**VAQF Scientific Report 2016-04**

# Offshore Energy Planning for Marine Protected Species off of Virginia's Coast:

## A Synthesis of Aerial Surveys in the Proximity of the Virginia Wind Energy Area (VA WEA) from 2012-2015

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**Executive Summary**

In November of 2012, the Virginia Aquarium & Marine Science Center Foundation Research and Conservation Division (VAQF) in collaboration with the University of North Carolina Wilmington (UNCW) began aerial surveys off the coast of Virginia to document large whale migration in the vicinity of the Virginia Wind Energy Area (VA WEA). The Virginia Coastal Zone Management Program at the Department of Environmental Quality of the Commonwealth of Virginia allocated block grant funds from the U.S. Department of Commerce, National Oceanic and Atmospheric Administration to support collection of marine protected species occurrence to inform offshore energy development and planning. These data have been collected for the purposes of establishing baseline data on large whale occurrence and seasonal presence to be integrated into mid-Atlantic ocean planning. This report represents a synthesis of three separate aerial survey projects supported by CZM grants awarded to VAQF.

Large whales, including humpback (*Megaptera novaeangliae*), fin (*Balaenoptera physalus*), minke (*Balaenoptera acutorostrata*), and North Atlantic right (*Eubalaena glacialis;* NARW) whales were seasonally present in the survey area between November and April and distribution within the survey area varied by species in distance from shore, distance from the VA WEA, and depth at the sighting location. Fin whales were distributed further offshore of the WEA and right whales were seen within VA WEA boundary. Sighting rates (sightings/100 km], which allowed us to correct for effort during the years of the survey, varied by species. Humpback and right whale sighting rates were highest in January and fin whales sighting rates highest in April. For minke whales, the least commonly sighted large whale, the highest sighting rate was in March.

The only other cetaceans observed in the WEA were, bottlenose, common and spotted dolphins. The most commonly sighted and broadly distributed delphinid species was the bottlenose dolphin, which was sighted in all months surveyed except for February and March, with highest sighting rates in April through June. Highest sighting rates for common dolphins were in January and March. Atlantic spotted dolphins were only documented in May and June and the higher sighting rate was in June.

Ninety-four percent of all turtle sightings (n=564 of 602) were loggerhead sea turtles (*Caretta caretta*). There were also ten sightings of single leatherback sea turtles (*Dermochelys*

*coriacea*) and 32 sightings of single hard-shelled turtles where species identification could not be established and are listed as "unidentified turtle." Loggerhead sea turtles were primarily sighted in the spring and summer months, but there were thirty-three fall and five winter sightings. The winter sightings were near the offshore ends of the transect lines closest to warmer gulf stream waters. Leatherback sea turtles were sighted exclusively in summer.

In addition to cetaceans and sea turtles, other pelagic marine vertebrates, such as ocean sunfish (*Mola mola*), basking shark (*Cetorhinus maximus*), and unidentified sharks were observed. Commercial, military, and recreational vessels were also encountered in the survey area. These vessels were categorized as either (1) "large shipping vessels" (*e.g.* commercial cargo, cruise ship, larger military vessels, and (2) "other vessels" (*e.g.* commercial, charter, recreational fishing and other recreational vessels such as sailboats or parasail boats). Vessels were sighted each month surveyed although the highest sighting rate of large vessels was in November and of small vessels was in January and September.

**Background**

On November 1, 2013, the federal Bureau of Ocean Energy Management (BOEM) announced Dominion Virginia Power was the provisional winner of the commercial wind lease area offshore of Virginia. The lease area includes 560 $km^2$ off the coast of Virginia Beach, extending from about 55 to 95 km offshore. The Virginia Offshore Wind Technology Advancement Project (VOWTAP), proposed to develop a test project on the continental shelf at the west edge of the Virginia's commercial wind energy area (VA WEA). A grid connected 12 megawatt offshore wind facility with two, six-megawatt turbines was funded by the Bureau of Ocean Energy Management (BOEM) for the Dominion Energy/VOWTAP project. As of March 23, 2016 BOEM approved the Research Activities Plan (RAP) submitted by the Virginia Department of Mines, Minerals, and Energy (DMME) pending final engineering review. This approval permits the installation and operation of the two wind turbines and associated underwater cabling.

Development of offshore wind energy could pose potential threats to marine animals, including direct effects (*i.e.* vessel interactions, collision and entanglement with structures, displacement, avoidance, or injury due to noise from construction or operations), indirect threats

(*i.e.* effects on prey species, increased risk of vessel interaction through displacement) (BOEM 2012), and cumulative impacts (*i.e.* the effect incurred from accumulation or magnification of multiple stressors). Developers will be required to assess their impact on marine animals, especially those managed under the U.S. Endangered Species Act of 1973 (ESA). The survey data synthesized in this document begins the process of providing information to potential developers about protected marine species such as marine mammals and sea turtles.

## Introduction

Aerial line transect surveys cover a large area in a relatively short period of time and allow for distribution and abundance estimates to be generated with sufficient survey effort. One of the most basic ecological questions asked is how many animals are present in an area. Abundance estimation can be relatively simple if the area studied is easily surveyed, and the animal studied is easy to detect, moves slowly, occurs individually or in small groups, and spends its time out in the open. Abundance estimation becomes more complex, however, when working with highly mobile marine animals such as cetaceans and sea turtles that spend a percentage of their time below the surface and thus unavailable to the observer for counting (Buckland *et al.* 2001).

For large areas such as the VA WEA, aerial surveys provide the most economical platform for covering the survey area in a timely manner. Line transect distance sampling is preferred over strip transect methodology for marine animals because the primary assumption of strip transects is that all of the animals in a strip are counted. Line transect methods do not require that all animals in the survey area are counted, only that those on the transect line are counted (Buckland *et al*. 2001). In line transect distance sampling, a probability of detection at various distances is developed, and abundance is estimated using this detection probability (Buckland *et al.* 2001). Because cetaceans and sea turtles dive regularly, the assumption that all animals on the transect line are counted is also violated, but corrections can be applied to surveys *post hoc* to account for sub-surface time.

This project focused primarily on collecting aerial survey data on baleen whale presence and distribution in the vicinity of the VA WEA. Data were collected using standardized

protocols consistent with aerial survey efforts along the east coast of the U.S. to support protected species monitoring for the Navy and the National Marine Fisheries Service (NMFS) to be integrated into ecological modeling for mid-Atlantic ocean planning (*e.g.* Read et al. 2014). From the data collected during the surveys, seasonal presence is presented, although it is important to note that there was not consistent monthly effort among the survey years. These data, therefore, represent preliminary seasonal presence results for each species sighted and do not meet the minimum BOEM survey guidance for baseline data collection issued in July of 2013 (BOEM 2013). Additionally, sightings were summarized relative to sea surface temperature, distance from the boundary of the VA WEA, depth, and distance from shore.

## Methodology

Aerial survey effort was initiated in the Atlantic Ocean off the coast of Virginia in November of 2012 to collect data on the location, presence, and seasonality of large whale species in the vicinity of the (VA WEA). The approximately 10,000 km² survey area included 12 transect lines oriented east-to-west that extended from the beach and ended 56 km to 93 km offshore (Table 1; Figure 1). The center of the survey area was the VA WEA, and transect lines extended to the north, south, inshore and offshore of the VA WEA.

Aerial survey, data collection, and management protocols were consistent with those used for protected marine species monitoring efforts off of Cape Hatteras, N.C., Onslow Bay, N.C., and Jacksonville, F.L. (McAlarney *et al*. 2015; Cummings *et al.* 2015). Aerial surveys were carried out in over-wing, twin-engine, Cessna 337 aircraft, which were maintained under provisions of 14 Code of Federal Regulations (CFR) Part 135 provided by Orion Aviation. Each plane was equipped with electronic positioning equipment and safety gear required for carrying out aerial surveys over open water. Two pilots were used for each flight. Both pilots met requirements as specified in 14 CFR Part 135; the pilot-in-command and crew met or exceeded all NOAA offshore flight safety requirements. The survey team included two observers and a coordinator. Surveys were flown only in safe operating conditions according to NOAA Aircraft Operations Center (AOC) standards and under visual flight regulations (VFR) flight conditions. Aerial surveys for endangered species were conducted under NOAA Scientific Research Permit

16473, held by Dr. D. Ann Pabst at UNC Wilmington and non-listed marine mammal species under Scientific Research General Authorization (GA) permit 17325 held by the Virginia Aquarium Foundation.

The survey transect lines were oriented perpendicular to shore, beginning at 36.50$^{o}$ N, and continued north at 7 km intervals to 37.50$^{o}$ N. Each transect line was approximately 50 nm (90 km) long. Surveys were flown at an altitude of 305 m (1,000 ft) and operational airspeeds of approximately 161 kph (100 mph). Two observers, positioned on each side of the aircraft, carried out the surveys. The plane was equipped with a Global Navigation System (GPS) to permit precise track-line fidelity. Each observer used an independent GPS to record precise time and geographic position of all marine mammal and sea turtle sightings. All reported times were in local EST/EDT time (UTC-5/4). Codes were used to identify and document discrete events throughout the survey (Table 2). Environmental parameters including visibility, Beaufort Sea State (BSS), cloud cover, and glare were collected throughout the survey period and each time an event was recorded. When a cetacean sighting occurred, the initial location on the track-line was recorded and the plane broke from the track-line. The sighting cues, vertical and horizontal angles of the initial sighting relative to the observer's vantage point in the plane were recorded at the time of the sighting. When the plane was directly over the animal(s) the location, species identification, reliability of species ID, and group size (minimum, maximum, and best estimate) were collected. Observers also recorded all sea turtle, other marine vertebrate, and small and large vessel locations, but did not break track for these sightings.

If a sighting occurred off-effort or while transiting to or from the survey area or between transect lines it was considered an "off-effort" sighting. Any cetaceans the survey team encountered while investigating a separate sighting cue were also labeled off-effort. If two species were seen associated with the same sighting cue both were considered on effort. Total number of individuals was based upon the best estimate of group size.

We did not break track when bottlenose dolphins were observed in the nearshore waters within 20 miles of shore. This approach was established to minimize survey effort in areas where the spatial distribution and relative abundance of coastal bottlenose dolphins has previously been established (Barco *et al.* 1999; Torres *et al.* 2003; Torres *et al.* 2005).

*Table 1*. Coordinates for transect line end points for the Virginia CZM survey area. The transect lines are listed from north to south.

| Transect | Western Endpoint | | Eastern Endpoint | |
|---|---|---|---|---|
| **Line** | **Latitude** | **Longitude** | **Latitude** | **Longitude** |
| 12 | 37.268736 | -75.788489 | 37.266861 | -74.823890 |
| 11 | 37.209250 | -75.798006 | 37.207656 | -74.838116 |
| 10 | 37.149764 | -75.857492 | 37.149108 | -74.841439 |
| 9 | 37.087857 | -75.935734 | 37.088869 | -74.856821 |
| 8 | 37.028387 | -75.957473 | 37.030180 | -74.881991 |
| 7 | 36.966509 | -75.978602 | 36.967806 | -74.899736 |
| 6 | 36.907162 | -75.969085 | 36.909441 | -74.893431 |
| 5 | 36.847758 | -75.952705 | 36.849911 | -74.875357 |
| 4 | 36.788890 | -75.937675 | 36.790881 | -74.859249 |
| 3 | 36.729562 | -75.916478 | 36.731035 | -74.840603 |
| 2 | 36.670179 | -75.888754 | 36.672447 | -74.811987 |
| 1 | 36.610843 | -75.861533 | 36.612875 | -74.787569 |

*Table 2.* Event codes used during aerial surveys.

| Event | |
|---|---|
| **Code** | **Value** |
| 1.1 | start/rejoin track |
| 1.2 | end of trackline |
| 2 | location of sighting cue |
| 2.3 | small vessel |
| 2.4 | actual location of cetacean |
| 2.41 | assumed location of cetacean |
| 2.42 | ending location of cetacean |
| 2.70 | sea turtle |
| 2.8 | large vessel sighting |
| 2.9 | non cetacean sighting |
| 3.1 | changing survey conditions |
| 10.0 | off effort sighting |

ESRI®ArcMap™ was used to store all geo-referenced trip, encounter, and sighting information. Data management was based on the Arc Marine data model (Wright, 2007). In addition, tracks and sighting points, from all aerial surveys were incorporated into separate feature classes. We included all sighting data from aerial surveys, plotted group size distributions, and reported numbers of species sighted in tables by date and time. We also plotted group sizes relative to the NARW Seasonal Management Area (SMA) and VA WEA. Sighting

rates were calculated for each species by month and season (sightings/100 km flown). Seasonal maps of large whale and sea turtle spatial distribution were also plotted with winter including January through March, spring including April through June, summer July through September, and fall October through December. The percentage of sightings by species relative to 10 km distance buffers around the VA WEA are also presented. To investigate sightings relative to the WEA and in relation to other environmental correlates (SST, depth, distance from WEA and shore) we performed the following analyses. We calculated the distance that each sighting was from the ocean coast of Virginia using the ArcGIS 10.1 Spatial Analyst Near Analysis tool. The coastline was obtained from the NOAA continuously updated shoreline project (http://shoreline.noaa.gov/data/datasheets/cusp.html). The distance each point was away from the Wind Energy Area (WEA), was calculated using the same method. The latest WEA GIS features were acquired from the BOEM GIS data portal (http://www.boem.gov/Renewable-Energy-GIS-Data/)We used the Marine Geospatial Ecology Tool (MGET) to extract sea surface temperatures to each point based sighting location, date and time (Roberts, et al. 2010). Sea surface temperatures were acquired from the National Climatic Data Center (2007 GHRSST Level 4 AVHRR_OI Global Blended Sea Surface Temperature Analysis. Ver. 1.0. PO.DAAC, CA, USA) at http://dx.doi.org/10.5067/GHAAO-4BC01. The bathymetric (depth) data were collected from NOAA National Geophysical Data Center using the ETOPO1 1 Arc-Minute Global Relief Model (Amante 2009) and extracted to all points using ArcGIS 10.1 Spatial Analyst Extract Value to Point tool. R was used for statistical analyses (R Core Team 2014). When data had homogenous variance, whether or not they were normally distributed, we used either a t-test or ANOVA with Tukey's *post hoc* comparison to compare means. When data did not have homogeneous variance, we used a Kruskal Wallis test with non-parametric *post hoc* comparison using the PMCMR package (Pohlert 2014). We did not attempt to transform these data because they are count data (O'Hara and Kotze 2010).

**Results**

We flew 226 transect lines totaling 20,782.5 km from November 2012 through November 2015 (Table 3). We conducted aerial surveys during all months except for July, although effort was not consistent each month among years (Figure 3*a*-*b*). The year 2014 had the highest level of survey effort (8185.1 km) while 2012 had the least (760.1 km; Figure 3*b*). Seasonally, the

highest amount of survey effort was in the spring (8848.9 km) and the lowest effort was in the summer (3143.6 km) (Figure 3*c*). Survey conditions during the 36 survey days ranged from a Beaufort Sea State (BSS) 1 (small waves, ripples/no whitecaps) to 5 (whitecaps >65%, waves > 5ft). An average BSS value was calculated each month as a way to compare conditions across time. This average was calculated by taking the distance flown at each sea state multiplied by the BSS number (*i.e.* BSS 1 x distances would be multiplied by 1).

*Table 3*. Transect lines, km flown and Hobbs hours (*i.e.* engine hours) during aerial surveys in the Virginia CZM survey area from November 2012 to November 2015. Transect line numbers are listed in the order in which they were flown.

| Date | Transect lines Flown AM | Transect lines Flown PM | Total km Flown | Hobbs Hours |
|---|---|---|---|---|
| 26-Nov-2012 | 5 to 8 | 0 | 378.4 | 3.2 |
| 27-Nov-2012 | 5 to 8 | 0 | 381.7 | 2.8 |
| 22-Feb-2013 | 3 to 6 | 7 to 10 | 821.2 | 6 |
| 20-Mar-2013 | 1, 2, 5, 6 | 0 | 379.2 | 3.3 |
| 29-Mar-2013 | 3 to 8 | 9 to 12 | 952.4 | 7.7 |
| 10-Apr-2013 | 1 to 4 | 5 to 8 | 751.5 | 5.9 |
| 11-Apr-2013 | 7 to 12 | 0 | 561.9 | 4.6 |
| 29-May-2013 | 1 to 6 | 7 to 10 | 932.1 | 6 |
| 30-May-2013 | 6, 7, 11, 12 | | 371.4 | 2.8 |
| 29-Oct-2013 | 7, 6, 8, 9 | 12 to 9 | 755.9 | 5.3 |
| 25-Feb-2014 | 1 to 6 | 7 to 10 | 850.2 | 7 |
| 2-Apr-2014 | 8, 7 | 0 | 185.5 | 1.7 |
| 4-Apr-2014 | 6a, 6b, 5, 4, 3 | 0 | 412.7 | 4.3 |
| 24-Apr-2014 | 0 | 1 to 6 | 553.1 | 4.6 |
| 25-Apr-2014 | 12 to 7 | 6 to 1 | 1007.1 | 8.2 |
| 26-Apr-2014 | 12 to 9 | 0 | 345.1 | 2.5 |
| 15-May-2014 | 12 to 5 | 0 | 550.8 | 4.7 |
| 20-Jun-2014 | 10 to 7 | 6 to 3 | 743.3 | 5.8 |
| 21-Jun-2014 | 0 | 6 to 5 | 198.8 | 2 |
| 15-Sep-2014 | 4-8; 3 | 0 | 566.0 | 4 |
| 8-Oct-2014 | 10 to 7 | 6 to 3 | 764.0 | 5.3 |
| 29-Nov-2014 | 12 to 9 | 8 to 5 | 717.1 | 5.2 |
| 30-Nov-2014 | 1 to 2 | 0 | 191.3 | 1.5 |
| 15-Dec-2014 | 8 to 5 | 0 | 379.6 | 2.8 |
| 16-Dec-2014 | 12 to 7 | 4 to 3 | 720.5 | 5.3 |
| 20-Jan-2015 | 12 to 9 | 8 to 5 | 0.0 | 6.7 |
| 21-Jan-2015 | 3 to 1 | 0 | 279.8 | 3.5 |
| 1-Mar-2015 | 4,3; inshore 2-1 | 0 | 289.2 | 2.4 |
| 19-Mar-2015 | 5-8 | 0 | 373.7 | 2.4 |
| 25-Apr-2015 | 8 to 5 | 4 to 1 | 752.6 | 6.2 |
| 25-May-2015 | 12 to 9 | 8 to 6 | 729.7 | 6.3 |
| 19-Jun-2015 | 8 to 5 | 4 to 1 | 753.3 | 2.4 |
| 27-Aug-2015 | 12 to 7 | 1 to 6 | 1112.1 | 7.2 |
| 28-Aug-2015 | 12 to 9 | 9 to 5 | 706.8 | 5.3 |
| 19-Sep-2015 | 1 to 4 | 6 to 9 | 758.7 | 5.4 |
| 1-Nov-2015 | 10 to 5 | 0 | 556.2 | 3.42 |
| **36 Days** | **226 Transect lines flown** | | **20,782.5 km** | **163.72 hrs** |

Collectively over 80% of the surveys were flown in a BSS 2 (whitecaps 0-33%, waves 1-2 ft -44.6% and 3 (whitecaps 33-50%, waves 2-3 ft -40.7%); (Figure 4*a-c*). Cetacean sighting rates decreased as BSS increased (Figure 5*a-c*). Other aerial surveys have demonstrated that the rate of cetacean sightings is negatively affected by an increase in the BSS (*e.g.* DeMaster et al. 2001, Gómez de Segura *et al*. 2006, Mallette *et al.* 2014, Cummings *et al*. 2015, McAlarney *et al.* 2012, 2015). This trend was also apparent in the present efforts where sightings dropped from 1.68 to 0 sightings per 100 km as BSS increased from 1 to 5.

Marine Mammal Sightings

A total of 231 sightings of 1,986 cetaceans, representing seven species, were observed while on effort during aerial surveys. In addition, there were 42 off-effort sightings of 390 cetaceans. Three delphinid species were sighted, including the bottlenose dolphin (*Tursiops truncatus*), common dolphin (*Delphinus delphis),* and Atlantic spotted dolphin *(Stenella frontalis).* Four large whale species, humpback (*Megaptera novaeangliae*), fin (*Balaenoptera physalus*), minke (*Balaenoptera acutorostrata*), and North Atlantic right (*Eubalaena glacialis*) whales, were encountered in the survey area (Figure 6). All of these baleen whale species are protected when they are located in waters within U.S. jurisdiction under the Marine Mammal Protection Act (MMPA 1972). Three species, the NARW, fin and humpback whale are listed as endangered under the ESA, although the listing status of the humpback whale has been proposed for revision (Waring *et al.* 2014). Occurrence within the survey area is discussed by individual species below. In addition, unidentified cetacean and delphinid species were documented. A total of five cetacean species were encountered while off-effort, bottlenose dolphin common dolphin Atlantic spotted dolphin, humpback, and fin whale. Off effort sightings are included in the sighting tables and maps for each species but are excluded from any calculations and are identified as off-effort.

**Delphinids**

Bottlenose dolphin (*Tursiops truncatus*) (Table 4, Figure 7)

This species was the most commonly observed cetacean species with a total of 186 sightings of 1,731 individuals. Of the total number listed above, thirty-four sightings of three hundred and forty-five dolphins occurred off-effort. Bottlenose dolphin were observed during all months surveyed except for February and March. The highest sighting rates were April through June and September (mean=1.6 sightings/100km; SD ±0.31). Group size ranged from one to 100 individuals (mean=9; SD±14.5). The majority of sightings occurred within 30 km of shore. Based on the distance from shore (*i.e.* less than 30 km), these bottlenose dolphins were most likely the inshore ecotype (Torres *et al*. 2003; Lynott 2013).

