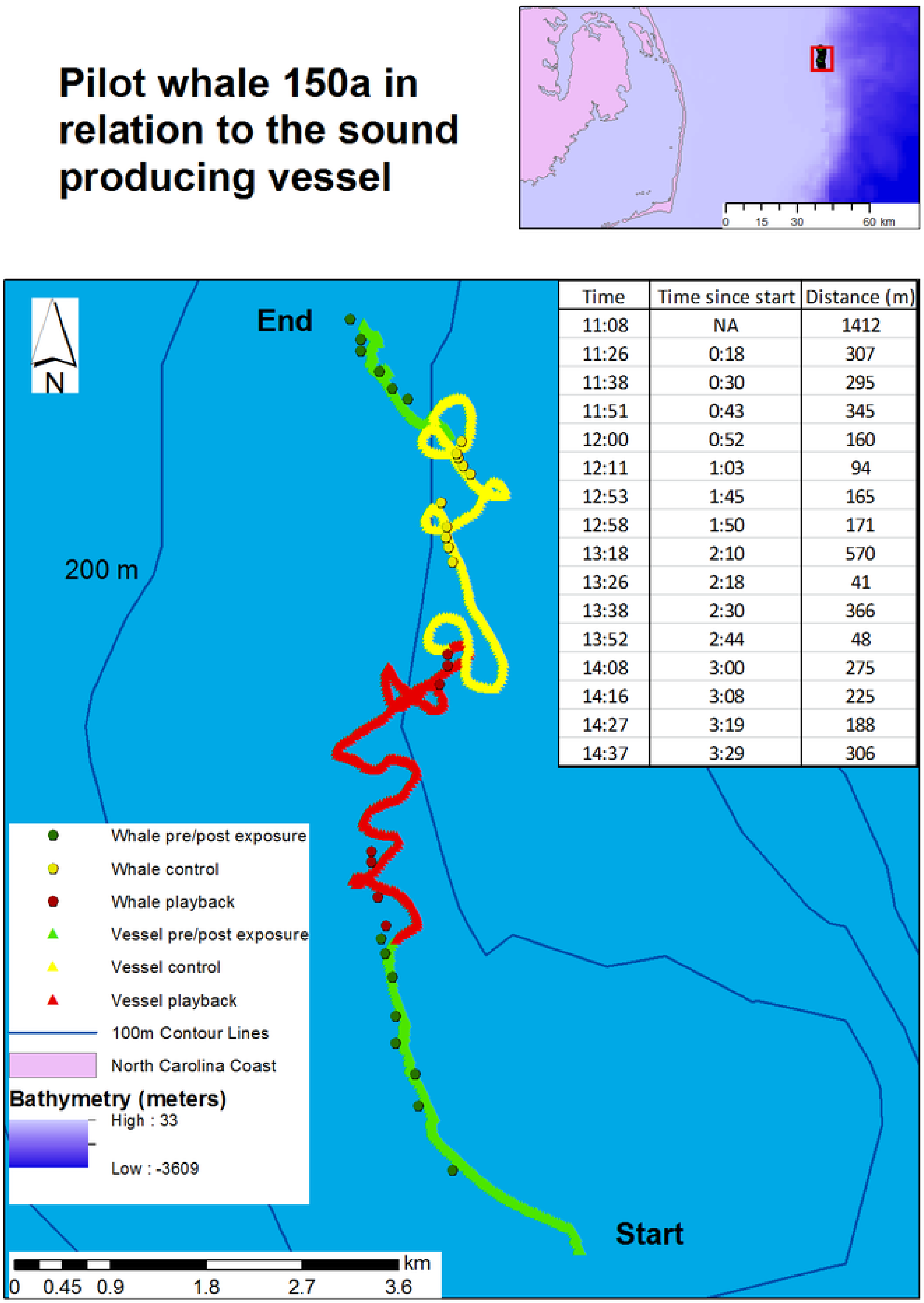


Figure 47. Tagging locations of short-finned pilot whales equipped with DTAGs in May and June 2011. The plot includes very short-duration attachments that were not included in the analysis.



Time	Time since start	Distance (m)
11:08	NA	1412
11:26	0:18	307
11:38	0:30	295
11:51	0:43	345
12:00	0:52	160
12:11	1:03	94
12:53	1:45	165
12:58	1:50	171
13:18	2:10	570
13:26	2:18	41
13:38	2:30	366
13:52	2:44	48
14:08	3:00	275
14:16	3:08	225
14:27	3:19	188
14:37	3:29	306

Figure 48. Example of behavioral response experiment with short-finned pilot whales off Cape Hatteras. The track of the observation vessel is indicated by a colored line: green represents periods of pre- and post-exposure; red indicates periods of exposure; and yellow marks periods of control. Dots denote whale positions.

Observers in a rigid-hulled inflatable boat observed and recorded the surface behavior of the focal (tagged) whale and its group members. Data collected at the surface included behavioral state, group spread, synchrony of surfacing, synchrony of heading, and activity level. The occurrence of foraging behavior was identified by feeding echolocation buzzes in the DTAG acoustic record. Analysis of these data is now almost complete and shows no evidence of any response to the sounds of the echosounder, either in surface or foraging behavior. A manuscript describing the results of this experiment will be prepared for submission to a journal in 2013.

This behavioral response experiment was a critical precursor to an ongoing study of the response of short-finned pilot whales to the sounds of predators in the Cape Hatteras survey area. This follow-on study, funded by the Strategic Environmental Research and Development Program (SERDP), was initiated in 2011 and is designed to increase scientific understanding of the response of various odontocete species to aversive acoustic stimuli. The use of sounds from natural predators (mammal-eating killer whales [*Orcinus orca*]) is predicated on the hypothesis that some odontocetes may perceive the sounds produced by military sonars as similar to those of predators. This study continued off Cape Hatteras in 2012. Ongoing baseline visual surveys and HARP deployments in the Hatteras region will continue to provide important information on the occurrence and distribution of pilot whales as well as other species. In addition, because many of the scientific staff for the AFAST baseline monitoring program and the SERDP-funded pilot whale project are the same, there is a mutually beneficial opportunity for coordination between the complementary efforts.

3.6 U.S. Navy 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 marine 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 and identifying marine mammals. Of particular interest is the probability of an animal occurring 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 type (whale, dolphin, etc.), assessing group size, and estimating their position. In order to achieve this, experienced MMOs search and collect information on marine mammals that are detected by themselves and/or the OT. A new analysis method was developed that allows estimation of the probability of animals approaching to within a specified stand-off range without being detected (the "sneak-up probability").

