AERIAL AND ACOUSTIC SURVEYS OF WHALES AND SEA TURTLES FOR OFFSHORE WIND ENERGY PLANNING IN MASSACHUSETTS

YEAR 2 REPORT

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Submitted: August 2014

With Support From:

MASSACHUSETTS
CLEAN ENERGY
CENTER

Executive Summary: Aerial Surveys for Whales and Sea Turtles for Offshore Wind Energy Planning in Massachusetts: Year 2

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Submitted to MASSCEC August , 2014

Introduction

The development of offshore alternative energy sources requires comprehensive assessments of biological resources within suitable energy areas to identify and mitigate any potential effects of that development on wildlife and fisheries. This report details the second annual assessment of the spatial and temporal patterns of marine fauna occurrence (with a particular emphasis on endangered large whales and sea turtles) in the Massachusetts Wind Energy Area (MA-WEA) south of Martha's Vineyard, and the first annual assessment in the adjacent Rhode Island Massachusetts Wind Energy Area (RIMA WEA) east of Block Island. The second year of survey effort was analyzed separately, and where appropriate preliminary comparisons between survey years was conducted .

In August of 2011, the Massachusetts Clean Energy Center (MassCEC) and the Executive Office of Energy and Environmental Affairs (EEA) established an agreement for conducting field surveys of marine life in the Massachusetts Wind Energy Area (MA-WEA). The first year of surveys (Year 1) spanned a twelve month period, from October 2011 to September 2012. In December of 2012 MassCEC and EEA entered a Cooperative Agreement with the Bureau of Ocean Energy Management that extended the survey period for an additional year and expanded the area surveyed to include the adjacent Rhode Island Massachusetts Wind Energy Area (RIMA WEA) offshore of Rhode Island. Subsequently, MassCEC awarded the Northeast Large Pelagics Survey Collaborative (NLPSC), comprised of the New England Aquarium (NEAq), the Provincetown Center for Coastal Studies (PCCS), and Cornell University's Bioacoustics Research Program (Cornell) a one-year extension to the existing contract, which started in January of 2013. The addition of the RIMA WEA offshore of Rhode Island to the existing MA WEA (together referred to as the "Study Area") resulted in a 70 nautical mile (nm) extension of survey track lines. Seventeen months of survey work were conducted under the extended agreement between October 2012 and February 2014 (Year 2). This additional survey effort strengthened the baseline data available for the Study Area, a first step in informing development planning and assessing potential effects on the behavior and ecology of resident or migratory species of marine mammals and sea turtles. When viewed over two years, aerial and acoustic data from the project to date demonstrate inter-annual variability and increase confidence in some distribution and abundance patterns of marine mammals observed in the first year of surveys.

Under the National Environmental Policy Act (1969), Federal agencies are required to integrate environmental assessments into offshore development and construction plans. Under the Marine Mammal Protection Act (1972) and the Endangered Species Act (ESA, 1973), many species that occur in the Study Area have special legal protections. Understanding the distribution, abundance and seasonality of endangered whales and sea turtles is critical to developing operational plans for different stages of wind farm development, and informing mitigation planning to minimize potential impacts. In particular, the Massachusetts Renewable Energy Task Force, created to facilitate communication amongst federal, state, local and tribal governments regarding renewable energy activities on the Outer Continental Shelf (OCS), identified the need to address potential impacts of acoustic disturbance on marine mammals, as well as the importance of continued study of marine species and habitats in the Study Area.

The offshore waters of southern New England are inhabited periodically by six species of large whale and five species of turtle, including finback, sei, North Atlantic right, humpback, minke, and rarely blue whales. Of these, the blue, fin, sei, humpback, and right whales are listed as endangered under the ESA (1973). In particular, occasional concentrations of occurrence or “hotspots” of right whale activity have been observed south of Cape Cod and near the Study Area in the spring, although right whale movement patterns in southern New England waters during the winter and spring months remain poorly understood. Sea turtles regularly found in southern New England waters include the loggerhead, leatherback, Kemp’s ridley, and green turtle, with occasional reports of hawksbill turtles from stranding records. All of these species are classified as endangered under the U.S. ESA.

Methods

For consistency, survey methodology initiated in Year 1 was repeated in Year 2. A multi-pronged approach was used, and both aerial and acoustic data were collected. The aerial survey method is enhanced beyond standard line transect survey methods by the addition of an automated vertical photography system. The forward motion compensated (FMC) system is used to capture the obscured trackline beneath the aircraft, and to strengthen data on small subsurface species such as sea turtles. The NLPSC conducted a total of twenty four aerial surveys within the Study Area for whales and sea turtles over a period of seventeen months (referred to as Year 2) between October , 2012 to February , 2014. To supplement the aerial survey data, passive acoustic monitoring was also conducted during Year 2. During Year 2, thirteen months of continuous underwater recording took place.

To detect large whale presence in the study area, the Cornell University Bioacoustics Team placed Marine Autonomous Recording Units (MARUs) at 9 locations within the MA and RI WEAs in Year 2 (Figure A). The same array of 6 MARUs was deployed in the MA WEA as in Year 1, and an additional 3 MARUs were deployed at 3 sites in the RI WEA. The MARUs recorded all large whale sounds continuously between February 2013 and February , 2014 (with a two day swap-over break on July and August). This additional, data stream, independent of the aerial surveys, will be particularly useful for understanding whale occurrence in periods of poor weather when aerial surveys were not feasible. In the deployment of MARUs (Aug 2013-Feb 2014) 6 of the 9 MARUs malfunctioned, affecting their ability to record sounds. Acoustic effort analyses were corrected for data loss from multiple MARU locations.

The MARU data also provide information on the ambient noise present throughout the study area. Analysis of the ambient noise environment over large spatial and temporal scales provides a broad, but revealing perspective on biological and anthropogenic habitat use. Acoustic data were processed using the Noise Analysis tools within the SEDNA toolbox for Matlab. For the ambient noise analysis, 3 different visual representations of sound were used: (1) frequency vs. time (spectrogram), (2) 1/ octave frequency band vs. time (1/ octave) and (3) power vs. frequency (sound pressure density spectra).

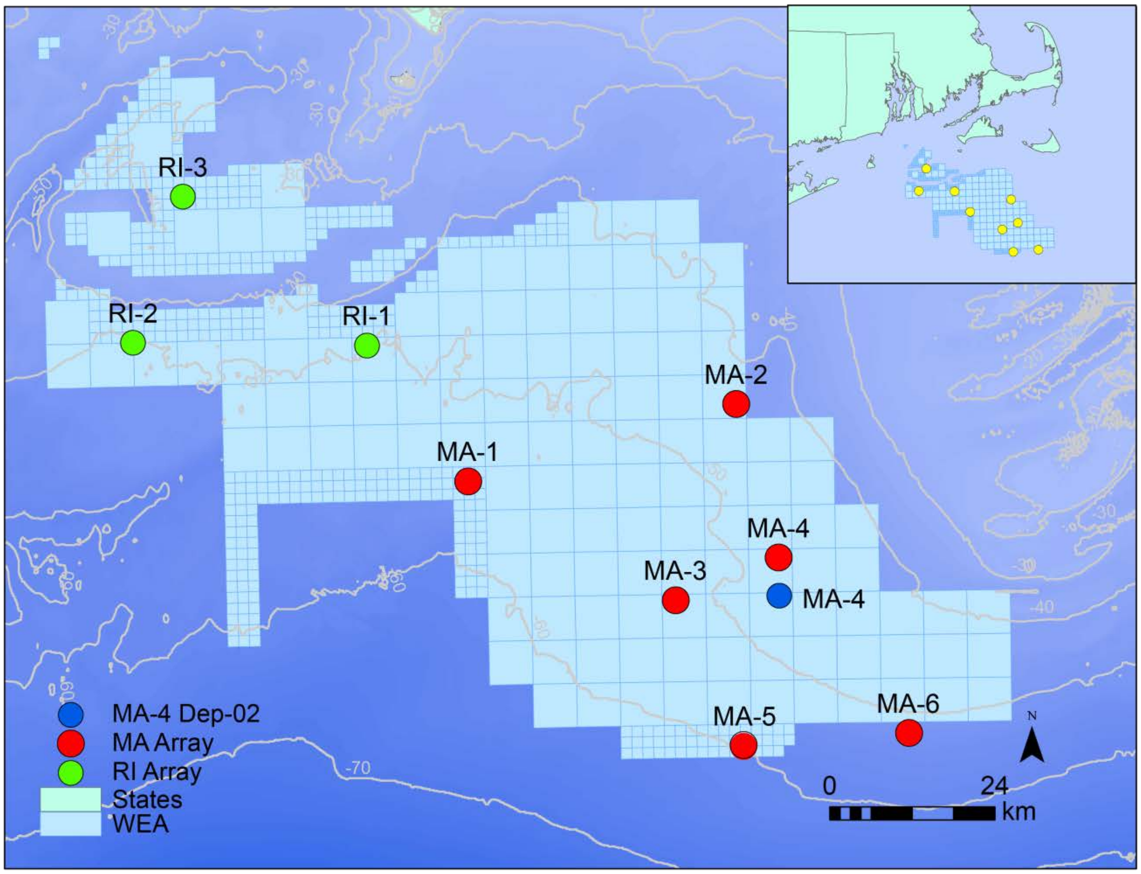


Figure A. Map of Marine Autonomous Recording Units through the Study Area. The three additional RI (in green) sites were added in year 2. White lines represent isobaths in 10 m intervals.

Aerial Survey Results

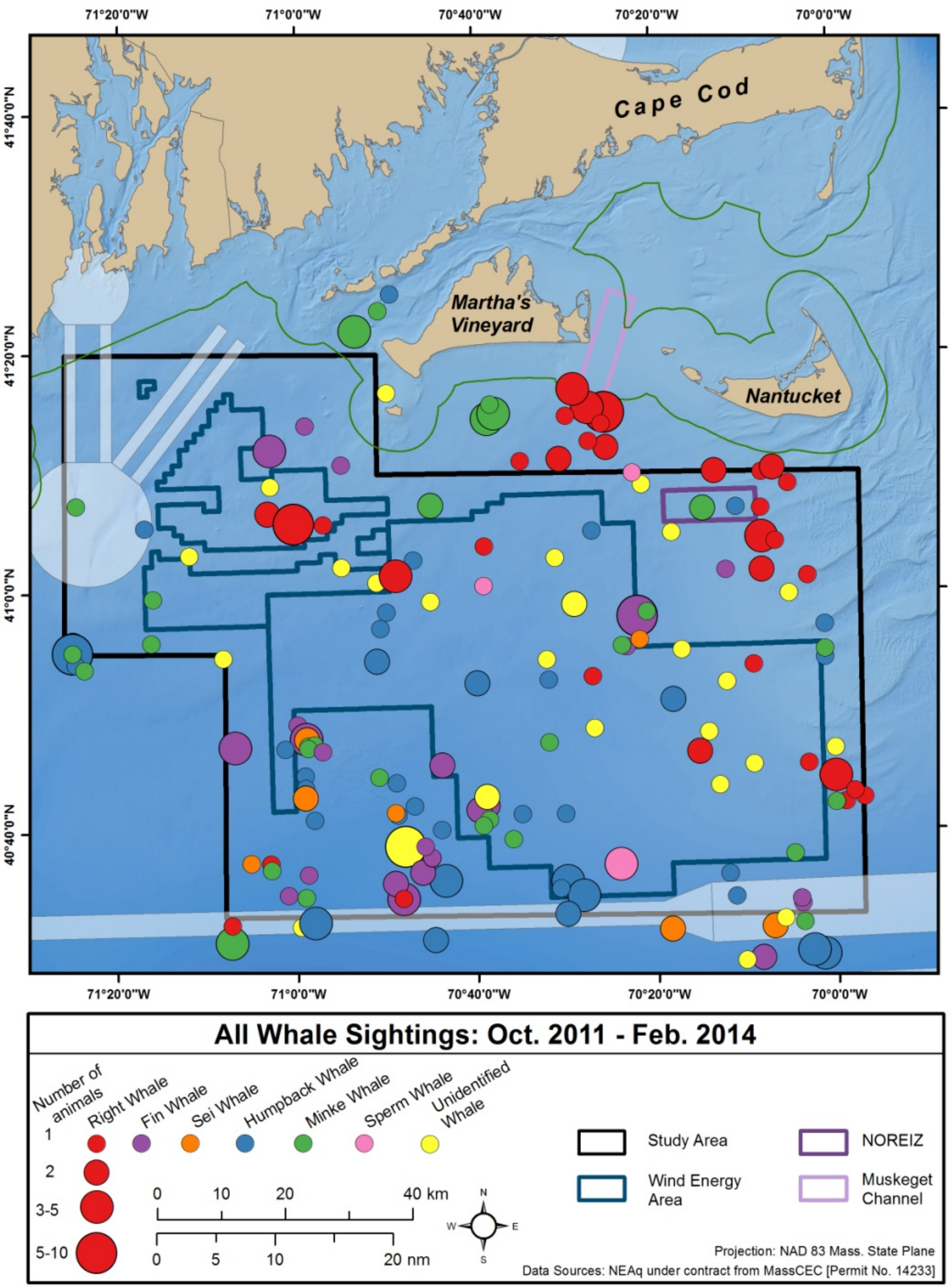
Whales

The aerial surveys recorded North Atlantic right, humpback, finback, minke, and sei whales during the year. Large whales in the survey area exhibited a wide range of behaviors including feeding and socializing with most occurring in the period from January through August. North Atlantic right whales accounted for all of the large whale sightings during the months of January and February, while the highest numbers of all other large whales were detected during May and June. When the combined large whale sightings for both survey years (October 2011 through February 2014) are reviewed, most occur during the spring months (**Table A**) and their spatial distribution is widespread (**Figure B**). Generally, right and minke whales are more frequently observed in the northern and eastern area of the study area, and humpbacks are observed in larger numbers offshore, although both species have been observed throughout the study area. Finback whales were observed throughout the study area.

Table A. All Large Whale Sightings (not the number of individual whales) by Survey, Year 1 and Year 2 Combined. Colors represent the seasons.

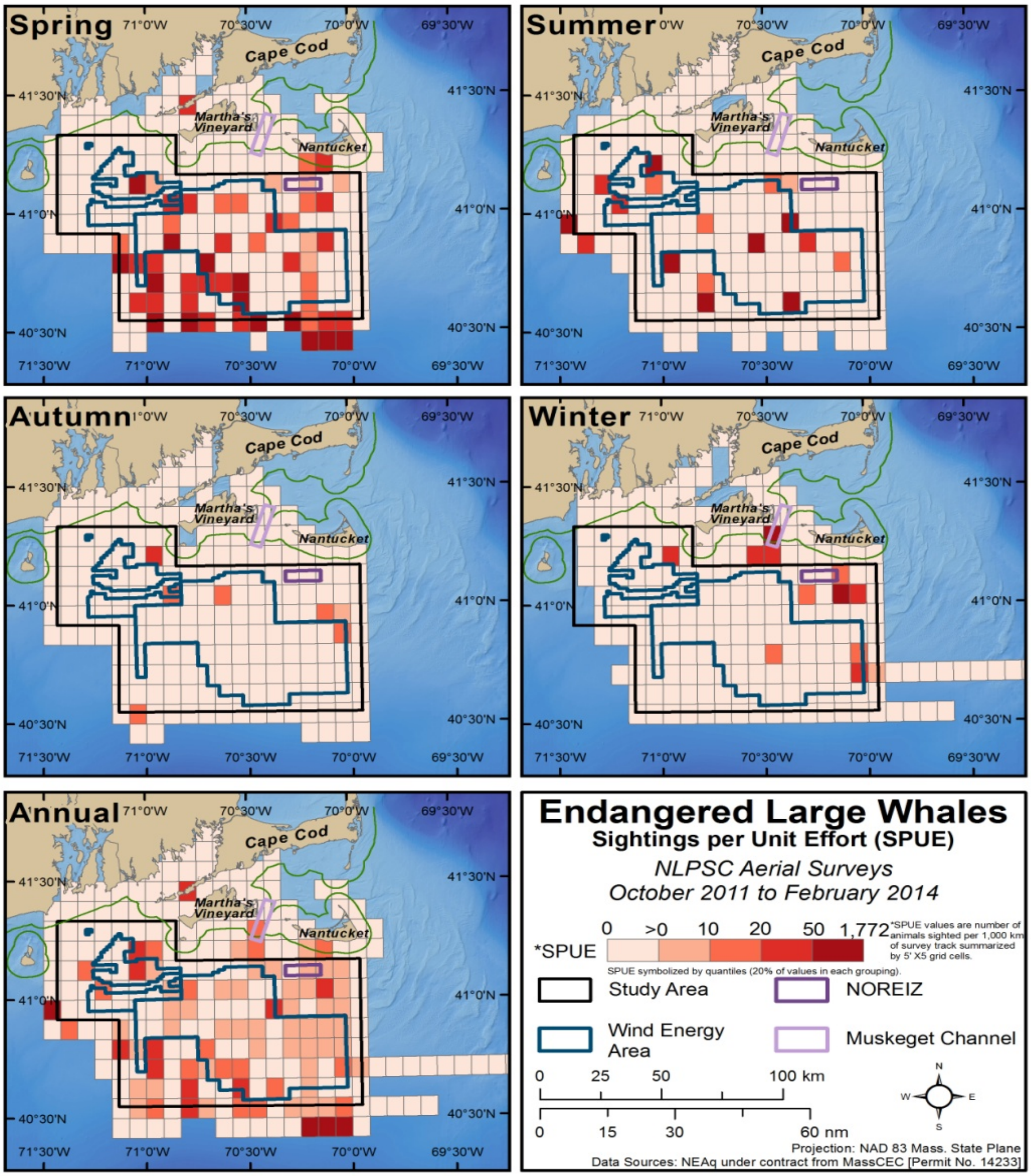
Survey Name	Date	Right Whale	Fin Whale	Sei Whale	Humpback Whale	Minke Whale	Sperm Whale	Unknown	Total
NLPSC001	10/19/2011				2				**2**
NLPSC002	10/23/2011								**0**
NLPSC003	11/6/2011								**0**
NLPSC004	11/26/2011								**0**
NLPSC005	12/5/2011								**0**
NLPSC006	12/12/2011								**0**
NLPSC007	1/9/2012								**0**
NLPSC008	1/26/2012	1	1						**2**
NLPSC009	2/5/2012								**0**
NLPSC010	3/6/2012								**0**
NLPSC011	3/23/2012	7		1		2		2	**12**
NLPSC012	3/24/2012	3						2	**5**
NLPSC013	4/1/2012	2			3			1	**6**
NLPSC014	4/6/2012	2	2		3	5		1	**13**
NLPSC015	5/7/2012		2		1	4		1	**8**
NLPSC016	5/18/2012								**0**
NLPSC017	6/10/2012		1			1			**2**
NLPSC018	6/24/2012		3						**3**
NLPSC019	7/3/2012								**0**
NLPSC020	7/13/2012								**0**
NLPSC021	8/7/2012						2		**2**
NLPSC022	8/23/2012					1		2	**3**
NLPSC023	9/12/2012		1						**1**
NLPSC024	9/17/2012						1		**1**
NLPSC025	10/23/2012								**0**
NLPSC026	12/13/2012								**0**
NLPSC027	2/15/2013	3							**3**
NLPSC028	2/26/2013	10							**10**
NLPSC029	3/29/2013	1			2			1	**4**
NLPSC030	4/18/2013	1	5		9	1		2	**18**
NLPSC031	4/26/2013		1	2	4			1	**8**
NLPSC032	4/29/2013		2	1	2	3			**8**
NLPSC033	4/30/2013		1		2	1		1	**5**
NLPSC034	5/18/2013		1	3	2	7		2	**15**
NLPSC035	6/5/2013		1		4	2			**7**
NLPSC036	6/6/2013		1		1				**2**
NLPSC037	6/21/2013				3	1		1	**5**
NLPSC038	7/30/2013		1		2	1		2	**6**
NLPSC039	8/7/2013							1	**1**
NLPSC040	8/20/2013								**0**
NLPSC041	9/18/2013								**0**
NLPSC042	10/22/2013		1					1	**2**
NLPSC043	11/5/2013								**0**
NLPSC044	11/21/2013							1	**1**
NLPSC045	1/15/2014	4						1	**5**
NLPSC046	1/17/2014							2	**2**
NLPSC047	2/1/2014								**0**
NLPSC048	2/4/2014								**0**
	Total	**34**	**24**	**7**	**31**	**40**	**3**	**25**	**162**

Figure B. All Whale Sightings, Year 1 and Year 2 combined, not corrected for effort.



To correct marine animal distribution maps for variable survey effort, sightings per unit effort (SPUE) values were calculated by dividing the total number of sightings by the total length (km) of transect lines per 5 minute square. Comprehensive seasonal and annual SPUE maps were created for all large whale sightings between October 2011 and February 2014 (**Figure C**). The compiled data from both years of surveys show a higher occurrence of large whales during the spring months than during any other time of year.

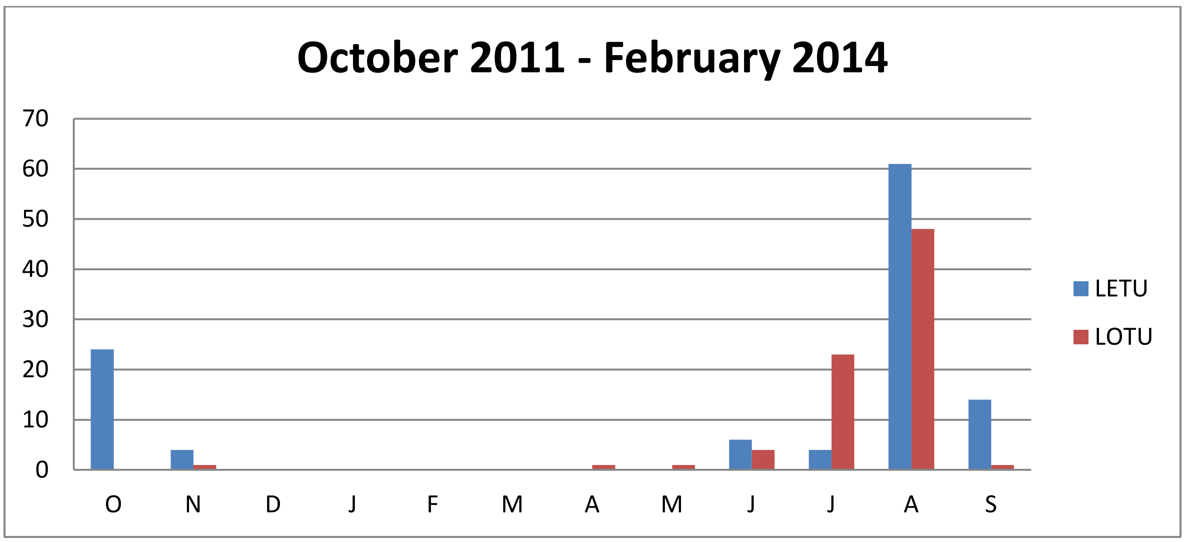
Figure C. Sighting Per Unit of Effort maps for all endangered large whales, Years 1 and 2 combined (Minke whales not included).



Turtles, Delphinoids, and other Species

The aerial surveys recorded only leatherback and loggerhead sea turtles. Though sightings of sea turtles were sparse, most of them occurred in the late summer during August. The low number of sightings of both of these species was in stark contrast to the high numbers sighted by observers during Year 1. Also of note was the absence of Kemp's Ridley turtles in Year 2. Both leatherback and loggerheads were primarily recorded in the northeast corner of the Study Area, near Nantucket Shoals. When compiled sightings of sea turtles are viewed collectively from October 2011 to 2014, peak presence occurred during the months of July and August (**Figure D**). This spatial and temporal data is consistent with those of tagged leatherback turtles in the region.

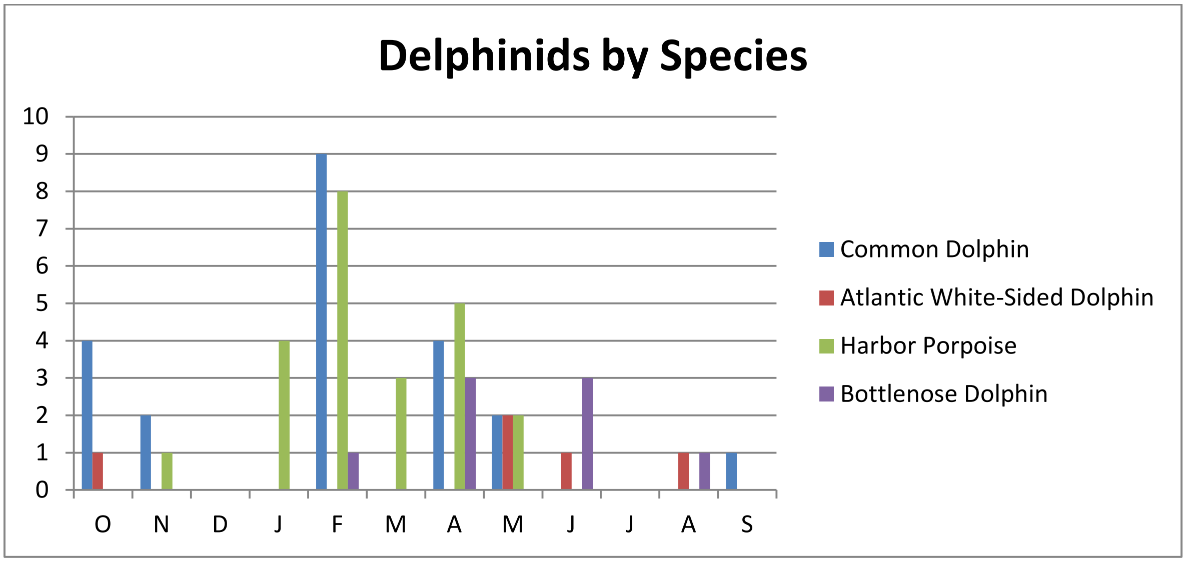
Figure D. Seasonal Occurrences of Leatherback and Loggerhead Turtles, Year 1 and Year 2 combined.



Four species of delphinid and one species of phocoenid were observed: bottlenose, white-sided, and common dolphins, pilot whales, and harbor porpoise (**Figure E**). Delphinids were observed throughout the year and the area, and the majority of these animals were not identified to species. Most delphinids were seen in large groups in autumn. Pilot whales were only sighted on one occasion and were detected in vertical photography during the month of June. Harbor porpoises were primarily observed during the spring and winter months.

An unusual aggregation of basking sharks was observed in November of 2013 in the southwestern corner of the Study Area. This sighting event was comprised of upwards of 800 individuals participating in a closed-mouth, close-following and circular swimming behavior known as "cartwheeling", typically associated with mating in sharks. This suggests that the area may be of particular importance to the species for social purposes, as the behaviors observed are not thought to be associated with feeding. The aerial survey team is drafting a manuscript on this record aggregation for scientific publication.

Figure E. Seasonality of Identified Delphinids and Harbor Porpoise (Year 2)



Acoustic Detections

Through the use of passive acoustic recording devices the presence of 5 species of large whales including right, fin, minke, humpback, and blue whales was confirmed. The months of the year when whales vocalizations were detected within the Study Area differed by species. Right whales were detected primarily in February and March. Right whale detections showed a decreasing trend after March, approaching a period of lowest detection in August and September. Fin whales were detected every day of recording from October 2013 through February of 2014, with the lowest acoustic presence in April. Minke and humpback whale presence was highest in April and decreased through October 2013. There were no minke whale detections from November 2013 through February 2014, however, humpback presence increased during those months. The only blue whale detections occurred in February 2013. In year two, right, fin, and humpback whales were detected in every month of sampling. This is in contrast to the Year 1 acoustic data, when no right whales were detected during the summer months (**Figure F**). Fin and humpback whales were acoustically present at least 1 day a month in each of the twenty five months of this study, while right whales were present in twenty one months, and minke and blue whales were acoustically present nineteen and six out of the twenty five months, respectively.

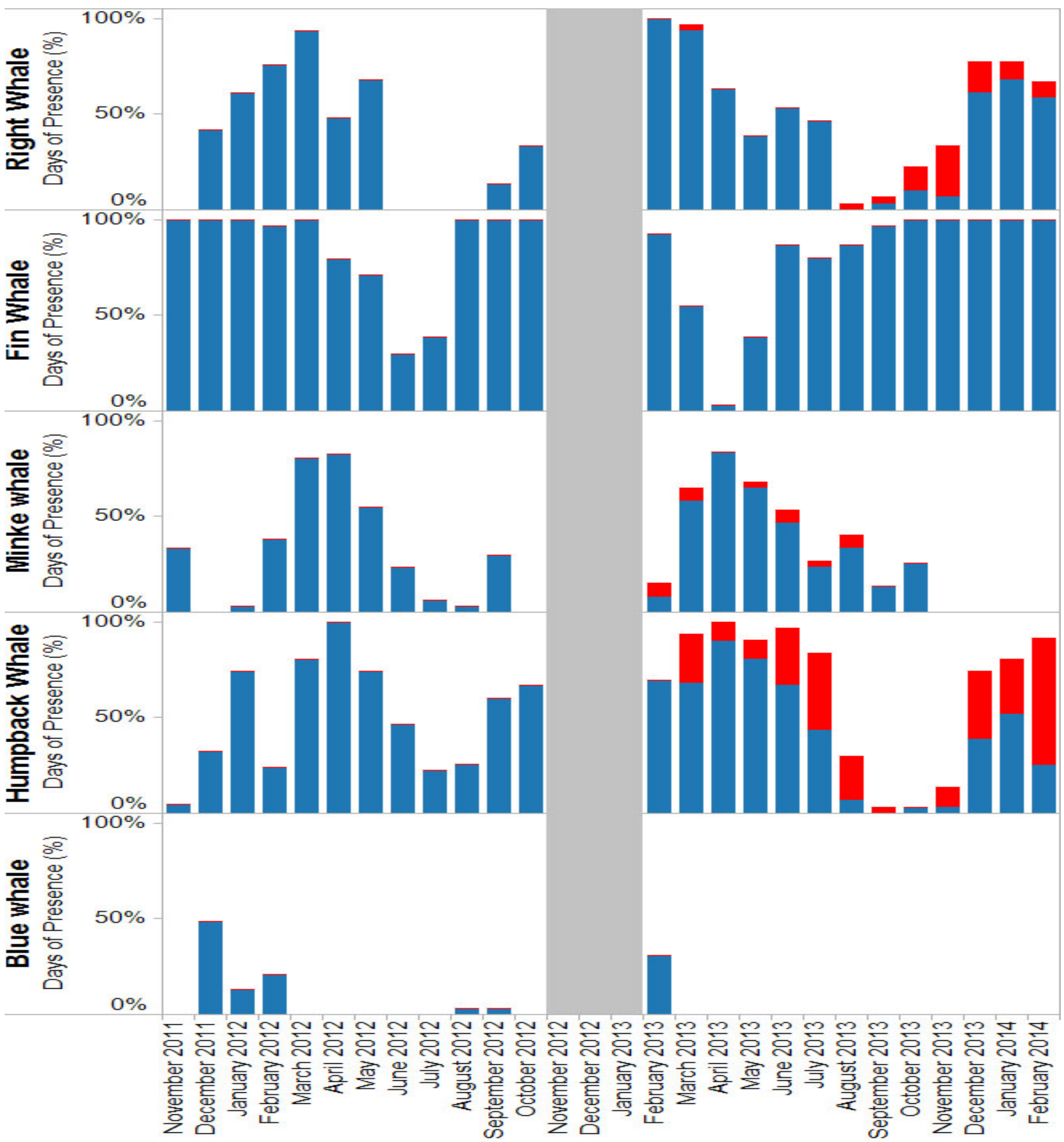
The vocalizations of various whales have different propagation characteristics, which mean that different species can be acoustically detected at widely different ranges from the MARUs. There are multiple variables (both biotic and abiotic) that can affect the actual detection ranges (source levels, frequency, depth of vocalizing whale, sound speed profiles, and bathymetry). The following list gives estimates of the potential distances a whale species may be detected by a MARU. These estimates are based on site conditions, source levels, and performance of hydrophones specific to those studies. The purpose of these estimates is to understand that some recorded vocalizations may have originated inside or outside of the MA and RI WEAs.

- Right whale calls: up to 25 km

- Humpback whale song: 12-29 km
- Minke whale pulse trains: up to 10 km
- Fin whale 20 Hz notes : >100 km Blue whale song: >100 km

Based on the variable detection ranges for different species, we are reasonably confident that acoustic detections of right, minke, and humpback whales indicate their presence within the MA WEA study area. Fin whales and blue whales, because of their longer range detectablility, may have been inside or outside the study area.

Figure F. Acoustic Detections of Large Whales, Year 1 and Year 2 (red portions of the bars indicate acoustic detections made in the RI WEA)

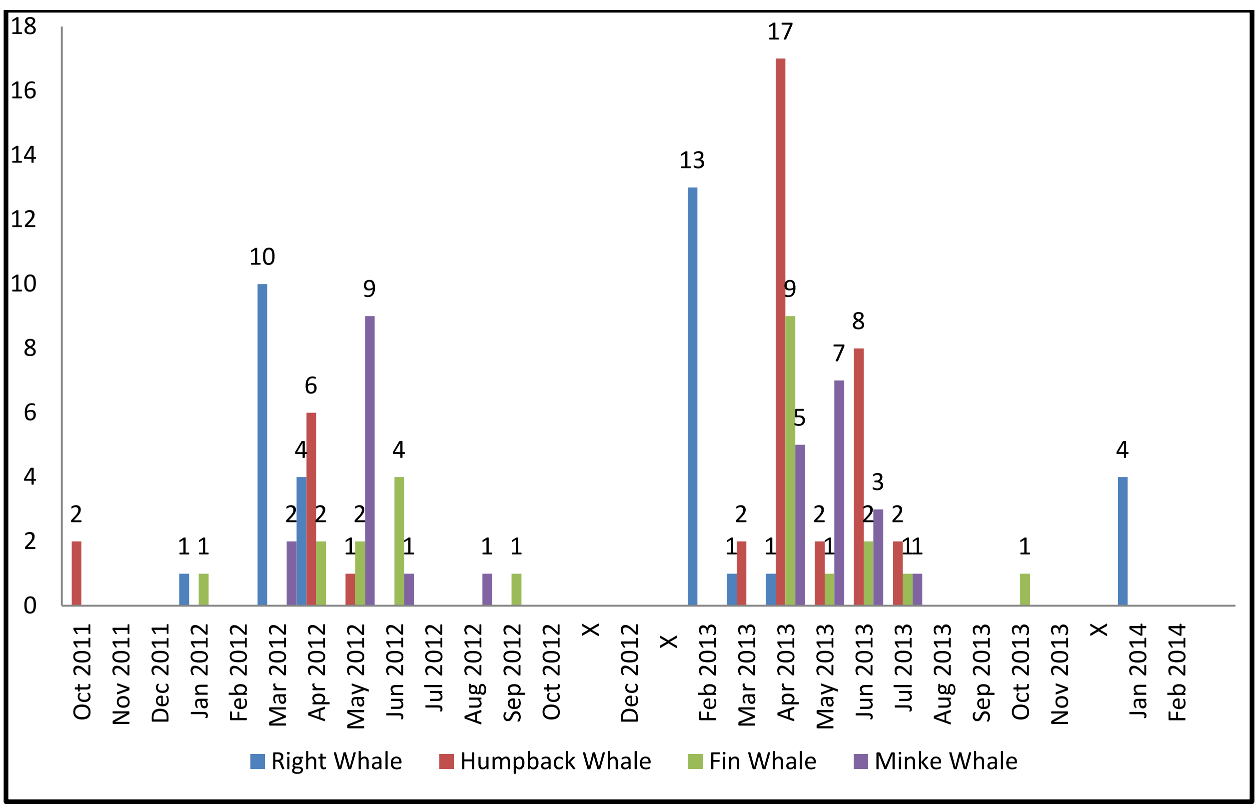


Aerial vs. Acoustic Data

Aerial detections of the four species of large whales that were also detected acoustically primarily occurred between the months of January and June during both Year 1 and Year 2. (**Figure G**). The aerial and acoustic presence data show similar spring and summer occurrence patterns for both humpback and minke whales. However, while neither humpback nor minke whales were visually detected in winter months, humpbacks had numerous acoustic detections. Fin whales were acoustically detected in all months of the year, however they were observed in the aerial surveys in only 6 months of the year, primarily in the spring. In the case of fin whales, the two data streams stand in striking contrast to one another during the month of April 2013, when the most fin whales were seen but almost none were heard.

The acoustic and aerial datasets are mostly consistent with each other in the case of right whales when both data types were able to be collected simultaneously. The winter and spring months represent the highest number of detections in both the aerial and acoustic datasets. However, one difference between the two years was that a significant right whale acoustic presence remained during the months of June and July of Year 2. Aerial detections ceased during this time, due to weather and logistical complications, although we know from previous experience that low right whale densities can be missed by aerial surveys. Though right whales were only detected acoustically, the 25nm listening radius of the MARU devices suggests at least a few right whales were present in the survey area during June and July.

Figure G. Aerial Detections of Four Species ofLarge Whales, Year 1 and Year 2. Species: Right whale, humpback whale, fin whale, and minke whale. Note: And X on the time scale represents a month when no aerial surveys were conducted.

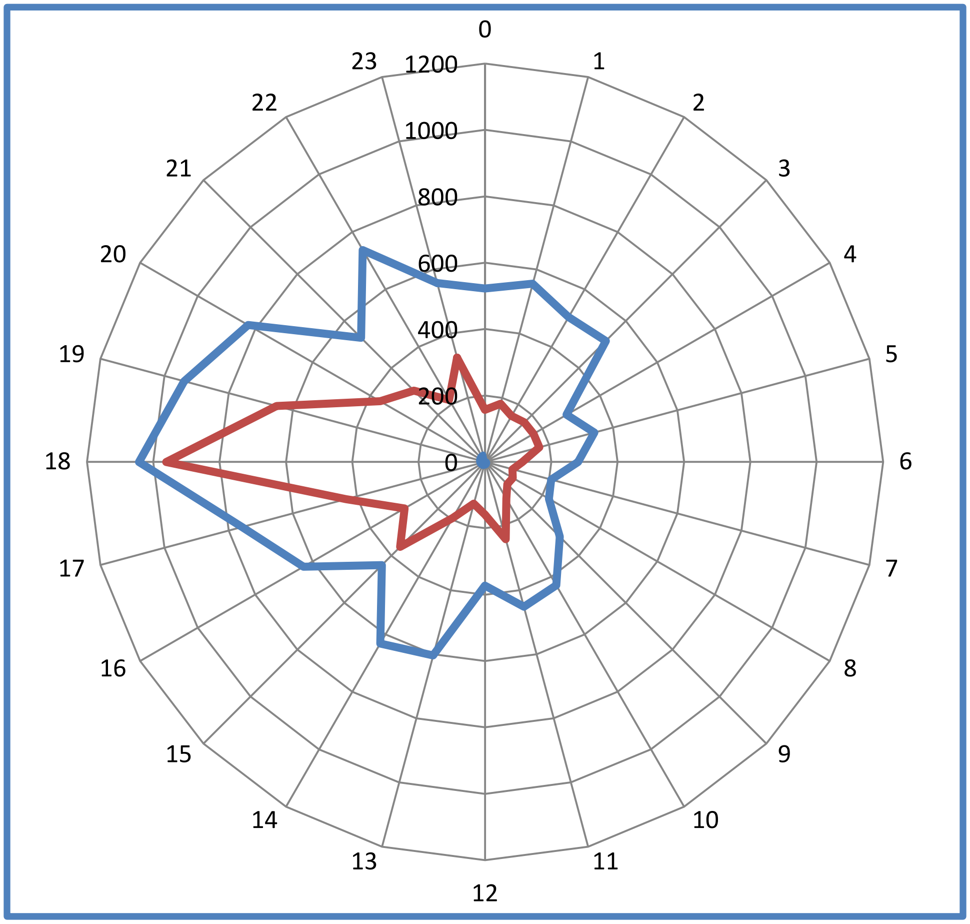


Right Whales

Thirty-six right whales were observed during Year 2, twenty of which have been identified to an individual catalogued in the North Atlantic Right Whale Catalog. Twenty-five percent of the whales identified were known to be reproductive females. Whales were observed feeding, traveling, and taking part in surface active groups (a socializing behavior). During these surface active groups, belly to belly contact and rolling were observed (behaviors known to be associated with mating). To date, a total of nine of the identified whales had confirmed sightings in Cape Cod Bay (CCB) in the same year. Five of these whales were seen between one and two months later in CCB, and the other four were sighted in CCB prior to their arrival in the Study Area over a range of two weeks to eleven months. None of these whales had confirmed sightings in the same year in the calving ground in the southeast US. During Year 2, there were far fewer sightings in the spring and more sightings in the winter than during Year 1. No right whale mother and calf pairs were observed during Year 2. Right whales were acoustically detected during all thirteen months of recording with the highest acoustic presence coinciding with the aerial sightings in winter and spring, and the lowest acoustic presence during August and September.

In the acoustic data, the specific locations of vocalizing whales were not determined, although in some cases their general locations could be estimated. In the case of right whales, enough detailed information was collected to demonstrate that right whales were more commonly found at or near sites MA-2, in the northeast corner of the MA WEA and site RI-3 in the center of the northern RIMA WEA. These acoustic localities are in strong agreement with the location of the sightings detected visually, suggesting a stronger presence of right whale in the northern section of the Study Area. Right whales were not acoustically detected in June, July or August in 2012, but they were acoustically detected during all three of these summer months in 2013 (Figure F, above). It is important to note that this temporal difference in acoustic presence cannot be attributed to the additional area that was surveyed in Year 2, as these summer detections occurred in the MA WEA. Of the 18,844 right whale detections that were confirmed through the whole sampling period, 12,699 of those were detected in 2013, twice the number of detections from 2012 (**Figure H**). When comparing the data from Year 1 to Year 2, right whale presence changed temporally and spatially. There was also likely an increase in their overall presence during Year 2, as suggested by the number of individuals detected aerially and the density of calls.

Figure 1. Number of right whale contact calls per hour (in EST) for Year 1 (red line) and Year 2 (blue line). Radial axes show number of calls in increments as indicated. Note: Multiple MARUs experienced data loss in Year 2, possibly resulting in a conservative estimate of diel call abundance.



Summary

The Year 2 aerial surveys and acoustic data doubled the amount information on the distribution and relative abundance of marine life in the Study Area. The results demonstrate a high degree of inter-annual variability in some species (e.g leatherback turtles) while relative consistency in others (some of the large whales). There were generally lower numbers of observer sightings during Year 2, although vertical photography counts for small, subsurface species were higher, validating the use of this method for species that are difficult for observers to detect. We anticipate that three years of surveys will provide us with enough compiled sightings data to estimate densities for some species of sea turtles. Three years of observer sightings data may also provide us with enough compiled data to estimate effective survey strip width for some large whale species, in order to calculate density estimations for the most abundant of the large whales, although confidence intervals area likely to be large.

The two years of aerial surveys and recordings are beginning to provide an overview of the seasonality of marine mammal and sea turtle occurrence in the Study Area. The SPUE data, where consistent in both years, is providing increased confidence in the seasonal and spatial patterns of distribution for some species (minke and right whales). Both aerial and acoustic data are largely in agreement about the occurrence of the most abundant species of large whales, with the exception of fin whales during the month of April and right whales in the summer months. The variance between years in the detected acoustic presence of right whales indicates that this species may not use this habitat in the same way each year. The nearly two-fold increase in acoustic detections of right whales demonstrates another change, and suggests inter-annual variability that needs further assessment. It is possible that the varying patterns of seasonality and distribution may be could be attributed to environmental or anthropogenic factors but additional research is required to describe the potential associations in more detail. Detailed comparisons of the acoustic and aerial survey data (planned for year three) should provide valuable information on whale behavior and occurrence. The ongoing third-year of effort will strengthen the existing baseline assessment by adding additional sightings data for most species, and may make statistical treatments of abundance, distribution, and seasonality feasible. These results may also provide some broad predictive power about endangered species distribution and seasonality that will assist managers in planning the development of wind energy in the area.

Publications from MA CEC Support

Taylor, J.K.D., R. D. Kenney, D.J. LeRoi, and S.D. Kraus. 2014. Automated Vertical Photography for Detecting Pelagic Species in Multitaxon Aerial Surveys. Marine Technology Society Journal 48(1):36-48.

Section 2: Aerial Surveys for Whales and Sea Turtles for Offshore Wind Energy Planning in Massachusetts

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(Modified for Section 2)

INTRODUCTION

In August of 2011, the Massachusetts Clean Energy Center (MassCEC) and the Executive Office of Energy and Environmental Affairs (EEA) established an agreement for conducting field surveys of marine life in the Massachusetts Wind Energy Area (MAWEA). Acronyms are listed in **Appendix 1.**The first year of surveys spanned a period of one year between October 2011 to September 2012. The twelve-month period of time that surveys were conducted under the original contract is henceforth referred to as Year 1.

In December of 2012 MassCEC and EEA entered a Cooperative Agreement with the Bureau of Ocean Energy Management that extended the survey period for an additional year and expanded the area surveyed to include the adjacent Rhode Island Massachusetts Wind Energy Area (RIMA). Subsequently, MassCEC awarded the New England Aquarium (NEAq) and the Northeast Large Pelagics Survey Collaborative (NLPSC) a one year extension to the existing contract. The addition of the RIMA offshore of Rhode Island to the existing MAWEA (these combined areas and the additional surrounding area covered by survey track lines are together referred to as the "Study Area") resulted in a 70 nm extension of survey track lines. Seventeen months of survey work was conducted under the extended agreement between October 2012 and February 2014, and this survey period is henceforth referred to as Year 2. This additional survey effort provided another year of information about spatial and temporal patterns of marine fauna occurrence in the Study Area. This effort strengthened the baseline dataset, a first step needed to inform development planning of any potential effects on the behavior and ecology of resident or migratory species of marine mammals, sea turtles, and birds (**Appendix 2**).

Under the National Environmental Policy Act (1969), Federal agencies are required to integrate environmental assessments of impacts from proposed actions. Under the Marine Mammal Protection Act (1972) and the Endangered Species Act (ESA, 1973), many species that occur in the Study Area have special legal protections. Understanding the distribution, abundance and seasonality of endangered whales and sea turtles is critical to developing operational plans for different stages of wind farm development, and to inform mitigation planning to minimize potential impacts. In particular, the Massachusetts Renewable Energy Task Force identified the need to address potential impacts of acoustic disturbance on marine mammals, and the importance of continued study of marine species and habitats in the Study Area.

Large whales that frequent offshore waters of Southern New England include the fin, sei, North Atlantic right, humpback, and minke whales and occasionally blue whales. Of these, the blue, fin, sei, humpback, and right whales are listed as endangered under the ESA (1973). In particular, occasional "hotspots" of right whale activity have occurred south of Cape Cod and near the WEA in the spring, possibly due to feeding opportunities. Still, right whale movement patterns in southern New England waters during the winter and spring months remain unknown. Sea turtles regularly found in northeastern United States waters include the loggerhead, leatherback, Kemp's Ridley, and green turtle, with occasional reports of hawksbill turtles from stranding records (Shoop and Kenney, 1992). All of these species are classified as endangered under the U.S. ESA.

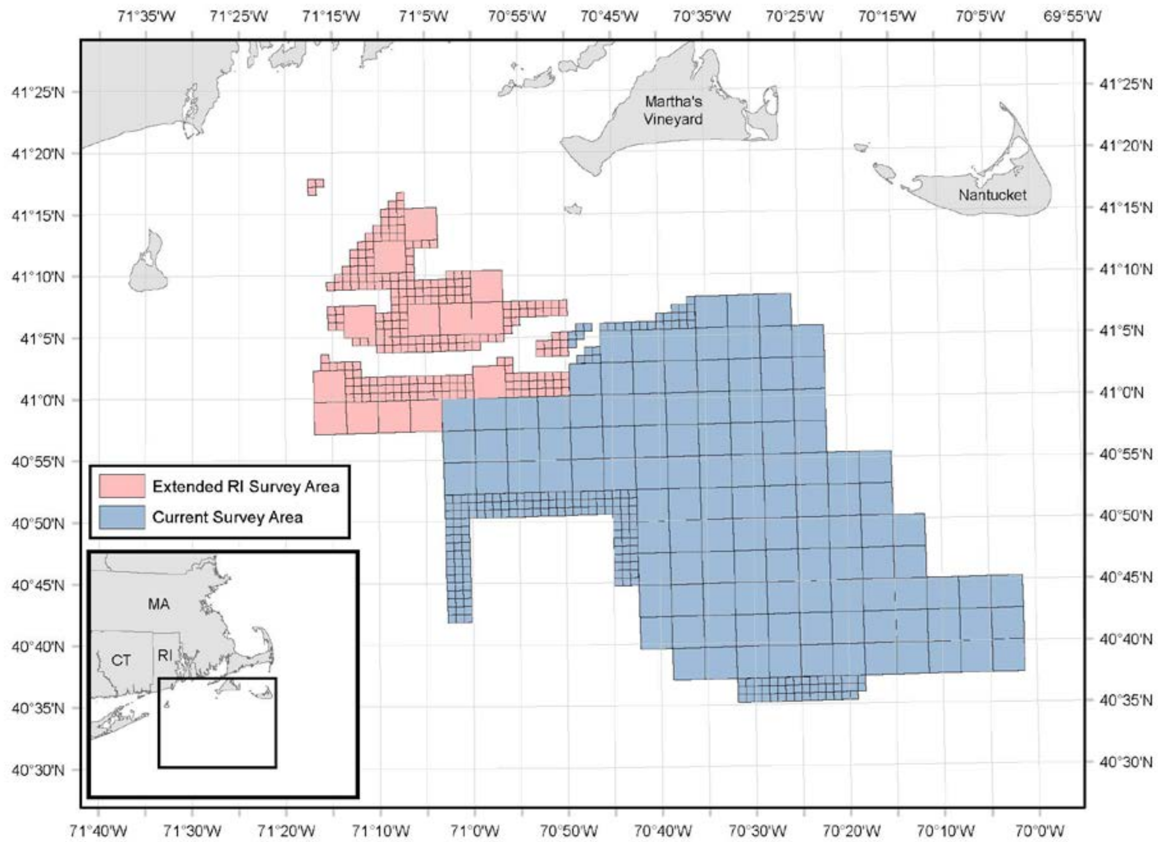
The NLPSC continues to fill gaps in information about endangered species and other marine life in the Study Area using a multi-faceted survey approach. The NEAq and PCCS conducted a total of twenty four aerial surveys over Study Area for whales and sea turtles over a period of seventeen months from October , 2012 to February , 2014 twice a month, weather permitting.

METHODS

Aerial Surveys

Aerial surveys were conducted on average twice per month in the wind energy area (WEA) (**Figure 1, Figure 2a**). Surveys were flown in a Cessna, O-2A Skymaster (tail numbers N9134Q and N102WB). This aircraft has high-wings, and centerline configured twin-engines, making it an appropriate platform for large whale surveys. The O-2A model has an existing camera port for the use of vertical photography equipment, and has an operational flight range of six and a half hours. Flight operations were not permitted to extend beyond 45 minutes reserve fuel at 120 knots at sea level, for any NLPSC survey, and the aircraft was required to be over land one hour before sunset.

Figure 1. The Massachusetts Wind Energy Area (MAWEA) and the Rhode Island Wind Energy Area (RIMA)



The aircraft was originally based at Concord Municipal Airport (CON) and moved to Nashua Municipal Airport (ASH) in April 2013. The flight base of operations for surveys was typically Plymouth Municipal Airport (PYM), with Norwood Memorial Airport (OWD) and New Bedford Regional Airport (EWB) as alternative staging locations, where the flight crew convened on the day of a survey. The NLPSC team monitored weather forecast websites consistently for suitable flight conditions in the Study Area, and the pilots additionally monitored conditions for the transit between airports. Surveys were flown under visual flight rules (VFR), and necessary flight conditions included a minimum ceiling of 2,000 feet (610 m), and visibility greater than 5 nm (9 km). Preferably wind speed was less than 10 knots with a Beaufort sea state of less than 3, although wind direction and swell height were factors in the quality of sighting conditions. Survey crew were on stand-by to fly every day of the year except for four holidays (Christmas Day, New Year's Day, July, and Thanksgiving). Necessary routine maintenance procedures were planned around periods of poor weather whenever possible. Prior to an anticipated flight, all survey crew were alerted at least 24-h beforehand, and placed on stand-by. Scheduled time of take-off from PYM depended on sunrise and sunset times.

All flight crew was certified in safety and emergency egress training within the last five years, and safety equipment was provided in accordance with NOAA Fisheries Service's Aircraft Operations Center safe-operating standards. The aircraft was equipped with a GPS, full IFR instrumentation, VHF marine and aviation radios, noise-reduction intercom headsets, life raft, PFDs, a medical kit, a waterproof VHF radio, a portable EPIRB, and an aircraft mounted ELT. Automated flight following (spidertracks.com) was activated and monitored by the ground contact during each survey flight to allow ground team members to track the aircraft's location in near-real-time (2-minute lag). Coast Guard Sector Southeastern New England was hailed periodically every 15 to 60 minutes in-flight by pilots or observers on the marine radio to provide position updates. Pilot-in-command (PIC) and second-in-command (SIC) sat forward. The two observers sat directly aft, scanning with the naked eye, using binoculars to confirm sighting cues.

In order to adopt best safety and scientific practices, it was necessary to coordinate closely with various state, federal and research organizations operating in the area. An email was distributed to these organizations on the morning of each flight with information on the flight plan. The Chief Survey Scientist coordinated with other aerial teams in order to prevent overlapping flight plans, including: NOAA's Atlantic Marine Assessment Program for Protected Species (AMAPPS); North Atlantic Right Whale Sighting Survey, NOAA Fisheries' Northeast Fisheries Science Center (NEFSC); the College of Staten Island avian research project, URI Department of Natural Resources Science for the Coastal Resources Management Council; University of New Hampshire's leatherback turtle spotter surveys; and Naval Undersea Warfare Center, Division Newport. The NOAA Regional Stranding Coordinators were also informed of flight activity. The NLPSC team provided information on survey coverage and sighting details to the Humpback Whale Research Group at PCCS, the Shark Research Program of the Massachusetts Division of Marine Fisheries, the North Atlantic Right Whale Sighting Survey in NOAA Fisheries' NEFSC, and a leatherback turtle PhD. Program, University of New Hampshire (see **Appendix 3** *Project Personnel and Associated Scientists*).

Survey Design

Surveys were flown at an altitude of 1,000 feet (305 m) and all attempts were made to maintain a groundspeed of 100 kn (185 km/h). The following line-transect methods were followed. Distance sampling for density and abundance estimates used f(0), for the probability density function of right-angle sighting distance (for that species and platform) evaluated at a distance of 0. The reciprocal of f(0) is the effective half-swath; the width of the strip on either side of the transect which is effectively searched. For observations made from Skymaster aircraft during the SCOPEX program, f(0) for large whales was 0.4760 (Kenney et al., 1995). The inverse is 1.13 nm (2.101 km), which is the effective half-swath coverage for large whales for surveys flown in a Skymaster at 750 ft. Based on these data (collected by the same aircraft in a similar area) and the slightly higher survey altitude of 1,000 ft (305 m), we expect observers can see all large whales at the surface out to slightly over one nautical mile. This means that each survey transect has an approximate strip width of 2 nm (3.7 km). Data-recording procedures for line-transect surveys adhere to strict rules to enhance statistical rigor. Different leg types were recorded (off watch, in transit, on transect line, on crossleg, circling), as well as particular leg stages (not on transect line, start, continue, break, resume, end) to differentiate those sightings to be included in density estimates (Kenney, 2011).

Observers' employed a scanning pattern for large whales, repeatedly sweeping forward and aft of perpendicular. Sightings of species other than large whales were recorded, but a 2 nm (3.7 km) scanning distance was maintained to prevent missing sightings while concentrating on nearby water. Using the described survey aircraft and configuration, a strip approximately 465 ft wide was obscured directly beneath the aircraft. To cover this area missed by observers, and to collect systematic information on the distribution and abundance of sea-turtles, an automated digital camera photographed vertical images directly beneath the flight path. Vertical images were processed post-flight for marine animals (sea birds, fish, sharks, turtles, and marine mammals), fishing gear, and vessels.

The MA WEA is located in the Nantucket Shelf Region, which includes Vineyard Sound, Nantucket Shoals and the continental shelf south of Martha's Vineyard, and the RI WEA is located east of Block Island. (**Figure 2a**). Additional alternative energy areas, including the Muskeget Channel and the NOREIZ area were also surveyed (**Figure 2b**). Lengths of the Muskeget and NOREIZ transect lines were 10.5 nm (19.4 km) and 8 nm (14.8 km) respectively. The lines over the MAWEA range from 37 nm (68.5 km) to 47 nm (87 km) in length, and those over the RIMA were 25 nm (46.3 km) in length. Minutes of longitude within the Study Area were designated line numbers (LEGNOs) 101 through 118 in the RIMA, and 1 through 72 from west to east in the MA WEA. The combination of the MA and RI WEAs includes 90 north-south transect lines separated by one mile, and on any given survey 10 survey lines were selected based upon a random start, and spaced 7 nm (13 km) apart to best cover the Study Area in a single day (**Figure 3**). A survey option number was randomly selected with options 1 through 9 being flown west to east, and the same line combinations 10 through 18 flown in an east to west direction. By varying time of day for take-off, direction of flight, and LEGNO starting points, transect line coverage was not biased and particular sections of the Study Area were not overlooked repeatedly at the same time of day, allowing for an unbiased assessment of the study area.