The population structure of bottlenose dolphins is complex with an offshore stock located near the continental shelf edge and multiple migratory and resident coastal stocks close to shore and in estuarine waters (Waring *et al.* 2013). The three coastal stocks that may occur in Virginia include approximately 22,000 individuals (Waring *et al.* 2013). Bottlenose dolphins are consistently seen in Virginia waters from May through October (Barco *et al.* 1999) and are regularly sighted from early spring through late fall with sightings and stranding events in Virginia waters all months of the year (Swingle *et al*. 2010, 2011, 2012, 2013, 2014). An Unusual Mortality Event (UME) for bottlenose dolphins along the Atlantic coast was declared on July 1, 2013, and 415 confirmed dolphin strandings were documented in Virginia that year, with over 1,600 animals documented during the event. Bottlenose dolphins are not protected under the Endangered Species Act (ESA), but the northern coastal migratory stock is listed as depleted under the Marine Mammal Protection Act (MMPA). It is unclear how the recent Unusual Mortality Event will affect stock status but it is unlikely that *Tursiops* will be listed under the ESA. The status of the offshore bottlenose dolphins stock in the Northwest Atlantic is unknown (Waring *et al.* 2014).

Table 4. Summary of bottlenose dolphin individuals and sightings from Nov. 2012 to Nov. 2015.Corrected sightings = sightings/100 km. Gray shading indicates no surveys flown that month.

| Month | Number of individual bottlenose dolphins 2012 | 2013 | 2014 | 2015 | Total dolphins | Total sightings | Total km flown | Corrected sightings |
|---|---|---|---|---|---|---|---|---|
| Jan | | | | 7 | **7** | **1** | 279.8 | **0.36** |
| Feb | | 0 | 0 | | **0** | **0** | 1671.4 | **0.00** |
| Mar | | 0 | | 0 | **0** | **0** | 1994.5 | **0.00** |
| Apr | | 79 | 124 | 103 | **306** | **63** | 4569.5 | **1.38** |
| May | | 111 | 148 | 117 | **376** | **49** | 2584 | **1.90** |
| Jun | | | 222 | 37 | **259** | **31** | 1695.4 | **1.83** |
| Jul | | | | | | | | |
| Aug | | | | 272 | **272** | **8** | 1818.9 | **0.44** |
| Sep | | | 63 | 33 | **96** | **17** | 1324.7 | **1.28** |
| Oct | | 68 | 31 | | **99** | **13** | 1519.9 | **0.86** |
| Nov | 7 | | 0 | 17 | **24** | **3** | 2224.7 | **0.13** |
| Dec | | | 12 | | **12** | **1** | 1100.1 | **0.09** |
| **Total** | **7** | **258** | **600** | **586** | **1451** | **186** | **20782.9** | **0.89** |

Common dolphin (*Delphinus delphis*) (Table 5, Figure 8)

Twenty-seven sightings of 400 individual common dolphins were observed. One sighting of 15 individuals was off-effort. Sightings were predominately greater than 20 nm off the coast, and were south of line 9. Group sizes were variable, ranging from two to 45 individuals (mean = 14.8; SD±11.4). Sightings occurred each month from November through April, with the highest sighting rate in January (0.71 sightings/100 km) followed by March (0.50 sightings/100 km). No sightings were recorded from May through October, although July was not surveyed.

The common dolphin (in the western north Atlantic also called the short-beaked common dolphin) is one of the most widely distributed species worldwide, and they typically occur over the continental shelf in waters 100-2,000 m deep. In the mid-Atlantic, they are often associated with the Gulf Stream (Doksaeter *et al.* 2008; Waring *et al.* 2008). Common dolphins regularly occur north of Cape Hatteras, North Carolina. From January to May they are found as far south as Cape Hatteras and typically spend the warmer water months in the U.S. northeast and Atlantic Canada (Hain *et al.* 1981; CETAP 1982; Payne *et al*. 1984). The current best abundance estimate for the western north Atlantic stock is estimated to be around 173,486 (CV=0.55) individuals (Waring *et al.* 2013). The current best estimate of common dolphins in the western Atlantic

Ocean combines two geographic estimates. Estimates from the Bay of Fundy to central VA [67,191 individuals (CV=0.29)] and from central VA to central Florida [2,993 (CV=0.87)] for a combined estimate of 70,184 (CV=0.28) (Waring *et al*. 2014). Short-beaked common dolphins are not listed as endangered or threatened under the ESA.

Table 5. Summary of common dolphin individuals and sightings from Nov. 2012 to Nov. 2015.Corrected sightings = sightings/100 km. Gray shading indicates no surveys flown that month.

| | **Number of individual common dolphins sighted** | | | | **Total** | **Total** | **Total** | **Corrected** |
|---|---|---|---|---|---|---|---|---|
| **Month** | **2012** | **2013** | **2014** | **2015** | **dolphins** | **sightings** | **km flown** | **sightings** |
| Jan | | | | 12 | **12** | **2** | 279.8 | **0.71** |
| Feb | | | 20 | | **20** | **1** | 1671.4 | **0.06** |
| Mar | | 156 | | 0 | **156** | **10** | 1994.5 | **0.50** |
| Apr | | 12 | 114 | 4 | **130** | **10** | 4569.5 | **0.22** |
| May | | 0 | 0 | 0 | **0** | **0** | 2584 | **0.00** |
| Jun | | | 0 | 0 | **0** | **0** | 1695.4 | **0.00** |
| Jul | | | | | | | | |
| Aug | | | | 0 | **0** | **0** | 1818.9 | **0.00** |
| Sep | | | 0 | 0 | **0** | **0** | 1324.7 | **0.00** |
| Oct | | 0 | 0 | | **0** | **0** | 1519.9 | **0.00** |
| Nov | 17 | | 0 | | **17** | **1** | 2224.7 | **0.04** |
| Dec | | | 65 | | **65** | **3** | 1100.1 | **0.27** |
| **Total** | **17** | **168** | **199** | **16** | **400** | **27** | **20782.9** | **0.13** |

<u>Atlantic spotted dolphin</u> (*Stenella frontalis*) (Table 6, Figure 9)

A total of four sightings of 92 individual dolphins occurred on effort and one sighting of 22 of this total was off-effort. Spotted dolphins were sighted in May and June with the higher sighting rate in June (0.18 sightings/100 km). All sightings were on the southern half of the transect lines; three of the sightings were offshore near or along the first shelf break while one sighting was 55 km from shore.

There are two distinct forms, or ecotypes, of the Atlantic spotted dolphin in the western north Atlantic: a heavily spotted, larger form that typically occurs on the continental shelf and is most often encountered at the 200 m isobath or shallower, and a less spotted and smaller form that occurs further offshore and around islands (Perrin *et al*. 1987, 1994). It is unclear which ecotype was sighted after examination of photos collected during this sighting and the animals'

location 96 km offshore (60 miles). The abundance estimate for *S. frontalis* in the western north Atlantic is 26,798 (CV=0.66); the status of the stock(s) is/are unknown (Waring *et al*. 2013). Spotted dolphins are protected under the ESA.

Table 6. Summary of spotted dolphin individuals and sightings from Nov. 2012 to Nov. 2015.Corrected sightings = sightings/100 km. Gray shading indicates no surveys flown that month.

| | **Number of individual spotted dolphins sighted** | | | | **Total** | **Total** | **Total** | **Corrected** |
|---|---|---|---|---|---|---|---|---|
| **Month** | **2012** | **2013** | **2014** | **2015** | **dolphins** | **sightings** | **km flown** | **sightings** |
| Jan | | | | 0 | **0** | **0** | 279.8 | **0.00** |
| Feb | | 0 | 0 | | **0** | **0** | 1671.4 | **0.00** |
| Mar | | 0 | | 0 | **0** | **0** | 1994.5 | **0.00** |
| Apr | | 0 | 0 | 0 | **0** | **0** | 4569.5 | **0.00** |
| May | | 0 | 6 | 0 | **6** | **1** | 2584 | **0.04** |
| Jun | | | 0 | 86 | **86** | **3** | 1695.4 | **0.18** |
| Jul | | | | | | | | |
| Aug | | | | 0 | **0** | **0** | 1818.9 | **0.00** |
| Sep | | | 0 | 0 | **0** | **0** | 1324.7 | **0.00** |
| Oct | | 0 | 0 | | **0** | **0** | 1519.9 | **0.00** |
| Nov | 0 | | 0 | 0 | **0** | **0** | 2224.7 | **0.00** |
| Dec | | | 0 | | **0** | **0** | 1100.1 | **0.00** |
| **Total** | **0** | **0** | **6** | **86** | **92** | **4** | **20782.9** | **0.02** |

**Baleen Whales**

Fin whale (*Balaenoptera physalus*) (Table 7, Figure 10-11)

Among the large whales, fin whales had the highest number of sightings and highest sighting rate during aerial surveys. Nineteen sightings of 31 individuals were observed, and two of these sightings of a total of three individuals were off-effort. Group size ranged from one to three individuals (mean = 1.6; ±0.80 SD). All sightings except for one was recorded along or east of the first continental shelf break. Sightings occurred from February through April, with the highest sighting rate in April (0.31 sightings/100 km) followed by March (0.20 sightings/100 km). There were no sightings documented from May through January (July was not surveyed). On at least one occasion aerial observers documented feeding behavior evidenced by extended ventral grooves (Figure 11).

Fin are the second largest whale species and are listed as endangered in the U.S. The North Atlantic population is considered to be a single population (stock), and the best available

(most current) estimate of abundance is 1,618 whales (CV=0.33) from 2011 NOAA shipboard surveys, although the survey did not cover the entire range (Waring *et al.* 2014). Fin whales are most commonly found from Cape Hatteras northward and spend the warmer months feeding in high latitude waters. It has been suggested that calving takes place in the fall and winter offshore of the U.S. mid-Atlantic, but no concrete evidence of overwintering exists (Waring *et al*. 2014).

Table 7. Summary of fin whale individuals and sightings from Nov. 2012 to Nov. 2015. Corrected sightings = sightings/100 km flown). Gray shading indicates no surveys flown.

| | **Number of individual fin whales sighted** | | | | **Total** | **Total** | **Total** | **Corrected** |
|---|---|---|---|---|---|---|---|---|
| **Month** | **2012** | **2013** | **2014** | **2015** | **whales** | **sightings** | **km flown** | **sightings** |
| Jan | | | | 0 | **0** | **0** | 279.8 | **0.00** |
| Feb | | 0 | 1 | | **1** | **1** | 1671.4 | **0.06** |
| Mar | | 9 | | 0 | **9** | **4** | 1994.5 | **0.20** |
| Apr | | 12 | 5 | 4 | **21** | **14** | 4569.5 | **0.31** |
| May | | 0 | 0 | 0 | **0** | **0** | 2584 | **0.00** |
| Jun | | | 0 | 0 | **0** | **0** | 1695.4 | **0.00** |
| Jul | | | | | | | | |
| Aug | | | | 0 | **0** | **0** | 1818.9 | **0.00** |
| Sep | | | 0 | 0 | **0** | **0** | 1324.7 | **0.00** |
| Oct | | 0 | 0 | | **0** | **0** | 1519.9 | **0.00** |
| Nov | 0 | | 0 | 0 | **0** | **0** | 2224.7 | **0.00** |
| Dec | | | 0 | | **0** | **0** | 1100.1 | **0.00** |
| **Total** | **0** | **21** | **6** | **4** | **31** | **19** | **20782.9** | **0.09** |

Humpback whale (*Megaptera novaeangliae*) (Table 8, Figure 12)

A total of seventeen sightings of 25 humpback whales were observed during the survey period. Four of these sightings including five individuals were recorded off-effort. Although there were fewer individuals and sightings of humpbacks, the overall sighting rate for this species (mean sightings 0.08/100km) was close to that of fin whales (mean sightings 0.09 /100km). Humpback group size ranged from one to four individuals (mean = 1.4; 0.80±SD). Humpback sightings occurred from November through April. The highest numbers of sightings and individuals were in January (five sightings of eleven individuals; 1.79 sightings/100 km) and April (eight sightings of seven individuals; 0.15 sightings/100 km). There were no sightings from May through October in the years aerial surveys were conducted (July was not surveyed).

Sixty percent of humpback sightings occurred within the SMA and on the inshore segments of transect lines. Thirty-two percent of the total sightings were along the first shelf break and 8% were within the VA WEA. On one occasion in January of 2015, aerial observers were able to collect fluke images of two humpback whales and through photo-ID matching efforts these individuals were matched to individuals previously sighted in the Gulf of Maine (*pers comm* Jooke Robbins).

Currently, humpback whales in U.S. Atlantic waters are designated as endangered species under the Endangered Species Act (ESA 1973). Six feeding grounds within the western North Atlantic representing relatively discrete subpopulations have been identified. Humpback whales in the western North Atlantic have been treated as a single stock although due to the strong site-fidelity of some individuals in the Gulf of Maine (GOM) this region has been reclassified as a separate feeding stock. Humpbacks that stranded or were observed live in the mid-Atlantic have been identified to three different feeding stocks based upon ongoing photo-identification efforts: primarily the Gulf of Maine stock, but also the Gulf of St. Lawrence and Newfoundland stocks (Barco *et al.* 2002).

Population estimates for the North Atlantic population including GOM range between 7,698 (genetic tagging methods) and 12,000 (photographic mark-recapture methods) depending upon methods utilized (reviewed in Waring *et al.* 2012; NMFS 2016). The minimum population estimate for the GOM is 823 individuals (CV=0) (Waring *et al.* 2014).

The population status of humpback whales is currently being revised. NOAA has proposed to revise the ESA listing to identify 14 Distinct Population Segments (DPS) two of which would be listed as threatened (Western North Pacific, Central America) and two listed as endangered (Cape Verde Islands/Northwest Africa). The remaining 10 DPSs including those humpback whales that migrate through mid-Atlantic waters have been proposed for delisting (80 FR 22303). A draft Monitoring Plan for Humpback Whale DPSs is available (http://www.nmfs.noaa.gov/pr/species/documents/hbw_draft_pdmp.pdf)

Table 8. Summary of humpback whale individuals and sightings (on and off effort) from Nov. 2012 to Nov. 2015. Corrected sightings = sightings/100 km). Gray shading indicates no surveys flown.

| | **Number of individual humpback whales sighted** | | | | **Total** | **Total** | **Total km** | **Corrected** |
|---|---|---|---|---|---|---|---|---|
| **Month** | **2012** | **2013** | **2014** | **2015** | **whales** | **sightings** | **flown** | **sightings** |
| Jan | | | | 11 | **11** | **5** | 279.8 | **1.79** |
| Feb | | 1 | 0 | | **1** | **1** | 1671.4 | **0.06** |
| Mar | | 2 | | 0 | **2** | **1** | 1994.5 | **0.05** |
| Apr | | 4 | 3 | 1 | **8** | **7** | 4569.5 | **0.15** |
| May | | 0 | 0 | 0 | **0** | **0** | 2584 | **0.00** |
| Jun | | | 0 | 0 | **0** | **0** | 1695.4 | **0.00** |
| Jul | | | | | | | | |
| Aug | | | | 0 | **0** | **0** | 1818.9 | **0.00** |
| Sep | | | 0 | 0 | **0** | **0** | 1324.7 | **0.00** |
| Oct | | 0 | 0 | | **0** | **0** | 1519.9 | **0.00** |
| Nov | 0 | | 1 | 1 | **2** | **2** | 2224.7 | **0.09** |
| Dec | | | 1 | | **1** | **1** | 1100.1 | **0.09** |
| **Total** | **0** | **7** | **5** | **13** | **25** | **17** | **20782.9** | **0.08** |

<u>North Atlantic right whale</u> (NARW) (*Eubalaena glacialis*) (Table 9, Figure 13-14)

Five sightings of eight individuals occurred during the survey period. Group size ranged from one to four individuals (mean = 1.6; SD±0.6). All sightings were offshore of the Seasonal Management Area (SMA), two were within the VA WEA, and six were within 20 km of the VA WEA. All sightings were between 30 and 75 km offshore. Sightings occurred in January, February and April. The highest sighting rate was in January (0.71 sightings/100 km). No sightings occurred in March or May through December (July was not surveyed).

The NARW have callosities, or large patches of raised tissue, on their heads and each whale has a unique callosity pattern which permits researches to identify individuals. Callosity patterns can be effectively documented with photography during aerial surveys (NEAQ; Reeves et al. 2007). Additionally, photographically documenting these whales provides the opportunity to assess general health through body condition and presence/absence of injuries. Image data can be used to identify when an individual is present in a specific location, and presence data can be pieced together to identify patterns in habitat use and migratory routes over time. These data also

contribute to understanding of population level demographics, health, mortality and reproductive success.

A sighting of NARWs were photo-documented on 25 February 2016 and reported as two individuals in a previous grant report, however photo-ID and matching efforts with the North Atlantic Right Whale Catalog (New England Aquarium NEAq; and collaborators) verified four individuals were documented during this encounter, and a total of five individuals were sighted this survey day. NARW's were sighted January, February and April. With the exception of one individual, all images captured an open mouth swimming behavior consistent with feeding (Figure 14). From photo ID records all individuals that have been matched to date (n=4) have been identified as juveniles and were not sighted in the calving/nursery grounds in the southeast region after sightings in Virginia. Three of these individuals were male and one was female.

The North Atlantic right whale is critically endangered under the U.S. Endangered Species Act. The minimum population size based upon photo-ID efforts indicate that as of 2011 465 individually recognized whales were living (Waring *et al.* 2014). This species has low reproductive rates and high mortality rates (Kraus *et al.*, 1986, 2001; Knowlton *et al.*, 1994) making it extremely vulnerable to continued population decline. North Atlantic right whales are a slow moving, coastal species that are susceptible to both vessel strikes and gear entanglements. The NARW spends the warm water months in high latitude waters feeding on copepods. In the fall, some individuals disperse from feeding areas in New England and Atlantic Canada. Breeding females travel to ocean waters off the Georgia/Florida border to calve (Kraus *et al.*, 1986; Kraus *et al.*, 2005; Johnson *et al.*, 2005; Knowlton *et al.*, 2012).

Recent passive acoustic studies found that NARW's were detected in all seasons in the mid-Atlantic (Hodge *et al.* 2015) and in all months off the coast of Virginia (Salisbury *et al.* 2015). The winter distribution of non-breeding females, adult males, and juvenile whales is largely unknown, and whales may move extensively between feeding and breeding areas (Waring et al. 2014). The mid-Atlantic region is the migratory corridor between summer feeding areas and winter breeding areas and may also be a destination for non-breeding individuals (Jacobsen *et al.*, 2004).

Table 9. Summary of NARW individuals and sightings from Nov. 2012 to Nov. 2015. Corrected sightings = sightings/100km flown). Gray shading indicates no surveys flown.

| | Number of individual NARWs sighted | | | | Total | Total | Total | Corrected |
|---|---|---|---|---|---|---|---|---|
| **Month** | **2012** | **2013** | **2014** | **2015** | **whales** | **sightings** | **km flown** | **sightings** |
| Jan | | | | 2 | **2** | **2** | 279.8 | **0.71** |
| Feb | | 0 | 5 | | **5** | **2** | 1671.4 | **0.12** |
| Mar | | 0 | | 0 | **0** | **0** | 1994.5 | **0.00** |
| Apr | | 0 | 1 | 0 | **1** | **1** | 4569.5 | **0.02** |
| May | | 0 | 0 | 0 | **0** | **0** | 2584 | **0.00** |
| Jun | | | 0 | 0 | **0** | **0** | 1695.4 | **0.00** |
| Jul | | | | | | | | |
| Aug | | | | 0 | **0** | **0** | 1818.9 | **0.00** |
| Sep | | | 0 | 0 | **0** | **0** | 1324.7 | **0.00** |
| Oct | | 0 | 0 | | **0** | **0** | 1519.9 | **0.00** |
| Nov | 0 | | 0 | 0 | **0** | **0** | 2224.7 | **0.00** |
| Dec | | | 0 | | **0** | **0** | 1100.1 | **0.00** |
| **Total** | **0** | **0** | **6** | **2** | **8** | **5** | **20782.9** | **0.02** |

Minke whale (*Balaenoptera acutorostrata*) (Table 10, Figure 15)

Minke whales were the least commonly sighted baleen whale. Two sightings of three minke whales were observed along and east of the first shelf break. The sighting of two individuals co-occurred with fin whales. Sightings occurred during March and April.

Minke whales are the smallest of the rorqual whales. They are not protected under the ESA but are protected by the MMPA. Minke whales inhabiting waters off the U.S. east coast are considered part of the Canadian East Coast stock, which occurs from to the western portion of the Davis Strait (45ºW) south to the Gulf of Mexico. Minke whale distribution is considered to be highly seasonal. The most recent abundance estimate for the Canadian East Coast Stock is 20,741 (CV=0.30). An abundance estimate was also calculated from central VA to the lower Bay of Fundy in Summer 2011 and the best available abundance estimate for this region is 2,591 (CV=0.81) (Waring *et al.* 2014).