Work was previously conducted to design and test a protocol for determining the effectiveness of the LOs in visually detecting marine mammals. The field protocol for the experiments was developed in consultation with members of the Naval Undersea Warfare Center Division, Newport; U.S. Fleet Forces Command (USFFC); Naval Facilities Engineering Command (NAVFAC); Commander, U.S. Pacific Fleet; and NMFS. The basic concept is that trained 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 surfacing of a marine mammal at a measured location and record whether that surfacing was also detected (a successful trial) or not (an unsuccessful trial) by the LO.

It was necessary to have an additional "liaison" MMO (LMMO) stationed with the LO, and in communication with the other MMOs, to help report when and where LOs detected animals at the surface. It was also necessary to have an additional team member tasked solely with data recording. In addition to recording surfacing events, MMOs attempted to keep track of which surfacings belonged to the same school or animals. The revised protocol (Burt and Thomas 2010) was applied to one further at-sea exercise (off Southern California), making four datasets in total.

In parallel with field protocol development, methods have been developed for using the data generated by these experiments to estimate the probability of animals entering the standoff range undetected. Intermittent availability models are necessary because many marine mammals remain below the surface for significant periods during dives. The extended methods currently only use information about the location of LO detections, but could conceivably be extended further to use information from the MMO/LO trials. During this reporting period, a new analysis method has been developed and tested that allows estimation of the probability of animals approaching to within a specified stand-off range without being detected (the "sneak-up probability"). The method is flexible in allowing for a variety of animal surfacing patterns: "clustered instantaneous"—where surfacings last just for an instant, but 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 members 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 and MMO detections, although it is also possible to focus just on the LO 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. Results are preliminary, but indicate that the U.S. Navy LOs are not completely effective, and that additional data are needed for more in-depth evaluation.

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4. Data Management and Availability

During the course of this project, large volumes of geo-referenced survey data, both effort tracklines and and sightings, are being generated. The Navy is committed to ensuring that data and reports generated by the marine species monitoring program are made available to the general public in order to promote transparency and collaboration. Aerial and vessel visual survey data are submitted to the Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP). OBIS-SEAMAP is a spatially referenced online database, aggregating marine mammal, seabird and sea turtle observation data from across the globe. Available survey data can be viewed and downloaded through the Navy's data provider page (http://seamap.env.duke.edu/provider/NAVY) on OBIS-SEAMAP (Halpin et al. 2009). At present, all baseline and exercise monitoring survey data included in this 5-year report have been contributed OBIS-SEAMAP. The monitoring data represent the second-largest contribution of geo-referenced data to OBIS-SEAMAP. Baseline monitoring data submissions from Duke University and UNCW as well as exercise monitoring efforts are listed in **Table 33**.

Table 33. Data submissions to OBIS-SEAMAP through 2012.

Baseline Monitoring	Year
UNCW Aerial Survey 1998-1999	1998-1999
UNCW Marine Mammal Sightings 1998-1999	1998-1999
UNCW Aerial Surveys for Monitoring of Proposed Onslow Bay USWTR Site - Left side	2007
UNCW Aerial Surveys for Monitoring of Proposed Onslow Bay USWTR Site - Right side	2007
USWTR JAX Aerial Survey - Right side- 2009-2010	2009-2010
USWTR JAX Aerial Survey - Left side- 2009-2010	2009-2011
USWTR Onslow Bay Aerial Survey - Left side - 2008-2010	2008-2010
USWTR Onslow Bay Aerial Survey - Right side - 2008-2010	2008-2010
UNCW USWTR JAX Aerial Surveys May - Oct 2010 - Left side	2010
UNCW USWTR JAX Aerial Surveys May - Oct 2010 - Right side	2010
USWTR JAX Aerial Survey - Right side - 2010-2011	2010-2011
USWTR JAX Aerial Survey - Left side - 2010-2011	2010-2011
USWTR Onslow Bay Aerial Survey - Left side - 2010-2011	2010-2011
USWTR Onslow Bay Aerial Survey - Right side - 2010-2011	2010-2011
USWTR JAX Aerial Survey - Right side - 2011-2012	2011-2012
USWTR JAX Aerial Survey - Left side- 2011-2012	2011-2012
AFAST Hatteras Aerial Survey - Left side - 2011-2012	2011-2012
AFAST Hatteras Aerial Survey - Right side - 2011-2012	2011-2012
DUML Vessel-Based Surveys for Monitoring of Proposed Onslow Bay USWTR Site	2007-2010
DUML Vessel-Based Surveys for USWTR Site 2009-2010	2009-2010
Exercise Monitoring	**Year**
JAX MISSILEX Aerial Monitoring 2010	2010
VACAPES FIREX and ASW Aerial Monitoring 2010	2010
JAX SEASWITI Vessel Monitoring 2010	2010
JAX SEASWITI Aerial Monitoring 2010	2010
VACAPES FIREX Aerial Monitoring 2011	2011

Baseline Monitoring	Year
VACAPES ASWEX Aerial Monitoring 2011	2011
JAX ASWEX Aerial Monitoring 2011	2011
JAX FIREX Aerial Monitoring 2011	2011
CHPT FIREX Aerial Monitoring 2011	2011
JAX MAVEX Aerial Monitoring 2012	2012

Key: AFAST = Atlantic Fleet Active Sonar Training; DUML = Duke University Marine Laboratory; JAX = Jacksonville Range Complex; UNCW = University of North Carolina at Wilmington; USWTR = Under Sea Warfare Training Range.

In addition to survey data made available through OBIS-SEAMAP, the Navy's marine species monitoring program web page (http://www.navymarinespeciesmonitoring.us/) serves as an online portal for information on the background, history, and progress of the program, as well as provides access to reports, documentation, data, and updates on current monitoring projects and initiatives. Reports from individual monitoring events, results of analyses, publications, and periodic progress reports for specific monitoring projects will be posted to the portal as they become available. The portal will also be used as a public forum to make known details of current and planned monitoring projects.

