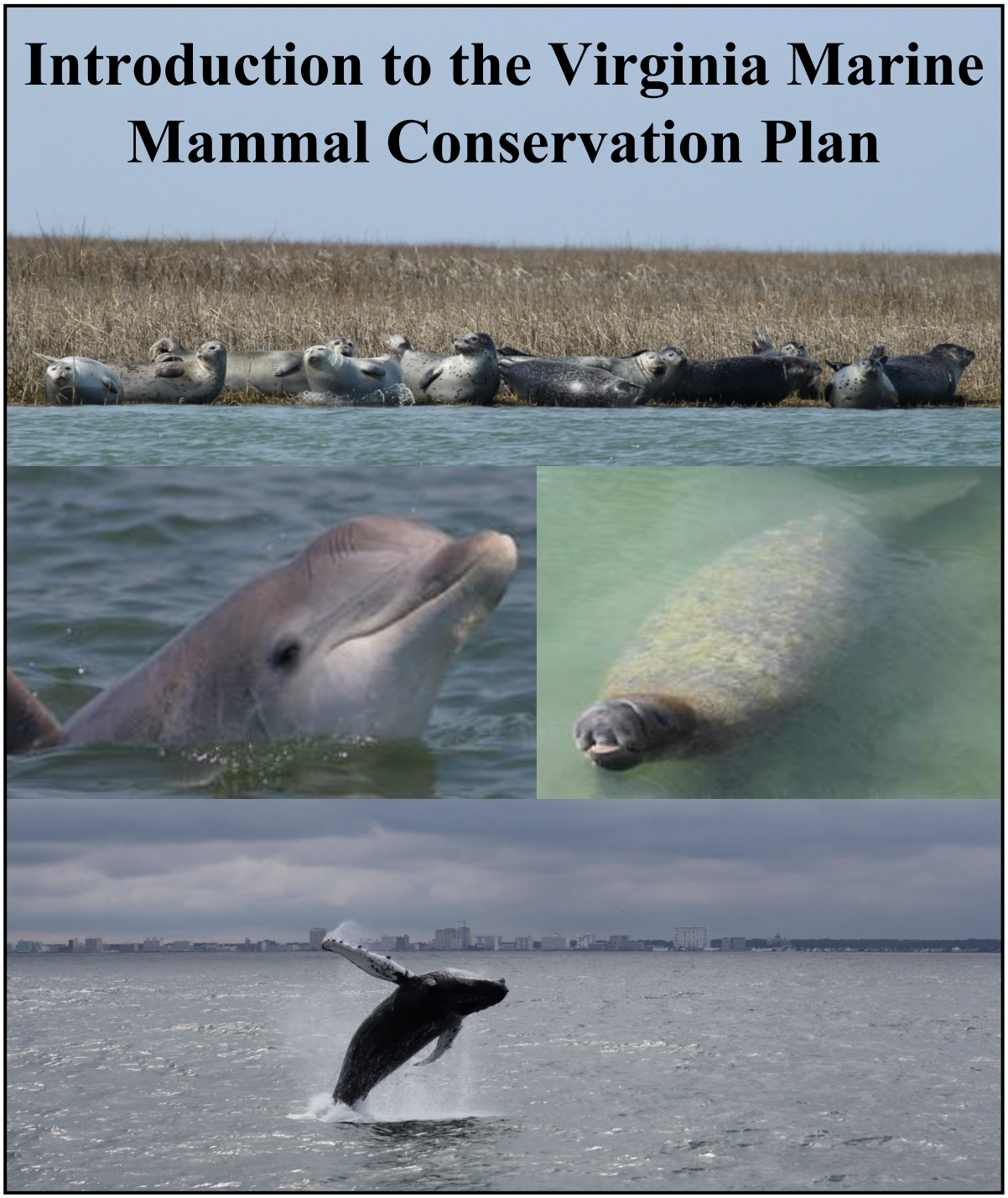
VAQF Scientific Report #2017-02

Introduction to the Virginia Marine Mammal Conservation Plan



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Title:

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2) Executive Summary

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AINS - Assateague Island National Seashore
ASMFC – Atlantic States Marine Fisheries Commission
BBNWR- Back Bay National Wildlife Refuge
BMP – Best Management Practice
BOEM – Bureau of Ocean Energy Management
CITES - Convention on International Trade in Endangered Species of Wild Fauna and Flora
DNNB - Dam Neck Naval Base
DOD – Department of Defense
ESA - Endangered Species Act
FCSP - False Cape State Park
IUCN - International Union for the Conservation of Nature
MARCO – Mid-Atlantic Regional Council on the Ocean
MDDNR – Maryland Department of Natural Resources
MDNRP - Maryland Natural Resources Police
MMPA – Marine Mammal Protection Act
MOU – Memorandum of Understanding
MPA – Maryland Ports Authority
NAQ – National Aquarium of Baltimore
NEPA – National Environmental Policy Act
NMFS – National Marine Fisheries Service
NOAA – National Oceanic and Atmospheric Association
NPS – National Park Service
ODU – Old Dominion University
PBR – Potential Biological Removal
SAR – Stock Assessment Report
SS – Strategic Stock (under the MMPA)
STDN - Sea Turtle Disentanglement Network
TNC – The Nature Conservancy
TRT – Take Reduction Team
UME – Unusual Mortality Event
US – United States
USACOE – US Army Corps of Engineers
USCG – US Coast Guard
USFWS – US Fish and Wildlife Service
USMC – US Marine Corps
USN – US Navy
UXO - Unexploded ordinances
VAQF – Virginia Aquarium Foundation
VDCR – Virginia Department of Conservation and Recreation
VDEQ – Virginia Department of Environmental Quality
VDEQ-CZM – Virginia Department of Environmental Quality – Coastal Zone Management Program
VDGIF – Virginia Department of Game and Inland Fisheries
VIMS – Virginia Institute of Marine Science
VMMS – Virginia Minerals Management Service
VMRC – Virginia Marine Resources Commission
VPA – Virginia Ports Authority
WFF – Wallops Island Flight facility

4) Introduction

I) General Overview of Plan

In 1995, the VDGIF and VIMS published the "Management Plan for Sea Turtles and Marine Mammals in Virginia" (Terwilliger and Musick 1995). The intent of this plan was to serve as a guide that defined and scheduled those actions believed necessary to manage sea turtles and marine mammals in the Commonwealth. The state plan represented the first cooperative private/public effort to identify, prioritize, and implement those steps necessary to conserve marine protected species in Virginia state waters. More than 20 years have passed since the plan was published. There has been a considerable amount of research conducted, knowledge gained and new regulations enacted during this period of time, which, collectively, provides sufficient incentive to explore new approaches towards the conservation and management of federally listed marine species. A revised Virginia and Maryland Sea Turtle Conservation Plan was drafted and submitted to state agencies in 2015. This introduction is the first step in revising the marine mammal portion of the 1995 Virginia Conservation Plan. This introduction contains revised and updated species descriptions, scientific results, and threats currently affecting marine mammals in Virginia. The plan includes only the most recent and geographically relevant information on individual species' descriptions, taxonomy, population status and distribution, life history characteristics, habitat utilization and other biological parameters to keep its length to a minimum and enhance its usefulness on a more local scale. Species that spend time in state waters are more thoroughly described and those exclusively found in offshore habitats are less well described.

II) Review of Federal Regulations regarding Marine Mammal Protection

Endangered Species Act (ESA): A law signed by Congress in 1973 to protect and recover imperiled species and the ecosystems they depend on. The ESA is administered by the US Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). While USFWS is primarily responsible for managing terrestrial and freshwater species and NMFS manages marine species, certain notable exceptions have occurred (*e.g.* Florida manatees and nesting sea turtles). Unlike the MMPA, the ESA is not specific to marine mammals and only provides protections to species deemed threatened or endangered.

International Union for Conservation of Nature (IUCN): A membership organization composed of government and civilian organizations whose mission is to provide the public with the knowledge and tools to (among other things) enable nature conservation. Experts of the IUCN are organized into commissions dedicated to species survival, environmental law, protected areas, social and economic policy, ecosystem management, and education and communication. The IUCN Red List is an inventory of the global conservation status of plant and animal species and it specifically evaluates the extinction risk of different species.

Marine Mammal Protection Act (MMPA): A U.S. law (16 US Code Chapter 31) signed in 1972 that specifically affords protections to all marine mammals within United States waters. Other marine vertebrate species or non-marine (*e.g.* aquatic and terrestrial) mammals are not covered under the MMPA. Although all marine mammals are protected under the MMPA, various exceptions exist under which certain 'takes' of marine mammals are permitted through either incidental (*e.g.* fisheries) or targeted (*e.g.* subsistence hunting) activities.

Potential Biological Removal (PBR): PBR is used by NMFS to manage marine mammal species by determining the allowable 'takes' for different activities (*e.g.* commercial fishing, geophysical surveys, naval maneuvers) and industries (*e.g.* petroleum, scientific research, *etc.*). PBR represents an estimate of the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population (50 CFR 229.2). PBR is calculated as a product of the estimated minimum population size, half of the maximum productivity rate (where actual productivity is not known), and a recovery factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The default maximum productivity rate used for cetaceans is 0.04. The recovery factor used depends on the amount of data on a species' status. Endangered, depleted, threatened stocks, or stocks of unknown status received different recovery factors. Where serious injury and/or mortality of stocks are known to be above PBR and federally managed commercial fisheries that are known to take marine mammals are involved, NMFS is mandated by the MMPA to convene a Take Reduction Team (see below).

Stock Assessment Reports (SAR): Reports prepared by NMFS using the latest available data to estimate population trends, minimum population estimates, productivity rates, PBR, anthropogenic mortalities, geographic ranges, *etc.* Scientific Review Groups (SRGs) are consulted for each SAR. SARs are reviewed annually for strategic stocks and every three years (or as significant new information is obtained) for non-strategic stocks.

Scientific Review Group (SRG): Three advisory groups (Alaska, Atlantic, Pacific) that consult for NMFS and USFWS regarding the status of marine mammal stocks (under Section 117 of the Marine Mammal Protection Act). Consultations cover SARs, associated population parameters (PBR, abundance estimates, distribution, population trends, *etc.*), influences on such parameters (incidental mortalities, stock identifications, *etc.*) and other relevant topics.

Strategic Stocks (SS): Marine mammal species, populations or groups that are: 1) endangered or threatened under the ESA, 2) declining and likely to be listed under the ESA, 3) considered depleted under the MMPA, and/or 4) exposed to direct anthropogenic mortality exceeding calculated PBR.

Takes: A marine mammal take is considered to be any interaction between a human or human activity and a marine mammal that results in the disturbance, distress, impairment, or death of that marine mammal. The term 'take' is defined in the Marine Mammal Protection Act (1972) as the act of harassing, hunting, capturing or killing, or attempt to do any such thing to a marine mammal. When determining whether takes exceed PBR, only those resulting in serious injury or mortality are considered.

Take Reduction Team (TRT): Convened as an advisory group to NMFS for the purpose of developing consensus recommendations to reduce incidental mortality and serious injury of particular marine mammal stocks in specific U.S. commercial fisheries. TRTs are composed of various stakeholder groups (*e.g.* researchers, conservation groups, fishers and fishery industry representatives, state and federal protected species managers, *etc.*). TRTs are formed to recover and/or prevent the depletion of strategic marine mammal stocks that interact with Category I (mortality and/or serious injury >- 50% of PBR) and II (mortality and/or serious injury between 1 to 50% of PBR) fisheries.

Unusual Mortality Event (UME): A marine mammal mortality event is a stranding or series of strandings that are "unexpected; involve a significant die-off of any marine mammal population; and demand immediate response" (http://www.nmfs.noaa.gov/pr/health/mmume/events.html**)**. The criteria used to

determine and/or declare an unusual mortality event are published in Federal Register notice (71 FR 75234) and are:

1. A marked increase in the magnitude or a marked change in the nature of morbidity, mortality or strandings when compared with prior records.
2. A temporal change in morbidity, mortality or strandings is occurring.
3. A spatial change in morbidity, mortality or strandings is occurring.
4. The species, age, or sex composition of the affected animals is different than that of animals that are normally affected.
5. Affected animals exhibit similar or unusual pathologic findings, behavior patterns, clinical signs, or general physical condition (*e.g.*, blubber thickness).
6. Potentially significant morbidity, mortality or stranding is observed in species, stocks or populations that are particularly vulnerable (*e.g.*, listed as depleted, threatened or endangered or declining). For example, stranding of three or four right whales may be cause for great concern whereas stranding of a similar number of fin whales may not.
7. Morbidity is observed concurrent with or as part of an unexplained continual decline of a marine mammal population, stock, or species.

III) Relevant Species and Species Descriptions

The in-shore and off-shore waters of Virginia are host to a considerable number of marine mammal species with great diversity in form, life style, and habitat. Many of these species are seasonally present or transient, traveling through and/or residing in waters in or offshore of Virginia seasonally and/or sporadically. This is especially true of species encountered along inland and near shore waterways, such as seals, manatees, certain baleen whale species and bottlenose dolphins. Marine mammals also show considerable diversity in distribution, ranging from estuarine and coastal species that have relatively high interaction rates with humans and human activities, to pelagic species whose interaction rates with humans are thought to be minimal or are poorly understood. Owing to the considerable variation in our knowledge of species occurrence, habitat and life-history in the mid-Atlantic region, the following listings of marine mammal species vary from individual species (adequate to considerable data) to related phylogenetic groups (minimal data). Population density for Virginia is not listed because the distribution of all of the species listed is considerably broader than Virginia waters alone. For cetaceans, recent habitat density modeling based on Roberts *et al.* (2016) can be found in the OBIS-SEAMAP Model Repository **(**http://seamap.env.duke.edu/models/). These models are being regularly updated and will also be available on the Mid-Atlantic Regional Council on the Ocean Data Portal (http://midatlanticocean.org/data-portal/).

Species were listed individually if one or more of the following criteria were met:

- Commonly occurring species within Virginia state waters
- Considerable species distribution and/or threat information was available
- Species was considered endangered or threatened under the U.S. Endangered Species Act of 1973

Species are grouped into larger categories rather than listed by species if one or more of the following criteria exist:

- Minimal information on species life history
- Poor understanding of species distribution in the mid-Atlantic region
- Primarily encountered in federal (EEZ) waters

The two most commonly stranded marine mammals in Virginia waters are the bottlenose dolphin and harbor porpoise (Figure 1). In historic records collected by the Virginia Aquarium & Marine Science Center (1988-2016), bottlenose dolphins represented 68% of all marine mammal strandings, followed by harbor porpoises (12%), common dolphins (4%), and harbor seals (3%). Numerous other delphinid species and non-delphinid toothed whales have stranded in Virginia waters, representing 5.2% and 1.8% respectively. Baleen whales represent a small fraction of total strandings, with humpback whales (1.4%) being the most common, followed by minke whales (0.5%), fin whales (0.4%), North Atlantic right whales (0.2%) and sei whales (0.1%). Stranding locations are reported in individual species descriptions when adequate information exists, however data collected represent location of discovery, not necessarily location of mortality.

In addition to stranding data, maps of animal groups observed during aerial surveys conducted from 2011 through 2016 are also available and provided in the attached figures. In some cases, data on a species exists only from stranding records (*e.g.* harbor porpoise, *Kogia* species, beaked whales, sei whale) while in other cases, most of the available distribution information was derived from the 2011-2016 aerial surveys (*e.g.* spotted dolphins).

Collectively, these data represent species' minimum presence in Virginia waters beyond what is generally known in the published literature. The lack of Virginia stranding and/or survey data on a species does not, however, represent the absence of a species in the region. There are numerous reasons why there may be little or no occurrence data for a species whose published range includes Virginia waters, such as the species: 1) was less likely to occur close to shore and thus be captured in the stranding record; 2) occurred in small groups or spent very little time at the surface, making it less likely to have been observed during surveys; 3) spent a small amount of time in Virginia waters (*e.g.* migrated through twice a year); 4) was a relatively rare species (*e.g.* northern right whales); and/or 5) was primarily distributed off the continental shelf (*e.g.* deep diving species).

(A) Odontocetes (Toothed whales)

1. Common bottlenose dolphin (*Tursiops truncatus*)

***Description*:** The larger of the two members of the genus *Tursiops*, *T. truncatus* is the most common marine mammal inhabitant of coastal Virginia waters. Adults can attain a length up to 380cm and 650kg, though most individuals are significantly smaller (Jefferson, Webber, Pitman, 2008). Male biased sexual dimorphism is seen in some populations. In the last 25 years, male and female bottlenose dolphins stranded in Virginia waters have not exceeded 325cm and 289cm, respectively.

Two morphologically and genetically distinct morphotypes of bottlenose dolphin have been identified in the western North Atlantic, namely coastal and offshore dolphins (Hersch and Duffield, 1990; Kenney, 1990). Offshore dolphins are typically larger bodied, more robust animals (Mead and Potter, 1995).

Status: Although the species as a whole is not considered endangered, there is no estimate of the global *T. truncatus* population. Bottlenose dolphins vary dramatically in home range size, habitat, diet and threats and are therefore not managed as a single group. Estimates of population sizes exist for

specific regions of the world, and management is typically based on local population estimates and threats. Additionally, the different bottlenose dolphin ecotypes are often treated differently in management decisions due to their drastically different potential biological removal (PBR) values and their status (or lack thereof) classification as a strategic stock.

Occurrence, Distribution and Abundance in Virginia waters: Bottlenose dolphins occur in Virginia waters throughout the entire year, however, their presence increases dramatically in spring and summer months. Significant dolphin presence in coastal ocean and Chesapeake Bay waters of Virginia typically begins in April or May and appears to be strongly correlated with water temperatures (Barco *et al.*, 1999). Dolphin residency commonly extends into August or September at which point southward migration begins, with dolphin presence significantly reduced by October or November (Figure 2).

The bottlenose dolphin is the most common marine mammal to strand in Virginia. Over the last 10 years, an average of 66 dolphins stranded per year (Figure 3) with the exception of 2013, which marked the start of a Bottlenose Dolphin Unusual Mortality Event (UME). The 2013-2015 Bottlenose Dolphin UME, attributed to a morbillivirus outbreak, affected almost the entire Atlantic coast of the U.S. The peak of this UME was in the summer and fall of 2013, and Virginia experienced an almost six-fold increase in strandings that year.

In addition to strandings, bottlenose dolphins are commonly sighted during aerial surveys. Surveys conducted May-Oct 2011-2013 regularly encountered bottlenose dolphins in Chesapeake Bay and ocean waters. Offshore aerial surveys conducted primarily in cooler months from 2012 through 2016 encountered bottlenose dolphins during all months.

Similar to the vessel survey sightings observed in Barco et al (1999), strandings typically increase in May and remain relatively high through October (Figure 4). The May peak appears to be driven by high infant mortality (stillbirth, infanticide, *etc.*) as many of the strandings are perinates (near time of birth).

Offshore bottlenose dolphin range extends outward past the continental shelf and slope, and offshore *Tursiops* show greater heterogeneity of genetic markers than the coastal ecotype (Hoelzel *et al.*, 1998; Natoli *et al.*, 2004). Numerous coastal stocks of bottlenose dolphins have been hypothesized and classified along the US Atlantic coast. Although the debate over how many stocks/ecotypes/species remains unresolved (McLellan *et al.*, 2002). Current federal management strategies recognize a Northern Coastal Migratory Stock (NCMS) and Southern Coastal Migratory Stock (SCMS) as well as numerous resident stocks from North Carolina to Florida (Waring *et al.*, 2016). The NCMS ranges from New Jersey to Delaware and northern Virginia in summer, and southern Virginia to southern North Carolina in winter. The SCMS ranges from southern Virginia to mid North Carolina in summer, and South Carolina to northern Florida in winter. Of the stocks relevant to Virginia waters are two coastal migratory stocks, northern and southern, the offshore ecotype due to their presence in local offshore waters and occasional stranding along Virginia coastline. Photo-identification data suggest that at least one of the resident stocks, the northern North Carolina estuarine stock, also occurs seasonally in Virginia waters, though the regularity of their occurrence is unknown (Urian *et al.*, 2016). Although precise defining ranges have not been described, Torres *et al.* (2003) found that within 7.5 km of shore, all biopsied dolphins belonged to the coastal ecotype, while all sampled dolphins beyond 34 km from shore or deeper than 34 m were offshore ecotype. Between the two ranges (7.5-34 km) both types occur at

undefined frequencies. Based on aerial surveys, Kenney (1990) suggested that coastal bottlenose dolphins north of Cape Hatteras, North Carolina are restricted to waters shallower than 25 m.

Diet and foraging in Virginia waters: Most of what is known about the diet of bottlenose dolphins in Virginia waters is based on stomach contents analyses of stranded, deceased individuals. In a 2016 scientific report from the Virginia Aquarium Foundation, stomach content analysis results were presented for 200 stranded bottlenose dolphins (Phillips *et al.*, 2016). In that analysis, 32 species from 22 families of prey items were identified from otoliths and squid beaks. The most common prey family (Sciaenidae) occurred in 93% of dolphins and accounted for 71% of the diet, followed by Clupeidae, Phycidae, Engraulidae, Moronidae, and Loliginidae. Croaker (*Micropogonias undulatus*) was considered the most important prey species as it accounted for the highest number, frequency and reconstructed mass, followed by spot (*Leiostomus xanthurus*) and seatrouts (*Cynoscion* sp.; at least 3 species). Presenting with far lower numbers were menhaden (*Brevoortia tyrannus*), hake (*Merluccius* sp.), anchovy (*Anchoa* sp.), longfin inshore squid (*Doryteuthis pealeii*), silver perch (*Bidyanus bidyanus*), and striped bass (*Morone saxatilis*). Phillips *et al.* (2016) also found that prey size increased with dolphin size but that significant differences in diet did not exist between male and female dolphins. Seasonal diet shifts were also identified, with seatrouts being the dominant (>25%) prey species in spring, and croaker (~50%) followed by spot (22%) in the summer and fall. Menhaden increased from 2-3% in summer and fall to 13% in spring. Striped bass consumption was highest in spring at 8%. Other prey species (*e.g.* anchovy, hake, longfin inshore squid) were common but comprised much smaller portions of the diet. This study suggests that while many of the aforementioned prey species comprised significant portions of local bottlenose dolphin diet, seatrouts, croaker, spot and menhaden appeared to be critical prey species at different times of the year. Additionally, the correlation between dolphin size and prey size suggests that robust populations of dolphins comprised of numerous ontogenetic stages depend on prey populations with similarly varied ontogenetic stages.