Each survey used a system which integrates the GPS, digital vertical camera, forward motion compensation (FMC) mount, remote key pads and Panasonic Toughbook computer using a data acquisition program, *d-tracker*. Automated data logs tracked effort throughout the survey, whereas sighting data logs were prompted by observers. Data collection in-flight was designed to limit distractions to observers' scanning pattern. All sighting entries were initiated using remote key pads mounted on each side of the aircraft so that observers did not have to remove their gaze from the viewfield, reducing the chance of missing a sighting. Sighting details were dictated into digital voice recorders and transcribed post-flight using e-tracker, a data editing program. *D-tracker* program functions and output format were designed

Figure 2a. Entire Study Area

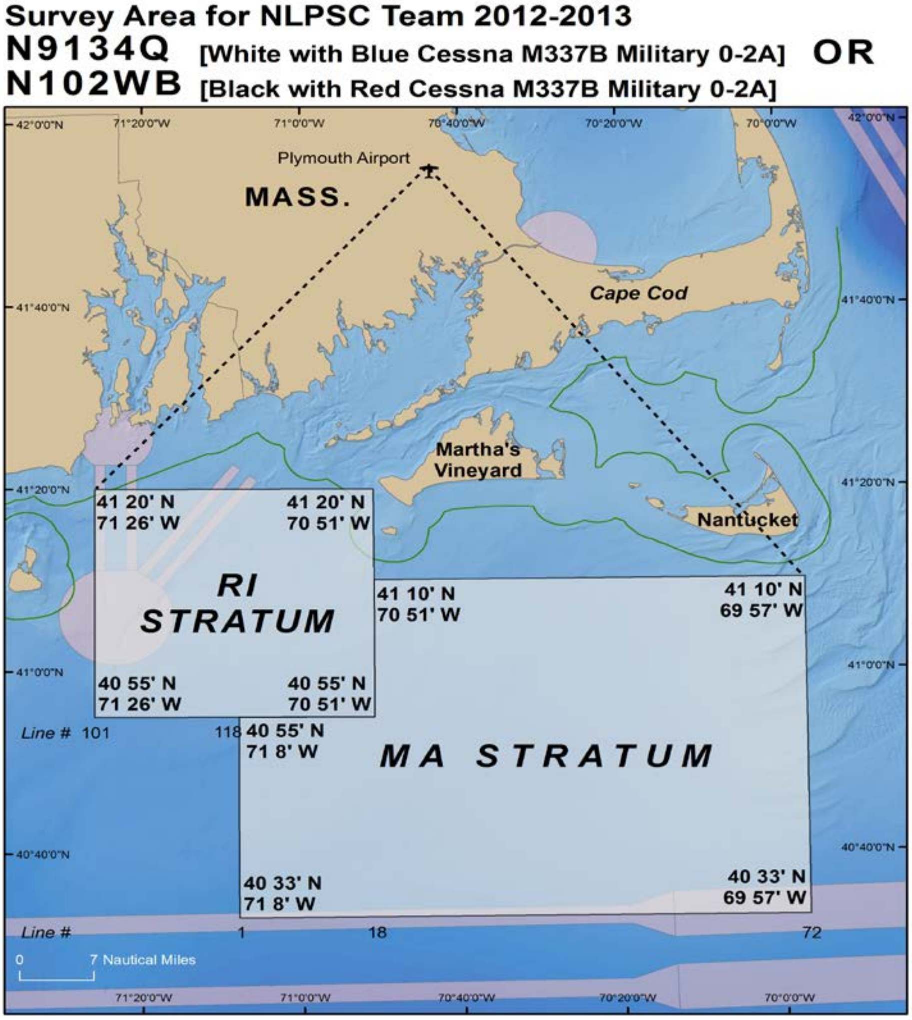


Figure 2b. Additional Alternative Energy Areas

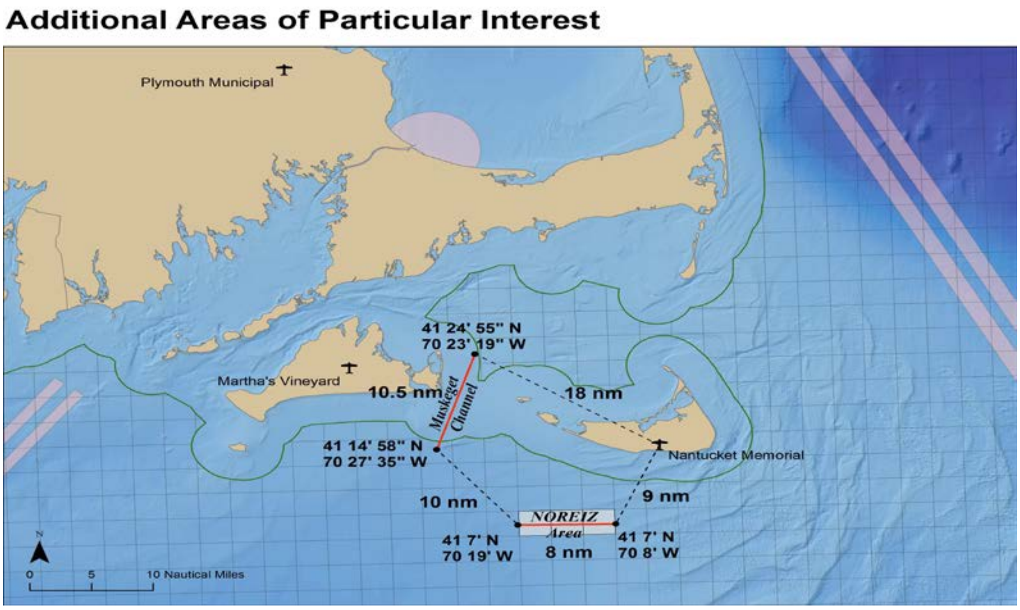
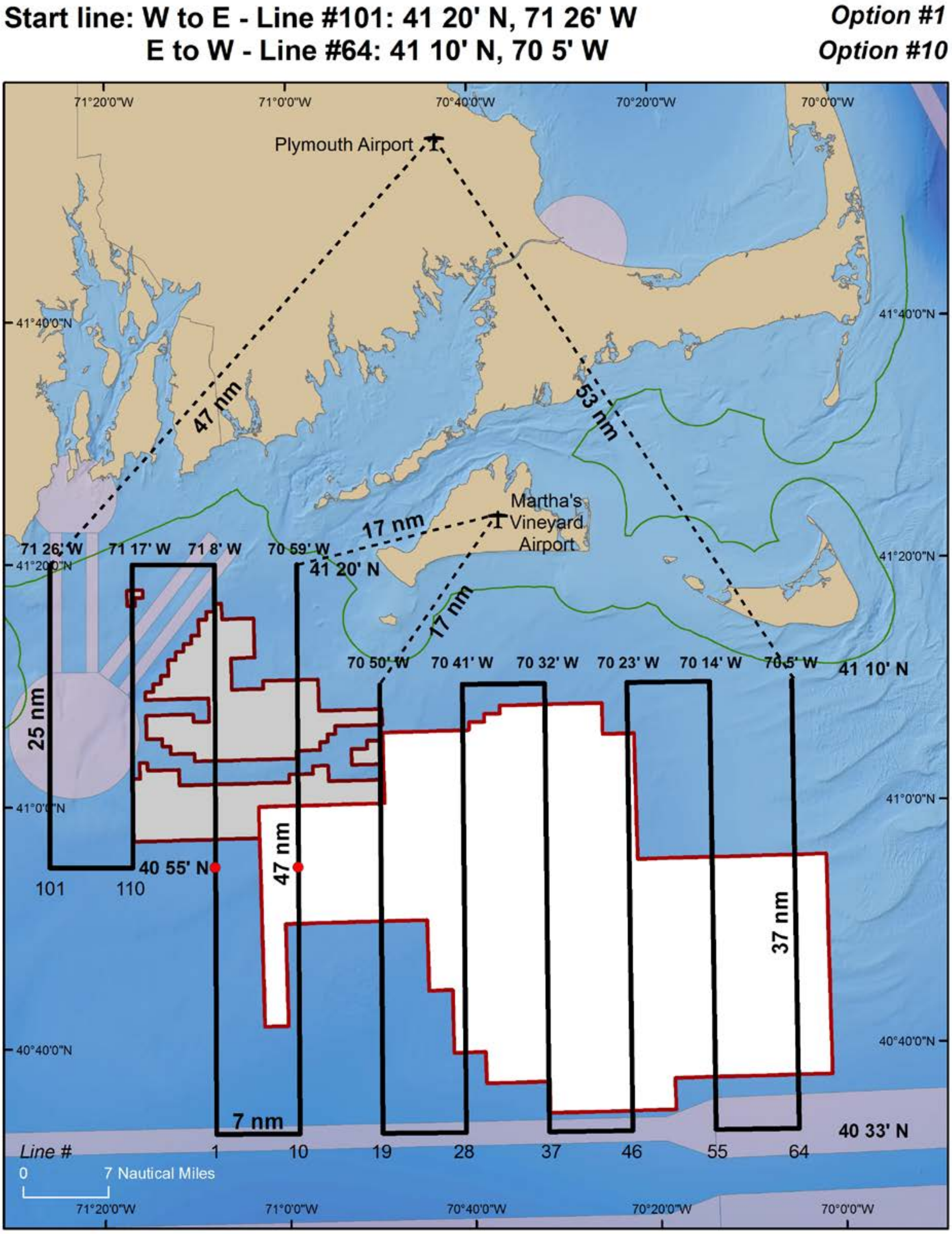


Figure 3. Example of Aerial Survey Design showing 2 Flight Options



for compatibility with the North Atlantic Right Whale Consortium (NARWC) database at the University of Rhode Island (details in **Appendix 4**; see also (://www.narwc.org/pdf/consortium_database.). *D-tracker* enables user-defined parameters to be modified via the laptop, such as vertical camera trigger intervals, and the display of latitude or longitude (**Appendix 5**). The mount system GPS output a proprietary NMEA formatted sentence, PGRME, that provided estimated horizontal and vertical position error in meters to record positional accuracy of the data. Altitude was recorded from the mount system GPS since the aircraft did not have a radar altimeter. At each data log, d-tracker recorded: Time, Latitude, Longitude, GPS Ground Speed, GPS Quality, GPS Number of Satellites, GPS Altitude, GPS Heading, Magnetic Heading, Lens Focal Length, Ground Covered Sideways, Ground Covered Forward, Picture Interval, and Picture Count, to a comma delimited CSV text file format (CSV). All data were recorded each time the camera fired, when prompted by an Observer, and at regular user-defined intervals, to allow for calculations of overall survey effort, and sighting abundance and distribution. Raw data was transcribed, proofed and backed-up immediately after each flight. E-tracker created a KML file of sightings recorded by Observers, viewable in Google Earth, and a GPX file for geo-referencing the vertical image database. Following the vertical image raw data processing, the CSV file is amended to include all of those fields defined in **Appendix 4**, combining sightings made by observers and those detected in vertical photography.

Aerial Observer Methods

Nikon binoculars (8 x 42 6.3°) were used to confirm sighting cues. A data log was prompted at the time a sighting was first seen from the transect line. If sighted forward of perpendicular, the aircraft continued heading along the transect line until the sighting was abeam, at which point the observer measured the distance from the transect line and prompted another right angle data log. If the animal was suspected to be a right whale, the aircraft broke from the transect line to circle in the vicinity to confirm species identification and / or for observers to photograph. If the animal was verifiably not a right whale, the aircraft did not break from the transect line, a distance was recorded when the sighting was at a right angle, and the aircraft continued heading on track. Distances from the transect line were estimated using calibrations on the wing strut (Mbugua, 1996; Ridgway, 2010). Distances in nautical miles were recorded by Observers in the following classifications: within 1/8; 1/8 to 1/4; 1/4 to 1/2; 1/2 to 1; 1 to 2; 2 to 4 and more than 4, indicating port or starboard.

Observers collected photographic identifications of individual right whales using a Nikon D300 or D300s with a 300 mm Nikkor lens and 1.7 x teleconverter with a resulting focal length of 500 mm. Observers photographed out of an open window while the aircraft circled overhead; either through hinged cut-out windows in the rear, or a crank-out window forward. Photographers collected oblique photographs of the entire rostral callosity pattern of each right whale sighted, and any other scars or markings that were obvious. Every attempt was made to document each individual within a given aggregation in order to provide residency and demographic information. While one observer photographed, the other kept a written record of frame numbers, initial time and location of sighting, event duration, and noted behaviors, group composition, direction of travel, and distinguishing features such as scars whenever applicable. The first whale photographed on a single survey received a letter for reference beginning at 'A'. Only whales that were photographed received a reference letter. If a whale was not noted by observers during the survey, but later discovered in photographic analysis, the whale received a number, starting with # 1 for the first undetected individual. During photographic documentation, approaches to right whales were limited to the minimum amount of time necessary to obtain photographs and complete the survey, and altitude was kept above a minimum of 900 ft when circling as per NMFS permit No. 14233. At the conclusion of photographic work the aircraft returned to the transect line at the point of departure, and a data point recording “resumption of survey effort” was logged. These methods conform to research protocols followed by the NARWC and are consistent with the aerial survey protocols followed by the U.S. National Marine Fisheries Service Northeast Fisheries Science Center.

Right whale images were uploaded and processed in the NARWC Catalog, and were compared to other records in the Catalog to identify individuals. Sightings of fish, rays, sharks, turtles, seals, dolphins and large whales (that were not right whales) were recorded and passed without breaking from the transect line in order to maximize flight time available. Vessels that were within 4 nm of the track line were recorded. No fishing gear was recorded in-flight, although unusual debris or pollution was noted, such as oil slicks. Sightings of fixed fishing gear were recorded in vertical images but not by observers, to prevent attention being distracted from target animal sightings. Associated sighting data was taken for all of those factors described in **Appendix 4** when relevant, including: human activity code, species or taxa (SPECCODE); a factor of confidence in the reliability of species identified (IDREL); estimated abundance (NUMBER, estimated by observers); and a factor of estimated precision of abundance (CONFIDNC, also estimated by observers). Uncertainty was recorded at the discretion of the observers. For example, if an observer could not distinguish a common from an Atlantic white-sided dolphin, they could record it as a definite unidentified common or white-sided (UNCW). If an observer could not identify the dolphin to species with full confidence, they would record it as a definite unidentified dolphin (UNDO) or a probable common dolphin depending on their confidence.

Aerial Vertical Photography Method

The military 02-A version of the Skymaster 337 has built in camera ports, and only minimal modifications were required to adapt NLPSC vertical photography equipment to fit into the existing camera port. A quarter inch thick optical glass plate was modified for installation in the ventral opening of the fuselage. The FMC mount was adapted so that the camera, mount housing, and mechanisms fit into the existing port, and was secured to the floor panels (**Appendix 5**). The FMC mount was powered using the aircraft’s 28V DC electrical system.

A full-frame digital SLR camera was mounted in the FMC unit for vertical photography. The mount and camera were remotely operated by *d-tracker* and EOS Utility programs running on the laptop, with the main functions controlled using remote key pads. A Canon EOS 5D Mark II or Mark III camera (upgraded June , 2013) was equipped with a Zeiss telephoto 85 mm manual focus lens (f/1.4), and was set to shoot at either 0 % overlap (i.e. back-to-back images) or any user defined intervals. The majority of vertical images in Year 2 were collected at 0% overlap (an interval of roughly two seconds). Surveys 25 and 27 were shot at 5 second intervals, while surveys 26 and 28-48 were shot at 0% overlap.

At a survey altitude of 1,000 feet (305 m), each image covered an area 424 by 282 ft (129 by 86 m) directly beneath the aircraft (0.0111 or 0.00324). With the camera set to 0 % overlap, the entire length of each transect line was covered at a strip width of 424 ft (129 m). Large, fine file size (not raw) images were stored directly on the camera’s memory card and backed up post-flight during data transcription. Vertical images were run through GPicSync, a software program that uses the GPX record to insert locations into the images' metadata. A summary of these methods and preliminary results can be found in Taylor et al. (2014).

Photo Analysis (PA) was conducted to count and identify all marine wildlife recorded in the vertical images. PA was performed on a 24" monitor screen or larger, using FastStone Image Viewer for Windows. Only images collected on-track (excluding those collected during circling, cross-legs or transits) were processed. PA was completed between survey flights and consisted of biotic and abiotoc sighting counts per image, categorized by human activity code, species or taxa, with the area in the image noted for reference. Like the observer data, a confidence level was allocated for species identification and abundance certainties. Image quality was assessed based on amount of glare that occupied the frame, and overall quality that might be affected by cloud cover, time of day, or sea state. Observers recorded detections in vertical images of all the same species and taxa that were noted during aerial surveys, but fishing gear and all vessels captured in images was also recorded.

Data Products

Right Whale Catalog, Photographic Database

Photographs of right whale callosity patterns were used as a basis for identification and cataloging of individuals, following methods developed by Payne et al. (1983) and Kraus et al. (1986b). New whales are added to the catalog when there is enough photographic information to confirm beyond doubt that it does not already match an existing cataloged whale, and documentation provides enough information for future sightings to be matched. This conservative approach ensures that data analyses for the population are based on robust identifications with a high probability of re-identification if a whale is photographed in the future (Hamilton et al., 2007).

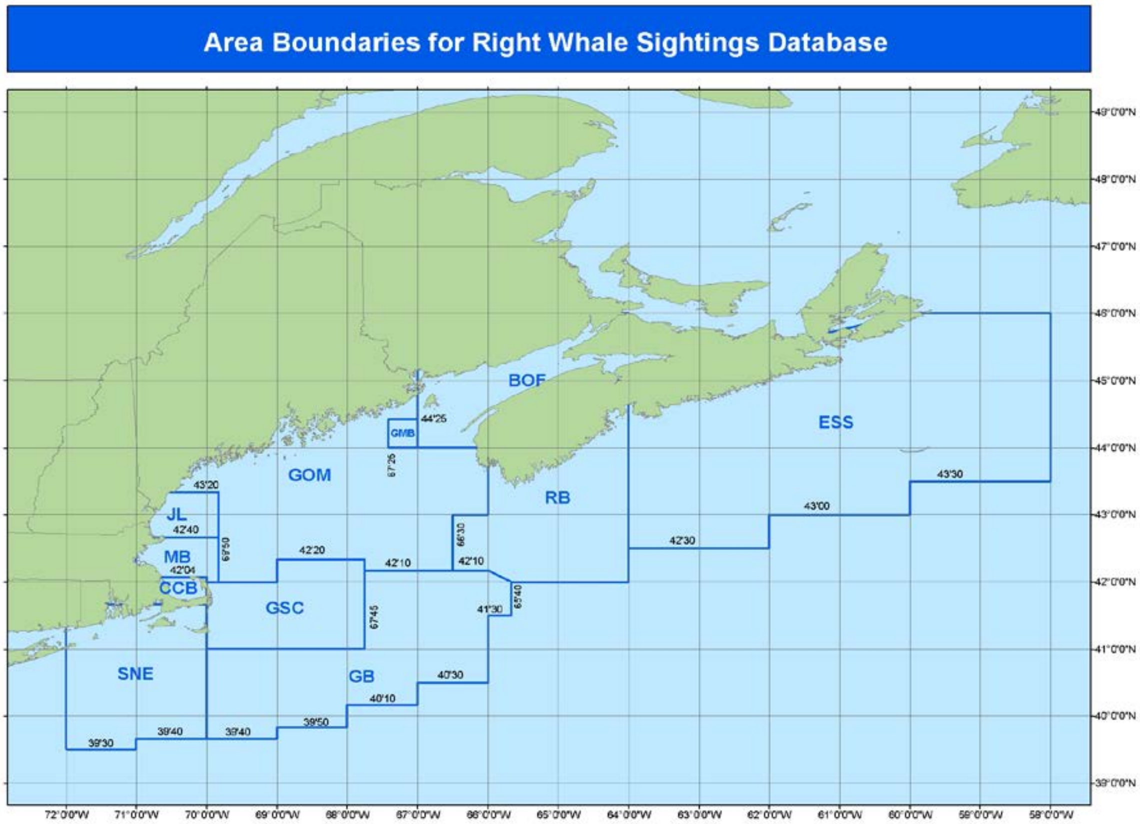
Right whale images are stored by NEAq in a data management program, Digital Image Gathering and Information Tracking System (DIGITS), which is curated by NEAq (Hamilton et al., 2007). This software system is used to process, match and track digital images and data for individual identification studies. DIGITS includes data from 313 different contributors, dating back to the first recorded event on 24 March, 1935. Identification data on the individual right whales reported in this document, including age, sex, and reproductive status, should be considered preliminary. The data from the MA WEA is included in the DIGITS regional classification of southern New England (SNE) (**Figure 4**). Right whale sighting data was entered and processed in DIGITS by the NLPSC aerial survey team throughout Year 2. Confirmation of whales is being performed by NEAq researchers under a different contract. An open-access online version of confirmed sightings can be viewed at: http://rwcatalog.neaq.org/Terms.aspx.

Sightings and Effort Database

Data management and submission procedures followed the NARWC protocols (Kenney, 2001, 2010). The NARWC dataset is widely used by federal and state agencies for environmental assessments, as it includes sighting information on all species of marine mammals and sea turtles from most systematic survey efforts along the east coast of the U.S since 1978. The NARWC database is linked to the DIGITS catalog and updated regularly.

The survey team proofed all survey data tables before submitting to Dr. Robert Kenney at URI's Graduate School of Oceanography for quality assurance and checking (QA/QC). The NLPSC team submitted individual survey data tables to the NARWC periodically, allowing for ongoing feedback and improvements to data collection methods. Data was submitted approximately three weeks after the date of a survey flight to allow time for the task of vertical photography data processing, which was performed by two observers. Once confirmed to the appropriate level of confidence, sightings information was inserted at the line of data that corresponded to the image. At the conclusion of Year 2, a QA/QC comparison was performed between NLPSC and URI datasets to correct inconsistencies.

Figure 4. Areas of the Northeast Region as defined in DIGITS



Vertical Photography Database

The raw database of JPG vertical images included all images taken from activation to shut-down, whereas the culled database included only those taken while on a transect line (LEGTYPE = 2). The raw database was burned onto a series of DVD-Rs, and both the raw and culled images were backed up on external hard drives. Observers performing PA recorded target species sightings for inclusion in the CSV survey data table. Although seabirds were not a focus of photo analysis (PA), observers incidentally recorded sightings of birds. All images containing target biotic and abiotic sighting detections were filed for reference.

Following photo analysis, recorded sightings were submitted in an excel table to the Chief Survey Scientist for verification. In cases where the NLPSC survey team was uncertain of species identification, advice was sought from experts in the field for opinions on species identification and reliability. The Chief Survey Scientist compared detection rates and quality of data between the two observers for consistency.

Initial survey dataset analyses were conducted by two observers during surveys 25 and 27 until the cross-observer validation of target species detections exceeded 90%. After observers were trained, experienced, and the cross validation rates were near unity, the vertical image collection interval was reduced from one every 5 seconds to 0% overlap, for survey 26, and then for the remainder of Year 2 starting with survey 28. Essentially the vertical images collected at this rate are non-overlapping and adjacent, effectively covering the entire track line strip not visible to the observers under the aircraft. At this point, both observers began analyzing every fifth photo, while one observer (PCCS) conducted a "scan through" of every image, to search for obvious sightings. This technique was employed as it was thought to greatly increase the number of vertical photography sightings detected in the Year 2 surveys.

Sightings per Unit of Effort (SPUE)

To get a true sense of marine animal distribution, (corrected for effort bias), the number of sightings per 5 minute by 5 minute longitudinal square were divided by the transect lines within that square. Effort is measured in kilometers of survey and numbers of 5-min by 5-min cells covered when Observers are on-watch in decent sighting conditions (visibility at least 2 nm and Beaufort less than 4). SPUE is calculated to give number of individual animals sighted per 1,000 km (540 nm):

$$1000 \times \frac{\text{Number of Individuals Sighted}}{\text{Effort (km)}}$$

SPUE maps represent sightings with an identification reliability (IDREL, determined by observers) of *probable*(2) or *definite*(3), through Year 2, partitioned by seasons and annually. No IDREL recorded as *unsure*(1) are included in these maps. (**Appendix 6**).

Animal Density Estimation

Although density estimation is feasible from these surveys, robust estimation requires at least 25-30 on-track sightings of each species, to create appropriate f(0) measurements and subsequent calculations. In Year 2, marine mammal and sea turtle sightings numbers were very low, and yielded counts too low to do this for any species. We are hopeful that the combined data from three years of survey work will provide adequate numbers to estimate densities for some of the large whales and sea turtles. However, for this report, no density estimations were completed.

RESULTS

NLPSC Aerial Surveys

Although the Year 2 contract was not issued until December of 2012, the NPLSC survey team used surplus aircraft time from Year 1 to fly the MAWEA in October and December of 2012. Likewise in Year 2, bad weather provided surplus aircraft time, which was used to extend survey efforts between December of 2013 and March of 2014 when the Year 3 extension was issued. To summarize the bridge surveys between Years 1 and 2, and to incorporate the data from the bridging surveys between Years 2 and 3, this Year 2 report encompasses a period of 17 months (October 2012 – February of 2014). Twenty-four surveys were performed between October, 2012 and February, 2014. Surveys are numbered consecutively from the first flight, NLPSC025 to the final, NLPSC048. **Table 1** shows the survey number, date and hours flown per flight. The seasonal tables and maps are defined as follows: Spring: March to May; Summer: June to August; Autumn: September to November; and Winter: December to February.

Table 1. Survey Dates and Hours (*Partial Survey)

Survey Name	Date	Hours	Survey Name	Date	Hours
NLPSC025*	10/23/2012	5.7	NLPSC037	6/21/2013	6.4
NLPSC026*	12/13/2012	2.9	NLPSC038*	7/30/2013	7
NLPSC027*	2/15/2013	6.1	NLPSC039*	8/7/2013	4.6
NLPSC028*	2/26/2013	5.5	NLPSC040	8/20/2013	7
NLPSC029	3/29/2013	6.6	NLPSC041	9/18/2013	6.9
NLPSC030*	4/18/2013	5.6	NLPSC042*	10/22/2013	4.7
NLPSC031*	4/26/2013	4.6	NLPSC043	11/5/2013	6.5
NLPSC032*	4/29/2013	3.2	NLPSC044	11/21/2013	6.2
NLPSC033*	4/30/2013	3.6	NLPSC045*	1/15/2014	2.8
NLPSC034	5/18/2013	7	NLPSC046*	1/17/2014	4.6
NLPSC035*	6/5/2013	2.6	NLPSC047	2/1/2014	6
NLPSC036*	6/6/2013	4.3	NLPSC048*	2/4/2014	4.4

Flight and Photographic Effort

During this period, twenty-four surveys were flown, consisting of eight complete and sixteen partial flights (Complete Survey List by FILEID in **Appendix 7.**). A full survey flight covered 384.5 nm (712 km) or greater. **Table 2** summarizes effort data for the Year 2. The total on-transect distance flown was 6560.5 nm (km). This does not include distances when the aircraft was in transit, on cross-legs, or after breaking from the transect line, although observers remained on-watch during these times. A survey was considered to be partial if any of the ten transect lines and/or additional areas of particular interest were reduced. Surveys were conducted in all months except November 2012 during the period between Year 1 and Year 2, and in January and

December of 2013 due to an extraordinary stretch of poor weather conditions. For these 3 of the 17 months, a combination of poor weather conditions and aircraft maintenance prevented any surveys from occurring. In 7 of the surveyed months, only a single survey day was completed, usually due to weather constraints.

Table 2. Flight and Photographic Effort Summaries

Total Flight Hours	125
Average Flight Hours per Full Survey (n = 8)	6.6
Average Flight Hours per Survey (n = 24)	5.1
Total nm / km of Trackline Flown	6,560 / 12,149
Total Images Collected to Date	171,126
Average No. Images Collected per Full Survey	10,240
Total Unique Images Analyzed or Scanned to Date	103,230
Total Images Analyzed to Date, including duplicates	127,205
Average Images Analyzed or Scanned per Full Survey (n = 8)	6,842

A total of 171,226 images were collected, occupying 1.04 TB of storage, averaging 6.5 MB per image. A total of 103,230 on-transect images were collected, including 4245 collected at 5-second intervals, and 98, 985 collected at 0 % overlap per full flight (**Table 3**). During NLPSC 025 and 027, the camera was fired at 5-sec intervals. Both observers analyzed each photo collected on track for these two flights for validation. The number of images analyzed per observer per full flight at 0 % averaged 6,842.

Table 3. Number of Vertical Images Collected per Flight (* Partial Survey)

Survey	**Raw**	**On Transect**	**Survey**	**Raw**	**On Transect**
NLPSC025	3588	2303	NLPSC037	9811	7264
NLPSC026	3989	2449	NLPSC038	6438	4157
NLPSC027	3757	1942	NLPSC039	5801	3589
NLPSC028	10071	4245	NLPSC040	12493	8041
NLPSC029	8348	5101	NLPSC041	9595	7087
NLPSC030	4696	2778	NLPSC042	6537	4288
NLPSC031	6510	4885	NLPSC043	11935	8131
NLPSC032	4222	2643	NLPSC044	8520	6911
NLPSC033	3851	2345	NLPSC045	9274	1688
NLPSC034	11156	7475	NLPSC046	4527	3154
NLPSC035	4571	3042	NLPSC047	10064	4726
NLPSC036	5028	3074	NLPSC048	6344	1912
			Total	**171126**	**103230**

The average effort by 5 minute squares throughout the WEA is given in **Figure 6** and **Table 4** which show the minimum, maximum, total and means for survey effort during these 17 months of NLPSC aerial surveys.

Figure 6. Effort by Season and Summarized for the Entire Survey Period

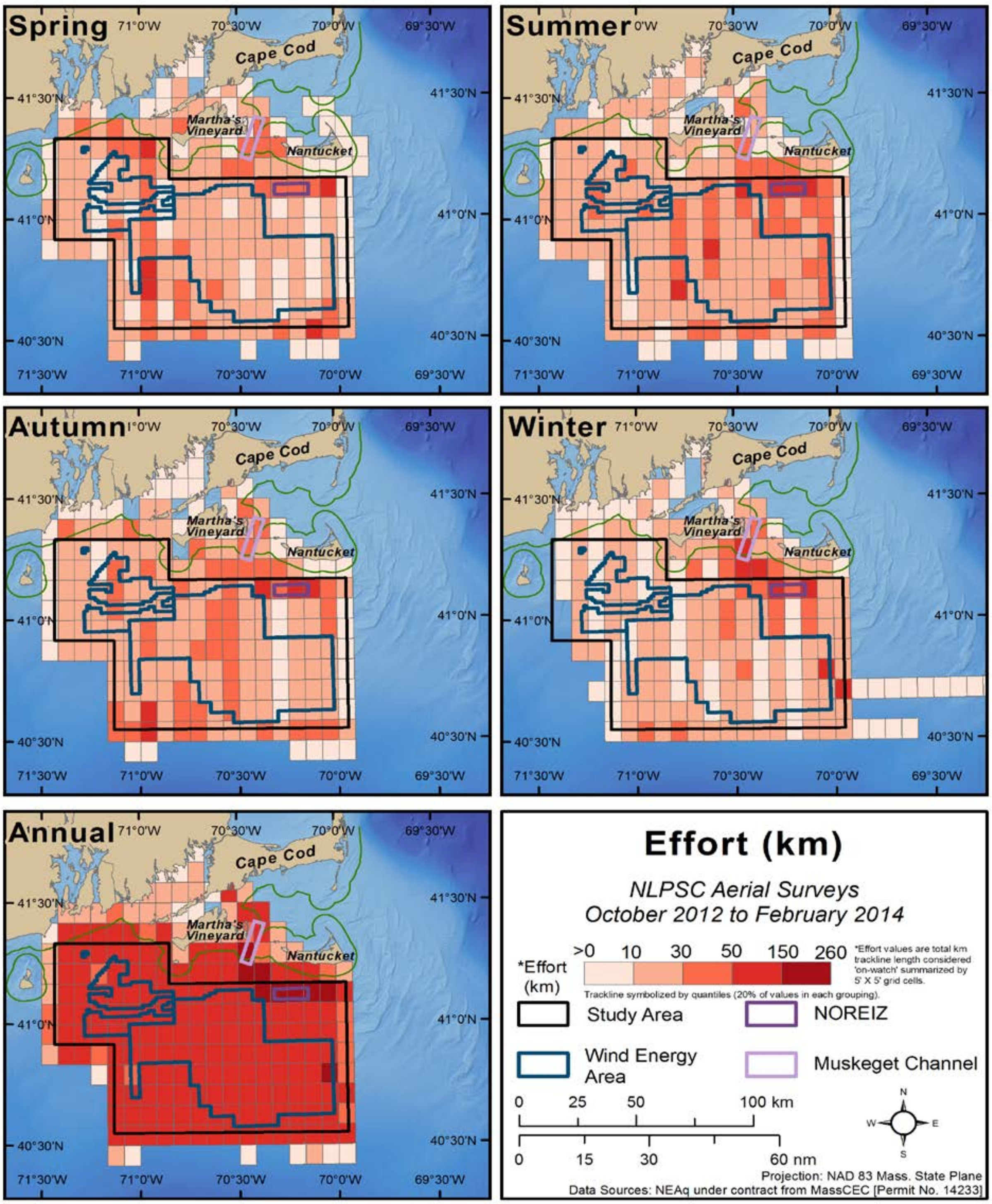


Table 4: Effort in kilometers of survey for 5-min by 5-min squares (n=173) that are within the WEA

October 2012 - February 2014	
	Effort (km)
Min	5.9
Max	232.0
Sum	15522.4
Mean	89.7

Sightings and Seasonality

There were a total of 686 animal sightings throughout the 17 months of surveys, with the lowest in winter (n = 86), when 32.3 flight hours covered 1564.5 nm (2897.5 km) of transect lines, and the highest in summer (n = 203), when 31.9 flight hours covered 1721.5 nm (3188.2 km). The locations of all sightings made during the surveys are shown on the maps in **Figures 7a – 7h** by species, divided into taxonomic groups. The sighting location also indicated the number of animals sighted at each location by the size of the circle. The only animal category that is not represented in these figures is Unidentified Animal (UNID), although those sightings are included in Grand Totals. All sightings by survey are provided in **Appendix 8**.

Numbers of all sightings per survey (not abundance) are shown in **Tables 5a – 5f**. Sightings include both those detected by observers in-flight and those detected in vertical images, including *possible*, *probable* and *definite* species identifications. The Total sums categories in each table per survey, and Grand Total sums all animal sightings per survey, excluding human activity codes. Each taxonomic group is followed by histograms which show the seasonality of the sightings, as the number of sightings by month (**Figures 7a -10b**). There is one histogram by species and a second histogram of all species combined for each taxonomic group.

For target species (large whales and sea turtles), additional seasonal charts were created. Histograms for four of the large whales as well as the two species of sea turtles detected provide a seasonal picture of sightings for the total survey period from October 2011 to February 2014 (**Figures 7c and 8c**). The peak presence of four large whales (right, humpback, minke, and fin) was observed between January and June. The two commonly detected sea turtles (leatherback and loggerhead) occurred mostly between July and October.

Unidentified large whales were mapped with other large whales (**Figure 13a**). This included one unidentified rorqual whale (UNRO), one unidentified fin or sei whale (UNFS) and 13 unidentified large whales (UNLW). There were no unidentified medium whales sighted during the survey period. One of the large whales mapped was sighted in photo analysis, and it was recorded as an unidentified large whale. The map of turtle species includes leatherback, loggerhead and unidentified turtles (**Figure 13b**). Only one of these sightings was detected in photo analysis, and it was a leatherback turtle. **Figures 13c - 13f** show two maps for all sightings throughout Year 2, separating those detected by observers in-flight, and those collected in the vertical images. These paired

Table 5a. Large Whale Sightings per Survey
(Note: *Sightings* refers to the number of times a species was sighted, not the number of individuals sighted.)

Survey Name	Date	Right Whale	Fin Whale	Sei Whale	Humpback Whale	Minke Whale	Unidentified Large Whale	Total	Grand Total
NLPSC025	10/23/2012							**0**	15
NLPSC026	12/13/2012							**0**	1
NLPSC027	2/15/2013	3						**3**	18
NLPSC028	2/26/2013	10						**10**	22
NLPSC029	3/29/2013	1			2		1	**4**	9
NLPSC030	4/18/2013	1	5		9	1	2	**18**	23
NLPSC031	4/26/2013		1	2	4		1	**8**	43
NLPSC032	4/29/2013		2	1	2	3		**8**	14
NLPSC033	4/30/2013		1		2	1	1	**5**	9
NLPSC034	5/18/2013		1	3	2	7	2	**15**	126
NLPSC035	6/5/2013		1		4	2		**7**	35
NLPSC036	6/6/2013		1		1			**2**	9
NLPSC037	6/21/2013				3	1	1	**5**	55
NLPSC038	7/30/2013		1		2	1	2	**6**	20
NLPSC039	8/7/2013						1	**1**	50
NLPSC040	8/20/2013							**0**	61
NLPSC041	9/18/2013							**0**	53
NLPSC042	10/22/2013		1				1	**2**	29
NLPSC043	11/5/2013							**0**	35
NLPSC044	11/21/2013						1	**1**	14
NLPSC045	1/15/2014	4					1	**5**	13
NLPSC046	1/17/2014						2	**2**	6
NLPSC047	2/1/2014							**0**	20
NLPSC048	2/4/2014							**0**	6
Total		**19**	**14**	**6**	**31**	**16**	**16**	**102**	**686**

Figure 7a. Large Whale Seasonality of the Four Most Abundant Species

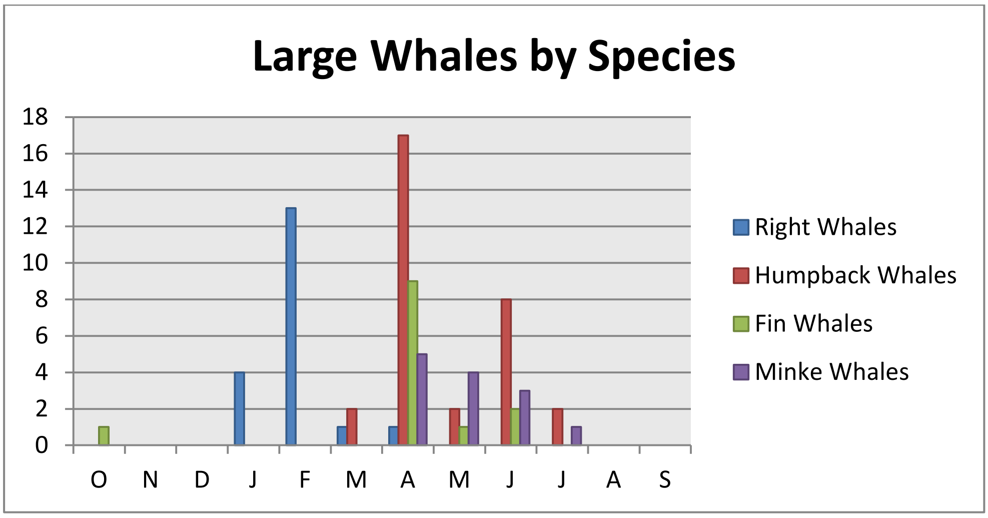


Figure 7b. Seasonality of all Large Whales

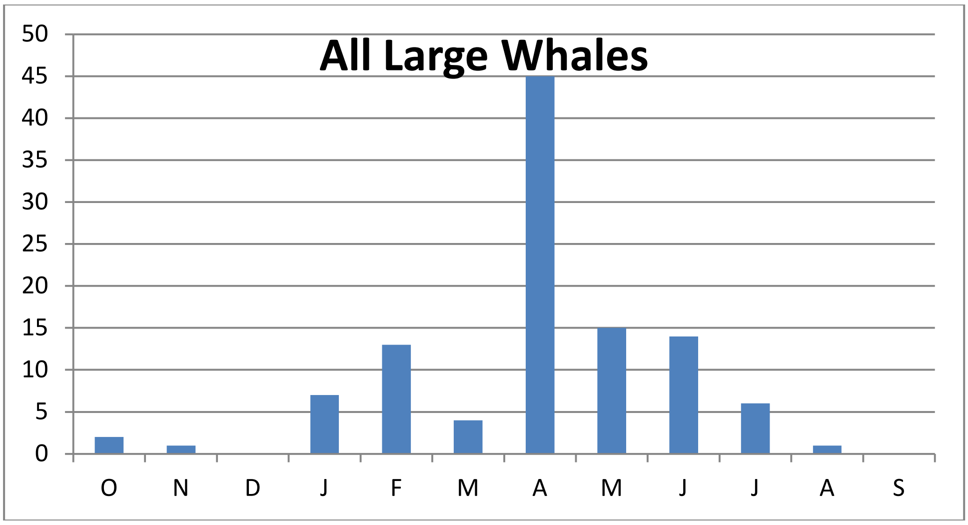
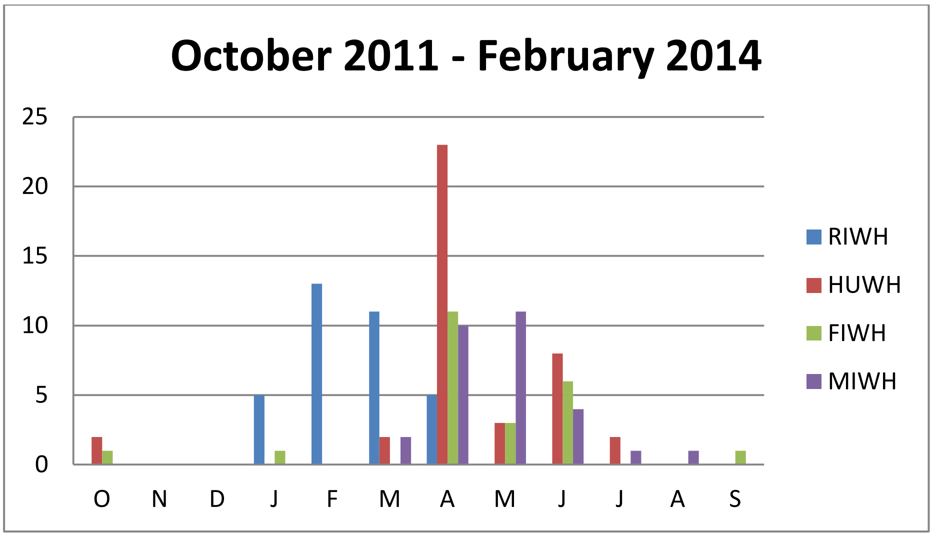


Figure 7c. Seasonality of all Large Whales over Years 1 and 2 Combined



maps are provided for delphinids and harbor porpoises, sharks, and fishes. Delphinid species and harbor porpoises are mapped together, and were often detected in photo analysis. A large portion of this taxonomic group includes unidentified dolphins (UNDO), as these animals are difficult to identify to species without obtaining photographs. The only pilot whales detected over the seventeen month period were found in photo analysis, as none were sighted by observers. Large pods of dolphins were occasionally flown directly over intentionally in order to gain an accurate abundance estimate, and retrieve species identification verification. In these cases, the photographed data point was retained since it was the most accurate sighting position.

Table 5b. Sea Turtle Sightings per Survey (Note: *Sightings* refers to the number of times a species was sighted, not the number of individuals sighted.)

Survey Name	Date	Leatherback Turtle	Loggerhead Turtle	Unidentified Turtle	Total	Grand Total
NLPSC025	10/23/2012				**0**	15
NLPSC026	12/13/2012				**0**	1
NLPSC027	2/15/2013				**0**	18
NLPSC028	2/26/2013				**0**	22
NLPSC029	3/29/2013				**0**	9
NLPSC030	4/18/2013				**0**	23
NLPSC031	4/26/2013				**0**	43
NLPSC032	4/29/2013				**0**	14
NLPSC033	4/30/2013				**0**	9
NLPSC034	5/18/2013				**0**	126
NLPSC035	6/5/2013				**0**	35
NLPSC036	6/6/2013				**0**	9
NLPSC037	6/21/2013				**0**	55
NLPSC038	7/30/2013	1			**1**	20
NLPSC039	8/7/2013	3	1	4	**8**	50
NLPSC040	8/20/2013	5	1	3	**9**	61
NLPSC041	9/18/2013	1	1	3	**5**	53
NLPSC042	10/22/2013			1	**1**	29
NLPSC043	11/5/2013				**0**	35
NLPSC044	11/21/2013				**0**	14
NLPSC045	1/15/2014				**0**	13
NLPSC046	1/17/2014				**0**	6
NLPSC047	2/1/2014				**0**	20
NLPSC048	2/4/2014				**0**	6
Total		**10**	**3**	**11**	**24**	**686**

Figure 8a. Seasonality of Leatherback and Loggerhead Sea Turtles

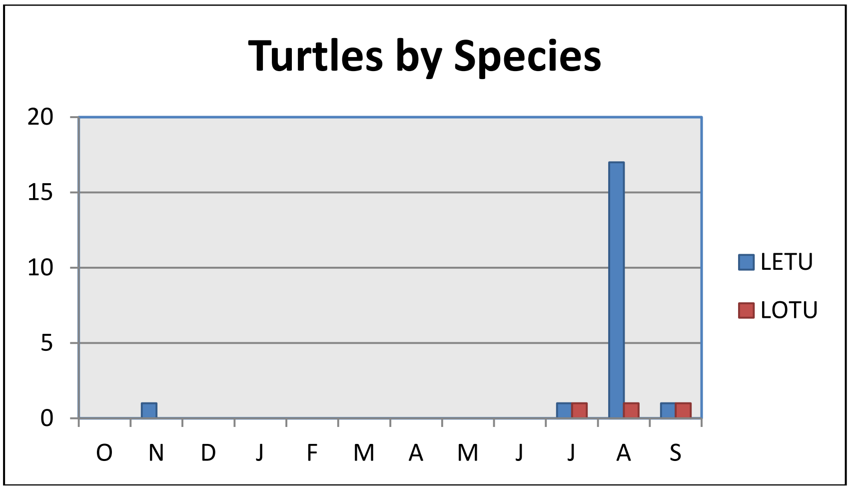


Figure 8b. Seasonality of All Sea Turtles

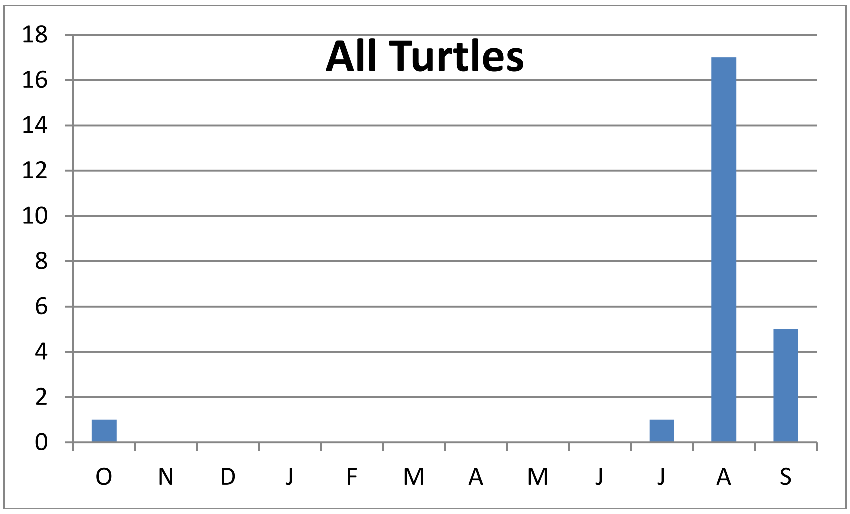


Figure 8c. Seasonality of Leatherback and Loggerhead Turtles, Years 1 and 2 Combined

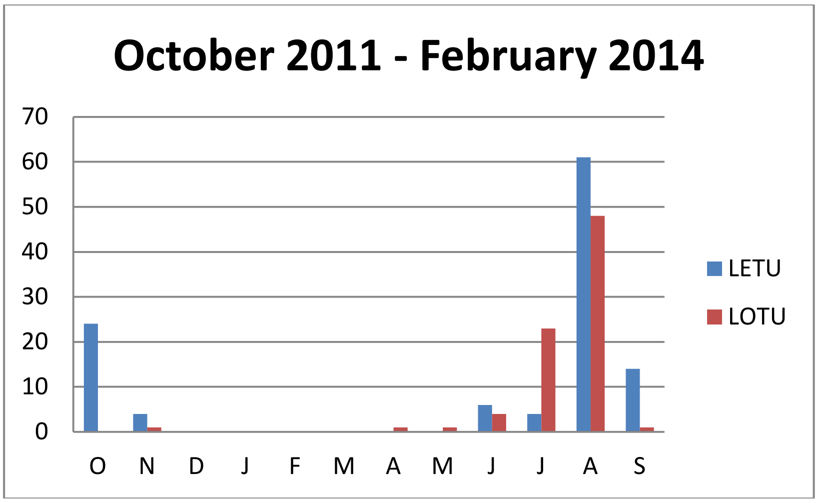


Table 5c. Delphinid and Harbor Porpoise Sightings per Survey
(Note: *Sightings* refers to the number of times a species was sighted, not the number of individuals sighted.)

Survey Name	Date	Pilot Whale	Risso's Dolphin	Bottlenose Dolphin	Common Dolphin	Atlantic White-sided Dolphin	Harbor Porpoise	Unidentified Dolphin	Total	Grand Total
NLPSC025	10/23/2012				2			11	**13**	15
NLPSC026	12/13/2012							1	**1**	1
NLPSC027	2/15/2013				2		5	6	**13**	18
NLPSC028	2/26/2013						1	8	**9**	22
NLPSC029	3/29/2013						3	2	**5**	9
NLPSC030	4/18/2013			1				3	**4**	23
NLPSC031	4/26/2013			2	3		5	10	**20**	43
NLPSC032	4/29/2013				1			3	**4**	14
NLPSC033	4/30/2013								**0**	9
NLPSC034	5/18/2013				2	2	2	12	**18**	126
NLPSC035	6/5/2013								**0**	35
NLPSC036	6/6/2013	1		1				1	**3**	9
NLPSC037	6/21/2013			2		1		5	**8**	55
NLPSC038	7/30/2013							2	**2**	20
NLPSC039	8/7/2013			1		1		12	**14**	50
NLPSC040	8/20/2013							6	**6**	61
NLPSC041	9/18/2013				1			18	**19**	53
NLPSC042	10/22/2013				2	1		15	**18**	29
NLPSC043	11/5/2013				1			14	**15**	35
NLPSC044	11/21/2013				1		1	7	**9**	14
NLPSC045	1/15/2014						3	5	**8**	13
NLPSC046	1/17/2014						1	3	**4**	6
NLPSC047	2/1/2014			2	5		1	6	**14**	20
NLPSC048	2/4/2014				2		1	1	**4**	6
Total		**1**	**0**	**9**	**22**	**5**	**23**	**151**	**211**	**686**

Figure 9b. Seasonality of Delphinids by Species

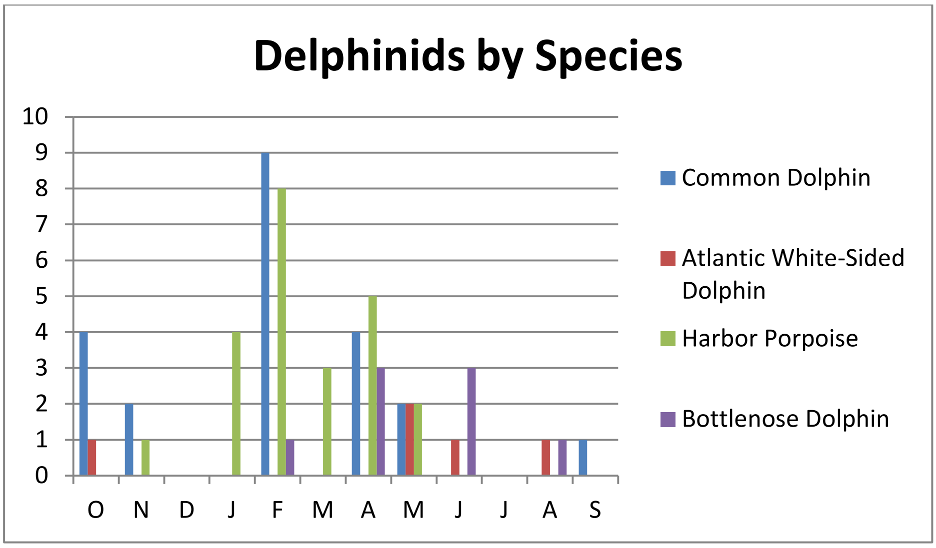


Figure 9b. Seasonality of All Delphinids

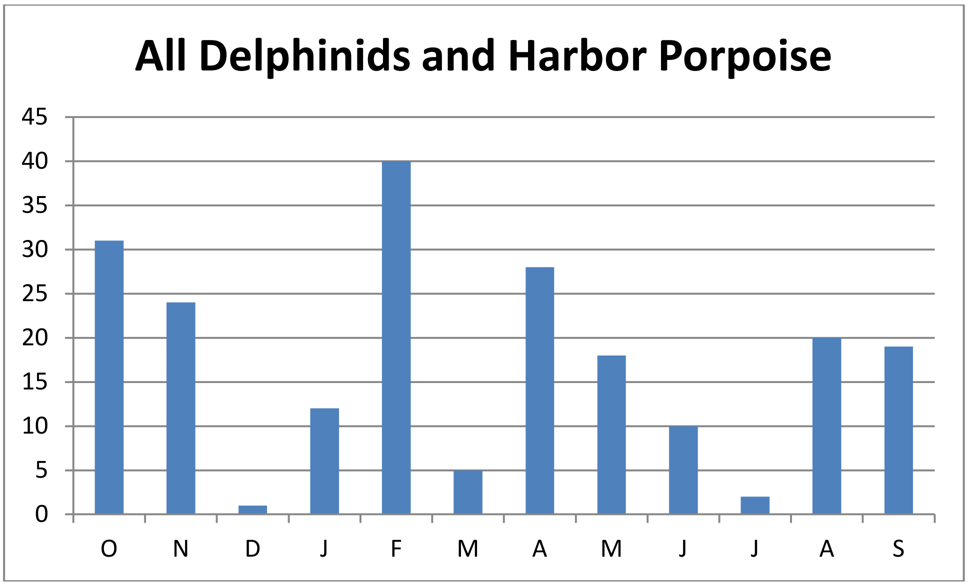


Table 5d. Seal Sightings per Survey
(Note: *Sightings* refers to the number of times a species was sighted, not the number of individuals sighted.)

Survey Name	Date	Gray Seal	Harbor Seal	Unidentified Seal	Total	Grand Total
NLPSC025	10/23/2012				**0**	15
NLPSC026	12/13/2012				**0**	1
NLPSC027	2/15/2013			1	**1**	18
NLPSC028	2/26/2013			2	**2**	22
NLPSC029	3/29/2013				**0**	9
NLPSC030	4/18/2013				**0**	23
NLPSC031	4/26/2013	3		2	**5**	43
NLPSC032	4/29/2013				**0**	14
NLPSC033	4/30/2013				**0**	9
NLPSC034	5/18/2013	1		3	**4**	126
NLPSC035	6/5/2013				**0**	35
NLPSC036	6/6/2013				**0**	9
NLPSC037	6/21/2013				**0**	55
NLPSC038	7/30/2013				**0**	20
NLPSC039	8/7/2013		1		**1**	50
NLPSC040	8/20/2013			1	**1**	61
NLPSC041	9/18/2013				**0**	53
NLPSC042	10/22/2013				**0**	29
NLPSC043	11/5/2013			2	**2**	35
NLPSC044	11/21/2013				**0**	14
NLPSC045	1/15/2014				**0**	13
NLPSC046	1/17/2014				**0**	6
NLPSC047	2/1/2014	1	4	1	**6**	20
NLPSC048	2/4/2014			1	**1**	6
	Total	**5**	**5**	**13**	**23**	**686**

Figure 10a. Seasonality of Seals by Species

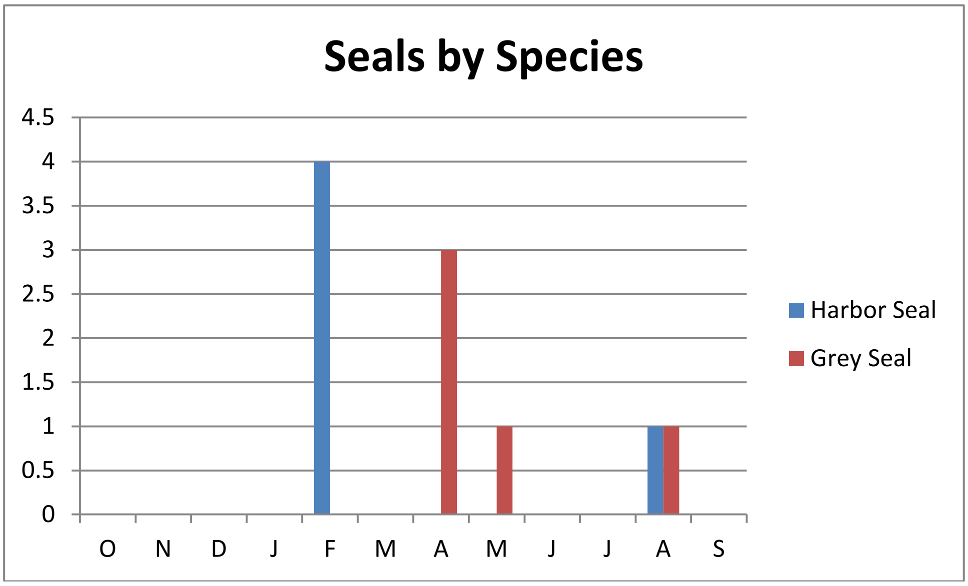
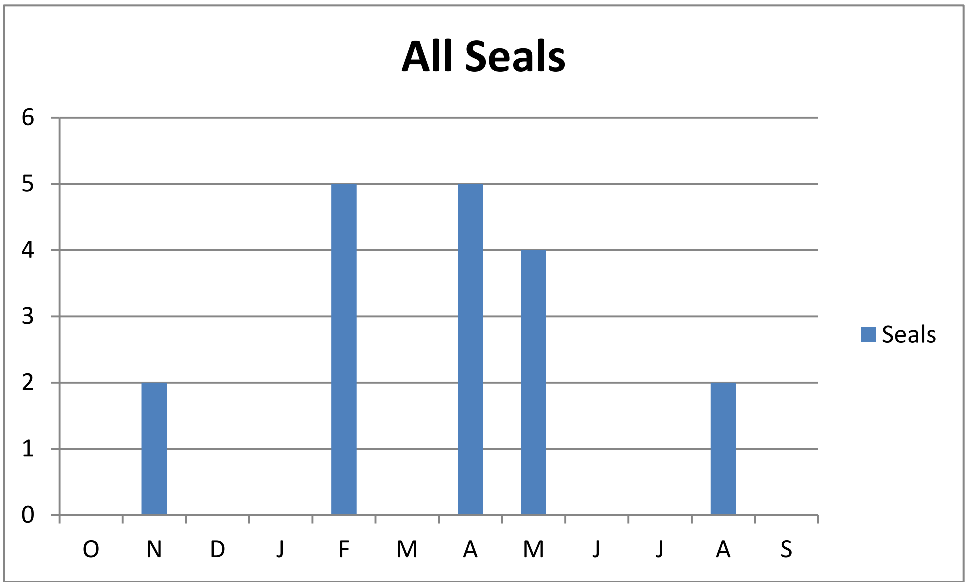


Figure 10b. Seasonality of All Seals



Shark sightings occurred primarily along transect lines as the majority of sightings were sub-surface, within 1 nm of the aircraft. In the case of both seals and fishes, all sightings occurred at less than 1 nm from the track. Seal species mapped include harbor seals, grey seals and unidentified seals. Single seals were sighted in photo analysis of several surveys. Of the eight seals sighted using this method, four were grey seals and four were unidentified. There were no direct fly-overs of seal haul-out sites, and therefore no high density areas are included in the map.

Fixed fishing gear was recorded when detected in vertical images, and also occasionally by observers in-flight. Although all vessels within 4 nm of the track were recorded, only vessels over 100 ft were mapped, excluding all smaller vessel sightings recorded in vertical images or by Observers.

Table 5e. Shark Sightings per Survey
(Note: *Sightings* refers to the number of times a species was sighted, not the number of individuals sighted.)