5. Progress, Feasibility, and Lessons Learned

5.1 Baseline Monitoring

The current monitoring program will continue to provide baseline information on the occurrence, distribution, density, and behavior of protected marine species in the Cape Hatteras, Onslow Bay, and JAX survey areas throughout the remainder of 2013 and beyond. In addition to the current visual survey work, the program is anticipated to focus more intensively on deep-diving odontocetes in future years. Dedicated surveys conducted offshore in the Onslow Bay survey area in August and November 2010 and March 2011 yielded three sightings of beaked whales (*Mesoplodon* sp.). All beaked whale sightings occurred between the 1,000- and 2,000-m isobaths, well offshore of the existing Onslow Bay survey area. Current survey effort off Cape Hatteras has produced a large number of beaked and sperm whale sightings off the continental shelf break (**Figures 14-15**). As noted above, pilot whales are one of the most common cetaceans observed off Cape Hatteras; current and future research will continue to address the behavior of this species. Plans are also underway to document the distribution and seasonal occurrence of beaked and sperm whales from Cape Hatteras to Onslow Bay by adding a series of track lines that will be flown during transits from Wilmington to Cape Hatteras.

A large amount of analysis is currently underway with existing data collected during the baseline monitoring program. This analysis includes: quantitative comparisons of the densities of cetaceans and sea turtles in all three survey areas, including inter-annual trends; photo-ID analysis of odontocetes in all three survey areas, with a future comparison to be made amongst the areas; creation of habitat models for cetaceans and sea turtles in the three survey areas; detailed documentation of the occurrence of vocalizing cetaceans in JAX and off Cape Hatteras; and further integration of the visual and acoustic records of cetacean species.

The monitoring program members will continue to coordinate and collaborate with other research efforts in the region. Personnel from Duke University are scheduled to participate in a National Oceanic and Atmospheric Administration research cruise intended to document the distribution of short- and long-finned pilot whales in the Mid-Atlantic during the autumn of 2013. The Duke University-University of North Carolina at Wilmington Oceanographic Consortium sponsored a week-long research cruise on the Research Vessel (R/V) *Cape Hatteras* in the Cape Hatteras survey area in October 2012. During this cruise, an underwater glider equipped with an acoustic recording system was deployed near the HARP deployment site in this area. The system recorded continuously throughout the deployment, though software to conduct onboard detection is being considered for development. Visual surveys, with concurrent prey mapping using an EK-60 system, will be conducted from the R/V *Cape Hatteras* to ground-truth the cetacean species present, and photo-ID images and biopsy samples will be collected.

Finally, given the importance of understanding patterns of residency, there are plans to monitor the movements of individual odontocetes over the medium- to long-term using satellite-telemetry methods. A pilot project is planned with pilot whales in JAX for 2013. If successful, this work will expand to Cape Hatteras in subsequent years.

Passive acoustic detection, classification, localization, and tracking methods provide a unique mechanism for obtaining extremely valuable information collected from PAM. Methods for estimating animal density using passive-acoustic data collected from fixed hydrophones have been demonstrated recently (Marques et al. 2009, Marques et al. 2011, Marques et al. 2012, Martin et al. 2013, Moretti et al. 2010). However, these approaches generally require intensive and/or relatively complex acoustic processing and statistical techniques. In many cases, important ancillary information (e.g., calling or click rates and probability of detection) must be available, and this can be difficult to obtain without using complementary field methods for observing and following individuals and groups of animals (e.g., visual focal-follows, electronic tagging, and active acoustics). Section 3.2.3 summarizes the extensive passive acoustic data collections that have been a significant component of the baseline monitoring program and provide important complimentary information on the distribution and occurrence of marine mammals at various locations. Together with the ongoing aerial surveys, density estimates may also be generated from this data.

5.2 Exercise Monitoring

5.2.1 Aerial Surveys

Aerial surveys are both a proven and valuable tool; however, limitations associated with this method of data collection remain. Although aerial surveys have proven a reliable means to gather pre-, during-, and post-exercise information for marine mammals using focal follow ‘circling’ techniques in some regions (i.e. SOCAL OPAREA, Smultea et al. 2012), this is largely a result of relatively high marine mammal densities.

With U.S. Navy training exercises occurring in high Beaufort Sea State conditions, attempting to locate marine mammals and sea turtles from the air in choppy seas remains a challenge. If animals are located while flying in poor sea conditions, reliably circling on them for extended periods to obtain critical behavioral information used in subsequent analyses remains problematic. Similar concerns exist concerning required safety exclusion (i.e., standoff) zones related to particular training range boxes monitored before, during, and post exercise. Given the high level of training that occurs on a daily basis within these areas, entire range boxes may require total exclusion based on the nature of the exercise (i.e., FIREX or MISSILEX), which reduces required monitoring time accordingly. Previous surveys conducted in Beaufort Sea States of 3 or higher rarely, if ever, yield valuable information.

Based on the SAG recommendations, limited sightings due to relatively low densities, and logistically difficult to reach U.S. East Coast offshore ranges, aerial surveys for exercise monitoring do not represent a particularly good return on investment.

5.2.2 Vessel Surveys

In optimal sea conditions, vessel surveys provide a useful tool to gather presence/absence or behavioral information from a distance using high-powered binoculars. This may be a particularly useful option with regards to marine mammal monitoring occurring during MFAS or underwater detonations. Observations focused on individuals or groups of animals can provide critical baseline information before, during, and after exercises and may also allow reactions to be documented. However, training exercises occur in a variety of sea conditions and often far from shore in the case of ASW events in the Atlantic. Given the logistics and associated costs involved, large-vessel surveys have not been shown to be as effective to monitor marine mammals in offshore training exercise areas as originally assumed. As stated earlier with respect to aerial surveys, training exercises can proceed in less than optimal Beaufort Sea State conditions, making it difficult to locate marine mammals from a smaller and less stable platform. Additional problematic issues are associated with safe standoff distances required while operating near U.S. Navy ships conducting maneuvers while transmitting MFAS or using explosives make vassel surveys of limited use for exercise monitoring in these situations.

Based on the relatively small amount information obtained, offshore vessel surveys during large-scale training exercises do not appear to provide a valuable means of gathering monitoring data. However, this method of gathering data could prove invaluable should future efforts focus on controlled or incidental exposure experiments, if resources can be managed to take advantage of optimal weather windows. In contrast to monitoring from a large vessel, small-vessel-based monitoring has proven to be beneficial. For instance, surveys during MINEX events off Virginia Beach provide a better means of monitoring given the number of opportunities and proximity to shore. Monitoring these small scale MINEX events requires relatively little logistic investment and can easily be postponed without sacrificing committed resources

5.2.3 Passive Acoustic Monitoring

Passive acoustic localization and tracking of marine mammals requires that precise, time-synchronized data be recorded from multiple hydrophones in a system; for example, a multi-element towed hydrophone array, an autonomous recorder array distributed on the seafloor, or a cabled hydrophone-array distributed on the seafloor. The recording system must consist of a multi-channel network of time-synchronized sensors (or a method to precisely time-synchronize the data). A real-time acoustic data-collection and analysis system (versus a post-processing approach that only provides information months after the data are collected) offers significant advantages over a post-processing approach, especially when the experimental design calls for monitoring or mitigating human activities.