Reproductive activity in Virginia waters: Reproductive activity is challenging to assess in the turbid waters of Virginia. Although not much is known about reproductive activity in Virginia waters, a well-known bottlenose dolphin nursery exists along the southern tip of the mouth of the Chesapeake Bay. Mother/calf pairs and groups with numerous perinatal dolphins were seen every year along the Cape Henry-Fort Story coastline, with a peak occurring in July (Barco *et al.*, 1999). These nursing groups tended to preferentially use the protected waters of the Bay portion of the Cape Henry coastline.

2. Harbor porpoise *(Phocoena phocoena)*

***Description*:** The only member of the porpoise family seasonally endemic to the waters of Virginia, harbor porpoises (*P. phocoena*) are small (130-190 cm in length), stocky toothed whales, with spade-shaped teeth that distinguish them from dolphins. Stranded harbor porpoises in Virginia's records from the last 25 years have not exceeded 169 cm in body length. Almost half (47%, n=251) of the individuals with an accurate length were immature and 1.1-1.2 m in total length.

Status: The harbor porpoise is not listed as threatened or endangered under the Endangered Species Act and the Gulf of Maine/Bay of Fundy stock is not considered strategic under the Marine Mammal Protection Act. The latest minimum population estimate for the southernmost population of harbor porpoises (Gulf of Maine/Bay of Fundy) is 60,970, with the most current abundance estimate for

this stock being 79,993 (Waring *et al.*, 2016). While the population that occurs in Virginia waters, which is part of the Gulf of Maine stock, is not considered threatened or endangered, the total mortality and serious injury due to U.S. fisheries is ≥10% of the calculated potential biological removal and it is therefore considered a strategic stock that is managed through the NOAA-NMFS Take Reduction Planning process.

Occurrence, Distribution and Abundance in Virginia waters: There are four proposed populations of harbor porpoises in the western North Atlantic (Gaskin, 1984; 1992), and numerous analyses have been conducted which support those population distinctions. While the Gulf of Maine/Bay of Fundy population is the southernmost one with relevance to Virginia, mitochondrial DNA and microsatellite analyses indicate that the Gulf of Maine/Bay of Fundy population is not the only population found in the mid-Atlantic in the winter (Waring *et al.,* 2016). Harbor porpoise distribution tends to be focused in more northern waters of the Atlantic US and Canada during summer months. In winter months, porpoises disperse more widely and can be encountered in waters off Virginia in intermediate densities. Harbor porpoises can be found from shallow coastal waters to deep offshore waters, with heaviest densities located over the continental shelf (Westgate *et al.*, 1998).

The harbor porpoise is the second most common marine mammal to strand in Virginia after the bottlenose dolphin (12% of marine mammal strandings from 1988-2016, n=327). Since 1988, there have been an average of 11 strandings per year (range 1-46), however, in the last ten years that has decreased to 6 strandings per year (range 2-15; Figure 5). The changes in porpoise strandings are very likely related to the increase and later collapse of the spiny dog fish (*Squalus acanthias*) fishery which was identified as a major factor in mid-Atlantic fishery interactions along with the monkfish (*Lophius americanus*) fishery by the Harbor Porpoise Take Reduction Team (S. Barco, pers. comm.). The strandings are highly seasonal, occurring almost exclusively from February through May (98%, n=319; Figure 6). Strandings are concentrated on the ocean-facing beaches of Virginia Beach, but also occur regularly in the lower Chesapeake Bay and ocean-facing beaches along Virginia's Eastern Shore (Figure 7).

Despite over 32,706 km of aerial survey trackline flown in Virginia in the winter months, no harbor porpoises have been sighted. This is not unusual as the species occurs in small groups and can be cryptic. Most porpoise surveys in the Western North Atlantic are conducted using ships as platforms (Waring *et al.* 2016).

Diet and foraging in Virginia waters: In a study conducted by a Bowdoin College honors student in 2013, the stomach contents of 37 harbor porpoises stranded in northern North Carolina (n=3) and Virginia (n=34) from 1997-2010 were examined. The study identified anchovy and hake as the most important prey. Atlantic herring, Atlantic menhaden, longfin squid, and shrimp were also common in the diet (Schoettle, 2013).

Reproductive activity in Virginia waters: Insufficient data for Virginia.

3. Short-beaked common dolphin *(Delphinus delphis)*

Description: A relatively sleek dolphin species with a fairly long slender beak and tall, pointy dorsal fin. Prominent coloration includes dark brown to gray back with a white belly and tan thoracic patch (Jefferson, Webber and Pitman, 2008). Coloration on the sides generate a distinctive "hourglass" pattern. Adults in the northeastern Atlantic can grow up to 250 cm in length, while individuals in the eastern Pacific only grow to a maximum of 235 cm. In Virginia waters, the largest stranded individuals were a 245 cm male and a 227 cm female.

Status: Under the Endangered Species Act (ESA), short-beaked common dolphins are not considered threatened or endangered. The Western North Atlantic stock is also not considered a strategic stock under the Marine Mammal Protection Act (MMPA), however the U.S. fishery-based mortality and serious injury rates are significant as they are ≥ 10% of calculated PBR. There are an estimated 173,486 short-beaked common dolphins off of the Atlantic coast of North America. Using the default cetacean value for maximum productivity, the potential biological removal (PBR) for short-beaked common dolphins is 1,125 individuals (Waring *et al.*, 2016).

Occurrence, Distribution and Abundance in Virginia waters: Short-beaked common dolphins are an oceanic species found from nearshore to far offshore temperate and subtropical waters of the Pacific and Atlantic oceans. Occurrence of common dolphins in Virginia waters is not well understood, however the Chesapeake Bay is not considered normal habitat for this species. Strandings of *D. delphis* in Virginia waters total 108 during the period of 1988-2016. Other than one stranding in 1990, *D. delphis* did not commonly strand until 1998 (Figure 8). Since then, there has been an average of 6 strandings per year (range 1-20). Peak stranding numbers consistently occur in winter and spring, with highest total numbers in March and April (57%, n=61; Figure 9). This species is known to strand *en mass*, and such events have been recorded in Virginia waters. Similar to stranding data, *D. delphis* has most commonly been sighted in winter and early spring (April) with a few late fall (December) sightings. Despite flying over 22,000 km during surveys for sea turtles from May-Oct, no *D. delphis* were observed in Chesapeake Bay or coastal ocean waters. They have only been sighted on more recent surveys where effort was concentrated in cooler months (Figure 10).

Diet and foraging in Virginia waters: Insufficient data for Virginia. Short-beaked common dolphins feed primarily on small schooling fishes and squid (Jefferson, Webber and Pitman, 2008).

Reproductive activity in Virginia waters: Insufficient data for Virginia.

4. Other delphinids

i. Atlantic spotted dolphin *(Stenella frontalis):*

Description: Although similar in body shape to the bottlenose dolphin, the spotted dolphin's coloration varies considerably by developmental stage. Neonates have no spots, while calves develop a dark cape, light gray sides and a white belly (Jefferson, Webber and Pitman, 2008). Very young spotted dolphins often resemble slender bottlenose dolphins. A prominent spinal blaze often develops. Spots are gradually developed on the belly and eventually grow and multiply to cover much of the body. Adults typically have white-tipped beaks, and countless dark ventral spots and light dorsal spots. Spots

can grow so numerous that the dark cape and spinal blaze are partially or wholly obscured (Jefferson, Webber and Pitman, 2008). Diets of Atlantic spotted dolphins consist of a wide array of fish and squids as well as benthic invertebrates (Jefferson, Webber and Pitman, 2008).

Status: Although some regulatory bodies (*e.g.* IUCN) consider this species data deficient, Atlantic spotted dolphin populations are not considered threatened by human activity.

Occurrence, Distribution and Abundance in Virginia waters: Two geographic forms are recognized based on their coloration and osteology. The larger, more spotted form is more commonly seen over the continental shelf while the smaller, lighter form is found in oceanic waters. Although Atlantic spotted dolphins are found in offshore waters from New England to Brazil, they are rarely found in Virginia waters. There were four group sightings of *S. frontalis* from 2011-2016 in May and June of 6 to 40 individuals per sighting (Figure 11). Since 1988, there have been three strandings in Virginia.

Diet and foraging in Virginia waters: Insufficient data for Virginia. Atlantic spotted dolphins feed on a variety of epi- and mesopelagic fish and squid, in addition to benthic invertebrates (Jefferson, Webber and Pitman, 2008).

Reproductive activity in Virginia waters: Insufficient data for Virginia.

ii. Atlantic white-sided dolphin *(Lagenorhynchus acutus):*

Description: A robust dolphin with a large girth and striking coloration consisting of black or gray pectoral flippers, dorsal fin, flukes, upper jaw, back and upper sides. The lower jaw and belly are counter shaded with white, and a yellow band runs along their sides from the level of the dorsal fin to just in front of the flukes (Jefferson, Webber and Pitman, 2008). The peduncle has prominent dorsal and ventral keels—especially in mature males--tapering abruptly at the flukes. The beak is very short and the mouth contains small, pointed teeth. Adults of this species can attain a length of 280 cm but females are generally smaller (250 cm). Females weigh significantly less, with maximum weights of 182 kg, compared to males (235 kg) (Jefferson, Webber and Pitman, 2008).

Status: Although substantial numbers of Atlantic white-sided dolphins are taken in fisheries (*e.g.* mid-water trawls) or hunted in local drive fisheries (*e.g.* Norway, Faroe Islands, *etc.*), the species is not considered threatened. The estimate for current abundance of the western North Atlantic stock is 48,819, with a minimum population estimate of 30,403 and a PBR of 304 (Waring *et al.*, 2016).

Occurrence, Distribution and Abundance in Virginia waters: Atlantic white-sided dolphins primarily inhabit cold, deep waters of the outer continental shelf to the 100 m depth contour. Their primary range is from just south of Cape Cod to subpolar regions far north. Available data suggest that three stock units may exist in the western north Atlantic, the southern-most being the Gulf of Maine stock (Waring *et al.*, 2016). Presence in Virginia waters is minimal, with documented occurrence through sporadic stranding records. Since 1988, there have been 14 (1988-2013) documented strandings of Atlantic white-sided dolphins in Virginia waters (Figure 12). Virginia and North Carolina waters are believed to represent the extreme southern extent of the species' winter range.

Diet and foraging in Virginia waters: In general, the diet of this species consists of small schooling fish such as herring, mackerel, cod, smelt, hake and sand lance, though shrimp and squid are also taken (Jefferson, Webber and Pitman, 2008).

Reproductive activity in Virginia waters: Insufficient data for Virginia.

iii. Striped dolphin *(Stenella coeruleoalba)*

Description: A robust delphinid with a moderately long beak and a prominent crease between the melon and beak (Jefferson, Webber and Pitman, 2008). The mouth contains 40-55 thin teeth in each quadrant. The body's extremities show moderate curvature with a moderately falcate dorsal fin and recurved pectoral fins that terminate acutely. Striped dolphins have distinctive coloration with a white to pink ventrum and dark gray to blue gray cape along the dorsum. A white stripe or spinal blaze extends from the thorax upward toward the dorsal fin and a larger, while slender black stripe for which the species is named extends from the beak to the eye which it surrounds and travels caudal to the anus, delineating the countershading of the dark flanks from the white belly. This distinctive coloration typically precludes misidentification with other species. A second but much shorter black stripe extends from the eye to the cranial flipper insertion (Jefferson, Webber and Pitman, 2008).

Status: The IUCN lists striped dolphins as a species of least concern (2008). The most recent abundance estimate for the western North Atlantic is approximately 54,800 based on 2011 surveys (NOAA, 2014). Under US law, striped dolphins are not listed under the Endangered Species Act. Although protected under the MMPA, total U.S. fishery-related mortalities are not believed to exceed 10% (42.8) of the calculated PBR (428); Western North Atlantic striped dolphins are therefore not considered a strategic stock. Nonetheless, the population trends are unknown due to insufficient data.

Occurrence, Distribution and Abundance in Virginia waters: Striped dolphins are not found in coastal waters of Virginia. Stranding records indicate 15 single strandings from 1988-2016 (Figure 13).

Diet and foraging in Virginia waters: Insufficient data for Virginia. In general, striped dolphins are known to feed on cod, lanternfish and squid as well as numerous other small midwater and pelagic fish found between 200-700 m of depth along the continental slope and oceanic regions (Jefferson, Webber and Pitman, 2008). Because striped dolphins do not normally occur in Virginia waters, information on local prey preferences and foraging behavior is deficient.

Reproductive activity in Virginia waters: Insufficient data for Virginia.

iv. Long/Short-finned pilot whales *(Globicephala melas & G. macrorhynchus):*

Description: Pilot whales are separated into short (*G. macrorhyncus*) and long-finned species (*G. melas*). Robust, black or grayish brown body with a bulbous melon that can overhang the beak and a mouth line that is upswept. The peduncle is long and tall. The pectoral fins are long and sickle-shaped and the dorsal fin is short, falcate and wide at the base. One of the larger delphinid species, pilot whales can grow to 720 cm (*G. macrorhyncus* males) and 570 cm (*G. melas* females) and weigh as much as 3,600 kg (*G. macrorhyncus* males).

Status: Little is known about the true population size especially since sightings data is typically reported as short and long-finned pilot whales combined.

Occurrence, Distribution and Abundance in Virginia waters: Along the Atlantic coast of the U.S., pilot whales are found along the continental shelf edge of the northeast United States coast with northern migrations in summer and southern migrations in winter (Payne and Heinemann 1993). Surveys have resulted in estimated distribution patterns showing a southern distribution for short-finned and northern distribution for long-finned pilot whales. Along the shelf break of the mid-Atlantic region (North Carolina to New Jersey), short and long-finned pilot whales overlap in range (Payne and Heinemann 1993). Since 1988, 13 long-finned and 8 short-finned pilot whales have stranded in Virginia (Figure 14).

Diet and foraging in Virginia waters: Insufficient data for Virginia. Pilot whales primarily feed on squid, however they will take small to medium-sized fish such as mackerel, cod, turbot, herring, hake and dogfish (Jefferson, Webber and Pitman, 2008).

Reproductive activity in Virginia waters: Insufficient data for Virginia.

v. Rough-toothed dolphin *(Steno bredanensis):*

Description: A robust species that is smaller than the bottlenose dolphin, grows up to 280 cm and can weigh 155 kg (Jefferson, Webber and Pitman, 2008). The moderately long beak and gently sloping melon give the head a conical shape. Pectoral flippers are relatively large and placed further caudal than most delphinid species. The body is generally dark gray with a darker narrow cape on the top. White or pale pink color is typically seen along the lips, bottom jaw and belly. White focal scars from cookie-cutter sharks are common across the body. The teeth have numerous ridges that give this species its common name.

Status: There is no abundance estimate for rough-toothed dolphins in the Atlantic and therefore no PBR. Although data deficient, this species status is not one of concern (Jefferson, Webber and Pitman, 2008).

Occurrence, Distribution and Abundance in Virginia waters: Most commonly this species travels in small groups of 10-20, however large pods in excess of 100 have been observed (Jefferson, Webber and Pitman, 2008). Rough-toothed dolphins are an offshore species typically found in deep oceanic waters in tropical and subtropical latitudes. Virginia waters are at the northern extent of their primary range. There are, therefore, few records of rough-toothed dolphins in Virginia waters and all 14 records (1988-2013) are from a mass stranding in 2002 (VAQF Scientific Report #2014-07a; Figure 15).

Diet and foraging in Virginia waters: Insufficient data for Virginia. Rough-toothed dolphins are known to feed on fish and cephalopods. Fish prey species include large species such as *Mahi mahi* (Jefferson, Webber and Pitman, 2008).

Reproductive activity in Virginia waters: Insufficient data for Virginia.

vi. Risso's dolphin *(Grampus griseus)*

Description: A robust, blunt-headed dolphin with a bulging melon that has a pronounced vertical crease down the front. Risso's dolphins have a distinct but rounded beak compared to the elongated, pointy beak of most other delphinids. Their mouth line is upward sloping and the mouth hides only a few large pointy teeth on the lower jaw and usually lacks teeth on the upper jaw. The dorsal fin is tall and pointed. Coloration in adults varies from almost white to dark gray but is distinctive due to the extensive distribution of white patches, scars and spots caused by squid beaks and suckers as well as conspecific aggression. Calves and juveniles exhibit few scars or skin defects and are usually brown to gray in color.

Status: The most recent abundance estimate for the western north Atlantic stock is 18,250. The minimum population estimate is 12,619, with a PBR of 126. Risso's dolphins are not considered threatened or endangered. Individuals are taken in fisheries (*e.g.* longlines, driftnets, and purse seines) as well as some directed drive fisheries (*e.g.* Japan).

Occurrence, Distribution and Abundance in Virginia waters: Primarily a deep water species found at the continental slope and outer shelf but also in some oceanic regions. Risso's dolphins have a wide range from tropical waters to temperate regions of both hemispheres (Jefferson, Webber and Pitman, 2008). Due to their offshore preference, Risso's dolphins are not typically found in Virginia waters with the exception of stranded individuals for which there are 22 records from 1988-2016 (VAQF Scientific Report #2014-07a; Figure 15).

Diet and foraging in Virginia waters: Insufficient data for Virginia. While Risso's dolphins feed on crustaceans and cephalopods, squid appear to be the preferred prey and are thought to be responsible for many of the white scars that coat their blubber (Jefferson, Webber and Pitman, 2008).

Reproductive activity in Virginia waters: Insufficient data for Virginia.

5. Other toothed whales (ziphiids & physeteriids)

i. Sperm whale *(Physeter macrocephalus)*

***Description*:** The largest of the toothed whales, growing up to 1800 cm long and weighing as much as 57,000 kg, sperm whales show male-biased sexual dimorphism (Jefferson, Webber, Pittman, 2008). The body of sperm whales is predominantly dark gray to black color with small white regions around the mouth and ventrum. The head is enormous, constituting up to one-third of the total length, with a squared off leading edge and laterally compressed appearance. At the tip of the head sits a single, S-shaped blowhole. The pectoral flippers appear disproportionately short, while the flukes are broad and triangular with a nearly straight trailing edge (Jefferson, Webber, Pittman, 2008). The dorsal ridge of the peduncle has numerous prominent bumps following a thick, low dorsal fin. Like kogiids, sperm whales only have functional teeth in the lower jaw (18-26 pairs) (Jefferson, Webber, Pittman, 2008).

***Status*:** Sperm whales are listed as endangered under the ESA, depleted under the MMPA and a CITES Appendix 1 animal throughout their range. Although there is no good estimate of the total number of sperm whales, the best estimates are between 200,000 and 1,500,000. For the North Atlantic sperm whale population, the most recent minimum estimate is 1,815 (NOAA, Stock Assessment, 2015).

Although U.S. fishery-related mortality and serious injury for the N. Atlantic stock is considered insignificant (<10% of calculated PBR), it is considered a strategic stock due to endangered listing on the ESA.

Occurrence, Distribution and Abundance in Virginia waters: In winter, sperm whales in the United States Atlantic EEZ waters concentrate east and northeast of Cape Hatteras, North Carolina. These populations shift northward in spring to the waters east of Delaware and Virginia or further north. Sightings tend to be focused along the continental shelf edge and over the slope into the mid-oceanic regions. Female-juvenile social groups show site fidelity and latitudinal range limitations (Whitehead, 2002; Englehaupt, 2009), while males migrate to northern feeding grounds and to variable locations with breeding populations. Two sperm whales have stranded in Virginia, one in 2015 and one in 2016. The second was a perinate (Figure 16).

Diet and foraging in Virginia waters: Insufficient data for Virginia. Sperm whales feed primarily on large squid but sharks, skates and numerous fish species are also taken (Jefferson, Webber and Pitman, 2008).

Reproductive activity in Virginia waters: Insufficient data for Virginia. There is no documented reproductive activity in Virginia waters, though sperm whale calving grounds are believed to exist east and northeast of Cape Hatteras, NC. One of the two sperm whales that stranded in Virginia was a perinate.

ii. Pygmy/Dwarf sperm whales (*Kogia breviceps* & *K. sima*)

Description*:* Kogiids are oddly shaped odontocetes with a shark-like, underslung jaw. Their bodies are robust and counter-shaded dark gray to black above and white to pink on their ventrum. The pectoral flippers are quite small, as is the dorsal fin. There are usually no teeth in the upper jaw, while the lower jaw contains 7-16 pairs of long, curved, pointed teeth (Jefferson, Webber, Pittman, 2008). Adult pygmy sperm whales grow up to 380 cm in length while dwarf sperm whales in the north Atlantic typically do not exceed 250 cm (Jefferson, Webber, Pittman, 2008). This size difference in adults can be used to differentiate species when upper ranges of body length are achieved by pygmy sperm whales.

Both kogiids species have unique pigmentation in the cervical region that resembles a bracket or parenthesis, called a “false gill” (Jefferson, Webber, Pittman, 2008). Until recently there were no reliable external features that could be used to distinguish between pygmy (*K. breviceps*) and dwarf (*K. sima*) sperm whales. It is now known that the ventral apex of the false gill in *K. breviceps* recurves rostral and extends significantly further than in *K. sima* (Keenan-Bateman *et al.*, 2016).