Survey Name	Date	Basking Shark	Blue Shark	Dusky Shark	White Shark	Spiny Dogfish	Unidentified Shark	Total	Grand Total
NLPSC025	10/23/2012				1		1	**2**	15
NLPSC026	12/13/2012							**0**	1
NLPSC027	2/15/2013						1	**1**	18
NLPSC028	2/26/2013							**0**	22
NLPSC029	3/29/2013							**0**	9
NLPSC030	4/18/2013	1						**1**	23
NLPSC031	4/26/2013							**0**	43
NLPSC032	4/29/2013						1	**1**	14
NLPSC033	4/30/2013						1	**1**	9
NLPSC034	5/18/2013	34	10	2		16	2	**64**	126
NLPSC035	6/5/2013	5	2				3	**10**	35
NLPSC036	6/6/2013	1					1	**2**	9
NLPSC037	6/21/2013	19	6				1	**26**	55
NLPSC038	7/30/2013	9		1			1	**11**	20
NLPSC039	8/7/2013	20		1			2	**23**	50
NLPSC040	8/20/2013	19	6	8	1		8	**42**	61
NLPSC041	9/18/2013	12	1	1			6	**20**	53
NLPSC042	10/22/2013	2						**2**	29
NLPSC043	11/5/2013	12						**12**	35
NLPSC044	11/21/2013	2						**2**	14
NLPSC045	1/15/2014							**0**	13
NLPSC046	1/17/2014							**0**	6
NLPSC047	2/1/2014							**0**	20
NLPSC048	2/4/2014							**0**	6
	Total	**136**	**25**	**13**	**2**	**16**	**28**	**220**	**686**

Figure 11a. Seasonality of Sharks by Species

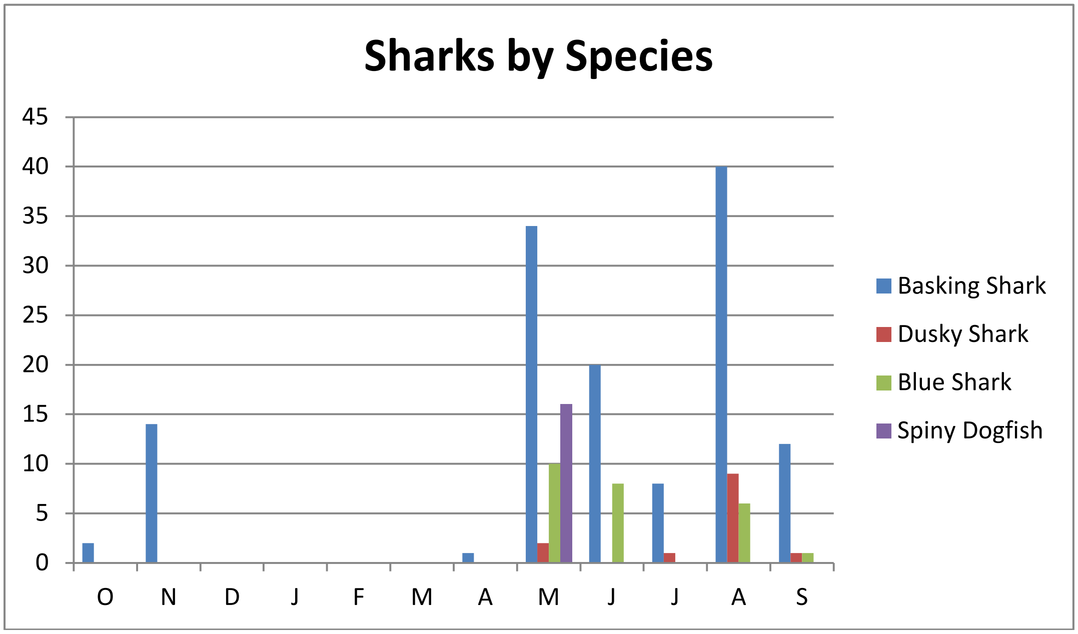


Figure 11b. Seasonality of All Sharks

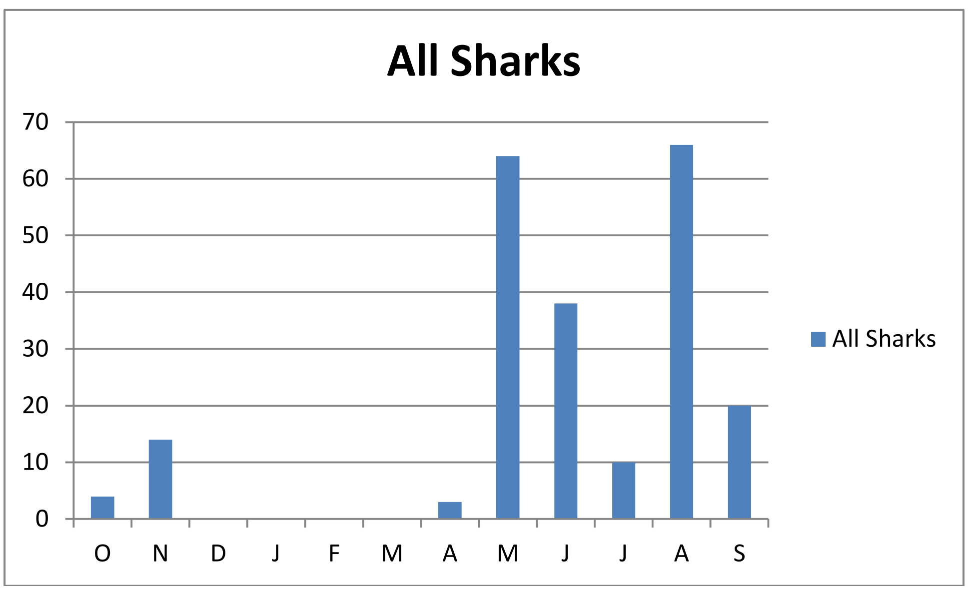


Table 5f. Fish Sightings per Survey
(Note: *Sightings* refers to the number of times a species was sighted, not the number of individuals sighted.)

Survey Name	Date	Ocean Sunfish	School of Fish	Tuna	Total	Grand Total
NLPSC025	10/23/2012				**0**	15
NLPSC026	12/13/2012				**0**	1
NLPSC027	2/15/2013				**0**	18
NLPSC028	2/26/2013	1			**1**	22
NLPSC029	3/29/2013				**0**	9
NLPSC030	4/18/2013				**0**	23
NLPSC031	4/26/2013	10			**10**	43
NLPSC032	4/29/2013	1			**1**	14
NLPSC033	4/30/2013				**0**	9
NLPSC034	5/18/2013	18	4		**22**	126
NLPSC035	6/5/2013	4	11	1	**16**	35
NLPSC036	6/6/2013	2			**2**	9
NLPSC037	6/21/2013	12	3		**15**	55
NLPSC038	7/30/2013				**0**	20
NLPSC039	8/7/2013	2	1		**3**	50
NLPSC040	8/20/2013	1	2		**3**	61
NLPSC041	9/18/2013	3	6		**9**	53
NLPSC042	10/22/2013	3	3		**6**	29
NLPSC043	11/5/2013	5	1		**6**	35
NLPSC044	11/21/2013	1	1		**2**	14
NLPSC045	1/15/2014				**0**	13
NLPSC046	1/17/2014				**0**	6
NLPSC047	2/1/2014				**0**	20
NLPSC048	2/4/2014	1			**1**	6
	Total	**64**	**32**	**1**	**97**	**686**

Figure 12a. Seasonality of Ocean Sunfish

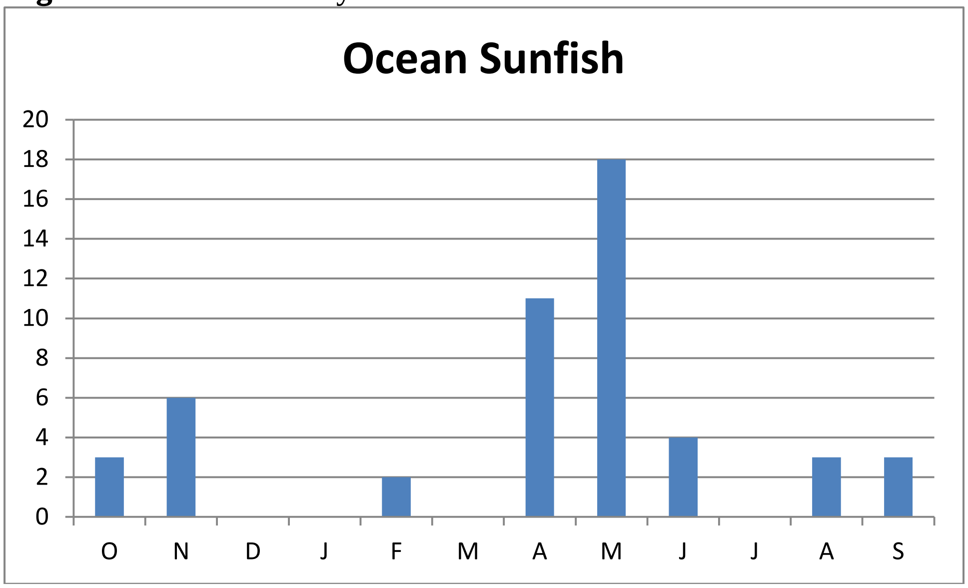


Figure 12b. Seasonality of All Fish

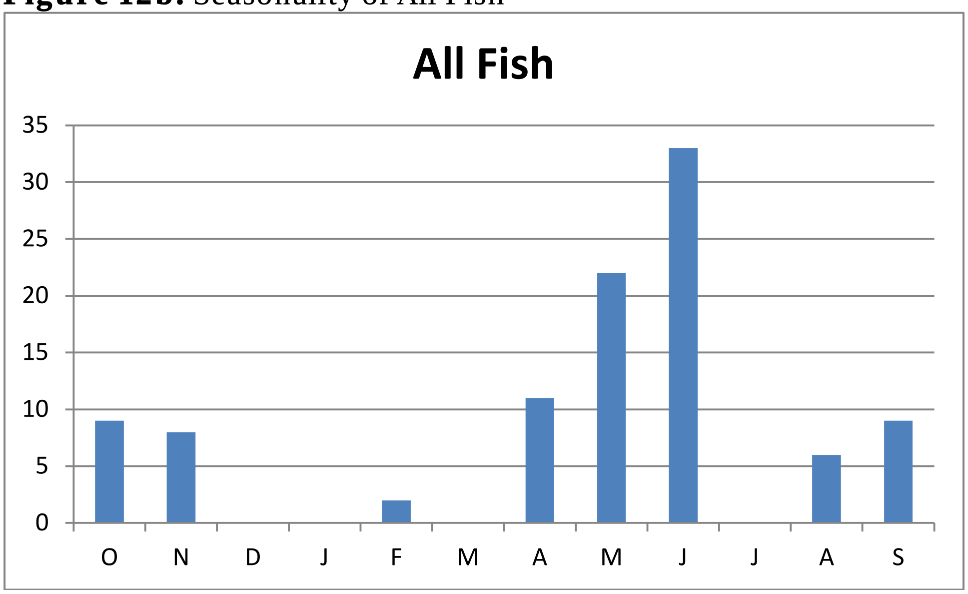


Table 5g. Year 2Fishing Gear and Vessel Sightings (Over 100 ft)

Survey Name	Date	Fixed Fishing Gear	Coast Guard Cutter	Cruise Ship	Container Ship	Tanker	Large Sailing Vessel	Total
NLPSC025	10/23/2012	1			1			**2**
NLPSC026	12/13/2012	1			1			**2**
NLPSC027	2/15/2013							**0**
NLPSC028	2/26/2013				1			**1**
NLPSC029	3/29/2013	14		1		6		**21**
NLPSC030	4/18/2013	3						**3**
NLPSC031	4/26/2013	16						**16**
NLPSC032	4/29/2013	9						**9**
NLPSC033	4/30/2013	2	1		1		1	**5**
NLPSC034	5/18/2013	24			2	5		**31**
NLPSC035	6/5/2013	28				3	1	**32**
NLPSC036	6/6/2013	11						**11**
NLPSC037	6/21/2013	9				2	1	**12**
NLPSC038	7/30/2013	1				2		**3**
NLPSC039	8/7/2013	5	1					**6**
NLPSC040	8/20/2013	1					1	**2**
NLPSC041	9/18/2013	4	1		1	2		**8**
NLPSC042	10/22/2013	23	1					**24**
NLPSC043	11/5/2013	10					1	**11**
NLPSC044	11/21/2013	28						**28**
NLPSC045	1/15/2014	1	1					**2**
NLPSC046	1/17/2014	18				4		**22**
NLPSC047	2/1/2014	1				1		**2**
NLPSC048	2/4/2014	3			1	3		**7**
	Total	**213**	**5**	**1**	**8**	**28**	**5**	**259**

Figure 13a. Year 2 Large Whale Sightings

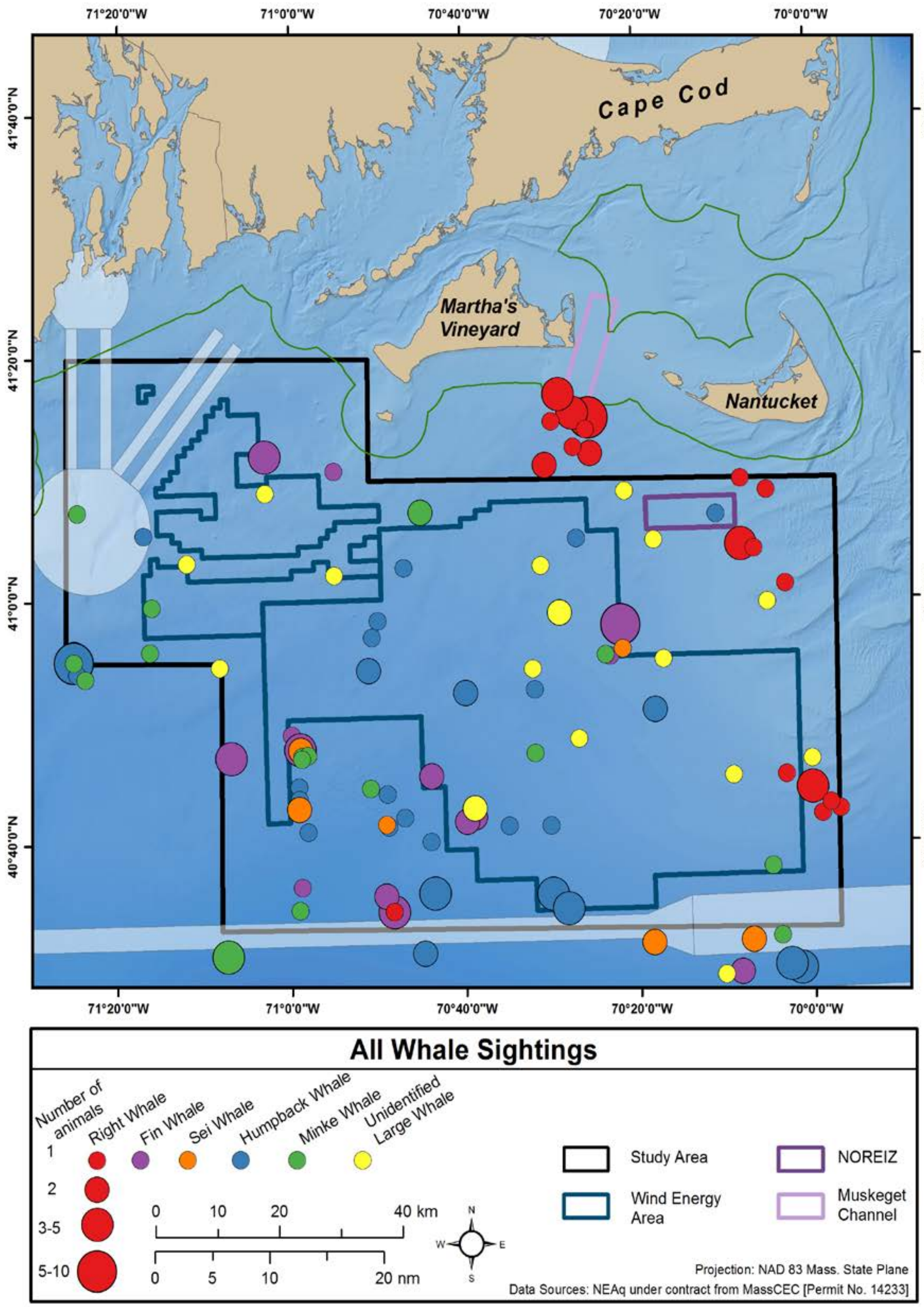


Figure 13b. Year 2 Seal Sightings

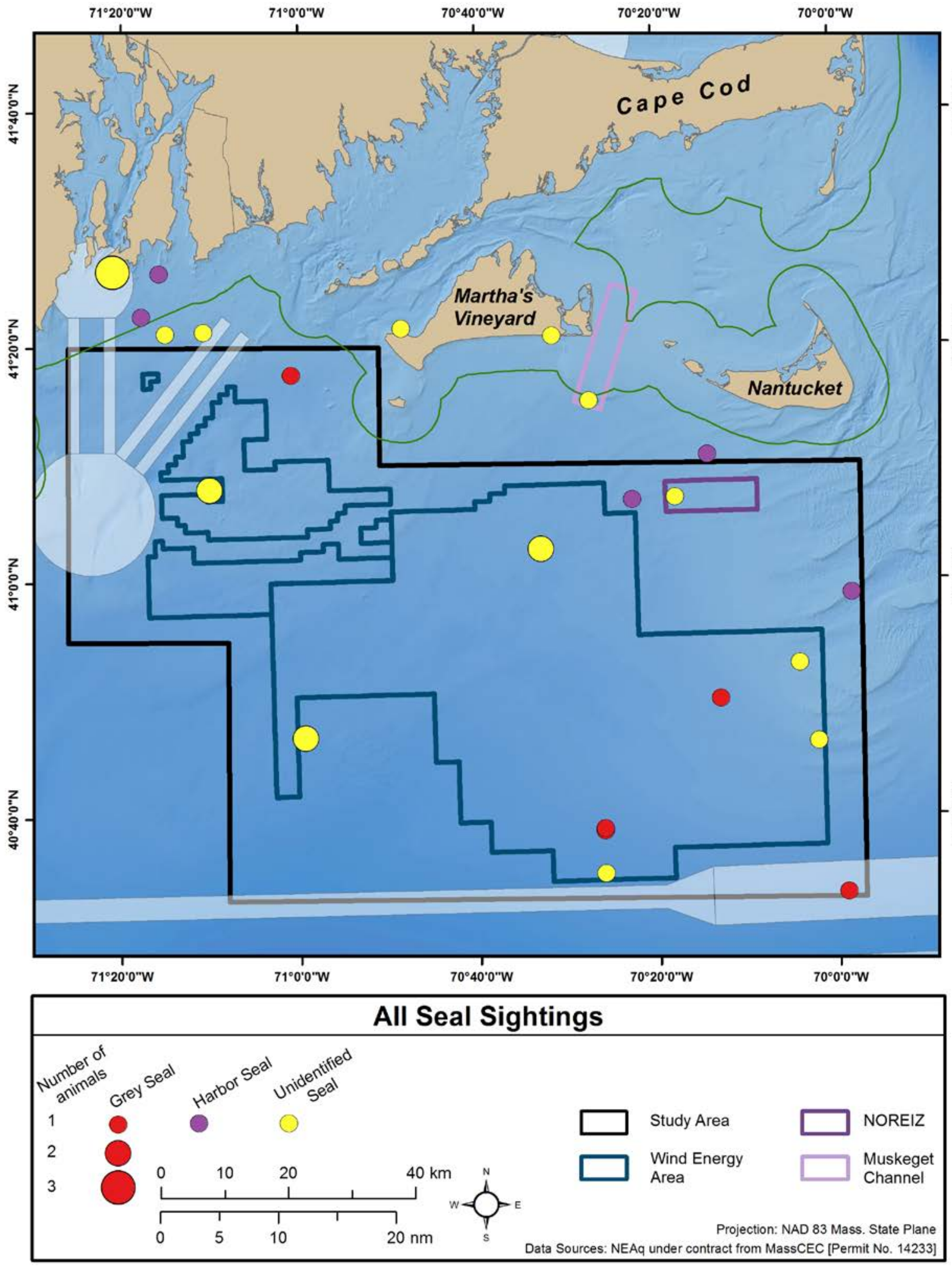


Figure 13c. Year 2 Sea Turtle Sightings

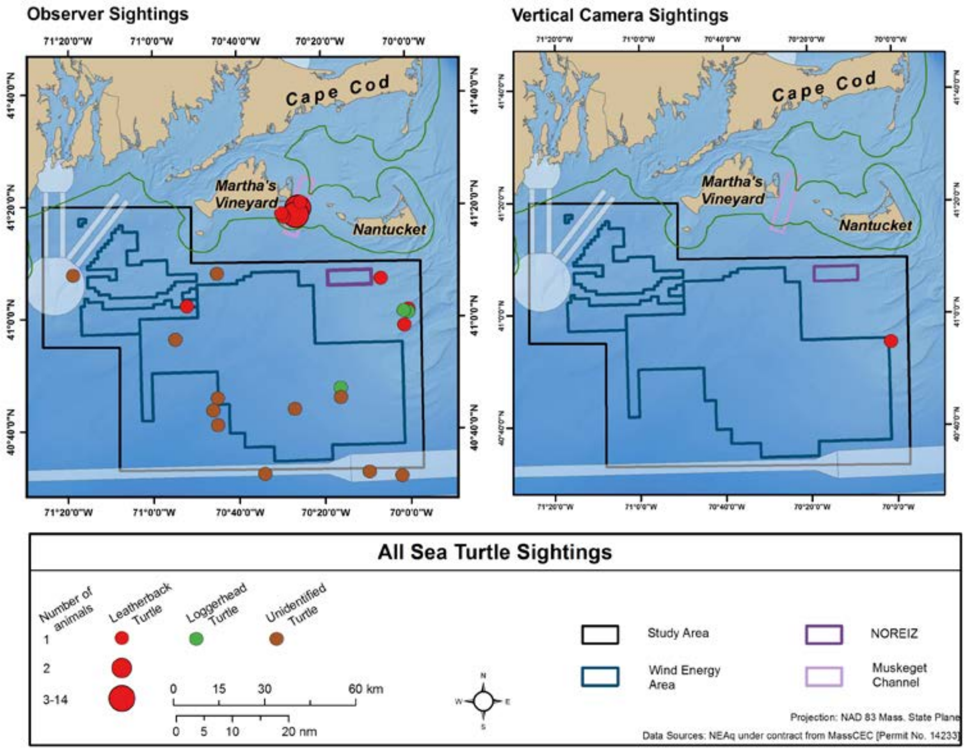


Figure 13d. Year 2 Delphinid and Harbor Porpoise Sightings

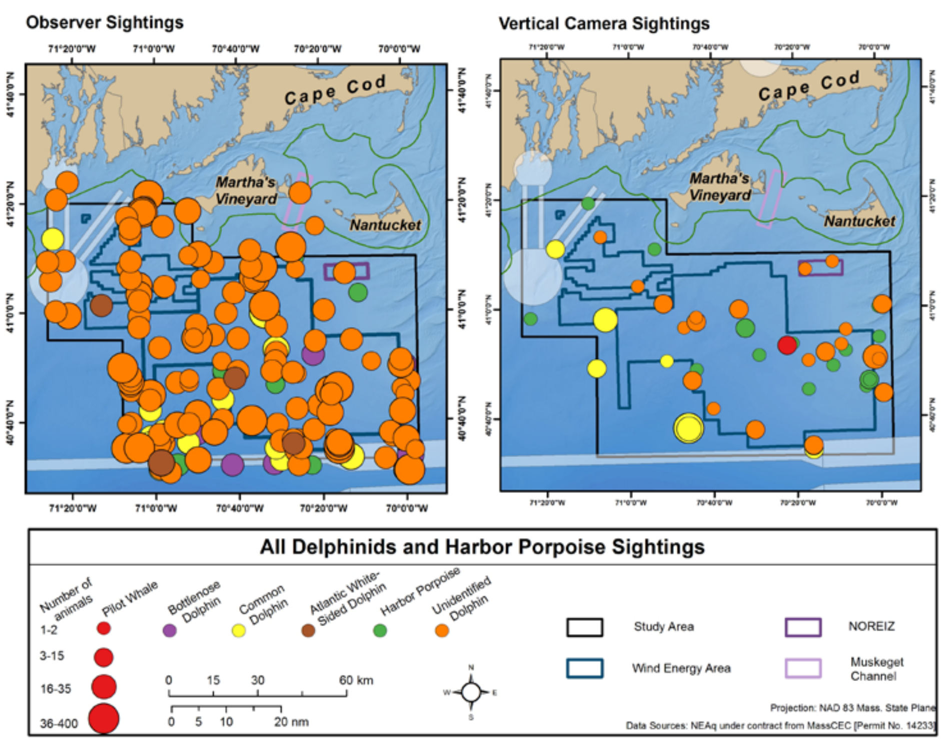


Figure 13e. Year 2 Shark Sightings

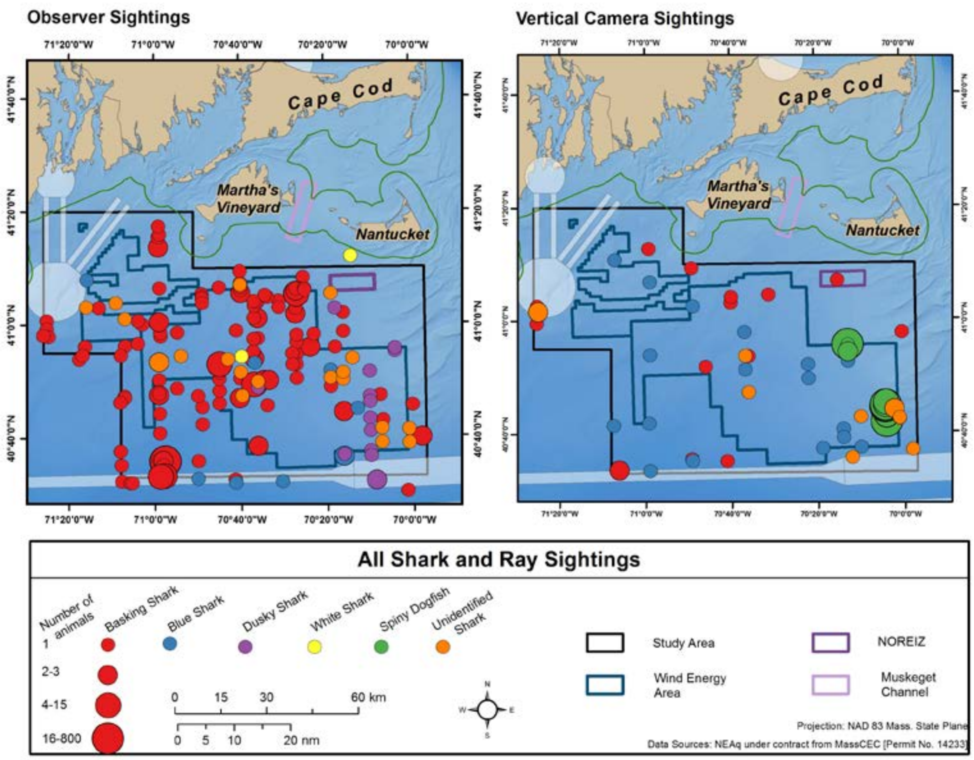


Figure 13f. Year 2 Fish Sightings

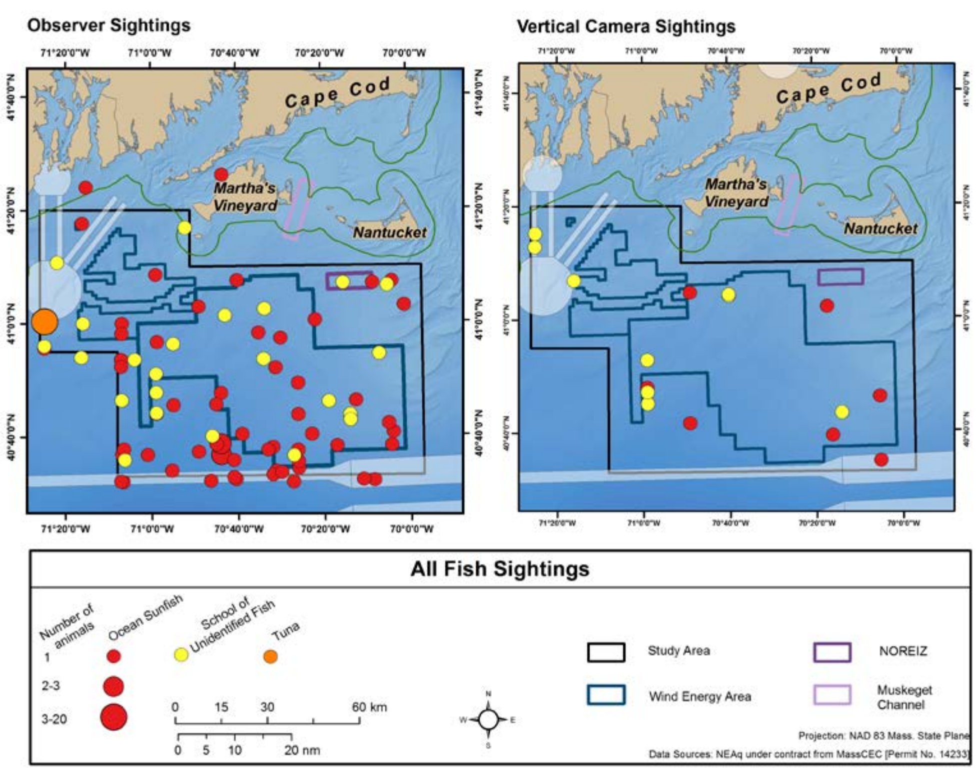


Figure 13g. Year 2 Vessels Over 100 ft

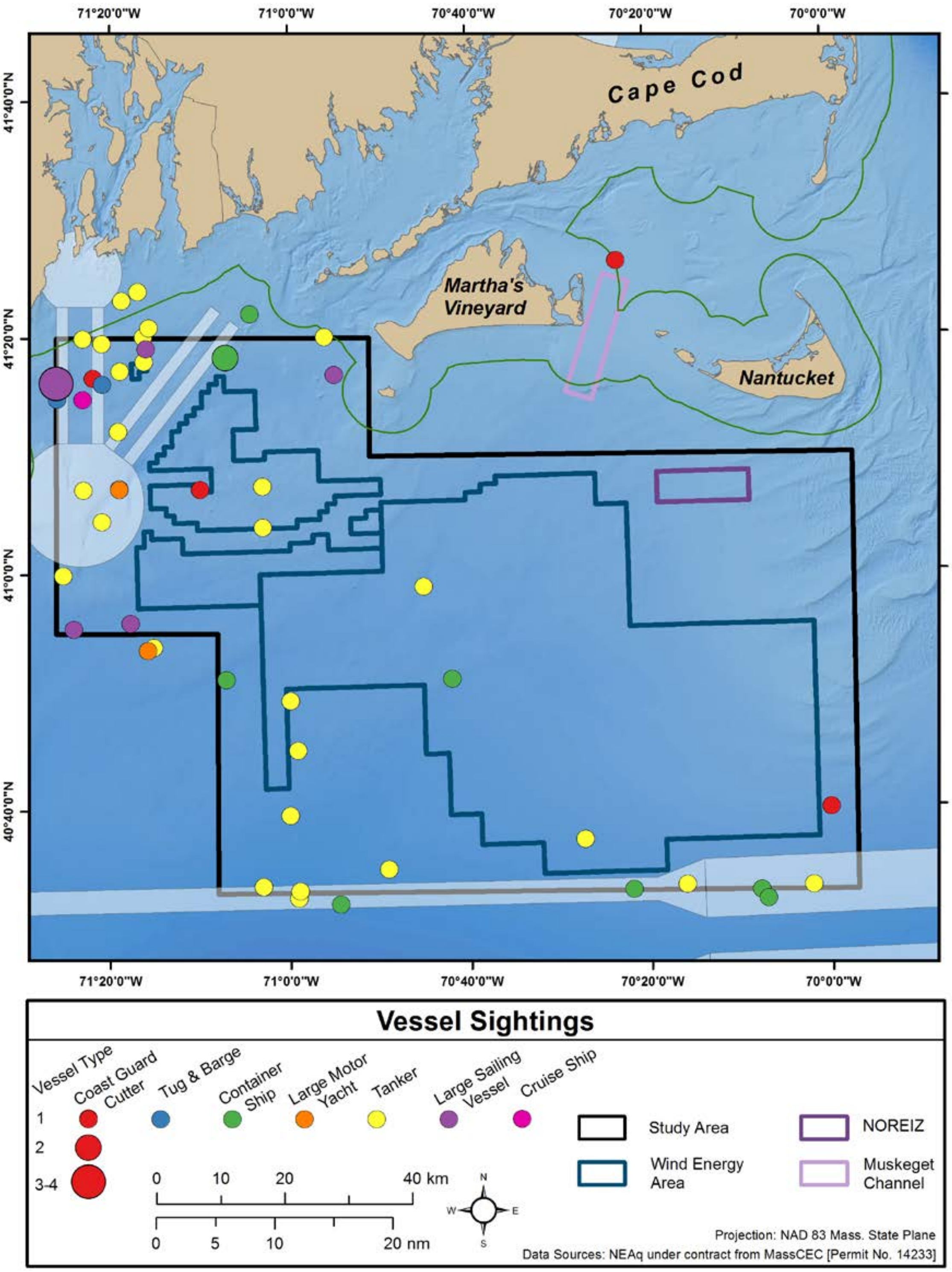
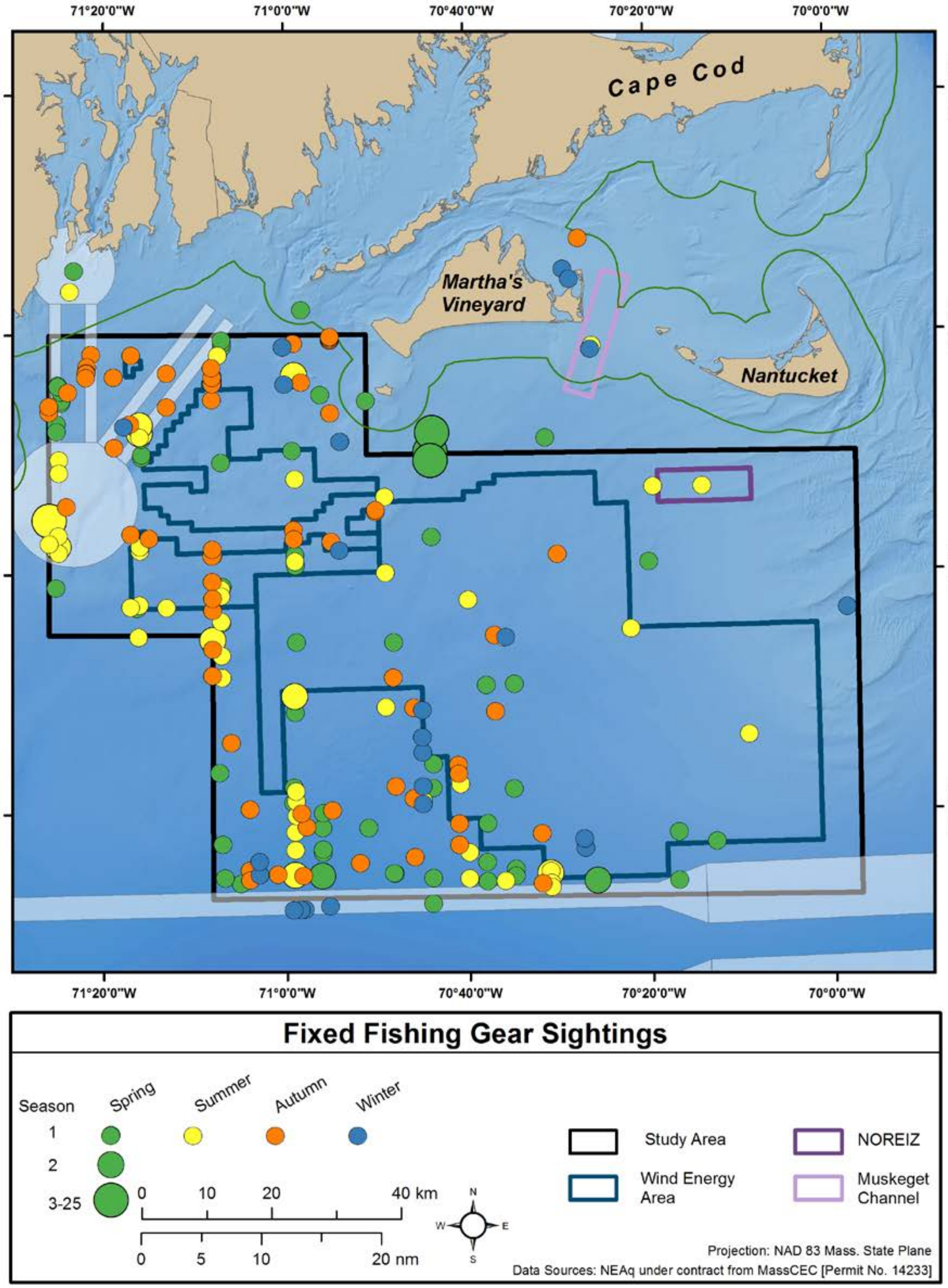


Figure 13h. Year 2 Fixed fishing gear detected in vertical images



Sightings per Unit of Effort (SPUE)

SPUE maps represent probable and definite species identification sightings, throughout the entire seventeen months of surveys, partitioned by seasons and annually. SPUE calculations were performed on all large whale species including right, humpback, fin, minke and sei whales sighted throughout Year 2 and the resultant maps are found in **Appendix 6**. Additional SPUE maps include all delphinids and harbor porpoises, leatherback turtles, loggerhead turtles, all seals, and all sharks.

Animal Density Estimation

There were an inadequate number of sightings detected in vertical photographs and by observers to estimate density for any species. We anticipate that Year 3 will provide enough sightings data to estimate effective survey strip width, and to then calculate density estimations for the more abundant species.

Sighting Distances

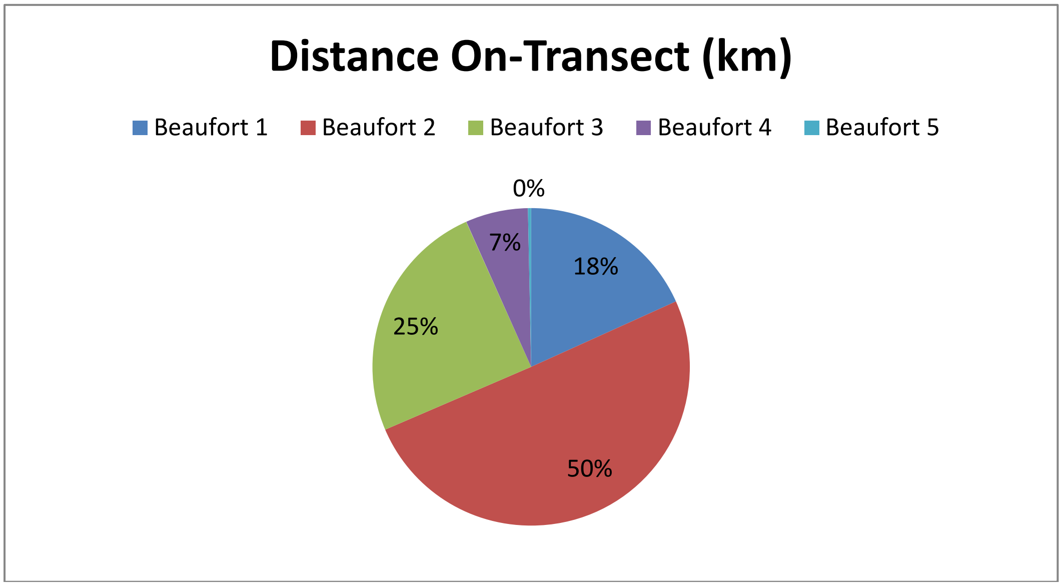
Sighting distances are shown for sightings detected in various Beaufort Sea States. For definitions of the Beaufort scale see Appendix 5, *NARWC Sightings Database Codes and Descriptions.* Only sightings made while on-transect had a distance estimated from the point of detection. All sightings with an identification reliability of 1, 2, and 3, including those in the Unidentified category, were used the Sightings Distances analyses (**Figures 15-21**).

There were three sightings in Beaufort sea state 4, one of which was a humpback whale at unknown distance from the track, and two of which were less than 1/8 nm from the track (an unidentified large whale and a harbor porpoise). On-transect km surveyed in Beaufort 4 comprised 7 % (774 km) of the total distance (**Figure 14**). There were no sightings detected in Beaufort 5, which comprised less than 1% (39 km) of the total on-transect survey (**Table 6**).

Table 6. Distance of on-transect km of Survey flown in various Beaufort Sea States

Sea State	Distance (km)	%
Beaufort 1	2217.3	18.25
Beaufort 2	6108.9	50.28
Beaufort 3	3009.5	24.77
Beaufort 4	774.0	6.37
Beaufort 5	39.4	0.33
Total	12149.1	

Figure 14. Percent of on-transect km of Survey flown in various Beaufort Sea States



There were 4 sightings comprised of 23 individuals, detected at distances greater than 1 nm from the transect line. All of these were marine mammals except one sighting of an individual basking shark (identified as possible) sighted at 1 nm. Of the remaining 3 cetacean sightings, one was a group of 20 unidentified dolphins, one was a single humpback whale, and the other an unidentified large whale. The unidentified dolphins and unidentified whale were both sighted in Beaufort Sea State 2, and the humpback whale was breaching when sighted in Beaufort 3.

Figure 15. Distances from transect line for All Sightings by Beaufort Sea States

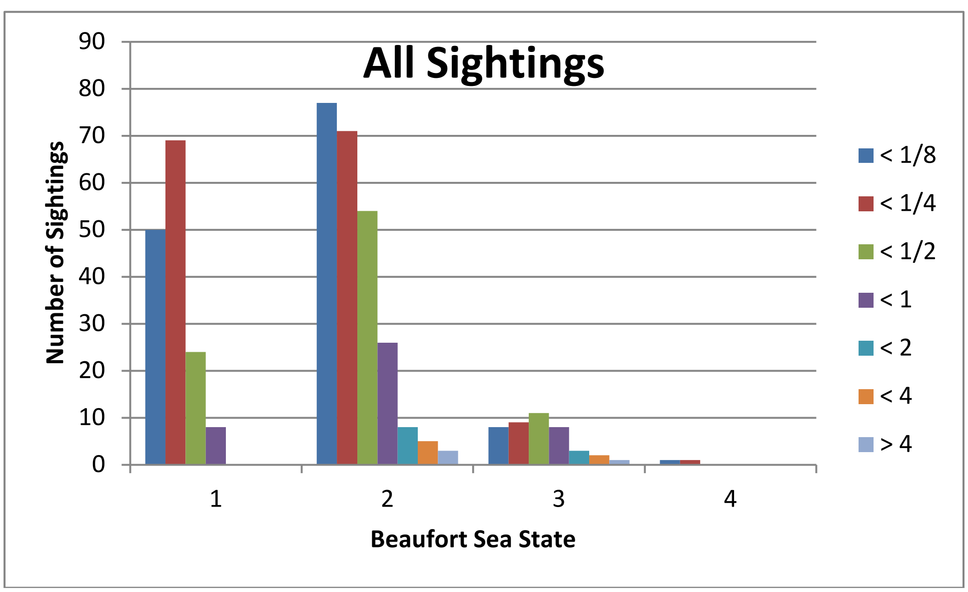


Figure 16. Sighting Distances for Large Whales by Beaufort Sea States

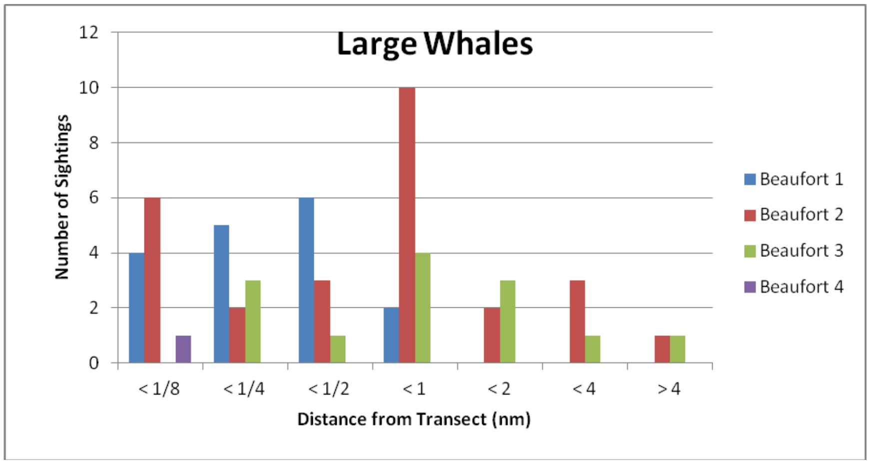


Figure 17. Sighting Distances for Sea Turtles in various Beaufort Sea States

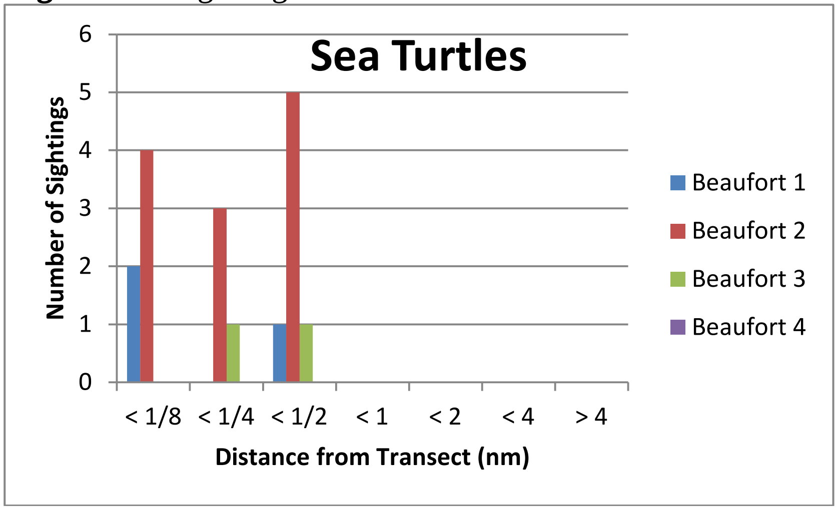


Figure 18. Sighting Distances for Dolphins and Porpoises in various Beaufort Sea States

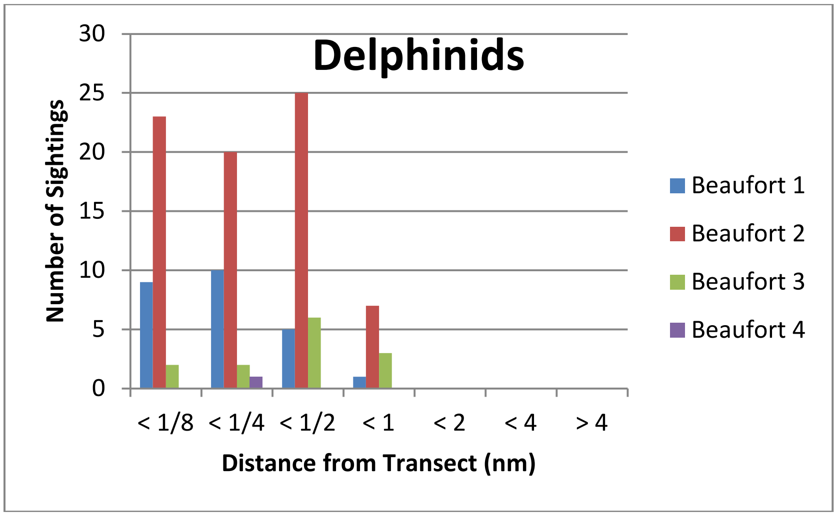


Figure 19. Sighting Distances for Sharks and Rays in various Beaufort Sea States

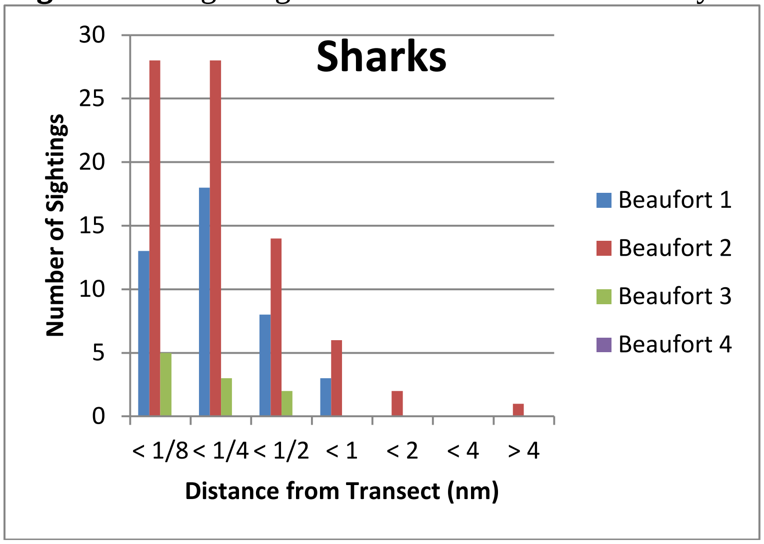


Figure 20. Sighting Distances for Fish in various Beaufort Sea States

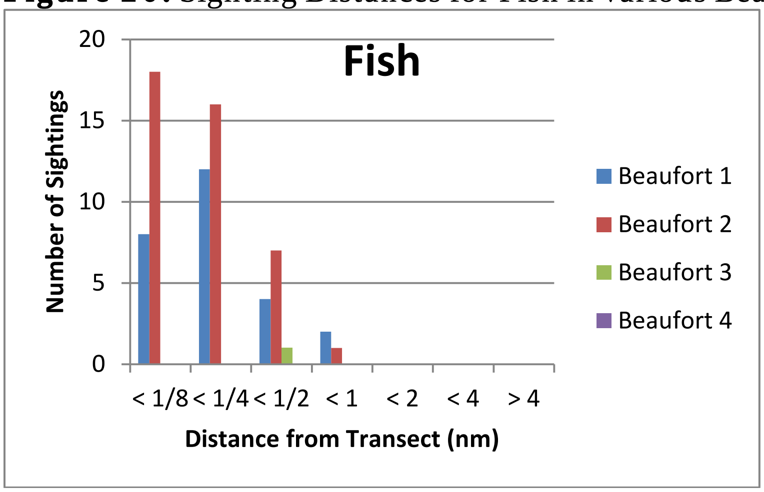
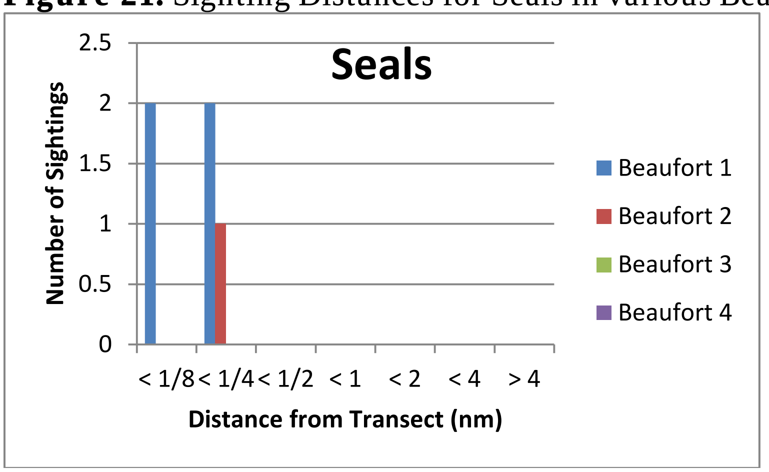


Figure 21. Sighting Distances for Seals in various Beaufort Sea States

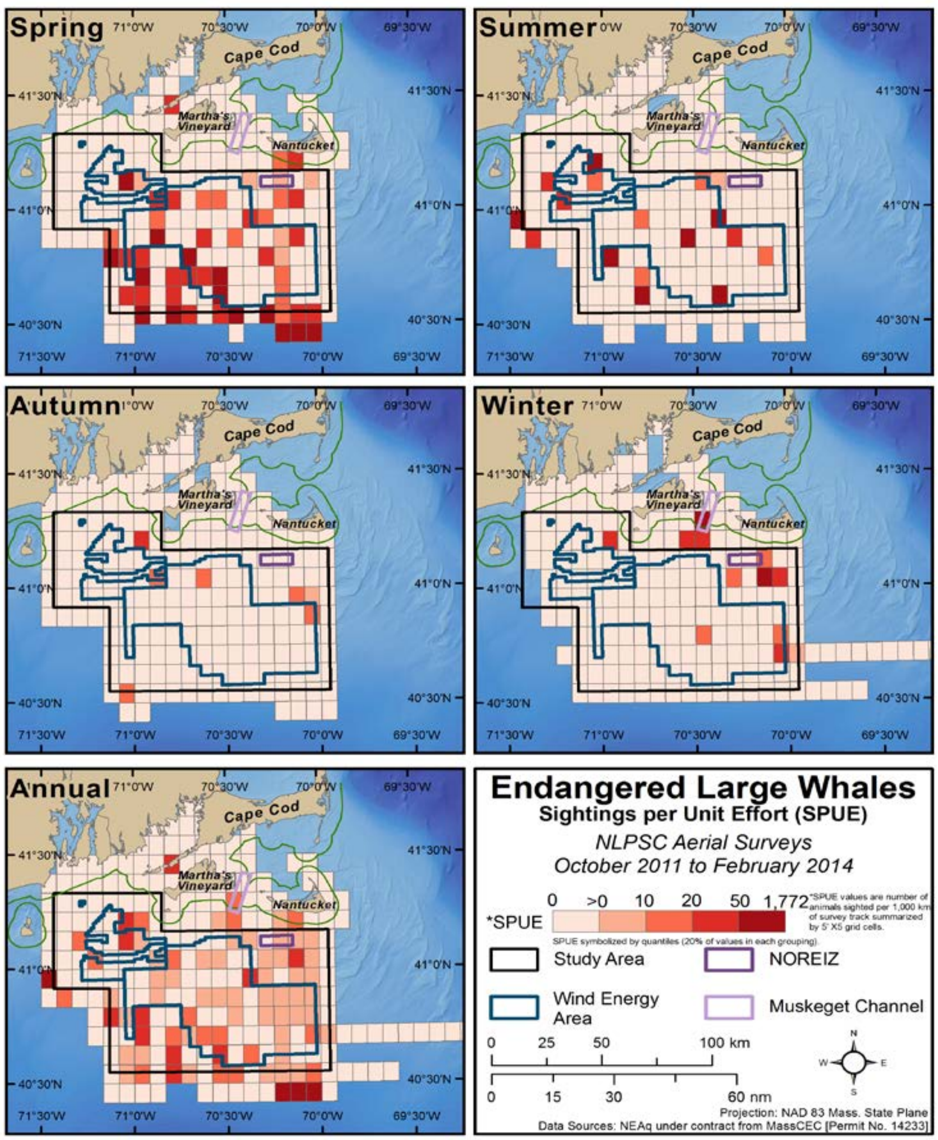


Sightings per Unit of Effort (SPUE)

To correct marine animal distribution maps for effort bias, the number of sightings per 5 minute square were divided by the transect lines within that square, and were partitioned by seasons and annually. SPUE calculations were performed on all species that had more than 10 sightings and are provided in **Appendix 6**.

An additional comprehensive SPUE map was created for all large whale sightings between October 2011 and February 2014 (Figure 22). The compiled data from Year and Year 2 show a higher occurrence of large whales during the spring months than during any other time of year, and widespread distribution throughout the Study Area.

Figure 22. SPUE maps for Endangered Large Whales 2011-2014



Coefficient of Variation in Species Abundance between Years 1 and 2

In order to detect variation between Year 1 and Year 2 of surveys, the numbers of on-track sightings were compared. These numbers were corrected for effort by dividing by the total survey track line mileage flown. Sightings in the comparable areas: the Massachusetts WEA (MA Stratum) and the areas of interest (Muskeget Channel and NOREIZ[1]) were used in this comparison (**Table 7**). Sightings from the Rhode Island WEA (RIMA) were excluded where surveys were conducted only during Year 2. The coefficient of variation (CV) is the ratio of the standard deviation and mean, and is the measure of variability of the data. After normalizing for effort, when the CV is higher, it means that the data has high variability between years. In this case, finback, humpback, and loggerhead turtles show very high levels of variability. Minke and right whales show much lower variability between the Year 1 and Year 2. The remaining species show high levels of variability, but because the absolute numbers are so small, these measures cannot be considered statistically meaningful. Three years of data collection will provide a more robust estimate of inter-annual variability for all species.

Table 7. Coefficient of Variation Between Years 1 and 2 for Cetaceans and Sea Turtles.

	FIWH	HUWH	LETU	LOTU	MIWH	RITU	RIWH	SEWH	SPWH
Number of Sighted Individuals Year 1	9	6	60	65	7	4	22	1	6
Normalized for Effort and Location	0.0013	0.0008	0.0085	0.0092	0.0010	0.0006	0.0031	0.0001	0.0008
Number of Sighted Individuals Year 2	26	28	23	3	5	0	13	6	0
Normalized for Effort and Location	0.0049	0.0053	0.0043	0.0006	0.0009	0.0000	0.0025	0.0011	0.0000
Significant Difference	0.0026	0.0031	0.0029	0.0061	0.0000	0.0004	0.0005	0.0007	0.0006
Coefficient of Variation	83.07	102.22	45.83	125.04	3.53	141.42	16.86	109.96	141.42

Right Whale Sightings

A total of thirty-six right whales were sighted during Year 2. Twenty-nine of these Thirty-six whales were photographed between February 15 – April 18 of 2013, and on January 15 of 2014 (**Table 8**). Of the twenty-nine whales photographed, twenty have been matched to a known individual (seventeen confirmed), while two whales have been confirmed as unmatchable, and seven whales have not yet been matched. Of the twenty matched; 55% were males (n=11), 30% females (n=6), and 15% of unknown sex (n=3). Of these twenty right whales, 65% were adults (n=13), and 35% were juveniles (n=7). Of the six known females, five were reproductive (EGNO 2503, 1608, 1611, 2605, 3101) and had produced three, two, three, two, and one calves respectively. Birth year was known for fourteen of the twenty whales matched. The two eldest (birth year unknown) were at least thirty-seven (male EGNO 1146) and at least forty (male EGNO 1320), and the youngest were both four year old juveniles (EGNO 3923 and 3999) of unknown sex (**Table 9**).

At the time of writing, eleven of the seventeen matched and confirmed whales had confirmed sightings in other habitats in 2013. None of these whales had confirmed sightings in the southeastern US and three of these whales had no confirmed sightings in other locations during the previous year (2012). The other areas where these whales were sighted in 2013 include Cape Cod Bay (CCB), Massachusetts Bay (MB) and Roseway Basin (RB). Of the eleven whales that were sighted in other habitats, nine were seen in CCB and MB and two in RB. Of these nine individual whales, five were seen in CCB between two weeks and two months after they were sighted in the Study Area, and four of them were sighted in CCB between one and eleven months prior to their visit to the Study Area. The closest sighting record to the date seen by the NLPSC team was of EGNO 3101, who was documented twenty one days prior in Cape Cod Bay. The longest stretch between the NLPSC team sightings was of EGNO 1611 which was sighted nearly two years earlier in the Gulf of Maine. Two of the individuals seen during the second year of surveys were repeat visitors to the Study Area, and also sighted by NLPSC observers in 2012. They were EGNO 2605 "Smoke (April 2012) and EGNO 1804 "Katz" (March 2012).

In terms of behavior, eleven of the thirty-six individuals sighted were involved in surface active groups (SAG), and four of these individuals were sighted or photographed making belly to belly contact. Only one individual was sighted skim feeding at the surface, and this was in close proximity to a humpback whale.

Additional right whales were discovered in photographs during DIGITS photo processing which increased the number of individual right whales detected from thirty-four to thirty-six. There were single additional individuals detected on both February 26, 2013 and January 2014.

Table 8: Sighting Information of Right Whales Sighted by the NLPSC Aerial Team

Sighting Number	EG #	Date	Time	Letter	Latitude	Longitude	Behaviors
1	2503*	2/15/2013	1448	A	40.7593	-70.0502	MOTIONLESS BELOW SURFACE
2		2/15/2013	1540	B	41.0213	-70.0477	
3	3890*	2/15/2013	1617	C	41.2517	-70.4243	SAG
	1611	2/15/2013	1617	D	41.2517	-70.4243	SAG
		2/15/2013	1617	E	41.2517	-70.4243	SAG
		2/15/2013	1617	F	41.2517	-70.4243	SAG
		2/15/2013	1617	G	41.2517	-70.4243	SAG
		2/15/2013	1617	H	41.2517	-70.4243	
4	3999*	2/26/2013	1111	A	41.2582	-70.4557	
	3742*	2/26/2013	1111	B	41.2582	-70.4557	
		2/26/2013	1111	C	41.2582	-70.4557	
		2/26/2013	1111	D	41.2582	-70.4557	
5	3923*	2/26/2013	1128	E	41.2842	-70.4827	SAG
	3101*	2/26/2013	1128	F	41.2842	-70.4827	SAG, BELLY TO BELLY
		2/26/2013	1128	G	41.2842	-70.4827	SAG, BELLY UP
		2/26/2013	1128	H	41.2842	-70.4827	SAG
6		2/26/2013	1130	I	41.2353	-70.4302	
7	2605*	2/26/2013	1241	J	41.0762	-70.1335	SAG, BELLY TO BELLY
	1239*	2/26/2013	1241	K	41.0762	-70.1335	SAG
	3714*	2/26/2013	1241	L	41.0762	-70.1335	SAG
8	3190*	2/26/2013	1241	M	41.0697	-70.1078	SAG, BELLY TO BELLY
		2/26/2013	1252	#1	41.0788	-70.1256	
9	1608*	2/26/2013	1308	N	41.1663	-70.1322	
10	3832*	2/26/2013	1321	O	41.2027	-70.4215	
	2310*	2/26/2013	1321	P	41.2027	-70.4215	
11		2/26/2013	1359	Q	41.2113	-70.4540	
12		2/26/2013	1338	R	41.2467	-70.4960	
13	3550*	2/26/2013	1555	S	41.1867	-70.5090	
	1611*	2/26/2013	1555	T	41.1867	-70.5090	
14	1174*	3/29/2013	1555	A	41.1498	-70.0822	
15	1331*	4/18/2013	1555	A	40.5758	-70.8043	SKIM FEED W/ HUWH
16	1146	1/15/2014	1418	A	40.7418	-70.0007	
	1804	1/15/2014	1418	B	40.7418	-70.0007	
		1/15/2014	1418	C	40.7418	-70.0007	
17	1320	1/15/2014	1418	D	40.7053	-69.9822	
18		1/15/2014	1425	E	40.7113	-69.9478	
19		1/15/2014	1427	F	40.7202	-69.9657	

* Confirmed

Table 9: Preliminary Identifications and Demographic data on Right Whales Sighted by the NLPSC Aerial Team

EG #	Name	Sex	Calving Female	Age	Born	Age Class
1146	Van Halen	M	N	37+	U	A
1174*		M	N	A	U	A
1239*		M	N	32	1981	A
1320	Mohawk	M	N	40+	U	A
1331*		M	N	U	U	A
1608*	Morse	F	Y	27	1986	C
1611*	Clover	F	Y	27	1986	C
1804	Katz	M	N	26	1988	A
2310*		M	N	U	U	A
2503*	Boomerang	F	Y	18	1995	C
2605*	Smoke	F	Y	17	1996	C
3101*	Harmonia	F	Y	12	2001	C
3190*	Panama	M	N	A	U	A
3550*		U	N	8	2005	J
3714*	Sawtooth	M	N	6	2007	J
3742*		M	N	6	2007	J
3832*		M	N	5	2008	J
3890*		F	N	5	2008	J
3923*		U	N	4	2009	J
3999*		U	N	4	2009	J

* Confirmed

DISCUSSION

The existing agreement between MA CEC and EEA and the Bureau of Ocean Energy Management was extended in December 2012, allowing for completion of a second year of surveys (Year 2). The agreement also expanded the area surveyed to include the adjacent Rhode Island Massachusetts Wind Energy Area (RIMA). The addition of the RIMA offshore of Rhode Island to the existing MAWEA (both areas together with the additional areas covered by track lines are hereby referred to as the “Study Area”) resulted in a seventy nautical mile extension of survey track lines. Seventeen months of survey work was conducted under the extended agreement between October 2012 and February 2014. This additional survey effort provided another year of information about spatial and temporal patterns of marine fauna occurrence in the Study Area. During this Year 2 survey period, the NLPSC doubled its aerial survey effort to date and built upon an existing data set from an initial year of surveys (Year 1) conducted in the Massachusetts WEA between October of 2011 and September of 2012, and began systematic data collection in the extended RIMA portion of the Study Area.