Table 10. Summary of minke whale individuals and sightings from Nov. 2012 to Nov. 2015. Corrected sightings = sightings/100 km. Gray shading indicates no surveys flown.

| | **Number of individual minke whales sighted** | | | | **Total** | **Total** | **Total** | **Corrected** |
|---|---|---|---|---|---|---|---|---|
| **Month** | **2012** | **2013** | **2014** | **2015** | **whales** | **sightings** | **km flown** | **sightings** |
| Jan | | | | 0 | **0** | **0** | 279.8 | **0.00** |
| Feb | | 0 | 0 | | **0** | **0** | 1671.4 | **0.00** |
| Mar | | 2 | | 0 | **2** | **1** | 1994.5 | **0.05** |
| Apr | | 0 | 1 | 0 | **1** | **1** | 4569.5 | **0.02** |
| May | | 0 | 0 | 0 | **0** | **0** | 2584 | **0.00** |
| Jun | | | 0 | 0 | **0** | **0** | 1695.4 | **0.00** |
| Jul | | | | | | | | |
| Aug | | | | 0 | **0** | **0** | 1818.9 | **0.00** |
| Sep | | | 0 | 0 | **0** | **0** | 1324.7 | **0.00** |
| Oct | | 0 | 0 | | **0** | **0** | 1519.9 | **0.00** |
| Nov | 0 | | 0 | 0 | **0** | **0** | 2224.7 | **0.00** |
| Dec | | | 0 | | **0** | **0** | 1100.1 | **0.00** |
| **Total** | **0** | **2** | **1** | **0** | **3** | **2** | **20782.9** | **0.01** |

**Unidentified Cetaceans**

Unidentified delphinid (Table 11; Figure 16)

On eleven occasions species identification could not be established with 100% certainty although observers were confident of the scientific family classification of the sighting (*i.e.* body size and color pattern suggested these individuals were within the Family Delphinidae). These sightings were documented as "unidentified delphinids" and included 74 individuals. Group size ranged from one to 15 individuals (mean = 6.7; SD = 4.7). January had the highest sighting rate of 0.71 sightings/100 km flown.

Table 11. Summary of unidentified delphinid individuals and sightings from Nov. 2012 to Nov. 2015. Corrected sightings = sightings/100 km. Gray shading indicates no surveys flown.

| | **Number of individual unidentified delphinids sighted** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Month** | **2012** | **2013** | **2014** | **2015** | **Total delphinids** | **Total sightings** | **Total km flown** | **Corrected sightings** |
| Jan | | | | 14 | **14** | **2** | 279.8 | **0.71** |
| Feb | | 4 | 0 | | **4** | **1** | 1671.4 | **0.06** |
| Mar | | 20 | | 0 | **20** | **2** | 1994.5 | **0.10** |
| Apr | | 0 | 6 | 0 | **6** | **1** | 4569.5 | **0.02** |
| May | | 0 | 0 | 0 | **0** | **0** | 2584 | **0.00** |
| Jun | | | 6 | 15 | **21** | **3** | 1695.4 | **0.18** |
| Jul | | | | | | | | |
| Aug | | | | 0 | **0** | | 1818.9 | **0.00** |
| Sep | | | 8 | 0 | **8** | **1** | 1324.7 | **0.08** |
| Oct | | 1 | 0 | | **1** | **1** | 1519.9 | **0.07** |
| Nov | 0 | | 0 | 0 | **0** | **0** | 2224.7 | **0.00** |
| Dec | | | 0 | | **0** | **0** | 1100.1 | **0.00** |
| **Total** | **0** | **25** | **20** | **29** | **74** | | **20782.9** | **0.36** |

Unidentified cetacean (Table 12; Figure 17)

On two occasions, the scientific order of a sighted group could be established, but the family could not be determined with 100% certainty. These "unidentified cetacean" sightings included 12 individuals, none of which were located within the VA WEA.

Table 12. Summary of unidentified cetacean individuals and sightings from Nov. 2012 to Nov. 2015. Corrected sightings = sightings/100 km). Gray shading indicates no surveys flown.

| | **Number of individual unidentified cetaceans sighted** | | | | **Total** | **Total** | **Total** | **Corrected** |
|---|---|---|---|---|---|---|---|---|
| **Month** | **2012** | **2013** | **2014** | **2015** | **CETA** | **sightings** | **km flown** | **sightings** |
| Jan | | | | 0 | **0** | **0** | 279.8 | **0.00** |
| Feb | | 0 | 0 | | **0** | **0** | 1671.4 | **0.00** |
| Mar | | 2 | | 0 | **2** | **1** | 1994.5 | **0.05** |
| Apr | | 0 | 0 | 0 | **0** | **0** | 4569.5 | **0.00** |
| May | | 10 | 0 | 0 | **10** | **1** | 2584 | **0.04** |
| Jun | | | 0 | 0 | **0** | **0** | 1695.4 | **0.00** |
| Jul | | | | | | | | |
| Aug | | | | 0 | **0** | **0** | 1818.9 | **0.00** |
| Sep | | | 0 | 0 | **0** | **0** | 1324.7 | **0.00** |
| Oct | | 0 | 0 | | **0** | **0** | 1519.9 | **0.00** |
| Nov | 0 | | 0 | 0 | **0** | **0** | 2224.7 | **0.00** |
| Dec | | | 0 | | **0** | **0** | 1100.1 | **0.00** |
| **Total** | **0** | **12** | **0** | **0** | **12** | **2** | **20782.9** | **0.06** |

Sea Turtles (Tables 13-16, Figures 18*a-c* and 19-20)

Six hundred and twenty-three sightings of 915 sea turtles including two confidently identified species were observed during the surveys. Six sightings of six individuals occurred off-effort and are included in the total numbers above. Sighting rates were negatively correlated with Beaufort Sea State, with rates declining in sea states greater than a BSS 1 (Figures 18*a-c*). There were no sea turtles sighted in the survey area in December, January or March, but five loggerheads were sighted during one survey in February 2014. The highest sighting rate for sea turtles occurred in the spring (5.11 sightings/100 km) followed by summer (4.26 sightings/100km), fall (0.66 sightings/100km), and winter (0.13 sighting/100km; Table 13). Loggerhead sea turtles (*Caretta caretta*) represented the majority of sea turtle sightings (n=581,

93.3%). The other sea turtle species identified in the survey area was the leatherback sea turtle (*Dermochelys coriacea*), for which we had ten sightings of ten animals. For the remaining thirty-two sightings, species identification could not be made with 100% certainty and are therefore listed as "unidentified sea turtles." During summer and fall when water temperatures are warmer sea turtles are present offshore of Virginia. Sea turtles must come to the surface to breathe and spend time basking at the surface for thermoregulation when bottom waters that they forage in are cool. This means in spring months when sea turtles are moving into the area and water temperatures are cooler they are spending longer times at the surface basking making them more susceptible to vessel interactions. Both loggerhead and leatherback turtles are susceptible to vessel strikes and entanglements in fishing gear.

Sea turtles were distributed throughout the survey area, and loggerheads and unidentified turtles were sighted inside the VA WEA in spring, summer and fall. Eighty percent of sea turtle sightings, however, were greater than 20 km from the VA WEA boundary. There were no significant differences among loggerhead, leatherback and unidentified sea turtles in their mean distance from the VA WEA ($F_{2,612}$=0.313, p=0.73) nor were there were seasonal differences ($F_{3,611}$=1.952, p=0.12). The mean distance from the VA WEA for all turtles was 15.9km (±11.5km SD).

Table 13. Summary of all sea turtle species combined from Nov. 2012 to Nov. 2015. Corrected sightings = sightings/100 km flown). Gray shading indicates no surveys flown.

| | **Number of individual sea turtles sighted** | | | | **Total** | **Total** | **Total** | **Corrected** |
|---|---|---|---|---|---|---|---|---|
| **Season** | **2012** | **2013** | **2014** | **2015** | **turtles** | **sightings** | **km flown** | **sightings** |
| winter | | 0 | 5 | 0 | **5** | **5** | 3945.7 | **0.13** |
| spring | | 66 | 322 | 335 | **723** | **452** | 8848.9 | **5.11** |
| summer | | | 28 | 123 | **151** | **134** | 3143.6 | **4.26** |
| fall | 2 | 17 | 12 | 5 | **36** | **32** | 4844.7 | **0.66** |
| **Total** | **2** | **83** | **367** | **463** | **915** | **623** | **20782.9** | **3.00** |

<u>Loggerhead sea turtles</u> (*Caretta caretta*) (Table 14)

Sightings of loggerhead sea turtles occurred in seven of the eleven months surveyed, for a total of 893 animals. There were no loggerhead sightings in December, January or March. Loggerhead sea turtles were observed throughout the survey area. Eight sightings were located

within the VA WEA. Most sightings were of one turtle although several sightings included either two turtles in close proximity or several individuals (up to 10) that were counted as a group in order to avoid breaking track. The highest sighting rate for loggerhead sea turtles was in the spring (4.80 sightings/100 km) and summer (3.88 sightings/100 km; Table 14).

The winter sightings would normally be considered anomalous, but a plot of the sighting location compared to the measured sea surface temperature indicated that the turtles were in or very near warmer gulf stream water (10-15 °C) than predicted by the model (8.1-10.5 °C; Figure 20).

The loggerhead is the most common sea turtle species in Virginia, and loggerheads along the eastern coast of the U.S. Atlantic are considered part of the Northwest Atlantic Ocean distinct population segment (DPS) which is separated into five recovery units based on nesting grounds (NOAA 2011). Loggerhead sea turtles originating from nests from southern VA to the FL/GA border are considered to be in the Northern Recovery Unit which is currently listed as threatened under the Endangered Species Act (NMFS 2008, 2013).

Table 14. Summary of loggerhead turtle individuals and sightings from Nov. 2012 to Nov. 2015. Corrected sightings = sightings/100 km. Gray shading indicates no surveys flown.

| | **Number of individual loggerhead turtles sighted** | | | | **Total** | **Total** | **Total** | **Corrected** |
|---|---|---|---|---|---|---|---|---|
| **Month** | **2012** | **2013** | **2014** | **2015** | **turtles** | **sightings** | **km flown** | **sightings** |
| Jan | | | | 0 | **0** | **0** | 279.8 | **0.00** |
| Feb | | 0 | 5 | | **5** | **5** | 1671.4 | **0.30** |
| Mar | | 0 | | 0 | **0** | **0** | 1994.5 | **0.00** |
| Apr | | 0 | 21 | 11 | **32** | **29** | 4569.5 | **0.63** |
| May | | 58 | 54 | 187 | **299** | **207** | 2584 | **8.01** |
| Jun | | | 236 | 125 | **361** | **189** | 1695.4 | **11.15** |
| Jul | | | | | | | | |
| Aug | | | | 35 | **35** | **32** | 1818.9 | **1.76** |
| Sep | | | 28 | 76 | **104** | **90** | 1324.7 | **6.79** |
| Oct | | 17 | 8 | | **25** | **21** | 1519.9 | **1.38** |
| Nov | 0 | | 3 | 5 | **8** | **8** | 2224.7 | **0.36** |
| Dec | | | 0 | | **0** | **0** | 1100.1 | **0.00** |
| **Total** | **0** | **75** | **355** | **439** | **869** | **581** | **20782.9** | **2.80** |

Leatherback Sea Turtle (*Dermochelys coriacea*) (Table 15)

Ten leatherback sea turtles were observed during the survey and none were observed in the VA WEA. Leatherbacks were sighted in May, June, and August but were not consistently sighted in these months across years. The highest sighting rate for leatherback sea turtles were in the summer (0.16 sightings/100 km) whereas no leatherbacks were sighted in the winter or fall.

Throughout their U.S. range, leatherback sea turtles are listed as endangered under the Endangered Species Act (NMFS 1992; NMFS & USFWS 1992). This species is pelagic and feeds primarily on gelatinous prey. Unlike the other sea turtle species, they have a flexible, 'leathery' shell. They are found as far north as Atlantic Canada and exhibit the ability to maintain a body temperature greater than 10 °C above ambient water temperatures (Waring *et al.* 2013). Leatherbacks are the largest sea turtle species reaching >2 m in total length and weighing more than 700 kg (NMFS 1992b).

Table 15. Summary of leatherback turtles sighted from Nov. 2012 to Nov. 2015. Corrected sightings = sightings/100 km flown. Gray shading indicates no surveys flown.

| | **Number of leatherback turtles sighted** | | | | **Total** | **Total** | **Total** | **Corrected** |
|---|---|---|---|---|---|---|---|---|
| **Month** | **2012** | **2013** | **2014** | **2015** | **turtles** | **sightings** | **km flown** | **sightings** |
| Jan | | | | 0 | **0** | **0** | 279.8 | **0.00** |
| Feb | | 0 | 0 | | **0** | **0** | 1671.4 | **0.00** |
| Mar | | 0 | | 0 | **0** | **0** | 1994.5 | **0.00** |
| Apr | | 0 | 0 | 0 | **0** | **0** | 4569.5 | **0.00** |
| May | | 2 | 0 | 0 | **2** | **2** | 2584 | **0.08** |
| Jun | | | 0 | 3 | **3** | **3** | 1695.4 | **0.18** |
| Jul | | | | | | | | |
| Aug | | | | 2 | **2** | **2** | 1818.9 | **0.11** |
| Sep | | | 0 | 3 | **3** | **3** | 1324.7 | **0.23** |
| Oct | | 0 | 0 | | **0** | **0** | 1519.9 | **0.00** |
| Nov | 0 | | 0 | 0 | **0** | **0** | 2224.7 | **0.00** |
| Dec | | | 0 | | **0** | **0** | 1100.1 | **0.00** |
| **Total** | **0** | **2** | **0** | **8** | **10** | **10** | **20782.9** | **0.05** |

Unidentified (hard-shelled) sea turtles (Table 16)

Turtles labeled as unidentified were typically either of small size, submerged, or too far away for observers to make an accurate identification to species. Twenty-nine sightings of 32

unidentified sea turtles were recorded. These unidentified turtles were hard-shelled turtles, not leatherbacks. There was no obvious pattern in the distribution of these sightings. One individual was located in the center of the VA WEA, and two were located in the northwest portion of the VA WEA.

Table 16. Summary of unidentified sea turtle individuals and sightings from Nov. 2012 to Nov. 2015. Corrected sightings = sightings/100 km. Gray shading indicates no surveys flown.

| | **Number of individual unidentified turtles sighted** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Month** | **2012** | **2013** | **2014** | **2015** | **Total turtles** | **Total sightings** | **Total km flown** | **Corrected sightings** |
| Jan | | | | 0 | **0** | **0** | 279.8 | **0.00** |
| Feb | | 0 | 0 | | **0** | **0** | 1671.4 | **0.00** |
| Mar | | 0 | | 0 | **0** | **0** | 1994.5 | **0.00** |
| Apr | | 0 | 0 | 0 | **0** | **0** | 4569.5 | **0.00** |
| May | | 6 | 3 | 6 | **15** | **12** | 2584 | **0.23** |
| Jun | | | 8 | 3 | **11** | **10** | 1695.4 | **0.18** |
| Jul | | | | | | | | |
| Aug | | | | 4 | **4** | **4** | 1818.9 | **0.22** |
| Sep | | | 0 | 3 | **3** | **3** | 1324.7 | **0.23** |
| Oct | | 0 | 0 | | **0** | **0** | 1519.9 | **0.00** |
| Nov | 2 | | 1 | 0 | **3** | **3** | 2224.7 | **0.00** |
| Dec | | | 0 | | **0** | **0** | 1100.1 | **0.00** |
| **Total** | **2** | **6** | **12** | **16** | **36** | **32** | **20782.9** | **0.08** |

<u>Other Marine Vertebrate Sightings</u> (Figure 21)

Chondrichthyan fishes

Twenty-four sightings of approximately 526 unidentified sharks were observed. On the 20 of June 2014 a sighting of approximately 500 sharks was recorded. These sharks were in a densely associated group and remained subsurface and active during the sighting. Personal communication with local fish specialists at the Virginia Aquarium indicated this was likely a breeding congregation. Aside from this unusual sighting the group size was predominately of single sharks. Sharks were documented in all months except October through December, and June had the highest number of sightings and individuals documented. Three basking shark (*Cetorhinus maximus*) sightings were recorded during March, April and October surveys. Basking sharks are distributed from Newfoundland, Canada to Florida. This species is found in

the mid-Atlantic waters of the U.S. in spring and in New England, Gulf of Maine, and Canada in summer (Schulze-Haugen *et al.* 2003). There were a total of 18 sightings of 21 manta rays (*Manta birostris*) in April, June and September with the highest number of sightings in June. This species is globally distributed, inhabiting tropical, subtropical, and temperate waters. *Manta birostris* is seasonally distributed and resident around productive coasts with regular upwelling, in oceanic islands, and in the vicinity of pinnacles and seamounts (IUCN 2011). There is currently no stock assessment for this species although it has very low fecundity within the elasmobranchs. Cow-nosed rays were regularly sighted in the warmer months, often in large schools. Because their numbers would vastly outweigh other elasmobranch species, we are not including cow-nose ray sightings in the table or map of other vertebrate species.

Other fishes

Eleven sightings of twelve ocean sunfish (*Mola mola)* were recorded in February, March, May, June and August. All sightings except two were more than 55 km offshore.

Vessel sightings

Based on ship traffic and intensity, the ocean approach to the Chesapeake Bay presents a pronounced collision threat for whales (Firestone *et al.* 2008). For example, Hampton Roads is home to the third largest port on the East coast (BOEM 2012) and the combination of commercial, military, and recreational vessel traffic in the Chesapeake Bay approach makes the area one of the busiest on the east coast of the U.S. To reduce the likelihood of serious injury and death to large whales, particularly the critically endangered North Atlantic right whale (NARW), a Seasonal Management Area (SMA) was established at the entrance of the Chesapeake Bay, requiring commercial vessels 65 ft (19.8 m) or greater to restrict speed to 10 knots from November 1-April 30 in VA. The speed reduction does not apply to military or Coast Guard vessels. From December 2015 to March 2016, there were at least four vessel interactions with humpback whales documented near the mouth of Chesapeake Bay (VAQF Humpback Whale photo-ID catalog). Photo-ID records confirmed at least three of these individuals had been injury free three days to a month prior to sightings with substantial injuries in the coastal waters of

Virginia which suggests these injuries occurred while in mid-Atlantic waters (VAQF Humpback Whale photo-ID Catalog, and sighting data contributions from HDR, Inc. and Rudee Flipper).

Vessels were categorized as (1) “large vessels” (*e.g.* commercial cargo, cruise ship, military vessels, and (2) “other vessels” (*e.g.* commercial, charter, recreational fishing and other, smaller vessels such as sailboats or parasail boats). Most large vessels were estimated to be greater than 65 feet in length and thus, if not military or Coast Guard, would be subject to speed restrictions in the SMA from November through April. Entanglements in fishing gear and vessel strikes are leading causes of mortality for large whales in the Atlantic (Volgenau *et al.* 1995; Knowlton *et al.* 2001; Laist *et al.* 2001; Van der Hoop. *et al.* 2012, 2013).

Large vessels (Table 17*a*-*b*, Figure 22)

A total of 373 large vessels (*e.g*. tankers, car carriers, container, and federal vessels) were observed in the survey area and on every survey, with the highest sighting rates in September and November (Table 17*a*). Monthly sighting rates for large vessels ranged from 0.55 vessels/100 km in August to 2.34 vessels/100 km in September and November and ranged seasonally from 1.30 vessel/100 km in summer to 1.94 vessels/100 km in fall with an overall sighting rate of 1.61 vessels/100 km, higher than all species except loggerhead turtles. Large vessels were sighted throughout the study area including within the VA WEA but were more concentrated toward the mouth of Chesapeake Bay which includes channels to the ports of Hampton Roads and Baltimore (Figure 22).

Table 17*a*. Summary of large vessels and sightings from Nov. 2012 to Nov. 2015. Corrected sightings = sightings/100 km flown. Gray shading indicates no surveys flown.

| | **Number of large vessels sighted** | | | | **Total** | **Total** | **Total** | **Corrected** |
|---|---|---|---|---|---|---|---|---|
| **Month** | **2012** | **2013** | **2014** | **2015** | **vessels** | **sightings** | **Km flown** | **sightings** |
| Jan | | | | 5 | 5 | **5** | 279.8 | **1.79** |
| Feb | | 10 | 21 | | 31 | **28** | 1671.4 | **1.68** |
| Mar | | 28 | | 12 | 40 | **36** | 1994.5 | **1.80** |
| Apr | | 28 | 34 | 15 | 77 | **70** | 4569.5 | **1.53** |
| May | | 23 | 8 | 7 | 38 | **37** | 2584 | **1.43** |
| Jun | | | 19 | 8 | 27 | **24** | 1695.4 | **1.42** |
| Jul | | | | | | | | |
| Aug | | | | 10 | 10 | **10** | 1818.9 | **0.55** |
| Sep | | | 21 | 15 | 36 | **31** | 1324.7 | **2.34** |
| Oct | | 7 | 15 | | 22 | **22** | 1519.9 | **1.45** |
| Nov | 29 | | 20 | 16 | 65 | **52** | 2224.7 | **2.34** |
| Dec | | | 22 | | 22 | **20** | 1100.1 | **1.82** |
| **Total** | **29** | **96** | **160** | **88** | **373** | **335** | **20782.9** | **1.61** |

Small Vessels (Table 17*b*, Figure 22)

A total of 251 small vessels (*e.g.* recreational vessels- sail, parasail, sport fishing boats) were observed in 203 sightings during the surveys. Small vessels (estimated to be less than 65 ft in length) also occurred throughout the year with the highest numbers sighted in fall (1.38 vessels/100km), followed by summer, winter and spring. Small vessels were also distributed throughout the survey area but were concentrated near the mouth of Chesapeake Bay.