Sonobuoys are extremely effective as portable short-term (up to 8 hr) monitoring of remote areas from airplanes or vessels. They are easy to deploy and can be monitored and recorded with only a laptop and a few small (cigar-case-sized) receivers. Single sonobuoys can be deployed to monitor for the presence of vocalizing animals or multiple units can be deployed to triangulate the location of vocalizing animals. Sonobuoys have been used from vessels to locate and count humpback whales, North Pacific right whales (*Eubalaena japonica*), fin whales, and blue whales. Sonobuoys also have been used for monitoring exclusion zones to mitigate human activities. Further consideration should be given to these devices which are readily available for U.S. Navy use. Passive acoustic methods can complement aerial surveys by using sonobuoy deployments to simultaneously collect visual and acoustic behavioral data, as well as measure natural (e.g., fish, crustacean, etc.) and anthropogenic (e.g., MFAS and echo-sounders) sounds. This information is useful in providing greater context for interpreting visual behaviors of animals when at the surface, but also in providing information about their acoustic behaviors and can provide movement patterns when below the surface and out of visual observation. This approach was used for a pilot study in the Southern California Bight in which aerial focal follows were coupled with sonobuoy deployments and real-time monitoring (Smultea et al. 2012).

In cases where real-time monitoring is not practical or possible, deployments of arrays of autonomous recorders can be used. As noted in **Section 3.4.1.3**, 12 AMARs were deployed in conjunction with an ASWEX in September 2011 in the planned USWTR. Unclassified results of this analysis are expected to be available in late 2013. Similar array-style deployments are tentatively planned for winter 2012 and will continue to expand our understanding of marine mammals and sonar during MFAS events.

Regardless of what types of long-term PAM methods are used, their effectiveness is greatly enhanced if the data-collection strategy includes appropriate pre- and post-exposure sampling periods, to allow a reliable baseline to be established. This will allow a more robust comparative analysis of animal responses to all anthropogenic sound sources (e.g., vessels, echosounders, etc.), both individually and cumulatively. A sampling strategy should also cover larger areas than just the immediate areas affected so that the occurrence and behaviors of animals on the boundary of the affected area can be examined. Adequate spatial sampling requires deploying distributed hydrophones, hydrophone arrays, or sets of hydrophone arrays that are sufficiently dense to characterize animal occurrence and behaviors in the areas of interest. Such an approach will allow densities and distributions of calling animals to be statistically estimated with an acceptable level of uncertainty.

The effectiveness of higher spatial and temporal sampling has been demonstrated with cabled seafloor hydrophone arrays in instrumented acoustic ranges such as the U.S. Navy's Atlantic Undersea Test and Evaluation Center, Southern California Offshore Range, and PMRF (e.g., Moretti et al. 2010, Marques et al. 2012, Martin et al. 2013). However, the application of each of these approaches and systems for marine mammal research and monitoring has experienced limitations at some stage of the process. Although these fixed U.S. Navy training-range systems have provided enormous opportunities and yielded important insights into the types and levels of marine mammal responses to various underwater sound types, these ranges only cover a very small percentage of overall U.S. Navy OPAREAs. Furthermore, the spatial scales of some of these ranges and hydrophone densities are better matched to the spatial scales needed to monitor odontocetes than for mysticetes; thereby, making it very difficult to infer potential population-level impacts from results of individual behavioral responses. The same may be true for pelagic species of odontocetes that are not resident inside a range or area being monitored.

Collection of PAM data in association with environmental data (e.g., physical and biological oceanographic, ocean weather, and noise data), as well as characterization of anthropogenic activities (e.g., ships, seismic exploration, fishing activity) is needed to allow for better interpretation of passive acoustic data. Whenever possible, PAM should be complemented with visual and other field methods (e.g., tagging, photo-ID, visual behavioral monitoring) along with collection of environmental data. This will provide contextual information to allow better interpretation of results. Finally, for many species, especially the delphinids and some species of beaked whales, and a few species of baleen whales (Bryde's [*Balaenoptera edeni*], minke, and sei whales), validation of passive-acoustic data is still necessary to reliably identify sounds to species. Validation of delphinid whistles and echolocation clicks is especially needed in order to develop more reliable whistle and click classifiers. Teamed with Bio-Waves, Inc., the U.S. Navy is visually validating, single-species recordings of delphinids collected by Duke University, the NEFSC, and the SEFSC to develop and implement random-forest classifiers to identify whistles produced by delphinid species. Several different random-forest classifiers are planned to be tested, including one that classifies whistles to species and several that classify whistles to broader taxonomic categories (e.g., 'blackfish,' '*Stenella* species'). The classifiers that produce the most accurate results will be added to the suite of classifiers included in the whistle classification software, Real-time Odontocete Call Classification Algorithm (ROCCA). ROCCA is a module in the freely-available acoustic monitoring software platform PAMGuard. Classifiers for whistles produced by Atlantic delphinid species and a software bridge connecting PAMGuard's whistle detector to ROCCA are available also at the PAMGuard website. A similar tool is currently being developed that efficiently processes large volumes of PAM data in search of MFAS. Once developed, the ability to measure MFAS and assess its impact on marine mammal acoustic behaviors might be possible.

Finally, information about numbers and behaviors of animals collected concurrently with PAM data will allow these data to be understood and interpreted better. This can be accomplished by coupling passive acoustic monitoring with aerial- and vessel-based visual observation methods and animal tagging (especially acoustic dataloggers).

Ultimately, the use of passive-acoustic methods to estimate animal densities, to monitor acoustic and non-acoustic behaviors, and to assess potential responses to U.S. Navy sonar will require adequate sampling over spatial and temporal scales that are appropriately matched to the questions being posed and the species of interest. In general, this may require greater numbers of hydrophone sensors deployed for longer periods. Increased spatial and temporal sampling, along with improvements in data processing, will allow decreased uncertainty in results of the analyses and allow improved interpretation and application to management requirements for these important living marine resources.