For consistency, the NPLSC aerial survey methodology was repeated in Year 2. It represents an enhancement over standard line transect survey methods by adding automated vertical photography system to protect the un-observed trackline, and to collect data on small subsurface species. To supplement the aerial survey data, passive acoustic monitoring was also conducted during Year 2, and is covered under Section 3.

The aerial surveys recorded right, humpback, finback, minke, and sei whales. Large whales in the Study Area were observed exhibiting a wide range of behaviors including feeding and socializing. These large whale sightings occurred primarily in the period from January through July. North Atlantic right whales accounted for all of the large whale sightings during the months of January and February, while the highest numbers of all other large whales, which include humpback, minke, sei, and fin whales, were detected during May and June. When large whale sightings from the start of surveys in October 2011 through February 2014 are compiled and viewed collectively, it appears that the heaviest presence occurs during the spring months and that distribution is widespread and highly variable. The peak presence of the four most frequently detected large whales (right, humpback, minke, and fin) was observed to be between the months of January and June.

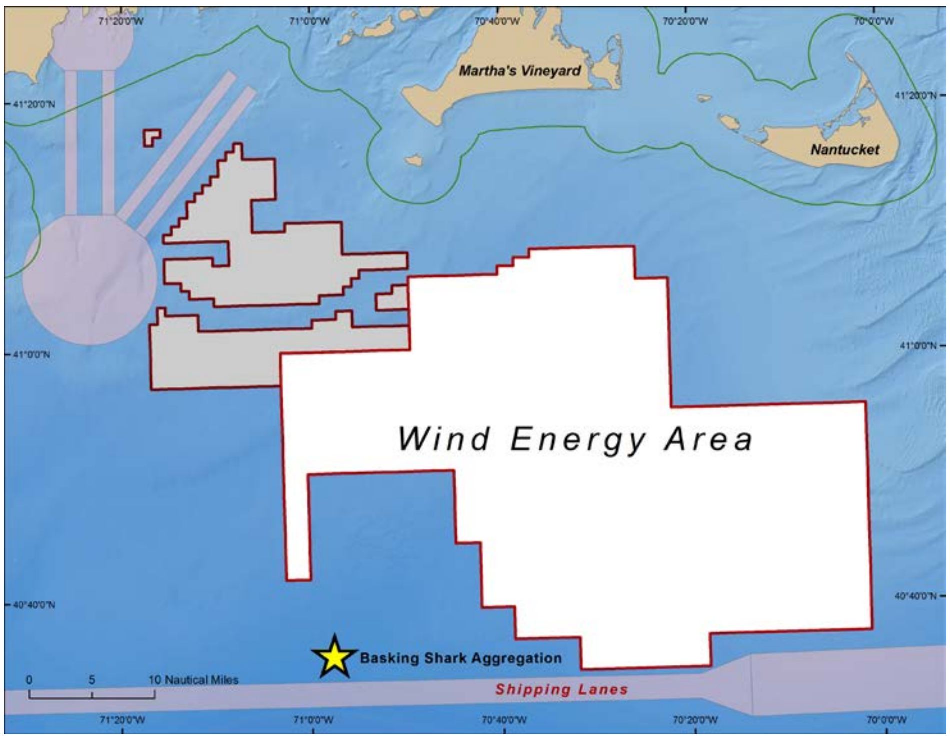
Thirty-six right whales were observed during Year 2, twenty of which have been identified. Twenty-five percent of the whales identified were known reproductive females. Whales were observed feeding, traveling, and taking part in surface active groups. During these surface active groups, belly to belly contact and rolling were observed (behaviors known to be associated with mating). A total of nine of the identified whales had been observed in the same year in Cape Cod Bay (CCB). Five of the nine whales were seen in CCB between two weeks and two months after they were sighted in the Study Area, and four had been sighted prior to arriving in the Study Area. None of these whales had confirmed sightings in the same year in the calving ground in the southeast US at the time of this writing. Compared to Year 1, there were far fewer sightings in the spring and more sightings in the winter during Year 2. No right whale mother and calf pairs were observed.

The surveys also recorded leatherback, and loggerhead sea turtles. The low number of sightings of both of these species was in stark contrast to the high numbers sighted by observers during Year 1. Also of note was the absence of Kemp's Ridley turtles in Year 2 of surveys. Though sea turtle sightings throughout the survey period were sparse, most occurred in the late summer, primarily in August. Both leatherback and loggerheads were primarily recorded in the northeast corner of the Study Area near Nantucket Shoals. When compiled sightings of sea turtles are viewed collectively from October 2011 to 2014, peak presence occurred between the months of July and October. These findings are consistent with those of tagged leatherback turtles which were recorded leaving the Northwest Atlantic Shelves between October and November, and one individual leatherback returning as early as May (Dodge 2014).

Delphinoids were observed throughout the seasons and the Study Area. Most individuals could not be identified to species and were recorded as Unidentified Dolphins. The largest groups of delphinoids were seen in autumn, as well as during the summer months. Fewer delphinoid sightings occurred during the spring and summer then during the previous year of surveys, suggesting that their seasonal presence may be variably from year to year.

An extremely unusual and massive aggregation of basking sharks was observed in November of 2013 in the southwestern corner of the Study Area (**Figure 23**). This sighting event was comprised of upwards of a thousand individuals participating in a closed-mouth, close-following and circular swimming behavior known as cartwheeling (Wilson 2004), that is usually associated with mating in sharks. This suggests that the area may be of particular importance to the species for social or migratory purposes, as the behaviors observed are not thought to be associated with feeding (Sims et al., 2000).

Figure 23. Location of Basking Shark Aggregation



Sightings per unit of effort (SPUE) analyses and density estimation are appropriate methods for assessing distribution and abundance of target species within the surveyed area. In this case, SPUE analyses are provided (**Appendix 6**), but should not be viewed as definitive, partly because a single year of surveys represents a snapshot, not an average, and we cannot assign any confidence to those distribution patterns.

There were an inadequate number of sightings to estimate density for any species. Despite a low sightings yield during Year 2, data from the Year 1 showed that the difference between mean photographic density estimates and visual density estimates were statistically significant for three species, including endangered loggerhead turtles (Taylor et al., 2014). Since sightings data for small, subsurface species were higher from the vertical photography data-stream, the use of this method increases the ability to estimate densities of species of interest that are difficult for observers to detect. We anticipate that three years of surveys will provide us with enough compiled sightings data to estimate densities for some species of sea turtles. Three years of observer sightings data may also provide us with enough compiled data to estimate effective survey strip width, and to then calculate density estimations for the most abundant of the large whales, though confidence intervals for these estimations may prove wide.

Though the two years of survey have not yet provided adequate abundance estimates for any cetaceans, they are beginning to provide an overview of the seasonality of occurrence in the MA WEA for many species. The SPUE data, where consistent between years, is developing an outline of the seasonal and spatial patterns of distribution for some species, recognizing our somewhat low statistical power to date. The ongoing third year of effort should further strengthen the existing baseline assessment by adding additional sightings data for most species, which should make statistical treatments of abundance, distribution and seasonality much more robust than is currently possible.

ACKNOWLEDGEMENTS

This work would not be possible without the support of the Massachusetts Clean Energy Center (MA CEC) and the Bureau of Ocean Energy Management. We thank Tyler Studds and Nils Bolgen of MA CEC for advice and support under this contract. We are grateful to our tireless observers and photo-analysts, Orla O'Brien and Leah Crowe. Thanks to our aircraft vendor Assist Aviation Solutions LLC, including Rick Bartle (Operations Manager), Aidan Wilps (Aircraft Maintenance Manager), project pilots Dan Fields, Don Turner, Keith Lapierre, Raymond Sevard, Richard Euler, and Scott Patten. Additionally, we thank New England Aquarium right whale data analyst Monica Zani for her assistance with processing North Atlantic right whale photographs and data. The NLPSC also thanks Captain Mark Leach of the F/V Sea Holly of Harwichport, MA, for overseeing the MARU deployment and retrieval cruises.

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Bioacoustics Research Program
Technical Report 14-05

Section 2: Passive Acoustic Monitoring for Marine Mammals in the Massachusetts and Rhode Island Wind Energy Areas

November 2011 – February 2014

Final Report
22 August 2014

Prepared for:

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Table of Contents

1 Background and Objectives

In August of 2011, the Massachusetts Clean Energy Center (MassCEC) and the Executive Office of Energy and Environmental Affairs (EEA) established an agreement for conducting field surveys of marine life in the Massachusetts Wind Energy Area (MA WEA). Shortly thereafter, the Bioacoustics Research Program (BRP) was contracted to conduct acoustic surveys in the MA WEA to document the acoustic occurrence of marine mammal species. The first year of recordings (hereafter referred to as Year 1) occurred from November 2011 through October 2012. The results from the first survey were compiled and presented in a final report in May 2013 (Tielens, J.T., B.J. Estabrook, A. Rahaman, C.W. Clark, A.N. Rice 2013). Upon completion of Year 1, BRP was contracted to continue collecting acoustic information for a second year (hereafter referred to as Year 2). The recordings from Year 2 occurred from February 2013 through February 2014. Three additional recording sites were added in Year 2 to also characterize the Rhode Island Massachusetts Wind Energy Area (RIMA WEA). The following is a report summarizing the scientific efforts to collect and analyze passive acoustic recording data in the MA WEA and the RIMA WEA in Year 2. Results from Year 1 are also included for comparison purposes.

The focus of BRPs data collection and analysis was to collect acoustic data to supplement broader efforts to characterize patterns of occurrence of marine mammal species, and characterize the existing ambient noise environment in the MA WEA and RIMA WEA. The results will be used to establish baseline information to inform future efforts to assess potential influences of anthropogenic noises produced by the construction and operation of future Offshore Renewable Energy (ORE) development. Determining patterns of marine mammal occurrence is a critical first step in order to determine any potential effects that an ORE development might have on the behavior and ecology of resident or migratory species of marine vertebrates.

This report focuses on 5 key species of marine mammals: North Atlantic right whales (*Eubalaena glacialis*), fin whales (*Balaenoptera physalus*), minke whales (*Balaenoptera acutorostrata*), humpback whales (*Megaptera novaeangliae*), and blue whales (*Balaenoptera musculus*). All 5 taxa produce species-specific vocalizations, and have been the subject of intensive study through passive acoustic monitoring by the Bioacoustics Research Program at Cornell University, with many automated data processing routines in place for the identification of their vocalizations (e.g., Urazghildiiev & Clark 2006; Urazghildiiev & Clark 2007a; Urazghildiiev et al. 2009). Of these species, the North Atlantic right whale is the most heavily endangered, with approximately only 500 individuals remaining (Kraus et al. 2005), thus understanding the occurrence of this species is critical.

Previous studies have shown that the North Atlantic right whale has been documented in low abundance near the MA WEA and RIMA WEA, though the seasonal periodicity in the area is unclear (Kenney & Winn 1986; Winn et al. 1986). However, the WEAs are approximately 100 km to the southwest of the Great South Channel, a high-use area of baleen whales (Kenney & Winn 1986), and whale species may be passing near the area while going to and from the Great South Channel.

The specific scientific objectives of the project presented here include:

1) Determine the occurrence and relative distributions of acoustically active right whales.
2) Determine the daily occurrence and relative distributions of acoustically active fin, humpback whales, blue whales, and minke whales.
3) Document the ambient noise environment throughout the MA WEA and RIMA WEAs.

2 Sound Recording Methods

2.1 Recording System

Acoustic data were collected using marine autonomous recording units (MARUs). A MARU is a digital audio recording system contained in a positively buoyant 17” glass sphere that is deployed on the bottom of the ocean for periods of weeks to months (Figure 2.1, Calupca et al. 2000). A hydrophone mounted outside the sphere is the mechanism for acquiring sounds that are recorded and these sounds are then stored in a binary digital audio format on internal electronic storage media. The MARU can be programmed to record on a specific schedule and deployed in a remote environment, where it is held in place by an anchor. At the conclusion of a deployment, the MARU is sent an acoustic command to release itself from its anchor and float to the surface for recovery. After the recovery, the MARU data are extracted, converted into audio files and stored on a server for analysis. The unit is then refurbished (batteries and hard drive replaced, etc.) in preparation for a subsequent deployment. Data recorded by a MARU are thus accessible only after the device is retrieved.

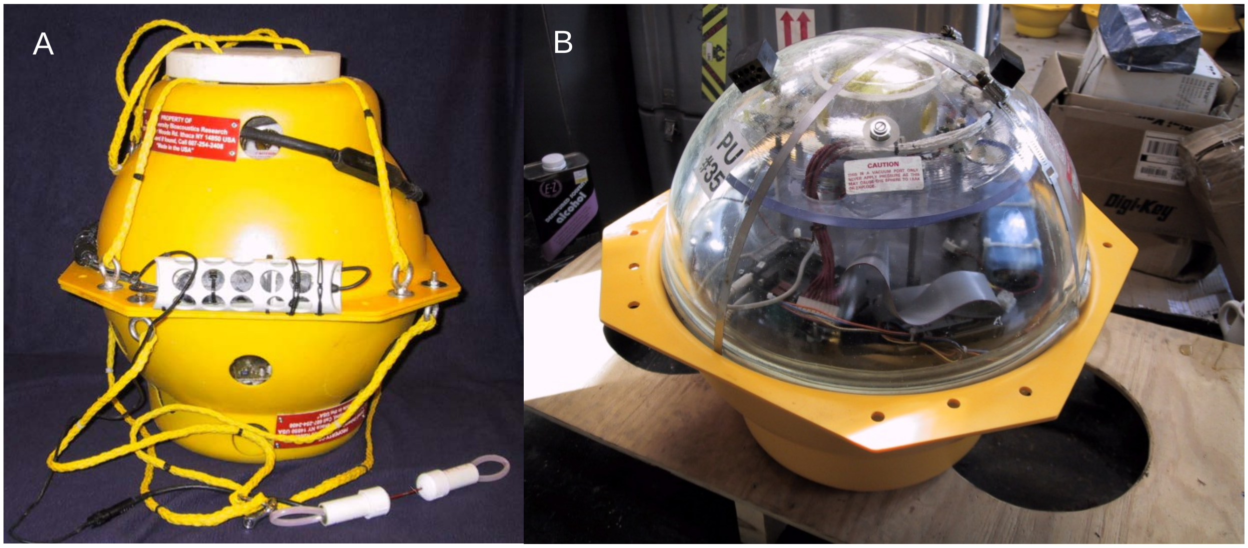

Figure 1. (A) External and (B) internal views of the Marine Autonomous Recording Unit (MARU) used for sound data recordings in this project.

2.2 Deployment and Recovery of MARUs

MARUs recorded sounds at 9 sites across the MA WEA and RIMA WEA over four deployment periods between November 2011 and February 2014. A deployment refers to an elapsed period of time when MARUs are deployed at a site and begin recording sound to when the MARUs are retrieved and stop recording. The period is usually determined by storage and/or battery limitations. The four deployments are referred to as Dep-01 and Dep-02 (or Year 1), and Dep-03 and Dep-04 (or Year 2). For both years, a total of 688 days of nearly continuous sounds were recorded. In Year 1, an array of 6 MARUs was deployed at 6 sites in or near the MA WEA. In Year 2, the same array of 6 MARUs in the MA WEA was deployed, and an additional 3 MARUs were deployed at 3 sites in the RIMA WEA. The two areas are hereafter referred to as the MA WEA and RIMA WEA arrays (Figure 2). The locations of the MARUs, and the total area in which the MARUs are able to detect sounds are referred to as the “acoustic survey area” in this report. MARUs were anchored at depths ranging between 43 m and 59 m, and recording sites were between 12 km and 30 km apart from each other.

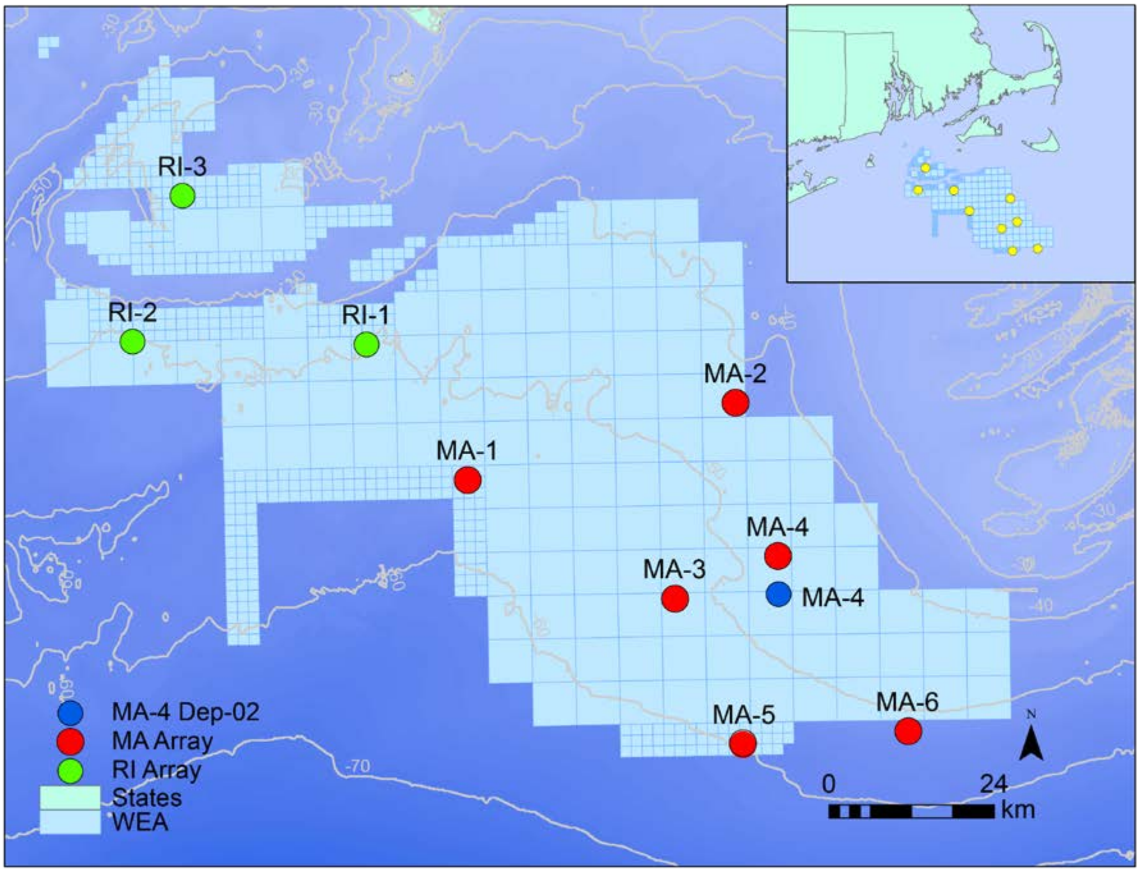

Figure 2. Map of the MA WEA MARU recording sites (red circles) and the RIMA WEA MARU recording sites (green circles). All MA WEA locations remained the same through Dep-01 and Dep-04 except for the location of site MA-4 (as indicated on the map by a blue circle) during Dep-02. The three additional RI MARU sites were added in Dep-03 and Dep-04. White lines represent isobaths in 10 m intervals. Both the MA WEA and RIMA WEA are shown.

In Dep-01 and Dep-02, 6 MARUs were deployed in the MA array and recorded sound from 10 November 2011– 25 April 2012 (Table 1) and 27 April – 03 October 2012 (Table 2). The sound data from April 26, 2012 was not analyzed due to the lapse in continuous recordings as a result of the scheduled swapping of MARUs between Dep-01 to Dep-02. In Dep-03 and Dep-04, the 6 MARUs in the MA WEA were deployed at the same locations, and 3 additional MARUs were deployed in the RIMA WEA. MARUs in Dep-03 recorded from 16 February – 30 July 2013 Table **3**), and in Dep-04, MARUs recorded from 2 August 2013 – 12 February, 2014 (Table 4). Data were not collected between 31 July and 1 August 2013 because of scheduled swapping of MARUs between Dep-03 and Dep-04. No MARUs were deployed from 04 October 2012 to 15 February 2013, during the development of the Year 2 contract.

Table 1. MARU details for Dep-01, Year 1.

MARU Site ID	Sample Rate	Depth (m)	Latitude (Decimal °)	Longitude (Decimal °)	Start Analysis Date	End Analysis Date	Total Days
MA-1	2 kHz	53.0	40.861153	-70.731355	11/10/11	04/25/12	168
MA-2	2 kHz	43.5	40.937497	-70.381737	11/10/11	04/25/12	168
MA-3	2 kHz	51.0	40.743865	-70.460382	11/10/11	04/25/12	168
MA-4	2 kHz	47.9	40.748645	-70.325957	11/10/11	04/25/12	168
MA-5	2 kHz	59.3	40.598968	-70.373767	11/10/11	04/25/12	168
MA-6	2 kHz	53.0	40.612642	-70.155803	11/10/11	04/25/12	168

Table 2. MARU details for Dep-02, Year 1.

MARU Site ID	Sample Rate	Depth (m)	Latitude (°)	Longitude (°)	Start Analysis Date	End Analysis Date	Total Days
MA-1	2 kHz	53	40.861122	-70.730675	04/27/12	10/03/12	160
MA-2	2 kHz	43.5	40.937277	-70.381443	04/27/12	10/03/12	160
MA-3	2 kHz	51	40.74385	-70.460660	04/27/12	10/03/12	160
MA-4	2 kHz	47.9	40.748428	-70.325302	04/27/12	10/03/12	160
MA-5	2 kHz	59.3	40.598985	-70.374470	04/27/12	10/03/12	160
MA-6	2 kHz	53	40.61281	-70.156442	04/27/12	10/03/12	160

Table 3. MARU details for Dep-03, Year 2. Rows shaded in gray indicate MARUs that malfunctioned, resulting in loss of data.

MARU Site ID	Sample Rate	Depth (m)	Latitude (°)	Longitude (°)	Start Analysis Date	End Analysis Date	Total Days
MA-1	2 kHz	54	40.861366	-70.731475	02/16/13	07/30/13	165
MA-2	2 kHz	44	40.937538	-70.381538	02/16/13	07/30/13	165
MA-3	2 kHz	52	40.743839	-70.460769	02/16/13	07/30/13	165
MA-4	2 kHz	47	40.785980	-70.326255	02/16/13	07/30/13	165
MA-5	2 kHz	59	40.599727	-70.370483	02/16/13	07/30/13	165
MA-6	2 kHz	53	40.612335	-70.156631	02/16/13	07/30/13	165
RI-1	2 kHz	50	40.995197	-70.863563	02/16/13	07/30/13	165
RI-2	2 kHz	51	40.997913	-71.169242	N/A-	N/A-	0
RI-3	2 kHz	33	41.141746	-71.104171	02/16/13	07/30/13	165

Table 4. MARU details for Dep-04, Year 2. Rows shaded in gray indicate MARUs that malfunctioned, resulting in loss of data.

MARU Site ID	Sample Rate	Depth (m)	Latitude (°)	Longitude (°)	Start Analysis Date	End Analysis Date	Total Days
MA-1	2 kHz	54	40.8612	-70.7315	N/A	N/A	0
MA-2	2 kHz	44	40.9421	-70.3821	N/A	N/A	0
MA-3	2 kHz	52	40.7436	-70.4607	08/02/13	01/15/14	167
MA-4	2 kHz	47	40.7859	-70.3259	N/A	N/A	0
MA-5	2 kHz	59	40.5993	-70.2617	08/02/13	02/12/14	195
MA-6	2 kHz	53	40.6125	-70.1553	N/A	N/A	0
RI-1	2 kHz	50	40.9955	-70.8642	08/02/13	02/07/14	190
RI-2	2 kHz	51	40.9978	-71.1683	08/02/13	02/12/14	195
RI-3	2 kHz	33	41.1421	-71.1038	08/02/13	02/12/14	195

2.3 MARU Settings

MARUs were programmed to record continuously at a sampling rate of 2 kHz. Each MARU had a 10 Hz high-pass filter to reduce electrical interference from the recording unit and an 800 Hz low-pass filter to prevent aliasing (artificial spread of energy to lower frequencies), for an effective acoustic recording bandwidth of 10 – 800 Hz.

2.4 MARU Malfunctions

In some instances the MARUs malfunctioned; affecting their ability to record sound. Below describes the malfunctions that occurred in Dep-03 and Dep-04 (Year 2). No malfunctions occurred in Dep-01 or Dep-02 (Year 1).

In Dep-03, the MARU at site RI-2 was found to have a bad polyfuse on one battery pack that caused repeated power cycling, leading to corruption of the data on the compact flash (CF) cards resulting in unrecoverable sound data.

There were multiple MARU malfunctions in Dep-04. The MARU at site MA-3 was found to have a broken pin on one of its external waterproof connectors, leading to the recording ending early on 16 January 2014. The MARU at site RI-1 stopped recording early on 8 February, when the power supply depleted. The MARUs at sites MA-1 and MA-2 had CF cards that reported incorrect capacities and did not have any data consistent with the audio, and MARUs at sites MA-4 and MA-6 had corrupted file headers. We suspect that these four failures (no data were recovered) were due to re-use of the CF cards and CF power cycling, as recent lab testing of these conditions has shown similar corrupted file headers. Current and future deployments are using new CF cards to avoid these issues.

2.5 Data Processing

Sound data from the MARUs were extracted and converted into continuous sounds files after each recovery. Figure 3 shows a 2-minute spectrogram of recorded sound at all six MARUs in the MA array during Dep-02. During this particular time period, minke, fin, and humpback whales were vocalizing simultaneously. A total of 101,520 hours of sound data were recorded and analyzed. Unless otherwise noted, all times are represented in Greenwich Mean Time (GMT).

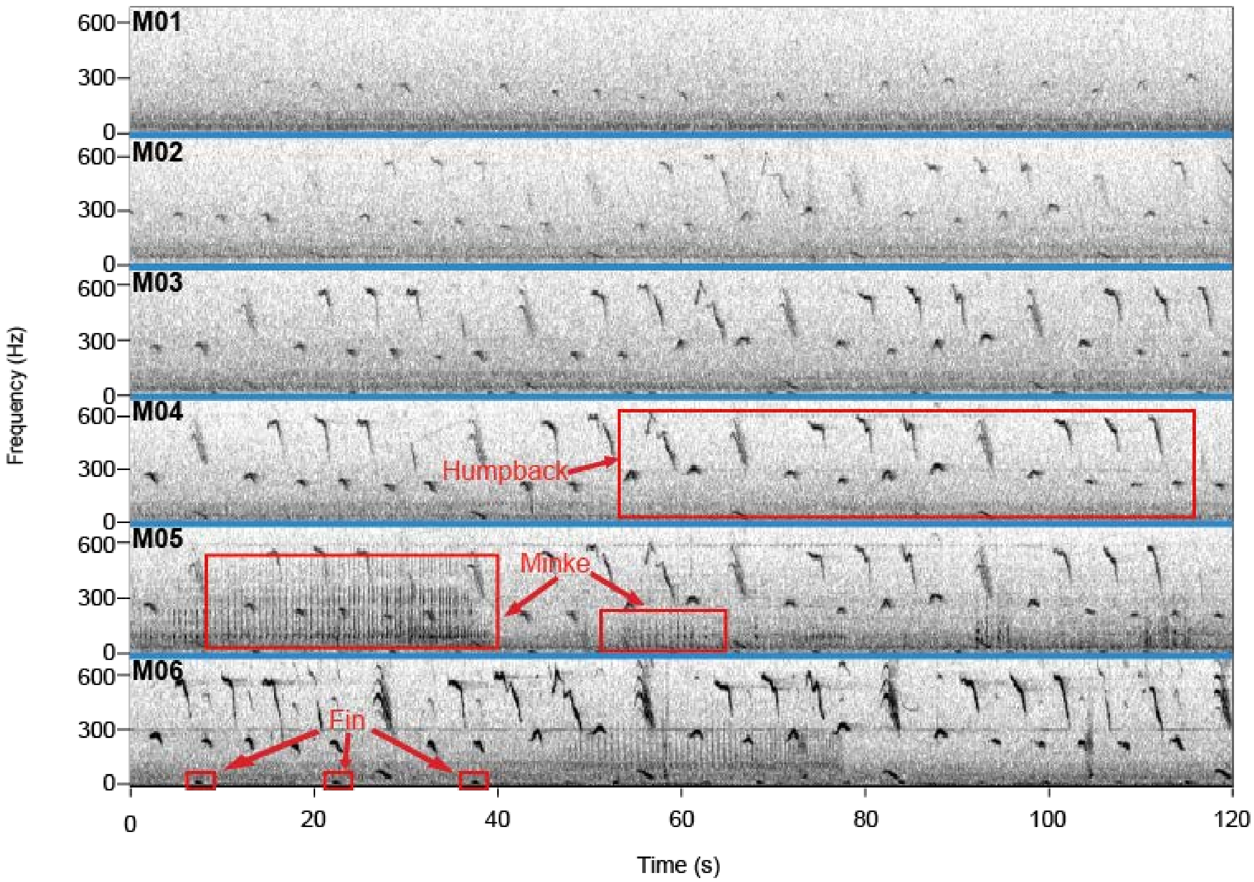

Figure 3. A representative 2-minute duration spectrogram of all 6 MARUs in the MA array deployed in the project area on 16 March 2012. As identified in the figure, three species of whale (humpback, minke, and fin) were vocalizing during the same 2-minute period.

3 Sound Analysis Methods

3.1 Determination of Species Presence

The determination of presence of a whale species depended on the ability to identify characteristic vocalizations in the audio data for each of the 5 focal species. In this analysis, a confirmed vocalization of a whale species meant at least one or more individuals of that species was present and vocalizing at that time. This analysis did not attempt to determine the number of animals vocalizing. Also, the absence of species vocalizations did not confirm that one or more whale species were absent during that time, but could have also indicated 1) a whale was present but not vocalizing, or 2) a whale was present and vocalized but the sound was not recorded by the hydrophone due to amplitude, propagation, or other issues (following Mellinger et al. 2007). The confirmed vocalizing of one or more whales is referred to as *acoustic presence* in the remainder of this report.

The detection range or listening area of a species is the distance a specific type of vocalization can propagate and be recorded by a MARU. Calculation and modeling of a detection range for a MARU is dependent on several known environmental parameters specific to the recording area, and the source level of the vocalizing whale. The determination of detection ranges specific to the MARU array was beyond the scope and budget of this project. In place of an extensive modeling effort, a detection range for each species is inferred based on previous research. The following list gives an estimate of the potential distances over which the vocalizations of individual whale species are believed to travel and still be detected by a recorder. These are theoretical estimates based on site conditions, source levels, and performance of hydrophones specific to the studies that are cited. The purpose of these estimates is to understand that some recorded vocalizations may have originated inside or outside of the MA and RIMA WEAs.

- Right whale calls: up to 25 km (Laurinolli et al. 2003)
- Humpback whale song: 12-29 km (Clark & Clapham 2004; Stafford et al. 2007)
- Minke whale pulse trains: up to 10 km (Risch et al. 2014)
- Fin whale 20 Hz notes : >100 km (Payne & Webb 1971b; Širovic et al. 2007)
- Blue whale song: >100 km (Payne & Webb 1971b; Širovic et al. 2007)

The MARU arrays were configured to be able to record vocalizations from within the MA and RIMA WEAs, but may also record vocalizations from farther outside the WEAs.

Figure 4 shows the MARU array in relation to the MA and RIMA WEAs. Reference lines were added at two distances from the MARU array to be able to compare the WEAs with estimated detection ranges for the different species mentioned above. The red line represents a 25 km boundary around the MARU array (8,627) where all five whale species' vocalizations could be detected under low ambient noise conditions. Based on the literature, vocalizations from right, minke, and humpback whales may not be recorded beyond this 25 km range. The black line represents a 50 km boundary around the MARU arrays. According to the literature, a fin whale and blue whale may be detected outside of this 50 km range.

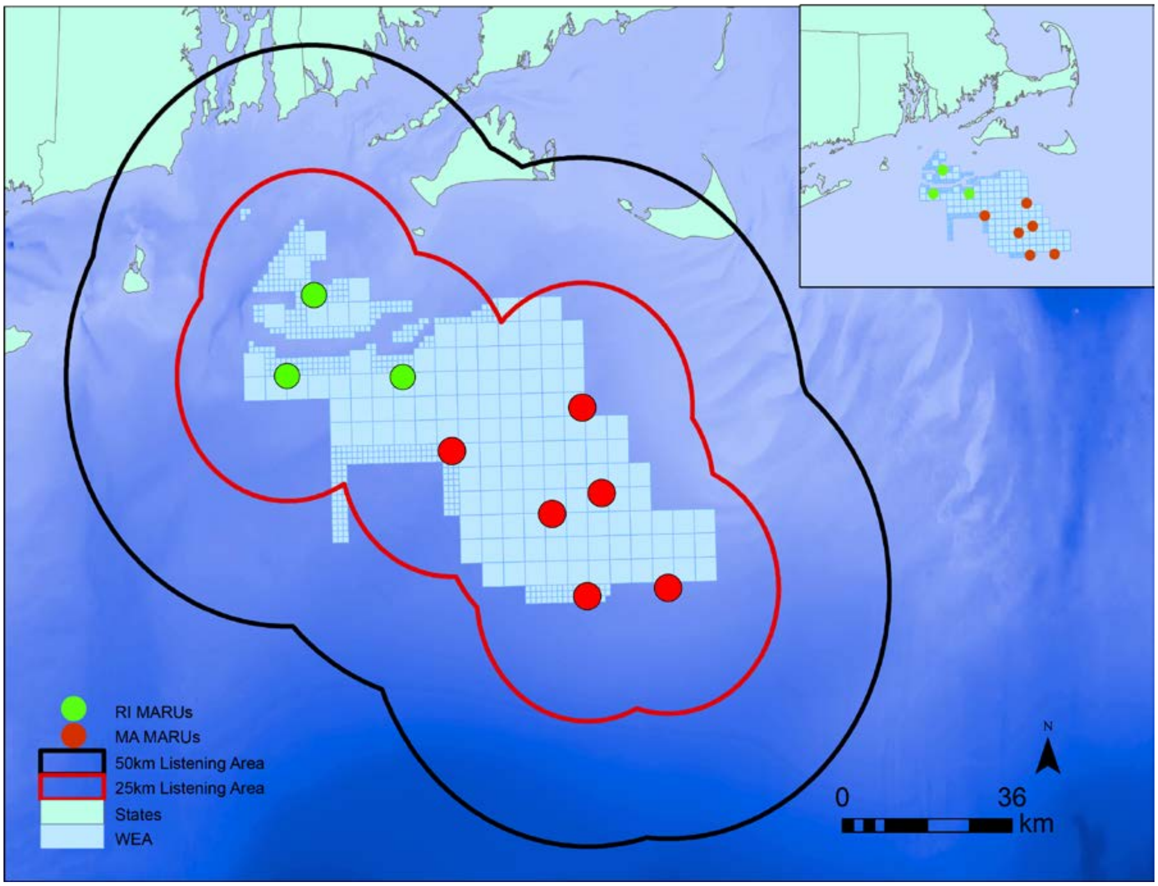

Figure 4. Map showing potential estimated listening areas at 25 km (red line) and 50 km (black line) from the MARU arrays, based on the published or theoretical properties of the propagation range of calls from the focal species of interest. However, it should be noted that the detection range of the MARUs will be influenced by weather, changes in ambient noise levels (both environmental and anthropogenic), depth and position of the vocalizing whales, and whale source levels. Both the MA array (red circles) and RIMA array (green circles) are represented.

3.2 Species Identification

The identification of each species was accomplished by either (1) automated detectors trained in detecting specific sounds with the verification of the detections by trained humans, or (2) visual inspection of the sound by expert human analysts without the aid of an automated detector. The sections below describe the methods by which each species of whale was identified to determine acoustic presence.

The temporal and spatial resolution at which the acoustic presence of each species was determined varied depending on a number of factors, including the availability of automated detectors, characteristics of species vocalizations, and in the case of right whales, the desire to collect finer resolution of acoustic presence information because of their endangered status under the Endangered Species Act (Kraus et al. 2005). Table 5 provides a summary of the temporal and spatial resolution of acoustic presence that was determined for each whale species in this analysis.

Table 5. Temporal and spatial resolution of the acoustic presence analysis for each whale species.

Whale Species	Temporal Resolution	Spatial Resolution
Right Whale	Instantaneous	Determined acoustic presence at each MARU
Fin Whale	Hourly (Year 1)/ Daily (Year 2)	RI and MA
Minke Whale	Daily	RI and MA
Humpback Whale	Daily	RI and MA
Blue Whale	Daily	RI and MA

[1] *RI and MA array* indicates that acoustic presence was determined by finding a vocalization at any one of the 6 MARUs in the MA WEA array and 3 MARUs in the RIMA WEA array; not at each of the 9 individual MARUs.

3.2.1 Acoustic Presence by Automated Detectors

Right whale

The acoustic presence of right whales was determined by using software that automatically detects right whale contact calls. Contact calls (see example, Figure 5) are the most common calls produced by right whales (Clark 1982; Parks & Tyack 2005; Parks & Clark 2007), and are used frequently to determine acoustic presence of right whales in an area (Clark et al. 2007; Mellinger et al. 2011; Morano et al. 2012; Mussoline et al. 2012). The detector was used to find contact calls recorded on all 9 channels (a channel referring to recordings from a single MARU) for the entire sampling period. All detections were then reviewed by human analysts to determine any instance in which a right whale was producing contact calls, and to ensure that no false positive detections were included in the results.

The automated detection process consisted of two stages. In the first stage, the multi-channel MARU data were processed by a customized, Matlab-based right whale detection algorithm referred to as ISRAT (Urazghildiiev & Clark 2006; Urazghildiiev & Clark 2007a; Urazghildiiev & Clark 2007b; Urazghildiiev et al. 2009). The result of this stage was a file containing all potential ISRAT-detected right whale contact calls. For the second stage, the detections from ISRAT were configured to operate in conjunction with the interactive sound visualization tools provided by the Raven Software package (Bioacoustics Research Program 2011). The ISRAT-detected right whale contact call events were carefully evaluated in Raven by analysts with expertise in the recognition of whale sounds. Various notes within the humpback whale song can have very similar characteristics to the right whale contact call, making it difficult to distinguish between the two calls. To distinguish right whale contact calls from humpback vocalizations, analysts used a number of spectrographic characteristics including frequency and duration, concentration of energy within the calls, arrival patterns, contextual information of humpback and right whale acoustic presence in and around the period when the call was detected, as well as the aural characteristics of the detected sound.

In analyzing the detections in Raven, a specialized viewing tool was implemented to allow the user to simultaneously view both thumbnail spectrogram views of the detected event and a larger context view of the spectrogram. The context view included additional time before and after the event from all MARUs in the array. Having both views provided additional information to help classify acoustic detections, including being able to view the acoustic presence of calling patterns over time, arrivals on multiple MARUs, and potential vocalizations from other species. The spectrogram settings for the thumbnail view included a duration equivalent to the detected event plus 3-seconds before and after the event, a 50-400 Hz frequency range, and FFT size and window setting of 512. The spectrogram settings for the context view included a page duration of 90-seconds, frequency range of 10-450 Hz, and FFT size and window setting of 512.

In some instances, the contact call could have been produced with enough intensity and from a location in the array that could cause a single contact call to have been recorded on multiple MARUs. To eliminate the pseudoreplication of a contact call, and thus right whale acoustic presence in our analyses, analysts reviewed all contact calls that were automatically detected as described above, but recorded only the first arrival of the contact call (following Morano et al. 2012). In addition to preventing the pseudoreplication of acoustic presence, recording only the first arrival of a contact call also provided information on the approximate location of the calling right whale as being within the recording radius of the nearest MARU to where the call was first detected.

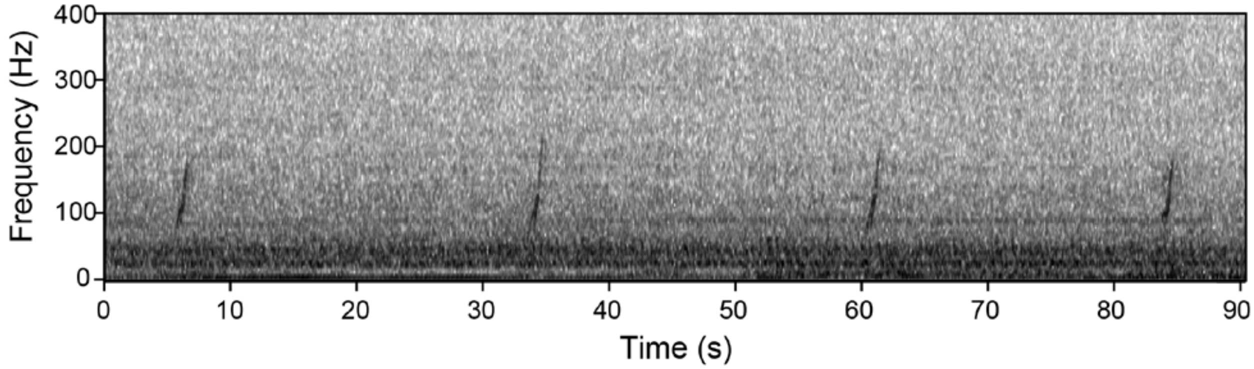

Figure 5. Spectrogram showing an example of four right whale contact calls recorded on MA-2 on 14 May 2012.

Fin Whale

The occurrence of fin whale song was the basis for determining if a fin whale was acoustically present on any one or more of the 6 MARUs in the MA WEA array and 3 MARUs in the RIMA WEA array. Acoustic presence was determined on an hourly basis for each day in Year 1, and on a daily basis in Year 2. Fin whale song is comprised of long sequences of individual 20-Hz notes (Watkins et al. 1987; McDonald et al. 1995; Clark et al. 2002). Figure 6 shows an example of a series of 20-Hz notes that are part of a fin whale song. Because of the high amplitude and propagation distance of the fin whale song (Payne & Webb 1971b; Širovic et al. 2007), the resulting arrival of the same sound on multiple MARUs, and the long duration of the songs (typically 1-20 min., Watkins et al. 1987), determining the first arrival of a song was not completed and therefore the estimated location of the animals within the array was not determined.

To identify 20-Hz notes in an automated way, the XBAT (eXtensible BioAcoustic Tool, Bioacoustics Research Program 2012) matched-filter data template detector was applied to the acoustic data from all MARUs in both arrays. The detector is trained using multiple exemplars of 20-Hz fin whale notes and is able to detect sounds with similar characteristics. Each detected sound is given a match-filter score based on its similarity to the characteristics of the exemplars. The 10 acoustic events with the highest matched-filter score for each day of data on any one of the 6 MARUs in the MA WEA array or the 3 MARUs in the RIMA WEA array were then evaluated by expert analysts using the interactive sound visualization tools provided by the Raven software environment.

The detections were reviewed in Raven, as described for right whales (see above), however, rather than reviewing the 2 kHz sound files, we used a Matlab-based script to decimate the sound files down from 2 kHz to 100 Hz in order to optimize spectrogram resolution in the low frequency range and reduce the reload time for spectrogram generation, thus increasing analysis efficiency. The spectrogram settings for the thumbnail view included a page duration of 2-seconds before and after the detected event, 8-30 Hz frequency range, and FFT size and window setting of 512. The spectrogram parameters for the context view included a 120-second spectrogram window duration, frequency range of 0-50 Hz, and FFT size and window setting of 97. The occurrences of confirmed fin whale 20-Hz notes were used to complete the task of determining fin acoustic presence.

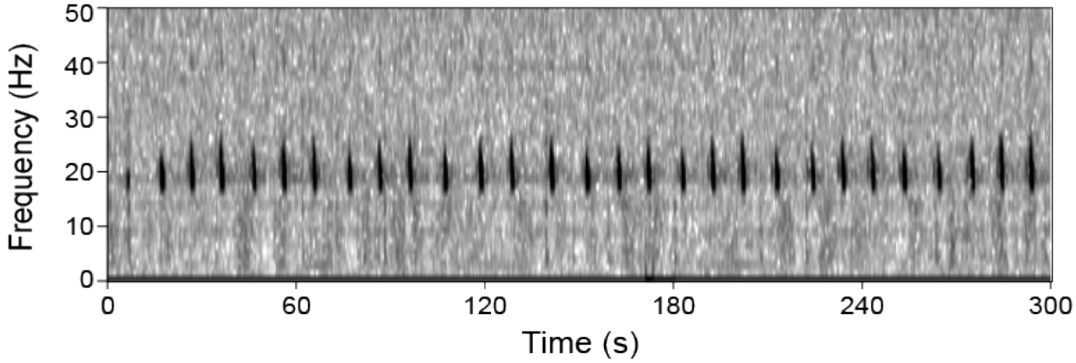

Figure 6. Example of a segment of fin whale song recorded at MA-1 on 16 March 2012. The song shown in this figure is characterized by a long sequence of 20-Hz notes occurring at regular intervals of *ca*. 11-seconds.

Minke Whale

The occurrence of minke whale pulse train vocalizations was the basis for determining if a minke whale was present on any one of the MARUs in both the MA WEA array and the RIMA WEA array on a daily basis during both Year 1 and Year 2 (Mellinger et al. 2000; Risch et al. 2014). Figure 7 shows an example of a minke whale pulse train. An automatic detection procedure was applied to the multi-channel MARU acoustic data in order to identify minke pulse train vocalizations. The automatic detection was implemented in a high performance computing (HPC) platform using a custom built algorithm that operates within Matlab R2012b (Dugan et al. 2013; Popescu et al. 2013). The algorithm comprised the following stages: digital signal processing/signal conditioning of acoustical sound data, transformation to the spectrogram domain using Short-Time Fourier Transform (STFT), detection of vocalizations using region of interest (ROI) image and projection processing, feature extraction of the identified area, and finally classification of detected signatures. These stages were applied to the acoustical data at 60-second frames and when a minke vocalization was detected it was marked as an event in the spectrogram.

The detections were then reviewed in Raven, as described for right whales (see above). The spectrographic settings for the thumbnail view included a page duration of 3-seconds before and after the detected event, 25-500 Hz frequency range, and FFT size and window setting of 512. The spectrogram settings for the context view included a spectrogram window duration of 60-seconds, a frequency range of 25-500 Hz, and a FFT size and window setting of 512. The occurrences of confirmed minke whale pulse train sounds were used to complete the task of determining daily acoustic presence.

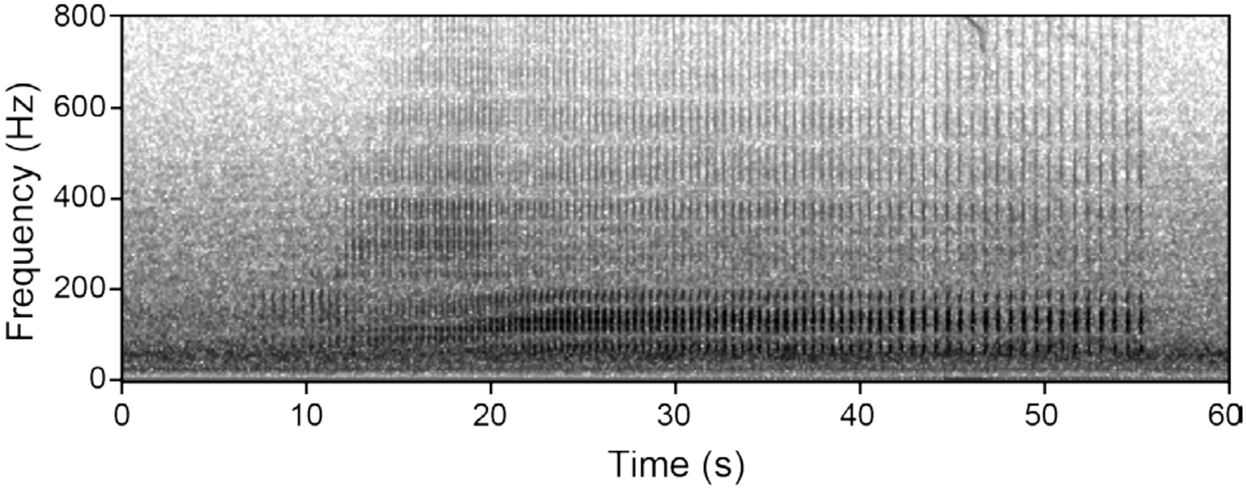

Figure 7. A 60-second spectrogram showing an example of a minke pulse train recorded at MA-3 on 20 March 2012.

3.2.2 Acoustic Presence by Visual Inspection

Humpback Whale

The humpback whale acoustic presence task was accomplished by detecting the occurrence of humpback whale sounds on any one of the 6 MARUs in the MA WEA array and 3 MARUs in the RIMA WEA array for each day of analysis. Humpback whales produce a complex and variable suite of vocalizations that are difficult to successfully and consistently detect in an automated way. Because of this, humpback vocalizations were investigated by visual inspection of the entire sound stream. There were two major types of humpback whale sounds considered: songs and social calls, as shown in Figure 8 and Figure 9. Figure 8 shows an example of a series of humpback whale sounds that are part of a humpback whale song (Payne & McVay 1971), and Figure 9 shows examples of humpback whale social calls (Silber 1986; Chabot 1988).

Two procedures were used for the humpback whale detection analysis, neither of which made use of a humpback-specific automated detection process. In the first procedure, analysts took advantage of the fin whale and right whale auto-detection efforts. During the course of these analyses, any opportunistically identified and confirmed instances of humpback whale sounds were noted and used to complete the task of determining daily acoustic presence for humpback whales. If during the fin or right whale analyses there was no identification of a humpback whale sound on a particular date, then a second procedure was conducted: analysts used Raven to browse through the multi-channel spectrogram to search for humpback whale species-specific sounds throughout the day using a 5-minute spectrogram window duration, frequency range of 10-600 Hz, and a FFT size and window setting of 512. When an instance of either a humpback song or social call was identified on that day, the analyst marked the vocalization for acoustic presence and moved to the next day.

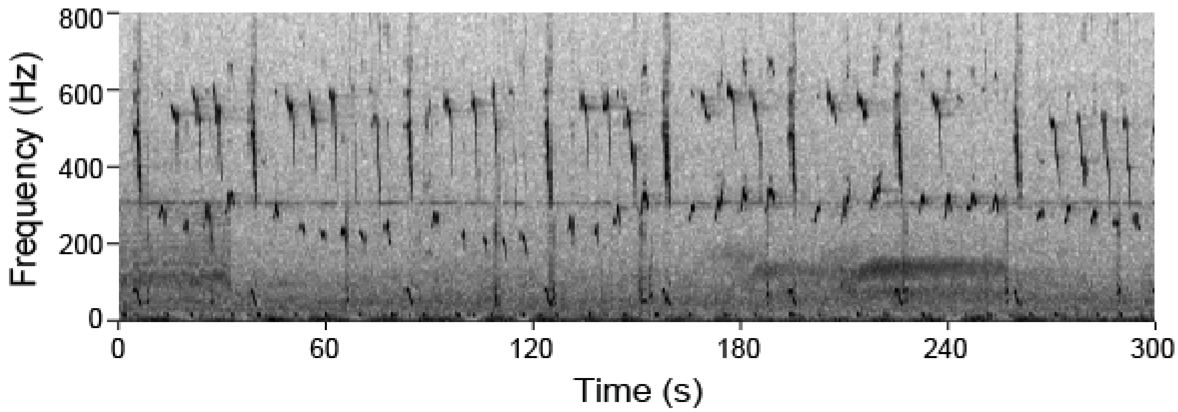

Figure 8. A 5-minute spectrogram recorded at MA-6 on 16 March 2012 showing characteristic repeated sound patterns in a segment of humpback whale song. Also visible in this spectrogram are fin whale 20-Hz song notes at the bottom of the spectrogram.

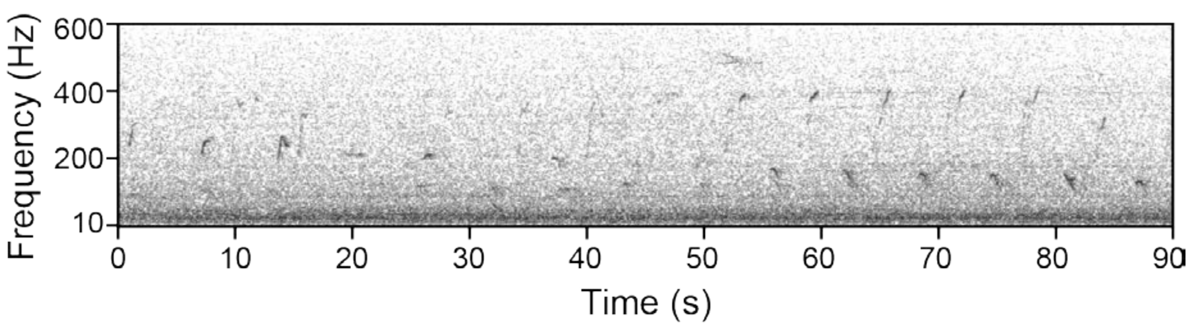

Figure 9. A 90-second spectrogram showing several humpback whale social calls on 30 April 2012 at MA-6.

Blue Whale

The daily occurrence of blue whale song on any one of the 6 MARUs in the MA WEA array and 3 MARUs in the RIMA WEA array was the basis for determining if a blue whale was acoustically present. Blue whale song was characterized by sequence phrases between 15 and 20 Hz (Mellinger & Clark 2003) (Figure 10). The determination of daily acoustic presence of blue whale song on each MARU was accomplished by applying a standardized set of spectrogram analysis parameters to a decimated version of the data from the original 2000 Hz down to 100 Hz. The decimating was done in order to yield a higher resolution spectrogram focused on the low frequency region occupied by blue whale phrase sequences which have a dominant frequency of approximately 17-18 Hz (Figure 10). Analysts then used the interactive sound visualization tools provided by the Raven software environment to search for characteristic patterns of 14-22 Hz blue whale sounds. In analyzing these data, a page length of 2-hours and a frequency range of 10-25 Hz were used. The FFT size and window were set to 512 points.

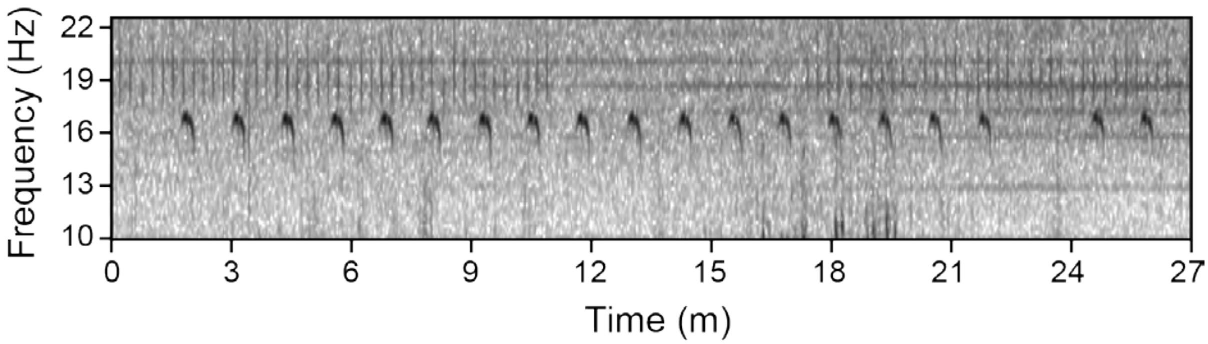

Figure 10. A 27-minute spectrogram showing an example of a blue whale song recorded at MA-4 on 23 December 2011.

3.3 Data Synthesis

The following sections describe the methods used to synthesize raw acoustic presence data to produce meaningful acoustic presence information. It is important to note that the loss of data due to MARU malfunction was not factored into the results, and that the results may provide a conservative estimate of acoustic presence (for details on missing data, refer to section 2.2).

3.3.1 Monthly Acoustic Presence

Once the identification of the 5 species was accomplished as described in section 3.2, the species acoustic presence information was synthesized and converted to examine the data at different temporal and spatial scales. The instantaneous acoustic presence data collected for right whales and the hourly acoustic presence data collected for fin whales in Year 1 were converted to daily acoustic presence to allow for comparisons to minke, humpback, and blue whale daily acoustic presence. In this way, the daily acoustic presence of all 5 species was determined for the entire project period (November 2011 to February 2014). Daily acoustic presence indicates that one or more whales produced a vocalization that was recorded on one or more MARUs in both arrays. Daily acoustic presence was then converted to the total number of days a whale was detected in a month compared to the total number of days with recorded sound in that same month. This is referred to as the “monthly acoustic presence”, and is calculated as follows:

$$\text{Monthly acoustic presence (\%)} = \frac{Number\ of\ days\ per\ month\ with\ acoustic\ presence}{Number\ of\ days\ recorded\ per\ month} \times 100$$

Using this metric, a month in which acoustic presence was found on all days that were recorded in that month would result in 100% monthly acoustic presence. Zero days with acoustic presence on all days recorded in a month would result in a monthly acoustic presence value of 0%.

3.3.2 Interannual Variability

To illustrate interannual variability, the monthly acoustic presence in the months of February through October in both 2012 and 2013 were compared for each of the five species. These months were chosen because they were the only months in which there were sound recordings in both 2012 and 2013.

3.3.3 Right Whale Call Abundance and Diel Occurrence

The higher resolution acoustic presence information collected for right whales was used to analyze their (1) daily and monthly call abundance and (2) diel call abundance. Right whale call abundance data are different than acoustic presence data in that they not only indicate whether right whales were present, but also provide information on when and how often right whales were vocalizing (calling). To compare the call abundance of right whales on a daily basis over time, the total number of detected first arrival contact calls was summed for each day. To compare the call abundance of right whales over time on a monthly basis, the total number of detected first arrival contact calls was summed for each month and then divided by the total number of days with recorded sound in each month (the number of contact calls divided by the number of days recorded). The diel pattern was determined by calculating the total number of first arrival calls detected within each hour. Times in the diel analysis are reported in Eastern Standard Time (EST) zone, with no correction for Daylight Saving Time.

3.3.4 Spatial and Seasonal Distribution of Right Whale Call Abundance

Additional analyses were performed for right whales in order to determine the locations of vocalizing right whales within the study area and the seasonality of right whale vocalizations. Here, “call abundance” refers to the presence of right whale upcalls. For the purpose of these analyses, the MARU where the contact call arrived first was considered to be the closest location to the right whale at the time of the vocalization. The data were used to determine 1) the total number of first arrival contact calls at each MARU, and 2) the total number of first arrival contact calls in each season and at each MARU.