Table 17*b*. Summary of small vessels (estimated less than 65 ft) and sightings from Nov. 2012 to Nov. 2015. Corrected sightings = number sightings/ km flown) *100. Gray shading indicates no surveys flown.

| | **Number of small vessels sighted** | | | | **Total** | **Total** | **Total** | **Corrected** |
|---|---|---|---|---|---|---|---|---|
| **Month** | **2012** | **2013** | **2014** | **2015** | **vessels** | **sightings** | **Km flown** | **sightings** |
| Jan | | | | 20 | **20** | **20** | 279.8 | **7.15** |
| Feb | | 8 | 7 | | **15** | **14** | 1671.4 | **0.84** |
| Mar | | 8 | | 2 | **10** | **10** | 1994.5 | **0.50** |
| Apr | | 4 | 12 | 7 | **23** | **23** | 4569.5 | **0.50** |
| May | | 7 | 2 | 5 | **14** | **11** | 2584 | **0.43** |
| Jun | | | 15 | 10 | **25** | **19** | 1695.4 | **1.12** |
| Jul | | | | | | | | |
| Aug | | | | 10 | **10** | **8** | 1818.9 | **0.44** |
| Sep | | | 16 | 42 | **58** | **31** | 1324.7 | **2.34** |
| Oct | | 3 | 5 | | **8** | **7** | 1519.9 | **0.46** |
| Nov | 17 | | 10 | 20 | **47** | **39** | 2224.7 | **1.75** |
| Dec | | | 21 | | **21** | **21** | 1100.1 | **1.91** |
| **Total** | **17** | **30** | **88** | **116** | **251** | **203** | **20782.9** | **0.98** |

## Seasonal differences and ecological correlates

Large Whales in the Proximity of the VA WEA

Since all months were not surveyed with the same level of effort between years and no survey effort occurred in July, we used corrected number of sightings (not individuals) to compare sighting rates among months and seasons with unequal effort. Spring had the highest level of effort (8,849 km flown), nearly twice that of fall (4,845km flown), and more than twice that of both winter (3,946 km flown) and summer (3,144 km flown).

Despite more than 3000 km flown in summer, there were no large whale sightings in August or September. The sighting rate in fall (0.06 sightings/100 km) was lower than spring (0.26 sightings/100 km; Table 18*a*). All four species (fin, humpback, NARW, and minke) were sighted in winter. The highest sighting rates of large whales occurred in winter (0.43 sightings/100 km) and spring (0.26 sightings/100 km; Figure 21; Table 18*a*).

In spring, fin whales had the highest sighting rate (0.18 sightings/100 km; Table 18*b*), followed by humpback whales (0.08 sightings/100 km; Table 18*c*). Humpback whales in winter had the highest sighting rate (0.18 sightings/100 km; Table 18*c*) and all were sighted within 10 km of the coast and within the designated shipping lanes (Figure 12). The critically endangered NARW had the highest sighting rate in winter (0.10 sightings/100km) with the only other sightings in spring (0.01 sightings/100 km; Table 18*d*). Although minke whales were sighted in low numbers the highest sighting rate was in winter (0.03 sightings/100 km) followed by spring (0.01 sightings/100 km; Table 18*e*).

Table 18*a*. Summary of all large whale species combined from Nov. 2012 to Nov. 2015. Corrected sightings = sightings/100 km flown). Gray shading indicates no surveys flown.

| | **Number of individual large whales sighted** | | | | **Total** | **Total** | **Total** | **Corrected** |
|---|---|---|---|---|---|---|---|---|
| **Season** | **2012** | **2013** | **2014** | **2015** | **whales** | **sightings** | **km flown** | **groups** |
| winter | | 14 | 6 | 13 | **33** | **17** | 3945.7 | **0.43** |
| spring | | 16 | 10 | 5 | **31** | **23** | 8848.9 | **0.26** |
| summer | | | 0 | 0 | **0** | **0** | 3143.6 | **0.00** |
| fall | 0 | 0 | 2 | 1 | **3** | **3** | 4844.7 | **0.06** |
| **Total** | **0** | **30** | **18** | **19** | **67** | **43** | **20782.9** | **0.21** |

Table 18*b*. Summary of all fin whales sighted from Nov. 2012 to Nov. 2015. Corrected sightings = sightings/100 km flown). Gray shading indicates no surveys flown.

| | Number of individual fin whales sighted | | | | Total | Total | Total | Corrected |
|---|---|---|---|---|---|---|---|---|
| **Season** | **2012** | **2013** | **2014** | **2015** | **whales** | **sightings** | **Km flown** | **sightings** |
| winter | | 9 | 1 | 0 | **10** | **5** | 3945.7 | **0.13** |
| spring | | 12 | 5 | 4 | **21** | **14** | 8848.9 | **0.16** |
| summer | | | 0 | 0 | **0** | **0** | 3143.6 | **0.00** |
| fall | 0 | 0 | 0 | 0 | **0** | **0** | 4844.7 | **0.00** |
| **Total** | **0** | **21** | **6** | **4** | **31** | **19** | **20782.9** | **0.09** |

Table 18*c*. Summary of all humpback whales sighted from Nov. 2012 to Nov. 2015. Corrected sightings = sightings/100 km flown). Gray shading indicates no surveys flown.

| | Number of individual humpback whales sighted | | | | Total | Total | Total | Corrected |
|---|---|---|---|---|---|---|---|---|
| **Season** | **2012** | **2013** | **2014** | **2015** | **whales** | **sightings** | **km flown** | **sightings** |
| winter | | 3 | 0 | 11 | **14** | **7** | 3945.7 | **0.18** |
| spring | | 4 | 3 | 1 | **8** | **7** | 8848.9 | **0.08** |
| summer | | | 0 | 0 | **0** | **0** | 3143.6 | **0.00** |
| fall | 0 | 0 | 2 | 1 | **3** | **3** | 4844.7 | **0.06** |
| **Total** | **0** | **7** | **5** | **13** | **25** | **17** | **20782.9** | **0.08** |

Table 18*d*. Summary of all North Atlantic right whales sighted from Nov. 2012 to Nov. 2015. Corrected sightings = sightings/100 km flown). Gray shading indicates no surveys flown.

| | Number of individual NARW sighted | | | | Total | Total | Total | Corrected |
|---|---|---|---|---|---|---|---|---|
| **Season** | **2012** | **2013** | **2014** | **2015** | **whales** | **sightings** | **km flown** | **sightings** |
| winter | | 0 | 5 | 2 | **7** | **4** | 3945.7 | **0.10** |
| spring | | 0 | 1 | 0 | **1** | **1** | 8848.9 | **0.01** |
| summer | | | 0 | 0 | **0** | **0** | 3143.6 | **0.00** |
| fall | 0 | 0 | 0 | 0 | **0** | **0** | 4844.7 | **0.00** |
| **Total** | **0** | **0** | **6** | **2** | **8** | **5** | **20782.9** | **0.02** |

Table 18*e*. Summary of all minke whales sighted from Nov. 2012 to Nov. 2015. Corrected sightings = sightings/100 km flown). Gray shading indicates no surveys flown.

| | **Number of individual minke whales sighted** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Season** | **2012** | **2013** | **2014** | **2015** | **Total whales** | **Total sightings** | **Total km flown** | **Corrected sightings** |
| winter | | 2 | 0 | 0 | **2** | **1** | 3945.7 | **0.03** |
| spring | | 0 | 1 | 0 | **1** | **1** | 8848.9 | **0.01** |
| summer | | | 0 | 0 | **0** | **0** | 3143.6 | **0.00** |
| fall | 0 | 0 | 0 | 0 | **0** | **0** | 4844.7 | **0.00** |
| **Total** | **0** | **2** | **1** | **0** | **3** | **2** | **20782.9** | **0.01** |

We also compared sightings of large whale species by distance from the VA WEA (Figure 20), sea surface temperature (SST), distance from shore, and depth (Figure 24). Each suggested significant differences among species except for SST.

We calculated the distance from each sighting to the nearest boundary of the VA WEA and compared the distances between species and seasons. There were significant seasonal differences with all species combined among the three seasons in which they were sighted ($F_{2,39}$=6.664, p=0.003; Figure 23*a*-*c*). Spring (mean=29.7 km ±13.2 km SD) and winter (mean=16.8km ±9.9 km SD) were significantly different from each other and fall was similar to both of the other seasons. There was a significant difference in the mean distance the four large whale species were found from the VA WEA ($F_{3,38}$=3.824, p=0.017). The mean distance from the WEA ranged from 8.7 km (SD ±8.67 km) for right whales to 28.9 km (SD ±10.9km) for fin whales. Tukey's *post hoc* comparison indicated that these two species were significantly different from each other in the distance from the WEA and humpback and minke whales were similar to all species.

We investigated the relationship between several environmental correlates and large whale distribution among species. There was no significant difference in the sea surface temperature at which sightings of large whale species occurred ($F_{3,29}$=0.636; p=0.06). All sightings occurred when the sea surface temperature was between 5.5 and 15.0 °C (mean= 6.3 °C; Figure 24*b*). A study by Whitt *et al.* 2013 identified the range of SST (5.5 – 12.0 °C) that NARW's were sighted off the coast of New Jersey which also corresponds to the SST that NARW's were sighted off the coast of Virginia during these aerial surveys.

There were significant differences in how far from shore the different large whale species were sighted ($F_{3,30}$=14.99, P<0.001; Figure 24*c*). Post-hoc comparison showed no difference between fin (mean=73.6km ±13.7km SD) and minke (mean=81.2km ±0.8km SD) distribution, which were both farther offshore than right (mean=46.2km ±15.3km SD) and humpback whales (mean=31.6km ±22.7km SD).

**Aerial Survey Summary**

The mouth of the Chesapeake Bay and continental shelf waters off of Virginia are of particular interest as this area is used by a variety of protected species including fin, humpback, minke, sei, and critically endangered North Atlantic right whales (Mead 1977, Ambler 2011, Waring *et al.* 2013, Wiley and Asmutis 1995, Kenney *et al.* 2001, Mallette *et al.* 2014). Shipping, military activities, commercial fishing, and offshore energy development pose challenges to management and conservation of protected species, especially around the mouth of the Chesapeake Bay and Atlantic ocean waters off Virginia. (Barco *et al.* 2012). Recent passive acoustic studies found that NARW's were detected in all seasons in the mid-Atlantic (Hodge *et al.* 2015) and in all months off the coast of Virginia (Salisbury *et al.* 2015). This project has confirmed the presence of at least four large whale species and provided new data on exact location, behavior and differences among species and seasons.

Sea turtles and marine mammals may be both indirectly (*e.g.* increasing ambient and vessel noise, displacement from critical habitat) and directly (*e.g.* vessel strikes and entanglements) impacted by activities associated with offshore energy development (Kraus et al. 2005, Waring *et al*. 2012, Van Der Hoop 2013; Jensen *et al.* 2015). These threats will only become more complex and compounded as offshore energy construction and development advances (*e.g*. Robbins *et al.* 2015, Knowlton *et al.* 2015, Salisbury *et al.* 2015, Jensen *et al.* 2015, King *et al.* 2015). Concomitant with offshore energy development, an increase in shipping traffic, especially during construction and maintenance of structures, may increase the likelihood of interaction to marine species such as the North Atlantic right, humpback, and fin whales as well as loggerhead and leatherback sea turtles which utilize these same areas (*e.g.* James 2013, Jensen *et al.* 2015, King *et al.* 2015). Understanding the impact of increased ambient noise from

shipping and elevated sound levels during the construction and operation of wind turbines is also critical to assess and mitigate affected species that rely predominately on acoustics for navigation, foraging, and communication (Whitt *et al*. 2013, King *et al.* 2015).

As offshore energy development moves forward, there exists a fundamental requisite to facilitate compatible ocean activities amongst various stakeholders. Dedicated monitoring efforts are essential to inform state and federal agencies responsible for permitting offshore energy development and mitigating impacts to protected marine species.

Baseline data are needed to understand protected marine species occurrence in the vicinity of the VA WEA and to develop references by which to compare and detect perturbations. Such data can provide insight into the distribution and seasonal presence of endangered baleen whale and sea turtle species and inform management decisions to reduce the likelihood of injury, mortality and long-term impacts on populations.

Data from the CZM aerial surveys collected from November 2012 – November 2015 indicate seasonal (fall, winter, spring) presence among large whale species (fin, humpback, NARW, and minke) in the vicinity of the VA WEA. Observational data during surveys indicate that three of the four large whale species documented (fin, humpback, NARW) exhibited behavior consistent with feeding suggesting this area is important not only for migration but also for foraging.

Important information we have presented includes proximity of large whales to the VA WEA and distance from shore with critically endangered right whales occurring closest to the wind energy area and thus most likely to be exposed or impacted by noise and vessel interactions associated with planning, development, operation and maintenance of turbines and other infrastructure. Interestingly, all of the right whales that have been identified to date have been juveniles and not pregnant adult females that we know migrate south in fall or mothers with newborn calves that migrate north in spring. Due to inconsistent survey effort across months we cannot determine whether we have missed adult female right whale migration or whether their migration occurs outside the study area.

Few other data exist on these species in vicinity of the VA WEA, and there is a critical gap in our understanding of how the critically endangered North Atlantic right whale uses the mid-Atlantic waters (Kraus *et al.* 1986; Knowlton *et al*. 2002; Schick *et al.* 2009; Whitt *et al.*

2013; Hodge *et al.* 2015; Salisbury *et al.* 2015, Rickard 2015). The mid-Atlantic region may not only be important for movement among existing critical habitats but may also provide physical and biological features essential to survival. Data reported here for NARW sightings off the coast of Virginia coupled with recent year-round passive acoustic studies initiated in mid-Atlantic ocean waters detected the NARW year-round (Whitt *et al.* 2013; Hodge *et al.* 2015; Salisbury *et al.* 2015).

These data also indicate seasonal (fall, spring, summer) presence of sea turtle species (loggerhead, leatherback, and unidentified turtles) in the vicinity of the VA WEA. The highest rate of sightings occurred in the spring and summer. Local research has demonstrated Chesapeake Bay and ocean waters are important for seasonal foraging by loggerhead, Kemps Ridley and green sea turtles and also serves as an important migratory corridor (Barco *et al.* 2015). These species are susceptible to vessel strikes and entanglement in gear and mitigation measures to minimize such impacts during peak presence should be implemented.

These results provide a finer scale description of whale distribution off the coast of Virginia than previously available. The line-transect data collected are also being integrated into ecological models to test hypotheses of distribution and habitat utilization for the U.S. mid-Atlantic coast and will ultimately be used to guide ocean planning (Roberts *et al.* 2016). Continued year-round survey effort and monitoring over time is necessary to provide (1) sufficient data for reliable abundance and density estimates, (2) seasonal patterns of species distribution, (3) changes in distribution and abundance associated with energy development and inter-annual variation in species occurrence, and (4) the identification of preferred and critical habitat.

It is strongly recommended that long-term and year-round monitoring efforts be implemented to mitigate potentially deleterious effects on protected species and habitats that may be associated with offshore energy development, recommendations similar to those proposed by other mid-Atlantic states (Whitt *et al.* 2013). Monitoring data should be integrated, near-real time into adaptive management and mitigation measures to minimize the direct, indirect and cumulative impacts (especially to the critically endangered NARW) at all stages of construction and development activities.

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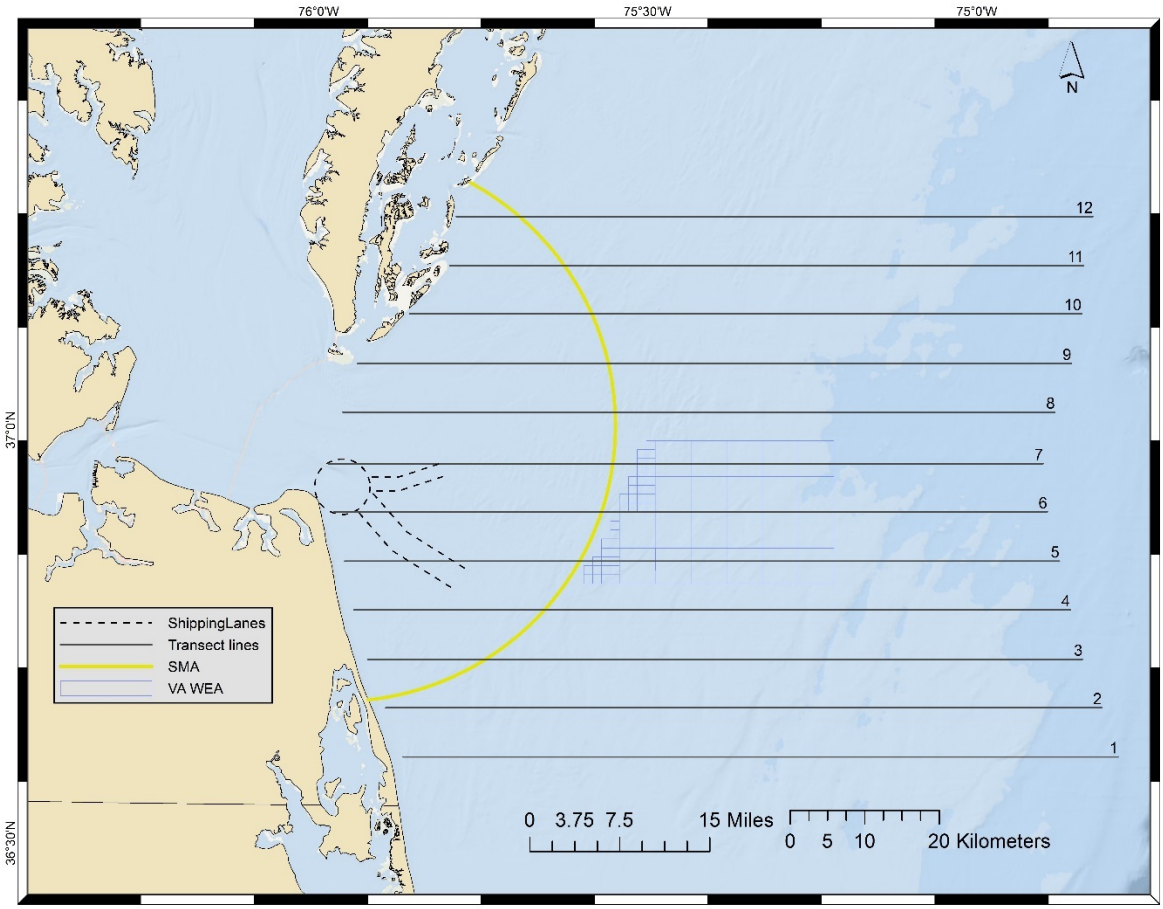


*Figure 1.* Transect lines flown for Virginia CZM aerial surveys from November 2012 to November 2015. The Virginia Wind Energy Area (VA WEA) is identified in blue and identifies the proposed wind lease blocks. The mid-Atlantic Seasonal Management Area (SMA; yellow half circle) delinates an area where vessels of 65 feet in length or greater must restrict speed to 10 knts from November 1 through April 30. The shipping lanes (black dashed lines) direct vessel traffic into and out of the Chesapeake Bay and designate the location that ships slow to receive harbor pilots for the ports of Hampton Roads and Baltimore. Coordinates for the 12 transect lines are listed in *Table* 1.

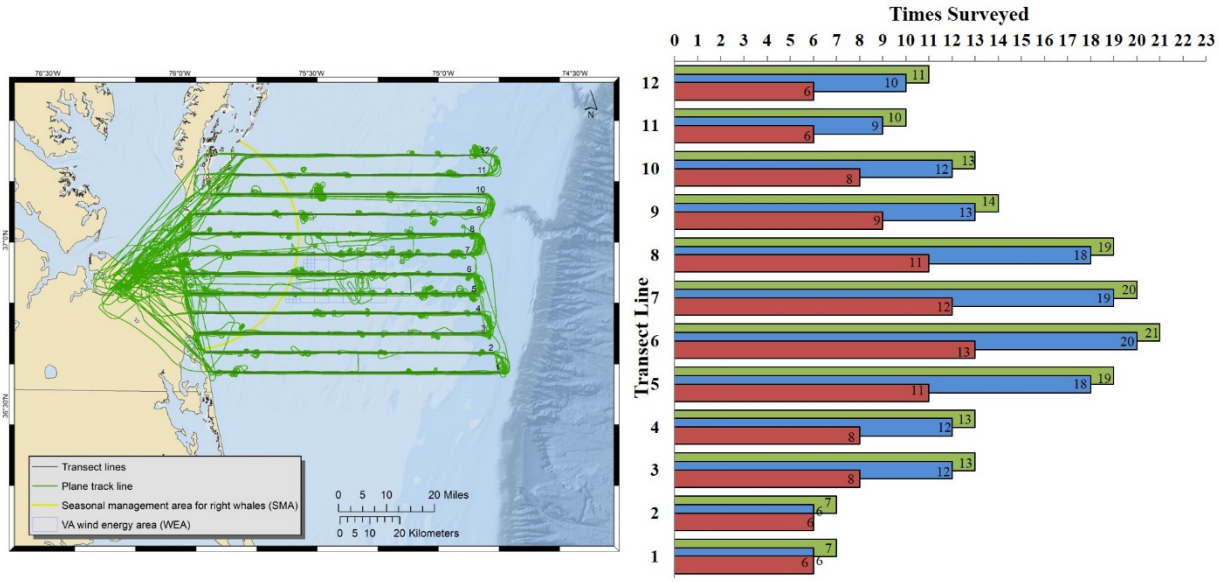


*Figure 2.* Survey tracks flown from November 2012 through November 2015. A total of 226 transect lines were flown over the duration of all grant periods. One hundred and four transect lines were flown under grant NA12NOS4190027 (red bars), 155 transect lines were flown under grant NA13NOS4190135 (blue bars), and 167 transect lines were flown under grant NA13NOS4190141.