5.2.4 MMOs Aboard Training Exercises and Observer Lookout Effectiveness Study

Civilian Navy marine species experts have participated in 11 monitoring events totaling 29 monitoring days through out the AFAST study area and associated east coast range complexes from 2009 through 2012. Despite accounting for a relatively small proportion of the 4-year period, each event involved 2-4 individuals as well as necessary logistic and travel days. With the exception of collecting important trials data for the lookout effectiveness study (Section 3.6), the return on investment for most MMO events is very low. FIREX and ASWEX exercises in particular are typically conducted far from shore and require extensive coordination in order to transport and accommodate MMOs. The notable exception is for MINEX monitoring which takes place within a few miles of the coast and doesn't require additional travel for MMOs to participate. These events are easily monitored within the span of a single day inclusive of logistics and are much less complicated to coordinate with the military units conducting the training. As a result future MMO monitoring may be focused on MINEX as well as specific opportunities to continue gathering data to support the ongoing lookout effectiveness study.

With regards to the lookout effectiveness study, recommendations for future data-collection efforts are to focus on a single vessel type and an area where the number of trials-per-cruise is likely to be maximized. Resources would be devoted to extending the intermittent-availability models so that they use both the locations of observed animals and the outcomes of the MMO trials, thereby unifying the models developed to date for instantaneous and intermittent availability.

Major accomplishments related to this project to date include initial development of data-collection protocols and analytic methods, data-collection trials, completion of a proof-of-concept for detection functions, consultation with NMFS technical staff for input on analysis methods, and investment in continued refinement of the analytic methods and focus on additional data collection for the future.

U.S. Navy Fleet training organizations are currently evaluating the preliminary results from the proof-of-concept phase to determine if improvements in lookout training programs are warranted. Initial steps in progress include evaluating incorporation of marine mammal survey techniques into watchstander training and revision of Marine Species Awareness Training. As more data become available, other options for improving lookout training will be evaluated as appropriate.

6. Future Directions

6.1 Revised Monitoring Program Approach

Originally, five study questions were developed between NMFS and the U.S. Navy as guidance for developing monitoring plans, and all existing range-specific monitoring plans attempted to address each of these study questions. However, the state of knowledge for the various Range Complexes is not equal, and many factors, including level of existing information, amount of training activity, accessibility, and available logistics resources all contribute to the ability to perform particular monitoring activities. In addition, the U.S. Navy monitoring program has historically been compartmentalized by Range Complex and focused on effort-based metrics (e.g., survey days, trackline covered, etc.).

A 2010 U.S. Navy-sponsored monitoring meeting in Arlington, Virginia initiated a process to critically evaluate the current U.S. Navy monitoring plans and begin development of revisions/updates to both existing region-specific plans and the ICMP. Discussions at that meeting, and at the U.S. Navy/NMFS annual adaptive management meeting in October 2010, established a way forward for continued refinement of the U.S. Navy's monitoring program. This process included establishing a SAG composed of leading marine mammal scientists, with the initial task of developing recommendations that would serve as the basis for a Strategic Planning Process for marine species monitoring.

In June 2011, the U.S. Navy hosted a Marine Mammal Monitoring Workshop with guidance and support from NMFS, which included scientific experts and representatives of environmental non-governmental organizations (SAG 2011). The purpose of the workshop was to present a consolidated overview of monitoring activities accomplished in 2009 and 2010 pursuant to the MMPA Final Rules currently in place, including outcomes of selected monitoring-related research and lessons learned, and to seek feedback on future directions. A significant outcome of this workshop was to continue consolidating monitoring efforts from individual Range Complex plans in order to improve the return on investment by focusing on specific objectives and projects which can most efficiently and effectively be addressed throughout the U.S. Navy's Range Complexes.

6.1.1 Scientific Advisory Group

The SAG was established in 2011 with the initial task of evaluating current naval monitoring approaches under the ICMP and existing LOAs to develop objective scientific recommendations (SAG 2011). While recommendations were fairly broad from a geographic perspective, the SAG did provide specific programmatic recommendations that serve as guiding principles for the continued evolution of the U.S. Navy Marine Species Monitoring Program. Notable keystone recommendations from the SAG include:

- Working within a conceptual framework of knowledge, from basic information on the occurrence of species within each range complex, to more specific matters of exposure, response, and consequences.
- Striving to move away from a "box-checking" mentality – monitoring studies should be designed and conducted according to scientific objectives, rather than on merely cataloging effort expended.

- Approaching the monitoring program holistically and select projects that offer the best opportunity to advance understanding of the issues, as opposed to establishing range-specific requirements.
- Facilitating collaboration among researchers in each region, with the intent to develop a coherent and synergistic regional monitoring and research effort.

In addition to broader programmatic and conceptual recommendations, the SAG evaluated each range complex for a series of factors including level of U.S. Navy activity; diversity and density of marine mammals; need for information on basic occurrence, presence of species of concern; and ability to most effectively address questions related to exposure, response, and consequences.

6.1.2 Adaptive Management & Strategic Planning Process

The objective of the Strategic Planning Process is to continue the evolution of U.S. Navy marine species monitoring towards a single integrated program, incorporating expert review and recommendations, and establishing a more transparent framework for evaluating and implementing monitoring work across the U.S. Navy Range Complexes and study areas. The Strategic Planning Process is intended to be a primary component of the ICMP and provide a “vision” for U.S. Navy monitoring across geographic regions—serving as guidance for determining how to most efficiently and effectively invest the marine species monitoring resources to address ICMP top-level goals and satisfy MMPA LOA regulatory requirements.

The Strategic Planning Process has five major implementation steps:

1. Identify overarching intermediate scientific objectives
2. Develop individual monitoring project concepts
3. Evaluate, prioritize, and select monitoring projects
4. Execute selected monitoring projects
5. Report and evaluate progress and results.

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.

This Strategic Planning Process will serve as the single marine species monitoring requirement for all U.S. Navy testing and training activities under the AFTT MMPA LOA, which will supersede the current LOAs for AFAST and the East Coast/GOMEX Range Complexes beginning in 2014. Along with the ICMP, it clearly identifies the goals and objectives of the Navy monitoring program, presents the guidance and expert review that will be used to direct efforts, and defines the process for evaluating and selecting how the U.S. Navy’s marine species monitoring program budget is invested.

6.2 Future Planned Monitoring

The current LOAs for AFAST and the East Coast/GOMEX Range Complexes remain in effect until they are replaced by a single LOA for AFTT in January 2014. **Table 34** summarizes monitoring commitments for 2013-2014 under the AFAST LOA, allowing for increased flexibility within the VACAPES, CHPT, and JAX OPAREAs in order to allow continued input and guidance from the SAG and research community.