Status: Because of the difficulty of differentiating pygmy from dwarf sperm whales, their survey-based population estimates are generalized to the *Kogia* genus (Waring *et al.*, 2014). The abundance estimate for kogiids from central Florida to the Bay of Fundy is 3,785 individuals. The PBR for *Kogia* spp. in the western north Atlantic is 26 individuals. Neither pygmy nor dwarf sperm whales in the western north Atlantic are listed as threatened or endangered under the ESA nor are they considered a strategic stock.

Occurrence and Distribution in Virginia waters: There have been 36 strandings of *Kogia sp*. in Virginia waters from 1988-2016 (Figure 16). From 1988 to 2016 pygmy sperm whales stranded more commonly in Virginia (n=25) than dwarf sperm whales (N=10), both species strand alive at a relatively high rate compared to other cetaceans in Virginia with 42% and 50% of pygmy and dwarf sperm whales strandings respectively being alive when discovered. Peak stranding season for pygmy sperm whales in Virginia is summer followed by fall, and for dwarf sperm whales is winter followed by summer. Twenty-eight of the 36 strandings (78%) occurred on ocean-facing beaches of the Atlantic coast.

Diet and foraging in Virginia waters*:* Insufficient data for Virginia. While pygmy and dwarf sperm whales are thought to feed primarily on cephalopods, some regional differences exist, where dwarf sperm whales feed in shallower waters than pygmy sperm whales. Deep sea fishes and shrimp are also taken, with as many as 67 different prey species documented in some regions (Jefferson, Webber and Pitman, 2008).

Reproductive activity in Virginia waters: Insufficient data for Virginia.

iii. Beaked whales (*Mesoplodon* sp.)

Description: Beaked whales are the second most diverse group of toothed whales after the delphinids. The group is comprised of numerous species, most of which belong to the genus Mesoplodon. Only four mesoplodont species inhabit the western north Atlantic, namely the True's beaked whale (*M. mirus*), Gervais' beaked whale (*M. europaeus*), Blainville's beaked whale (*M. densirostris*) and Sowerby's beaked whale (*M. bidens*) (Mead, 1989). In addition to these mesoplodont species, a ziphiid species, the Cuvier's beaked whale (*Ziphius cavirostris*) also inhabits the offshore waters of the northwest Atlantic. Beaked whales are characterized by fairly robust, spindle-shaped bodies with small pectoral flippers and short, stout dorsal fins placed fairly caudal (Jefferson, Webber, Pittman, 2008). Their head typically terminates in a fairly gentle sloping melon and long and narrow beak through which a pair of teeth erupts in males. The location and shape of the teeth is often diagnostic of the species. Cuvier's beaked whales are slightly different in that their heads have beaks that are not as long and the melon is more bulbous (Jefferson, Webber, Pittman, 2008).

Status: A combination of survey results suggests that several thousand beaked whales occupy the northwest Atlantic waters. The most recent Cuvier's beaked whale abundance estimates is 6,532 with a PBR of 50 (NOAA Stock Assessment, 2014). Beaked whales are not considered a strategic stock under the MMPA, and are not listed as threatened or endangered under the ESA.

Diet and foraging in Virginia waters: Insufficient data for Virginia. Based on stomach contents of stranded individuals, beaked whales are known to be primarily deep water squid eaters, however some fish species and crustaceans are also taken (Jefferson, Webber and Pitman, 2008).

Occurrence and Distribution in Virginia waters: Insufficient data. Virtually nothing is known about beaked whale distribution in Virginia waters. Stranding data suggest that Gervais' beaked whales occur most commonly, with six of the ten beaked whales that stranded in Virginia since 1988 being Gervais (Figure 17). A similar stranding pattern exists in North Carolina but aerial surveys suggest that Cuvier's beaked whale (*Ziphius cavirostris*), a species that is not represented in the stranding record of either state, is sighted much more frequently that other species (W. A. McLellan *pers. comm*.).

Reproductive activity in Virginia waters: Insufficient data for Virginia. A live mother/neonate calf Gervais beaked whale pair stranded in Virginia in the spring of 2002.

(B) Mysticetes (Baleen whales)

1. North Atlantic right whale (*Eubalaena glacialis*)

Description*:* Large, stocky black whale with minimal white patches or splotches on the underside. North Atlantic right whales can attain lengths in excess of 1800 cm (56ft) and weights of 90,000 kg (>198,000 lbs) and show slight female biased sexual dimorphism (Jefferson, Webber, Pittman, 2008). The pectoral flippers are quite broad and rounded distally, unlike most other baleen whales. The head of adults can account for one third to one fourth of the total length and is covered in patches of brown to gray, rough, thickened skin called callosities. Callosities are typically attachment sites for whale lice and are used in photo-identification of individual whales. Right whales have a distinctive high arched jawline that accommodates 200-270 long (up to 3m) baleen plates (Jefferson, Webber, Pittman, 2008). The combination of arched jawline and long baleen plates enables right whales to feed on plankton by skimming the surface of the water, rather than lunge/gulp feeding like most other baleen whales. North Atlantic right whales are often recognized at sea by the combination head callosities, lack of a dorsal fin and a distinctive, bushy, V-shaped blow.

Status*:* This species is listed as endangered under the Endangered Species Act, with a potential biological removal (PBR) of 1. The exact number of North Atlantic right whales is not known, however the minimum population size based on recognized whales from the North Atlantic right whale catalog was 476 in 2011.

Occurrence, Distribution and Abundance in Virginia waters*:* The North Atlantic population ranges from the winter calving grounds off of northeast Florida and southeast Georgia, to the summer feeding grounds in New England waters, the Canadian coast and Newfoundland. Due to their migration through Virginia waters, the mouth of the Chesapeake Bay has a seasonal management area (November 1-April 30) mandating reduced ship speeds out to approximately 20 nm.

Winter surveys have demonstrated calf presence as far north as Cape Fear, North Carolina suggesting the calving grounds may extend further north. Survey data show a strong affinity for coastal waters and/or those within the 100 m isobath, although surveys and telemetry data have shown utilization of offshore deep water off the continental shelf (Mate *et al.*, 1997; McLellan *et al.* 2003; Baumgartner and Mate, 2005). Virginia waters are considered transit waters for North Atlantic right whales during their migrations and seven sightings of up to four individuals occurred from 2011 to 2016 (Figure 16). Although there are numerous unconfirmed reports of right whales inside the Chesapeake Bay, their presence in Bay waters would be rare and may be accidental. Only four North Atlantic right whales have stranded in Virginia, one each in 2001, 2002, 2004, and 2005 (Figure 18). Three occurred in winter (February and March) and one occurred in summer (September). All right whale strandings in Virginia waters occurred on ocean-facing beaches along the City of Virginia Beach and the barrier islands seaward of the lower Delmarva Peninsula. Sizes of stranded individuals ranged from 771 cm to 1600 cm.

Diet and foraging in Virginia waters*:* Insufficient data for Virginia. Right whale diet consists almost exclusively of krill (*e.g. Calanus finmarchicus*) and other small invertebrates (Jefferson, Webber

and Pitman, 2008). Right whales have been shown to require high density patches of krill to optimize foraging efficiency (Baumgartner *et al.*, 2003).

Reproductive activity in Virginia waters*:* There are no reports of reproductive activity in Virginia waters. North Atlantic right whales appear to primarily use Virginia waters as transit waters between their calving grounds in the southeast US and the feeding grounds in northeast United States (Cole *et al.*, 2013). Two adult female right whales that stranded in Virginia in 2004 were pregnant with near term fetuses. One was founding floating off the coast in early February, and the other was presumably struck by a navy vessel off Virginia and stranded in Northeastern North Carolina in late November.

2. Humpback whale *(Megaptera novaengliae)*

***Description*:** The humpback whale is easily distinguished from other mysticetes by its extremely long pectoral flippers (up to one-third of the body length). They are also the most acrobatic of the large whales, often observed breaching. The head, jaws, and leading edge of the pectoral flippers have numerous bumps known as tubercles. Many of the tubercles on the rostrum as associated with sensory hairs believed to be used for sensing prey patches (Jefferson, Webber, Pittman, 2008). The body shape is more robust than other rorquals. Adult females can reach lengths approximately 100-150 cm longer than males, to a maximum of 1600-1700 cm, though 1400- 1500 cm is more typical. Calves are 400-450 cm long at birth and become independent at approximately 1 year old when they are 800-1000 cm in length (Jefferson, Webber, Pittman, 2008).

Status: In September 2016, NOAA-NMFS issued a final determination (81 FR 62259) that divided the humpback whale into 14 global distinct population segments (DPS). This ruling also removed the species-level listing as endangered and instead placed four DPS's as endangered, one as threated, and the remainder as not listed under the Endangered Species Act (ESA). Humpback whales occurring in the North Atlantic are part of the West Indies distinct population segment which is considered not in danger of extinction as part of this ruling. The humpback whale population is stable or growing according to recent abundance estimates; however, this stock is still considered depleted and maybe be below the optimum sustainable population in the U.S. Atlantic EEZ (Waring *et al.* 2016). There is a monitoring plan for the nine DPS's not listed as threatened or endangered under the ESA and the humpback whale is still protected under the Marine Mammal Protection Act (National Marine Fisheries Service, 2016).

***Occurrence, Distribution and Abundance in Virginia waters*:** The Gulf of Maine humpback whale stock consists of six subpopulations based on feeding grounds in the North Atlantic (Waring *et al.* 2016). Barco *et al.* (2002) identified stranded and live-sighted individuals in the mid-Atlantic as belonging to three of these subpopulations: Gulf of Maine, Gulf of St. Lawrence, and Newfoundland.

Humpback whales are the most commonly stranded large whale in Virginia, totaling 37 strandings from 1988-2016 (Figure 19). Although VAQS has recorded a stranding or entanglement of a humpback whale in every month of the year, April has had the highest historical number of strandings (n=6) and 62% of historical strandings occurred between January and June (winter and spring, n=23; Figure 20). Fall (October- December) has had the lowest number of strandings (n=6, 16%). These stranded whales have ranged in length from 640 cm to 1540 cm; however, 76% (n=19) of those with an accurate length were between 800-1000 cm, a length considered to be newly independent animals

(Wiley *et al.*, 1995, Clapham *et al.* 1999). Only two individuals, a 1250 cm female and a 1540 cm female were larger than 1100 cm. Twenty-seven (73%) of the 37 strandings primarily occurred on ocean-facing beaches but some have occurred within the lower Chesapeake Bay.

Live sighting records from vessel and aerial surveys indicate that humpback whales are seasonally present in Virginia waters from November to April, with the highest concentration off of Cape Henry and the mouth of the Chesapeake Bay (Figure 21). More than 50 different whales have been identified using photo-ID in recent years (S. Mallette *pers. comm*.). These animals are often observed engaging in feeding behaviors. Most of these animals are estimated to be 800-1200 cm in length, indicating that primarily juveniles occur in Virginia waters. Barco *et al.* (2002) suggested that the mid-Atlantic waters may serve as a supplemental feeding ground for juvenile and occasionally mature animals.

Diet and foraging in Virginia waters*:* Insufficient data for Virginia. The primary prey for humpback whales in Virginia waters is thought to be Atlantic menhaden (*Brevoortia tyrannus*). Whales have been observed foraging on schools of menhaden during vessel surveys, and necropsies of individuals stranded in Virginia waters have revealed large numbers of menhaden in the stomachs. Other small schooling fishes such as Atlantic croaker (*Micropogonias undulatus)* and bay anchovy (*Anchoa mitchilli*) have also been identified in stranded humpbacks for Virginia (S. Barco *pers. comm*.). During vessel and aerial surveys, humpbacks have been observed engaging in lunge-feeding behaviors, including rare observations of bubble-net feeding.

Reproductive activity in Virginia waters: Insufficient data for Virginia. There is currently no indication that reproductive activity occurs in Virginia waters. Additionally, there have been no confirmed reports of mother/calf pairs in inshore waters, nor have neonatal or pregnant females stranded in Virginia (VAQ unpublished stranding data).

3. Minke whale *(Balaenoptera acutorostrata)*:

Description: Minke whales are the smallest of the rorquals in the northwestern Atlantic, growing to only 880 cm in length and less than 10,000 kg in mass, with female biased sexual dimorphism (Jefferson, Webber, Pittman, 2008). Like other rorquals, minkes have streamlined bodies but a more sharply pointed rostrum than larger rorquals. The pectoral flippers are relatively narrow and pointed, with a prominent white blaze or patch that is characteristic of minke whales. The body is gray dorsally and white ventrally, with streaks of intermediate shading along the flanks (Jefferson, Webber, Pittman, 2008).

Status: Considered part of the Canadian east coast stock, minke whales in the northwest Atlantic are thought to number 20,741 individuals, with a PBR of 162. Since minke whales are neither listed as threatened or endangered under the ESA, nor is their fishery-related mortality and serious injury believed to exceed 10%, the Canadian east coast stock is not considered strategic under the MMPA.

Occurrence and Distribution in Virginia waters: There have been 12 strandings of minke whales in Virginia waters from 1988-2016. Peak stranding season in Virginia is spring followed by fall and summer. Eight of the 12 strandings occurred on ocean-facing beaches of the Atlantic coast. Both aerial

survey sightings of minke whales have been in excess of 100 km (Figure 22), but whale-watch boats have occasionally sighted minke whales closer to shore (VAQ staff pers. comm.)

Diet and Foraging in Virginia waters: Insufficient data for Virginia. Minke whales forage by lunge-feeding on small invertebrates such as euphausids and copepods, squid, large fish species such as wolfish and dogish, and small schooling fishes such as capelin, herring, mackerel, sandlance, whiting, sand eel, salmon, cod, coal fish, sprat, pollock, haddock, anchovy, saury, walleye pollack and lanterfish (Jefferson, Webber and Pitman, 2008). The only information on minke whale prey species in Virginia waters are based on stomach contents recovered from stranded individuals. In such cases, Menhaden appeared to be the primary prey species.

Reproductive activity in Virginia waters: Insufficient data for Virginia.

4. Fin whale *(Balaenoptera physalus)*:

Description: The second largest species of whale after blue whales, Fin whales are long and relatively slender, reaching lengths just under 2400 cm, with female biased sexual dimorphism (Jefferson, Webber, Pittman, 2008). Most adult fin whales likely weight less than 90,000 kg but individuals weighing up to 120,000 kg have been reported. Fin whales have a pointed, V-shaped head that has a single median ridge along the rostrum. The dorsal fin is relatively tall but rises from the dorsum at a gradual rate. The body of fin whales is black to dark brown-gray along the dorsum and flanks, and fades to white along the ventrum (Jefferson, Webber, Pittman, 2008). Long ventral throat pleats can number 50-100 and extend far caudal to the level of the umbilicus. The color of the head is asymmetrical and diagnostic of fin whales. While the lower left jaw is predominantly black, the lower right jaw is white or pale gray. The rostral half to third of the baleen plates on the right side have much more white coloration than the rest of the baleen plates, similar to the lower jaw color asymmetry (Jefferson, Webber, Pittman, 2008).

Status: The North Atlantic fin whale stock is considered a strategic stock due to its listing as endangered under the ESA. The current abundance estimate for the North Atlantic fin whale stock is 1,618 but is believed to be an underestimation due to lack of survey coverage (NOAA SAR, 2017). Because of this presumed underestimation, the NOAA estimated PBR of 2.5 is also presumed to be low.

Occurrence and Distribution in Virginia waters: There have been a total of 11 fin whale strandings in Virginia from 1988-2016. Most strandings occurred in winter (February and March), followed by a few strandings in the spring and summer. Six of the strandings occurred in the Chesapeake Bay (three on eastern shore; three on western shore) and five occurred on the Atlantic coast (Figure 23). Fin whales have been sighted on aerial surveys, primarily >80 km from shore, but whale watches annually sight a few fin whales closer to shore (VAQ staff pers. comm.; Figure 23).

Diet and Foraging in Virginia waters: Fin whales feed primarily by lung-feeding on schooling fishes such as capelin, herring, mackerel, sandlance and blue whiting, though squid and small invertebrates are also taken (Jefferson, Webber, Pittman, 2008). Similar to stranded humpback whales, menhaden have been found in the stomachs of fin whales stranded in Virginia, however no information exists on prey species that are targeted in active or regular fin whale feeding bouts of in Virginia waters.

Reproductive activity in Virginia waters*:* Insufficient data for Virginia.

5. Sei whale *(Balaenoptera borealis)*:

Description*:* Adult sei whales can attain lengths of 1800cm and weight as much as 45,000 kg, with slight female biased sexual dimorphism. Large, slender rorqual whales similar in appearance to fin whales, with a prominent falcate dorsal fin, a relatively pointed rostrum and a single dorsal ridge along the rostrum (Jefferson, Webber, Pittman, 2008). Owing to similar coloration and overlapping ranges, the sei whale is often confused with a Bryde's whale (*Baleanoptera edenii*) which if close enough can be seen to have three dorsal ridges on the rostrum. Sei whale body color is mostly dark gray to brown with a whitish belly and numerous scars along the flanks and tail (Jefferson, Webber, Pittman, 2008). Unlike fin whales, sei whale throat pleats number 32-65 and are short, ending far cranial to the umbilicus. A few nearly white baleen plates may occur, but the pronounced right-left color asymmetry seen in fin whales does not occur (Jefferson, Webber, Pittman, 2008).

Status*:* Sei whales are considered a strategic stock under the MMPA due to their listing as endangered under the ESA. The PBR for the Nova Scotia stock of sei whales is 0.5 based on a minimum population estimate of 236 (Waring *et al.*, 2016)

Occurrence and Distribution in Virginia waters: Sei whales are typically found in deeper waters (Hain *et al.*, 1985) and therefore rarely occur in Virginia. There have been a total of 3 sei whale strandings in Virginia waters from 1988-2016. Two of the strandings occurred within the Chesapeake Bay and the carcasses had lesions consistent with being carried on the bow of a ship, while the third one occurred on the Virginia Beach oceanfront and had lesions consistent with blunt trauma from a large vessel (Figure 24).

Diet and Foraging in Virginia waters: Insufficient data for Virginia. Sei whales primarily skim feed on copepods and other small prey but have been known to lunge feed and take krill, cephalopods, sardines and anchovies (Jefferson, Webber, Pittman, 2008).

Reproductive activity in Virginia waters*:* Insufficient data for Virginia.

(C) Pinnipeds (True seals)

1. Harbor seal (*Phoca vitulina*)

Description: Harbor seals are relatively small seals with little to no apparent sexual dimorphism. Robust individuals often have an indistinct neck and pelvis giving them a very streamlined appearance. Coat coloration is variable but typically has many small to medium dark spots and small rings (Jefferson, Webber and Pitman, 2008). Although spots are distributed across the whole body, higher concentrations usually occur on their backs and sides. Coalescence of their dorsal markings is common, giving them a dark, counter-shaded appearance. Coat coloration can vary from gray to brown on the back and lighter tan to silvery gray on the bottom, however uniformly dark brown-black animals are not uncommon and are typically accompanied by pale rings and oval spots (Jefferson, Webber and Pitman, 2008). Harbor

seal pups have a silver-gray lanugo coat that is shed prior to birth and is therefore not normally observed.

Harbor seal eyes are set quite close to each other and have prominent vibrissae above them. The nostrils form a "V" the outer margins of which line up closely with the inner margins of the eyes. Although they lack external ears like all phocid seals, the ear openings are visible (Jefferson, Webber and Pitman, 2008).

Status: A 2012 survey resulted in an abundance estimate of 75,834 (CV=0.15), with a minimum population estimate of 66,884 individuals. The PBR for the western North Atlantic stock is estimated at 2,006 individuals. The greatest source of anthropogenic morbidity and mortality is believed to be due to interactions with gillnets (*e.g.* Northeast sink gillnet, bottom-set monkfish gillnet, *etc.*; Warring *et al.*, 2016). Harbor seals in Virginia are considered part of the Western North Atlantic population which—based on mitochondrial DNA analyses—appears highly differentiated from the Eastern North Atlantic population.

Occurrence and Distribution in Virginia waters: Harbor seals are a coastal pinniped species present throughout the North and mid-Atlantic. Harbor seal presence in Virginia waters is seasonal with sightings usually beginning in winter (January-February) and extending into spring (April-May; Figure 25). Strandings include primarily juvenile individuals but sightings include adults and juveniles. Only one animal small enough to be considered a pup has stranded in Virginia. Harbor seals have consistently stranded in Virginia since 1991, but as larger, healthier individuals have established haul-outs in the region, the number of strandings has declined (Figure 26). Increased harbor seal presence in Virginia is suggested by anecdotal sightings, survey data (Reese, Jones and Bartlett, 2016) and stranding records (Figure 27). Survey data from the last few years show several locations that have consistent seasonal usage as haul-out sites (Rees, Jones, and Bartlett, 2016). Between years, individuals have been re-sighted at the same haul-out locations suggesting a certain degree of site-fidelity (Rees, Jones, and Bartlett, 2016). Generally, the haul-outs appear to be used primarily by adult-sized individuals whereas singly hauled out animals along Virginia's coast are usually yearlings. Stranding records show distinct seasonality with winter and spring months having the highest stranding numbers (VAQF Scientific Report #2014-07a).

Diet and foraging in Virginia waters: Insufficient data for Virginia. Harbor seals feed on a variety of species of fish, cephalopods and crustaceans from all levels of the water column (Jefferson, Webber and Pitman, 2008). There have been no consistent studies of harbor seal diet or foraging behavior in the mid-Atlantic region.

Reproductive activity in Virginia waters: Reproductive activity has not been observed in Virginia waters.