3.4 Ambient Noise Analysis

Sound is a critical component of the broader marine environment, and many, if not most, marine animals use sound in different aspects of their life history. Measurements of ocean ambient noise (inclusive of environmental, biological and anthropogenic sounds) have long been used to characterize different geographic areas from an oceanographic or physical perspective (for example, see reviews by Wenz 1962; Wenz 1972; Urick 1986). These measurements are now being calculated in different ecosystems to evaluate how marine animals may be influenced by sound from environmental and anthropogenic processes (e.g., Samuel et al. 2005; Simard et al. 2010; Clark et al. 2011). Analysis of the ambient noise environment over large spatial and temporal scales provides a broad, but revealing perspective on biological and anthropogenic habitat use.

3.4.1 Acoustical Signal Processing

Acoustic data were processed using the Noise Analysis tools within the SEDNA toolbox for Matlab (Dugan et al. 2011) using a Hann window, a FFT size of 2048 samples, a time resolution of 10.24 seconds, a frequency resolution of 0.98 Hz, and a recorded sample rate of 2 kHz. For the ambient noise analysis, 3 different visual representations of sound were used: (1) frequency vs. time (spectrogram), (2) 1/ octave frequency band vs. time (1/ octave) and (3) power vs. frequency (sound pressure density spectra).

3.4.2 Spectrograms

Spectrograms represent sound data using frequency (Hz) as a function of time and amplitude (dB) represented by a color scale (Figure 26, Figure 28, and Figure 31, Panel A). Spectrograms are helpful in illustrating variation in sound data over long periods of time and can be useful for visually identifying long-term acoustic trends and potential noise sources. Long-term spectrograms that span the duration of the analysis period were created for 3 representative sites using 1-hour integration time slices and a FFT of 2048 samples. For particular days of interest on specific channels (n=4), long-term spectrograms comprising a 24-hour period were generated using 2-minute integration time slices and a FFT of 2048. These days of interest included a day with low overall acoustic activity, a day with high levels of biological acoustic activity, a day with high levels of anthropogenic acoustic activity, and a day with overlapping biological and anthropogenic acoustic activities. The frequency scale for these long-term spectrograms is linear with frequencies between 10-1 kHz. The color scale in the spectrogram ranges from blue (lower dB levels) to red (higher dB levels).

3.4.3 1/3rd Octave Bands

Traditional signal processing methods use the approach of dividing up the acoustic signal into smaller individual bands (based on octaves) for analysis. Dividing the sound into third octave bands is also useful when looking at noise in a biological context. Third octave bands are commonly used for two principal reasons: (1) use of these bands cover a 10-to-1 frequency range, and reduces the amount of time required for computation and processing (Peterson & Gross 1978) and (2) the function of the mammalian ear can be approximated as a set of bandpass filters with a sensitivity of approximately 1/ of an octave (Richardson et al. 1995; Madsen et al. 2006).

The acoustic data for this project were post processed to produce figures that show the noise at the 1/ octave frequency bands between 10-708 Hz as a function of time. The color scale for the 1/ octave figures, which indicates changes in amplitude, match the color scale used for the spectrograms described above.

3.4.4 Sound Pressure Density Spectrum

The sound power density spectrum illustrates sound levels (dB) as a function of frequency (Hz). Data are represented using a spectral series of lower , median , and upper percentiles. The spectral series relates the relative sound level to a frequency value based on the ambient noise measurements within the sound data. The percentile represents the relative sound level (dB re:1 /Hz) in which 5% of the ambient noise falls below in a given frequency in the data set. The percentile represents the relative sound level in which 50% of the ambient noise falls under a particular frequency. The percentile represents the relative sound level in which 95% of the ambient noise falls under in a given frequency. In order to understand the variation in relative sound levels and frequency distribution across the project area, we generated power spectral densities for 3 representative recording sites for the duration of recording period, and for the four 24-hour days of interest.

4 Results

4.1 Monthly Acoustic Presence in Year 2

The monthly acoustic presence for the 5 focal species in Year 2 is illustrated in Figure 11. Table 5 presents the data used to calculate monthly acoustic presence, as described in Section 3.3.1. All 5 focal species were observed during the Year 2 recording period, but each showed differing patterns of monthly acoustic presence over space and time throughout the sampling period. Right whales were acoustically present every month of recording, with the highest acoustic monthly presence occurring in February and March. After March, there was a trend of decreasing presence with the lowest monthly acoustic presence occurring in August and September. Acoustic presence then increased again from December through February 2014. Fin whales were acoustically present every day of recording from October 2013 through February 2014. The lowest monthly acoustic presence occurred in April 2013. Minke and Humpback whales showed similar patterns in acoustic presence, with the highest monthly acoustic presence occurring in April 2013, followed by a trend of decreasing acoustic presence through October 2013. However, there were no acoustic detections of minke whales from November 2013 through February 2014, whereas humpback presence increased during that same time period. Blue whale vocalizations were only detected on four consecutive days in February 2013, during the Year 2 sampling effort. Out of the five focal species in Year 2 of this study, vocalizations of three whales (right whale, fin whale, and humpback whale) were detected in every month that was sampled from February 2013 through February 2014.

Year 2

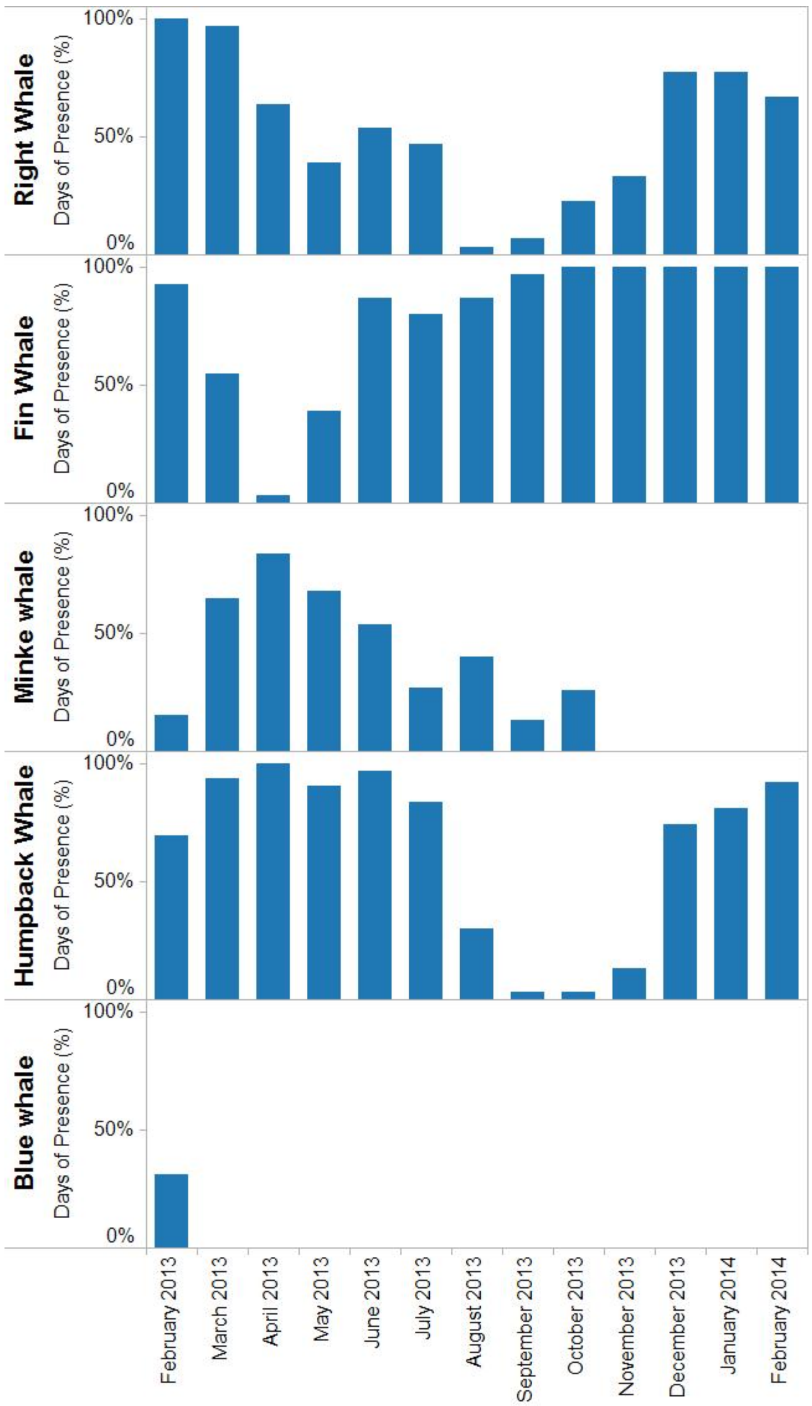

Figure 11. Year 2 monthly acoustic presence within the acoustic survey area for right whale contact calls, fin whale 20-Hz notes, minke whale pulse trains, humpback song and social calls, and blue whale song. The percentage is normalized for recording effort (the number of days with acoustic presence divided by the number of days sampled x 100). Note: Multiple MARUs experienced data loss in Year 2, possibly resulting in a conservative estimate of monthly acoustic presence. See section 2.2 for details.

Table 5. Year 2; number of MARU recording days per month, number of days with acoustic presence per month for all species, and the monthly acoustic presence for all species. "Hb" refers to humpback presence.

Month and Year	Number of days with recordings	Right		Fin		Hb		Blue		Minke	
		Number Days with Acoustic Presence	Monthly Acoustic Presence (%)	Number Days with Acoustic Presence	Monthly Acoustic Presence (%)	Number Days with Acoustic Presence	Monthly Acoustic Presence (%)	Number Days with Acoustic Presence	Monthly Acoustic Presence (%)	Number Days with Acoustic Presence	Monthly Acoustic Presence (%)
Feb 2013	13	13	100	12	92	9	69	4	31	2	15
Mar 2013	31	30	97	17	55	29	94	0	0	20	65
Apr 2013	30	19	63	1	3	30	100	0	0	25	83
May 2013	31	12	39	12	39	28	90	0	0	21	68
Jun 2013	30	16	53	26	87	29	97	0	0	16	53
Jul 2013	30	14	47	24	80	25	83	0	0	8	27
Aug 2013	30	1	3	26	87	9	30	0	0	12	40
Sep 2013	30	2	7	29	97	1	3	0	0	4	13
Oct 2013	31	7	23	31	100	1	3	0	0	8	26
Nov 2013	30	10	33	30	100	4	13	0	0	0	0
Dec 2013	31	24	77	31	100	23	74	0	0	0	0
Jan 2013	31	24	77	31	100	25	81	0	0	0	0
Feb 2013	12	8	67	12	100	11	92	0	0	0	0

4.2 Monthly Acoustic Presence in Year 1 and Year 2

Figure 12 shows the monthly acoustic presence for all species for both Year 1 and Year 2. Fin whales and humpback whales were acoustically present in all of the 25 months sampled. Right whales were acoustically present in 21 out of the 25 months sampled. Minke whales were acoustically present in 19 out of the 25 months sampled. Blue whales had the lowest monthly acoustic presence among the 5 species, with vocalizations detected in only 6 of the 25 months.

Right, minke, and humpback whales show similar seasonal patterns of monthly acoustic presence, with an increase in monthly acoustic presence in the spring months, and a decrease in the summer and fall months. The highest monthly acoustic presence in 2012 for right, minke, and humpback whales occurred in March and April. In 2013 the highest acoustic presence for minke and humpback occurred in April once again, but the highest right whale acoustic presence occurred in February in 2013. Right whale and humpback whale monthly acoustic presence increased again in December 2013 through February 2014, but minke acoustic presence was not recorded during those months.

The patterns of fin whale and blue whale monthly acoustic presence were the inverse of the other 3 focal species. Fin whales were the least acoustically active in the spring and summer months between March and July and the most active in the fall and winter months, between November and March. Of the 5 species, Fin whales were the most acoustically active throughout the recording period with 100% monthly acoustic presence in 12 out of the 25 months sampled. Blue whale acoustic presence was the lowest of the five species; with presence recorded only in December 2011 through February 2012, August and September 2012, and in February 2013.

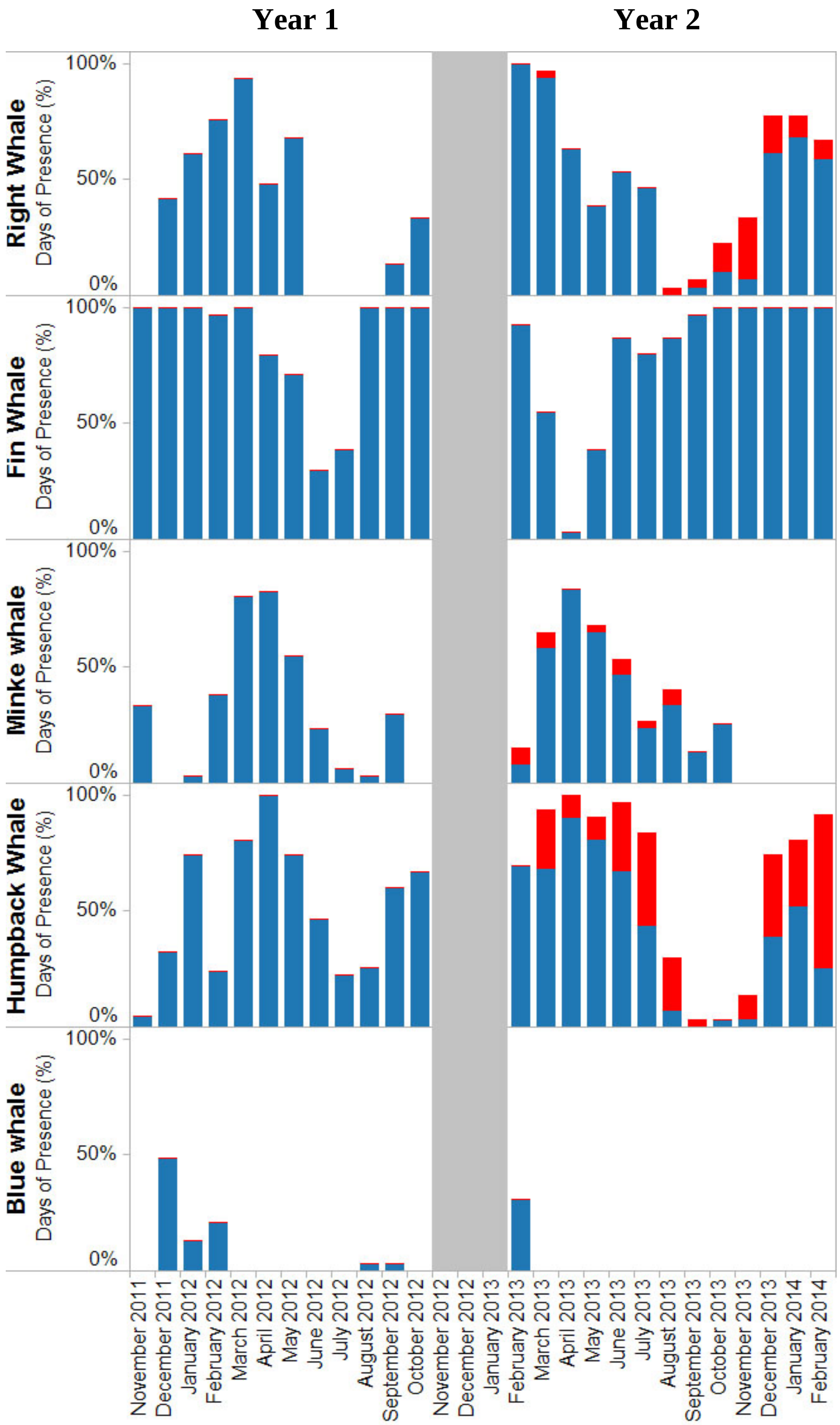

Figure 12. Monthly acoustic presence for right whale contact calls, fin whale 20-Hz notes, minke whale pulse trains, humpback song and social calls, and blue whale song. The proportions of the bars in red represent the presence detected only in the RIMA array. The percentage is normalized for recording effort (the number of days with acoustic presence divided by the number of days sampled x 100). Note: Multiple MARUs experienced data loss in Year 2, possibly affecting the results. See section 2.2 for details.

4.3 Interannual Variability

Figures 13 - 17 presents a subset of data from Figure 12 in a way that allows for an analysis of the interannaul variability of whale presence for all 5 focal species. To do this, only data from overlapping months in both 2013 and 2014, which included the months of February through October, are graphed. Each of the 5 focal species exhibited changes in monthly acoustic presence between the two years. Figure 13 shows the monthly acoustic presence for right whale contact calls in both 2012 and 2013. In 2012, the highest right whale monthly acoustic presence occurred between February and May in both years. In 2012, contact calls were not detected between June and August; however, a high number of contact calls were detected during those same months in 2013. Right whale contact call presence in August 2013 was detected in the RIMA array only (not in the MA WEA array).

Fin whales also exhibited changes in acoustic presence patterns between 2012 and 2013 (Figure 14). In 2012, presence was high in all 9 months except June and July, with the highest acoustic presence in March, and August through October. In 2013, monthly acoustic presence was highest in August through October and lowest in March through May. Monthly acoustic presence of minke whale pulse trains showed slight differences between 2012 and 2013, particularly in the summer months of June – August, and October, where acoustic presence was noticeably higher in 2013 (Figure 15). Similar to minke whale vocal activity, humpback whale monthly acoustic presence was higher in 2013 than 2012 in the months of June - August (Figure 16). In 2012 there is a significant increase in acoustic presence in September and October that did not occur in those same months in 2013. Blue whale monthly acoustic presence was low relative to the presence of other species in this study in both years, with blue whale vocalizations found in three months in 2012 and only one month in 2013 (Figure 17).

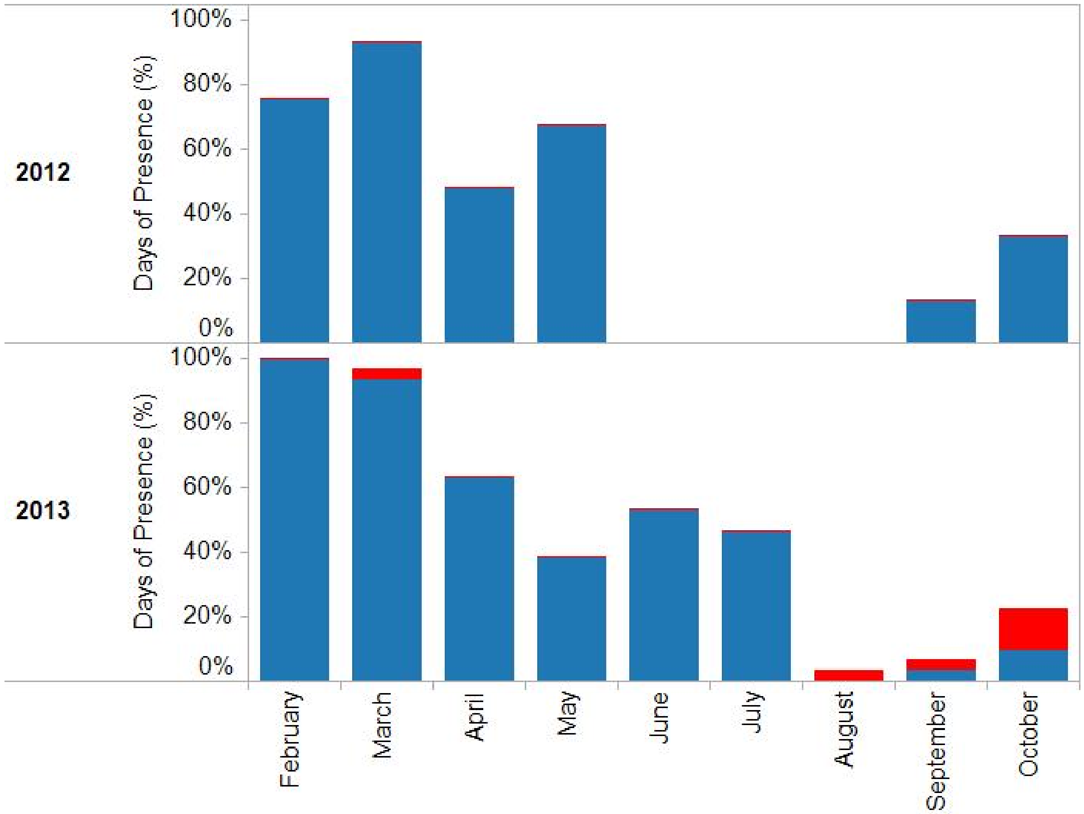

Figure 13. Interannual variability of the monthly acoustic presence of right whale contact calls detected from February through October in both 2012 and 2013. The proportions of the bars in red represent the presence detected only in the RIMA array. The proportions of the bars in blue represent presence detected in either the MA array only, or both the MA and RIMA array. Note: Multiple MARUs experienced data loss in 2013. See section 2.2 for details.

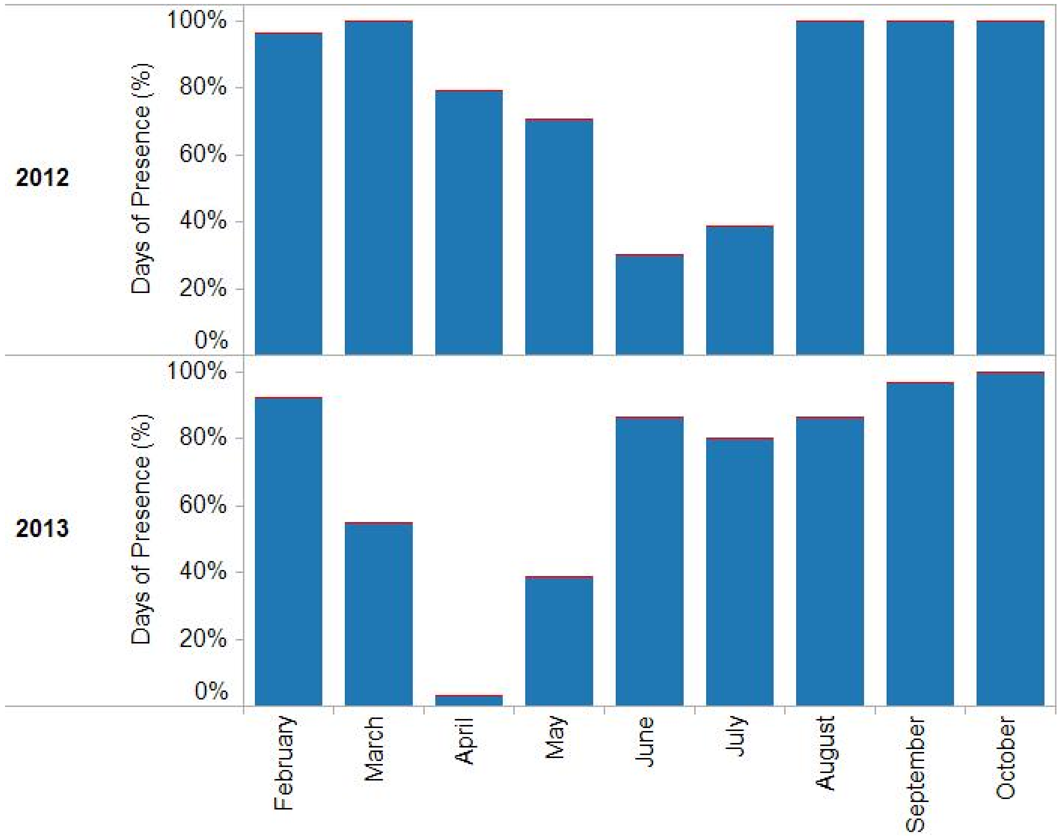

Figure 14. Interannual variability of the monthly acoustic presence of fin 20 Hz notes detected from February through October in both 2012 and 2013. The proportions of the bars in red represent the presence detected only in the RIMA array. The proportions of the bars in blue represent presence detected in either the MA array only, or both the MA and RIMA arrays. Note: Multiple MARUs experienced data loss in 2013. See section 2.2 for details.

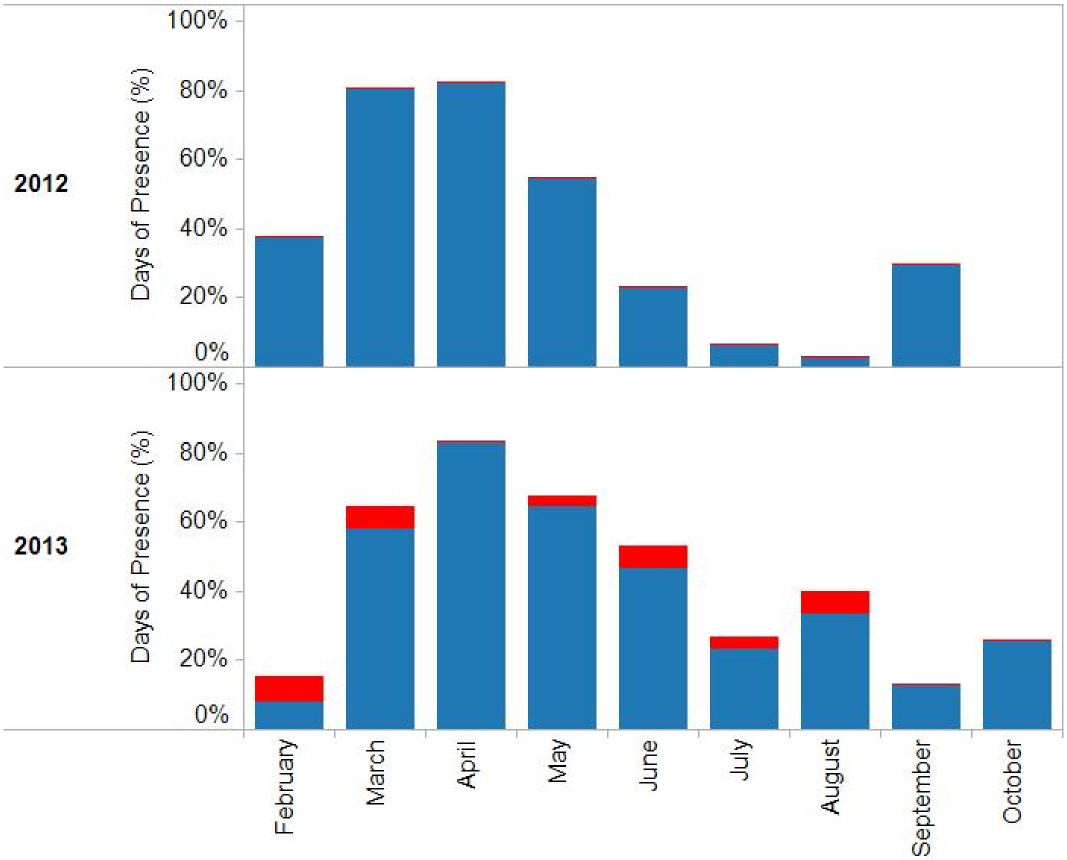

Figure 15. Interannual variability of the monthly acoustic presence of minke whale pulse trains detected from February through October in both 2012 and 2013. The proportions of the bars in red represent the presence detected only in the RIMA array. The proportions of the bars in blue represent presence detected in either the MA array only, or both the MA and RIMA arrays. Note: Multiple MARUs experienced data loss in 2013. See section 2.2 for details.

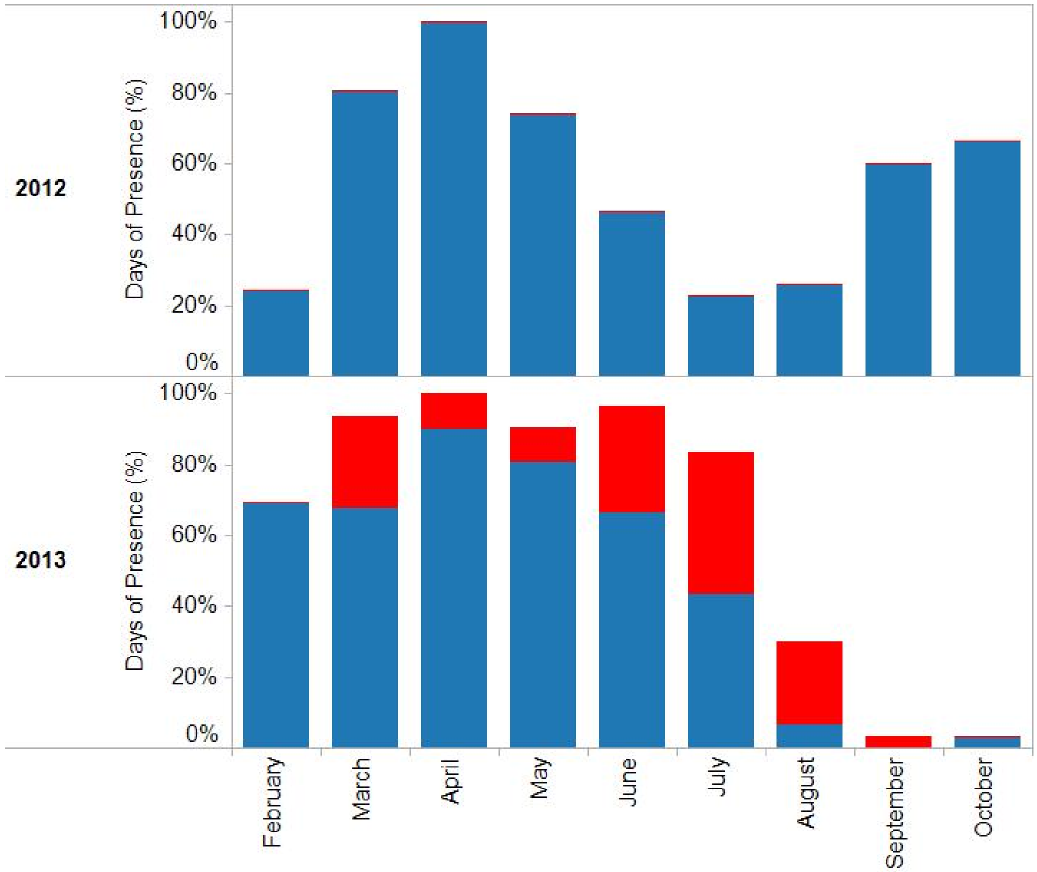

Figure 16. Interannual variability of the monthly acoustic presence of humpback vocalizations detected from February through October in both 2012 and 2013. The proportions of the bars in red represent the presence detected only in the RIMA array. The proportions of the bars in blue represent presence detected in either the MA array only, or both the MA and RIMA arrays. Note: Multiple MARUs experienced data loss in 2013. See section 2.2 for details.

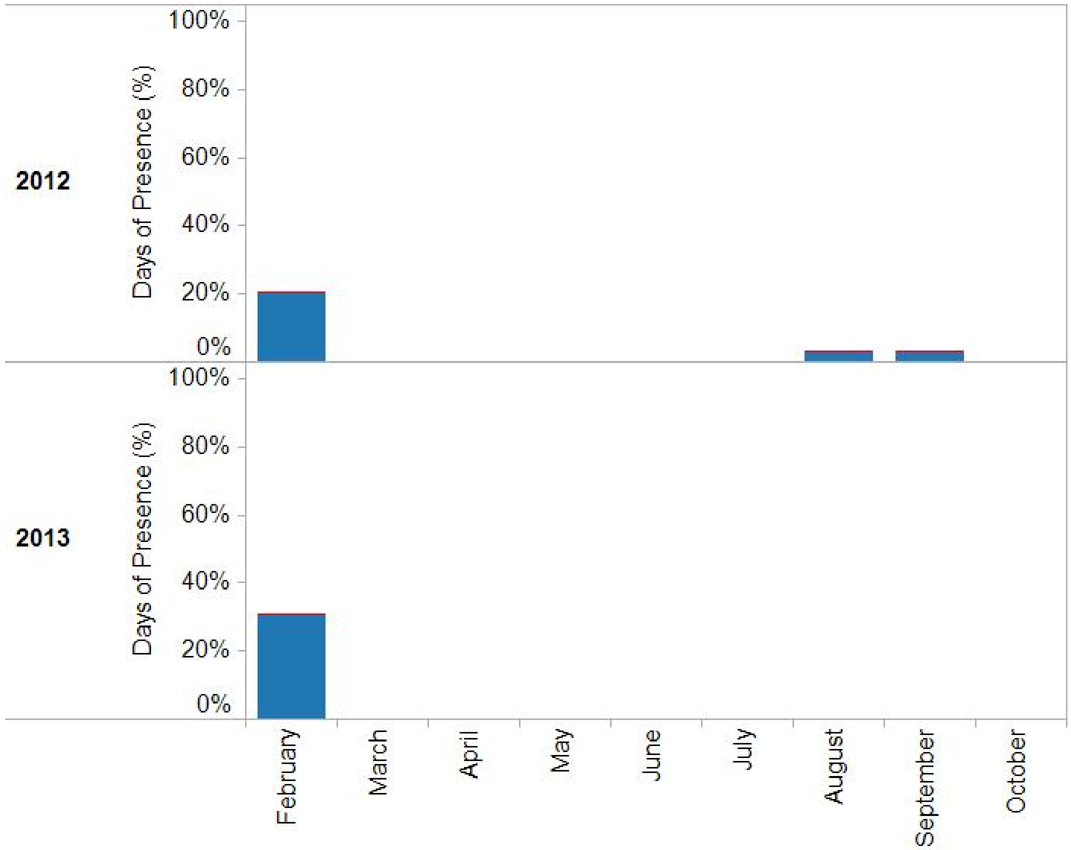

Figure 17. Interannual variability of the monthly acoustic presence of blue whale song detected from February through October in both 2012 and 2013. The proportions of the bars in red represent the presence detected only in the RIMA array. The proportions of the bars in blue represent presence detected in either the MA array only, or both the MA and RIMA arrays. Note: Multiple MARUs experienced data loss in 2013. See section 2.2 for details.

4.4 Right Whale Call Abundance and Diel Occurrence

During Year 2, right whale contact calls were difficult to distinguish from some elements of humpback whale song. The similarities between humpback song and right whale contact calls were not as prevalent in the Year 1 recordings. The similarities in characteristics of the song caused the ISRAT right whale detector to find more than 300,000 unconfirmed detections. Of those detections, only 12,699 were confirmed right whale contact calls and much of the remaining detections were false detections attributed to humpback whale song. The highest number of true right whale contact calls in Year 2 occurred on 20 Feb 2013, with 618 calls. Of the 361 recording days in Year 2, 180 days (50%) had confirmed contact calls, and 181 days did not have presence of contact calls.

When considering both Year 1 and Year 2, a total of 18,844 first arrival contact calls were confirmed across all recording sites throughout the entire recording period (Figure 18). The highest number of contact calls in each month occurred in March 2012 (3,598) and March 2013 (4,714), accounting for 44% of the total number of contact calls out of the entire recording period. Over 2012 and 2013 there were 6 days with greater than 400 contact calls each; these occurred on three days in March, two days in February and one day in June. No contact calls were detected during the periods spanning June through August 2012 and August and September of 2013.

A similar pattern was observed when comparing monthly call abundance normalized for days sampled (Figure 19). There was an increase in call abundance from January to March 2012, peaking in March 2012 (n=116), and then a decrease in call abundance from April through September 2012. A small increase occurred in the month of October 2012 (n=12) when compared to September. However, it should be noted that there were only 3 days of recordings in October 2012. Call abundance was highest in February 2013, and dropped in April 2013, with a slight increase during the summer months of June and July 2013. Call abundance decreased again in August and September 2013 and increased in November 2013, through the end of the recording period in February 2014. The increase in call abundance during the fall and winter months of November through January was observed during Year 2.

The analysis of diel patterns in call abundance of right whales in Year 2 revealed a similar pattern to Year 1 results (Figure 20). Call abundance was highest between 1700 and 2000 in both years, with 5,975 (32%) of the total 18,844 contact calls in both years occurring during those hours. The maximum number of calls occurred between 1800 and 1900 with 2,004 calls (11%). Approximately 1,025 calls (5%) were detected in the hours between 0700 and 1000. The minimum number of calls occurred between 0700 and 0800, with 292 (1.5%) calls.

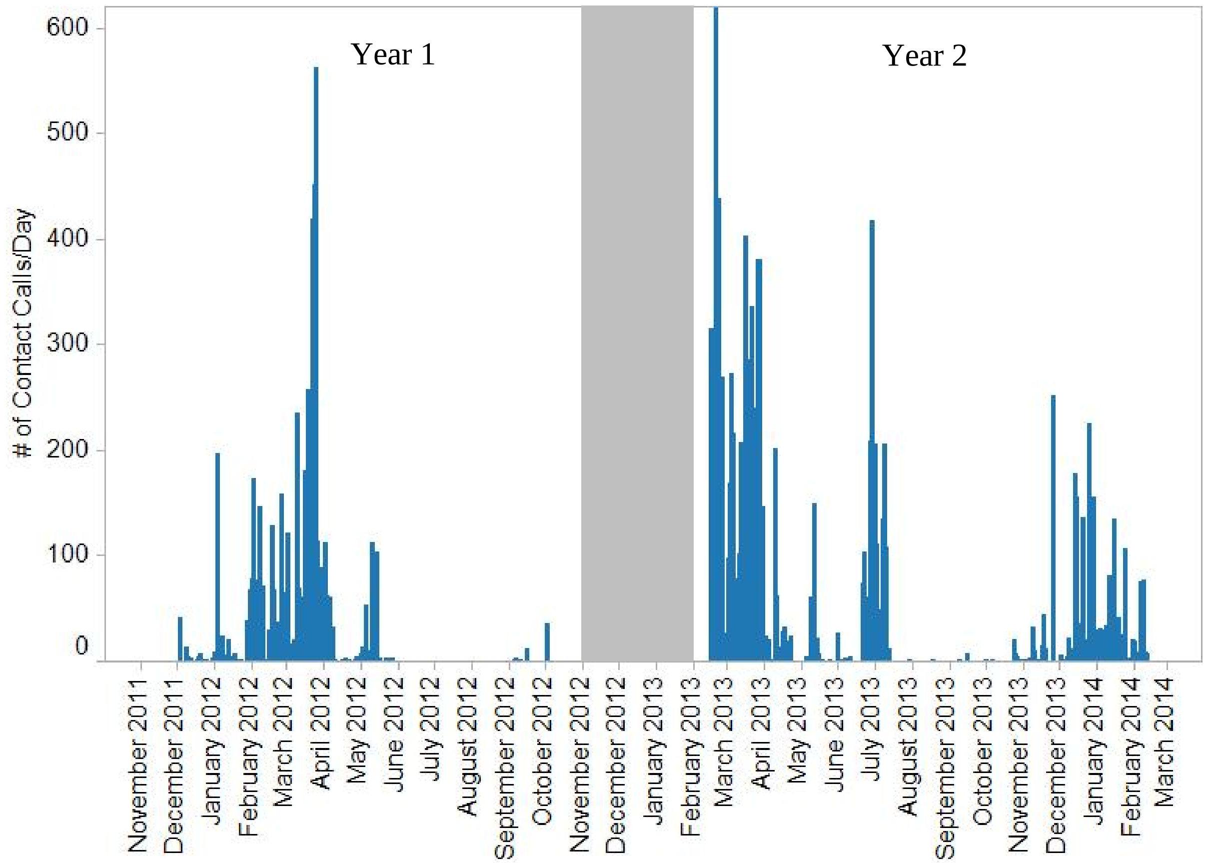

Figure 18. Total number of first arrival right whale contact calls in each day analyzed (10 November 2011 – 13 February 2014). Note: Multiple MARUs experienced data loss in Year 2, possibly resulting in a conservative estimate of call abundance. See section 2.2 for details.

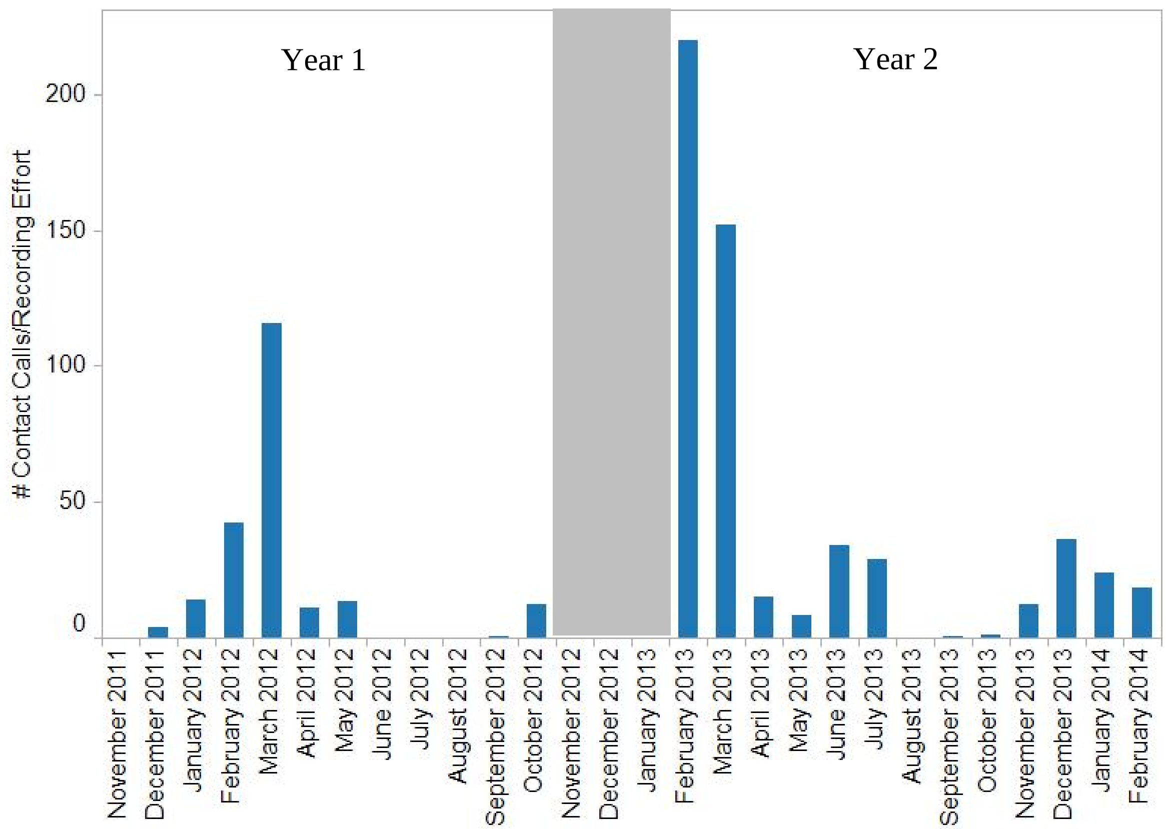

Figure 19. Total number of right whale contact calls in each month normalized for recording effort (number of calls divided by number of days sampled) for all days analyzed (10 November 2011 – 13 February 2014). Note: Multiple MARUs experienced data loss in Year 2, possibly resulting in a conservative of call abundance. See section 2.2 for details.

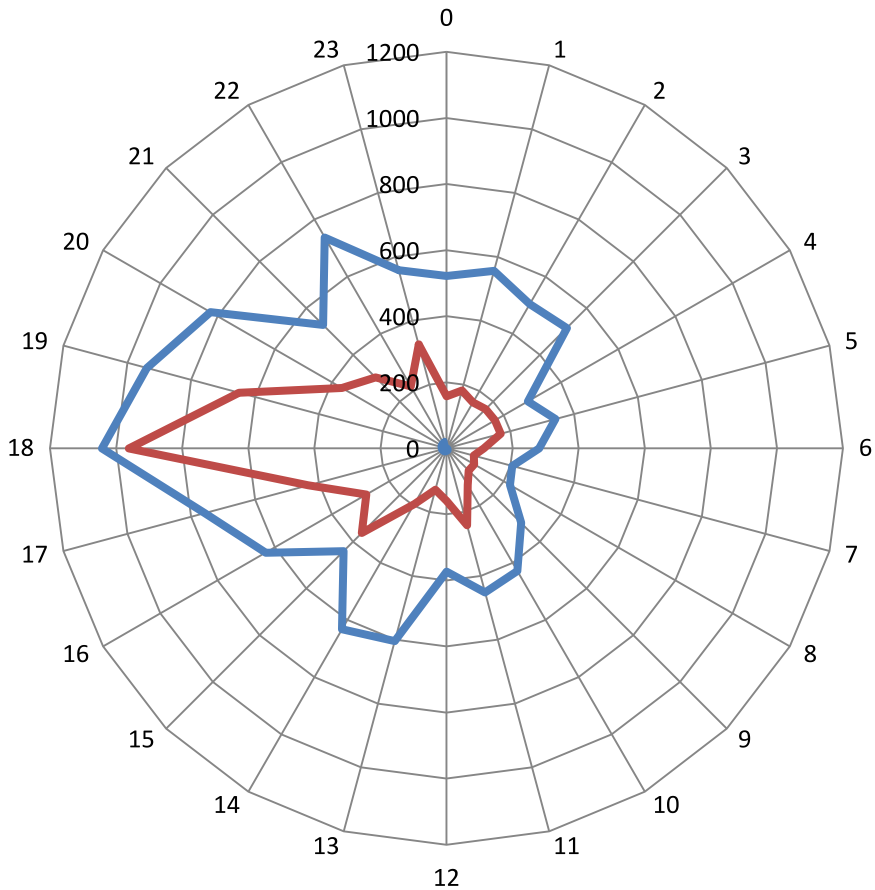

Figure 20. Number of right whale contact calls per hour (in EST) for Year 1 (red line) and Year 2 (blue line). Radial axes show number of calls in increments as indicated. Note: Multiple MARUs experienced data loss in Year 2, possibly resulting in a conservative estimate of diel call abundance. See section 2.2 for details.

4.5 Spatial Distribution of Right Whale Vocal Activity in Year 2

The spatial distribution of right whale contact calls was determined by identifying the closest MARU to all first arrival contact calls. The numbers of first arrival contact calls detected at each MARU for Year 2 are shown in Figure 21. In addition, Table 6 shows the total number of contact calls recorded in both Year 1 and Year 2 for each site. It is important to note that the loss of data due to MARU malfunction may have resulted in a conservative estimate for vocal activity for some sites (see section 2.2 for MARU malfunction information). A total of 18,844 right whale contact calls were detected on all 9 MARUs in the array when considering both Year 1 and Year 2. Of that total, 12,699 or 67% of the contact calls were detected in Year 2. Figure 21 shows that the presence of right whale contact calls in Year 2 was greatest at site MA-2 (n = 2933), and the second highest vocally active site was RI-3 (n = 2400). The least number of right whale contact calls occurred at MA-1 (n = 386). Figure 22 shows the seasonal distribution of right whale contact calls in Year 2. Table 7 shows the corresponding values for each MARU in each season. Right whale vocal activity was most concentrated in the spring and winter periods. The least number of detected calls occurred in the fall. The contact calls in the summer are concentrated in the easternmost sites of the MA WEA (MA-2 through MA-6), with very few calls detected in the RIMA WEA.

Table 6. Number of first arrival right whale contact calls detected per site for Year 1 and Year 2. “NA” indicates that no sound data was collected in the RIMA WEA array during Year 1.

	# of Contact Calls	
MARU Site ID	**Year 1**	**Year 2**
MA-1	1689	386
MA-2	3161	2933
MA-3	300	1217
MA-4	377	1420
MA-5	229	1507
MA-6	389	1446
RI-1	NA	921
RI-2	NA	469
RI-3	NA	2400

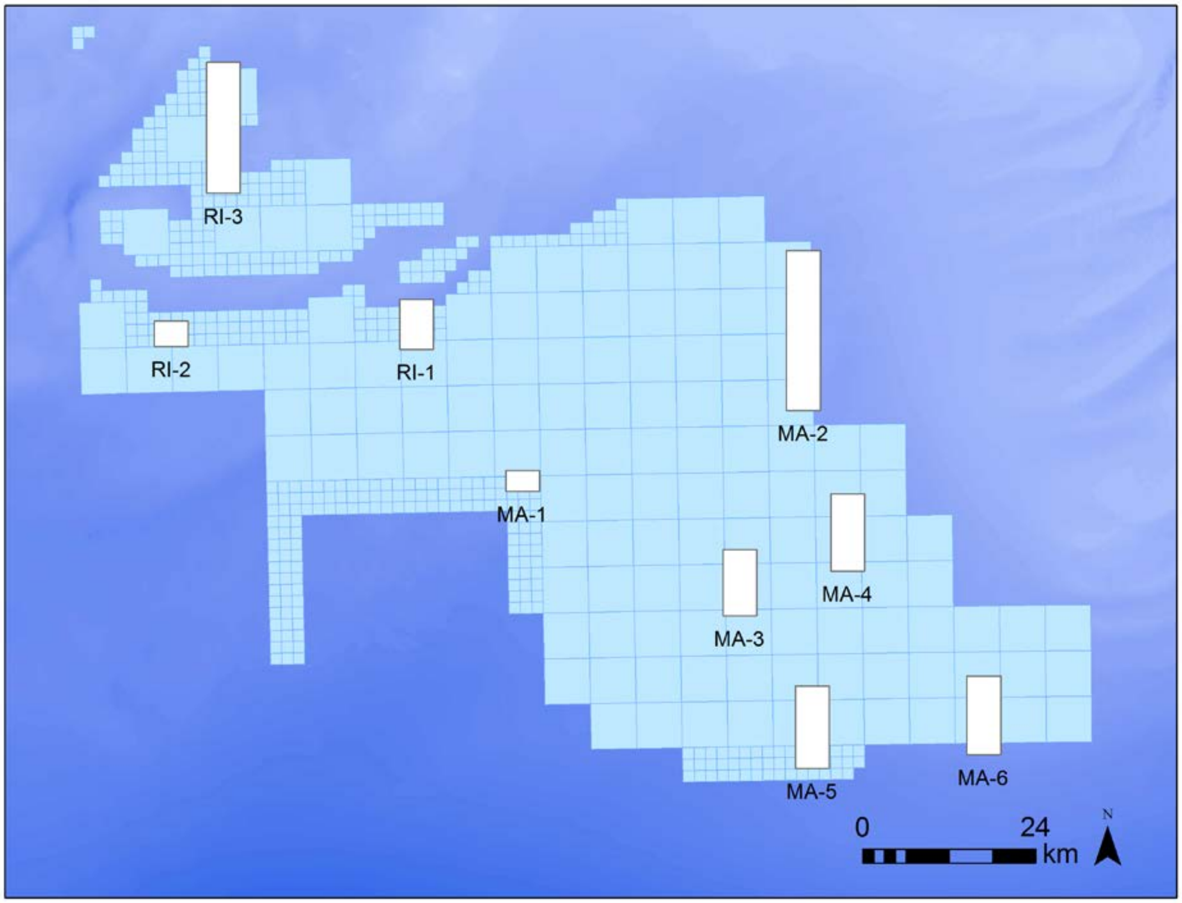

Figure 21. Total number of right whale contact calls detected in Year 2 at each site. Note: Multiple MARUs experienced data loss in Year 2, possibly affecting the results. See section 2.2 for details.

Table 7. Number of first arrival right whale contact calls detected per site for each season in Year 2.

	# of Contact Calls			
MARU Site ID	Autumn (Sept-Nov)	Winter (Dec – Feb)	Spring (Mar – May)	Summer (Jun – Aug)
MA-1	0	8	320	58
MA-2	0	1634	1013	286
MA-3	77	655	341	144
MA-4	0	287	708	425
MA-5	210	668	227	402
MA-6	0	318	551	577
RI-1	47	208	657	9
RI-2	7	462	0	0
RI-3	78	706	1616	0

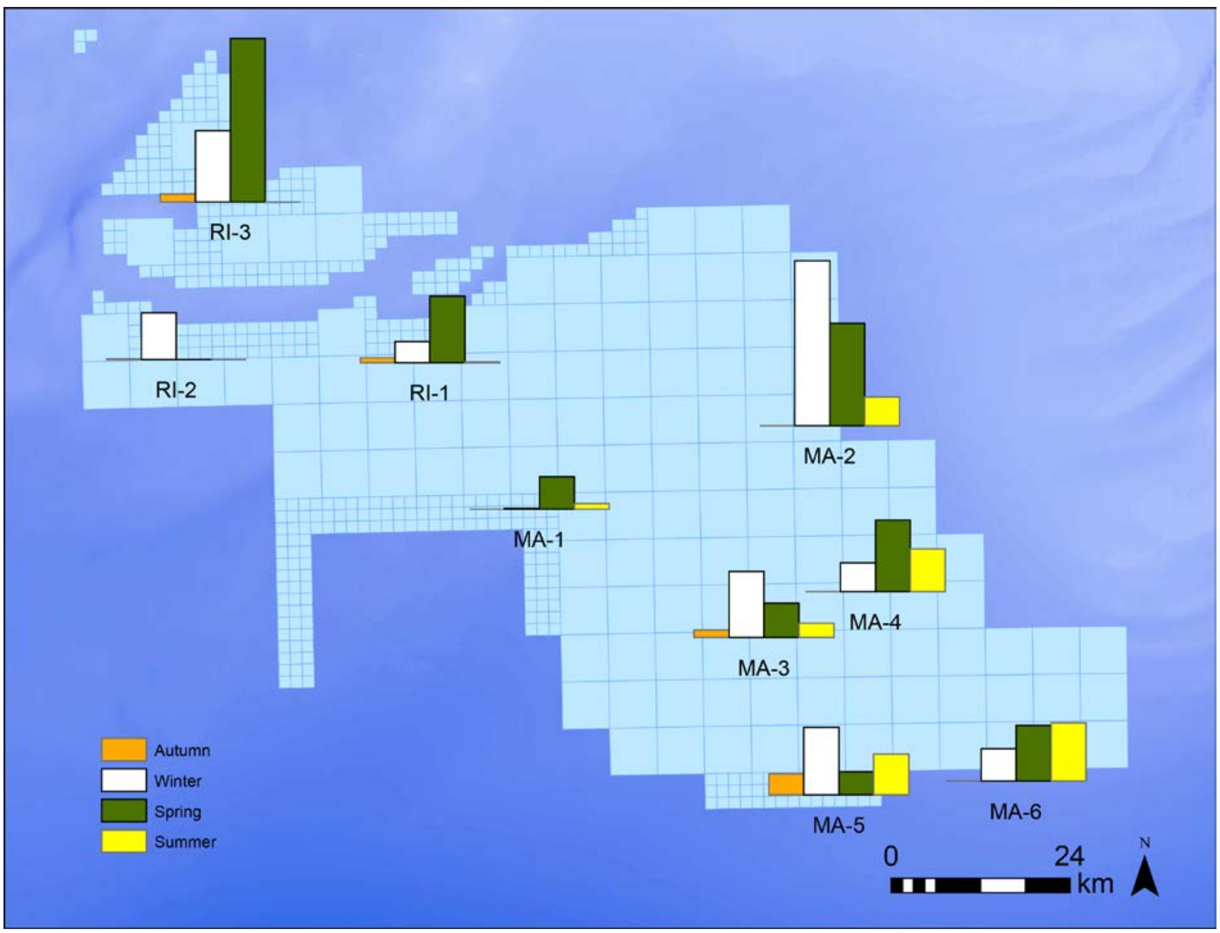

Figure 22. Year 2 seasonal distribution of right whale contact calls.

4.6 Additional Species Identified

During the sound analysis of the 5 target species, analysts identified additional marine mammal species of interest that were not a focus of this study. The identification of the vocalizations of species other than the 5 focal species was done opportunistically. If an analyst observed an identifiable vocalization from another species, a note was made in a tracking spreadsheet to be able to refer back to the day the vocalization occurred. The images below give examples of vocalizations from three species opportunistically observed during analysis: sei whale (Figure 23), sperm whale (Figure 24), and an unknown pinniped species (Figure **25**). Additional biological sounds were observed but were not definitively identified. Examples of additional sounds include multiple low frequency tonal sounds and also sequences of low frequency pulses. The characteristics of these sounds indicate they may be additional marine mammal and/or fish vocalizations.

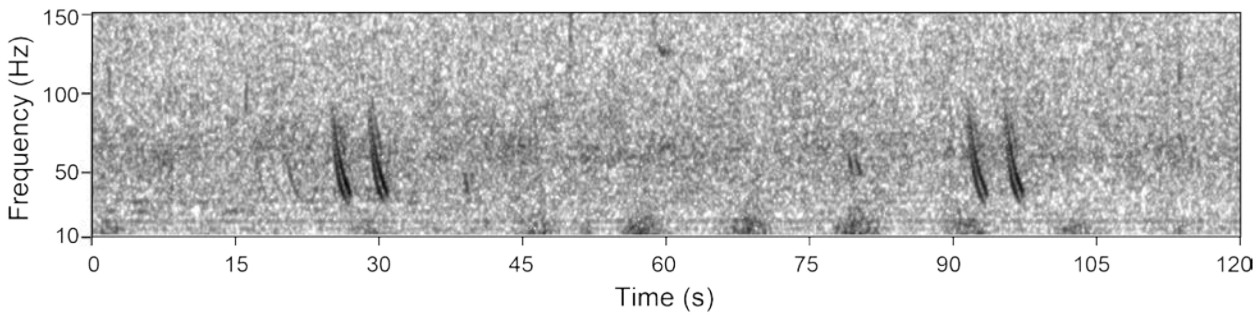

Figure 23. A 27-second spectrogram showing an example of a potential sei whale downsweeps (Baumgartner et al. 2008) recorded at MA-5 on 11 May 2011.

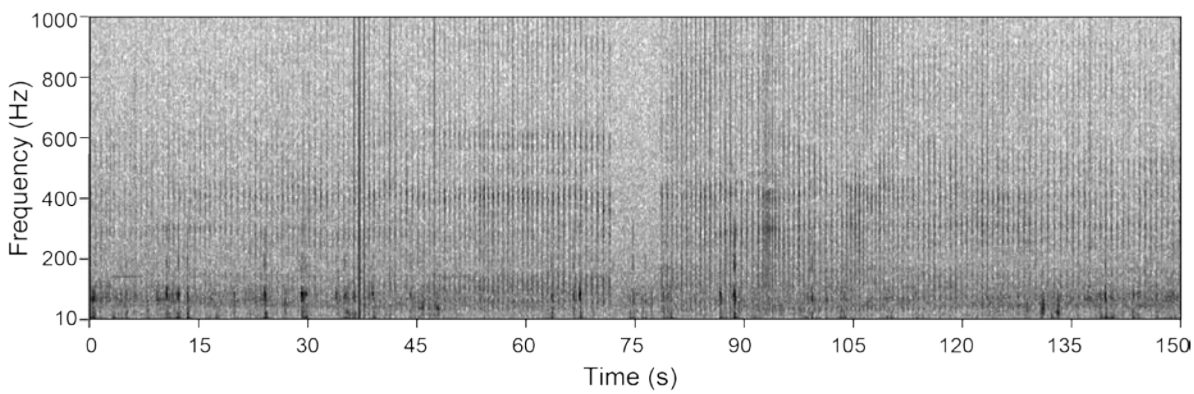

Figure 24. A 150-second spectrogram showing an example of a sperm whale click train (darker vertical pulses) (Watkins & Schevill 1977; Goold & Jones 1995; Newcomb et al. 2002) recorded at MA-1 on 09 September 2012.

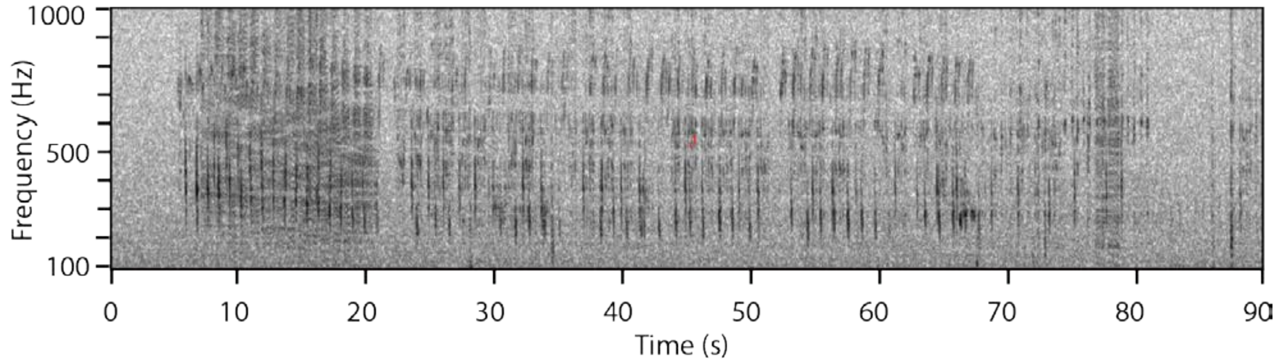

Figure 25. A 90-second spectrogram showing an example of biological sounds, which are believed to be pinniped vocalizations, recorded at MA-2 on 28 May, 2013.