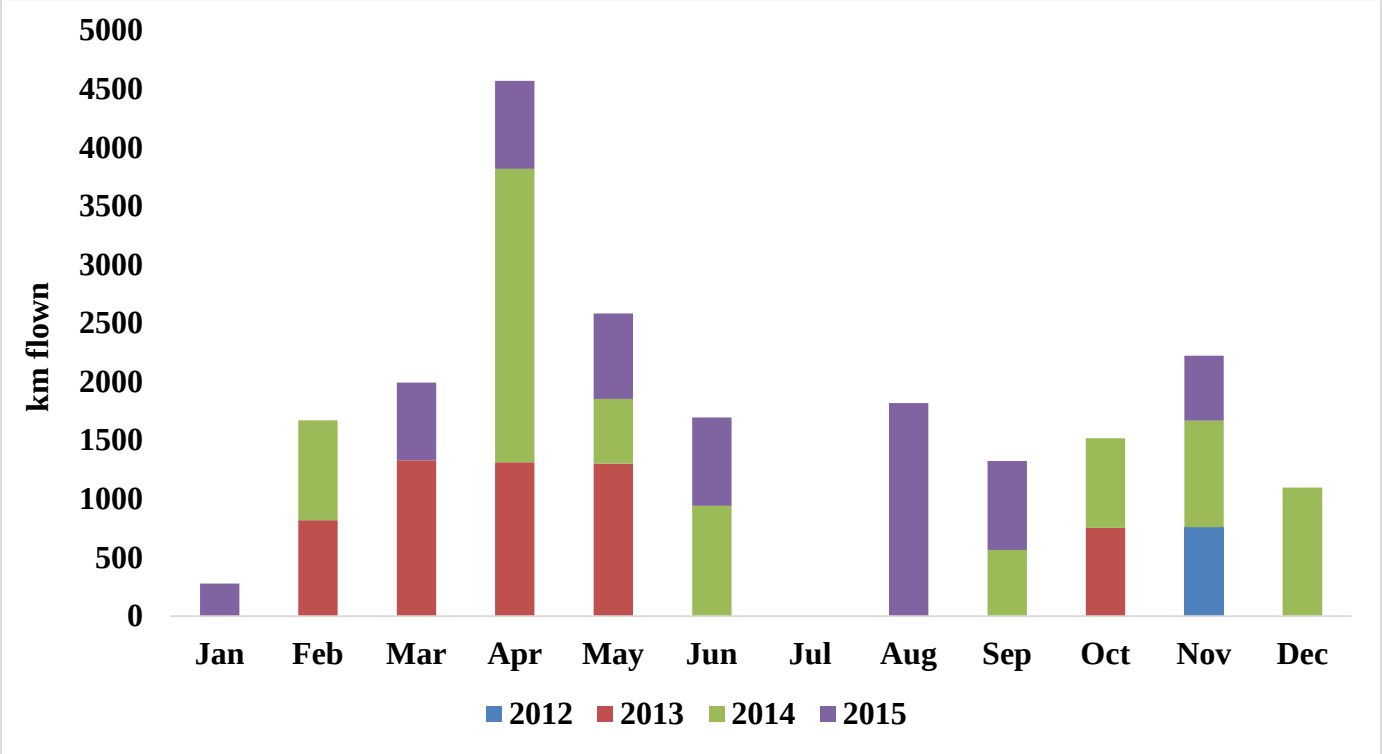


*Figure 3a.* Aerial survey effort (km flown) each month and by year (2012-2015).

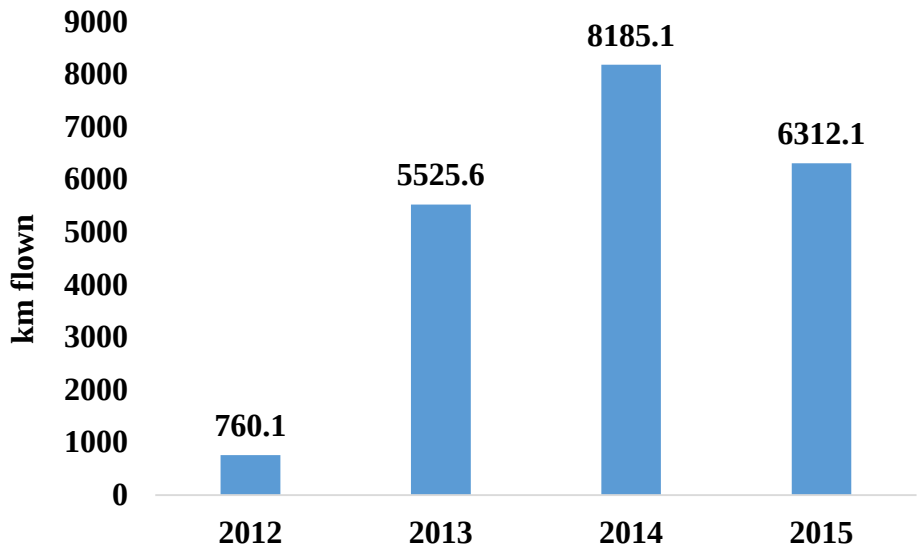


*Figure 3b.* Aerial survey effort (km flown) each year of CZM aerial surveys from 2012 through 2015.

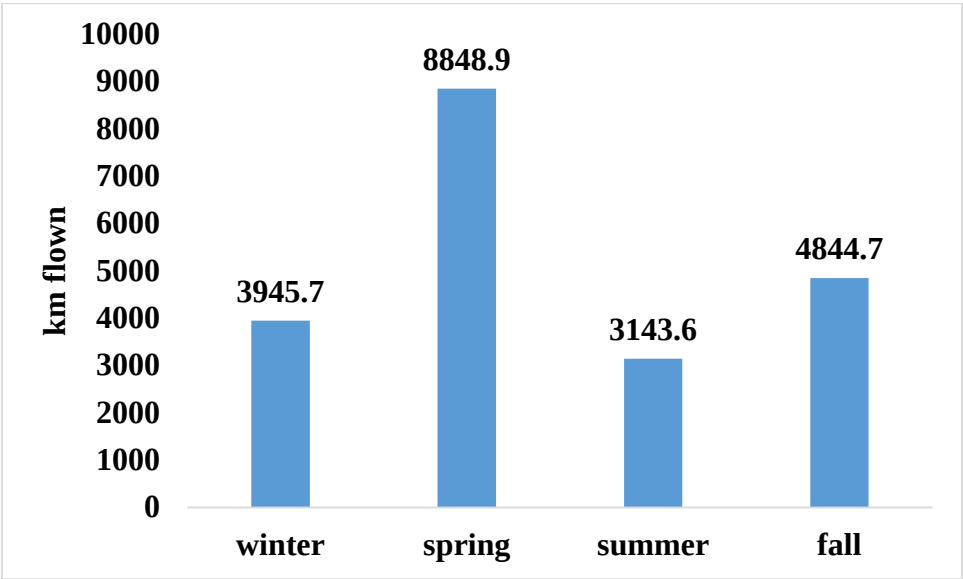


*Figure 3c.* Aerial survey effort by season. Seasons were defined as winter (January – March), spring (April- June), summer (July – Sept), and fall (October - December).

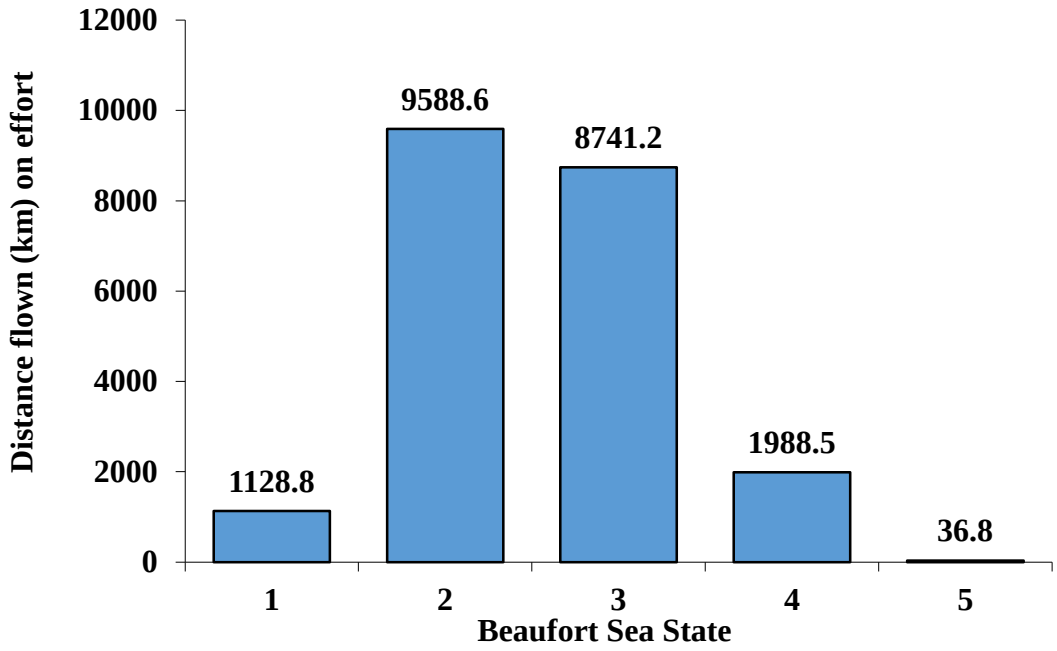


*Figure 4a*. Total distance surveyed per Beaufort Sea State from November 2012 to November 2015 during aerial surveys in the Virginia CZM survey area.

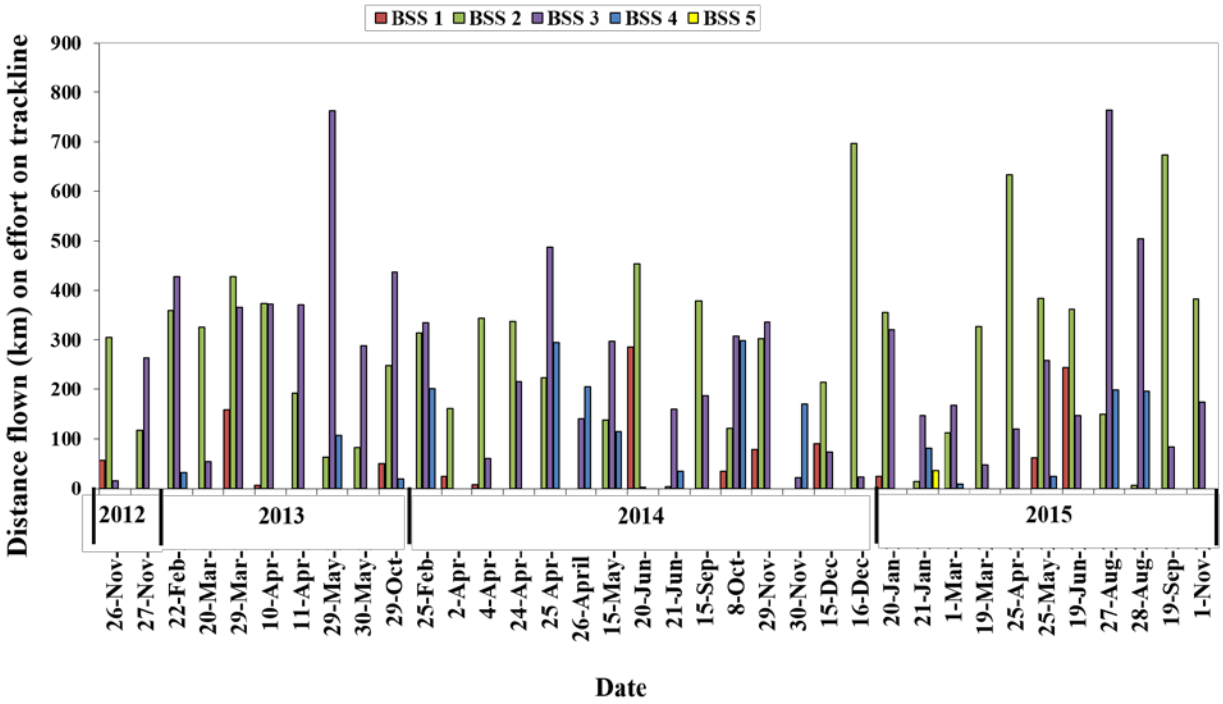


*Figure 4b.* Effort by Beaufort Sea State for each day from November 2012 to November 2015 during aerial surveys in the Virginia CZM survey area.

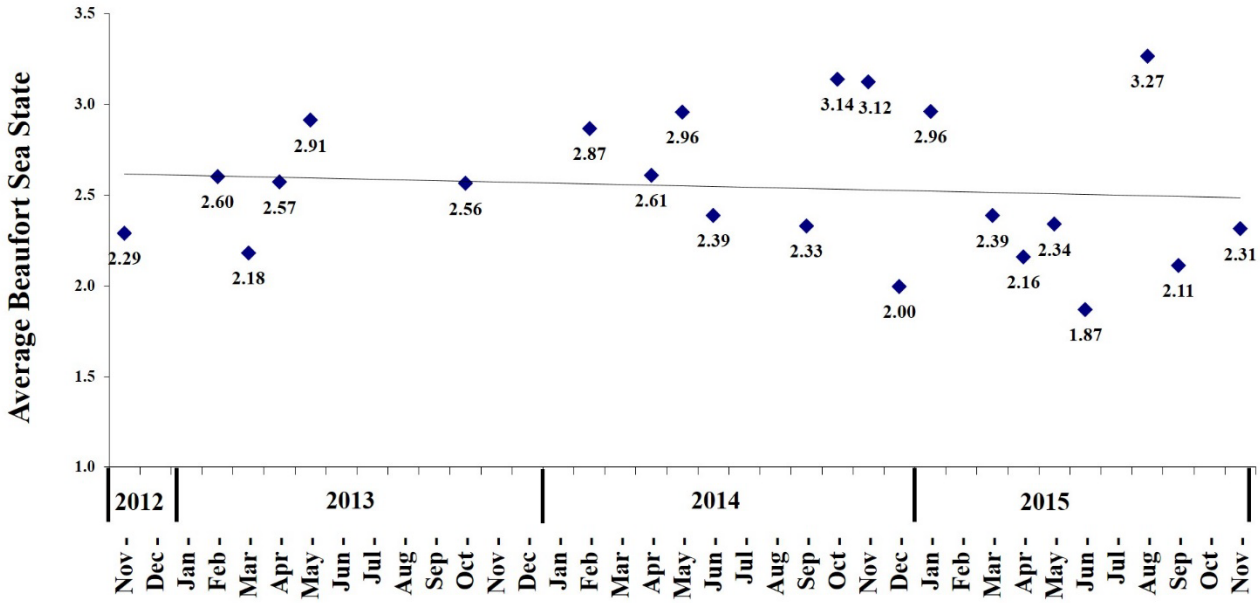


*Figure 4c.* Average Beaufort Sea State for each month from November 2012 to November 2015 during aerial surveys in the Virginia WEA. Values were calculated using the formula AvgBSS=[(Distance @1*1) +..../Total distance flown that day]

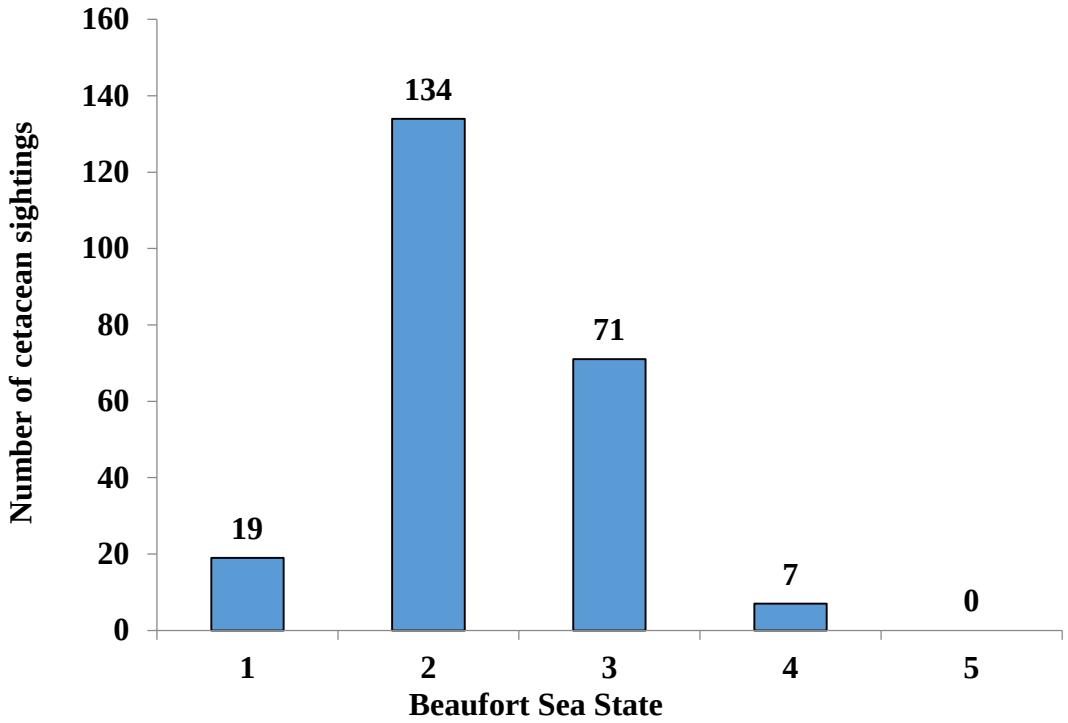


*Figure 5a.* Number of cetacean sightings per Beaufort Sea State from November 2012 to November 2015 during aerial surveys in the Virginia CZM survey area.

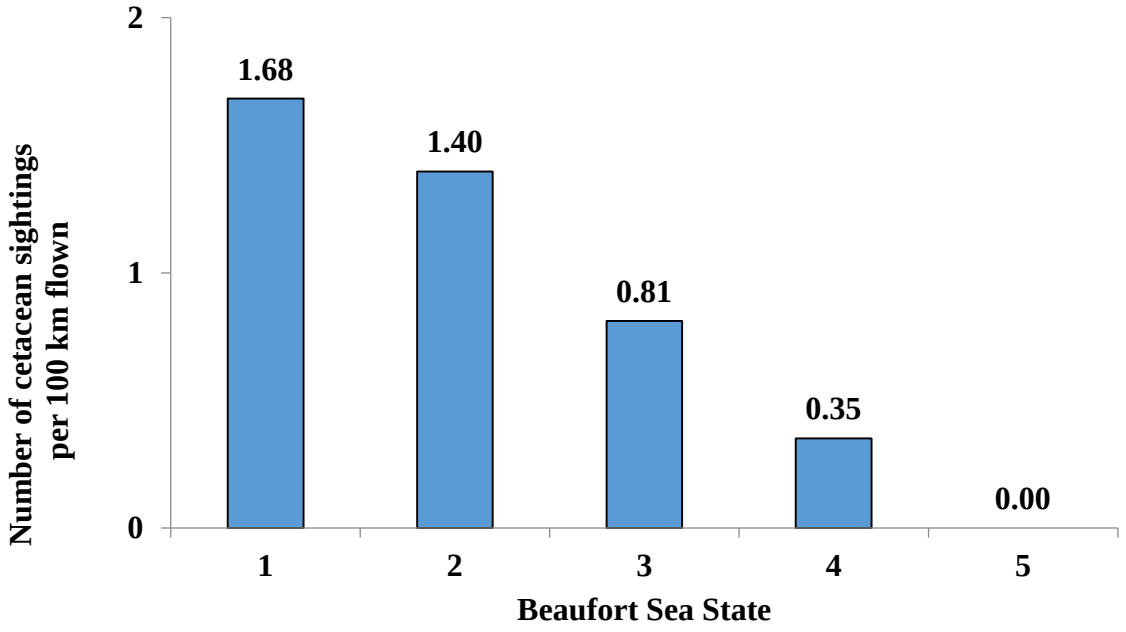


*Figure 5b*. Cetacean sightings per 100 km flown by Beaufort Sea State from November 2012 to November 2015 during aerial surveys in the Virginia CZM survey area.

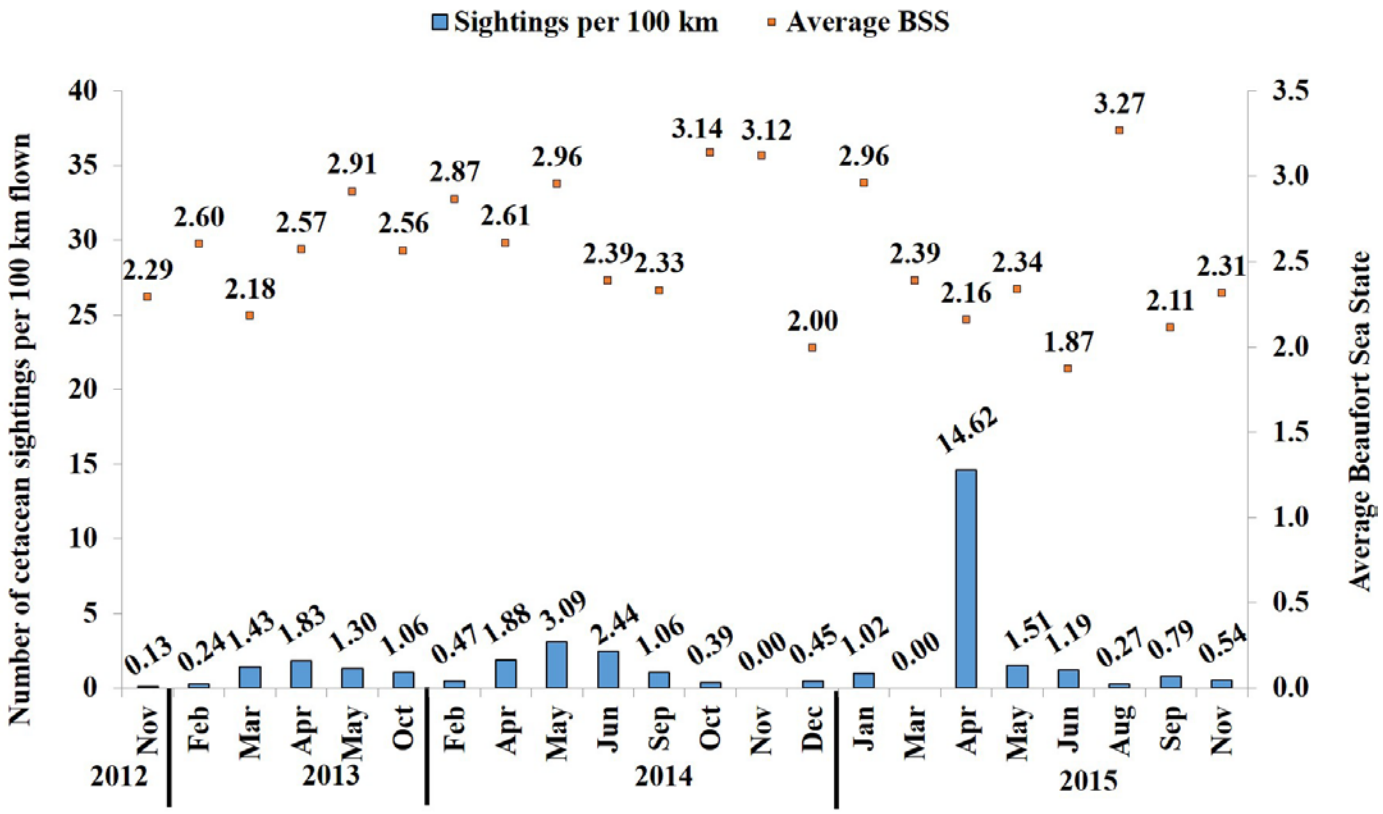


*Figure 5c*. Cetacean sightings per 100 km surveyed (primary Y axis) and average Beaufort Sea State per month (secondary Y axis) from November 2012 to December 2015 during aerial surveys in the Virginia CZM survey area.