Emphasis on visual surveys before, during, and after training events has been decreased and more resources are directed to passive acoustic monitoring of ASW exercises, tagging work, and the associated data analyses. These modifications are in direct alignment with the Strategic Planning Process (**Section 6.1.2**) and will continue to focus resources on methods and projects proposed by the scientific community through the Strategic Planning Process that offer the best opportunity for advancing our knowledge and addressing ICMP top-level goals U.S. Navy-wide.

Table 34. 2013-2014 annual monitoring commitments for AFAST.

Marine Mammal Observers (MMOs)	2 events in conjunction with exercises.
MMO/Lookout Comparison Study	40 hr data-collection trials (across all U.S. Navy ranges).
Aerial Surveys – VACAPES/CHPT/JAX OPAREAs	36 days.
Vessel Surveys – VACAPES/CHPT/JAX OPAREAs	24 days.
Marine Mammal Tagging	-Field work and data analysis in the JAX OPAREA in coordination with vessel surveys. -Initiate tagging project in Hatteras survey area.
Passive Acoustics – Baseline	Continue recording and data analysis for 3 strategically-located HARPs.
Passive Acoustics – Exercise Monitoring	Deployments of pop-up buoys in conjunction with ASW exercises.

Key: AFAST = Atlantic Fleet Active Sonar Training; ASW = Anti-submarine Warfare; CHPT = Cherry Point; HARP = High-frequency Acoustic Recording Package; hr = hour(s); JAX = Jacksonville; MMO = Marine Mammal Observer; OPAREA = Operating Area; U.S. = United States.

With regard to the longitudinal baseline monitoring projects, the methods have been modified in response to recommendations from the SAG, as well as the increasing level of knowledge within these regions since beginning this effort over 4 years ago. The modifications include:

- Discontinuing standard line-transect shipboard surveys in Onslow Bay and JAX and replacing them with photo-ID and biopsy sampling effort.
- Adding a photo-ID and biopsy-sampling component off Cape Hatteras.
- Significantly reducing aerial line-transect survey effort in Onslow Bay and re-allocating this survey effort to Cape Hatteras.
- Reducing the number of HARPs from two to one in both Onslow Bay and JAX and adding a HARP off Cape Hatteras. All three of these HARPs will monitor year-round.

Specific to AFAST, the SAG noted that while the combination of line-transect aerial surveys, photo-ID, and PAM has proven particularly useful, there are several other important monitoring opportunities, including the use of satellite tags to characterize medium-term movements and habitat use, the use of acoustic data-logging tags (e.g., DTAGs) to monitor acute response to acoustic exposure, and a unique opportunity for addressing potential stock- or population-level consequences at the planned USWTR site in the JAX OPAREA, before and after concentrated sonar activities commence. As a result, two new tagging projects have been added to the AFAST monitoring program beginning in 2012 and 2013. An odontocete tagging project within the boundaries of the planned USWTR in the JAX OPAREA is focused on documenting movement and diving patterns of small whales (e.g., pilot whales, Risso's dolphins, *Kogia* sp., beaked whales, etc.) with the expectation of potentially addressing behavioral response to U.S. Navy training activities in the future. Similarly, a project for tagging of deep-diving odontocetes (e.g., *Kogia* sp., beaked whales, sperm whales) will be initiated off Cape Hatteras in 2013 to characterize diving and vocalization patterns. Both of these areas are commonly used for U.S. Navy training and represent good opportunities for addressing questions of exposure and response under the conceptual framework proposed by the SAG.

In addition to the annual monitoring requirements for explosives training in the East Coast/GOMEX Range Complexes (**Section 3.1**), several new projects have been initiated to further understanding of potential impacts from MINEX and explosive ordnance disposal training events. Monthly small-boat visual surveys were implemented beginning in August 2012 to further existing knowledge on the occurrence, distribution, and density of marine mammals near Naval Station Norfolk, Joint Expeditionary Base Little Creek - Fort Story, and within the MINEX W-50 training area of VACAPES where the majority of MINEX activities occur. To complement the visual survey data, Ecological Acoustic Recorders (EARs; PAM devices) and C-PODs (echolocation click detectors) were deployed in August 2012 in the MINEX W-50 box of VACAPES, and will be maintained for approximately one year. The devices are optimized to capture explosive events conducted by the U.S. Navy's EOD team over the course of a year as well as marine mammal vocal activity. In addition to supplementing the visual occurrence data, these devices will allow analysis of marine mammal vocal activity before, during, and after explosive training exercises.

Finally, an ancillary project has been initiated to develop more accurate acoustic propagation models for explosives in shallow-water environments by recording explosive charges of various sizes and at multiple distances. Researchers from the University of Washington will analyze the acoustic data to estimate source and received levels at the measurement locations. The results will be compared to several relevant existing acoustic propagation models.

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Jennifer Dunn	Nicholas School of the Environment, Duke University	Baseline Monitoring
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Dagmar Fertl	HDR, Inc.	Exercise Monitoring Effort / Technical Review Comment Incorporation
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Lynne E.W. Hodge	Nicholas School of the Environment, Duke University	Baseline Monitoring / Passive Acoustics
Thomas A. Jefferson	Clymene Enterprises	Technical Review
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APPENDIX A

List of Publications/Presentations from AFAST Monitoring

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Appendix A: Publications And Presentations Resulting From AFAST-Related Monitoring Efforts

2007

Urian, K. W., A. J. Read, W. A. McLellan, D. A. Pabst, C. Paxton, D. Borchers, R. J. McAlarney, and P. B. Nilsson. 2007. Monitoring plan for the proposed Undersea Warfare Training Range in Onslow Bay, NC USA. Abstracts, Seventeenth Biennial Conference on the Biology of Marine Mammals. 29 November - 3 December 2007. Cape Town, South Africa.

2008

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2010

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APPENDIX B

Selected Photographs from Baseline Monitoring Surveys by Duke University and University of North Carolina at Wilmington

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Appendix B: Selected Photographs from AFAST Monitoring Efforts

The following is a selection of photographs taken by Duke University and the University of North Carolina at Wilmington during the longitudinal monitoring efforts (vessel and aerial) under the AFAST Monitoring Plan.

Figure B-1. North Atlantic right mother and calf pair. Photo taken during calf birthing event reported in Foley et al. (2011).