4.7 Ambient Noise

4.7.1 Long-Term Ambient Noise Analysis

Ambient noise results are presented for each MARU by both year and deployment. The acoustic survey area represents a dynamic ambient noise environment, with noise contributions from a diverse biological community of vocalizing animals. Also present were periodic anthropogenic sources of sound that contributed at varying levels to the sound environment (Figure 30). Three representative sites were chosen for an in-depth, long-term ambient noise analysis based on duration of near-continuous recording and position within the array. Throughout the recording period, MARUs that were stationed closer to the Ambrose-Nantucket Traffic Separation Scheme (TSS) recorded louder ambient noise levels than those further from the TSS.

Of the 3 sites in which detailed ambient noise analysis was conducted, RI-3 was the quietest, with sound levels rarely exceeding 95 dB. In Year 2, the highest sound pressure level of the percentile between 50 and 100 Hz, a frequency band typically representative of shipping noise (Wenz 1962), was approximately 95 dB (Figure 27, Panel A). In the 20 Hz frequency band, there was a peak in sound pressure between August 2013 and February 2014, likely attributed to fin whale 20-Hz notes (Figure 27, Panel B). A loud anthropogenic noise of unknown origin occurred in the first week of March 2013 and is visible in both spectrograms (Figure 26, Panel A and B) and by peaks in the sound pressure density spectrum (Figure 27, Panel A) between 50 and 200 Hz. This same sound was loud enough to arrive at other sites in the array. The noise appears to be mechanical, but the source of the noise was not able to be confirmed.

Sound levels at site MA-3 were between those of MA-5 and RI-3, in which the percentile curve rarely reached below 95 dB between 10 – 100 Hz. Throughout both Year 1 and Year 2, there was a steady presence of ship noise; evident by the warm colors concentrated around 40-80 Hz in the 1/ octave spectrogram (Figure 28, Panel B). Year 2 experienced slightly lower sound pressure levels (approximately 97 dB) between 50 and 100 Hz than Year 1 (100 dB). In early March, 2013, loud anthropogenic activity is illustrated by the red streaks in the 1/ octave spectrogram and by the peak in relative sound pressure levels between 100 and 200 Hz (Figure 29, Panel C). Around 20 Hz, a red and yellow band is visible in the 1/ octave spectrogram between December 2011 and February 2012 of Year 1, and again between December 2013 and January 2014 of Year 2, when the recording period ended. This increase in relative sound pressure levels at 20 Hz is also represented in the sound pressure density spectra between November 2011 and April 2012 of Year 1, and August 2013 and February 2014 of Year 2 (Figure 29, Panel A and D, respectively), where relative sound levels in the percentile curves of both time periods reached 105 dB. The source of this event is likely attributed to fin whale song.

Site MA-5 is positioned closest to the Ambrose-Nantucket TSS and recorded the loudest sound pressure levels within the 50-100 Hz frequency band (110 dB) (Figure 31 and Figure **32**). A series of zoomed-in spectrograms from Year 2 (Figure 30) illustrate shipping activity in three different time scales; 90 days (Panel A), 5 days (Panel B), and 7 hours (Panel C). In panels B and C, shipping events clearly overlap humpback whale song in both frequency and time. The loudest percentile noise levels occurred around 50 Hz throughout both sampling years (Figure 32), in contrast with MA-3, where sound pressure levels reached a maximum around the 20 Hz frequency band. At MA-5, there was an increase in sound pressure levels in the 20 Hz frequency band in both sampling years, however, due to the higher levels of low-frequency noise; those peaks are less evident than with MA-3. High sound pressure levels around 20 Hz (105 dB) in the 1/ octave spectrogram and the sound pressure density spectrum illustrate the contribution of fin whale song to the ambient noise environment between November 2011 and October 2012 of Year 1 (Figure 32, Panel A), and between February 2013 and February 2014 of Year 2 (Figure 32, Panel D). In the sound pressure level density figures of both sampling years, there is a slight decrease in the percentile sound levels above 600 Hz that is not as prevalent at MA-3 or RI-3. This may represent humpback whale song, since songs recorded during this survey typically did not exceed 600 Hz and most humpback whale songs originated nearest to MA-5.

Each MARU recorded some degree of self-noise for both deployments. The self-noise is generated internally and subsequently recorded, and can be seen by the small peaks in the percentile power spectra between 910 Hz and 1000 Hz at each site.

4.7.2 Representative 24-hour Ambient Noise Analysis

Four, representative 24-hour spectrograms were chosen to illustrate variations in ambient noise sources and noise levels. The four days comprise one day with low acoustic activity (Figure 33), a day with high levels of biological acoustic activity (Figure 34), a day with high levels of anthropogenic acoustic activity (Figure 35), and a day with overlapping biological and anthropogenic acoustic activities (Figure 36).

Site MA-1 on 11 November 2011 was chosen to represent a quiet day, in which relative sound levels did not exceed approximately 90 dB for the percentile (Figure 33, Panel C). There were a few distant shipping events that occurred at the beginning of the 24-hour period, but they were not close enough to the MARU to generate high sound levels. No obvious biological sounds were represented in this figure, though there was an acoustic event that occurred around 80 Hz throughout most of the day, which is visible on panels A, B and C. Due to the continuous nature and acoustic characteristics of the sound, the source of this signal is suspected to be debris that repeatedly bumped into the suspended MARU as a result of wave action or tidal activity.

Site MA-3 on 20 March 2012 represents a biologically active sound day, where humpback whale song, minke vocalizations, and fin whale 20-Hz song were visible in both the spectrograms and the power density spectrum figures (Figure 34, Panel A, B and C). Humpback whale song occurred throughout most of the 24-hour period. In the power density spectrum figure (Panel C), there is a decrease in relative sound levels around 575 Hz in the percentile, that corresponds with the maximum frequency range of the humpback whale song on this day. Minke whale vocalizations occurred at the beginning of the 24-hour period, with bouts of vocal activity visible between hours 00:00 and 03:00, and between 05:30 and 06:00. In the 1/ octave figure (Figure 34, Panel B), the higher amplitude component of the minke whale vocalization is visible between 100 and 160 Hz. Fin whale 20 Hz notes occurred throughout most of the 24-hour period. The 20 Hz notes are visible in the 1/ octave figure (Figure 34, Panel B) and the power density spectrum (Figure 34, Panel C) in the 20 Hz frequency band. Relative sound levels reached 100 dB between 50 and 100 Hz in the power density spectrum, which corresponds with the frequency range of the visible anthropogenic activity that occurred throughout the day.

At site MA-6 on 28 May 2012, anthropogenic activity occurred through much of the 24-hour period (Figure 35). Noise levels frequently reached above a relative sound level of 100 dB for the percentile between 10 and 125 Hz (Figure 35, Panel C). There were no obvious biological acoustic signals visible during this 24-hour recording period.

Site MA-6 on 14 March 2012 represents a day of both high biological and anthropogenic activity (Figure 36). Humpback whale song occurred throughout the day, with brief breaks between song that can be seen in the spectrogram and the 1/ octave figures (Figure 36, Panels A and B). There was also a decrease in the relative sound level of the percentile 575 Hz, which was roughly the maximum frequency of the humpback whale song on this day. Fin whale notes occurred throughout the 24-hour period and can be seen in the 1/ octave figure (Figure 36, Panel B) and the power density spectrum (Figure 36, Panel C) near the 20 Hz frequency band. Shipping noise and other anthropogenic sounds occurred throughout the day, which caused relative sound levels below approximately 125 Hz to exceed 100 dB. At times, shipping noise exceeded the amplitude of the humpback whale song, preventing the humpback song from being distinguishable from the shipping noise in the spectrogram.

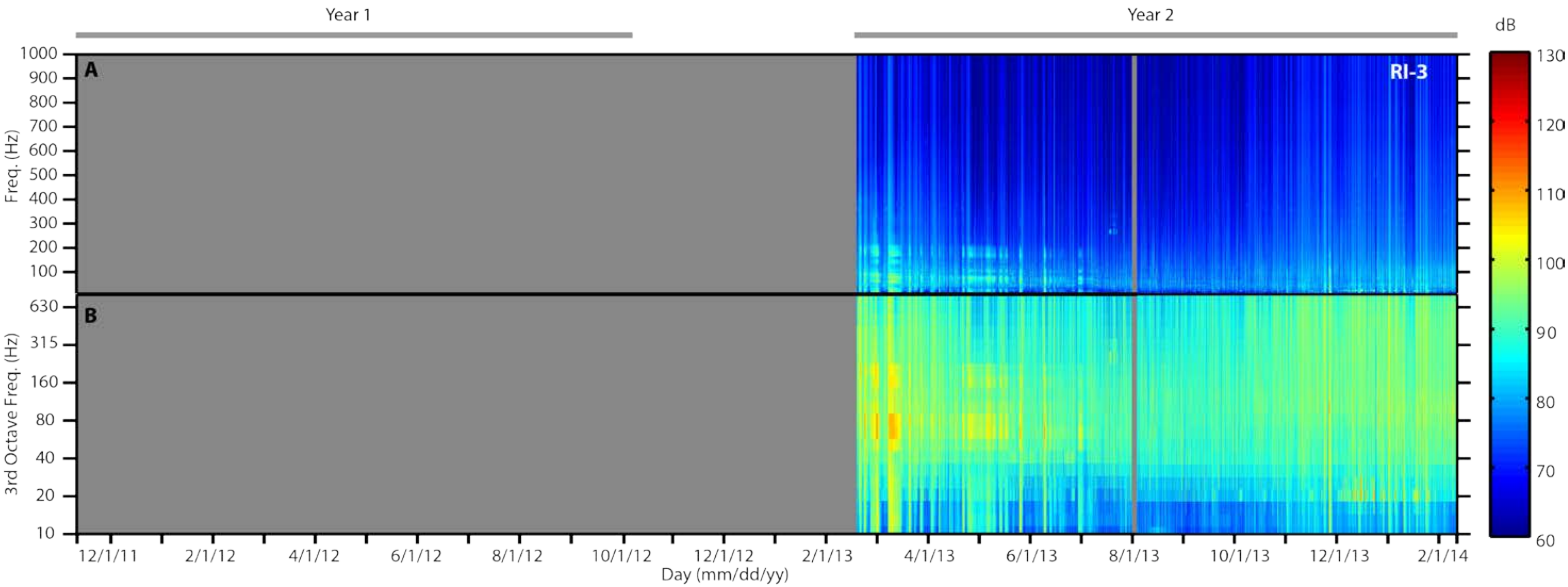

Figure 26. Spectrogram of audio data from RI-3, spanning the project period from November 2011 through February 2014, represented as A) linear frequency axis from 10 – 1000 Hz and B) 1/ octave band frequencies between 10 -708 Hz. the color bar to the right of the panels indicates the power scale, in dB (re: 1 µPa). Sections in grey represent time periods where no audio data were collected. There is no sound data for RI-3 since it was not deployed during Dep-1 and Dep-2 (Year 1).

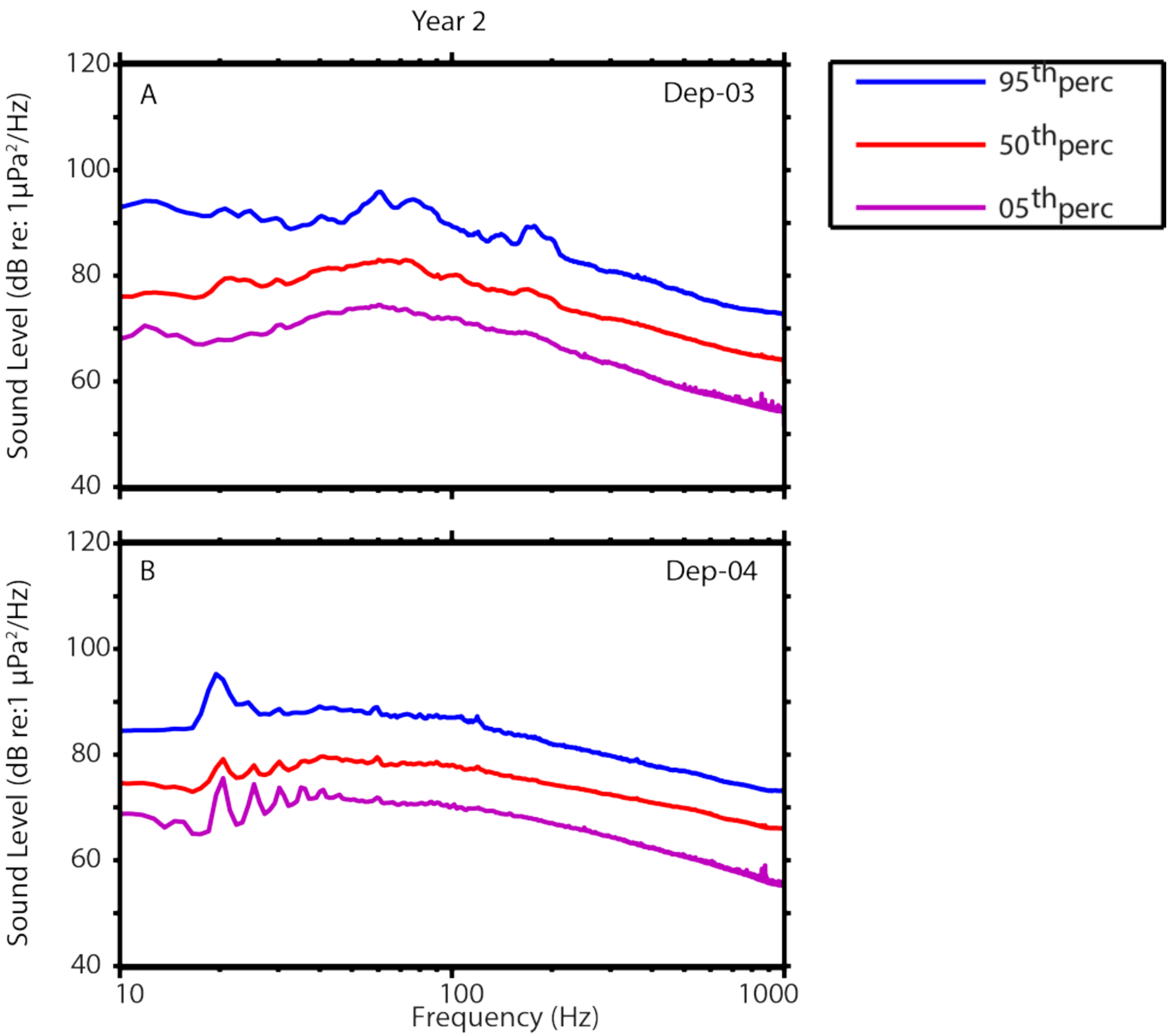

Figure 27. Sound pressure density spectra of audio data from RI-3 showing sound pressure levels (dB re: /Hz) versus frequency for each deployment. Each spectral series is represented as statistical percentiles - the upper percentile (blue), the median percentile (red), and the lowest percentile (purple) – to show the variability in the sound over each time period.

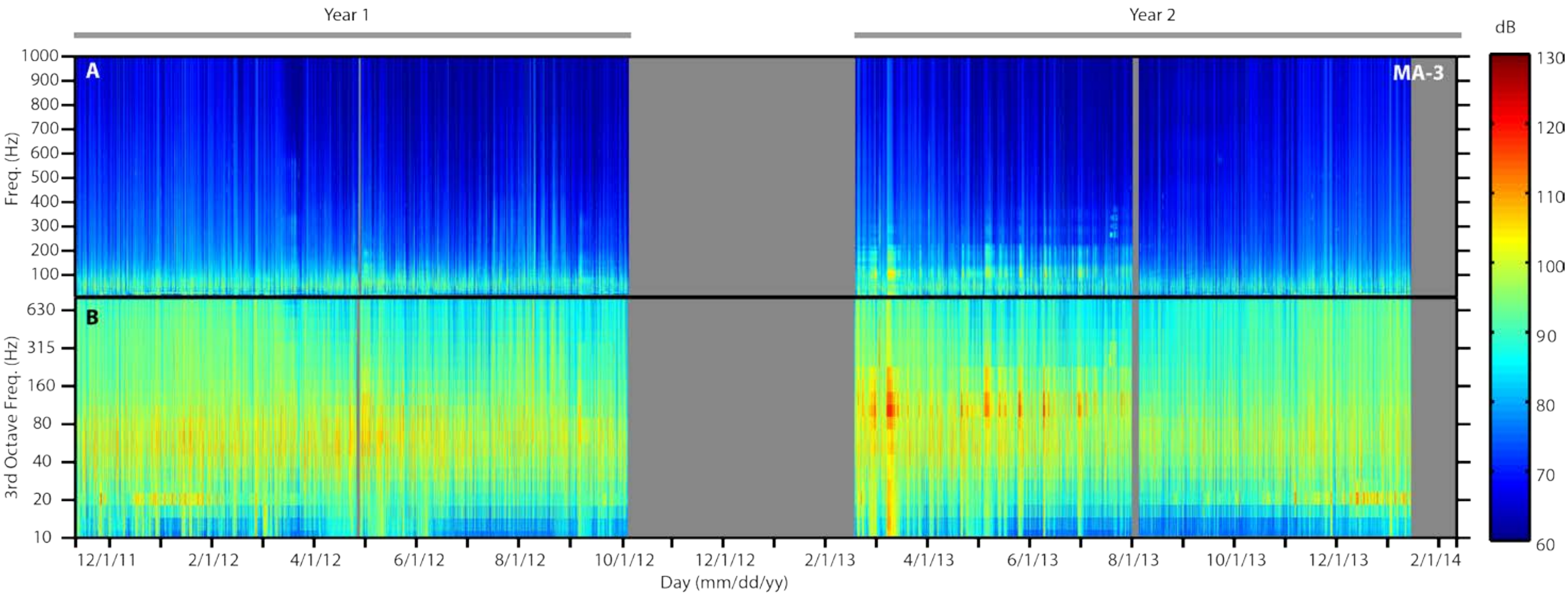

Figure 28. Spectrogram of audio data from MA-3, spanning the project period from November 2011 through February 2014, represented as A) linear frequency axis from 10 – 1000 Hz and B) 1/ octave band frequencies between 10 -708 Hz. the color bar to the right of the panels indicates the power scale, in dB (re: 1 µPa). Sections in grey represent time periods where no audio data were collected.

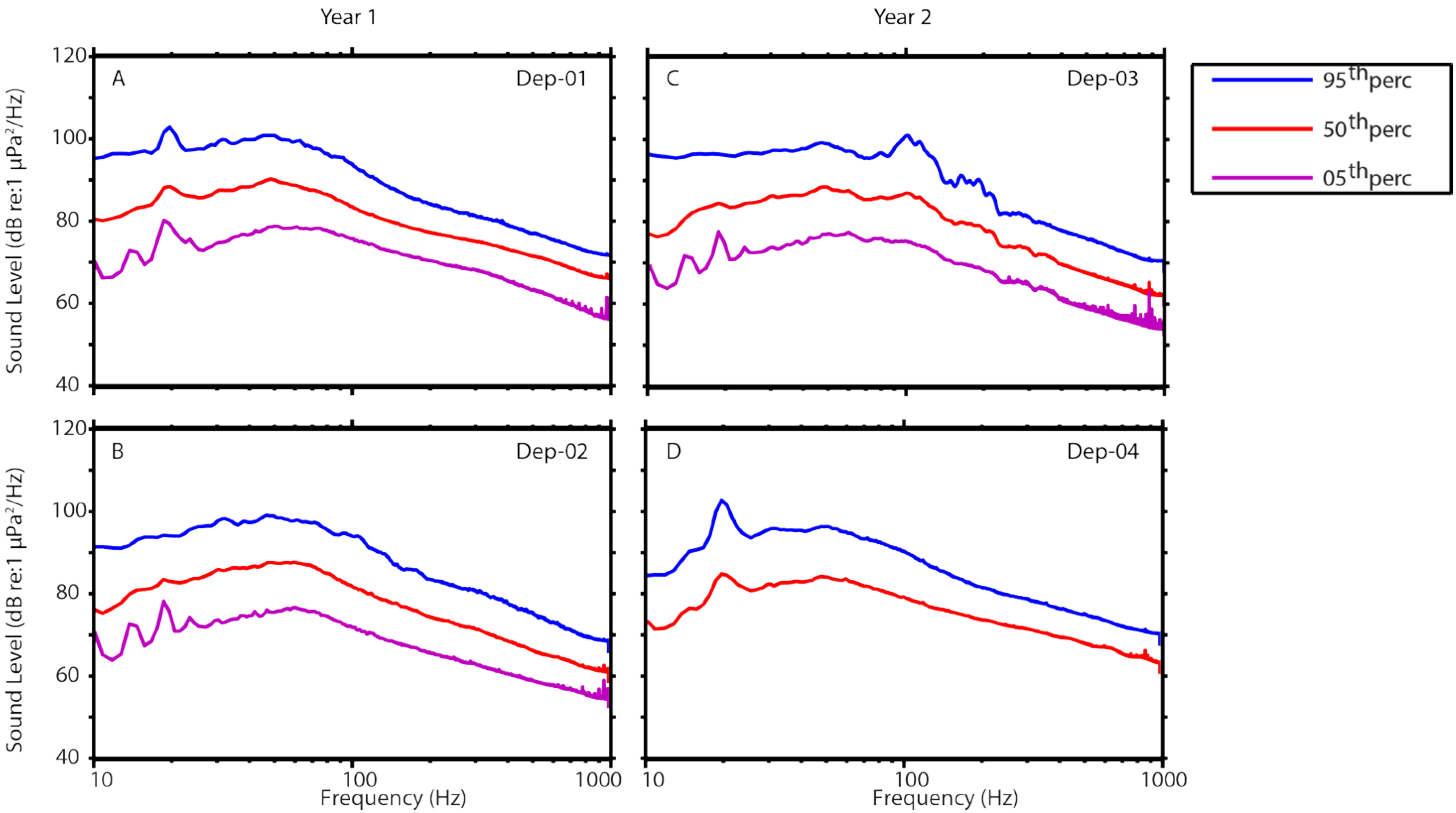

Figure 29. Sound pressure density spectra of audio data from MA-3 showing sound pressure levels (dB re: /Hz) versus frequency for each deployment. Each spectral series is represented as statistical percentiles - the upper percentile (blue), the median percentile (red), and the lowest percentile (purple) – to show the variability in the sound over each time period.

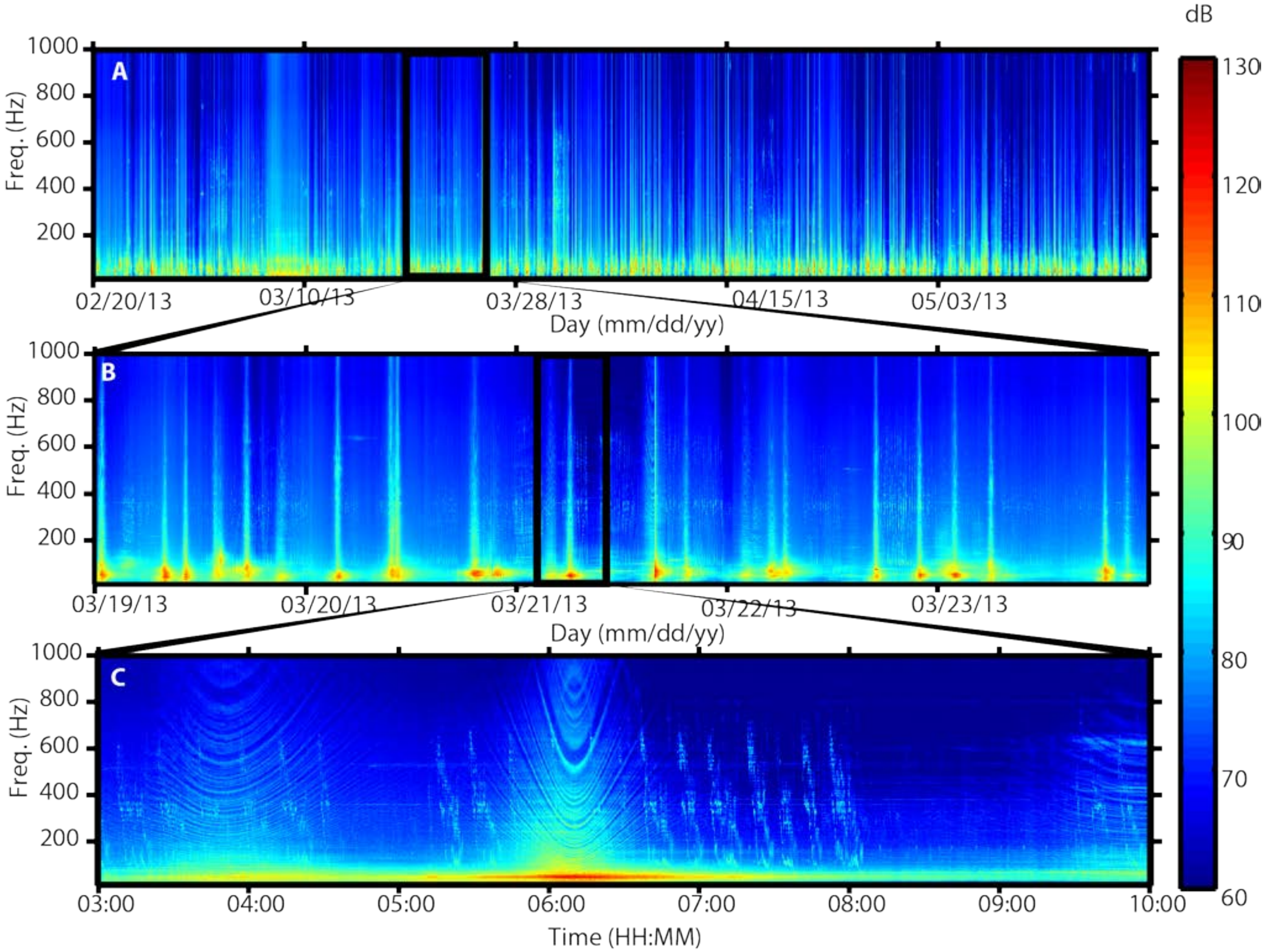

Figure 30. Spectrograms of audio data from MA-5 spanning three different time periods between 20 February 2013 and 20 May 2013; A) 90 days, B) 5 days, C) 7 hours, with time along the x-axis and linear frequency from 10 – 1000 is along the y-axis. The sound events that appear as red and yellow colors below 100 Hz are ships passing the recording site.

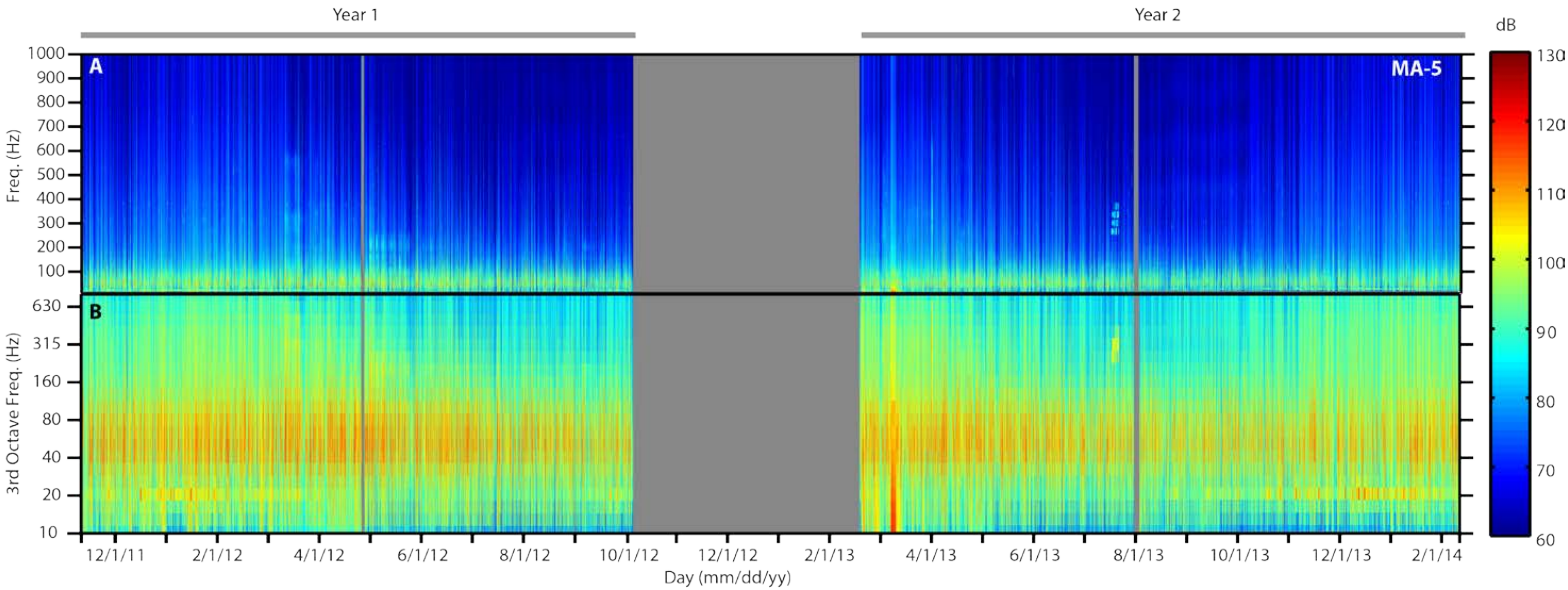

Figure 31. Spectrogram of audio data from MA-5, spanning the project period from November 2011 through February 2014, represented as A) linear frequency axis from 10 – 1000 Hz and B) 1/ octave band frequencies between 10 -708 Hz. the color bar to the right of the panels indicates the power scale, in dB (re: 1 µPa). Sections in grey represent time periods where no audio data were collected.

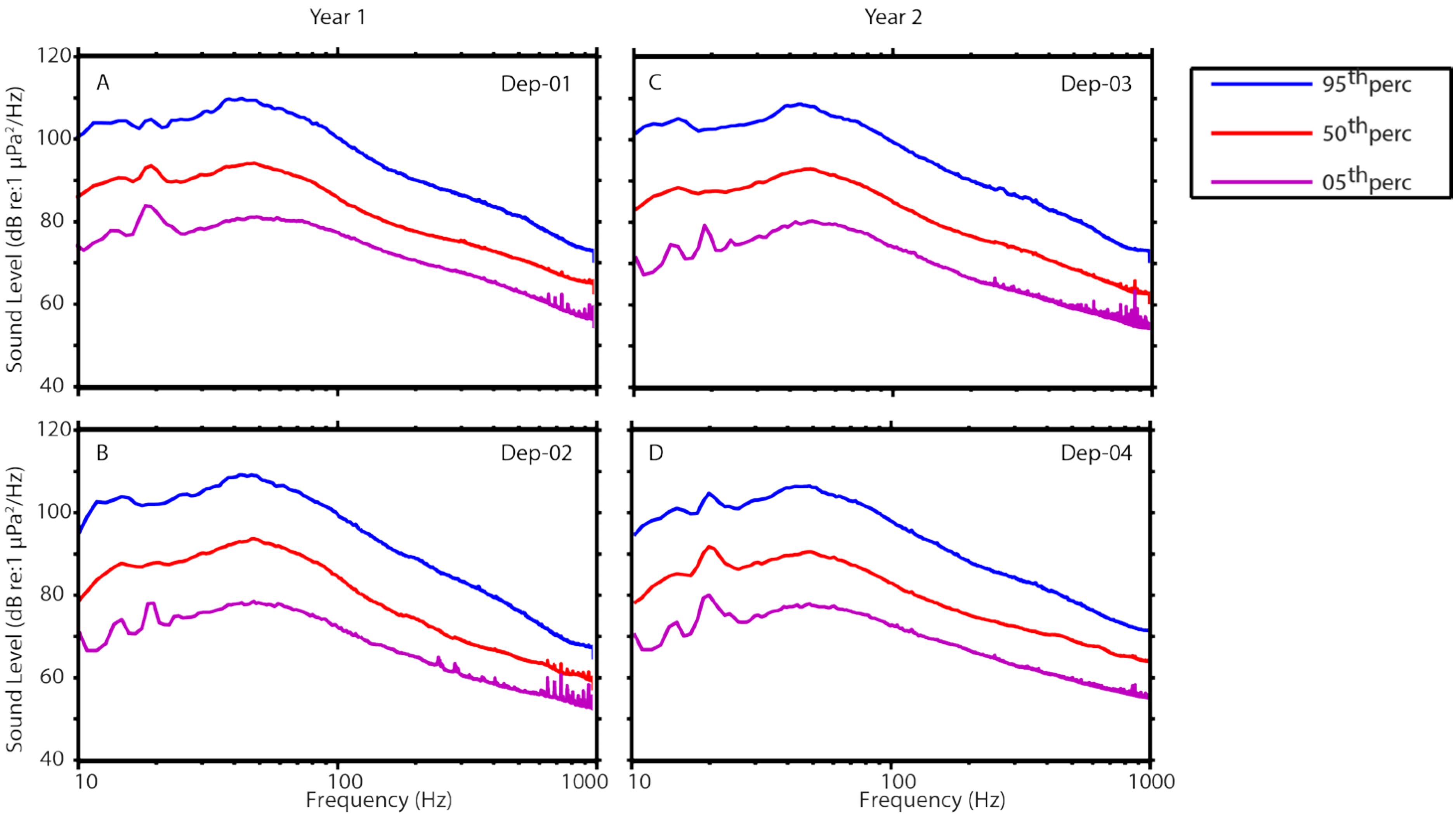

Figure 32. Sound pressure density spectra of audio data from MA-5 showing sound pressure levels (dB re: /Hz) versus frequency for each deployment. Each spectral series is represented as statistical percentiles - the upper percentile (blue), the median percentile (red), and the lowest percentile (purple) – to show the variability in the sound over each time period.

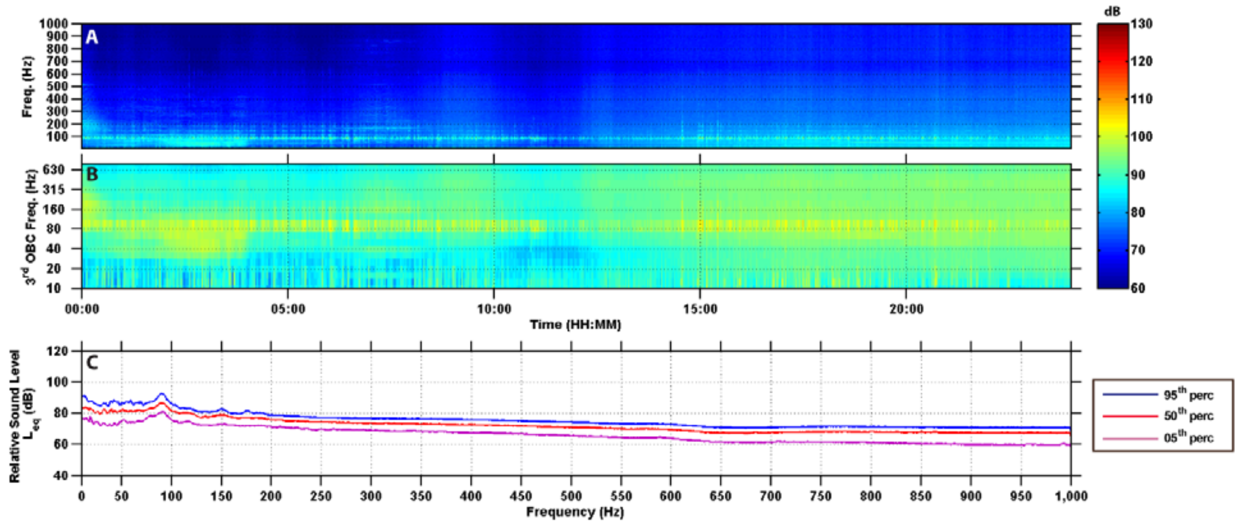

Figure 33. Ambient noise analysis figures for a 24-hour recording period at site MA-1 on 11 November 2011. These figures show little variation in ambient noise activity occurring at this recording station throughout the 24-hour period; representing a relatively quiet sound day.

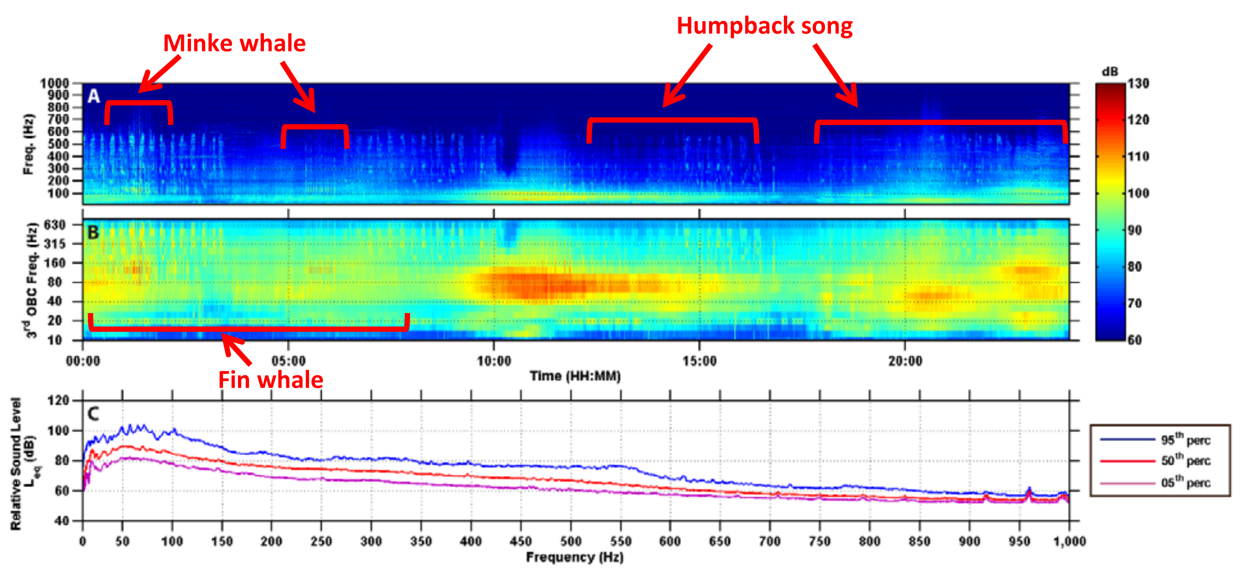

Figure 34. Ambient noise analysis figures for a 24-hour recording period at site MA-3 on 20 March 2012. This figure represents a biologically diverse sound day, with humpback song, minke whale vocalizations, and fin whale notes. Some anthropogenic activity is also visible.

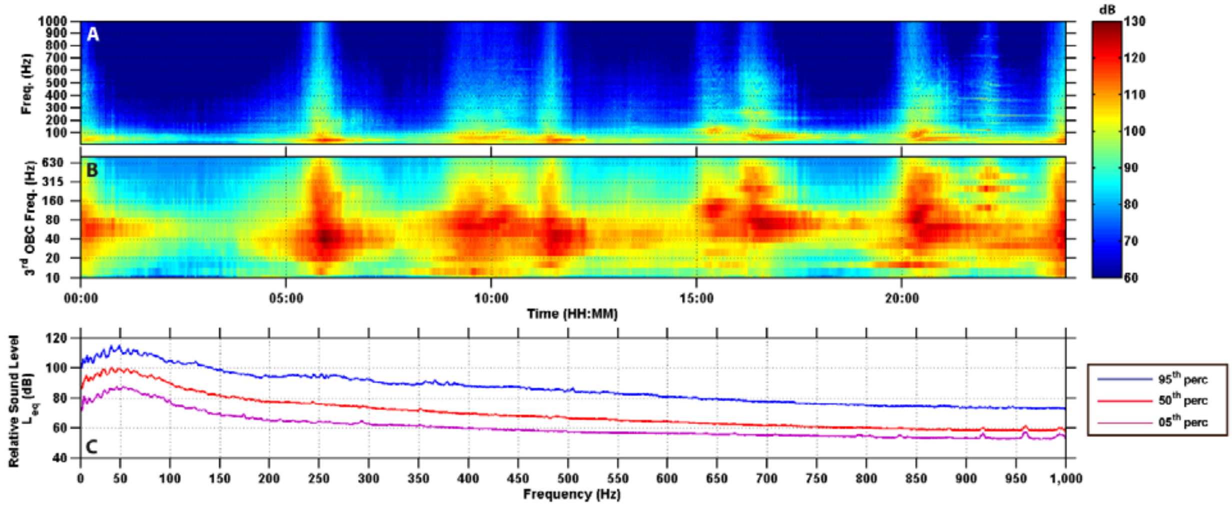

Figure 35. Ambient noise analysis figures for a 24-hour recording period at site MA-6 on 28 May 2012. This figure illustrates increased noise from anthropogenic activities such as shipping; which appear as red and yellow events in the spectrograms (Panel A and B).

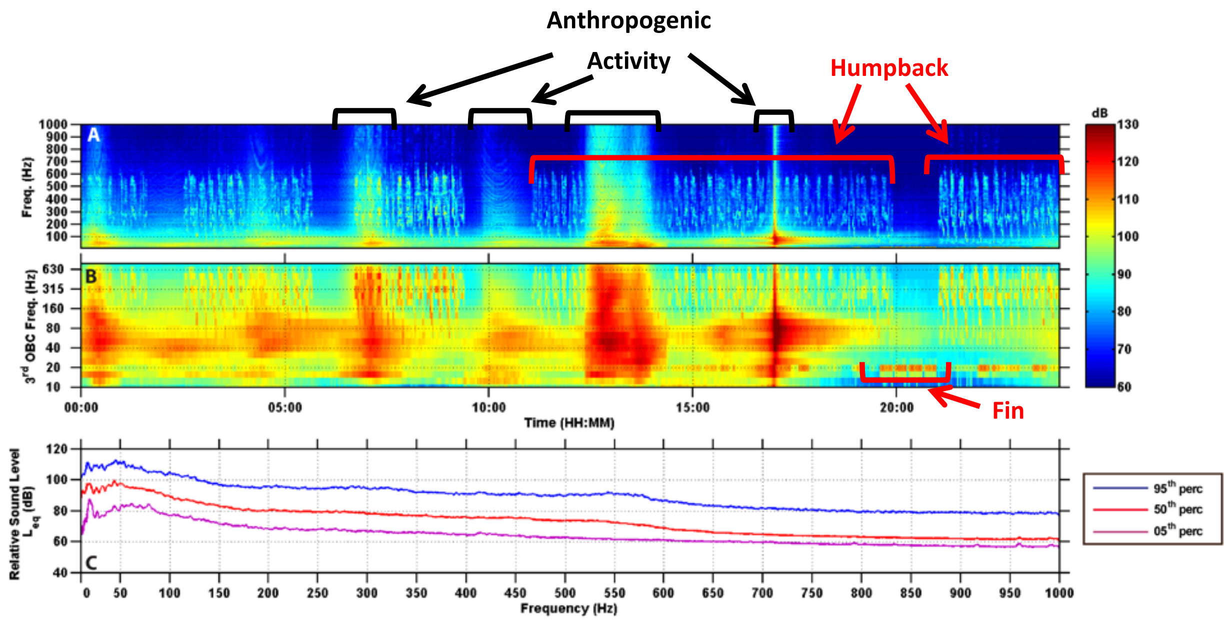

Figure 36. Ambient noise analysis figures for a 24-hour recording period on 14 March 2012 at site MA-6. This figure shows a variety of both anthropogenic and biological acoustic events that occurred throughout the 24-hour period.

5 Discussion

5.1 Patterns of whale acoustic presence

This report presents the results of Year 2 of a multi-year acoustic analysis. Also presented is a preliminary analysis of both Year 1 and Year 2 to begin to understanding the changes in the detection of marine mammal vocalizations over long time periods. A more in-depth analysis of long-term spatial and temporal trends will be conducted during the Year 3 analysis. Year 2 experienced a loss in recording data due to MARU malfunction, which may have resulted in conservative estimates of acoustic presence.

5.1.1 Year 2

In Year 2 (February 2013– February 2014), right whale, fin whale, and humpback whale vocalizations were recorded in all months analyzed. Minke whale vocalizations were detected in 9 months of the year-long study, but not detected from November 2013 through February 2014. Blue whale vocalizations were only detected in one month; February 2013. The highest monthly acoustic presence of right whale occurred in February and March 2013, and the lowest occurred in August and September 2013. The highest acoustic presence of both minke and humpback whales occurred in April which is the same month when fin whale acoustic presence was the lowest. Fin whale vocalizations were detected throughout the year and occurred on every day of recorded sound during the months of October 2013 through February 2014.

A total of 12,699 right whale contact calls were confirmed in Year 2. The majority of these calls occurred in February. A look at the diel pattern of the calls revealed similar results as Year 1, in which most calls occurred between the hours of 1700 to 2000. The spatial analysis of right whale vocalizations indicates that most contact calls originated from the area near MA-2 (northeastern-most site) and RI-3 (northern-most site), and the fewest vocalizations were detected at MA-1. A synthesis of these same contact calls to determine seasonal patterns shows that most calls occurred during the winter and spring. The relatively fewer contact calls that were detected during the summer were associated with the easternmost MARUs. The least number of calls occurred in the autumn.

During the second sampling year, part of the humpback whale song included a signal that exhibited similar acoustic properties as the right whale contact call. Although this was observed and detected to a lesser degree in the first year of sampling, that humpback signal in the second year caused the right whale detector used in this study to detect over 303,000 contact call events, only approximately 4% of which were actually confirmed right whale contact calls. Because humpback whale song generally occurs during the peak season in which right whale contact calls are present, analysts had to carefully evaluate the acoustic context of each right whale detection by reviewing adjacent channels and time periods around the detected event to determine if it was a right whale contact call or a humpback whale. This process was more time consuming than anticipated due to the unexpected volume of detections. This also brings to light the potential variability in the vocalizations of marine mammals that can exist, even within the same species (Payne & Webb 1971a; Risch et al. 2014). In the case of humpback whales, all males within a region will sing very similar songs at any given time, but song structure can progressively change over time (Cerchio et al. 2001); possibly explaining this difference between years. Another potential explanation could be an increase in numbers of animals in Year 2 compared to Year1. However, determining the number of animals was beyond the scope of this study.

5.1.2 Year 1 and Year 2

When considering which months of the year whales were acoustically present throughout the entire study (Year 1 and Year 2), acoustic presence varied temporally and spatially, depending on the species. Fin whale and humpback whale were acoustically present at least 1 day in all of the 25 months of this study, while right whales were acoustically present at least 1 day in 21 months, and minke and blue whales were acoustically present at least 1 day in 19 and 6 out of the 25 months, respectively. In addition, sperm whale and sei whale vocalizations were opportunistically identified during the analysis Year 1 and Year 2 data. These data indicate that all of the large whale species known to occur within the Western North Atlantic Ocean can be detected from bottom-mounted hydrophones deployed within the acoustic survey area, suggesting that this area is likely ecologically important for these species.

Differences in monthly acoustic presence as well as differences in seasonal patterns were observed between species. Right, minke and humpback whales exhibited somewhat similar seasonal trends of monthly acoustic presence with maximum acoustic presences occurring in the spring (March and April), and decreased acoustic presence during the summer and early fall. Fin whales showed an elevated level of monthly acoustic presence during the fall, winter and spring months. The monthly acoustic presence of blue whales followed a completely different pattern than the other 4 focal species, with acoustic presence detected only in winter (December-February) and in the late summer of 2012 (August and September). The discontinuous acoustic presence of blue whales could indicate pulses of the population moving through the area at different times of the year, illustrating a less predictable seasonal trend in acoustic presence, in contrast with the other 4 species, which exhibit strong seasonal patterns.

One of the purposes of collecting multiple years of data was to better understand the interannual variability of marine mammal presence. A comparison of the vocal presence for the five focal species showed changes in presence for each species between Year 1 and Year 2 of this study. Right whales were not detected from June – August in 2012 of Year 1, but were detected during these months in 2013 of Year 2. Of the 18,844 right whale acoustic detections that were confirmed through the whole sampling period, 12,699 of those were detected in 2013, twice the number of detections from 2012. The pattern of decreased fin whale vocal presence occurred in the summer months in 2012, but this decreased acoustic presence occurred in the spring (April and May) in 2012. Humpback vocal presence decreased in July and August of 2012, but in 2013 the activity continued to be strong though August but then decreased in September. The multiple changes observed between years may indicate behavioral changes over time in response to changing environmental factors (e.g. temperature, prey availability, weather patterns, etc.), however, evaluating those causal factors spans beyond the scope of this study.

The specific locations of whales relative to the WEAs were not determined because this was outside the scope of the project, however in some cases their general location can be estimated (see Morano et al. 2012). Because of the varying acoustic properties of different marine mammal species, different species can be acoustically detected at vastly different ranges. Therefore, the locations of the vocalizing whales from the 5 focal species (right, fin, minke, humpback, and blue whales) could have occurred from varying distances in or around the WEAs. We did not measure the detection range of the MARUs, however there is literature estimating detection ranges using localization (Laurinolli et al. 2003; Clark & Clapham 2004; Munger et al. 2011), or sound propagation modeling (Stafford et al. 2007; Širovic et al. 2007; Munger et al. 2011). Although there are multiple variables that can affect the actual detection range values (Marques et al. 2012) (e.g. source levels, frequency, source level and depth of vocalizing whale, sound speed profiles, bathymetry), we reference these published values and describe the generally approximated detection range of our MARUs for each species (see below).

In the case of right whales, enough detailed information was collected to identify the nearest MARU to a whale at the time of the vocalization. The combined results from both Year1 and Year 2 demonstrate that acoustic presence of right whales was higher at or near site MA-2, in the northeast corner of the MA WEA, and secondly at RI-3, in the northern section of the RIMA WEA. We estimate that the right whales can be detected by a MARU up to approximately 25 km from the MARU (McDonald & Moore 2002; Laurinolli et al. 2003; Clark et al. 2010). In the case of fin whales and blue whales, species whose calls propagate for long distances (Payne & Webb 1971b; Širovic et al. 2007), individuals could have been vocalizing either near the MARU array, or up to tens to greater than a hundred kilometers away. Using estimates of the detectable ranges for humpback and minke whale vocalizations found in the literature (Clark & Clapham 2004; Stafford et al. 2007; Risch et al. 2014) we estimate that the minke and humpback whales could have originated from up to 10 km to 29 km from the nearest MARU, respectively.

5.2 Ambient Noise

Temporal and spatial variability are principle characteristics of the ambient noise environment. Thus, long term studies are needed to statistically characterize this ambient noise variability within an environment (Wenz 1972). In these long-term acoustic data collection efforts, analysis of ambient noise allows for the opportunity to broadly evaluate the periodicity of physical environmental processes, acoustically active biological constituents of an acoustic environment, and the contribution of anthropogenic sounds to the ambient noise environment. The combined analysis of biological acoustic activity in relation to different anthropogenic or environmental sound levels offers the opportunity to examine how increases in noise levels may impact behavior of vocal and non-vocal species.

The ambient noise analysis of the MA and RIMA WEAs showed temporal and spatial variability between seasons and between the 9 recording sites. Sites further offshore recorded higher noise levels, indicating that some biological and anthropogenic acoustic events originated closer to the southeast region of the recording area. The fin whale and humpback whale vocalizations were loudest on MA-5 and MA-6, signifying that the vocalizing individuals were positioned farther offshore, in deeper water. The prevalence of high relative sound levels from 10-50 Hz on all MARUs is likely a result of the noise contribution from shipping traffic (Andrew et al. 2011). When comparing the relative sound levels at 50 Hz, RI-3 (the site farthest North West) recorded the lowest levels and MA-5 (the site furthest South East) recorded the highest levels, implying that the shipping activity occurred nearest to sites in the southeast region of the array, which are closest to the Ambrose-Nantucket TSS.

Overall, anthropogenic noise levels from shipping and other activities were low when compared to recordings of heavily trafficked shipping corridors (Rice, A.N., 2014). However, there were several instances in which a loud recorded shipping event occurred simultaneously with a vocalizing whale (i.e. humpback whale song was visible and audible before and after a period of intense ship noise), making the biological signal indistinguishable among the shipping noise, and thus decreasing the detection probability of the call both to other whales and the MARU. The decreased detection ability of animal sounds to conspecifics is known as masking (Hatch et al. 2008). Since whales rely on acoustic communication as part of their life histories, masking may have significant ecological impact for these species (Clark et al. 2009).

5.3 Future Directions

The whale presence data from this study reveal seasonal patterns of acoustic presence occurrence for 5 focal whale species over a 25-month period. The varying patterns of vocalization between species suggest that differing environmental factors may be driving whale vocalization. Due to the high degree of interannual variability of marine mammals, both spatially and temporally (e.g., Baumgartner & Mate 2003; Keiper et al. 2005), this study is being conducted for a total of three years. The third year of data will continue to add to the understanding of the overall variability of marine mammal occurrence. Data collection at these larger temporal scales will bring additional resolution to decision-making regarding Offshore Renewable Energy (ORE) development to help minimize potential impacts to marine mammals and their habitat. Future comparisons of the data collected in this study to various environmental factors, such as water temperature, presence or distribution of food resources, oceanographic patterns, combined with visual survey observations and results, could also provide valuable information in understanding and predicting whale behavior and occurrence.

Long-term measurements of ambient noise can provide a mechanism to document baseline sound levels to compare against possible future changes and perturbations, which may be critical in evaluating the status of marine ecosystems (McDonald et al. 2008). Chronically high levels of ambient noise can contribute to masking of marine mammal communication (Clark et al. 2009), potentially resulting in behavioral and physiological stress responses (Kight & Swaddle 2011; Rolland et al. 2012), therefore is it important to characterize the acoustic environment of biologically active habitats.

6 Credits & Acknowledgements

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Appendix 1. Abbreviations and Acronyms

AMAPPS	Atlantic Marine Assessment Program for Protected Species
ASSIST	ASSIST Aviation Solutions LLC
BOEM	Bureau of Ocean Energy Management
CCS	Center for Coastal Studies
CON	Concord Municipal Airport
Cornell	Cornell University's Bioacoustics Research Program
CSV	Comma-separated Values. Stores tabular data in plain-text form to a comma delimited file.
DIGITS	Digital Image Gathering and Information Tracking System
EEA	Executive Office of Energy and Environmental Affairs
EGNO	*Eubalaena glacialis* Catalogue Number
ELT	Emergency Locator Transmitter
EPIRB	Emergency Position Indicating Radio Beacon
FMC	Forward Motion Compensation
GSC	Great South Channel
JL	Jeffrey's Ledge
MA CEC	Massachusetts Clean Energy Center
NARWC	North Atlantic Right Whale Consortium
NEAq	New England Aquarium
NEFSC	Northeast Fisheries Science Center
NLPSC	Northeast Large Pelagic Survey Collaborative
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOREIZ	Northeast Offshore Renewable Energy Innovative Zone
OAE	Offshore Alternative Energy
OCS	Outer Continental Shelf
PA	Photo Analysis
PFD	Personal Flotation Device
PIC	Pilot-in-Command
PLB	Personal Location Beacon
PYM	Plymouth Municipal Airport
QA/QC	Quality Assurance and Checking
RFI	Request for Interest
SAG	Surface Active Groups
SAS	Statistical Analysis System
SCOPEX	South Channel Ocean Productivity Experiment
SIC	Second-in-Command
SPUE	Sightings per Unit Effort
The Task Force	The Massachusetts Renewable Energy Task Force
URI	University of Rhode Island
USCG	United States Coast Guard
VFR	Visual Flight Rules
VHF	Very High Frequency
WEA	Wind Energy Area

Appendix 2. List of Marine Species

Common names	**Latin names**
Thresher shark	*Alopias* sp.
Hammerhead shark	*Sphyrna* sp.
Atlantic white-sided dolphin	*Lagenorhynchus acutus*
Basking shark	*Cetorhinus maximus*
Blue shark	*Prionace glauca*
Blue whale	*Balaenoptera musculus*
Bottlenose dolphin	*Tursiops truncatus*
Common dolphin	*Delphinus delphis*
Common minke whale	*Balaenoptera acutorostrata*
Dusky shark	*Carcharhinus obscurus*
Fin whale, finback	*Balaenoptera physalus*
Gray seal	*Halichoerus grypus*
Green turtle	*Chelonia mydas*
Harbor porpoise	*Phocoena phocoena*
Harbor seal	*Phoca vitulina*
Hawksbill turtles	*Eretmochelys imbricate*
Humpback whale	*Megaptera novaeangliae*
Kemp’s Ridley turtle	*Lepidochelys kempii*
Leatherback turtle	*Dermochelys coriacea*
Loggerhead turtle	*Caretta caretta*
North Atlantic right whale	*Eubalaena glacialis*
Ocean sunfish	*Mola mola*
Pilot whale	*Globicephala genus*
Risso’s dolphin	*Grampus griseus*
Sei whale	*Balaenoptera borealis*
Sperm whale	*Physeter macrocephalus*

Appendix 3. Project Personnel and Associated Scientists

Name	Field of Research / Project / Title	Organization
Bartle, Rick	Aviation Operations Manager	ASSIST Aviation Solutions, LLC
Bolgen, Nils	Program Director	Massachusetts Clean Energy Center
Burnham, James	Special Assistant to the CEO	Massachusetts Clean Energy Center
Channel, Fred	Field Project Manager	Cornell University
Chisholm, John	Shark Research Program	Massachusetts Division of Marine Fisheries
Clarke, Christopher	Co-Principal Investigator	Cornell University
Conger, Lisa	North Atlantic Right Whale Sighting Survey	NOAA's NEFSC
Crowe, Leah	Observer (Year 2)	Center for Coastal Studies
Dodge, Kara	Ph.D. Leatherback Turtle Tagging Program	University of New Hampshire
Duley, Peter	Atlantic Marine Assessment Program for Protected Species and North Atlantic Right Whale Sighting Survey	NOAA's NEFSC
Euler, Richard	Pilot-in-Command	ASSIST Aviation Solutions, LLC
French, Tom	Assistant Director	Massachusetts Division of Fisheries and Wildlife, Natural Heritage & Endangered Species
Gatzke, Jennifer	Atlantic Marine Assessment Program for Protected Species and North Atlantic Right Whale Sighting Survey	NOAA's NEFSC
Griffith, Sally	Project Administrator	Massachusetts Clean Energy Center
Hagbloom, Marianna	Alternate Observer	New England Aquarium
Henry, Allison	Atlantic Marine Assessment Program for Protected Species and North Atlantic Right Whale Sighting Survey	NOAA's NEFSC
Hughes, Pat	Marine Policy Director	Center for Coastal Studies
Kenney, Robert	Co-Principal Investigator	University of Rhode Island, Graduate School of Oceanography
Khan, Christin	Atlantic Marine Assessment Program for Protected Species and North Atlantic Right Whale Sighting Survey	NOAA's NEFSC
Kraus, Scott	Principal Investigator	New England Aquarium
Lapierre, Keith	Pilot-in-Command	ASSIST Aviation Solutions, LLC
Leach, Mark	Captain	Fishing Vessel Sea Holly. Harwich, MA
Leiter, Sarah	Chief Survey Scientist / Observer (Year 2)	New England Aquarium
Lynch, Robert	Observer (Year 1)	Center for Coastal Studies
Mayo, Charles 'Stormy'	Co-Principal Investigator	Center for Coastal Studies
McLellan, William	Marine Mammal Stranding Program	University of North Carolina Wilmington

Montgomery, Tracy	Research Assistant / Observer (Year 1)	New England Aquarium
Mussoline, Sarah	Chief Survey Scientist / Observer (Year 2)	New England Aquarium
Patten, Scott	Pilot-in-Command	ASSIST Aviation Solutions, LLC
Palka, Debra	Atlantic Marine Assessment Program for Protected Species and North Atlantic Right Whale Sighting Survey	NOAA's NEFSC
Rice, Aaron		Cornell University
Robbins, Jooke	Humpback Whale Research	Center for Coastal Studies
Setsam-Wilps, Aidan	Pilot-in-Command / Mechanic	ASSIST Aviation Solutions, LLC
Sevard, Raymond	Pilot-in-Command	ASSIST Aviation Solutions, LLC
Skomal, Greg	Shark Research Program	Massachusetts Division of Marine Fisheries
Studds, Tyler	Project Manager	Massachusetts Clean Energy Center
Taylor, Jessica	Chief Survey Scientist / Observer (Year 1)	New England Aquarium
Thompson, Jessica	Observer (Year 3)	Center for Coastal Studies
Turner, Don	Pilot-in-Command	ASSIST Aviation Solutions, LLC
Wikgren, Brooke	GIS Specialist	New England Aquarium
Winiarski, Kristopher	Avian Research Project	URI Department of Natural Resources

Appendix 4. NARWC Sightings Database Codes and Descriptions for all used throughout NLPSC aerial surveys. For a comprehensive list see: ://gsosun1.gso.uri.edu/~rkenney/DATABASE/Users%20Guide%20%28revised%29.