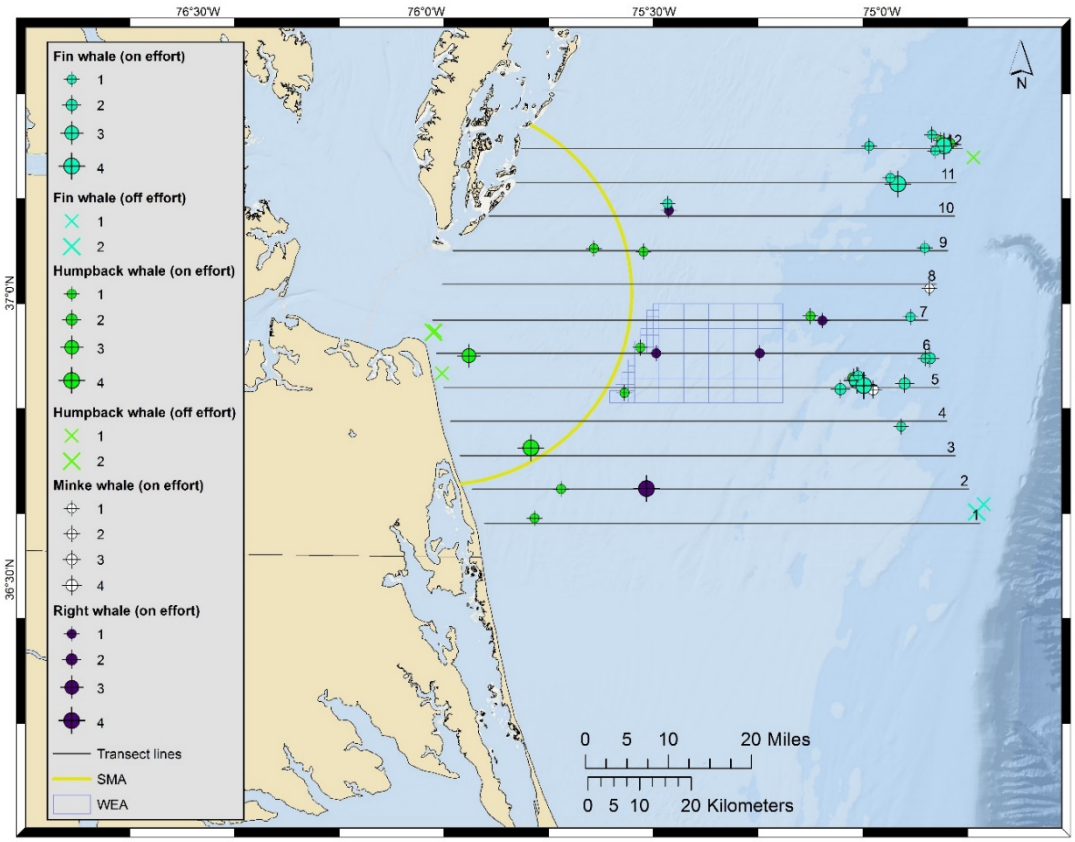


*Figure 6.* All baleen whale sightings during aerial surveys conducted in Virginia from November 2012 to November 2015. Circles with cross hairs indicate on effort sightings and solid X indicates off-effort sightings.

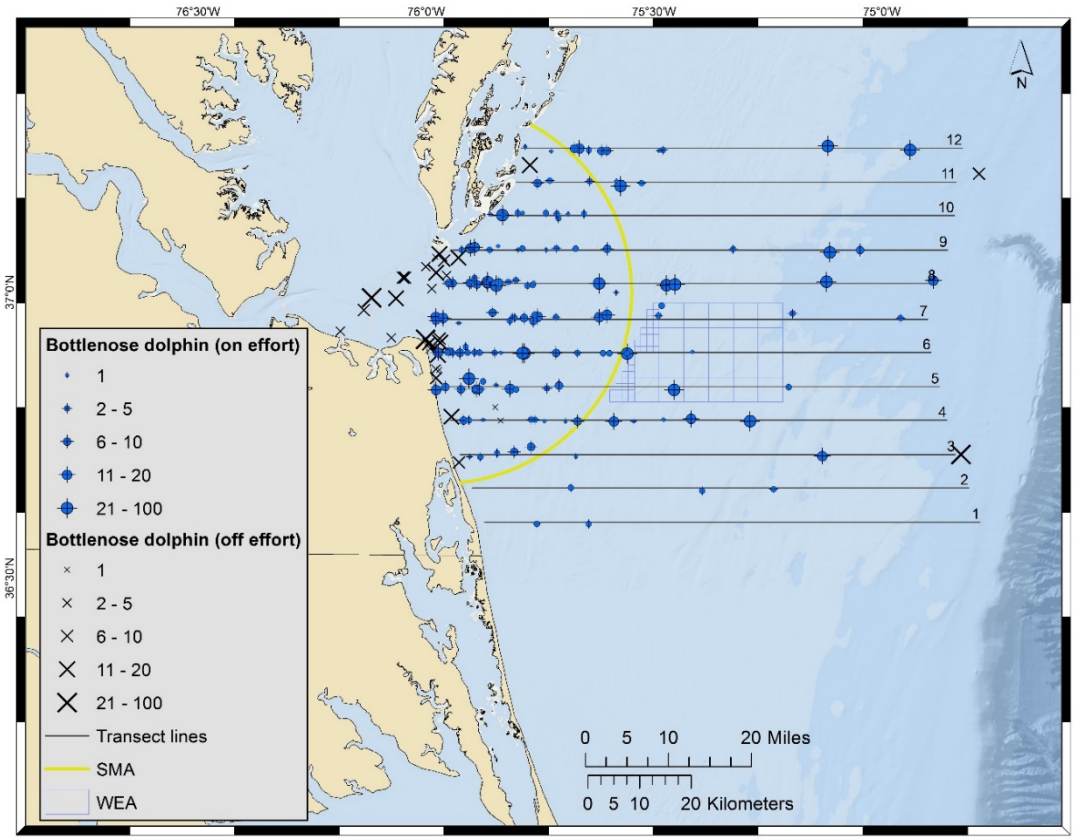


*Figure 7.* Bottlenose dolphin (*Tursiops truncatus*) sightings indicating group size. Off-effort sighting indicated by the black X.

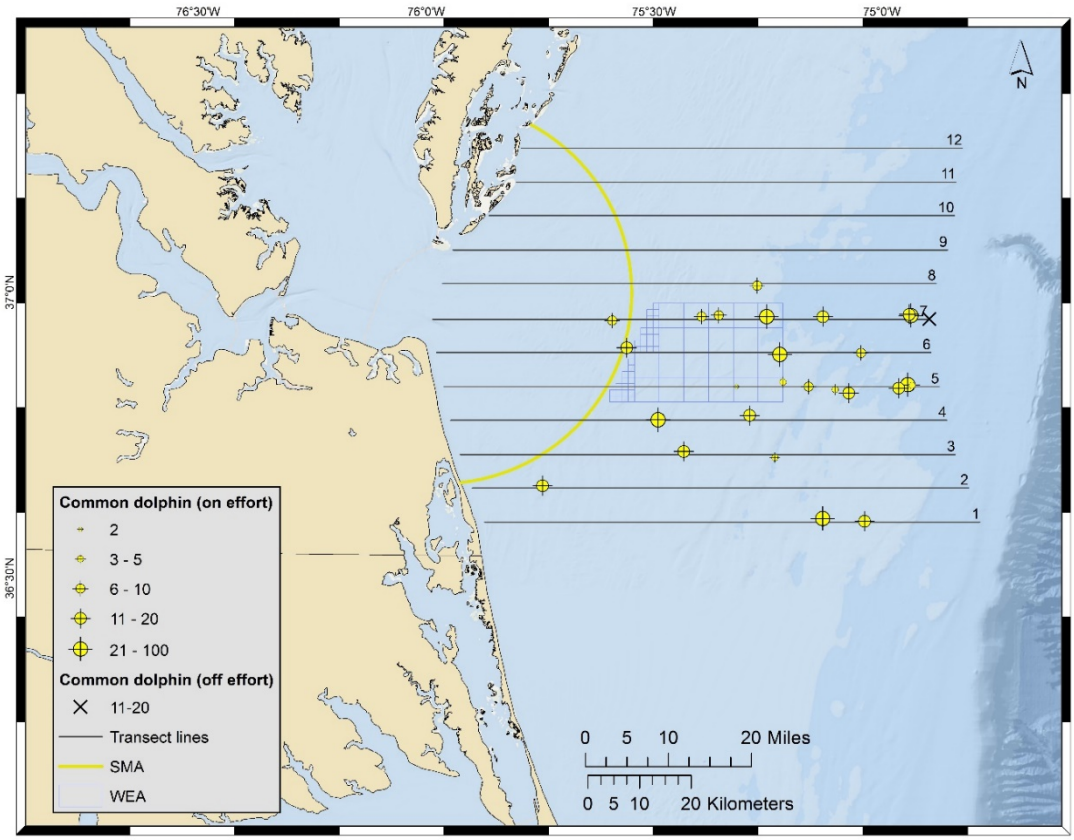


*Figure 8.* Common dolphin (*Delphinus delphis*) sightings indicating group size. Off-effort sighting indicated by the black X.

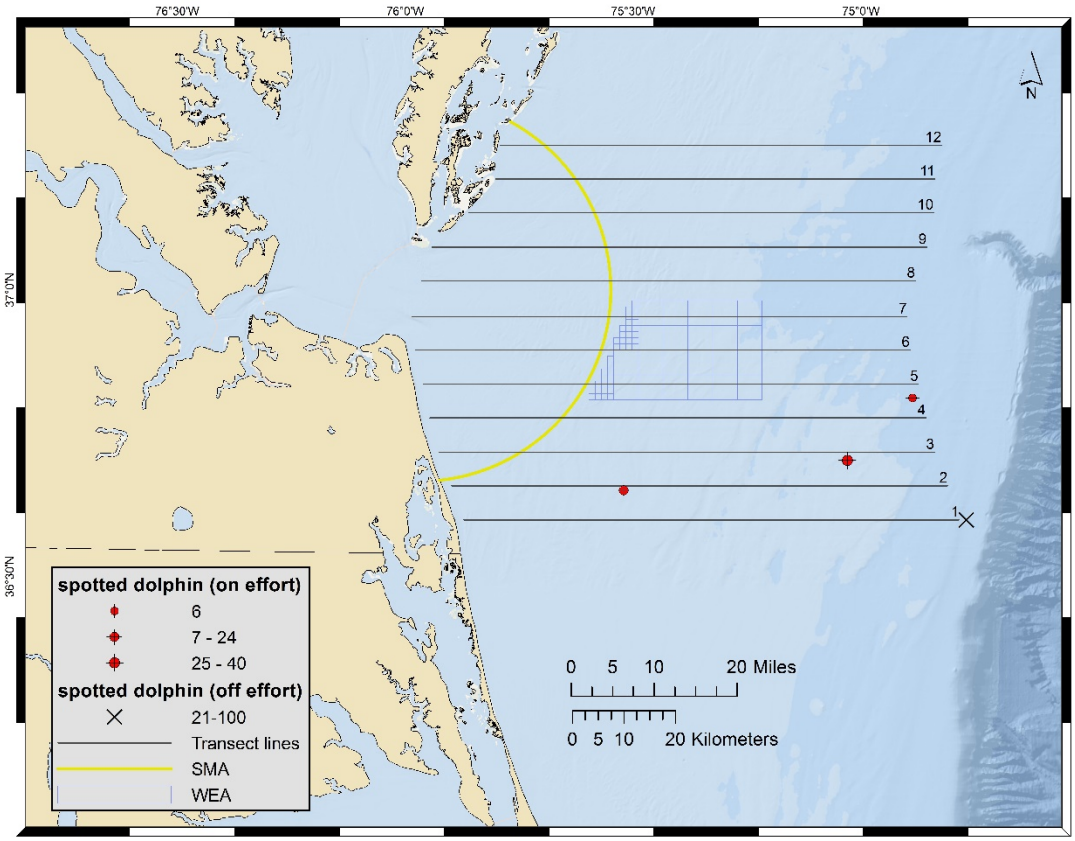


*Figure 9.* Atlantic spotted dolphin (*Stenella frontalis*) sightings indicating group size. Off-effort sighting indicated by the black X.

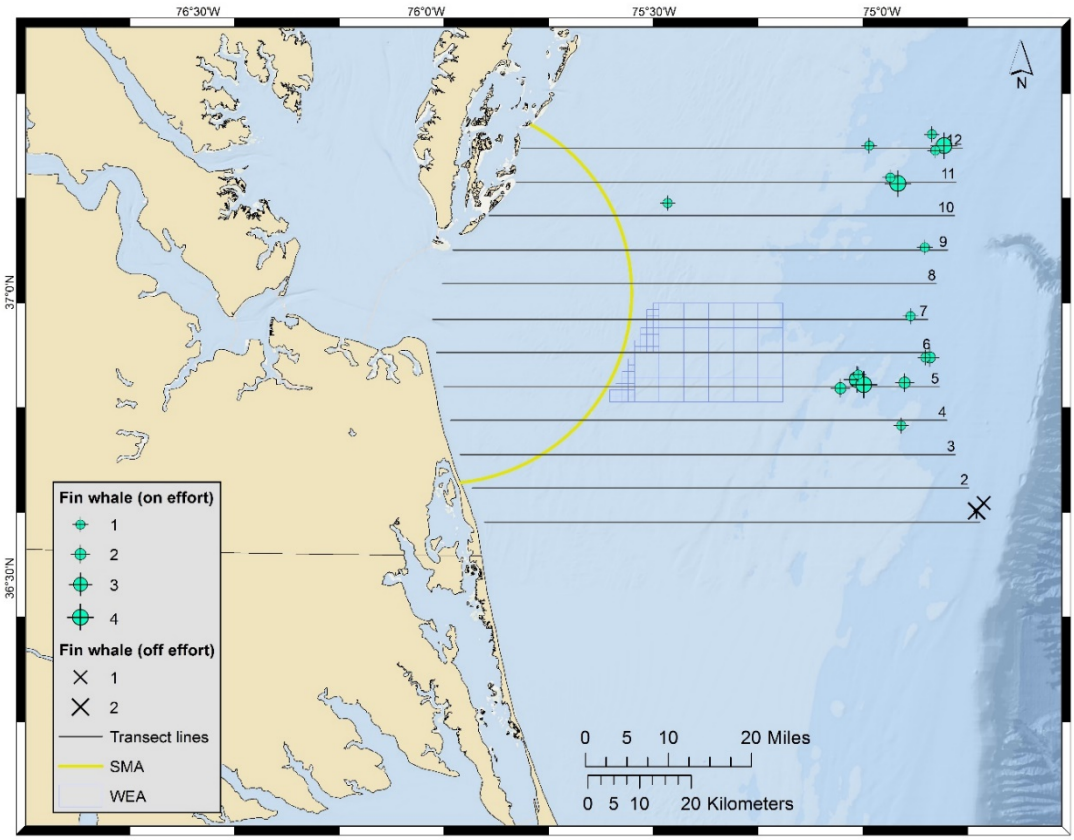


*Figure 10.* Fin whale (*Balaenoptera physalus*) sightings indicating group size. Off-effort sighting indicated by the black X.

*Figure 11.* Fin whale feeding with ventral grooves extended. Images were collected under UNCW NOAA Scientific Permit #16473.

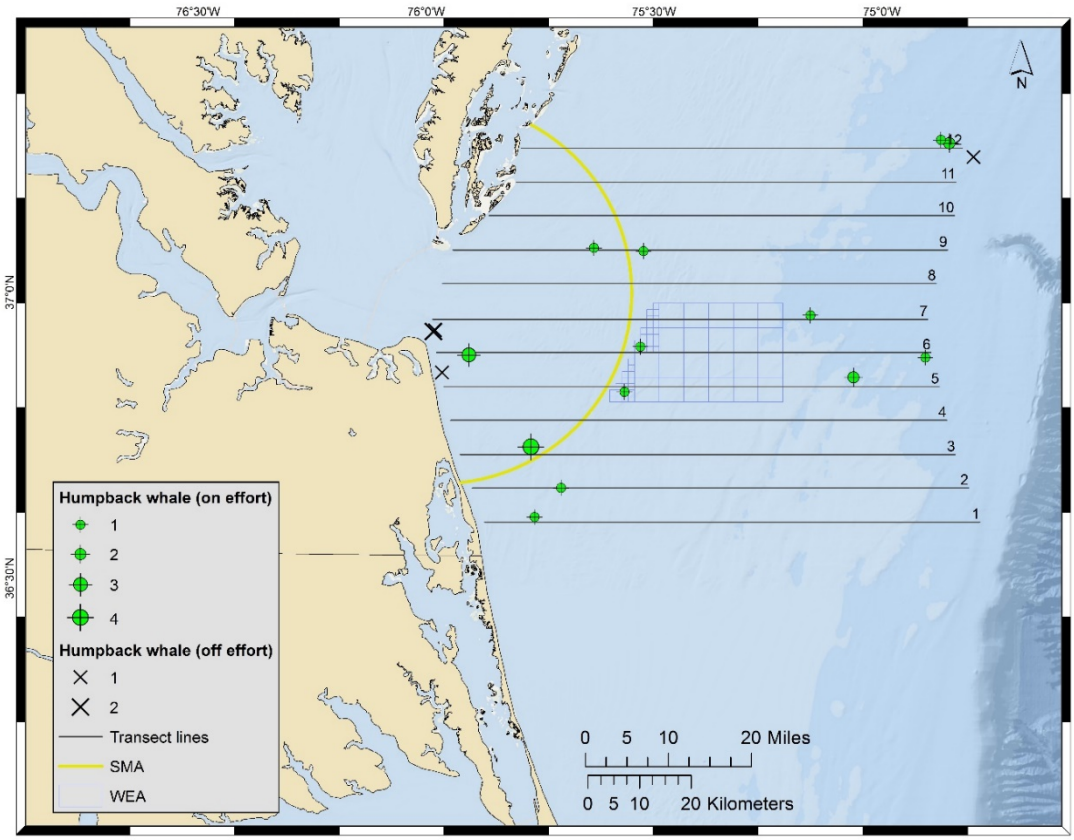


*Figure* 12. Humpback whale (*Megaptera novaeangliae*) sightings indicating group size. Off-effort sightings indicated by the black X.