2. Harp seal *(Pagophilus groenlandica)*

Description: Relatively long-headed seals with a seemingly slightly upturned muzzle and close-set eye. Harp seals have the most complicated color pattern changes of any pinniped. With the exception of the pure white coat of newborns, the rest of the pelage patterns are relatively distinctive. Following the white coat is a brief "gray coat" or "ragged jacket" stage during which they molt the

lanugo and begin exposing the underlying "beater" coat. The juvenile "beater" coat consists of a slightly counter shaded dark gray coat above and lighter gray coat below. Beaters have numerous irregular spots and blotches along their whole body. Following the "beater" stage is the "bedlamer" stage, which begins with the next molt. They gradually develop their dark harp pattern on the back and flanks as they lose their spots. When in the transitional stage of developing a harp on their back but still showing spots, they are known as "spotted harps". The final stage known as "old harps" occurs when all the spots are lost and the black face and harp on their back develop fully.

Status: The IUCN lists harp seals as a species of least concern based on their large population numbers and increasing population trends in at least two of the three main populations.

Occurrence and Distribution in Virginia waters: Harp seals are primarily found in Arctic and North Atlantic waters. Although the harp seal has historically been considered a vagrant species when found in New York or further south, it is now the second most common phocid to strand in Virginia and has been a relatively regular seasonal stranding since 2001. Other than three cases, harp seals typically strand from February to April in Virginia (Figure 28). As with other seal species, harp seal strandings are primarily yearlings (79%); however there have been occasional adult strandings and sightings. The largest harp seal stranding was a 170 cm adult male.

Diet and foraging in Virginia waters: Insufficient data for Virginia. Throughout their range, harp seals feed on diverse prey species (> 130 species) of crustaceans and fishes, including capelin, arctic cod, polar cod, and Atlantic cod (Jefferson, Webber and Pitman, 2008). Harp seals in Virginia waters are typically in poor body condition and are in most cases considered out of habitat. Juvenile harp seals, the most common sighting in Virginia waters are often seen eating sand on beaches.

Reproductive activity in Virginia waters: There is no known information on reproductive activity in Virginia waters. Breeding occurs in the water from mid- to late March, and pupping occurs on pack ice from late February to mid-March. Following the breeding season, adults migrate north to the ice for their annual molt. Therefore it is unlikely that any reproductive activity occurs in Virginia waters.

3. Gray seal (*Halichoerus grypus*)

Description: Gray seals are a relatively large phocid species that exhibits substantial male-biased sexual dimorphism. Males can grow up to 230 cm long and weigh up to 310 kg, while females average 200 cm in length and can weigh as much as 186 kg (Jefferson, Webber and Pitman, 2008). Gray seals possess long, wide heads with a pronounced muzzle. Adult males have a slightly convex muzzle that terminates in nostrils that are roughly parallel to each other, forming a distinct "W" compared to the "V" nostrils seen in other phocid seals. The coats of adult gray seals can vary from gray to brown or black with numerous irregular dark blotches and spots focused mostly on the back but sometimes present on the belly. Older males darken with age and can have few visible spots. Newborn gray seals have a white lanugo that is molted in 2-4 weeks and replaced by a coat with subtle blotches similar to females (Jefferson, Webber and Pitman, 2008).

Status: The minimum population estimate for gray seals in U.S. waters does not exist, however the total Canadian population has been estimated at 505,000 (Warring *et al.*, 2016). Estimated PBR for the western North Atlantic gray seal population is unknown. Primary causes of anthropogenic mortality

of gray seals occur from fisheries interactions in Canadian and U.S. waters and nuisance removals in Canadian waters (Warring *et al.*, 2016).

Occurrence and Distribution in Virginia waters: Gray seals found in Virginia waters belong to one (eastern Canadian) of three North Atlantic populations. Three breeding herds are found in eastern Canada (Sable Island, Gulf of St. Lawrence, Nova Scotia) but those herds overlap during non-breeding periods and are considered a single population (Jefferson, Webber and Pitman, 2008). Gray seal presence in Virginia waters is sporadic, occurring in winter and early spring, however observations appear to be increasing. Gray seals in Virginia waters consist of a mixture of adult and weanling individuals. Gray seals were not regularly observed in Virginia until 2003. Since 2003, there have been 1-2 per year with a high of 4 in 2015. Like other pinnipeds in Virginia, gray seals occur seasonally. Strandings occurred almost exclusively from March to May (Figure 29). The largest gray seal to strand in Virginia was 164 cm though 75% (n=15) were less than 120 cm and assumed to be yearlings.

Diet and foraging in Virginia waters: Insufficient data for Virginia. Gray seals feed on various benthic, demersal and schooling fish species. Some known prey species include sand lance, whiting, saury, smelt, skates, capelin, Pollock, cod, haddock, flounder, salmon, mollusks and cephalopods, however seabirds are also known to have been taken (Jefferson, Webber and Pitman, 2008).

Reproductive activity in Virginia waters: Reproductive activity has not been observed in Virginia waters and is only known to occur from Massachusetts north to the Baltic Sea.

4. Hooded seal *(Cystophora cristata)*

Description: Hooded seals are large seals with male-biased sexual dimorphism. The pectoral flippers are short and pointed due to an elongated first digit. Their short, beaded vibrissae start off dark in pups and become light colored in adults. Hood seal pups have a distinctive and striking coat consisting of a silvery blue-gray cape and white belly and flanks. Adult hooded seals have a silvery white pelage with extensive black blotches of various sizes along their whole body, while their heads and the tops of their pectoral flippers are all black. Adult males have a characteristic flap of skin on their nose that hangs down in front of their mouth. The flap of skin is an inflatable portion of the nasal cavity that when inflated forms a bi-lobed hood. The nostrils can be closed in order to force exhaled air into a bright nasal septum that is extruded and inflated like a balloon. The inflated nasal septum is used in social displays and vocalizations.

Status: Although hooded seal populations are relatively large, the IUCN currently lists hooded seals as vulnerable to extinction, primarily due to shrinking pack ice--critical habitat for hooded seal breeding—and recent negative population trends.

Occurrence and Distribution in Virginia waters: Virginia is not considered normal habitat for hooded seals. The hooded seal is a rare stranding in Virginia, half of which occurred in the summer and fall of 2006 (Figure 29). These animals ranged in size from 94 cm to 138 cm.

Diet and foraging in Virginia waters: Insufficient data for Virginia. Hooded seals feed primarily on squid and fish species such as Greenland halibut, Atlantic and Arctic cod, redfish species, herring and

capelin (Jefferson, Webber and Pitman, 2008). Since Virginia is considered to be outside of their normal range, diet information does not exist but is also likely not relevant.

Reproductive activity in Virginia waters: Insufficient data for Virginia. No data exist on reproductive activity in Virginia waters, however is it highly unlikely that any such activity occurs in Virginia waters. Hooded seals are highly dependent on thick pack ice for breeding. As such, reproductive activity likely only occurs in far northern/polar latitudes.

(D) Sirenians (manatees)

1. Florida manatee *(Trichechus manatus latirostris*):

Description: A subspecies of the West Indian manatee, Florida manatees are the largest of the manatees. They have large, dark gray bodies, with relatively short but stout pectoral flippers. A rounded muzzle with short, thick bristles (sensory vibrissae) is used for investigating objects and manipulating food. Slender long body hairs are found sparsely distributed across their whole body that are used for sensing currents and movements (Gaspard *et al.*, 2012). Manatees have a single large, round paddle (fluke) instead of the two, pointed flukes seen in cetaceans. Female biased sexual dimorphism is evident in older animals, many of which possess distinctive scars caused by vessel collisions.

Status: Florida manatees were downlisted from endangered to threatened in 2017 by the USFWS (Federal Register: 82 FR 16668). The most recent Florida manatee abundance estimate which was used in the USFWS downlisting decisions is that 6,350 individuals exist within the southeastern US (Martin *et al.*, 2015).

Occurrence and Distribution in Virginia waters: Florida manatees are primarily found in the warm coastal waters of Florida, however in warmer months they migrate out to neighboring states in the Gulf and along the Atlantic. While Virginia is not typically considered normal habitat for manatees and strandings have not been documented in Virginia, sightings in recent years have been consistent and seemingly on the rise in North Carolina and Virginia during late spring, summer and early fall months (Cummings *et al.*, 2014). Annual sightings in the 2015 and 2016 have ranged 13 and 17, respectively, though most sightings are unverified due to lack of information. As water temperatures drop, manatees are forced to migrate south. At temperatures below 16° C, manatees succumb to a condition known as cold-stress that leads to immunosuppression, secondary infections and eventual death (Bossart *et al.*, 2002).

Diet and foraging in Virginia waters: Insufficient data for Virginia. Manatees are herbivorous mammals feeding primarily on marine (*e.g.* turtle grass, manatee grass, and shoal grass) and freshwater (*e.g.* algae, *Hydrilla*, and water hyacinth) vegetation (Reynolds and Odell, 1991). Stomach contents from stranded manatees often contain marine invertebrates that are typically thought to be ingested accidentally as epibionts on the vegetation (A. Costidis pers. comm.), though opportunistic carnivory has been documented (Courbis and Worthy, 2003). The data about manatees in Virginia waters is based solely on sightings from the public. Since Virginia is considered to be outside of their normal range, diet information does not exist but is likely dominated by opportunistic foraging on marine seagrasses (*e.g.*) and intertidal vegetation.

Reproductive activity in Virginia waters: No reproductive activity has been documented in Virginia waters. Florida manatees typically breed in the form of mating herds consisting of a single female for which numerous males compete. Manatee presence in Virginia is very sporadic and only occurs during warm weather months. It is therefore unlikely that any mating occurs in Virginia waters.

IV) Limiting Factors, Causes of Mortality and Other Threats to Marine Mammals in Coastal and Off-shore Waters of Virginia.

A. Limiting Factors

While offshore species may be present year around, occurrence of marine mammals in Virginia waters is typically limited by either season (*e.g.* temperatures) or prey species availability. For instance, north Atlantic right whales are considered transient visitors that inhabit Virginia waters during their latitudinal migrations between the summer feeding grounds and winter calving grounds. That migration is seasonal and their occurrence in near shore waters is strongly correlated to sea surface temperatures. In the northern feeding grounds, right whale occurrence is linked to dense patches of zooplankton, especially late stage calanoid copepods (Baumgartner *et al.*, 2007). Similarly, winter presence of humpback whales in Virginia waters appears to be linked to prey density (*e.g.* menhaden) which is in turn affected by water temperature (Ahrenholz 1991). Bottlenose dolphins are thought to exist in different coastal migratory stocks and offshore ecotypes whose presence appears to be linked in part to bathymetry and season (Waring *et al.* 2016). Seals typically have breeding and pupping seasons that are often intimately linked to specific environmental parameters (*e.g.* pack ice). Seal presence in Virginia is therefore often limited by temperatures and seasons. Similarly, Florida manatee presence in Virginia waters is limited by their sensitivity to cold water. Manatees are therefore only found in Virginia waters during late spring, summer and early fall months.

B. Causes of Mortality

Mortality in marine mammals is due to a wide variety of causes. With the exception of discrete large scale mortality events due to disease (*e.g.* morbillivirus UME), biotoxin exposure (*e.g.* brevetoxicosis and domoic acidosis) or mass stranding, there is a general paucity of information regarding natural causes of mortality and their effects on marine mammal stocks. An additional and significant source of annual marine mammal mortality is caused by human activity, however, the level of such mortality has been challenging to document. Additionally, sub-lethal and cumulative effects of human activity are undoubtedly significant and therefore exigent, however difficult to assess and often do not receive the attention they deserve.

1. **Anthropogenic mortality and morbidity**: Mortalities and serious injuries most likely leading to mortality are frequently the result of human activities, whether incidental or intentional. Such interactions, whether lethal or sublethal are termed “human interactions.” Intentional marine mammal takes such as cetacean drive fisheries and seal hunts are illegal within US waters except where indigenous people are permitted a certain number of subsistence takes (*e.g.* Alaska). In Virginia waters there are no permitted subsistence hunts, therefore intentional takes likely occur infrequently when marine mammals interact with commercial and/or

recreational fishers as has been documented between seals and fishers in the northeast United States. Incidental takes resulting from activities not specifically targeting marine mammals are assumed to represent a greater threat to marine mammals in Virginia waters. Such incidental takes leading to mortality or serious injury are typically associated with one of three categories, namely those caused by interaction with a fishery (*e.g.* entanglement in nets or pot gear, hooking in hook and line fishery, *etc.*), interaction with a vessel (*e.g.* vessel collision, propeller wounding, *etc.*) and pollution (*e.g.* ingestion of marine debris, entanglement in ghost fishing gear, noise and chemical pollution, *etc.*).

A. Fishery Interactions

Mortalities due to fisheries interactions are relatively common in numerous marine mammal species. The number of mortalities due to fisheries interactions are not known, due in part to the lack of adequate fisheries observer coverage and the challenging nature of forensic evaluation of such mortalities. In acute mortality cases, the cause of death in fisheries interactions is often related to underwater entrapment (*e.g.* suffocation/drowning) (Moore *et al.*, 2013). If initially survived, fisheries interactions, especially when animals are carrying gear, can lead to chronic conditions with increased morbidity such as: infection, physical (*e.g.* skeletal) deformation, energetic impairment due to impaired foraging, and a general failure to thrive (Moore *et al.*, 2013). In Virginia waters, numerous mortalities of cetaceans have been documented in pound nets and gillnets, and numerous deceased bottlenose dolphins with ligature marks and abrasions consistent with twisted twine line (*e.g.* pound net) and monofilament net (*e.g.* gill net) are still recovered annually. Additionally, reports and sightings of live and dead bottlenose dolphins entangled in crab pot gear are not uncommon. A small haul seine fishery in Virginia Beach, Virginia has taken several dolphins over the last two decades (unpublished VAQ stranding data). The haul seine fishery involves less than three operators and is primarily prosecuted in the fall. It is also possible, though not documented, that the menhaden purse seine fishery takes bottlenose dolphins. Observation of and information from that fishery is extremely sparse and the fishery is legislatively protected in Virginia. A similar fishery in the Gulf of Mexico was uplisted from a category III to a category II fishery in 2012 following documented bottlenose dolphin takes in a pilot observer program (Hayes *et al.* 2017).

B. Vessel interactions

The commonality of vessel interactions varies considerably by species. Florida manatees are commonly struck by vessels (Lightsey *et al.*, 2006), resulting in extensive sublethal and lethal interactions (Rommel *et al.*, 2007). Reports of odontocete interactions with vessels are not reported as frequently as they are for large whales, however at least 25 species of small cetacean have been documented with vessel injuries, with 10 more unconfirmed species also possibly involved (van Waerebeek *et al.*, 2007). It is unclear what role habituation to vessels or residence in areas with high vessel traffic may have in terms of risk of collision, however it is likely to increase the likelihood. Large whales such as north Atlantic right whales, fin whales, sperm whales, gray whales and humpback whales commonly fall victim to vessel interactions (Douglas *et al.*, 2008; Jensen and Silber, 2003;

Laist *et al.*, 2001), with up to one third of strandings of these species in some regions involving vessel interactions (Laist *et al.*, 2001). Vessel interactions can range from sublethal injuries with little effect, to chronic, insidious injuries, to catastrophic interactions with immediate fatality (Campbell-Malone *et al.*, 2008; Moore *et al.*, 2013). Vessel collisions can result in blunt force trauma (*e.g.* hematomas, contusions, bone fractures) and/or forced submergence, sharp force trauma (*e.g.* incising propeller or skeg/rudder wounds) and exsanguination, or combination chop wounds involving incising and crushing injuries (Rommel *et al.*, 2007; Moore *et al.*, 2013). In north Atlantic right whales, severity of propeller injury appears to be correlated to injury location, and this is likely true for all species. Vessel noise (*e.g.* shipping noise) is a significant concern globally due to its ability to disturb cetacean populations (*e.g.* avoidance behavior) and mask important sounds (*e.g.* predator, prey, and communication sounds). Threats posed by vessel noise are covered in the following section on noise pollution.

C. Pollution

Marine mammals are affected by pollution in many overt and insidious ways. Pollution comes in many forms and includes obvious forms such chemical spills (*e.g.* Deep Water Horizon oil spill), trash or marine debris (*e.g.* great Pacific trash gyre), and discarded "ghost" fishing gear, and more insidious forms such as noise (*e.g.* mid-frequency active sonar, seismic surveys, *etc.*) and chemical pollution (*e.g.* PCBs, heavy metals, *etc.*).

The direct effects of trash and discarded fishing gear are relatively easy to document on individual animals if and when those animals are recovered, however the population level effects are much more difficult to estimate. Conversely, the effects of chemical spills are often impossible to accurately assess because they may go undetected and because dose response curves and detailed information on the pathophysiology of exposure do not exist for these species. Nonetheless, as apex predators, cetaceans can bioaccumulate a complex and considerable load of toxicants and pollutants (McKinney *et al.*, 2006) some of which can cause immunosuppression and anemia (Schwacke *et al.*, 2012). Some populations (*e.g.* arctic killer whales off the coast of Norway; southern resident killer whales in Pacific NW of US; bottlenose dolphins from the north Atlantic) have demonstrated record levels of polychlorinated biphenyls among mammals (Alonso *et al.*, 2014; Ross *et al.*, 2000; Wolkers *et al.*, 2007). Cook Inlet belugas have demonstrated copper levels in their livers that are higher than levels reported to cause kidney damage in bottlenose dolphins (Norman, 2011; URS Corp, 2010).

Noise pollution has received increasing attention in recent years. Sources and types of noise pollution can vary considerably from commercial (*e.g.* shipping noise, oil/gas exploration, *etc.*) to construction (*e.g.* pile-driving, dredging, *etc.*) and military (*e.g.* mid-frequency active sonar, demolitions/explosions, *etc.*). Effects of noise pollution can be highly variable, ranging from harassment level impacts (*e.g.* avoidance behavior, communication masking, *etc.*) to acoustic injury (*e.g.* temporary or permanent threshold shift) to mortality (*e.g.* decompression-like syndrome) (Castellote *et al.*, 2010; 2012; Fernandez *et al.*, 2004; Lusseau *et al.*, 2009; Southall *et al.*, 2012a; 2012b, 2016). What is

clear is that many marine environments are inundated by manmade sounds (*e.g.* shipping noise and seismic airguns), and evidence is mounting that such noise has deleterious effects on numerous marine mammal species (Castelotte *et al.*, 2010; 2012; Miksis-Olds *et al.*, 2007; Nowacek *et al.,* 2016; Sciacca *et al.* 2017; Wright *et al.*, 2007). Shipping noise is now one of the most prevalent types of ocean noise and has been increasing significantly every year (Andrew *et al.*, 2002; McDonald *et al.*, 2006; Wright, 2008). Similarly, geophysical surveys and the use of seismic airguns appear to be increasing, with permitting requests currently under review for the Atlantic and arctic regions. Such permitting requests are concerning to many conservationists because of the intensity of the sounds produced, the duration of the surveys, the distance that the sounds travel, and the paucity of information regarding adverse short and long-term impacts on marine mammals (Nieukirk *et al.*, 2004, 2012; Nowacek *et al.*, 2015; Sciacca *et al.*, 2017). Offshore wind farm development appears to have variable effects on marine mammals. It has been shown to produce short term impacts on marine mammal populations through reduced presence, with possible subsequent habituation leading to gradually increasing presence (Teilmann and Carstensen, 2012). Similarly, the duration of pile driving—an integral part of wind farm construction—was shown to have a significant impact on the radius of avoidance by harbor porpoises (Dähne *et al.*, 2013). Sound levels produced during pile driving can be quite high and travel significant distances, with behavioral effects to bottlenose dolphins estimated as far as 50 km away (Bailey *et al.*, 2010). Nonetheless, mitigation strategies such as using bubble curtains have shown promise for reducing noise propagation and consequent disturbance (Nehls *et al.*, 2016).

2. **Natural**: Threats to marine mammals also occur from natural sources. Infectious diseases (*e.g.* morbillivirus), harmful algal blooms (*e.g.* brevetoxins), resource/prey shifts and other variables can lead to nutritional stress, immunosuppression, and/or direct mortality (Dierauf and Gulland, 2001; Waltzek *et al.*, 2012). Additionally, it is believed that some natural phenomena (*e.g.* brevetoxicosis, domoic acid toxicity) can lead to acute and chronic impairment that may make marine mammals more susceptible to other threats, both natural and manmade (Bossart *et al.*, 2002; Buckmaster *et al.*, 2014; Montie *et al.*, 2012; Walsh, Luer, Noyes, 2005). Chronic exposure to biotoxins such as domoic acid may even affect brain development (Ramsdell and Zabka, 2008; Ramsdell and Gulland, 2008; Pulido, 2008).

   Infectious diseases are poorly understood in most marine mammal species, but can be categorized based on the type of infectious agent involved (*e.g.* fungal, viral, bacterial, protozoal, *etc.*). The manifestation of such diseases can be either as acute or chronic disease resulting in one of three subsequent outcomes, namely survival, morbidity or mortality. Little is known about infectious diseases in marine mammals inhabiting coastal and offshore waters of Virginia. What is known primarily involves emerging or resurging diseases such as morbillivirus and Brucella. Morbillivirus, a relative of canine distemper virus, can affect cetaceans and phocids and has been implicated as the cause of large scale mortalities of cetaceans. Most recently, morbillivirus was preliminarily diagnosed as the causative agent of a massive cetacean mortality event affecting much of the Atlantic coast of the U.S. (New York to

Florida) and spanning a time frame from July 1st, 2013 to July 15, 2015. The morbillivirus UME resulted in 1827 bottlenose dolphins mortalities, of which Virginia experienced the most (473) **(**http://www.nmfs.noaa.gov/pr/health/mmume/midatldolphins2013.html). Prior to this mortality event, an extensive morbillivirus associated event occurred in 1987-1988, resulting in 740 bottlenose dolphin mortalities, prompting the speculation that morbillivirus has a cyclical resurgence based on herd immunity patterns.