ALT	The aircraft altitude in meters, logged from the camera mount GPS output.		
ANHEAD	A two-digit code for the heading of a sighting, using a 16-point compass rose		
	00	N	
	01	NNE	
	02	NE	
	03	ENE	
	04	E	
	05	ESE	
	06	SE	
	07	SSE	
	08	S	
	09	SSW	
	10	SW	
	11	WSW	
	12	W	
	13	WNW	
	14	NW	
	15	NNW	
	16	Circling	
	17	Various courses	
	21	Stationary, but no anchored (vessels only)	
	22	Anchored (vessels only)	
BEAUFORT	BEAUFORT is sea state estimated on a wind force scale. The important factor is the presence of white-caps and their strong effect on sightability. Associated wind speed (knots), wave height (feet), and descriptive details for levels 0 to 5 on the Beaufort scale are provided. Preferential Beaufort for NLPSC aerial surveys was 3 or less.		
Beaufort	Wind	Waves	Description
0	0-1	0	*Calm*—Sea smooth and mirror like. From the air, the surface looks like a mirror, and glare from the sun is reduced to a very small area, maybe even only a reflection of the sun's disk.
1	1-3	¼	*Light air*—Scale-like ripples without waves or whitecaps. The surface looks scaly; sun glare extends less than half-way to the horizon.
0	4-6	½	*Light breeze*—Small, short wavelets; crests have a glassy appearance; occasional white-caps. From the air, white-caps look like points, with never more than one to three in view at once.
3	7-10	2	*Gentle breeze*—Large wavelets; some crests begin to break; foam of glassy appearance; scattered whitecaps. From the air, white-caps still appear small and point-like. There may be many in view at one time, but they generally can be seen only within a half-mile to a mile. They tend to disappear quickly and do not persist.
4	11-16	4	*Moderate breeze*—Small waves, becoming longer; fairly frequent white-caps. From the air, the whitecaps become elongate rather than point-like and persist as the wave moves away. White-caps are now visible beyond one or two miles away.
5	17-21	6	*Fresh breeze*—Moderate waves, taking a more pronounced long form; many and longer white-caps; there may be some spray. From the air, white-caps begin to look more like breakers, with foam patches persisting long after the wave breaks. White-caps are visible nearly to the horizon.

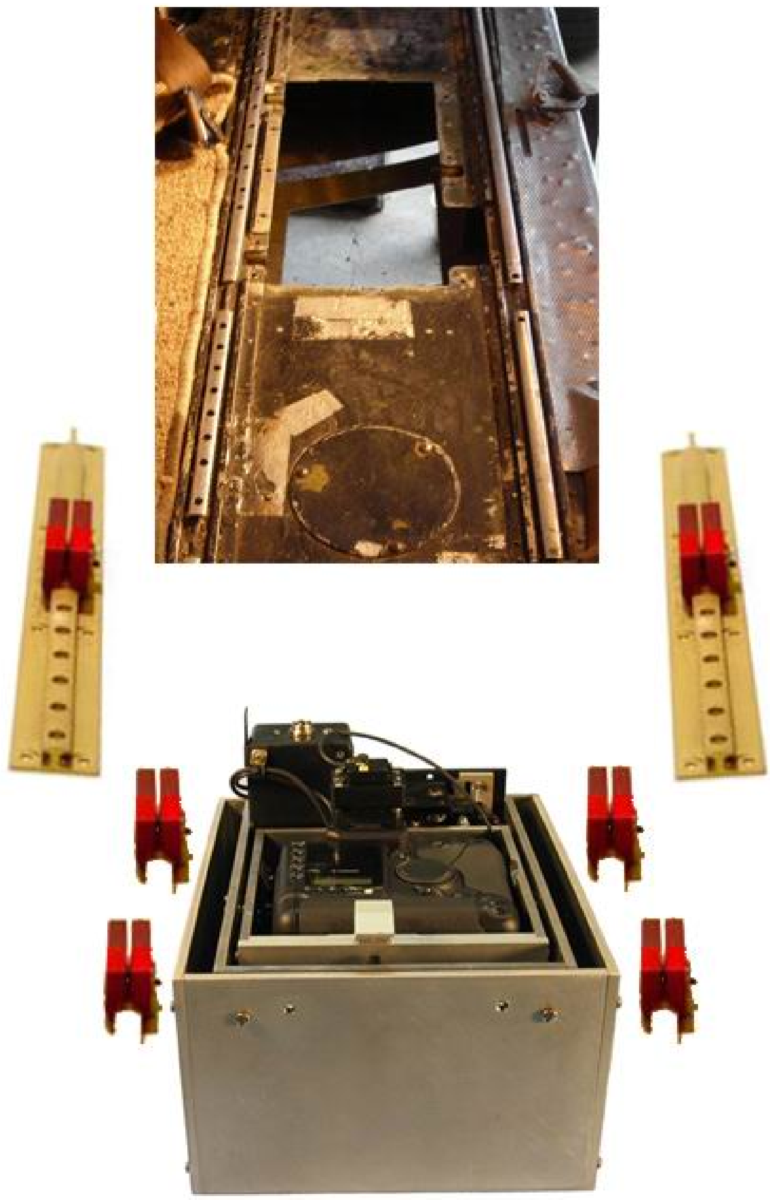
BEHAVIORS	Acrobatics (dolphins)	
	Apparent feeding	
	Associated with other cetaceans	
	Breach (whales)	
	Dead in water	
	Flipper slapping	
	Hauled out on beach (seals)	
	Hauled out on rocks (seals)	
	Surface active group (Right Whales)	
	Swimming steadily in one direction	
CLOUD	Code for cloud cover, measured in percent of sky covered.	
	1	Clear, < 10 % cloud cover
	2	Scattered, 10 – 50 % cloud cover
	3	Broken, 50 – 90 % cloud cover
	4	Overcast, > 90 % cloud cover
CONFIDNC	A two-digit code for the estimated precision associated with the number of animals counted at a particular sighting.	
	00	+/- 0
	01	+/- 1
	02	+/- 2
	03	+/- 5
	04	+/- 10
	05	+/- 25
	06	+/- 50
	07	+/- 100
	09	“At least” for group counts
	11	Number of animals unknown
EVENTNO	A sequentially assigned record number that includes all automated and Observer-prompted data records. Periodic fixes for later reconstruction of the survey track. Typically for aerial survey computer data-loggers, 30-second intervals are acceptable. NLPSC surveys recorded data at 1 to 5-second intervals to sync with vertical camera interval settings.	
GLARE	Describes the amount of sun glare affecting observer visibility. Since glare is a function of heading, and changes rapidly during circling, it is only required on-transect.	
	0	None
	1	Slight
	2	Moderate
	3	Severe
GLAREL	Describes the amount of sun glare in entire scanning range, affecting observer visibility on the left / port side of the transect line.	
GLARER	Describes the amount of sun glare in entire scanning range, affecting observer visibility on the right / starboard side of the transect line.	
HEADING	Heading of the survey aircraft in degrees true	

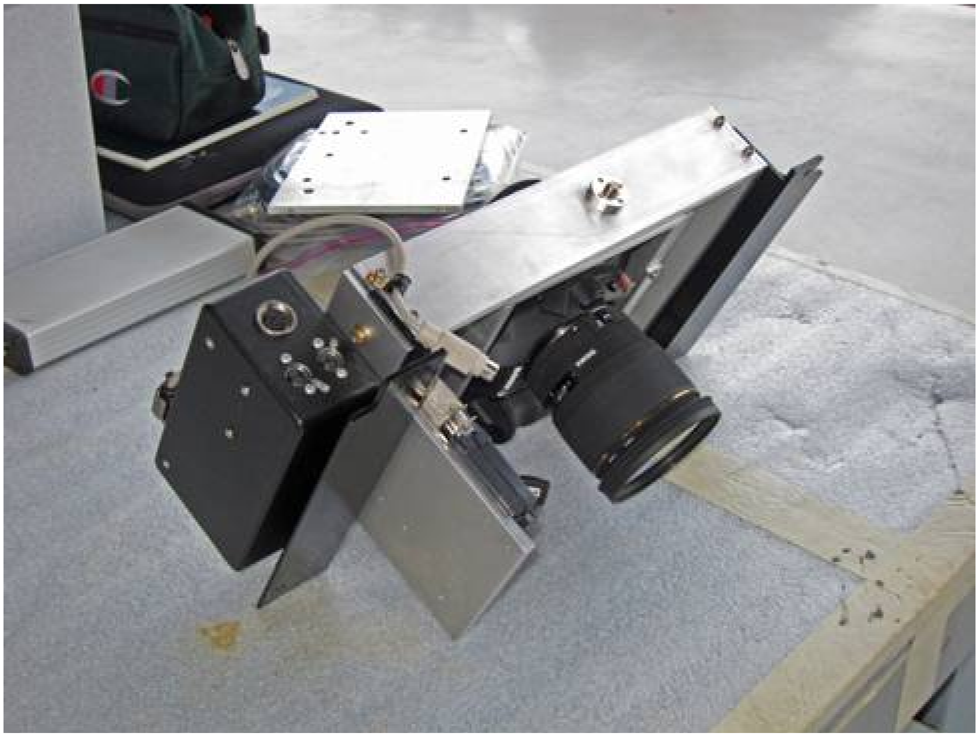
IDREL	A code for the observer’s judgment about the reliability of the stated identification of the species observed. The value of IDREL that is assigned should apply to the species identification that is used, not the sighting generally.	
	1	Unsure / possible
	2	Probable
	3	Definite / sure
	9	Unknown. Should be used for all sightings of vessels, fishing gear, human activities, pollution, debris, etc.
LEGNO	Aerial line-transect survey track number	
LEGSTAGE	A one-digit code for the stage of watch during a survey, recorded only during defined census lines (LEGTYPE = 2)	
	1	Begin line
	2	Continue line
	3	Break off line to circle
	4	Resume line
	5	End line
	6	Sighting by anyone other than an on-duty Observer
	7	Sighting detected in a vertical photograph
LEGTYPE	A one-digit code for the line type during line-transect surveys.	
	0	Off watch during transit, cross-leg or circling
	1	Transit
	2	Survey line
	3	Cross-leg
	4	Other (circling)
NUMBER	The number of animals (or vessels etc) counted at a sighting. If the number is not known (or for many pollution/human activity sightings where a number is neither logical nor practical), the field may be left blank, however in those cases the value for CONFIDNC must be ‘11’.	
NUMCALF	Number of calves counted at a sighting	
PHOTOS	A one-digit code to indicate whether photographs of a given sighting exist and if so, the type of documentation record.	
	1	No
	2	Yes, slides or prints (including digital)
SIGHTNO	Sighting number	

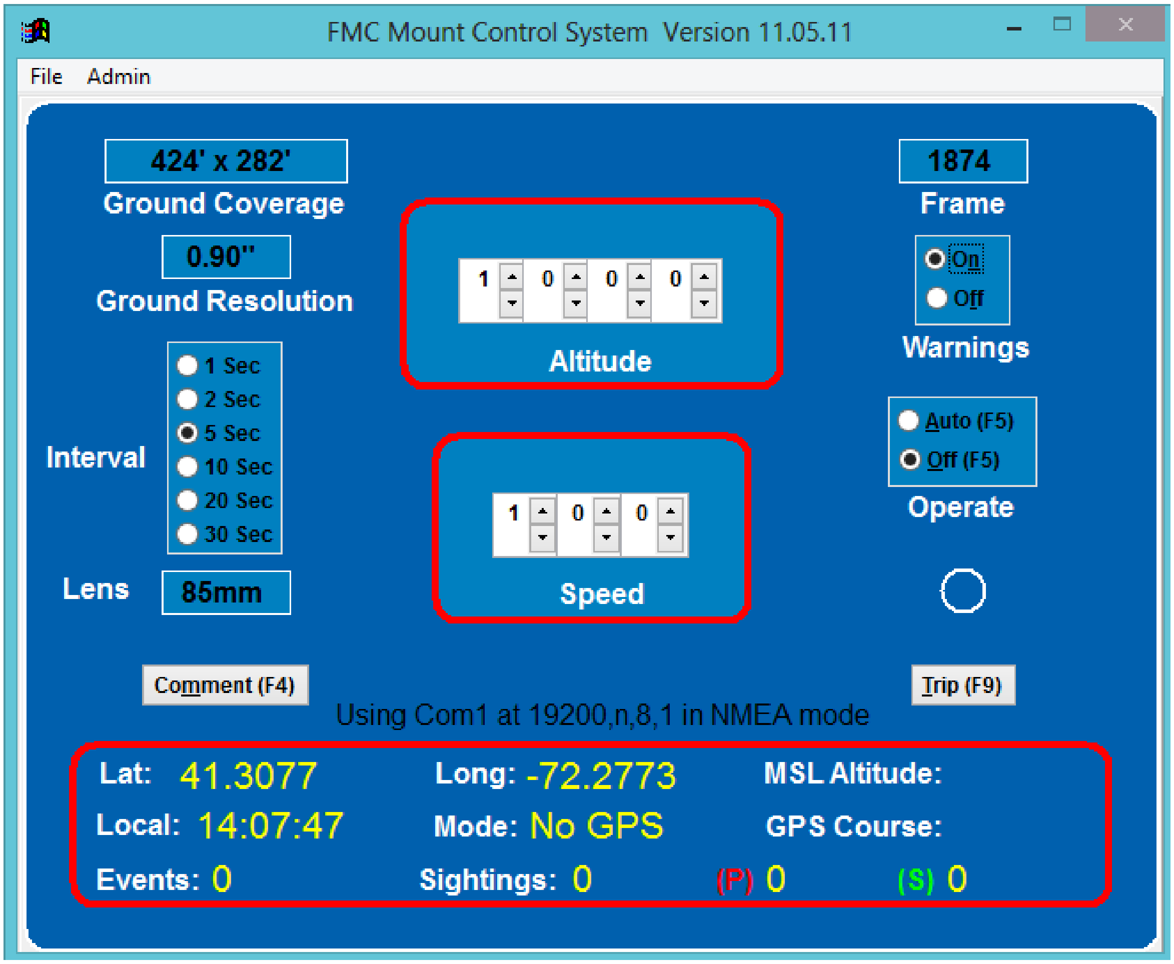
SPECCODE	SPECCODE is a four-letter code for the species sighted. SPECCODEs are essentially abbreviations of common names to make them easier to remember, following the standard practice of field ornithologists. There are a few exceptions, forced by the need to avoid duplicates. SPECCODE is required for all sightings including human activity, debris and pollution codes, and must be blank for all non-sighting records.		
	Biotic Sighting Codes		
	BASH	Basking Shark	*Cetorhinus maximus*
	BLSH	Blue Shark	*Prionace glauca*
	BODO	Bottlenose Dolphin	*Tursiops truncatus*
	DUSH	Dusky Shark	
	FIWH	Fin Whale	*Balaenoptera physalus*
	GRAM	Risso’s Dolphin	*Grampus griseus*
	GRSE	Gray Seal	*Halichoerus grypus*
	HAPO	Harbor Porpoise	*Phocoena phocoena*
	HASE	Harbor Seal	*Phoca vitulina*
	HHSH	Hammerhead Shark	*Sphyrna* sp.
	HUWH	Humpback Whale	*Megaptera novaeangliae*
	LETU	Leatherback Turtle	*Dermochelys coriacea*
	LOTU	Loggerhead Turtle	*Caretta caretta*
	MIWH	Minke Whale	*Balaenoptera acutorostrata*
	OCSU	Ocean Sunfish/Sharp-tailed Mola	*Mola mola*/*lanceolata*
	PIWH	Pilot Whale	*Globicephala* sp.
	RITU	Kemp’s Ridley Turtle	*Lepidochelys kempii*
	RIWH	Right Whale	*Eubalaena glacialis*
	SADO	Common Dolphin	*Delphinus delphis*
	SCFI	Fish School	
	SEWH	Sei Whale	*Balaenoptera borealis*
	SPWH	Sperm Whale	*Physeter macrocephalus*
	THSH	Thresher Shark	*Alopias* sp.
	TUNS	Unidentified Tuna	
	UNDO	Unidentified Dolphin or Porpoise	
	UNID	Unidentified Animal	
	UNLW	Unidentified Large Whale	
	UNMM	Unidentified Marine Mammal	
	UNMW	Unidentified Medium Whale	
	UNRA	Unidentified Ray	
	UNSE	Unidentified Seal	
	UNSH	Unidentified Shark	
	UNTU	Unidentified Turtle	
	WSDO	Atlantic White-Sided Dolphin	*Lagenorhynchus acutus*
	Human Activity and Debris / Pollution Codes		
	CG-C	Coast Guard Cutter	
	DE-O	Debris/pollution, oil slick or sheen	
	FG-U	Fixed fishing gear, unspecified type	
	FV-C	Fishing vessel, lobster / crab / other pot / trap fishery	
	MV-B	Tug and barge	
	MV-C	Container ship	
	MV-L	Merchant vessel, large	
	MV-O	Tanker	
	SV-L	Sailing vessel, large	

STRIP	A two-digit code identifying the right angle distance interval of a given sighting from the trackline for line-transect aerial survey. Odd numbers were sighted on the port side and even on the starboard.	
	1,2	0 to 1/8 nm
	3,4	1/8 to 1/4 nm
	5,6	1/4 to 1/2 nm
	7,8	1/2 to 1 nm
	9,10	1 to 2 nm
	11,12	2 to 4 nm
	13,14	> 4 nm
VISIBLTY	Estimated clear visibility in nautical miles during a survey. Maximum value allowed is > 5 nm.	
WEATHER	A single letter code that indicates a general description of weather	
	C	Clear
	F	Fog
	G	Gray
	H	Hazy
999	Break from transect line	

Appendix 5. Camera mount and d-tracker interface

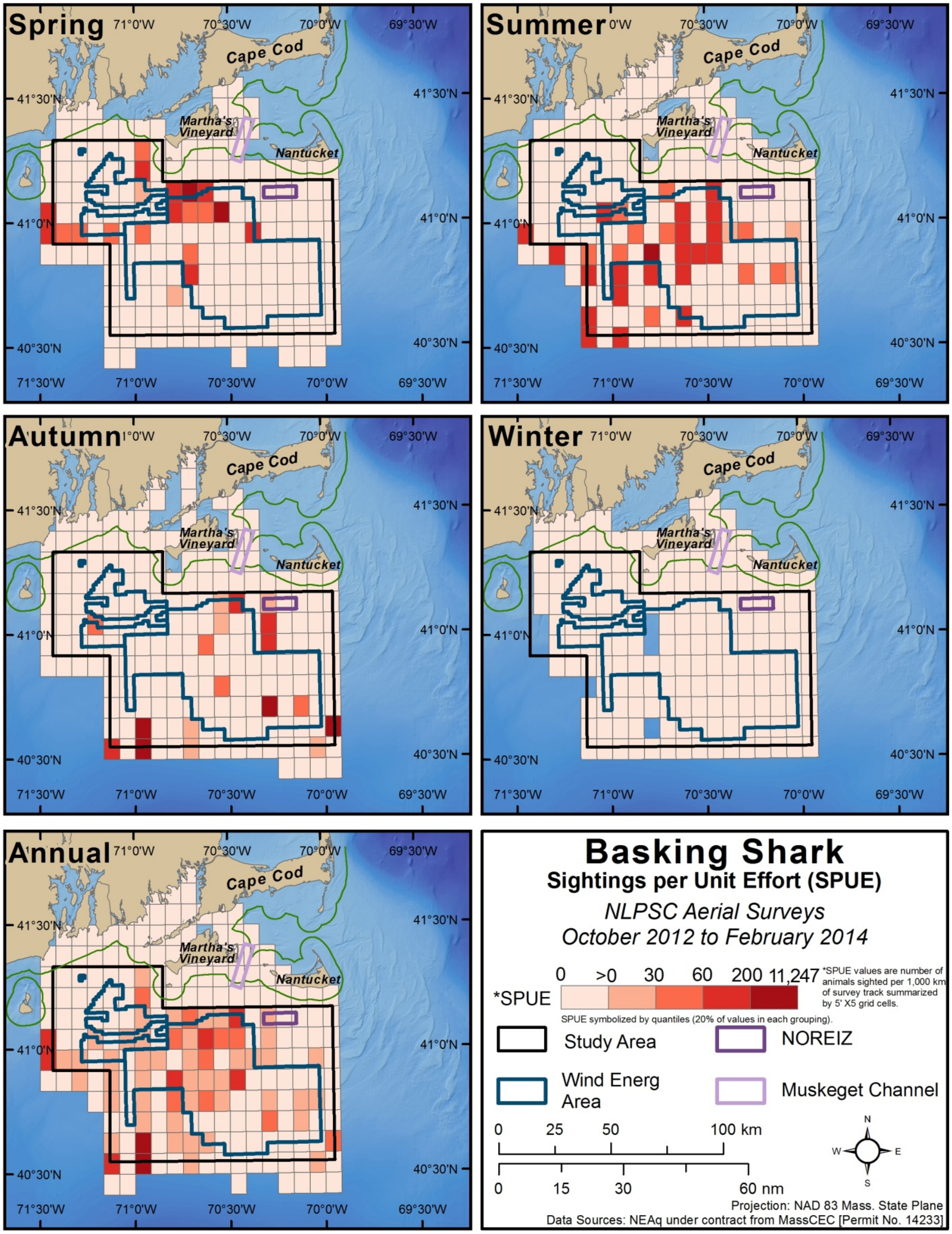


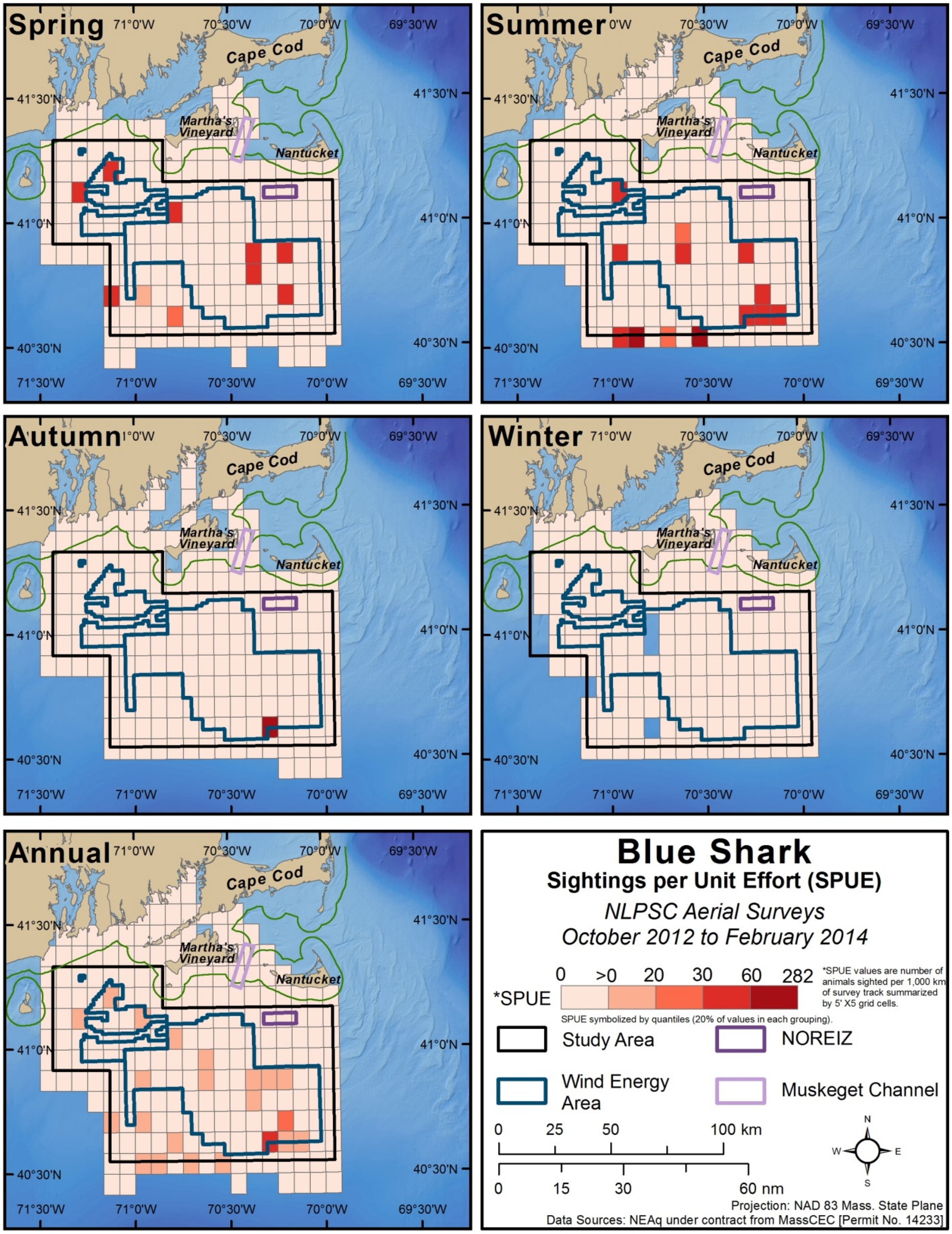


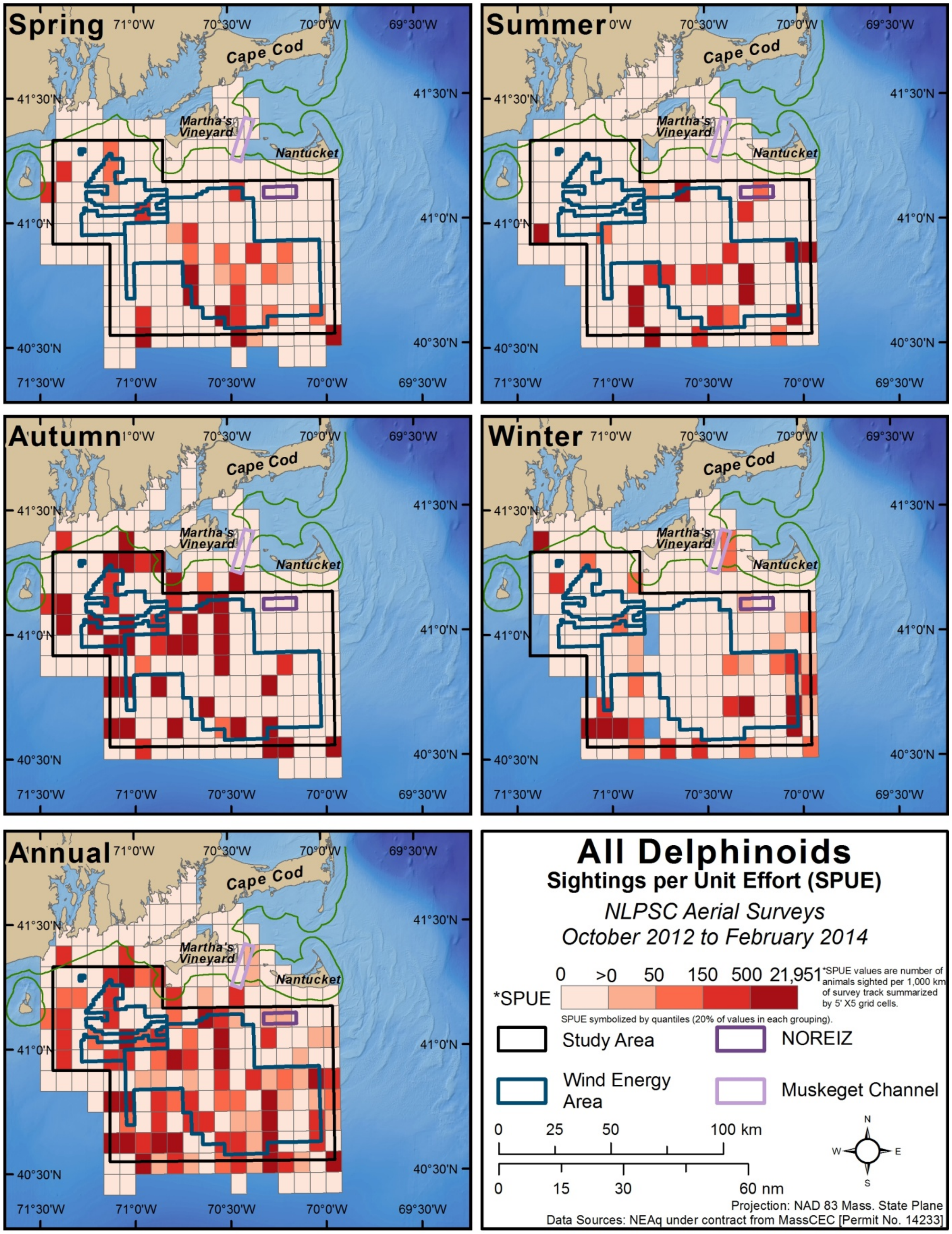

FMC Mount Control System Version 11.05.11
File Admin
424' x 282'
Ground Coverage
0.90"
Ground Resolution
Interval
1 Sec
2 Sec
5 Sec
10 Sec
20 Sec
30 Sec
Lens
85mm
1 0 0 0
Altitude
1 0 0
Speed
1874
Frame
On
Off
Warnings
Auto (F5)
Off (F5)
Operate
Comment (F4)
Trip (F9)
Using Com1 at 19200,n,8,1 in NMEA mode
Lat: 41.3077
Long: -72.2773
MSL Altitude:
Local: 14:07:47
Mode: No GPS
GPS Course:
Events: 0
Sightings: 0
(P) 0
(S) 0

Appendix 6. Sightings Per Unit of Effort Maps by Species

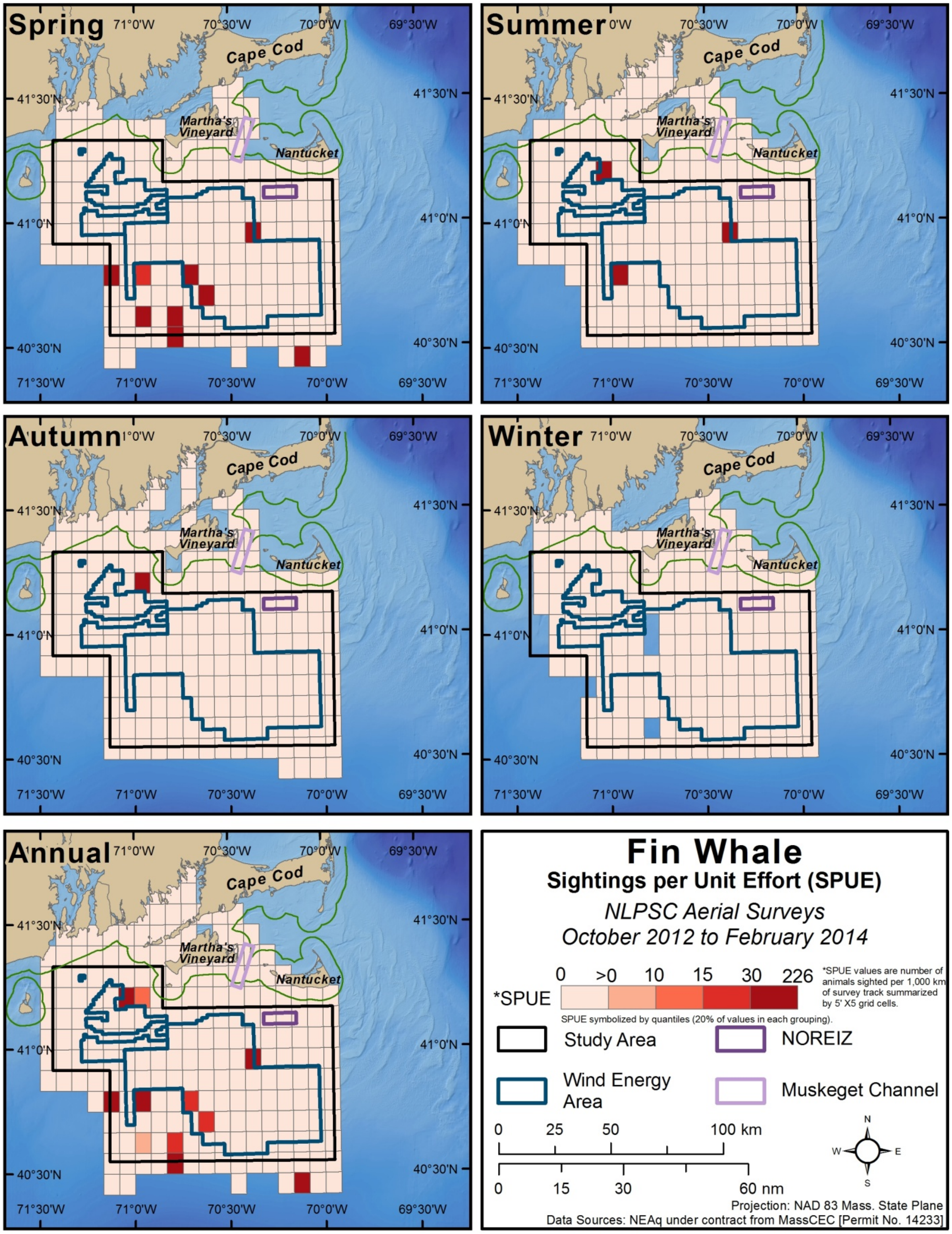
(Listed Alphabetically)

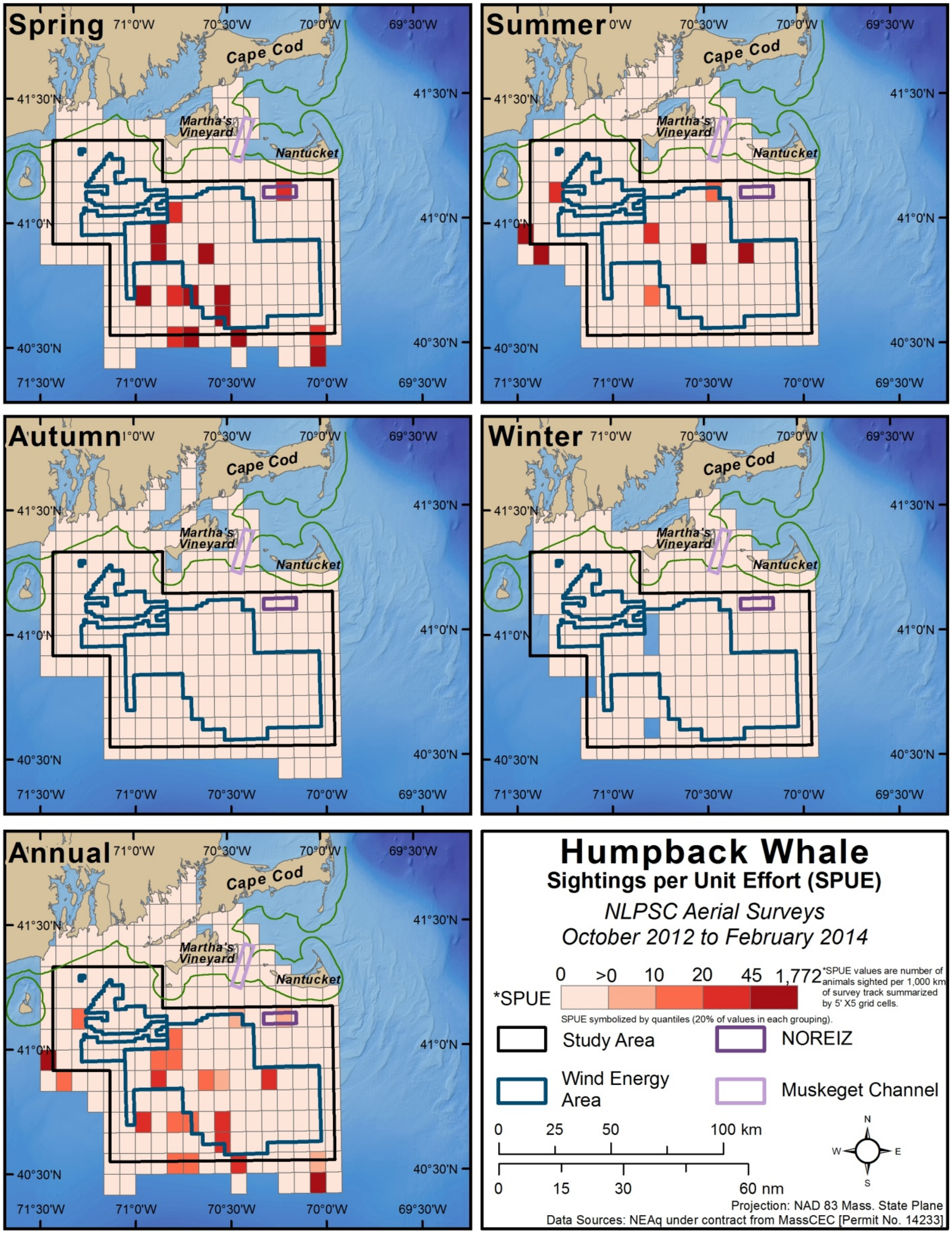

Spring
Summer
Autumn
Winter
Annual
Cape Cod
Martha's Vineyard
Nantucket
71°30'W
71°0'W
70°30'W
70°0'W
69°30'W
41°30'N
41°0'N
40°30'N
Basking Shark
Sightings per Unit Effort (SPUE)
NLPSC Aerial Surveys
October 2012 to February 2014
*SPUE
0
>0
30
60
200
11,247
*SPUE values are number of animals sighted per 1,000 km of survey track summarized by 5' X5 grid cells.
SPUE symbolized by quantiles (20% of values in each grouping).
Study Area
NOREIZ
Wind Energ Area
Muskeget Channel
0 25 50 100 km
0 15 30 60 nm
N
W
E
S
Projection: NAD 83 Mass. State Plane
Data Sources: NEAq under contract from MassCEC [Permit No. 14233]

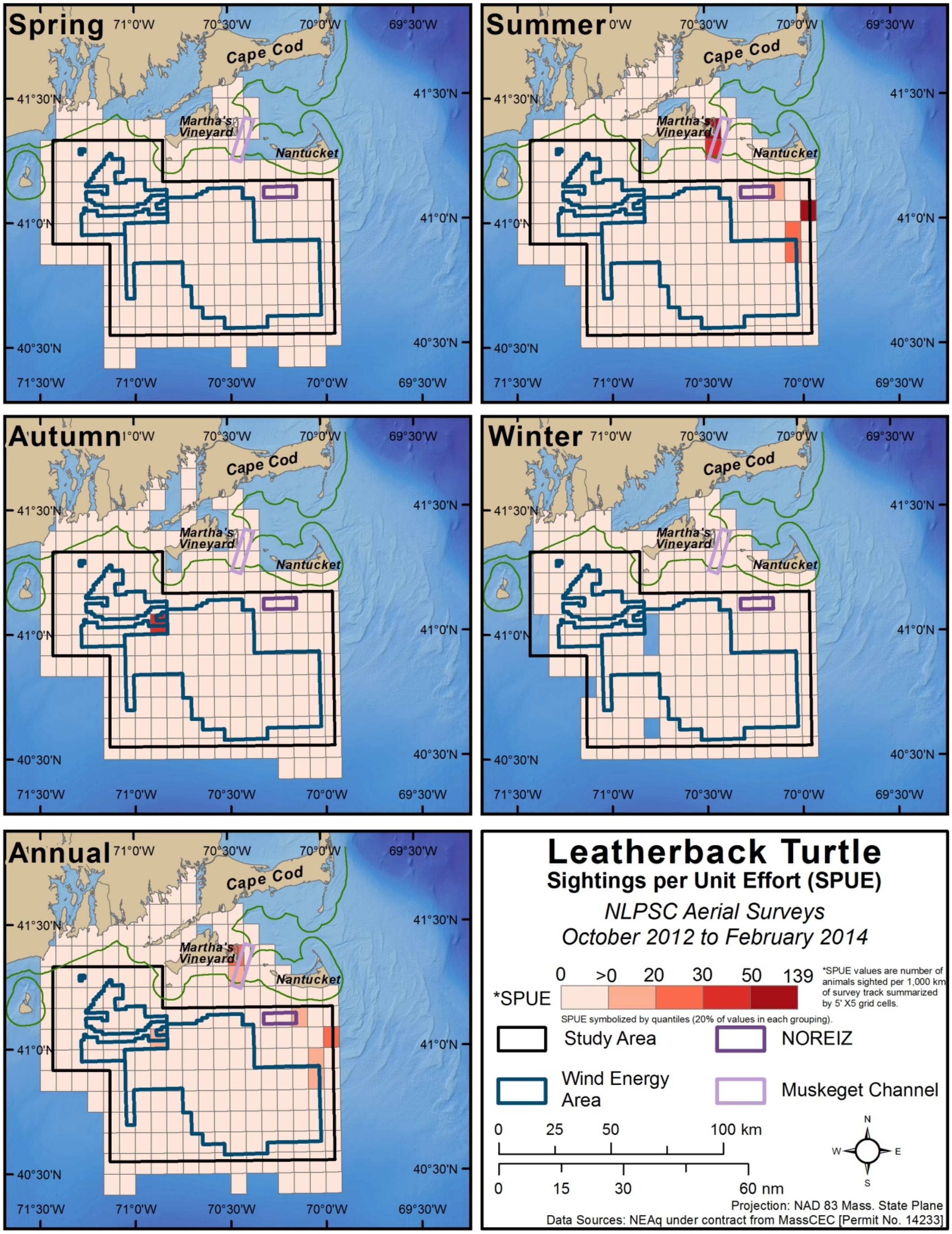

Spring
Summer
Autumn
Winter
Annual
Cape Cod
Martha's Vineyard
Nantucket
71°30'W
71°0'W
70°30'W
70°0'W
69°30'W
41°30'N
41°0'N
40°30'N
Blue Shark
Sightings per Unit Effort (SPUE)
NLPSC Aerial Surveys
October 2012 to February 2014
*SPUE
0
>0
20
30
60
282
*SPUE values are number of animals sighted per 1,000 km of survey track summarized by 5' X5 grid cells.
SPUE symbolized by quantiles (20% of values in each grouping).
Study Area
NOREIZ
Wind Energy Area
Muskeget Channel
0 25 50 100 km
0 15 30 60 nm
N
S
E
W
Projection: NAD 83 Mass. State Plane
Data Sources: NEAq under contract from MassCEC [Permit No. 14233]

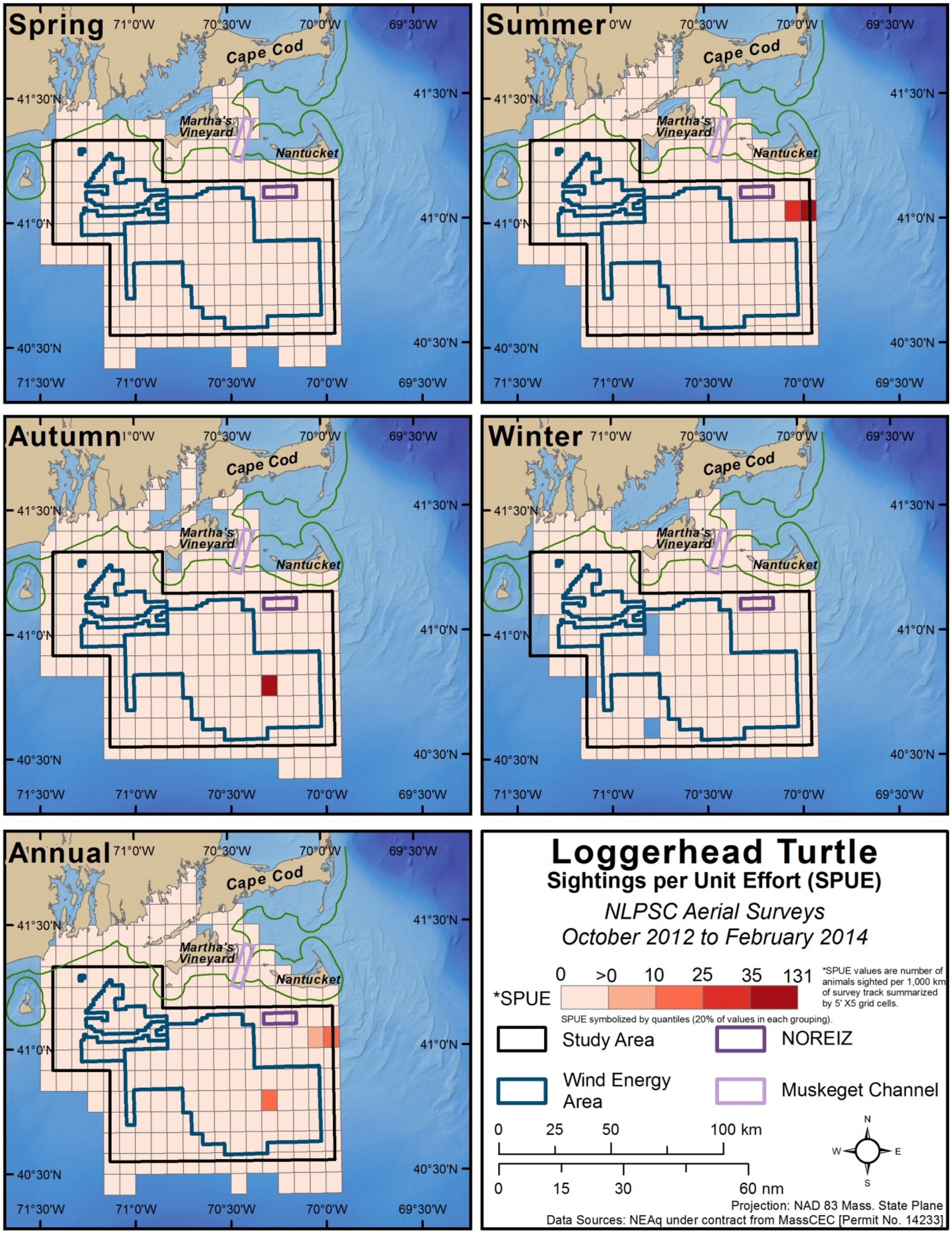


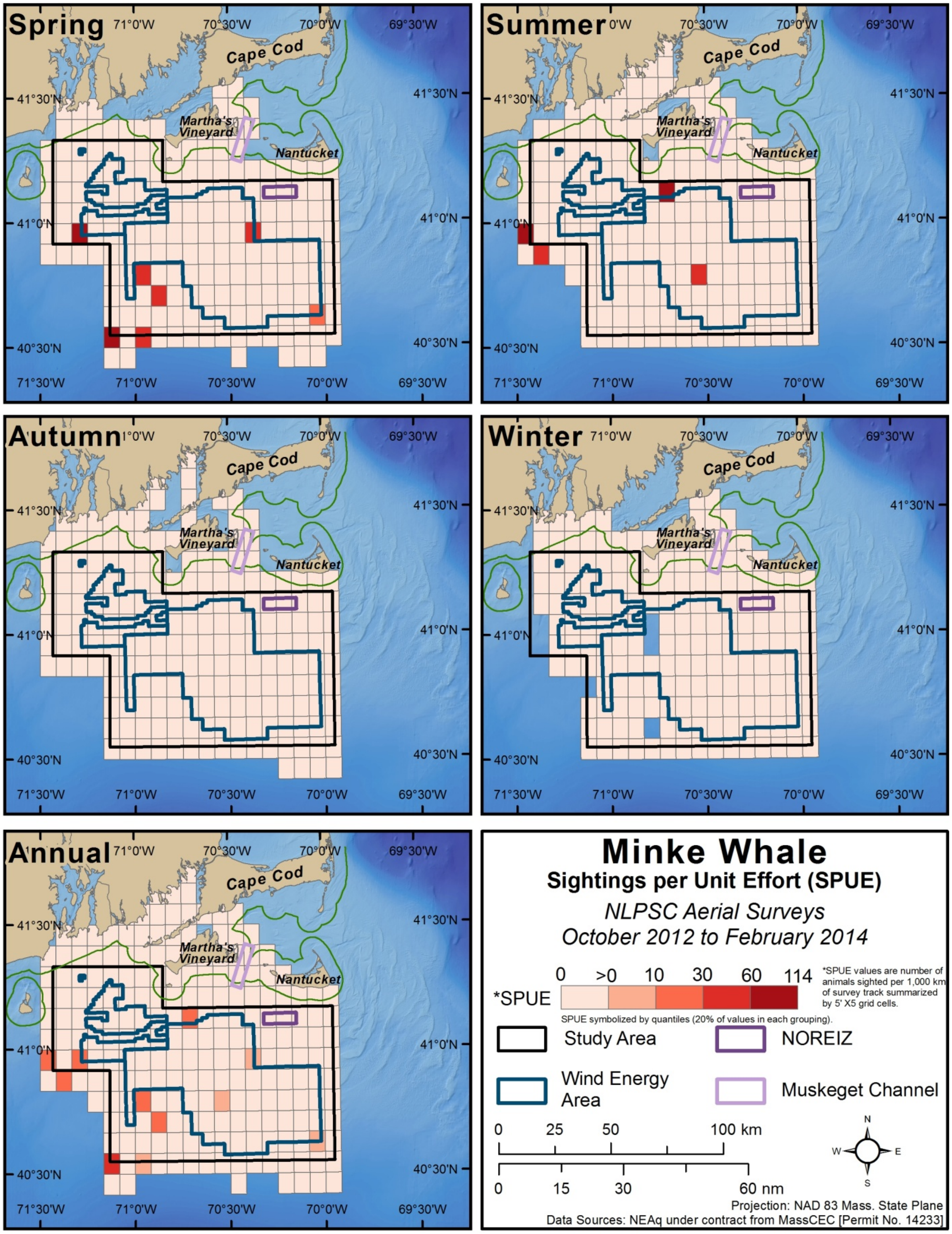
Spring
Summer
Autumn
Winter
Annual
Cape Cod
Martha's Vineyard
Nantucket
71°30'W
71°0'W
70°30'W
70°0'W
69°30'W
41°30'N
41°0'N
40°30'N
All Delphinoids
Sightings per Unit Effort (SPUE)
NLPSC Aerial Surveys
October 2012 to February 2014
*SPUE
0
>0
50
150
500
21,951
*SPUE values are number of animals sighted per 1,000 km of survey track summarized by 5' X5 grid cells.
SPUE symbolized by quantiles (20% of values in each grouping).
Study Area
NOREIZ
Wind Energy Area
Muskeget Channel
0 25 50 100 km
0 15 30 60 nm
N
W
E
S
Projection: NAD 83 Mass. State Plane
Data Sources: NEAq under contract from MassCEC [Permit No. 14233]

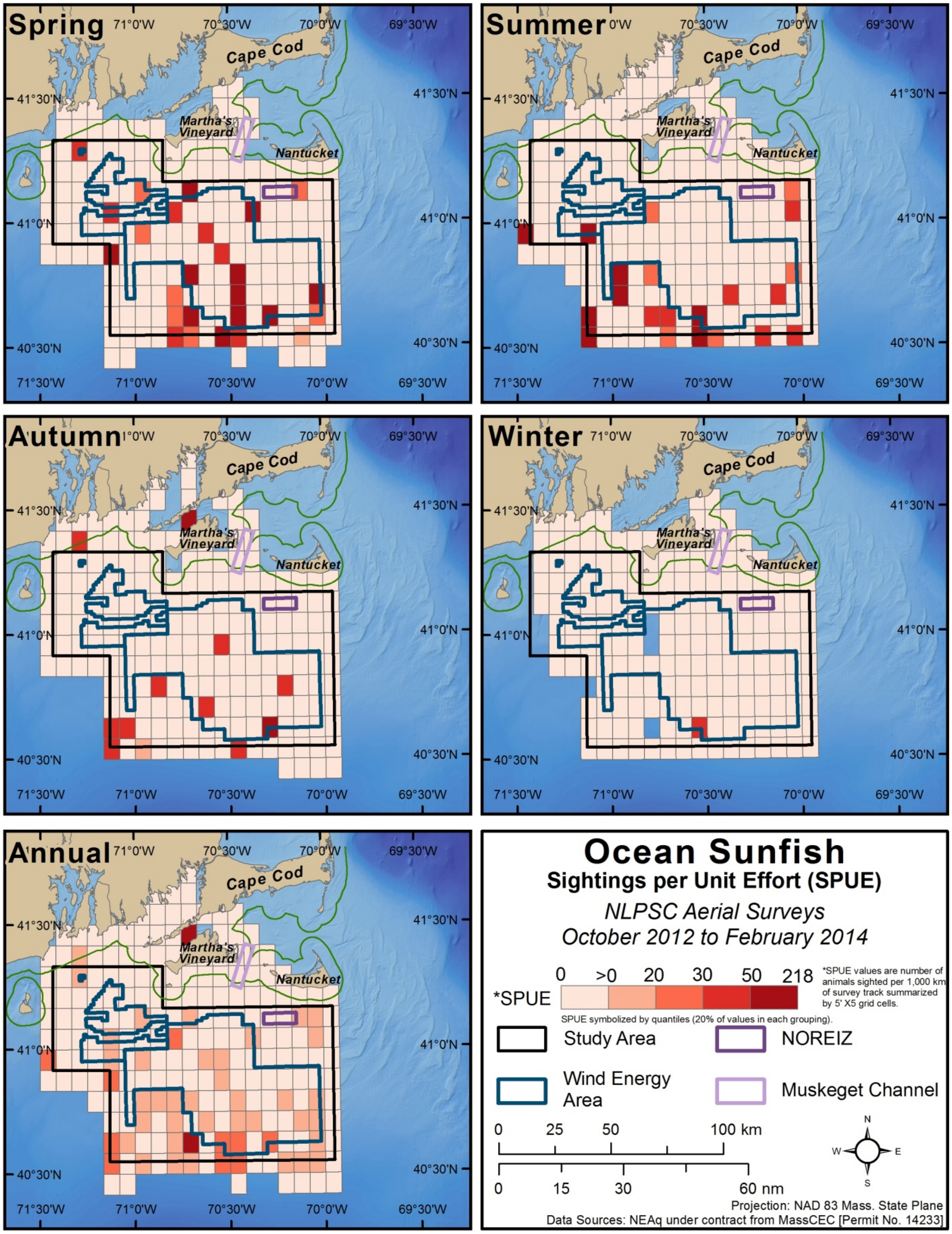

Spring
Summer
Autumn
Winter
Annual
Cape Cod
Martha's Vineyard
Nantucket
71°30'W
71°0'W
70°30'W
70°0'W
69°30'W
41°30'N
41°0'N
40°30'N
Fin Whale
Sightings per Unit Effort (SPUE)
NLPSC Aerial Surveys
October 2012 to February 2014
*SPUE
0
>0
10
15
30
226
*SPUE values are number of animals sighted per 1,000 km of survey track summarized by 5' X5 grid cells.
SPUE symbolized by quantiles (20% of values in each grouping).
Study Area
NOREIZ
Wind Energy Area
Muskeget Channel
0
25
50
100 km
0
15
30
60 nm
N
S
E
W
Projection: NAD 83 Mass. State Plane
Data Sources: NEAq under contract from MassCEC [Permit No. 14233]

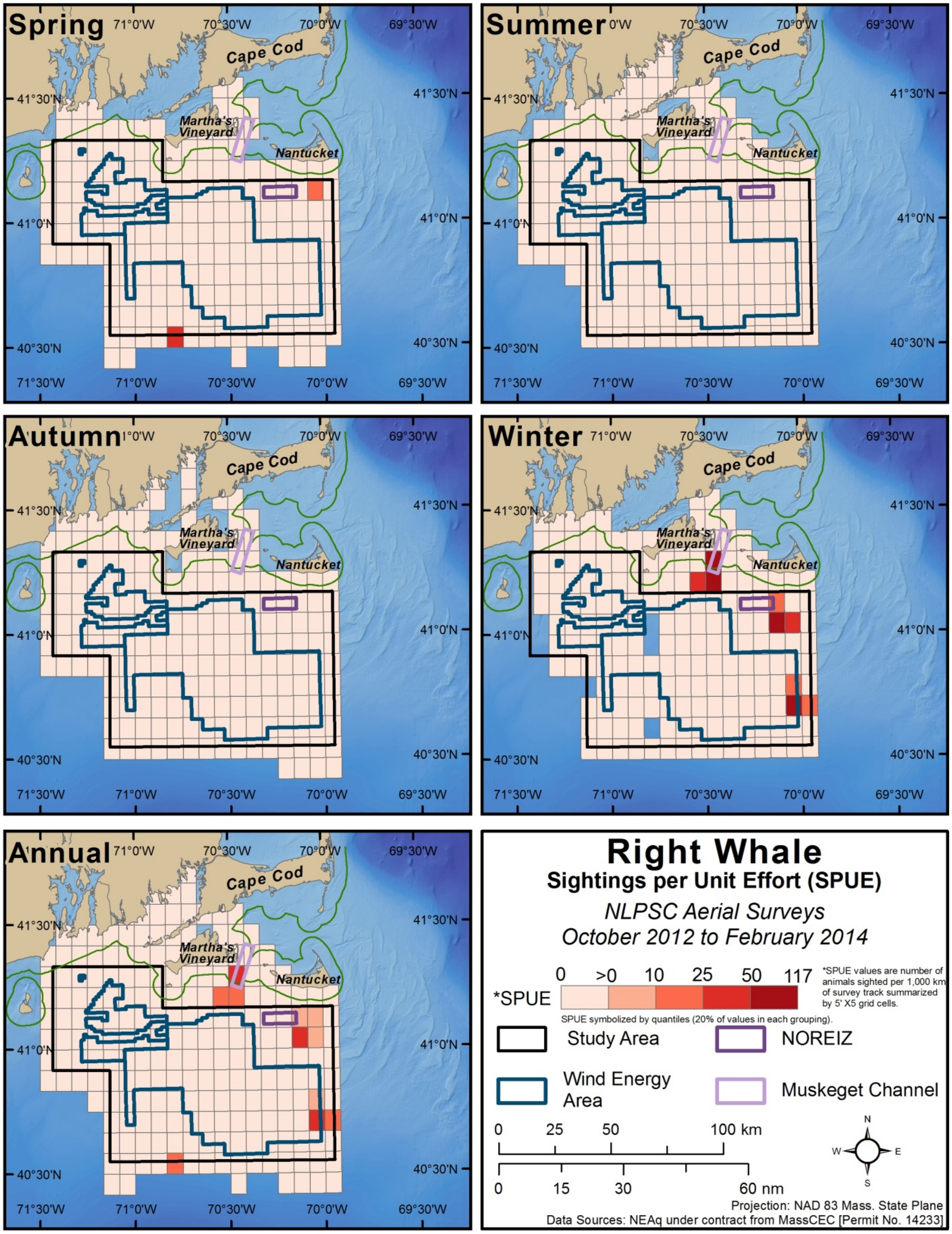

Spring
Summer
Autumn
Winter
Annual
Cape Cod
Martha's Vineyard
Nantucket
71°30'W
71°0'W
70°30'W
70°0'W
69°30'W
41°30'N
41°0'N
40°30'N
Humpback Whale
Sightings per Unit Effort (SPUE)
NLPSC Aerial Surveys
October 2012 to February 2014
*SPUE
0
>0
10
20
45
1,772
*SPUE values are number of animals sighted per 1,000 km of survey track summarized by 5' X5 grid cells.
SPUE symbolized by quantiles (20% of values in each grouping).
Study Area
NOREIZ
Wind Energy Area
Muskeget Channel
0 25 50 100 km
0 15 30 60 nm
N
W
E
S
Projection: NAD 83 Mass. State Plane
Data Sources: NEAq under contract from MassCEC [Permit No. 14233]