Figure B-2. Pilot whales (*Globicephala* spp).

Figure B-3. Sperm whale (*Physeter macrocephalus*).

Figure B-4. Rough-toothed dolphins (*Steno bredanensis*).

Figure B-5. Cuvier's beaked whale (*Ziphius cavirostris*).

Figure B-6. Bottlenose dolphin (*Tursiops truncatus*).

Figure B-7. Striped dolphins (*Stenella coeruleoalba*).

Figure B-8. Tagging short-finned pilot whales (*Globicephala macrorhynchus*) for behavioral response study.

Figure B-9. Short-finned pilot whale (*Globicephala macrorynchus*) tagged with a DTAG for the behavioral response study.

Figure B-10. Risso's dolphins (*Grampus griseus*).

Figure B-11. Atlantic spotted dolphins (*Stenella frontalis*).

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APPENDIX C

Exercise Monitoring Surveys

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Table C-1. Exercise Monitoring Surveys Conducted from April 2009 through August 2012.

Year	Dates	Survey type	Purpose	Range Complex	Reference
2008	July	PAM (Pop-up)	Pop-up deployment to monitor during ASWEX	CHPT	Hodge, L.E.W., J.T. Bell, A. Kumar, and A.J. Read. In press. *The influence of habitat and time of day on the occurrence of odontocete vocalizations in Onslow Bay, North Carolina*. *Marine Mammal Science* DOI: 10.1111/mms.12006.
2009-2010	11 September-08 October 2009; 04 December 2009-07 January 2010	PAM (Pop-up)	2 pop-up deployments (MARUs) to monitor ASWEX	JAX	Norris, T.F., J.O. Oswald, T.M. Yack, and E.L. Ferguson. 2012. *An Analysis of Marine Acoustic Recording Unit (MARU) Data Collected off Jacksonville, Florida in Fall 2009 and Winter 2009-2012*. Submitted to HDR Environmental, Operations and Construction, Inc., Norfolk, Virginia, under Contract No. CON-005-4394-009, subproject 164744, Task Order 03, prepared by Bio-Waves, Inc., Encinitas, California.
2009	27-30 April 2009	Vessel	Monitor during UNITAS GOLD 2009 (UNITAS 09)	JAX	NAVFAC Atlantic & NUWC. 2009. *Cruise Report, Marine Mammal Monitoring, UNITAS GOLD 2009, Jacksonville Range Complex*. Prepared for: Commander, United States Fleet Forces Command.
2009	06-07 August	Vessel/PAM (hydro-phone)	Monitor during 2 MINEX events	VACAPES	NAVFAC Atlantic. 2010. *Cruise Report, Marine Mammal Monitoring, Mine Neutralization Exercise Events, August 2009, VACAPES Range Complex*. Prepared for Commander, United States Fleet Forces Command.
2010	15-19 March	Vessel	Lookout Effectiveness Study, monitor during SEASWITI	JAX	Farak, A., S. F. Hanser, A. Kumar, and T. Mizerek. 2010a. *Cruise Report, Marine Species Monitoring & Lookout Effectiveness Study Southeastern Antisubmarine Warfare Integrated Training Initiative (SEASWITI), March 2010 Jacksonville Range Complex*. Prepared for: United States Fleet Forces.
2010	04-09 June	Vessel	Lookout Effectiveness Study, monitor during SEASWITI	JAX	Farak, A., A. Kumar, T. Mizerek and D. Rees. 2010. *Cruise Report, Marine Species Monitoring & Lookout Effectiveness Study, Southeastern Antisubmarine Warfare Integrated Training Initiative (SEASWITI), June 2010, Jacksonville Range Complex*. Prepared for Department of the Navy, Norfolk, Virginia.
2010	08-10 August	Vessel/PAM (hydro-phone)	Monitor during MINEX	VACAPES	NAVFAC Atlantic. 2011a. *Trip Report, Marine Mammal Monitoring, Mine Neutralization Exercise Events, August 2010, VACAPES Range Complex*. Prepared for Commander, United States Fleet Force Command.

Year	Dates	Survey type	Purpose	Range Complex	Reference
2010	08-10 August	Aerial	Monitor during MISSILEX (MAVEX)	JAX	HDR|e²M. 2010. *Jacksonville (JAX) MAVEX VP-30 Marine Species Monitoring, Aerial Monitoring Surveys, 8-10 August 2010: Trip Report*. Submitted to Naval Facilities Engineering Command (NAVFAC) Atlantic, Norfolk, Virginia, under Contract No. N62470-10-D-3011 Task Order 03, issued to HDR Inc., Norfolk, Virginia.
2010	09-10 August	Aerial	Monitor during ASWEX	VACAPES	HDR|EOC. 2011a. *Virginia Capes (VACAPES) FIREX & ASW Training Events, Marine Species Monitoring, Aerial Monitoring Surveys, 9-11 August 2010. Trip report*. Submitted to Naval Facilities Engineering Command (NAVFAC) Atlantic, Norfolk, Virginia, under Contract No. N62470-10-D-3011 Task Order 03, issued to HDR Inc., Norfolk, Virginia.
2010	10-11 August	Aerial	Monitor during FIREX	VACAPES	HDR|EOC. 2011b. *Virginia Capes (VACAPES) FIREX & ASW Training Events, Marine Species Monitoring, Aerial Monitoring Surveys, 9-11 August 2010. Trip Report*. Submitted to Naval Facilities Engineering Command (NAVFAC) Atlantic, Norfolk, Virginia, under Contract No. N62470-10-D-3011 Task Order 03, issued to HDR Inc., Norfolk, Virginia.
2010	05-06 October	Vessel	Monitor during FIREX	JAX	NAVFAC Atlantic. 2011b. *Trip Report, FIREX Marine Mammal Monitoring, Jacksonville Range Complex*. Prepared for: Commander, United States Fleet Forces Command.
2010	03-07 October	Aerial	Monitor during GUNEX	JAX	HDR|EOC. 2011c. *Jacksonville (JAX) Gunnery Exercise (GUNEX) Marine Species Monitoring, Aerial Monitoring Surveys, Trip Report, 3-7 October 2010*. Submitted to Naval Facilities Engineering Command (NAVFAC) Atlantic, Norfolk, Virginia, under Contract No. N62470-10-D-3011 Task Order 03, issued to HDR Inc., Norfolk, Virginia.
2010	03-05 December	Vessel/PAM	Monitor during SEASWITI	JAX	HDR. 2011d. *Jacksonville (JAX) Southeast Anti-Submarine Warfare Integration Training Initiative (SEASWITI) Marine Species Monitoring, Vessel Monitoring Surveys, Trip Report*. Submitted to Naval Facilities Engineering Command (NAVFAC) Atlantic, Norfolk, Virginia, under Contract No. N62470-10-D-3011 Task Order 03, issued to HDR Inc., Norfolk, Virginia.
2010	03-05 December	Aerial	Monitor during SEASWITI	JAX	HDR. 2011e. *Jacksonville (JAX) Southeast Anti-Submarine Warfare Integration Training Initiative (SEASWITI) Marine Species Monitoring, Aerial Monitoring Surveys, Trip Report*. Submitted to Naval Facilities Engineering Command (NAVFAC) Atlantic, Norfolk, Virginia, under Contract No. N62470-10-D-3011 Task Order 03, issued to HDR Inc., Norfolk, Virginia.