Lastly, interspecific and intraspecific aggression has been documented as a cause of mortality in numerous marine mammal species, including pinnipeds, harbor porpoises and bottlenose dolphins (Dunn *et al.*, 2002; Patterson *et al.*, 1998; Le Boeuf and Campagna, 1994). Documented mortalities include traumatic attack of harbor porpoises by dolphins, and of young or newborn dolphins by other dolphins.

3. Other Threats

A. **Disturbance/Harassment**: Disturbance can be caused by any number of the aforementioned anthropogenic activities (*e.g.* noise pollution, fisheries activities, *etc.*). Vessel traffic as well as vessel noise and other anthropogenic noise (*e.g.* geophysical surveys, sonar, pile driving, *etc.*) can cause significant disturbance and result in significant changes in behavior such as avoidance of important habitats, cessation of vocalization and social behaviors and alterations in foraging behavior (Dähne *et al.*, 2013; Miksis-Olds *et al.*, 2007; Nowacek*et al.,* 2001; Papale *et al.*, 2011; Sciacca *et al.*, 2017; Skeateet al., 2012; Teilmann& Carstensen, 2012; Wright, 2008). Such disturbance is believed to have the potential for deleterious downstream energetic consequences (Noren *et al.*, 2017). For example, anthropogenic noise caused by seismic airguns deployed during geophysical surveys can travel hundreds and even thousands of miles (Nieukirk *et al.*, 2004, 2012; Sciacca *et al.*, 2017) and a single survey often spans several weeks or months (Nowacek *et al.*, 2015). These generated sounds can be intense near the source and travel great distances, raising serious concerns about acute and long-term effects on neighboring and distant populations of marine mammals (Nowacek *et al.*, 2015).

B. **Habitat Encroachment/Climate Change**: The science of climate change effects on marine mammals is at its infancy. Evidence is slowly mounting that marine mammal populations are being affected by changing environmental conditions such as shifts in prey distribution and abundance, greater fluctuations in ambient and water temperatures, and alterations in polar pack ice. These environmental changes subsequently lead to marine mammal population redistributions. Although not conclusively linked to climate change, recent years have shown significant changes in the distribution of certain marine mammal species. The 2016 and 2017 north Atlantic right whale calving grounds saw record low numbers of mother and calf pairs despite recent perceived population trend increases. Simultaneously, body condition scores used to measure the health status of adult right whales have been worsening, leading scientists to speculate about prey shifts, disease, and loss of historical knowledge of alternate feeding grounds as the possible causes.

Similarly, North Carolina, Virginia and other mid-Atlantic states have been experiencing increases in phocid (true seal) sightings in winter and early spring months. Individual seals have been observed returning to some mid-Atlantic locations, including a few in Virginia, indicating a degree of seasonal residency and sight fidelity not historically seen in those latitudes (Rees et al., 2016). Other indirect effects of climate change could come in the form of sea level rise, which may lead to a reduction in phocid haul out sites, and rising water temperatures and rainfall changes that can drastically affect coastal watersheds and promote algal growth (Gobler *et al.*, 2017; Michalak *et al.,* 2013). Increasing in water temperatures, nutrient runoff and fresh water effluent, decreases in salinity and increases in carbon dioxide in the atmosphere can also be major contributors to the onset and persistence of harmful algal blooms (https://www.epa.gov/nutrientpollution/climate-change-and-harmful-algal-blooms) which can have negative population level effects on the health of marine mammals.

Broadly considered, habitat encroachment involves the intrusion of human presence and/or activity in ecosystems occupied by marine mammals. While many marine mammals are permanently aquatic and therefore not susceptible to the traditional influences of habitat encroachment, some deleterious examples can be found. Phocid seals haul out on land for various reasons, including breeding, rest, pupping, *etc.* In Virginia, seals presence appears to be increasing. Consequently, when seals haul out on land, they inevitably come into contact with humans and their pets. It is unclear what impact that has on seal populations in Virginia, however it is likely that detrimental impacts are primarily limited to individuals (*e.g.* avoidance, water re-entry, *etc.*) rather than population level effects. As a coastal species, Florida manatees can be affected by habitat encroachment. Coastal development (*e.g.* sea grass destruction), artificial fresh water effluents (*e.g.* storm drains and water runoff, harmful algal blooms, *etc.*), vessel traffic and coastal fishing practices (*e.g.* crab pot gear) can lead to manatee mortality and manatee habitat degradation (Orth *et al.*, 2006; USFWS, 2014). Marine habitat encroachment examples on marine mammals can include displacement by/conflict with human activities such as commercial shipping, offshore energy development (*e.g.* wind farms, seismic exploration, military maneuvers, *etc.*) and offshore fishing (*e.g.* pelagic longline, drift nets, *etc.*). Marine spatial planning efforts such as the MARCO Ocean Data Portal allows planners to visualize collective human use of ocean habitat simultaneously with marine mammal distribution (Figure 30).

V) Synopsis of State Regulatory Agencies, Existing Legislation, Regulations and Cooperative Agreements in Virginia

Two natural resource agencies in Virginia have authority over federally listed marine mammals, sea turtles and marine fishes (hereafter collectively referred to as protected marine species). They are the VDGIF and the VMRC. The VDGIF is charged with the management of all wildlife and inland fish in the Commonwealth (*Code of Virginia* §§29.1-103; 29.1-109) and, pursuant to the Virginia Endangered Species Act (*Code of Virginia* §§29.1-564-568), the VDGIF has authority to adopt the federal list of

endangered and threatened species; to list additional species as endangered or threatened in the Commonwealth; to manage and protect those species throughout the Commonwealth; and to develop, adopt, and enforce state regulations pertaining to all state and federally threatened and endangered wildlife species (excluding listed species of the Class Insecta). Via a Section 6 Cooperative Agreement with the USFWS, the VDGIF also is responsible for protection and management of species listed by the Secretary of Interior under the federal ESA. The VDGIF's Bureau of Wildlife Resources and Law Enforcement Division are primarily responsible for program development and implementation regarding protection and management of the Commonwealth's wildlife and inland fish, including endangered or threatened species.

The VMRC has the authority to develop and enforce fishery regulations pertaining to the protection and conservation of state and federally protected marine species. However, it is not responsible for developing or enacting state threatened and endangered species laws or regulations and draws no authority from the state or federal ESA. VMRC is charged with the conservation of marine life and has comprehensive management authority for all marine organisms and associated habitats within its jurisdiction that extends from the fall lines of all tidal rivers to the 3-Mile Limit Line of the Territorial Sea (*Code of Virginia* §28.2-101). This includes sea turtles and marine mammals as well as their prey bases (*Code of Virginia* §28.2-100). The VMRC's regulatory jurisdiction over activities affecting state-owned bottomlands, however, extends throughout the Commonwealth. The VMRC has authority over all commercial fishing activities within its jurisdiction and regulates the take of marine finfish and shellfish in Virginia's tidal waters. It is also responsible for establishing finfish and shellfish seasons, size and possession limits, species-specific landings, harvest quotas, and harvest size restrictions. The Code of Virginia authorizes the VMRC to promulgate regulations that conserve and promote the seafood and marine resources of the Commonwealth, establish and limit licenses, collect fisheries statistics (*Code of Virginia* §28.2-204) and prepare fishery management plans (*Code of Virginia* §§28.2-201, 28.2-203 and 28.2-203.1). VMRC's Law Enforcement, Fisheries, and Habitat divisions are responsible for development and implementation of programs that carry out these mandates.

The VDGIF conservation police officers and VMRC marine patrol officers share the same powers (*Code of Virginia* §§28.2-106, 29.1-205); thus they have equal authority to enforce the Commonwealth's endangered species laws. Moreover, the VMRC has standing law enforcement agreements with NMFS and the USFWS, enabling marine patrol officers to collaborate with their federal counterparts on protected species investigations, patrols, inspections, warrants, and arrests. The VDGIF has a standing law enforcement agreement with the USFWS that allows conservation police officers to serve as Deputy US Fish and Wildlife Special Agents and conduct investigations both in-state and across state lines when violations of federal wildlife laws have been committed.

A third state agency, VIMS, has conservation responsibilities as well, but has no authority to enact or enforce state regulations. VIMS, a part of the College of William and Mary (§23-49.1:1) is specifically mandated to serve the state in matters of marine research and has marine conservation duties under the Code of Virginia (§§28.2-1100-1101, 28.2-1103). VIMS has a three-part mission to conduct interdisciplinary research in coastal and estuarine science; to educate students and citizens; and to provide advisory service to policy makers, industry, and the public. VIMS' duties include advising, training, providing technical/scientific assistance, and conducting research for the VMRC, federal

agencies, and other public and private groups on the conservation and management of marine, coastal, and estuarine resources. Research at VIMS extends from inland watersheds to the open ocean and is conducted by teams of scientists with diverse expertise in areas such as plankton and nutrient dynamics; shoreline and wetlands processes; fisheries ecology and stock assessment; fisheries gear engineering and bycatch; aquaculture; genetics; immunology; toxicology; biological, chemical, and physical oceanography; aquatic diseases; computational modeling; and marine geological processes.

VI) Virginia Marine Mammal Conservation Programs

Below is a summary of state programs and activities that promote the conservation of marine mammals, including threatened and endangered species, in Virginia. These narratives are organized according to the agency or organization primarily responsible for each program.

State Agencies

Virginia Department of Game and Inland Fisheries

The Department of Game and Inland Fisheries (VDGIF) exercises conservation, management, regulatory, and enforcement jurisdiction over all state and federally threatened and endangered species that occur in the Commonwealth of Virginia, including protected marine species, but excluding listed insects and plants. Although all marine mammals are protected, only manatees that migrate to Virginia during warm weather months and several of the baleen whales that occur off Virginia are listed under the ESA. These include: critically endangered northern right whales, fin and sei whales. Humpback whales were de-listed in 2016, minke whales are not listed and blue whales are unlikely to occur on the continental shelf waters off Virginia. Recovery of state and federally listed species requires a substantial and well-coordinated effort to understand each species' distribution and abundance as well as its life history and ecology; thus, many of these programs are developed and implemented through partnerships with other conservation agencies and organizations.

Virginia's Wildlife Action Plan - On November 5, 2001, President Bush signed the Department of the Interior and Related Agencies Appropriations Act, 2002, which created the State Wildlife Grants (SWG) program. As indicated within this legislation, these grants were established to help fund the development and implementation of programs for the benefit of wildlife and associated habitats, including nongame species. The SWG program receives annual Congressional appropriations that are administered by the U.S. Fish and Wildlife Service (USFWS). The USFWS apportions these funds, using a legislated formula based on human population and geographic area, to fish and wildlife management agencies within the 50 states, the five U.S. territories, and the District of Columbia. To receive annual SWG appropriations, Congress stipulated that each wildlife agency must produce a Comprehensive Wildlife Action Plan (WAP). The latest version of the WAP, completed in 2015 (http://bewildvirginia.org/wildlife-action-plan/), includes endangered baleen whales in its list of species with the greatest conservation need (Appendix A). The updated Virginia Marine Mammal Conservation Plan details will be included in the WAP when completed.

VDGIF Activities Directly Associated with Marine Mammal Conservation and Recovery – Since 2001, VDGIF staff have served cooperators with the Virginia Stranding Network and assisted with response to marine mammal strandings throughout the Eastern Shore, on seaside marshes and barrier islands, and

in the Chesapeake Bay. Staff conducts limited field necropsies on and collects biological samples from carcasses that are not recovered, verifies reports of live stranded marine mammals, and provides general field support upon request. Staff has also given talks and developed articles on how to report strandings, and engaged in interagency coordination with state and federal partners on issues involving marine mammals.

Virginia Marine Resources Commission

The Marine Resources Commission (MRC) acts as the regulatory agency for recreational and commercial saltwater fishing and marine natural resource protection. Its law enforcement division, the Virginia Marine Police, are the front-line defenders of tidal natural resources, and comprise the largest division within the Virginia Marine Resources Commission. They have full law enforcement arrest powers throughout the Commonwealth. Marine Police Officers also conduct search and rescue operations, enforce boating safety laws, respond to emergency calls, investigate boating accidents and criminal activity, and provide counter-terrorism patrols to our military installations, shipyards, nuclear power plants, and other high-value maritime assets.

Through a cooperative law enforcement agreement between MRC, the National Marine Fisheries Service (NMFS) and the U.S. Fish & Wildlife Service, Marine Police Officers are deputized to enforce federal fish and wildlife laws, including the MMPA and ESA. The Virginia Marine Resources Commission also is part of a cooperative agreement with the United States Coast Guard that allows the Virginia Marine Police to enforce federally designated safety and security zones. Marine Police are cooperators in the Virginia Stranding & Disentanglement network and work closely with the Virginia Aquarium Stranding Response Program confirming reports, ferrying and assisting responders to marine animal disentanglements and towing marine mammal carcasses.

MRC protected resources staff serve as Virginia state representatives on federal Take Reduction Teams and work to balance commercial fishing and conservation efforts.

Virginia Institute of Marine Science

The Virginia Institute of Marine Science (VIMS) is the largest institution in the United States devoted to research and education in estuarine and coastal environments and is recognized worldwide for its expertise in marine science. VIMS researchers conduct interdisciplinary research in coastal and estuarine science; educate students and citizens; and provide advisory services to policy makers, industry and the public.

Virginia Department of Environmental Quality-Coastal Zone Management Program

The Virginia Coastal Zone Management (CZM) Program, established in 1986 through Executive Order, is a network of Virginia state agencies and local governments, that administers enforceable laws, regulations and policies that protect our coastal resources and fosters sustainable development.

The Department of Environmental Quality (DEQ) serves as the lead agency of the network, and houses the Virginia CZM Program. The program staff work with the networked agencies to develop and implement coordinated coastal policies and administer the program's annual grant award from the National Oceanic and Atmospheric Administration (NOAA), National Ocean Service, and Office for Coastal Management. The Virginia CZM program has supported stranding response and marine mammal research through this program.

CZM has been very active in marine debris reduction and marine spatial planning in Virginia and the larger mid-Atlantic region. Through a 5-year grant from NOAA (CZMA Section 309), the Virginia CZM Program supported the development of a comprehensive ocean planning process to sustain current ocean industries and needs, allow for new uses such as offshore energy development, and protect the ocean's habitats, wildlife and overall health. Virginia has been a key participant in development of the Mid-Atlantic Regional Council on the Ocean (MARCO), MARCO's online Mid-Atlantic Ocean Data Portal (http://portal.midatlanticocean.org/ocean-stories/every-map-tells-a-story/) and the Mid-Atlantic Regional Planning Body whose Mid-Atlantic Regional Ocean Action Plan (http://midatlanticocean.org/wp-content/uploads/2016/12/MidARegionalOceanActionPlan_November20161.pdf) was released in 2016. Both marine debris reduction and coordinated ocean planning support future marine mammal conservation and management.

Virginia Marine Mammal Stranding & Disentanglement Network

The Virginia Marine Mammal Stranding & Disentanglement Network is organized by the Virginia Aquarium & Marine Science Center's Stranding Response Program under the Aquarium's non-profit Foundation (VAQF). The Virginia network is the southernmost network in the Greater Atlantic Region (GAR) of NMFS, and VAQF is the sole Stranding Agreement holder in Virginia. The GAR Marine Mammal Stranding Coordinator, Mendy Garron, is located at the NMFS Regional Office in Gloucester, MA. Disentanglement is also coordinated through that office under the direction of David Morin. There are an average of 100 stranded and/or entangled marine mammals in Virginia each year, the majority of which are bottlenose dolphins (see Relevant Species Descriptions; Figure 1). All marine mammal and sea turtle species encountered by the stranding network are vulnerable to entanglement, with bottlenose dolphins, humpback whales, and leatherback sea turtles being the most commonly affected in Virginia waters.

Federal Agencies

NOAA Fisheries (NMFS) Office of Law Enforcement

NOAA Fisheries (aka NMFS) has an Office of Law Enforcement (OLE) in Virginia that covers a large portion of the southern GAR region including Virginia, Maryland, Delaware and parts of New Jersey. Along with state partners, MRC Marine Police, OLE officers assist with marine mammal response and enforcement for cases of marine mammal or sea turtle harassment, poaching, fisheries interactions, *etc.*

United States Coast Guard

District 5 (D5) of the US Coast Guard includes Sector Hampton Roads with six stations in Virginia. In coordination with NMFS and D5, US Coast Guard assets can be made available to assist with marine mammal stranding and disentanglement response.

Non-governmental agencies

Virginia Aquarium & Marine Science Center

The Virginia Aquarium & Marine Science Center (Aquarium) operates under a public/private partnership between the City of Virginia Beach and the non-profit Virginia Aquarium & Marine Science Center Foundation (Virginia Aquarium Foundation). The mission of the Aquarium, exemplified by its exhibits and programs, is *to inspire conservation of the marine environment through education, research and sustainable practices*. More than 14 million visitors have experienced the Aquarium since its opening in the summer of 1986.

In 2004, the Aquarium created the Research & Conservation (R&C) Division within its organizational framework. Since then, the Aquarium has employed dedicated research and conservation staff and is developing or providing support for regional, national, and international R&C efforts. These efforts reflect the Aquarium's educational and conservation mission and diverse animal collections. The division includes the Aquarium's offsite Marine Animal Care Center, the Stranding Response Program, and all other R&C activities and initiatives.

Virginia Aquarium Stranding Response Program – Within the Aquarium's R&C Division, the Stranding Response Program (VAQF) operates with support from the Virginia Aquarium Foundation, a non-profit 501-C3 organization. The mission of VAQF is to *promote the conservation of marine animal species through response, research, rehabilitation and education.* VAQF has been involved with marine mammal and sea turtle stranding response in the mid-Atlantic region since 1987 and to date has responded to over 1,000 marine strandings. It operates under a federal stranding agreement with NMFS and state threatened and endangered species permits. The Aquarium employs 4-6 full and part-time staff and maintains an active volunteer Stranding Team of 50-75 trained volunteers. In addition, there are numerous cooperating agencies, organizations, and, in rare cases, individuals who assist VAQF in response to stranded and entangled marine mammals.

VAQF also engages in the rescue and rehabilitation of live, debilitated seals recovered in Virginia and other states with the goal of releasing them back into the wild upon their recovery. There is not a cetacean rehabilitation program at the Aquarium. In many cases entangled cetaceans can be disentangled and immediately released. Most other live stranded cetaceans are euthanized by trained staff. Though rare, there are some circumstances under which a live stranded cetacean may be immediately released or held short-term for transfer to a permanent rehabilitation facility.

A new 18,000 sq. ft. Mid-Atlantic Marine Animal Conservation Center is expected to open in 2018 and will replace the current Marine Animal Care Center. This capitol project was made possible through a partnership between the City of Virginia Beach and the Virginia Aquarium Foundation. The facility will

include holding tanks, veterinary exam and surgery rooms, laboratory space and a necropsy facility as well as offices and training space.

Virginia Aquarium Marine Mammal Research – The Aquarium has engaged in marine mammal research since 1989. To date, Aquarium research efforts on marine mammals have focused estimating abundance and distribution, habitat use, photo-identification, ship speed, ambient noise, fishery interaction, life history, as well as morphological and anatomical studies. Aquarium staff have authored or co-authored scientific publications on bottlenose dolphin abundance and distribution, humpback whale occurrence and habitat use, manatee distribution, pound net interactions, large whale mortality, marine mammal (especially cetacean) fishery and vessel interactions, cetacean functional morphology, euthanasia, parasites, *etc.*

Public Outreach and Education – The Aquarium is actively involved with outreach and education to increase public awareness of marine mammals and sea turtles and the need to protect these species and their habitats. Every year, outreach staff present educational programs at local and regional festivals and give presentations to environmental school groups, civic organizations, and special Aquarium events. The Aquarium's Education Department has developed educational, tools, teaching resources and curriculum pertaining to marine mammal research and conservation for the classroom and less formal venues such as 4-H and scouts in Virginia and Maryland. The Aquarium has also developed a curriculum that introduces recreational vessel operators to the marine wildlife they are likely to encounter and offers proper vessel operating guidelines designed to minimize the potential for vessel interactions with or the harassment of marine wildlife. The *Boat Safely ~ Respect Wildlife* curriculum has been incorporated into existing boating safety courses in Virginia.