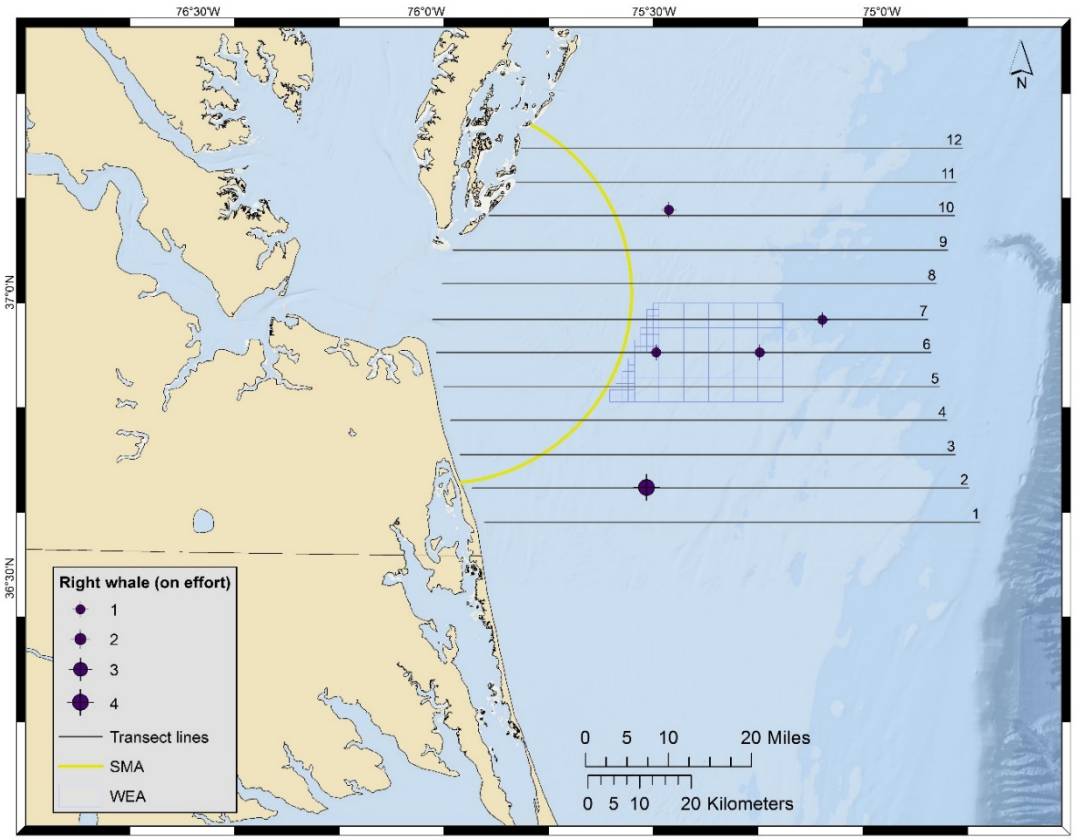


*Figure 13.* North Atlantic right whale (*Eubalaena glacialis*) sightings indicating group size.

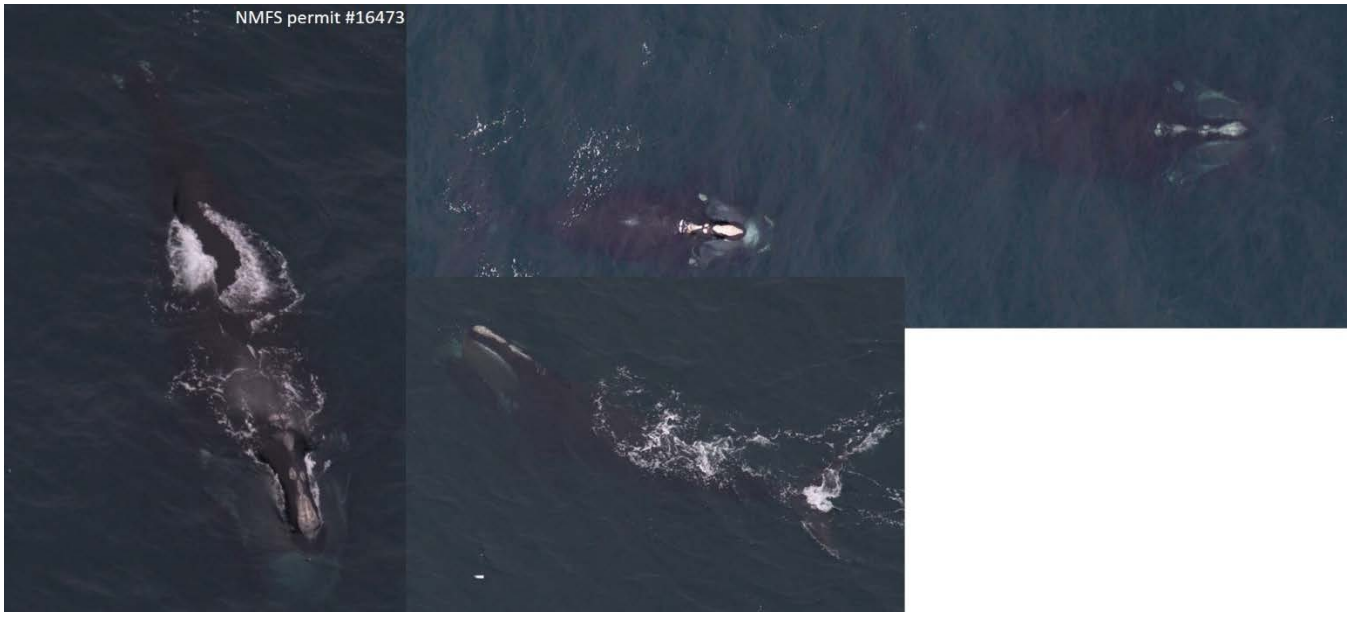


*Figure 14.* NARW whale swimming with mouth open a behavior that is consistent with feeding. Images were collected under UNCW NOAA Scientific Permit #16473

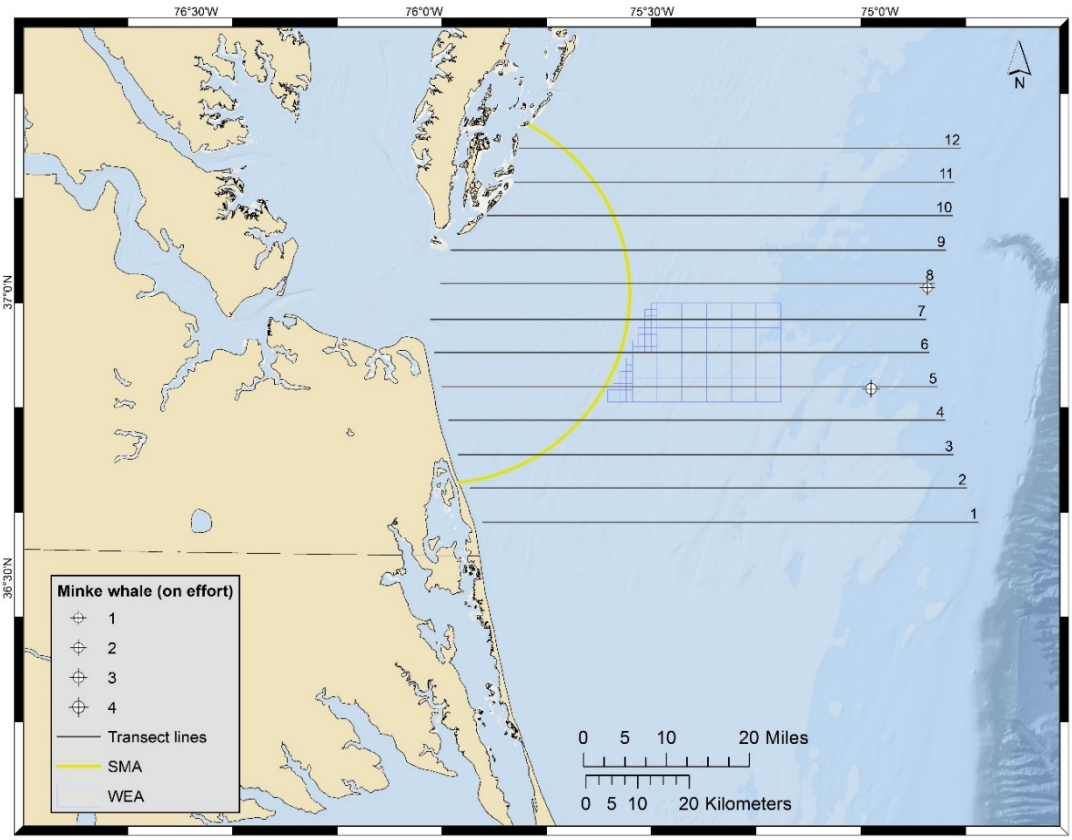


*Figure 15.* Minke whale (*Balaenoptera acutorostrata*) sightings indicating group size.

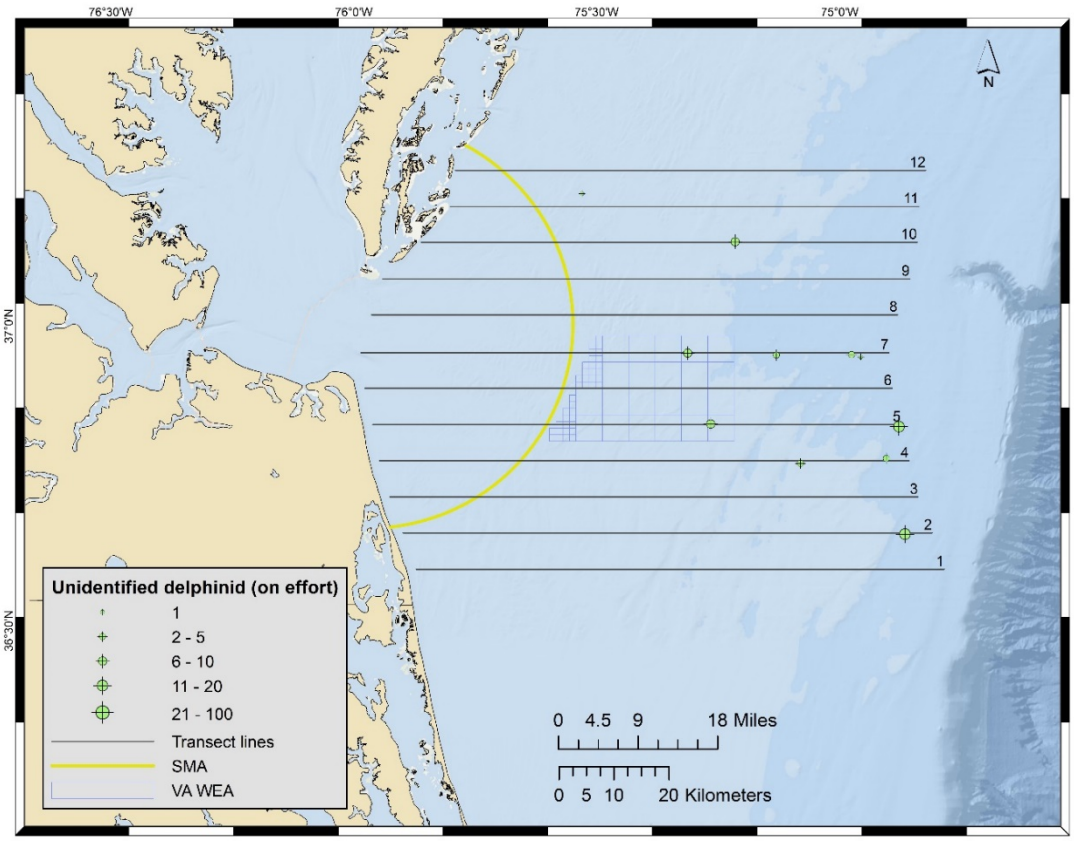


*Figure 16*. Unidentified delphinid sightings in the Virginia CZM survey area from November 2012 to November 2015

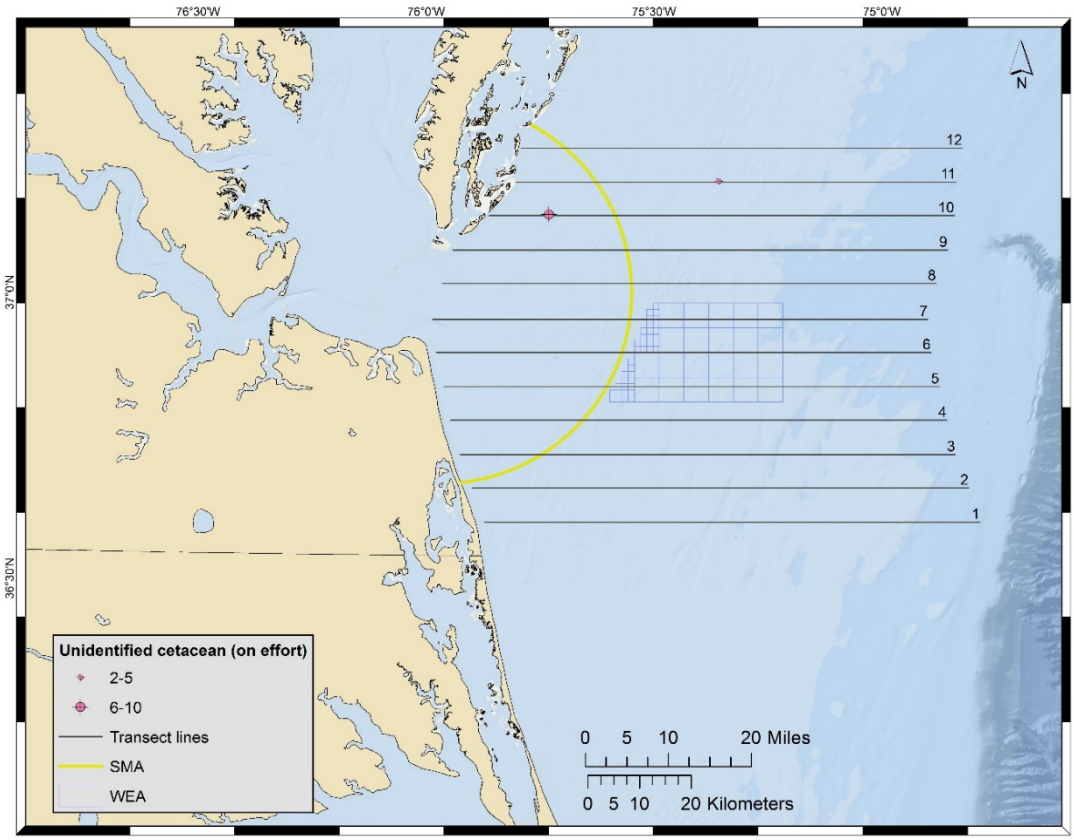


*Figure 17*. Unidentified cetacean sightings in the survey area from November 2012 to November 2015.

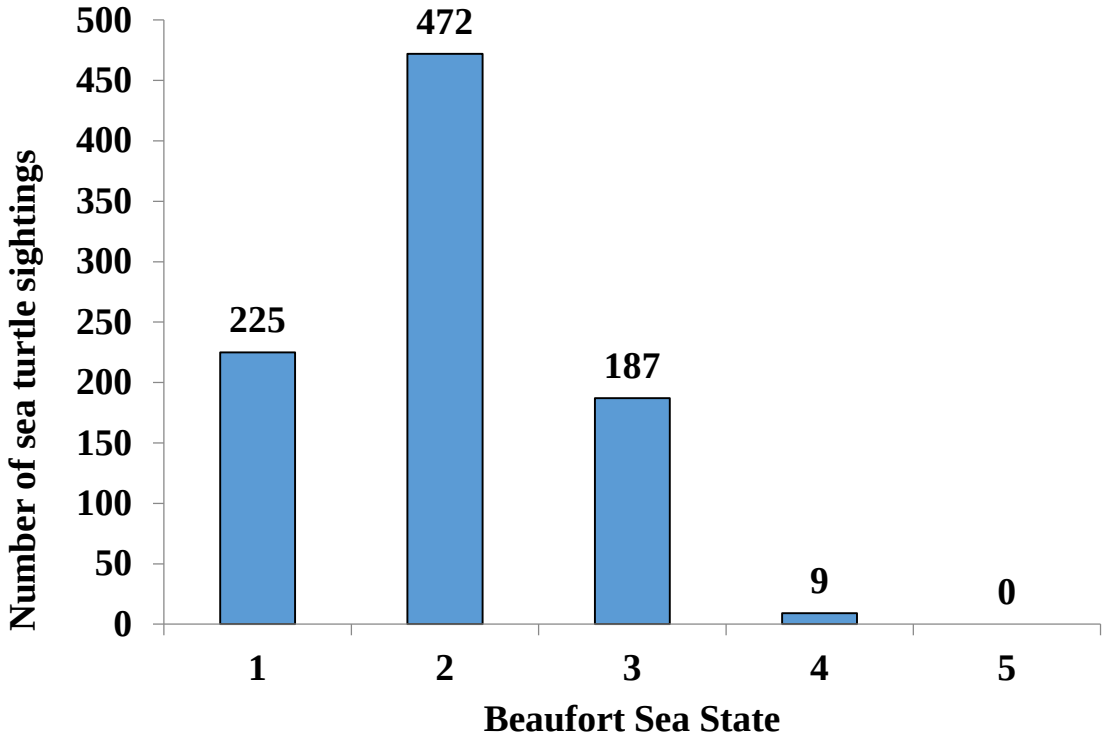


*Figure 18a.* Total number of sea turtle sightings by Beaufort Sea State in the survey area from November 2012 to November 2015

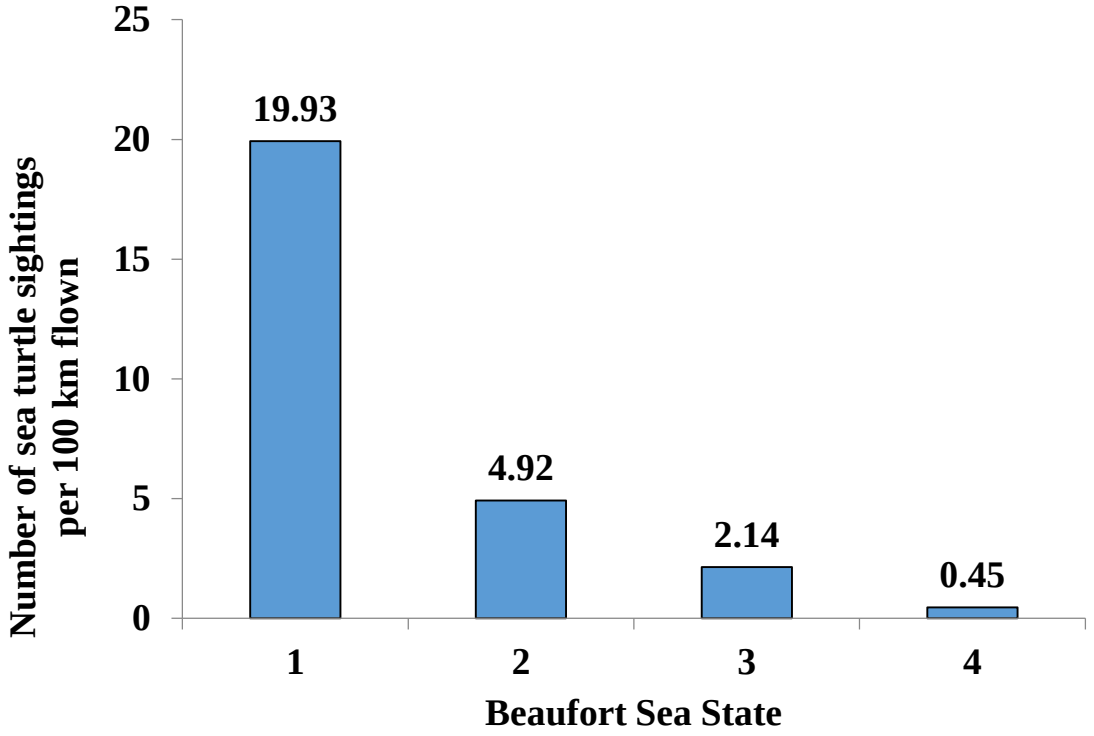


*Figure 18b.* Sea turtle sightings per 100 km flown by Beaufort Sea State in the survey area from November 2012 to November 2015

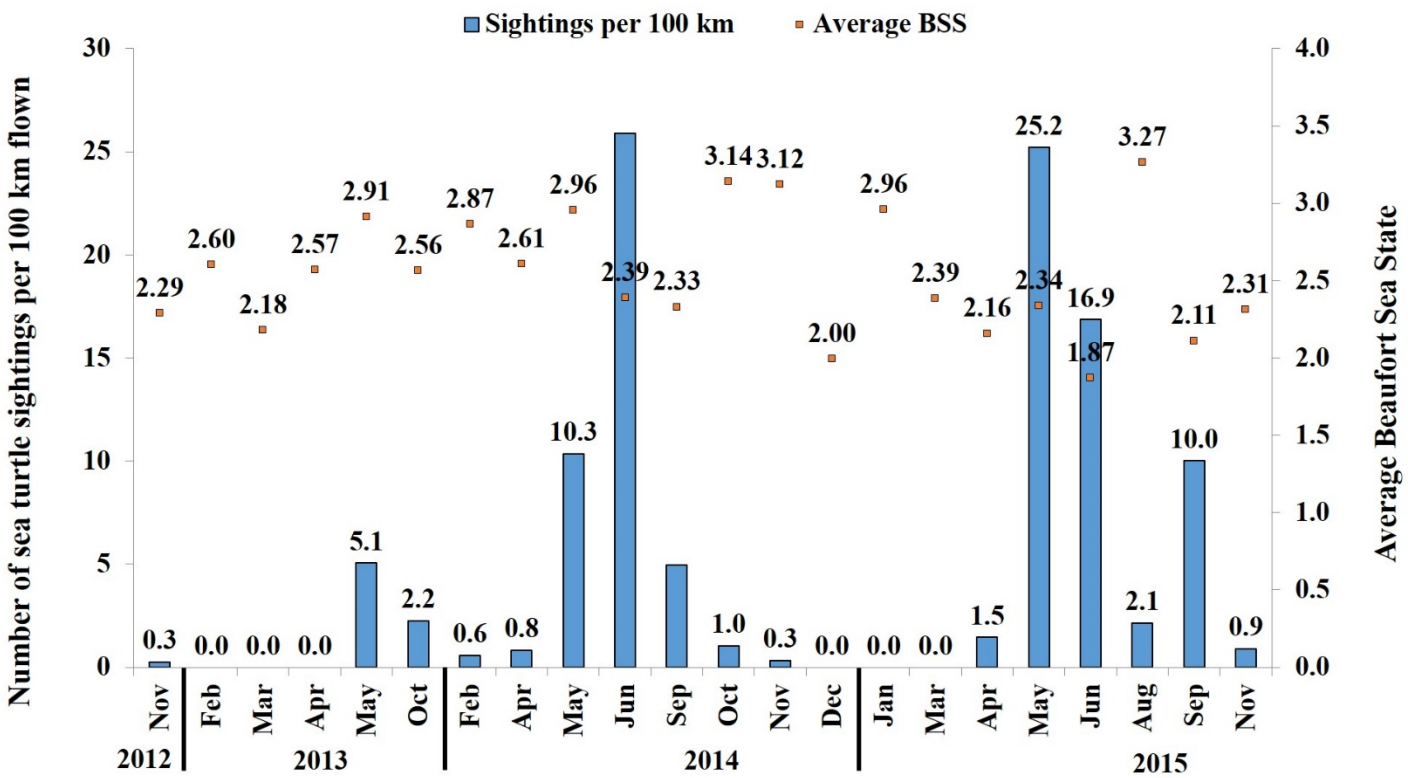


*Figure 18c.* Sea turtle sightings per 100 km surveyed (primary Y axis) and average Beaufort Sea State per month (secondary Y axis) in the survey area from November 2012 to November 2015.