Year	Dates	Survey type	Purpose	Range Complex	Reference
2011	13-14 July	Vessel	Monitor during FIREX	VACAPES	NAVFAC Atlantic. 2012a. *Trip Report, July 2011 FIREX Marine Mammal Monitoring, VACAPES Range Complex*. Prepared for: Commander, United States Fleet Forces Command.
2011	13-15 July	Aerial	Monitor during FIREX	VACAPES	HDR. 2011f. *Virginia Capes (VACAPES) FIREX With IMPASS Marine Species Monitoring, Aerial Monitoring Surveys, Trip Report, 13-15 July, 2011*. Submitted to Naval Facilities Engineering Command (NAVFAC) Atlantic, Norfolk, Virginia, under Contract No. N62470-10-D-3011 Task Order 03, issued to HDR Inc., Norfolk, Virginia.
2011	07-09 August	Vessel/PAM (buoy)	Monitor during MINEX	VACAPES	NAVFAC Atlantic. 2012. *Trip Report, Marine Mammal Monitoring, Mine Neutralization Exercise Event, August 2011, VACAPES Range Complex*. Prepared for: Commander, United States Fleet Forces Command.
2011	31 August & 10 September	Aerial	Monitor during ASWEX	VACAPES	HDR. 2011g. *Virginia Capes (VACAPES) Anti-Submarine Warfare Exercise (ASWEX) Marine Species Monitoring, Aerial Monitoring Surveys, 31 August and 10 September 2011: Trip Report*. Submitted to Naval Facilities Engineering Command (NAVFAC) Atlantic, Norfolk, Virginia, under Contract No. N62470-10-D-3011 Task Order 03, issued to HDR Inc., Norfolk, Virginia.
2011	15-20 September	Aerial	Monitor during ASWEX	JAX	HDR. 2011h. *Jacksonville (JAX) Anti-Submarine Warfare Exercise (ASWEX) Marine Species Monitoring, Aerial Monitoring Surveys, 15-20 September 2011: Trip Report.* Submitted to Naval Facilities Engineering Command (NAVFAC) Atlantic, Norfolk, Virginia, under Contract No. N62470-10-D-3011 Task Order 03, issued to HDR Inc., Norfolk, Virginia.
2011	19-21 September	Aerial	Monitor during FIREX	JAX	HDR. 2011i. *Jacksonville (JAX) Firing Exercise (FIREX) With Integrated Maritime Portable Acoustic Scoring and Simulator (IMPASS), Marine Species Monitoring, Aerial Monitoring Surveys, Trip Report, 19-21 September 2011*. Submitted to Naval Facilities Engineering Command (NAVFAC) Atlantic, Norfolk, Virginia, under Contract No. N62470-10-D-3011 Task Order 03, issued to HDR Inc., Norfolk, Virginia
2011	September-October	PAM	12 JASCO AMARs deployed to monitor during ASWEX. Data to be analyzed by MAI.	JAX	Analysis and report in progress

Year	Dates	Survey type	Purpose	Range Complex	Reference
2011	29-30 November	Aerial	Monitor during FIREX	CHPT	HDR. 2011j. *Cherry Point (CHPT) Firing Exercise (FIREX) with Integrated Maritime Portable Acoustic Scoring and Simulator (IMPASS) Marine Species Monitoring, Aerial Monitoring Surveys, Trip Report, 29-30 November 2011*. Submitted to Naval Facilities Engineering Command (NAVFAC) Atlantic, Norfolk, Virginia, under Contract No. N62470-10-D-3011 Task Order 03, issued to HDR Inc., Norfolk, Virginia.
2012	28-29 February	Aerial	Monitor during MISSILEX (MAVEX)	JAX	HDR. 2012a. *Jacksonville Maverick Missile Exercise (MAVEX) Event, Marine Species Monitoring, Aerial Monitoring Surveys, Trip Report, 28-29 February 2012*. Submitted to Naval Facilities Engineering Command (NAVFAC) Atlantic, Norfolk, Virginia, under Contract No. N62470-10-D-3011 Task Order 03, issued to HDR Inc., Norfolk, Virginia.
2012	29 May-01 June	Vessel	Monitor during ASWEX	JAX	DoN. 2012. *Cruise Report, Marine Mammal Monitoring ASWEX Jacksonville Range Complex*. Prepared for: Commander, United States Fleet Forces Command. Prepared by: Naval Undersea Warfare Center Division, Newport, Rhode Island.
2012	05-08 September 2012	Aerial	Monitor during FIREX	JAX	HDR. 2012b. *Jacksonville (JAX) Firing Exercise (FIREX) With Integrated Maritime Portable Acoustic Scoring and Simulator (IMPASS) Marine Species Monitoring, Aerial Monitoring Surveys, 5-8 September 2012: Trip Report*. Submitted to Naval Facilities Engineering Command (NAVFAC) Atlantic, Norfolk, Virginia, under Contract No. N62470-10-D-3011 Task Order 03, issued to HDR Inc., Norfolk, Virginia.
2012	26-29 September 2012	Aerial	Monitor during ASWEX	JAX	HDR. 2012c. *Jacksonville (JAX) Maverick Missile Exercise (MAVEX) Marine Species Monitoring, Aerial Monitoring Surveys, 26-29 September 2012: Trip Report*. Submitted to Naval Facilities Engineering Command (NAVFAC) Atlantic, Norfolk, Virginia, under Contract No. N62470-10-D-3011 Task Order 03, issued to HDR Inc., Norfolk, Virginia. 4 December 2012.