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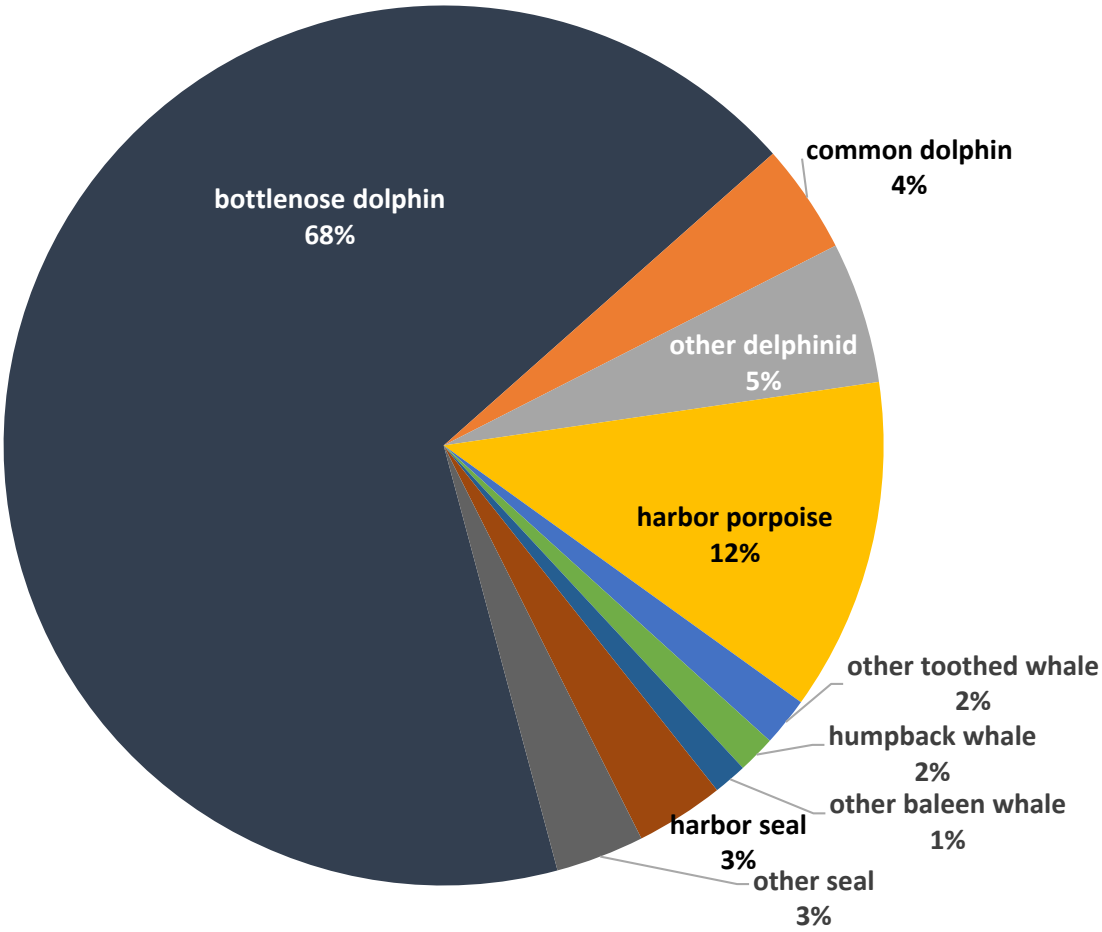

Other delphinid:
pilot whales
Risso's dolphin
spotted dolphin
clymene dolphin
striped dolphin

Other toothed whale:
sperm whale
pygmy & dwarf sperm whale
beaked whales

Other baleen whale:
northern right whale
fin whale
sei whale
minke whale

Other seal:
gray seal
harp seal
hooded seal

FIGURE 1. MARINE MAMMAL STRANDINGS IN VIRGINIA FROM 1988-2016.

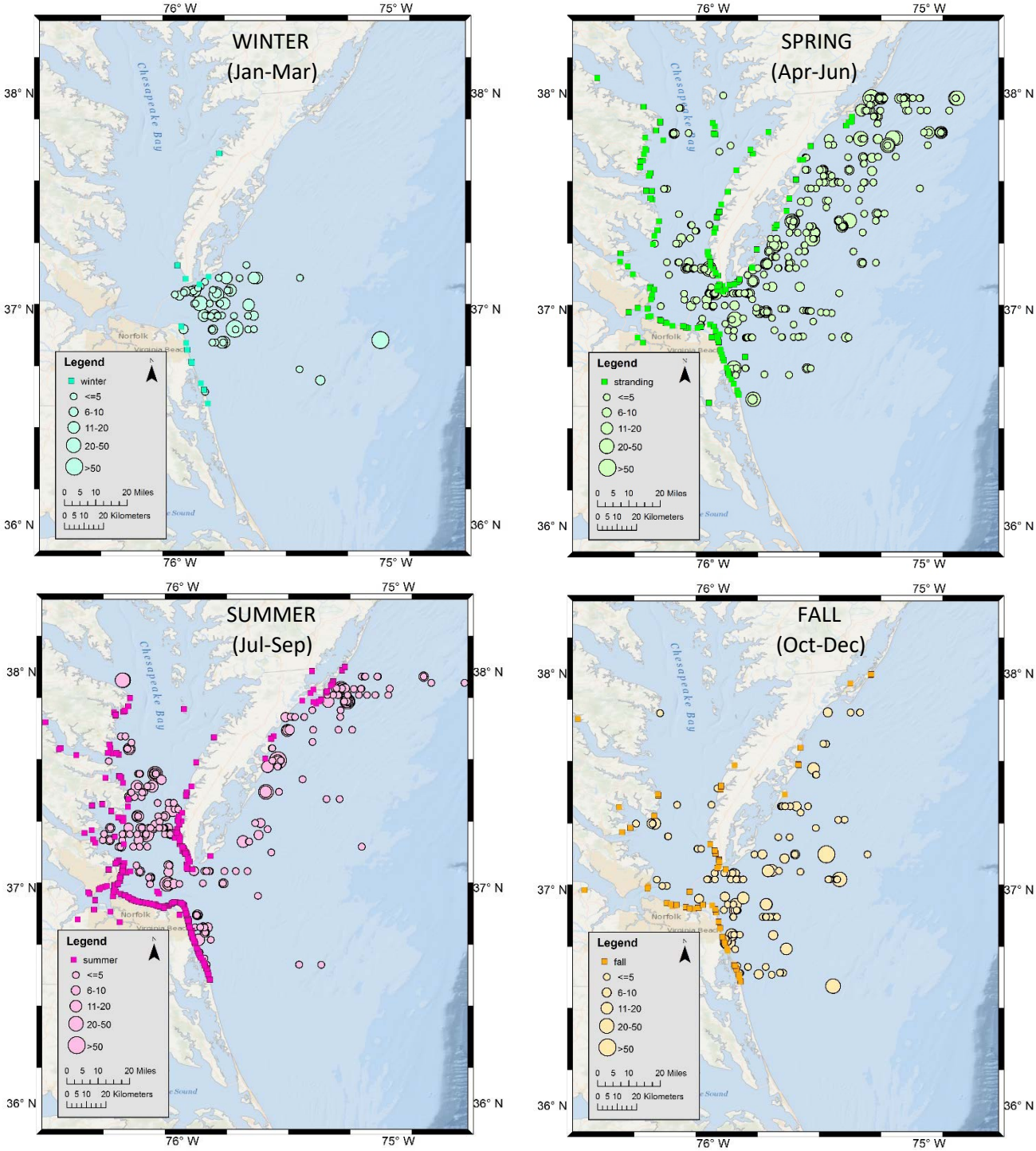

FIGURE 2. SEASONAL STRANDINGS (SQUARE) AND AERIAL SURVEY SIGHTINGS (CIRCLES GRADED BY GROUP SIZE) OF BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*) IN VIRGINIA FROM 2010 THROUGH 2016.

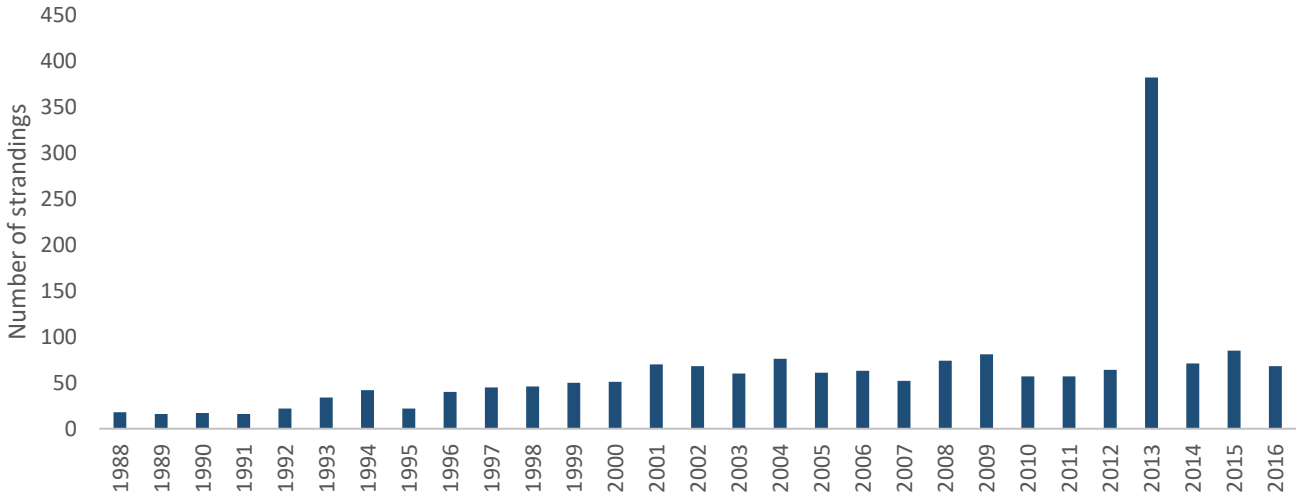

FIGURE 3. ANNUAL FREQUENCY OF BOTTLENOSE DOLPHIN STRANDINGS IN VIRGINIA.

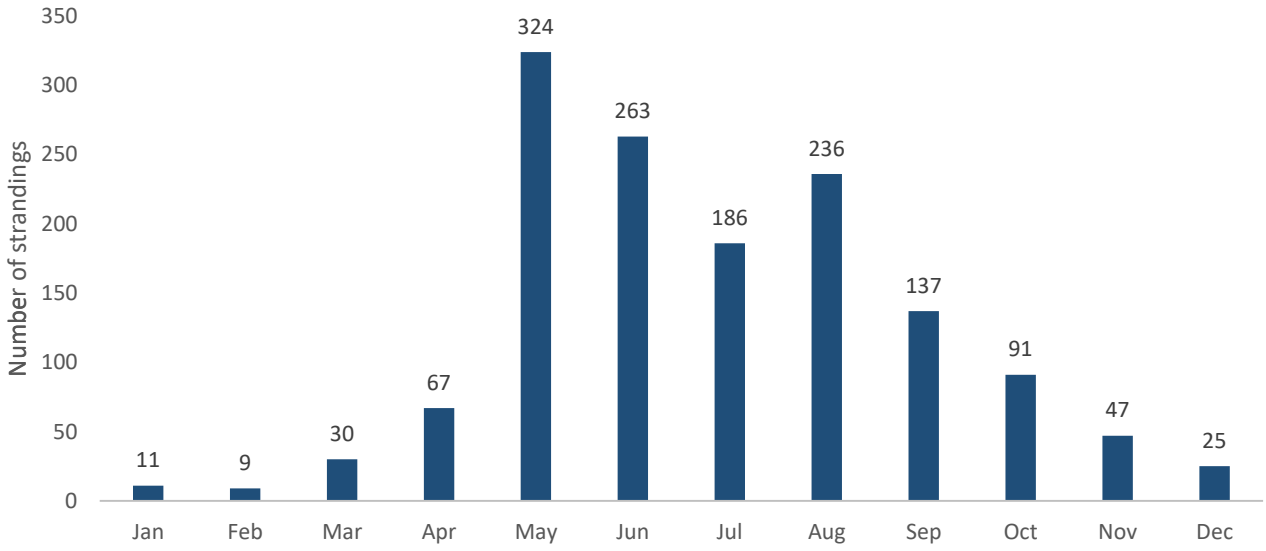

FIGURE 4. MONTHLY FREQUENCY OF BOTTLENOSE DOLPHIN STRANDINGS IN VIRGINIA, 1988-2016, EXCLUDING 2013.

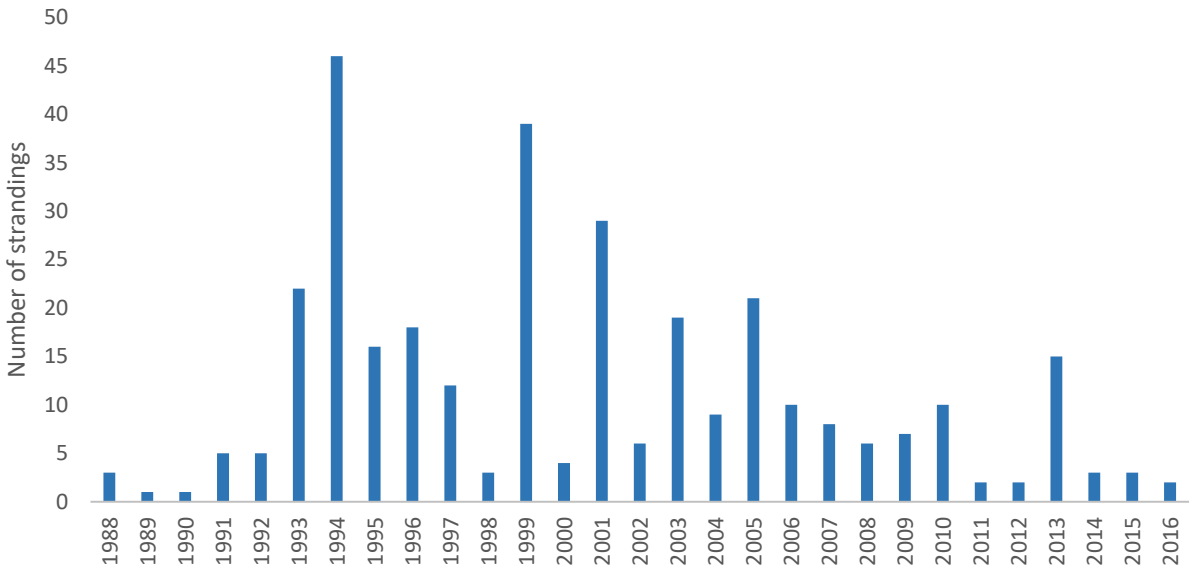

FIGURE 5. ANNUAL FREQUENCY OF HARBOR PORPOISE STRANDINGS RECORDED IN VIRGINIA.

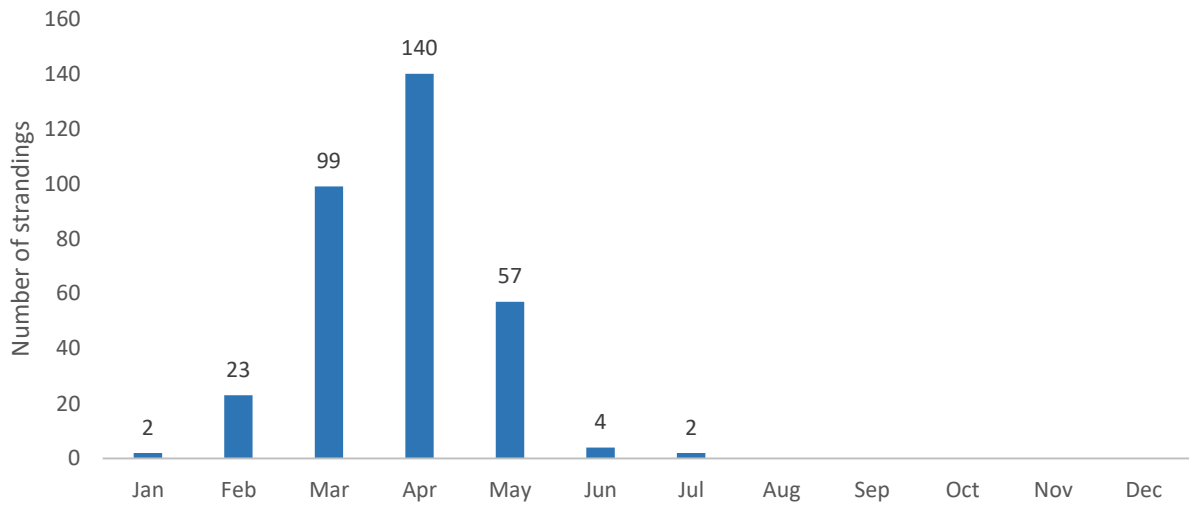

FIGURE 6. MONTHLY FREQUENCY OF HARBOR PORPOISE STRANDINGS IN VIRGINIA, 1988-2016.

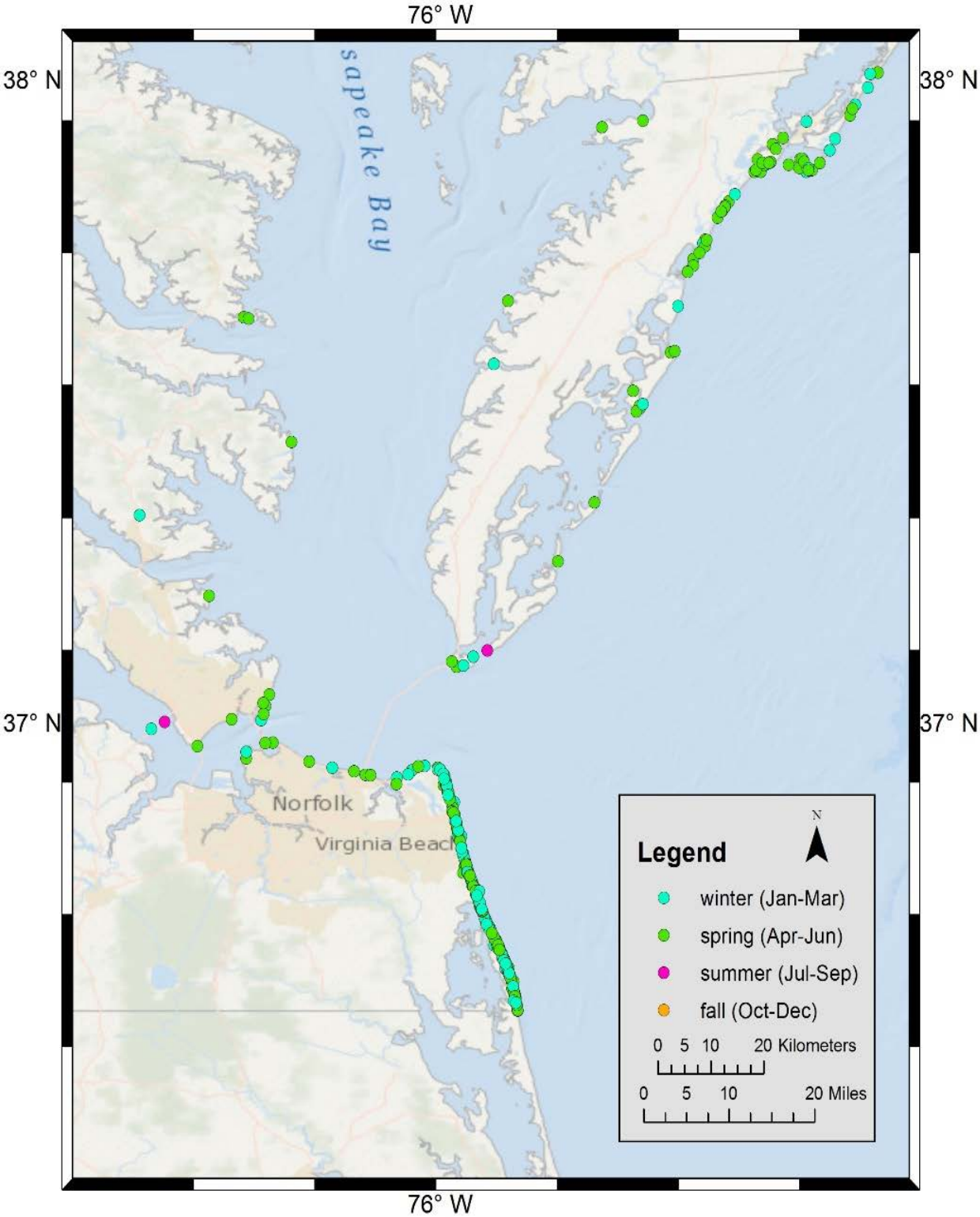

FIGURE 7. VIRGINIA HARBOR PORPOISE (*PHOCOENA PHOCOENA*) STRANDINGS BY SEASON FROM 1988-2016. ONLY TWO STRANDINGS OCCURRED IN SUMMER AND NONE WERE REPORTED IN FALL. THIS SPECIES WAS NOT OBSERVED DURING AERIAL SURVEYS CONDUCTED FROM 2011-2016.

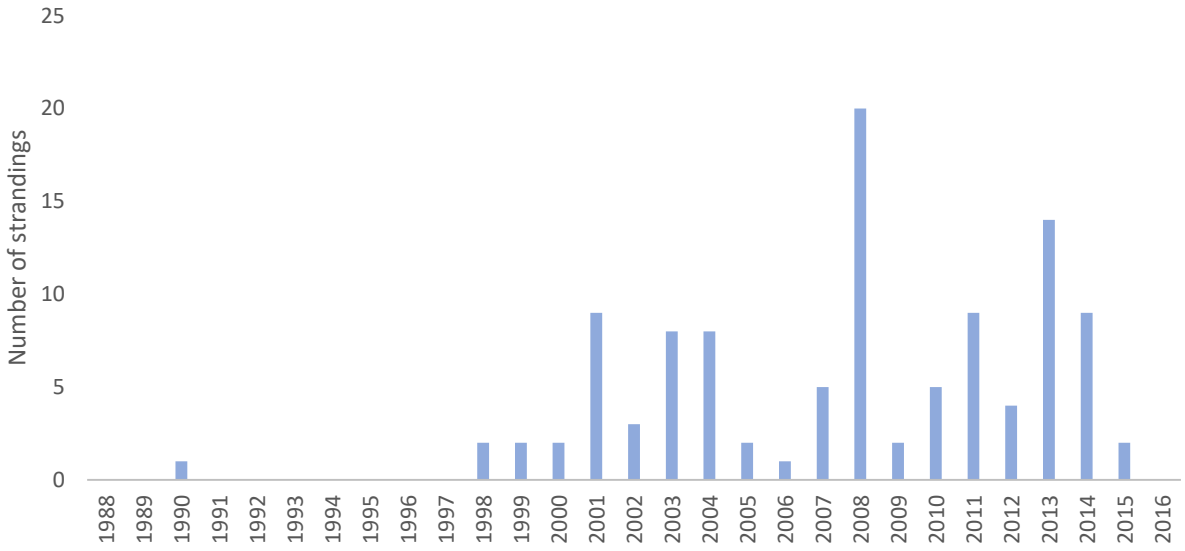

FIGURE 8. ANNUAL FREQUENCY OF COMMON DOLPHIN STRANDINGS IN VIRGINIA.