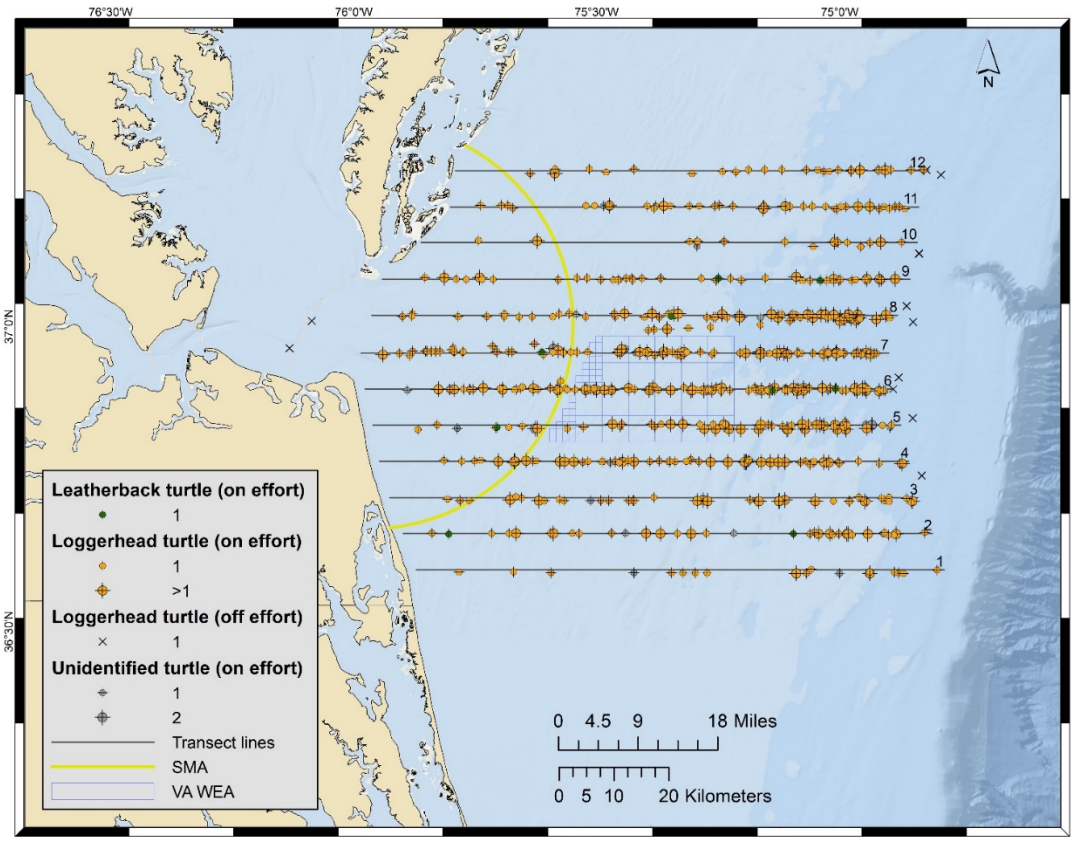


*Figure 19.* All sea turtle sightings, including: loggerhead (*Caretta caretta*), leatherback (*Dermochelys coriacea*), and unidentified sea turtle sightings. Circles with cross hairs indicate on effort sightings and solid X indicates off-effort sightings.

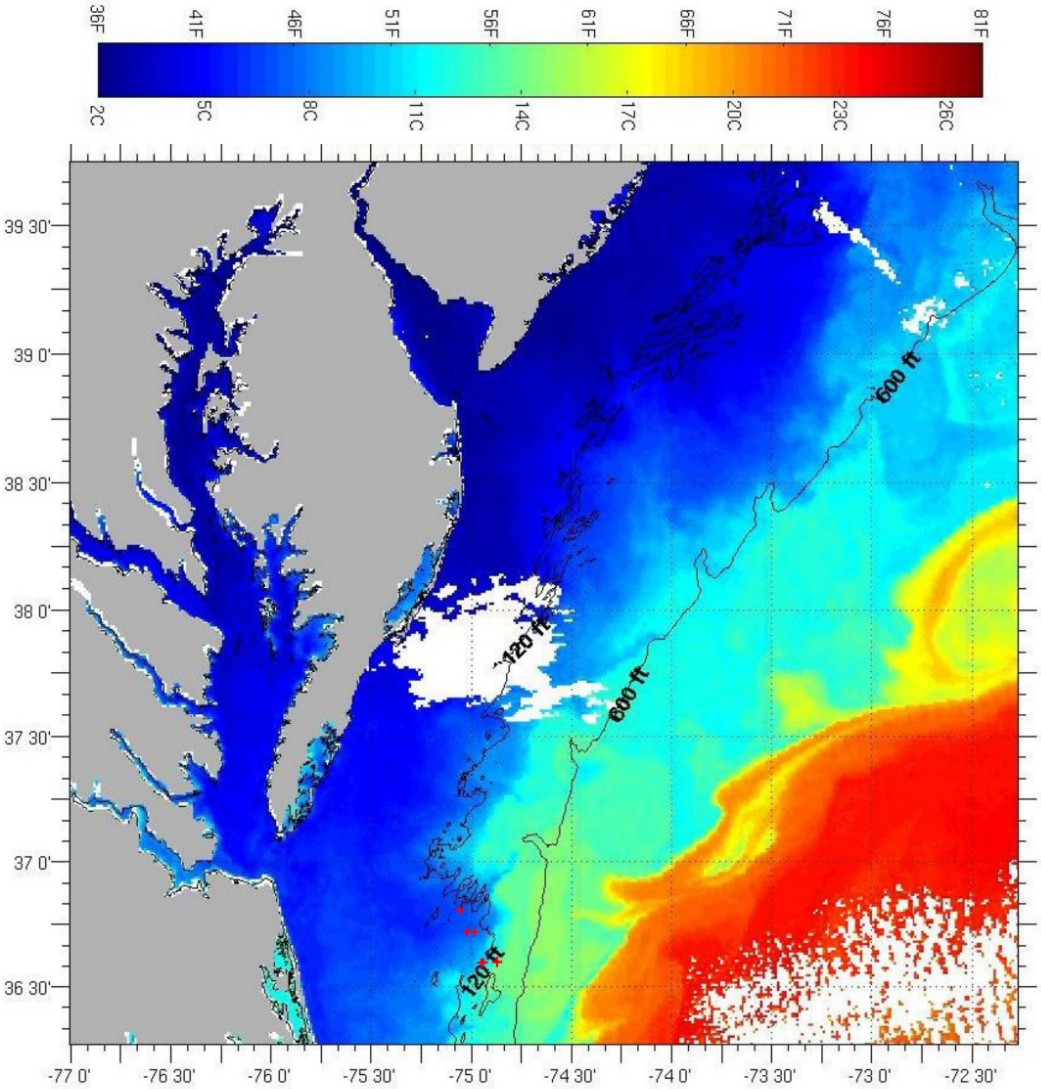


*Figure 20.* Sea Surface Temperature (SST) of an annomalous sighting of loggerhead sea turtles in February 2014. Sea turtle sightings are identified with a red cross along the 120 ft isopleth.

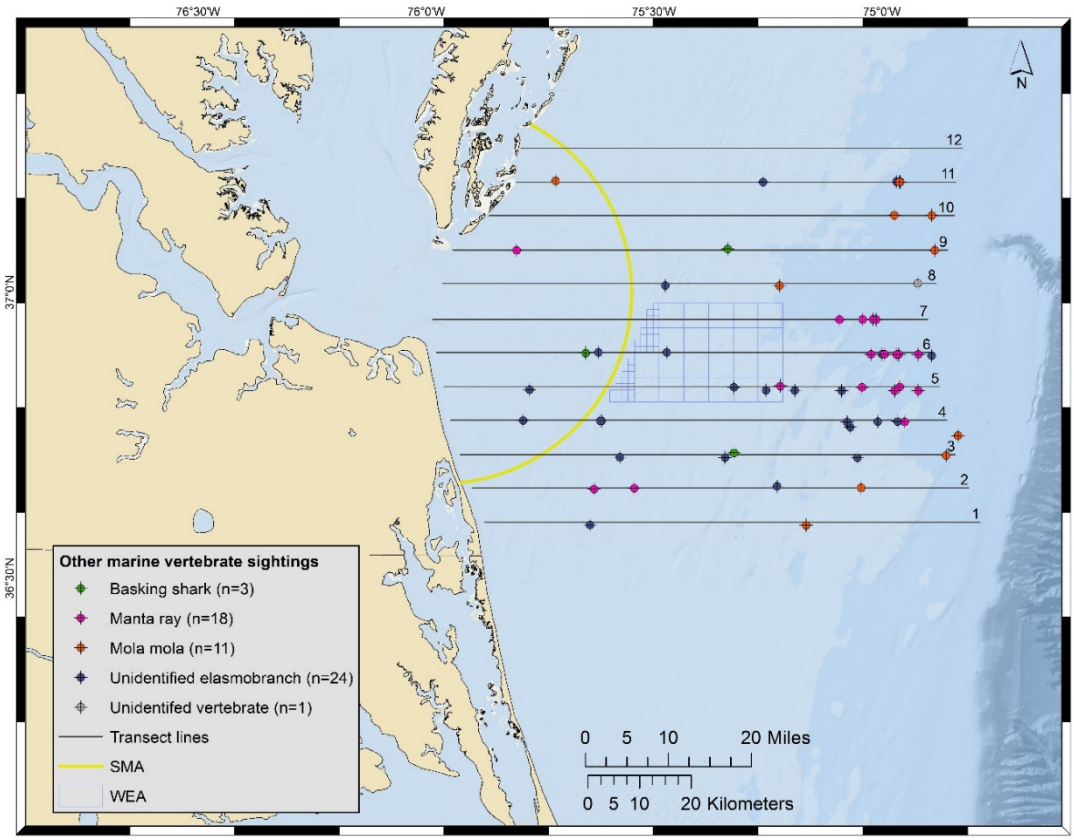


*Figure 21*. Other marine vertebrate sightings in the survey area from November 2012 to November 2015.

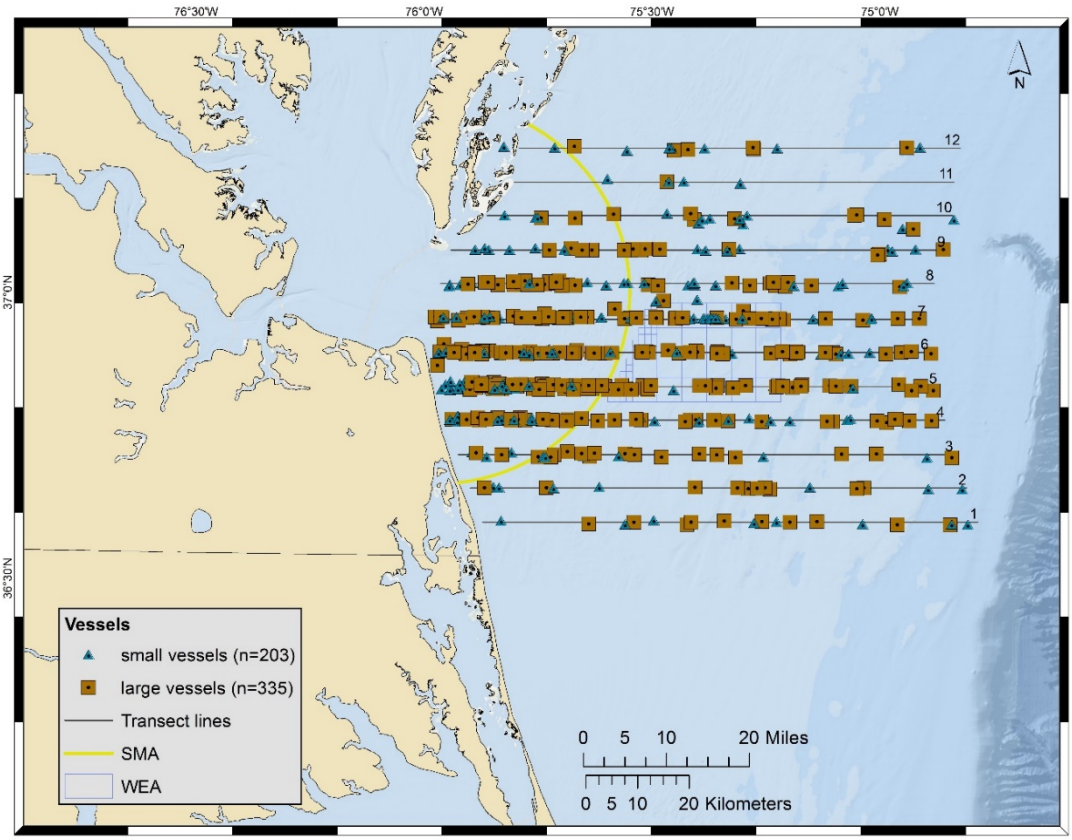


*Figure 22.* Large (*e.g.* tankers, military, cargo, and container vessels) and small vessel (e.g. recreational vessels- sail, parasail, sport fishing boats) sightings in the survey area from November 2012 to November 2015.

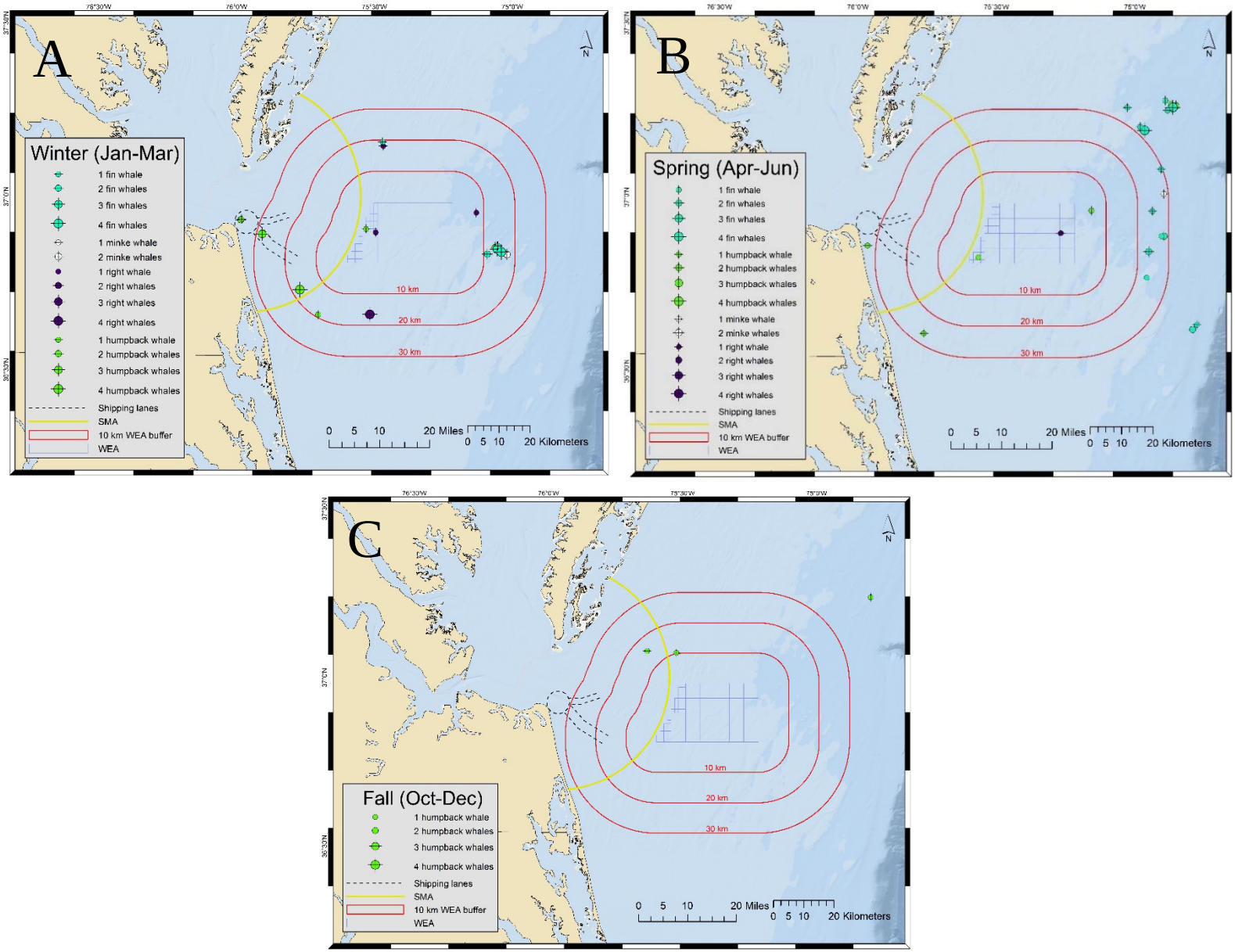


*Figure 23.* Large whale sightings from 2012 – 2015 with ten km intervals plotted relative to the boundary of the VA WEA, in (a) winter, (b) spring, (c) fall.

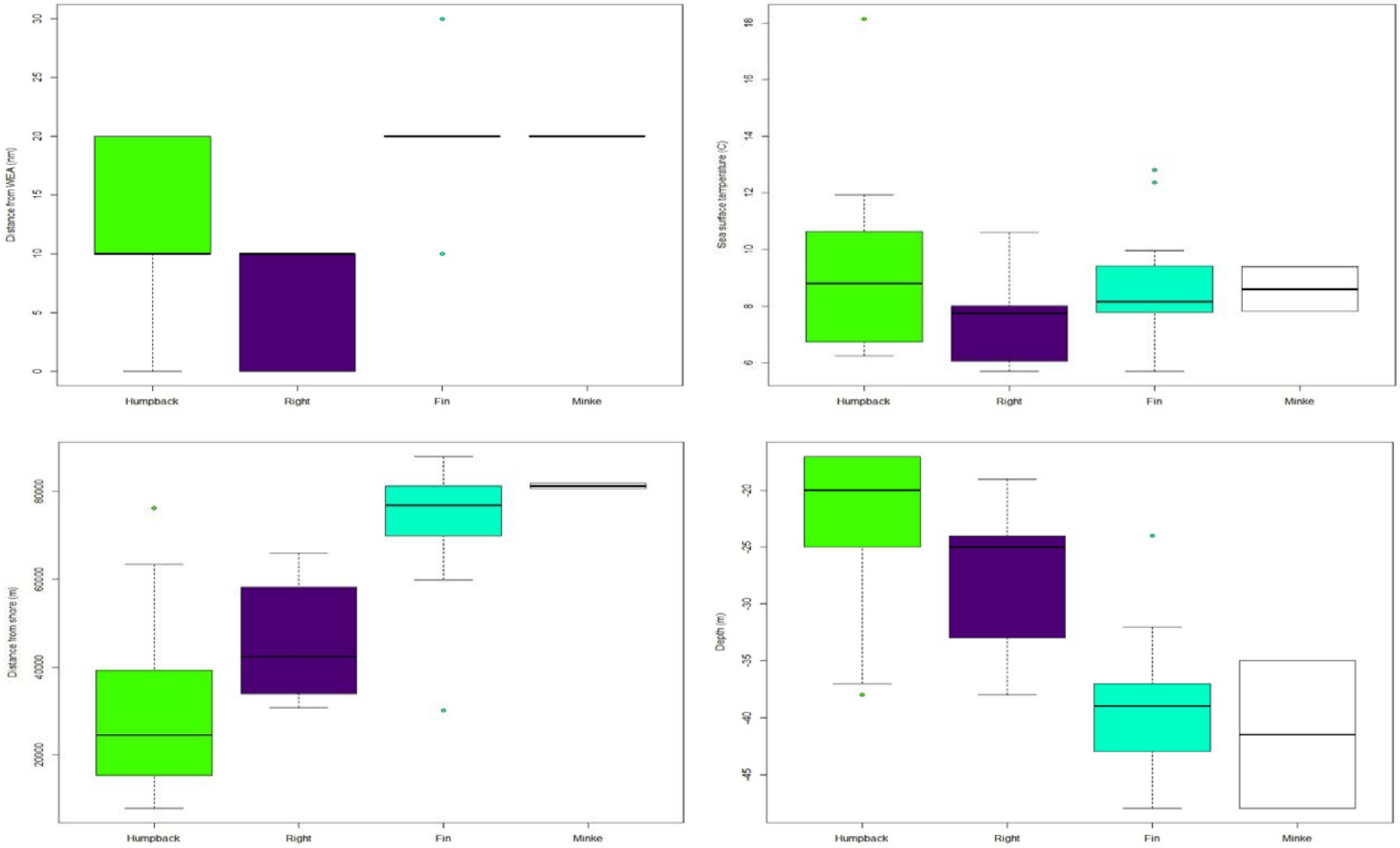


*Figure 24a.* Box plots representing whale sightings by species relative to: (a) distance from the VA WEA (b) Sea Surface Temperature (SST) (c) distance from the shore, and (d) depth.