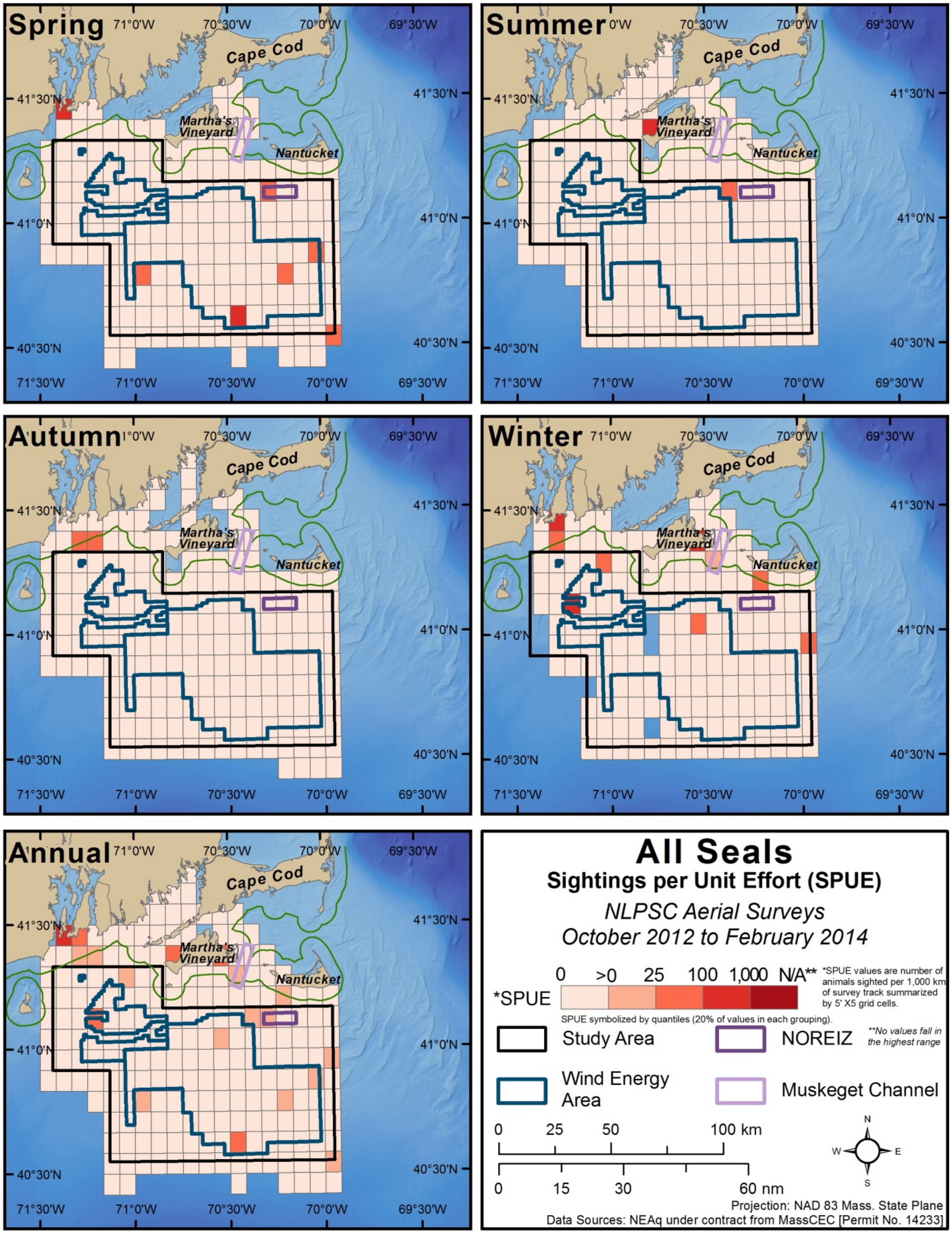

Spring
Summer
Autumn
Winter
Annual
Cape Cod
Martha's Vineyard
Nantucket
71°30'W
71°0'W
70°30'W
70°0'W
69°30'W
41°30'N
41°0'N
40°30'N
Leatherback Turtle
Sightings per Unit Effort (SPUE)
NLPSC Aerial Surveys
October 2012 to February 2014
*SPUE
0
>0
20
30
50
139
*SPUE values are number of animals sighted per 1,000 km of survey track summarized by 5' X5 grid cells.
SPUE symbolized by quantiles (20% of values in each grouping).
Study Area
NOREIZ
Wind Energy Area
Muskeget Channel
0 25 50 100 km
0 15 30 60 nm
N
W
E
S
Projection: NAD 83 Mass. State Plane
Data Sources: NEAq under contract from MassCEC [Permit No. 14233]

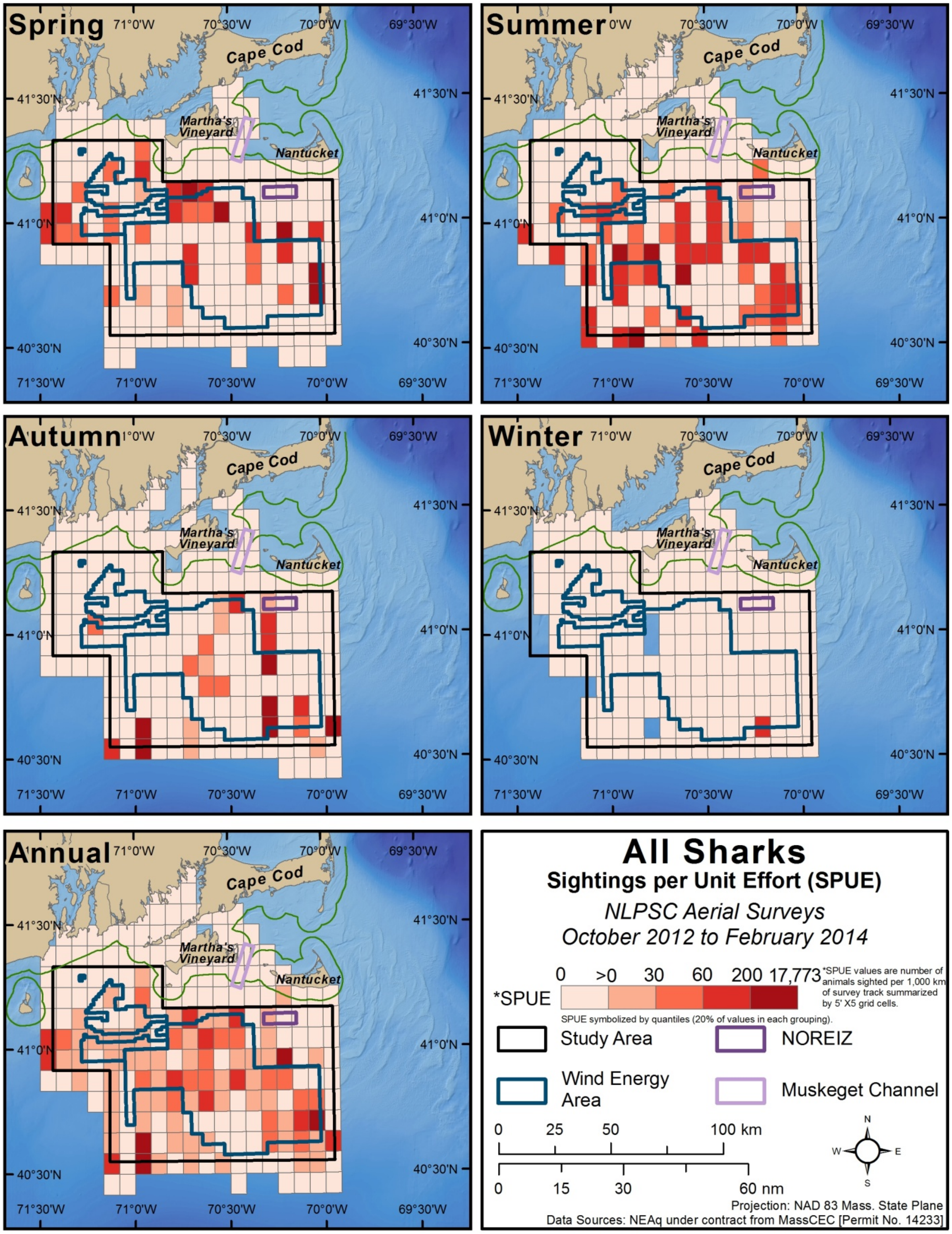

Spring
Summer
Autumn
Winter
Annual
Cape Cod
Martha's Vineyard
Nantucket
71°30'W
71°0'W
70°30'W
70°0'W
69°30'W
41°30'N
41°0'N
40°30'N
Loggerhead Turtle
Sightings per Unit Effort (SPUE)
NLPSC Aerial Surveys
October 2012 to February 2014
*SPUE
0
>0
10
25
35
131
*SPUE values are number of animals sighted per 1,000 km of survey track summarized by 5' X5 grid cells.
SPUE symbolized by quantiles (20% of values in each grouping).
Study Area
NOREIZ
Wind Energy Area
Muskeget Channel
0 25 50 100 km
0 15 30 60 nm
N
S
E
W
Projection: NAD 83 Mass. State Plane
Data Sources: NEAq under contract from MassCEC [Permit No. 14233]


Spring
Summer
Autumn
Winter
Annual
Cape Cod
Martha's Vineyard
Nantucket
71°30'W
71°0'W
70°30'W
70°0'W
69°30'W
41°30'N
41°0'N
40°30'N
Minke Whale
Sightings per Unit Effort (SPUE)
NLPSC Aerial Surveys
October 2012 to February 2014
*SPUE
0
>0
10
30
60
114
*SPUE values are number of animals sighted per 1,000 km of survey track summarized by 5' X5 grid cells.
SPUE symbolized by quantiles (20% of values in each grouping).
Study Area
NOREIZ
Wind Energy Area
Muskeget Channel
0
25
50
100 km
0
15
30
60 nm
N
S
E
W
Projection: NAD 83 Mass. State Plane
Data Sources: NEAq under contract from MassCEC [Permit No. 14233]


Spring
Summer
Autumn
Winter
Annual
Cape Cod
Martha's Vineyard
Nantucket
71°30'W
71°0'W
70°30'W
70°0'W
69°30'W
41°30'N
41°0'N
40°30'N
Ocean Sunfish
Sightings per Unit Effort (SPUE)
NLPSC Aerial Surveys
October 2012 to February 2014
*SPUE
0
>0
20
30
50
218
*SPUE values are number of animals sighted per 1,000 km of survey track summarized by 5' X5 grid cells.
SPUE symbolized by quantiles (20% of values in each grouping).
Study Area
NOREIZ
Wind Energy Area
Muskeget Channel
0 25 50 100 km
0 15 30 60 nm
N
W
E
S
Projection: NAD 83 Mass. State Plane
Data Sources: NEAq under contract from MassCEC [Permit No. 14233]


Spring
Summer
Autumn
Winter
Annual
Cape Cod
Martha's Vineyard
Nantucket
71°30'W
71°0'W
70°30'W
70°0'W
69°30'W
41°30'N
41°0'N
40°30'N
Right Whale
Sightings per Unit Effort (SPUE)
NLPSC Aerial Surveys
October 2012 to February 2014
0
>0
10
25
50
117
*SPUE
*SPUE values are number of animals sighted per 1,000 km of survey track summarized by 5' X5 grid cells.
SPUE symbolized by quantiles (20% of values in each grouping).
Study Area
NOREIZ
Wind Energy Area
Muskeget Channel
0 25 50 100 km
0 15 30 60 nm
N
W
E
S
Projection: NAD 83 Mass. State Plane
Data Sources: NEAq under contract from MassCEC [Permit No. 14233]


Spring
Summer
Autumn
Winter
Annual
Cape Cod
Martha's Vineyard
Nantucket
71°30'W
71°0'W
70°30'W
70°0'W
69°30'W
41°30'N
41°0'N
40°30'N
All Seals
Sightings per Unit Effort (SPUE)
NLPSC Aerial Surveys
October 2012 to February 2014
*SPUE
0 >0 25 100 1,000 N/A**
*SPUE values are number of animals sighted per 1,000 km of survey track summarized by 5' X5 grid cells.
SPUE symbolized by quantiles (20% of values in each grouping).
**No values fall in the highest range
Study Area
NOREIZ
Wind Energy Area
Muskeget Channel
0 25 50 100 km
0 15 30 60 nm
N
W
E
S
Projection: NAD 83 Mass. State Plane
Data Sources: NEAq under contract from MassCEC [Permit No. 14233]


Spring
Summer
Autumn
Winter
Annual
Cape Cod
Martha's Vineyard
Nantucket
71°30'W
71°0'W
70°30'W
70°0'W
69°30'W
41°30'N
41°0'N
40°30'N
All Sharks
Sightings per Unit Effort (SPUE)
NLPSC Aerial Surveys
October 2012 to February 2014
*SPUE
0
>0
30
60
200
17,773
*SPUE values are number of animals sighted per 1,000 km of survey track summarized by 5' X5 grid cells.
SPUE symbolized by quantiles (20% of values in each grouping).
Study Area
NOREIZ
Wind Energy Area
Muskeget Channel
0 25 50 100 km
0 15 30 60 nm
N
W
E
S
Projection: NAD 83 Mass. State Plane
Data Sources: NEAq under contract from MassCEC [Permit No. 14233]

Appendix 7. Survey List (Year 1 & 2)

SURVEY	FILEID	DATE	RECORDS
NLPSC001	a111282	10/9/2011	4,160
NLPSC002	a111296	10/23/2011	3,406
NLPSC003	a111310	11/6/2011	3,746
NLPSC004	a111330	11/26/2011	3,509
NLPSC005	a111339	12/5/2011	328
NLPSC006	a111346	12/12/2011	4,900
NLPSC007	a112009	1/9/2012	3,100
NLPSC008	a112026	1/26/2012	2,800
NLPSC009	a112036	2/5/2012	3,502
NLPSC010	a112066	3/6/2012	2,604
NLPSC011	a112083	3/23/2012	4,555
NLPSC012	a112084	3/24/2012	4,833
NLPSC013	a112092	4/1/2012	4,477
NLPSC014	a112097	4/6/2012	10,351
NLPSC015	a112128	5/7/2012	10,070
NLPSC016	a112139	5/18/2012	9,285
NLPSC017	a112162	6/10/2012	9,265
NLPSC018	a112176	6/24/2012	6,822
NLPSC019	a112185	7/3/2012	8,972
NLPSC020	a112195	7/13/2012	8,253
NLPSC021	a112220	8/7/2012	9,513
NLPSC022	a112236	8/23/2012	12,875
NLPSC023	a112256	9/12/2012	9,280
NLPSC024	a112261	9/17/2012	9,512
NLPSC025	a112297	10/23/2012	3,803
NLPSC026	a112347	12/13/2012	3,926
NLPSC027	a113046	2/15/2013	3,827
NLPSC028	a113057	2/26/2013	9,461
NLPSC029	a113088	3/29/2013	9,213
NLPSC030	a113108	4/18/2013	5,493
NLPSC031	a113116	4/26/2013	7,035
NLPSC032	a113119	4/29/2013	4,281
NLPSC033	a113120	4/30/2013	3,972
NLPSC034	a113138	5/18/2013	10,616
NLPSC035	a113156	6/5/2013	4,304
NLPSC036	a113157	6/6/2013	6,010
NLPSC037	a113172	6/21/2013	10,338
NLPSC038	a113211	7/30/2013	7,022
NLPSC039	a113219	8/7/2013	5,457
NLPSC040	a113232	8/20/2013	12,060
NLPSC041	a113261	9/18/2013	11,366
NLPSC042	a113295	10/22/2013	6,494
NLPSC043	a113309	11/5/2013	11,755
NLPSC044	a113325	11/21/2013	9,250
NLPSC045	a114015	1/15/2014	4,615
NLPSC046	a114017	1/17/2014	5,586
NLPSC047	a114032	2/1/2014	10,107

NLPSC048	a114035	2/4/2014	6,430

MONTH	DAY	YEAR	SPECCODE	NUMBER		
4	18	2013	FIWH	2	FIWH	35
4	18	2013	FIWH	2		
4	18	2013	FIWH	2		
4	18	2013	FIWH	3		
4	18	2013	FIWH	2		
4	26	2013	FIWH	2		
4	29	2013	FIWH	1		
4	29	2013	FIWH	3		
4	30	2013	FIWH	1		
5	18	2013	FIWH	1		
6	5	2013	FIWH	3		
6	6	2013	FIWH	7		
7	30	2013	FIWH	5		
10	22	2013	FIWH	1		
3	29	2013	HUWH	1	HUWH	58
3	29	2013	HUWH	1		
4	18	2013	HUWH	1		
4	18	2013	HUWH	3		
4	18	2013	HUWH	3		
4	18	2013	HUWH	3		
4	18	2013	HUWH	3		
4	18	2013	HUWH	1		
4	18	2013	HUWH	2		
4	18	2013	HUWH	1		
4	18	2013	HUWH	1		
4	26	2013	HUWH	1		
4	26	2013	HUWH	1		
4	26	2013	HUWH	3		
4	26	2013	HUWH	1		
4	29	2013	HUWH	1		
4	29	2013	HUWH	1		
4	30	2013	HUWH	2		
4	30	2013	HUWH	1		
5	18	2013	HUWH	1		
5	18	2013	HUWH	2		
6	5	2013	HUWH	2		
6	5	2013	HUWH	5		
6	5	2013	HUWH	8		
6	5	2013	HUWH	1		
6	6	2013	HUWH	1		
6	21	2013	HUWH	1		
6	21	2013	HUWH	1		
6	21	2013	HUWH	1		
7	30	2013	HUWH	1		
7	30	2013	HUWH	2		
2	15	2013	RIWH	1	RIWH	36

MONTH	DAY	YEAR	SPECCODE	NUMBER		
2	15	2013	RIWH	1		
2	15	2013	RIWH	6		
2	26	2013	RIWH	4		
2	26	2013	RIWH	4		
2	26	2013	RIWH	1		
2	26	2013	RIWH	3		
2	26	2013	RIWH	1		
2	26	2013	RIWH	1		
2	26	2013	RIWH	2		
2	26	2013	RIWH	1		
2	26	2013	RIWH	1		
2	26	2013	RIWH	2		
3	29	2013	RIWH	1		
4	18	2013	RIWH	1		
1	15	2014	RIWH	3		
1	15	2014	RIWH	1		
1	15	2014	RIWH	1		
1	15	2014	RIWH	1		
4	26	2013	SEWH	2	SEWH	10
4	26	2013	SEWH	2		
4	29	2013	SEWH	2		
5	18	2013	SEWH	2		
5	18	2013	SEWH	1		
5	18	2013	SEWH	1		
1	15	2014	UNFS	1		
1	17	2014	UNFS	1		
3	29	2013	UNLW	2		
4	18	2013	UNLW	1		
4	18	2013	UNLW	2		
4	26	2013	UNLW	1		
5	18	2013	UNLW	1		
5	18	2013	UNLW	1		
6	21	2013	UNLW	1		
7	30	2013	UNLW	1		
7	30	2013	UNLW	1		
8	7	2013	UNLW	1		
10	22	2013	UNLW	1		
11	21	2013	UNLW	1		
1	17	2014	UNLW	1		
4	30	2013	UNRO	1		
4	18	2013	MIWH	1		
4	29	2013	MIWH	3		
4	29	2013	MIWH	1		
4	29	2013	MIWH	1		
4	30	2013	MIWH	1		
5	18	2013	MIWH	1		

MONTH	DAY	YEAR	SPECCODE	NUMBER
5	18	2013	MIWH	1
5	18	2013	MIWH	1
5	18	2013	MIWH	1
5	18	2013	MIWH	1
5	18	2013	MIWH	1
5	18	2013	MIWH	1
6	5	2013	MIWH	1
6	5	2013	MIWH	1
6	21	2013	MIWH	1
7	30	2013	MIWH	2
4	18	2013	BODO	4
4	26	2013	BODO	25
4	26	2013	BODO	17
6	6	2013	BODO	5
6	21	2013	BODO	3
6	21	2013	BODO	4
8	7	2013	BODO	13
2	1	2014	BODO	5
2	1	2014	BODO	5
2	15	2013	HAPO	1
2	15	2013	HAPO	1
2	15	2013	HAPO	1
2	15	2013	HAPO	2
2	15	2013	HAPO	1
2	26	2013	HAPO	1
3	29	2013	HAPO	1
3	29	2013	HAPO	1
3	29	2013	HAPO	1
4	26	2013	HAPO	1
4	26	2013	HAPO	1
4	26	2013	HAPO	1
4	26	2013	HAPO	1
4	26	2013	HAPO	1
5	18	2013	HAPO	1
5	18	2013	HAPO	1
11	21	2013	HAPO	3
1	15	2014	HAPO	1
1	15	2014	HAPO	1
1	15	2014	HAPO	1
1	17	2014	HAPO	1
2	1	2014	HAPO	1
2	4	2014	HAPO	2
6	6	2013	PIWH	3
10	23	2012	SADO	20
10	23	2012	SADO	30
2	15	2013	SADO	10

MONTH	DAY	YEAR	SPECCODE	NUMBER
2	15	2013	SADO	4
4	26	2013	SADO	3
4	26	2013	SADO	7
4	26	2013	SADO	1
4	29	2013	SADO	4
5	18	2013	SADO	9
5	18	2013	SADO	4
9	18	2013	SADO	150
10	22	2013	SADO	36
10	22	2013	SADO	16
11	5	2013	SADO	20
11	21	2013	SADO	5
2	1	2014	SADO	6
2	1	2014	SADO	2
2	1	2014	SADO	5
2	1	2014	SADO	2
2	1	2014	SADO	3
2	4	2014	SADO	9
2	4	2014	SADO	1
10	22	2013	UNCW	12
10	23	2012	UNDO	40
10	23	2012	UNDO	10
10	23	2012	UNDO	10
10	23	2012	UNDO	50
10	23	2012	UNDO	20
10	23	2012	UNDO	400
10	23	2012	UNDO	15
10	23	2012	UNDO	15
10	23	2012	UNDO	5
10	23	2012	UNDO	3
10	23	2012	UNDO	10
12	13	2012	UNDO	8
2	15	2013	UNDO	7
2	15	2013	UNDO	10
2	15	2013	UNDO	13
2	15	2013	UNDO	1
2	15	2013	UNDO	2
2	15	2013	UNDO	10
2	26	2013	UNDO	2
2	26	2013	UNDO	2
2	26	2013	UNDO	5
2	26	2013	UNDO	3
2	26	2013	UNDO	1
2	26	2013	UNDO	1
2	26	2013	UNDO	1
2	26	2013	UNDO	1

MONTH	DAY	YEAR	SPECCODE	NUMBER
3	29	2013	UNDO	1
3	29	2013	UNDO	1
4	18	2013	UNDO	5
4	18	2013	UNDO	3
4	18	2013	UNDO	7
4	26	2013	UNDO	1
4	26	2013	UNDO	17
4	26	2013	UNDO	2
4	26	2013	UNDO	2
4	26	2013	UNDO	1
4	26	2013	UNDO	1
4	26	2013	UNDO	7
4	26	2013	UNDO	1
4	26	2013	UNDO	4
4	26	2013	UNDO	1
4	29	2013	UNDO	1
4	29	2013	UNDO	1
4	29	2013	UNDO	3
5	18	2013	UNDO	2
5	18	2013	UNDO	1
5	18	2013	UNDO	6
5	18	2013	UNDO	5
5	18	2013	UNDO	5
5	18	2013	UNDO	1
5	18	2013	UNDO	7
5	18	2013	UNDO	2
5	18	2013	UNDO	3
5	18	2013	UNDO	4
5	18	2013	UNDO	2
5	18	2013	UNDO	2
6	6	2013	UNDO	1
6	21	2013	UNDO	30
6	21	2013	UNDO	25
6	21	2013	UNDO	10
6	21	2013	UNDO	2
6	21	2013	UNDO	5
7	30	2013	UNDO	25
7	30	2013	UNDO	8
8	7	2013	UNDO	20
8	7	2013	UNDO	75
8	7	2013	UNDO	30
8	7	2013	UNDO	6
8	7	2013	UNDO	1
8	7	2013	UNDO	4
8	7	2013	UNDO	10
8	7	2013	UNDO	20

MONTH	DAY	YEAR	SPECCODE	NUMBER
8	7	2013	UNDO	70
8	7	2013	UNDO	15
8	7	2013	UNDO	2
8	7	2013	UNDO	8
8	20	2013	UNDO	2
8	20	2013	UNDO	30
8	20	2013	UNDO	15
8	20	2013	UNDO	18
8	20	2013	UNDO	16
8	20	2013	UNDO	15
9	18	2013	UNDO	400
9	18	2013	UNDO	12
9	18	2013	UNDO	30
9	18	2013	UNDO	6
9	18	2013	UNDO	4
9	18	2013	UNDO	50
9	18	2013	UNDO	50
9	18	2013	UNDO	40
9	18	2013	UNDO	10
9	18	2013	UNDO	2
9	18	2013	UNDO	7
9	18	2013	UNDO	100
9	18	2013	UNDO	80
9	18	2013	UNDO	30
9	18	2013	UNDO	20
9	18	2013	UNDO	200
9	18	2013	UNDO	30
9	18	2013	UNDO	70
10	22	2013	UNDO	10
10	22	2013	UNDO	20
10	22	2013	UNDO	20
10	22	2013	UNDO	10
10	22	2013	UNDO	10
10	22	2013	UNDO	75
10	22	2013	UNDO	15
10	22	2013	UNDO	15
10	22	2013	UNDO	5
10	22	2013	UNDO	7
10	22	2013	UNDO	20
10	22	2013	UNDO	40
10	22	2013	UNDO	15
10	22	2013	UNDO	3
11	5	2013	UNDO	10
11	5	2013	UNDO	1
11	5	2013	UNDO	1
11	5	2013	UNDO	10

MONTH	DAY	YEAR	SPECCODE	NUMBER
11	5	2013	UNDO	4
11	5	2013	UNDO	20
11	5	2013	UNDO	5
11	5	2013	UNDO	10
11	5	2013	UNDO	8
11	5	2013	UNDO	10
11	5	2013	UNDO	15
11	5	2013	UNDO	15
11	5	2013	UNDO	15
11	5	2013	UNDO	6
11	21	2013	UNDO	10
11	21	2013	UNDO	100
11	21	2013	UNDO	8
11	21	2013	UNDO	20
11	21	2013	UNDO	4
11	21	2013	UNDO	40
11	21	2013	UNDO	2
1	15	2014	UNDO	1
1	15	2014	UNDO	1
1	15	2014	UNDO	1
1	15	2014	UNDO	30
1	15	2014	UNDO	1
1	17	2014	UNDO	1
1	17	2014	UNDO	4
1	17	2014	UNDO	12
2	1	2014	UNDO	2
2	1	2014	UNDO	4
2	1	2014	UNDO	1
2	1	2014	UNDO	1
2	1	2014	UNDO	1
2	1	2014	UNDO	1
2	4	2014	UNDO	1
5	18	2013	WSDO	20
5	18	2013	WSDO	20
6	21	2013	WSDO	10
8	7	2013	WSDO	2
10	22	2013	WSDO	10
4	26	2013	GRSE	1
4	26	2013	GRSE	1
4	26	2013	GRSE	1
5	18	2013	GRSE	1
2	1	2014	GRSE	1
8	7	2013	HASE	1
2	1	2014	HASE	1
2	1	2014	HASE	1
2	1	2014	HASE	1

MONTH	DAY	YEAR	SPECCODE	NUMBER
2	1	2014	HASE	1
2	15	2013	UNSE	1
2	26	2013	UNSE	1
2	26	2013	UNSE	1
4	26	2013	UNSE	1
4	26	2013	UNSE	1
5	18	2013	UNSE	3
5	18	2013	UNSE	2
5	18	2013	UNSE	1
8	20	2013	UNSE	1
11	5	2013	UNSE	1
11	5	2013	UNSE	1
2	1	2014	UNSE	2
2	4	2014	UNSE	2
7	30	2013	LETU	1
8	7	2013	LETU	14
8	7	2013	LETU	4
8	7	2013	LETU	1
8	20	2013	LETU	1
8	20	2013	LETU	1
8	20	2013	LETU	1
8	20	2013	LETU	1
8	20	2013	LETU	1
9	18	2013	LETU	1
8	7	2013	LOTU	1
8	20	2013	LOTU	1
9	18	2013	LOTU	1
8	7	2013	UNTU	1
8	7	2013	UNTU	1
8	7	2013	UNTU	1
8	7	2013	UNTU	1
8	20	2013	UNTU	1
8	20	2013	UNTU	1
8	20	2013	UNTU	1
9	18	2013	UNTU	1
9	18	2013	UNTU	1
9	18	2013	UNTU	1
10	22	2013	UNTU	1
4	18	2013	BASH	1
5	18	2013	BASH	1
5	18	2013	BASH	1
5	18	2013	BASH	1
5	18	2013	BASH	1
5	18	2013	BASH	1
5	18	2013	BASH	1
5	18	2013	BASH	1

MONTH	DAY	YEAR	SPECCODE	NUMBER
5	18	2013	BASH	1
5	18	2013	BASH	1
5	18	2013	BASH	1
5	18	2013	BASH	1
5	18	2013	BASH	2
5	18	2013	BASH	1
5	18	2013	BASH	1
5	18	2013	BASH	1
5	18	2013	BASH	1
5	18	2013	BASH	1
5	18	2013	BASH	1
5	18	2013	BASH	1
5	18	2013	BASH	1
5	18	2013	BASH	1
5	18	2013	BASH	2
5	18	2013	BASH	1
5	18	2013	BASH	1
5	18	2013	BASH	1
5	18	2013	BASH	2
5	18	2013	BASH	1
5	18	2013	BASH	1
5	18	2013	BASH	1
5	18	2013	BASH	1
5	18	2013	BASH	1
5	18	2013	BASH	1
5	18	2013	BASH	1
5	18	2013	BASH	2
6	5	2013	BASH	1
6	5	2013	BASH	1
6	5	2013	BASH	1
6	5	2013	BASH	1
6	5	2013	BASH	1
6	6	2013	BASH	1
6	21	2013	BASH	1
6	21	2013	BASH	1
6	21	2013	BASH	1
6	21	2013	BASH	1
6	21	2013	BASH	1
6	21	2013	BASH	1
6	21	2013	BASH	1
6	21	2013	BASH	1
6	21	2013	BASH	1
6	21	2013	BASH	1
6	21	2013	BASH	1
6	21	2013	BASH	1
6	21	2013	BASH	2

MONTH	DAY	YEAR	SPECCODE	NUMBER
6	21	2013	BASH	1
6	21	2013	BASH	2
6	21	2013	BASH	1
6	21	2013	BASH	1
6	21	2013	BASH	1
6	21	2013	BASH	1
7	30	2013	BASH	1
7	30	2013	BASH	2
7	30	2013	BASH	1
7	30	2013	BASH	1
7	30	2013	BASH	1
7	30	2013	BASH	1
7	30	2013	BASH	1
7	30	2013	BASH	1
7	30	2013	BASH	1
8	7	2013	BASH	1
8	7	2013	BASH	1
8	7	2013	BASH	1
8	7	2013	BASH	1
8	7	2013	BASH	2
8	7	2013	BASH	1
8	7	2013	BASH	1
8	7	2013	BASH	5
8	7	2013	BASH	1
8	7	2013	BASH	3
8	7	2013	BASH	1
8	7	2013	BASH	1
8	7	2013	BASH	2
8	7	2013	BASH	1
8	7	2013	BASH	1
8	7	2013	BASH	1
8	7	2013	BASH	1
8	7	2013	BASH	1
8	7	2013	BASH	6
8	7	2013	BASH	1
8	20	2013	BASH	1
8	20	2013	BASH	1
8	20	2013	BASH	1
8	20	2013	BASH	1
8	20	2013	BASH	1
8	20	2013	BASH	4
8	20	2013	BASH	2
8	20	2013	BASH	2
8	20	2013	BASH	1
8	20	2013	BASH	2
8	20	2013	BASH	1

MONTH	DAY	YEAR	SPECCODE	NUMBER
8	20	2013	BASH	1
8	20	2013	BASH	1
8	20	2013	BASH	1
8	20	2013	BASH	1
8	20	2013	BASH	1
8	20	2013	BASH	1
8	20	2013	BASH	1
8	20	2013	BASH	1
9	18	2013	BASH	1
9	18	2013	BASH	1
9	18	2013	BASH	1
9	18	2013	BASH	1
9	18	2013	BASH	1
9	18	2013	BASH	3
9	18	2013	BASH	1
9	18	2013	BASH	1
9	18	2013	BASH	1
9	18	2013	BASH	1
9	18	2013	BASH	2
9	18	2013	BASH	1
10	22	2013	BASH	1
10	22	2013	BASH	1
11	5	2013	BASH	800
11	5	2013	BASH	1
11	5	2013	BASH	3
11	5	2013	BASH	1
11	5	2013	BASH	2
11	5	2013	BASH	1
11	5	2013	BASH	1
11	5	2013	BASH	1
11	5	2013	BASH	14
11	5	2013	BASH	3
11	5	2013	BASH	8
11	5	2013	BASH	2
11	21	2013	BASH	1
11	21	2013	BASH	1
5	18	2013	BLSH	1
5	18	2013	BLSH	1
5	18	2013	BLSH	1
5	18	2013	BLSH	1
5	18	2013	BLSH	1
5	18	2013	BLSH	1
5	18	2013	BLSH	1
5	18	2013	BLSH	1
5	18	2013	BLSH	1
5	18	2013	BLSH	1

MONTH	DAY	YEAR	SPECCODE	NUMBER
6	5	2013	BLSH	1
6	5	2013	BLSH	1
6	21	2013	BLSH	1
6	21	2013	BLSH	1
6	21	2013	BLSH	1
6	21	2013	BLSH	1
6	21	2013	BLSH	1
6	21	2013	BLSH	1
8	20	2013	BLSH	1
8	20	2013	BLSH	1
8	20	2013	BLSH	1
8	20	2013	BLSH	1
8	20	2013	BLSH	1
8	20	2013	BLSH	1
9	18	2013	BLSH	2
5	18	2013	DUSH	1
5	18	2013	DUSH	1
7	30	2013	DUSH	1
8	7	2013	DUSH	1
8	20	2013	DUSH	1
8	20	2013	DUSH	1
8	20	2013	DUSH	1
8	20	2013	DUSH	1
8	20	2013	DUSH	1
8	20	2013	DUSH	1
8	20	2013	DUSH	1
8	20	2013	DUSH	2
9	18	2013	DUSH	1
5	18	2013	SDOG	8
5	18	2013	SDOG	5
5	18	2013	SDOG	6
5	18	2013	SDOG	25
5	18	2013	SDOG	1
5	18	2013	SDOG	2
5	18	2013	SDOG	35
5	18	2013	SDOG	8
5	18	2013	SDOG	10
5	18	2013	SDOG	45
5	18	2013	SDOG	80
5	18	2013	SDOG	85
5	18	2013	SDOG	40
5	18	2013	SDOG	20
5	18	2013	SDOG	4
5	18	2013	SDOG	7
10	23	2012	UNSH	1
2	15	2013	UNSH	1

MONTH	DAY	YEAR	SPECCODE	NUMBER
4	29	2013	UNSH	2
4	30	2013	UNSH	1
5	18	2013	UNSH	1
5	18	2013	UNSH	1
6	5	2013	UNSH	1
6	5	2013	UNSH	1
6	5	2013	UNSH	2
6	6	2013	UNSH	2
6	21	2013	UNSH	1
7	30	2013	UNSH	1
8	7	2013	UNSH	1
8	7	2013	UNSH	1
8	20	2013	UNSH	1
8	20	2013	UNSH	1
8	20	2013	UNSH	1
8	20	2013	UNSH	1
8	20	2013	UNSH	1
8	20	2013	UNSH	1
8	20	2013	UNSH	1
8	20	2013	UNSH	1
9	18	2013	UNSH	1
9	18	2013	UNSH	1
9	18	2013	UNSH	1
9	18	2013	UNSH	1
9	18	2013	UNSH	1
9	18	2013	UNSH	1
10	23	2012	WTSH	1
8	20	2013	WTSH	1
2	26	2013	OCSU	1
4	26	2013	OCSU	1
4	26	2013	OCSU	1
4	26	2013	OCSU	1
4	26	2013	OCSU	1
4	26	2013	OCSU	1
4	26	2013	OCSU	1
4	26	2013	OCSU	1
4	26	2013	OCSU	2
4	26	2013	OCSU	2
4	26	2013	OCSU	1
4	29	2013	OCSU	1
5	18	2013	OCSU	1
5	18	2013	OCSU	1
5	18	2013	OCSU	1
5	18	2013	OCSU	1
5	18	2013	OCSU	1
5	18	2013	OCSU	1

MONTH	DAY	YEAR	SPECCODE	NUMBER
5	18	2013	OCSU	1
5	18	2013	OCSU	1
5	18	2013	OCSU	1
5	18	2013	OCSU	1
5	18	2013	OCSU	1
5	18	2013	OCSU	1
5	18	2013	OCSU	1
5	18	2013	OCSU	1
5	18	2013	OCSU	1
5	18	2013	OCSU	1
5	18	2013	OCSU	1
5	18	2013	OCSU	1
6	5	2013	OCSU	1
6	5	2013	OCSU	1
6	5	2013	OCSU	1
6	5	2013	OCSU	1
6	6	2013	OCSU	1
6	6	2013	OCSU	1
6	21	2013	OCSU	1
6	21	2013	OCSU	1
6	21	2013	OCSU	1
6	21	2013	OCSU	1
6	21	2013	OCSU	1
6	21	2013	OCSU	1
6	21	2013	OCSU	1
6	21	2013	OCSU	1
6	21	2013	OCSU	1
6	21	2013	OCSU	1
6	21	2013	OCSU	1
6	21	2013	OCSU	1
8	7	2013	OCSU	1
8	7	2013	OCSU	1
8	20	2013	OCSU	1
9	18	2013	OCSU	1
9	18	2013	OCSU	1
9	18	2013	OCSU	1
10	22	2013	OCSU	1
10	22	2013	OCSU	1
10	22	2013	OCSU	1
11	5	2013	OCSU	1
11	5	2013	OCSU	1
11	5	2013	OCSU	1
11	5	2013	OCSU	1
11	5	2013	OCSU	1
11	21	2013	OCSU	1
2	4	2014	OCSU	1

MONTH	DAY	YEAR	SPECCODE	NUMBER
5	18	2013	SCFI	1
5	18	2013	SCFI	1
5	18	2013	SCFI	1
5	18	2013	SCFI	1
6	5	2013	SCFI	1
6	5	2013	SCFI	1
6	5	2013	SCFI	1
6	5	2013	SCFI	1
6	5	2013	SCFI	1
6	5	2013	SCFI	1
6	5	2013	SCFI	1
6	5	2013	SCFI	1
6	5	2013	SCFI	1
6	5	2013	SCFI	1
6	5	2013	SCFI	1
6	21	2013	SCFI	1
6	21	2013	SCFI	1
6	21	2013	SCFI	1
8	7	2013	SCFI	1
8	20	2013	SCFI	1
8	20	2013	SCFI	1
9	18	2013	SCFI	1
9	18	2013	SCFI	1
9	18	2013	SCFI	1
9	18	2013	SCFI	1
9	18	2013	SCFI	1
9	18	2013	SCFI	1
10	22	2013	SCFI	1
10	22	2013	SCFI	1
10	22	2013	SCFI	1
11	5	2013	SCFI	1
11	21	2013	SCFI	1
6	5	2013	TUNS	20
4	30	2013	UNID	1
4	30	2013	UNID	1
4	30	2013	UNID	1
5	18	2013	UNID	1
5	18	2013	UNID	1
5	18	2013	UNID	1
6	5	2013	UNID	1
6	5	2013	UNID	5
6	21	2013	UNID	1
8	7	2013	CG-C	1
9	18	2013	CG-C	1
10	22	2013	CG-C	1
1	15	2014	CG-C	1

MONTH	DAY	YEAR	SPECCODE	NUMBER
4	30	2013	CG-U	1
3	29	2013	CRSH	1
4	30	2013	DE-B	1
5	18	2013	DE-B	1
2	15	2013	DE-G	1
8	20	2013	DE-O	1
2	26	2013	DE-U	1
5	18	2013	DE-U	1
6	6	2013	DE-U	1
2	1	2014	DE-W	1
2	1	2014	DE-W	1
2	1	2014	DE-W	1
2	1	2014	DE-W	1
11	21	2013	FG-C	1
11	21	2013	FG-C	1
2	1	2014	FG-D	1
10	23	2012	FG-U	1
12	13	2012	FG-U	1
3	29	2013	FG-U	1
3	29	2013	FG-U	1
3	29	2013	FG-U	2
3	29	2013	FG-U	1
3	29	2013	FG-U	1
3	29	2013	FG-U	1
3	29	2013	FG-U	1
3	29	2013	FG-U	1
3	29	2013	FG-U	1
3	29	2013	FG-U	1
3	29	2013	FG-U	1
3	29	2013	FG-U	1
3	29	2013	FG-U	1
4	18	2013	FG-U	1
4	18	2013	FG-U	1
4	18	2013	FG-U	1
4	26	2013	FG-U	1
4	26	2013	FG-U	1
4	26	2013	FG-U	2
4	26	2013	FG-U	1
4	26	2013	FG-U	1
4	26	2013	FG-U	1
4	26	2013	FG-U	1
4	26	2013	FG-U	1
4	26	2013	FG-U	1
4	26	2013	FG-U	1
4	26	2013	FG-U	1
4	26	2013	FG-U	1

MONTH	DAY	YEAR	SPECCODE	NUMBER
4	26	2013	FG-U	1
4	26	2013	FG-U	8
4	26	2013	FG-U	25
4	26	2013	FG-U	10
4	29	2013	FG-U	1
4	29	2013	FG-U	1
4	29	2013	FG-U	1
4	29	2013	FG-U	1
4	29	2013	FG-U	1
4	29	2013	FG-U	1
4	29	2013	FG-U	1
4	29	2013	FG-U	1
4	29	2013	FG-U	1
4	30	2013	FG-U	1
4	30	2013	FG-U	1
5	18	2013	FG-U	1
5	18	2013	FG-U	1
5	18	2013	FG-U	1
5	18	2013	FG-U	1
5	18	2013	FG-U	1
5	18	2013	FG-U	1
5	18	2013	FG-U	1
5	18	2013	FG-U	1
5	18	2013	FG-U	1
5	18	2013	FG-U	1
5	18	2013	FG-U	1
5	18	2013	FG-U	1
5	18	2013	FG-U	1
5	18	2013	FG-U	1
5	18	2013	FG-U	1
5	18	2013	FG-U	1
5	18	2013	FG-U	1
5	18	2013	FG-U	1
5	18	2013	FG-U	1
5	18	2013	FG-U	1
5	18	2013	FG-U	1
5	18	2013	FG-U	1
5	18	2013	FG-U	1
5	18	2013	FG-U	1
6	5	2013	FG-U	1
6	5	2013	FG-U	1
6	5	2013	FG-U	1
6	5	2013	FG-U	2
6	5	2013	FG-U	1
6	5	2013	FG-U	1
6	5	2013	FG-U	1

MONTH	DAY	YEAR	SPECCODE	NUMBER
6	5	2013	FG-U	1
6	5	2013	FG-U	1
6	5	2013	FG-U	1
6	5	2013	FG-U	1
6	5	2013	FG-U	2
6	5	2013	FG-U	2
6	5	2013	FG-U	1
6	5	2013	FG-U	1
6	5	2013	FG-U	1
6	5	2013	FG-U	1
6	5	2013	FG-U	1
6	5	2013	FG-U	1
6	5	2013	FG-U	2
6	5	2013	FG-U	1
6	5	2013	FG-U	1
6	5	2013	FG-U	1
6	5	2013	FG-U	1
6	5	2013	FG-U	1
6	5	2013	FG-U	1
6	5	2013	FG-U	1
6	5	2013	FG-U	2
6	6	2013	FG-U	1
6	6	2013	FG-U	1
6	6	2013	FG-U	1
6	6	2013	FG-U	1
6	6	2013	FG-U	1
6	6	2013	FG-U	1
6	6	2013	FG-U	1
6	6	2013	FG-U	2
6	6	2013	FG-U	1
6	6	2013	FG-U	1
6	6	2013	FG-U	1
6	21	2013	FG-U	1
6	21	2013	FG-U	3
6	21	2013	FG-U	1
6	21	2013	FG-U	1
6	21	2013	FG-U	1
6	21	2013	FG-U	2
6	21	2013	FG-U	2
6	21	2013	FG-U	1
6	21	2013	FG-U	1
7	30	2013	FG-U	1
8	7	2013	FG-U	1
8	7	2013	FG-U	1
8	7	2013	FG-U	1
8	7	2013	FG-U	1

MONTH	DAY	YEAR	SPECCODE	NUMBER
8	7	2013	FG-U	1
8	20	2013	FG-U	1
9	18	2013	FG-U	1
9	18	2013	FG-U	1
9	18	2013	FG-U	1
9	18	2013	FG-U	1
10	22	2013	FG-U	1
10	22	2013	FG-U	1
10	22	2013	FG-U	1
10	22	2013	FG-U	1
10	22	2013	FG-U	1
10	22	2013	FG-U	1
10	22	2013	FG-U	1
10	22	2013	FG-U	1
10	22	2013	FG-U	1
10	22	2013	FG-U	1
10	22	2013	FG-U	1
10	22	2013	FG-U	1
10	22	2013	FG-U	1
10	22	2013	FG-U	1
10	22	2013	FG-U	1
10	22	2013	FG-U	1
10	22	2013	FG-U	1
10	22	2013	FG-U	1
10	22	2013	FG-U	1
10	22	2013	FG-U	1
10	22	2013	FG-U	1
10	22	2013	FG-U	1
10	22	2013	FG-U	1
11	5	2013	FG-U	1
11	5	2013	FG-U	1
11	5	2013	FG-U	1
11	5	2013	FG-U	1
11	5	2013	FG-U	1
11	5	2013	FG-U	1
11	5	2013	FG-U	1
11	5	2013	FG-U	1
11	5	2013	FG-U	1
11	5	2013	FG-U	1
11	21	2013	FG-U	1
11	21	2013	FG-U	1
11	21	2013	FG-U	1
11	21	2013	FG-U	1
11	21	2013	FG-U	1
11	21	2013	FG-U	1
11	21	2013	FG-U	1

MONTH	DAY	YEAR	SPECCODE	NUMBER
11	21	2013	FG-U	1
11	21	2013	FG-U	1
11	21	2013	FG-U	1
11	21	2013	FG-U	1
11	21	2013	FG-U	1
11	21	2013	FG-U	1
11	21	2013	FG-U	1
11	21	2013	FG-U	1
11	21	2013	FG-U	1
11	21	2013	FG-U	1
11	21	2013	FG-U	1
11	21	2013	FG-U	1
11	21	2013	FG-U	1
11	21	2013	FG-U	1
11	21	2013	FG-U	1
11	21	2013	FG-U	1
11	21	2013	FG-U	1
11	21	2013	FG-U	1
11	21	2013	FG-U	1
1	15	2014	FG-U	1
1	17	2014	FG-U	1
1	17	2014	FG-U	1
1	17	2014	FG-U	1
1	17	2014	FG-U	1
1	17	2014	FG-U	1
1	17	2014	FG-U	1
1	17	2014	FG-U	1
1	17	2014	FG-U	1
1	17	2014	FG-U	1
1	17	2014	FG-U	1
1	17	2014	FG-U	1
1	17	2014	FG-U	1
1	17	2014	FG-U	1
1	17	2014	FG-U	1
1	17	2014	FG-U	1
1	17	2014	FG-U	1
1	17	2014	FG-U	1
1	17	2014	FG-U	1
2	4	2014	FG-U	1
2	4	2014	FG-U	1
2	4	2014	FG-U	1
3	29	2013	FV-C	1
3	29	2013	FV-C	1
3	29	2013	FV-C	1
3	29	2013	FV-C	1
3	29	2013	FV-C	1

MONTH	DAY	YEAR	SPECCODE	NUMBER
3	29	2013	FV-C	1
3	29	2013	FV-C	1
3	29	2013	FV-C	1
3	29	2013	FV-C	1
3	29	2013	FV-C	1
4	18	2013	FV-C	1
4	26	2013	FV-C	1
4	26	2013	FV-C	1
4	29	2013	FV-C	1
4	30	2013	FV-C	1
4	30	2013	FV-C	1
5	18	2013	FV-C	1
5	18	2013	FV-C	1
5	18	2013	FV-C	1
5	18	2013	FV-C	1
5	18	2013	FV-C	1
5	18	2013	FV-C	1
6	5	2013	FV-C	1
6	5	2013	FV-C	1
6	5	2013	FV-C	1
6	5	2013	FV-C	1
6	6	2013	FV-C	1
6	21	2013	FV-C	1
6	21	2013	FV-C	1
6	21	2013	FV-C	2
6	21	2013	FV-C	1
6	21	2013	FV-C	1
6	21	2013	FV-C	1
8	20	2013	FV-C	1
8	20	2013	FV-C	1
8	20	2013	FV-C	1
9	18	2013	FV-C	1
9	18	2013	FV-C	1
9	18	2013	FV-C	1
9	18	2013	FV-C	1
9	18	2013	FV-C	1
9	18	2013	FV-C	1
9	18	2013	FV-C	1
9	18	2013	FV-C	1
9	18	2013	FV-C	1
9	18	2013	FV-C	1
9	18	2013	FV-C	1
10	22	2013	FV-C	1
10	22	2013	FV-C	1
10	22	2013	FV-C	1
10	22	2013	FV-C	1

MONTH	DAY	YEAR	SPECCODE	NUMBER
10	22	2013	FV-C	1
10	22	2013	FV-C	1
10	22	2013	FV-C	1
10	22	2013	FV-C	1
10	22	2013	FV-C	1
11	5	2013	FV-C	1
11	5	2013	FV-C	1
11	5	2013	FV-C	1
11	5	2013	FV-C	1
11	5	2013	FV-C	1
11	5	2013	FV-C	1
11	5	2013	FV-C	1
11	5	2013	FV-C	1
11	5	2013	FV-C	1
11	5	2013	FV-C	1
11	5	2013	FV-C	1
11	5	2013	FV-C	1
11	5	2013	FV-C	1
11	5	2013	FV-C	1
11	21	2013	FV-C	1
11	21	2013	FV-C	1
11	21	2013	FV-C	2
11	21	2013	FV-C	1
11	21	2013	FV-C	1
11	21	2013	FV-C	1
11	21	2013	FV-C	1
11	21	2013	FV-C	1
11	21	2013	FV-C	1
11	21	2013	FV-C	1
11	21	2013	FV-C	1
11	21	2013	FV-C	1
11	21	2013	FV-C	1
11	21	2013	FV-C	1
2	1	2014	FV-C	1
2	1	2014	FV-C	1
2	1	2014	FV-C	1
2	1	2014	FV-C	1
2	4	2014	FV-C	1
2	4	2014	FV-C	1
2	4	2014	FV-C	1
10	23	2012	FV-G	1
10	22	2013	FV-H	1
10	22	2013	FV-H	1
6	21	2013	FV-P	1
3	29	2013	FV-T	1
3	29	2013	FV-T	1

MONTH	DAY	YEAR	SPECCODE	NUMBER
3	29	2013	FV-T	1
3	29	2013	FV-T	1
3	29	2013	FV-T	1
3	29	2013	FV-T	1
3	29	2013	FV-T	1
4	26	2013	FV-T	1
6	5	2013	FV-T	1
6	5	2013	FV-T	1
6	6	2013	FV-T	1
6	6	2013	FV-T	1
6	21	2013	FV-T	1
6	21	2013	FV-T	1
7	30	2013	FV-T	1
7	30	2013	FV-T	1
7	30	2013	FV-T	1
7	30	2013	FV-T	1
7	30	2013	FV-T	1
8	20	2013	FV-T	1
8	20	2013	FV-T	1
8	20	2013	FV-T	1
8	20	2013	FV-T	1
8	20	2013	FV-T	1
8	20	2013	FV-T	1
8	20	2013	FV-T	1
8	20	2013	FV-T	1
8	20	2013	FV-T	1
8	20	2013	FV-T	1
8	20	2013	FV-T	1
8	20	2013	FV-T	1
8	20	2013	FV-T	1
9	18	2013	FV-T	1
9	18	2013	FV-T	1
9	18	2013	FV-T	1
10	22	2013	FV-T	1
11	5	2013	FV-T	1
11	5	2013	FV-T	1
11	5	2013	FV-T	1
11	5	2013	FV-T	1
11	5	2013	FV-T	1
11	5	2013	FV-T	1
11	5	2013	FV-T	1
11	5	2013	FV-T	1
11	5	2013	FV-T	1
11	5	2013	FV-T	1
11	5	2013	FV-T	1
11	5	2013	FV-T	1

MONTH	DAY	YEAR	SPECCODE	NUMBER
11	21	2013	FV-T	1
11	21	2013	FV-T	1
11	21	2013	FV-T	1
11	21	2013	FV-T	1
11	21	2013	FV-T	1
11	21	2013	FV-T	1
11	21	2013	FV-T	1
11	21	2013	FV-T	1
1	17	2014	FV-T	1
2	1	2014	FV-T	1
2	1	2014	FV-T	1
2	1	2014	FV-T	1
2	4	2014	FV-T	1
2	4	2014	FV-T	1
2	4	2014	FV-T	1
2	15	2013	FV-U	1
2	15	2013	FV-U	2
2	15	2013	FV-U	1
2	26	2013	FV-U	1
2	26	2013	FV-U	1
2	26	2013	FV-U	1
3	29	2013	FV-U	1
3	29	2013	FV-U	1
3	29	2013	FV-U	1
3	29	2013	FV-U	1
3	29	2013	FV-U	1
3	29	2013	FV-U	1
4	29	2013	FV-U	1
4	29	2013	FV-U	1
4	29	2013	FV-U	1
4	29	2013	FV-U	1
4	29	2013	FV-U	1
4	29	2013	FV-U	1
4	29	2013	FV-U	1
4	29	2013	FV-U	1
4	29	2013	FV-U	1
4	29	2013	FV-U	2
4	29	2013	FV-U	1
4	30	2013	FV-U	1
4	30	2013	FV-U	1
4	30	2013	FV-U	1
4	30	2013	FV-U	1
4	30	2013	FV-U	1
4	30	2013	FV-U	1
5	18	2013	FV-U	1
5	18	2013	FV-U	2

MONTH	DAY	YEAR	SPECCODE	NUMBER
5	18	2013	FV-U	1
5	18	2013	FV-U	1
5	18	2013	FV-U	2
5	18	2013	FV-U	1
5	18	2013	FV-U	1
5	18	2013	FV-U	2
5	18	2013	FV-U	1
5	18	2013	FV-U	1
6	5	2013	FV-U	1
6	5	2013	FV-U	1
6	5	2013	FV-U	1
6	5	2013	FV-U	1
6	5	2013	FV-U	1
6	5	2013	FV-U	1
6	5	2013	FV-U	1
7	30	2013	FV-U	1
7	30	2013	FV-U	1
7	30	2013	FV-U	1
7	30	2013	FV-U	1
7	30	2013	FV-U	1
7	30	2013	FV-U	1
7	30	2013	FV-U	1
7	30	2013	FV-U	1
7	30	2013	FV-U	1
7	30	2013	FV-U	1
7	30	2013	FV-U	4
7	30	2013	FV-U	1
7	30	2013	FV-U	1
7	30	2013	FV-U	1
8	7	2013	FV-U	1
8	7	2013	FV-U	1
8	20	2013	FV-U	1
8	20	2013	FV-U	1
9	18	2013	FV-U	1
9	18	2013	FV-U	1
9	18	2013	FV-U	1
9	18	2013	FV-U	1
9	18	2013	FV-U	7
9	18	2013	FV-U	1
10	22	2013	FV-U	1
11	21	2013	FV-U	1
1	15	2014	FV-U	1
1	17	2014	FV-U	1
1	17	2014	FV-U	1
1	17	2014	FV-U	1
1	17	2014	FV-U	1

MONTH	DAY	YEAR	SPECCODE	NUMBER
1	17	2014	FV-U	1
1	17	2014	FV-U	1
1	17	2014	FV-U	1
2	1	2014	FV-U	1
2	1	2014	FV-U	1
2	1	2014	FV-U	1
2	1	2014	FV-U	1
2	1	2014	FV-U	1
2	1	2014	FV-U	1
2	1	2014	FV-U	1
2	4	2014	FV-U	1
2	4	2014	FV-U	1
2	4	2014	FV-U	1
2	4	2014	FV-U	1
9	18	2013	LE-V	1
12	13	2012	MV-B	1
6	21	2013	MV-B	1
10	23	2012	MV-C	1
12	13	2012	MV-C	1
2	26	2013	MV-C	1
4	30	2013	MV-C	1
5	18	2013	MV-C	2
5	18	2013	MV-C	1
9	18	2013	MV-C	1
2	4	2014	MV-C	1
5	18	2013	MV-O	1
5	18	2013	MV-O	1
5	18	2013	MV-O	1
5	18	2013	MV-O	1
5	18	2013	MV-O	1
6	21	2013	MV-O	1
6	21	2013	MV-O	1
7	30	2013	MV-O	1
7	30	2013	MV-O	1
9	18	2013	MV-O	1
9	18	2013	MV-O	1
1	17	2014	MV-O	1
1	17	2014	MV-O	1
1	17	2014	MV-O	1
1	17	2014	MV-O	1
2	1	2014	MV-O	1
2	4	2014	MV-O	1
2	4	2014	MV-O	1
2	4	2014	MV-O	1
2	4	2014	MV-S	1
3	29	2013	MV-T	1

MONTH	DAY	YEAR	SPECCODE	NUMBER
3	29	2013	MV-T	1
3	29	2013	MV-T	1
3	29	2013	MV-T	1
3	29	2013	MV-T	1
3	29	2013	MV-T	1
6	5	2013	MV-T	1
6	5	2013	MV-T	1
6	5	2013	MV-T	1
5	18	2013	MV-U	1
8	20	2013	MY-L	1
2	1	2014	MY-L	1
7	30	2013	MY-S	1
7	30	2013	MY-S	1
7	30	2013	MY-S	1
7	30	2013	MY-S	1
8	7	2013	MY-S	1
3	29	2013	RECV	1
3	29	2013	RECV	1
3	29	2013	RECV	2
4	29	2013	RECV	1
6	5	2013	RECV	1
6	21	2013	RECV	1
6	21	2013	RECV	1
6	21	2013	RECV	1
6	21	2013	RECV	1
6	21	2013	RECV	1
6	21	2013	RECV	1
6	21	2013	RECV	1
6	21	2013	RECV	1
6	21	2013	RECV	1
6	21	2013	RECV	1
6	21	2013	RECV	1
6	21	2013	RECV	1
6	21	2013	RECV	1
6	21	2013	RECV	1
7	30	2013	RECV	1
8	7	2013	RECV	1
8	7	2013	RECV	1
8	7	2013	RECV	1
8	7	2013	RECV	1
8	7	2013	RECV	1
8	7	2013	RECV	1
8	7	2013	RECV	4
8	7	2013	RECV	1
8	7	2013	RECV	1
8	7	2013	RECV	1

MONTH	DAY	YEAR	SPECCODE	NUMBER
8	7	2013	RECV	1
8	20	2013	RECV	1
8	20	2013	RECV	1
8	20	2013	RECV	1
8	20	2013	RECV	1
9	18	2013	RECV	1
9	18	2013	RECV	1
9	18	2013	RECV	1
9	18	2013	RECV	1
9	18	2013	RECV	1
9	18	2013	RECV	1
9	18	2013	RECV	1
9	18	2013	RECV	1
10	22	2013	RECV	1
10	22	2013	RECV	1
11	5	2013	RECV	1
11	21	2013	RECV	3
2	1	2014	RECV	1
2	1	2014	RECV	1
8	20	2013	SPFV	1
8	20	2013	SPFV	1
8	20	2013	SPFV	1
9	18	2013	SPFV	1
9	18	2013	SPFV	1
9	18	2013	SPFV	1
11	21	2013	SPFV	1
11	21	2013	SPFV	1
11	21	2013	SPFV	2
11	21	2013	SPFV	1
4	30	2013	SV-L	1
6	5	2013	SV-L	1
6	21	2013	SV-L	4
8	20	2013	SV-L	1
11	5	2013	SV-L	1
4	18	2013	SV-S	1
6	5	2013	SV-S	1
6	5	2013	SV-S	1
6	5	2013	SV-S	1
6	21	2013	SV-S	1
8	20	2013	SV-S	1
8	20	2013	SV-S	1
10	22	2013	SV-S	1
10	22	2013	SV-S	1
3	29	2013	UNVE	1
3	29	2013	UNVE	1
3	29	2013	WHAL	1

MONTH	DAY	YEAR	SPECCODE	NUMBER
3	29	2013	WHAL	1