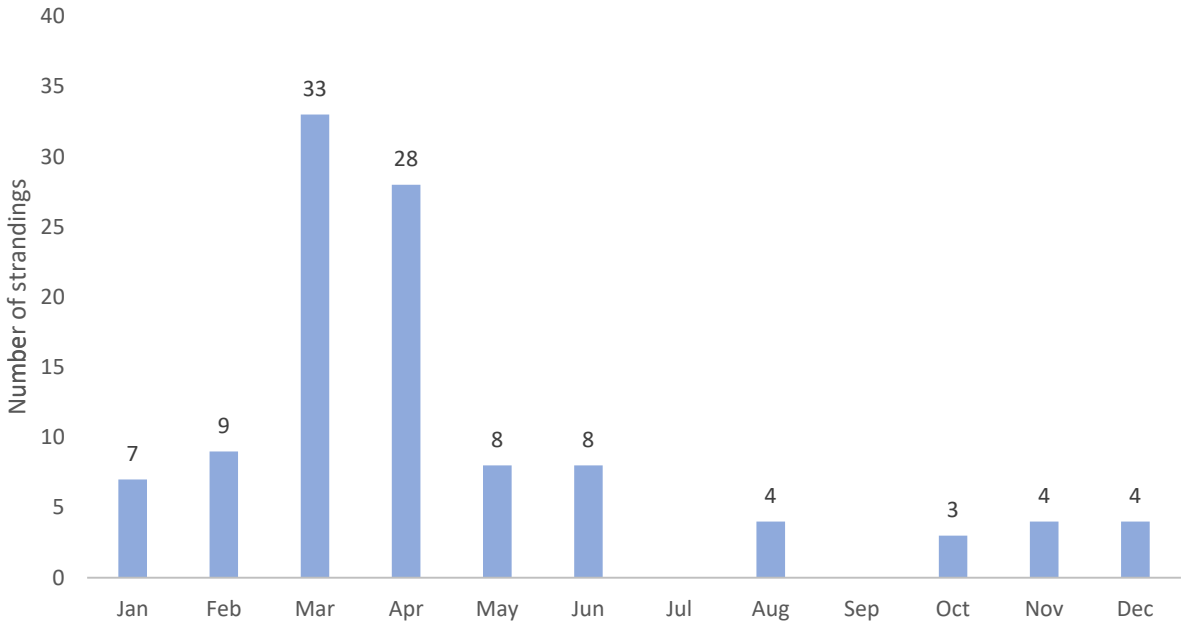

FIGURE 9. MONTHLY FREQUENCY OF COMMON DOLPHIN STRANDINGS IN VIRGINIA, 1988-2016

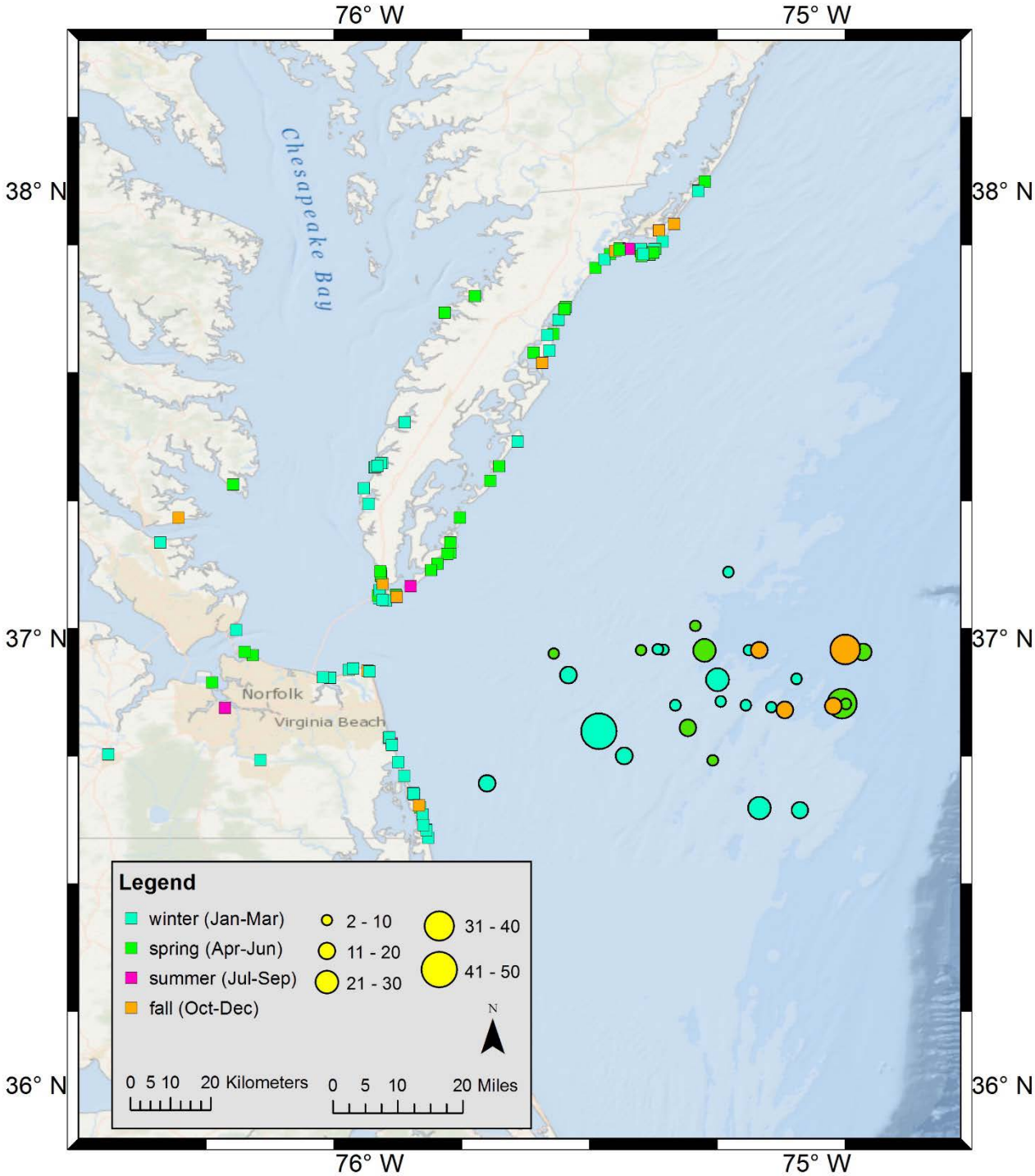

FIGURE 10. COMMON DOLPHIN (*DELPHINUS DELPHIS*) STRANDING LOCATIONS (SQUARE) AND AERIAL SURVEY SIGHTINGS (CIRCLE), BY SEASON. THE SIZE OF THE SIGHTING CIRCLES INDICATES GROUP SIZES.

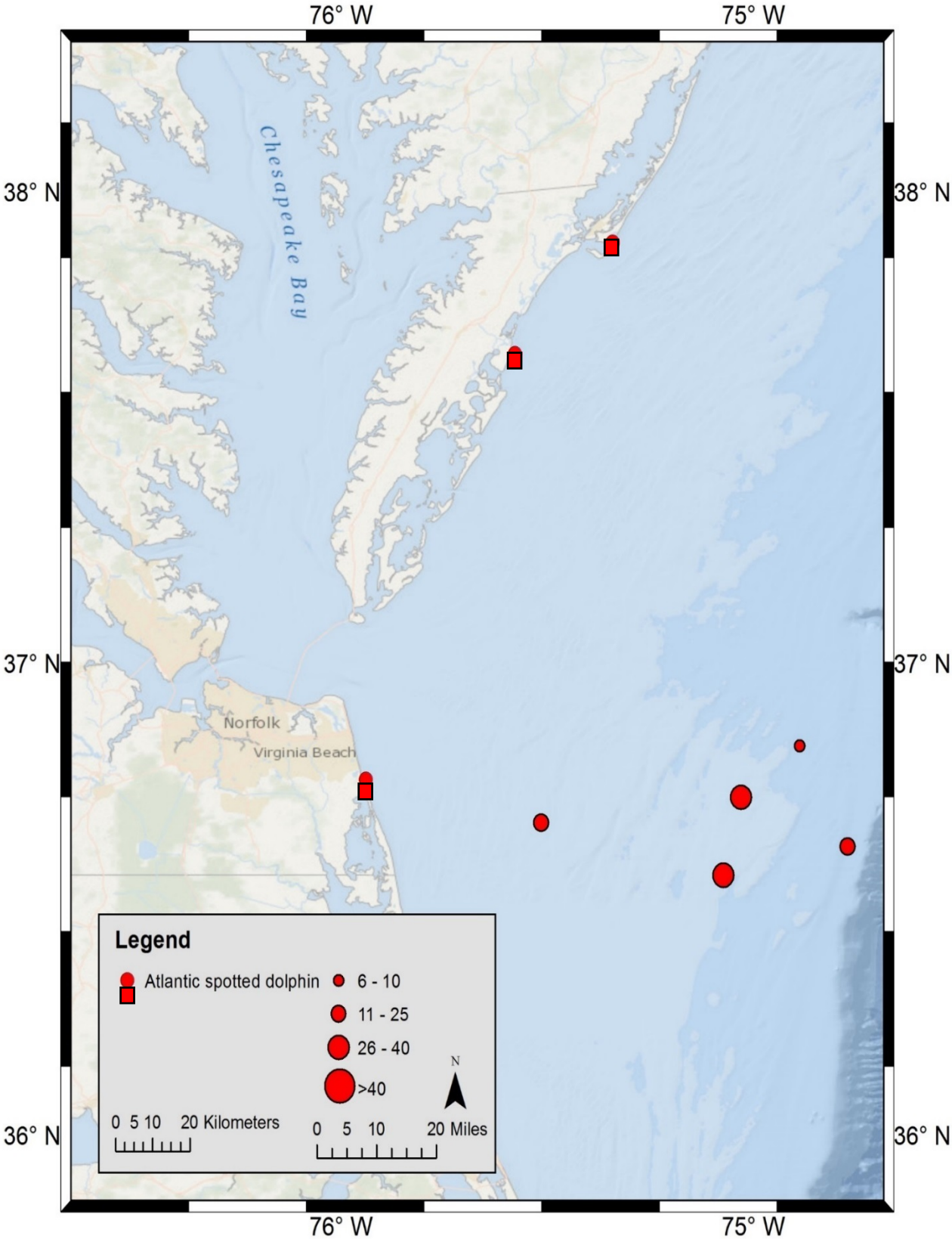

FIGURE 11. SPOTTED DOLPHIN (*STENELLA FRONTALIS*) STRANDING LOCATIONS (SQUARE) AND AERIAL SURVEY SIGHTINGS (CIRCLE). THE SIZE OF THE SIGHTING CIRCLES INDICATES GROUP SIZES.

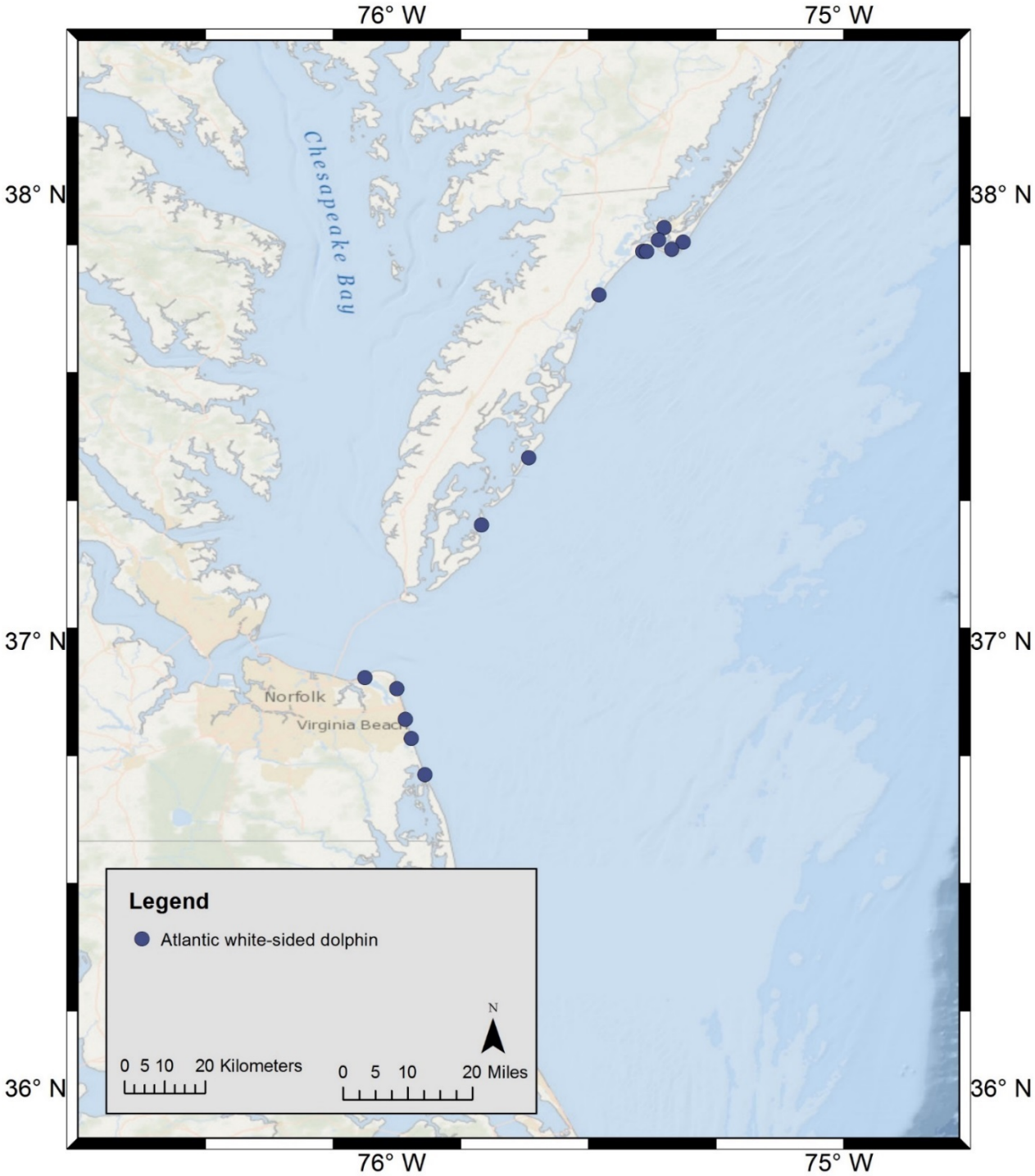

FIGURE 12. WHITE-SIDED DOLPHIN (*LAGENORHYNCHUS ACUTUS*) STRANDING LOCATIONS. THIS SPECIES WAS NOT OBSERVED DURING AERIAL SURVEYS CONDUCTED FROM 2011-2016.

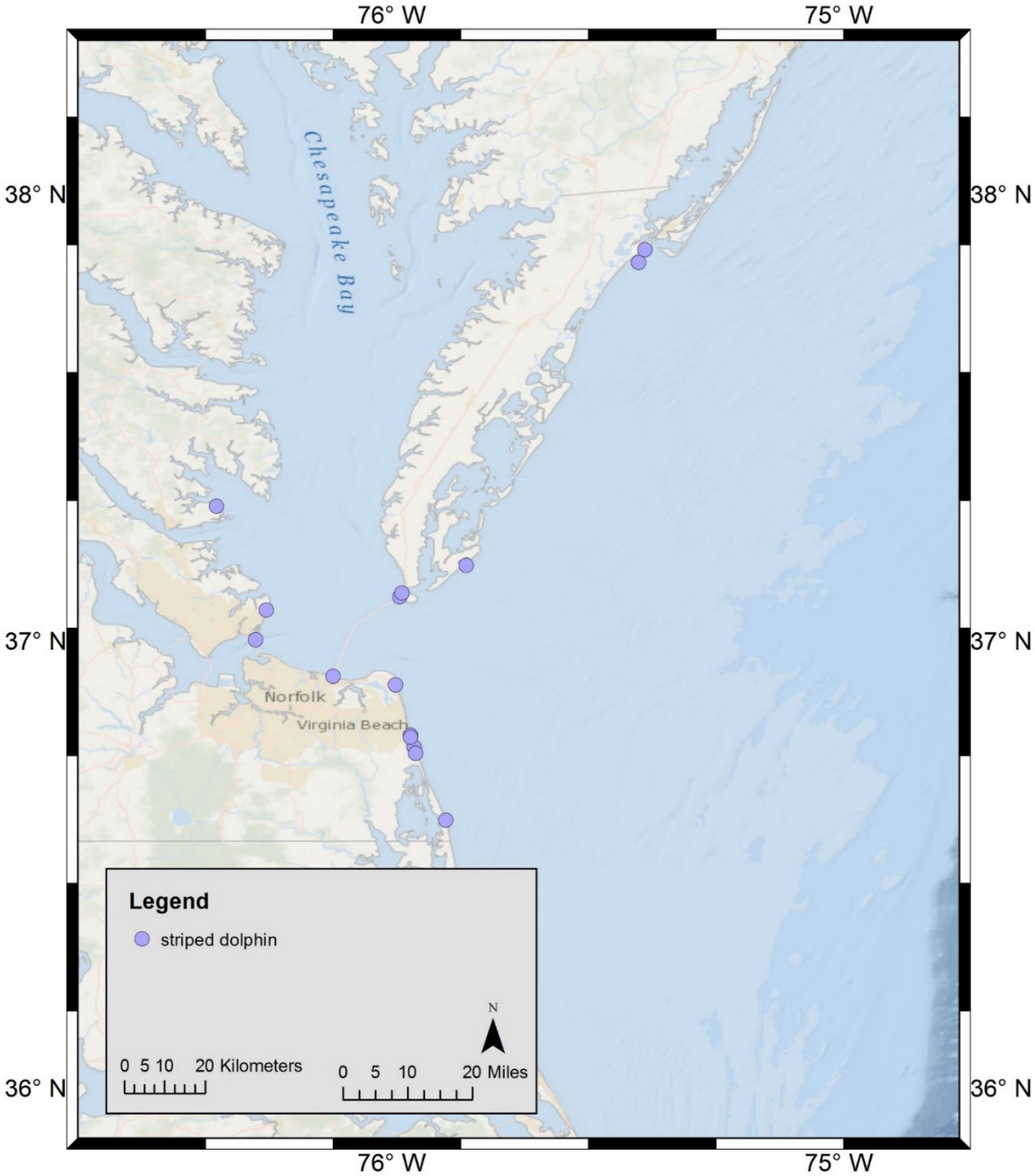

FIGURE 13. STRIPED DOLPHIN (*STENELLA COERULEOALBA*) STRANDING LOCATIONS. THIS SPECIES WAS NOT OBSERVED DURING AERIAL SURVEYS CONDUCTED FROM 2011-2016.

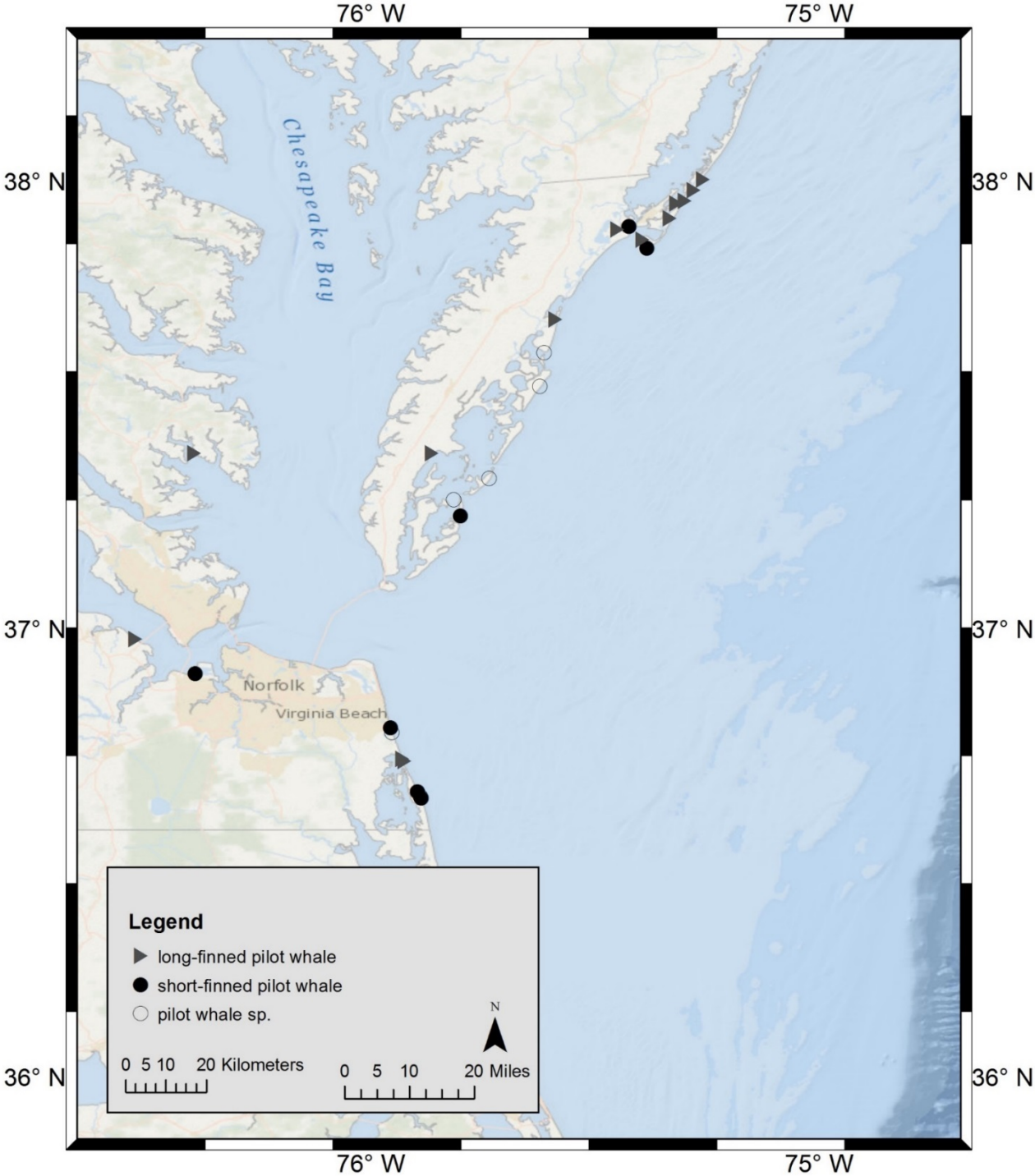

FIGURE 14. STRANDING LOCATION OF PILOT WHALES IN VIRGINIA FROM 1988-2016. THESE SPECIES WERE NOT OBSERVED DURING AERIAL SURVEYS CONDUCTED FROM 2011-2016.

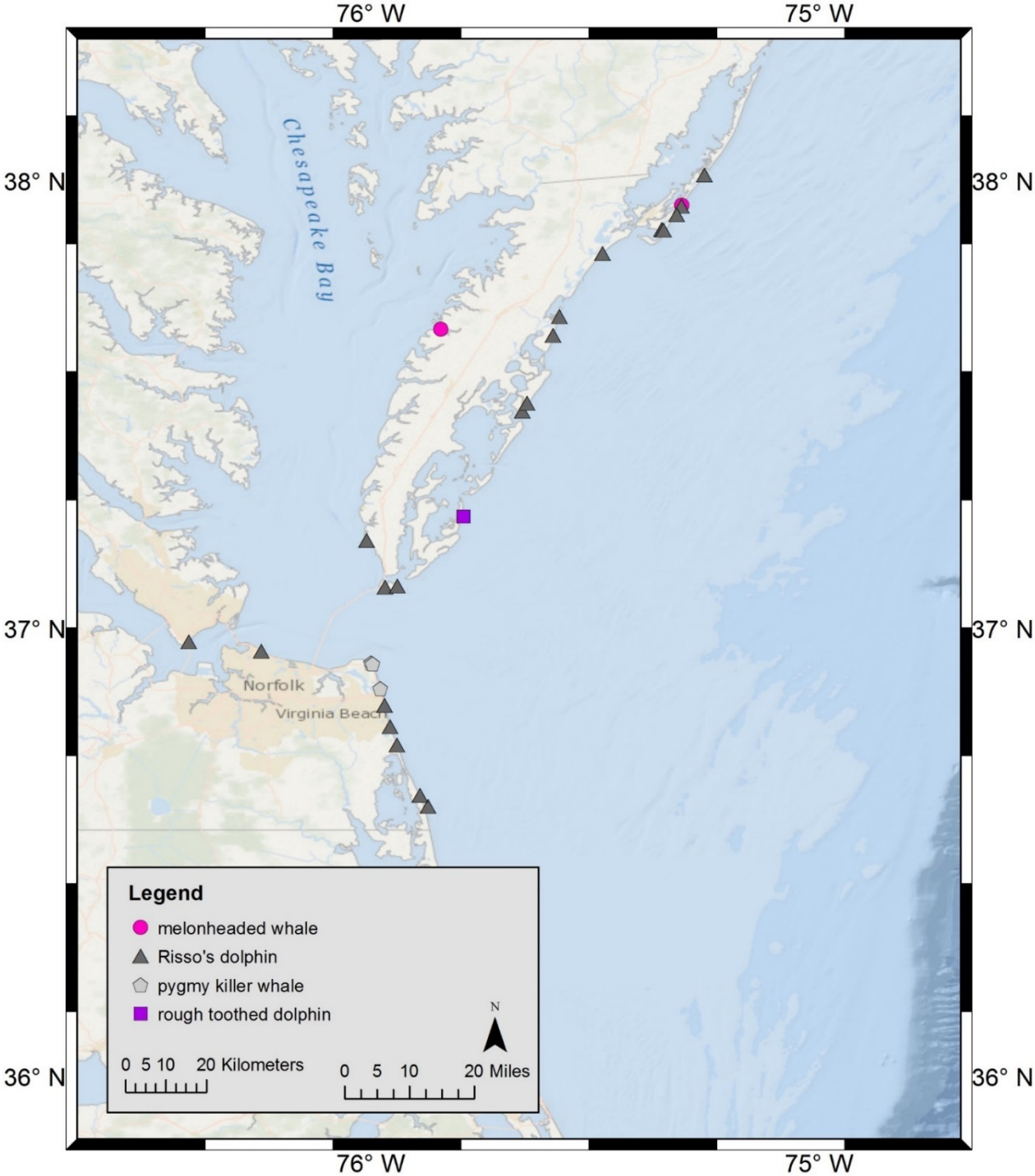

FIGURE 15. STRANDING LOCATIONS OF OTHER IDENTIFIED DELPHINID SPECIES IN VIRGINIA FROM 1988-2016. THESE SPECIES WERE NOT OBSERVED DURING AERIAL SURVEYS CONDUCTED FROM 2011-2016.

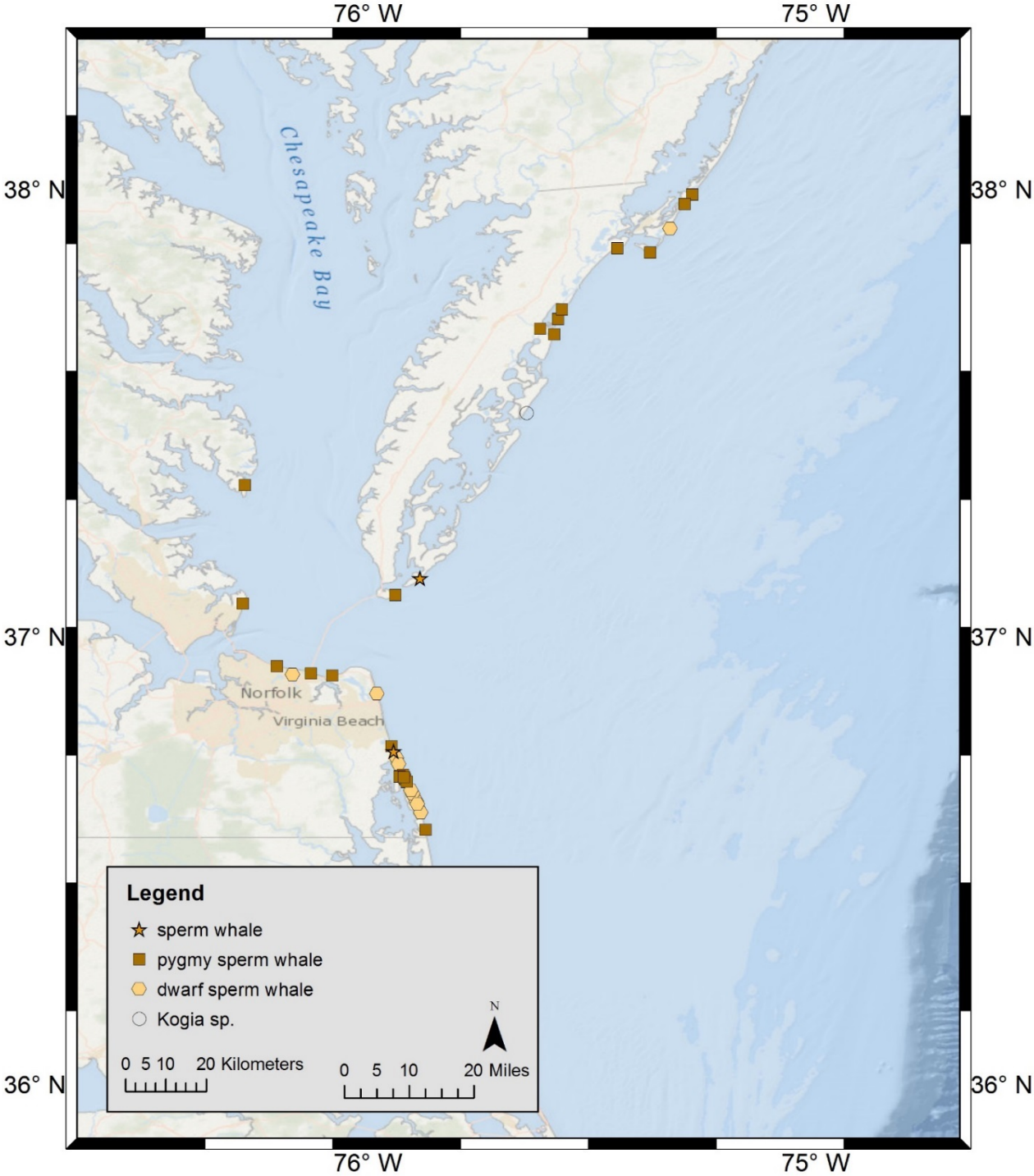

FIGURE 16. STRANDING LOCATIONS OF THREE SPERM WHALE SPECIES IN VIRGINIA FROM 1988-2016. THESE SPECIES WERE NOT OBSERVED DURING AERIAL SURVEYS CONDUCTED FROM 2011-2016.

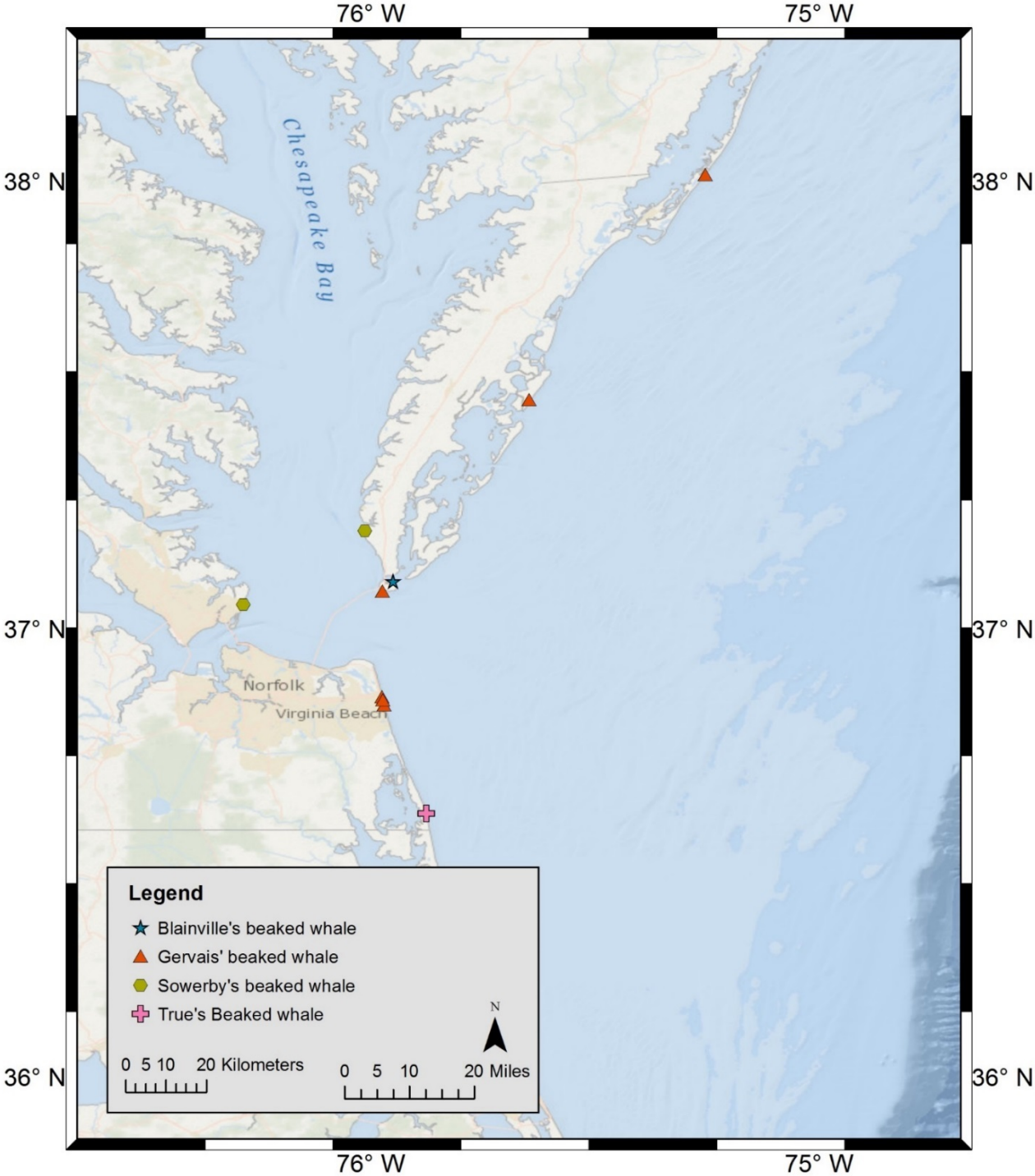

FIGURE 17. BEAKED WHALE STRANDING LOCATIONS IN VIRGINIA FROM 1988-2016. THESE SPECIES WERE NOT OBSERVED DURING AERIAL SURVEYS CONDUCTED FROM 2011-2016.

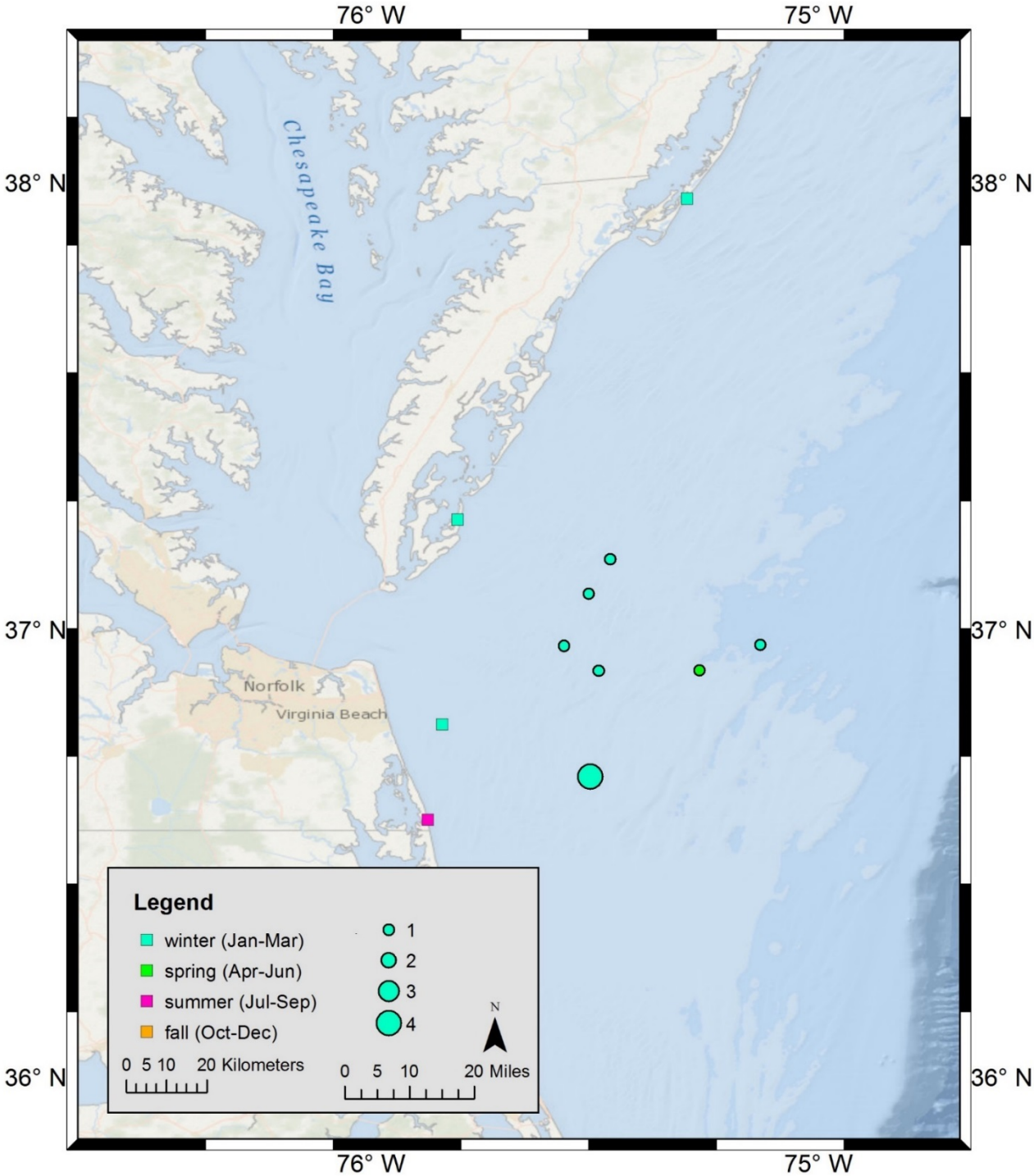

FIGURE 18. NORTHERN RIGHT WHALE (*EUBALAENA GLACIUALIS*) STRANDING LOCATIONS (SQUARE) AND AERIAL SURVEY SIGHTINGS (CIRCLE), BY SEASON. THE SIZE OF THE SIGHTING CIRCLE INDICATES GROUP SIZE.

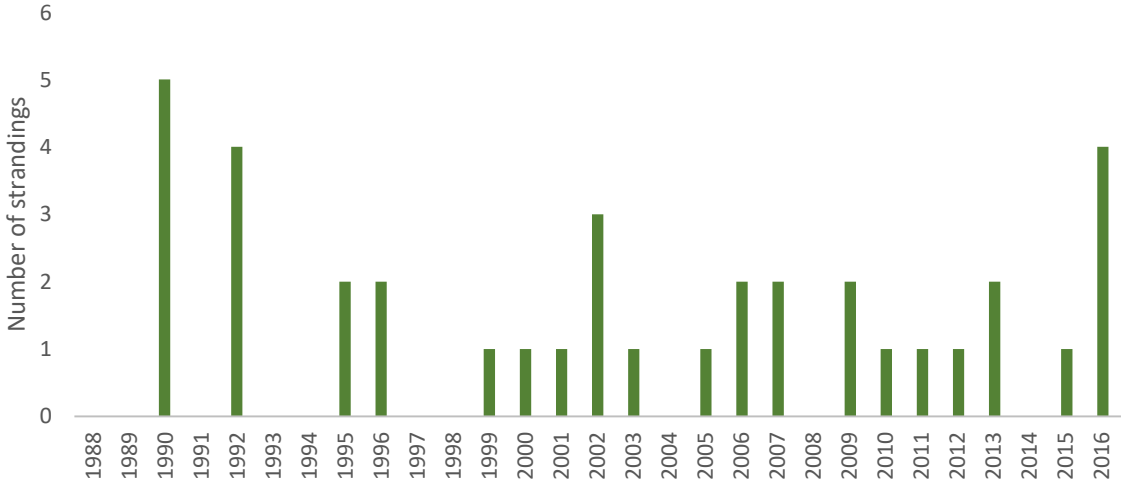

FIGURE 19. ANNUAL FREQUENCY OF HUMPBACK WHALE (*MEGAPTERA NOVAEANGLIAE*) STRANDINGS IN VIRGINIA.

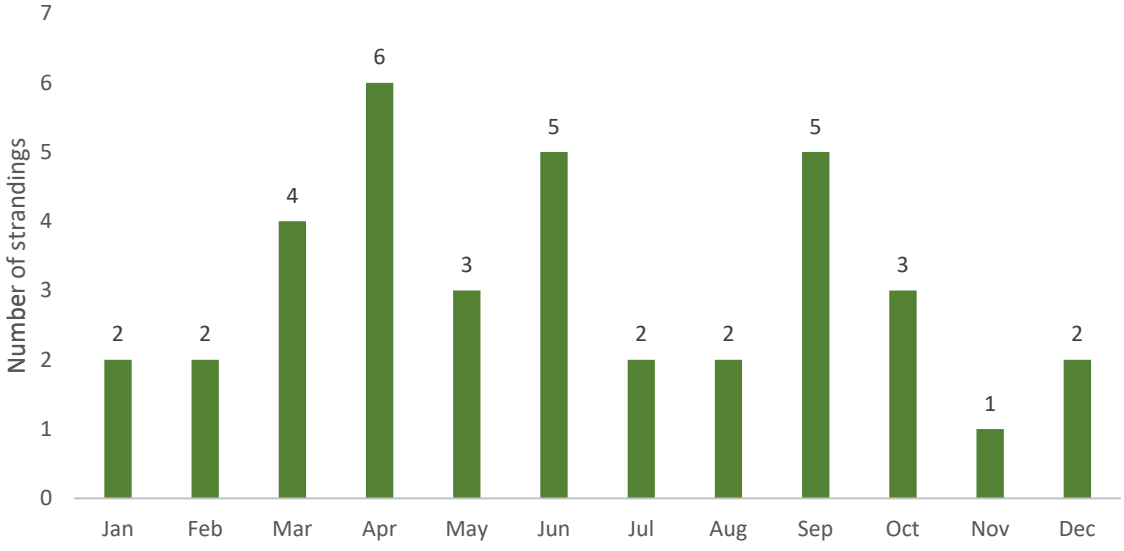

FIGURE 20. MONTHLY FREQUENCY OF HUMPBACK WHALE STRANDINGS IN VIRGINIA, 1988-2016.

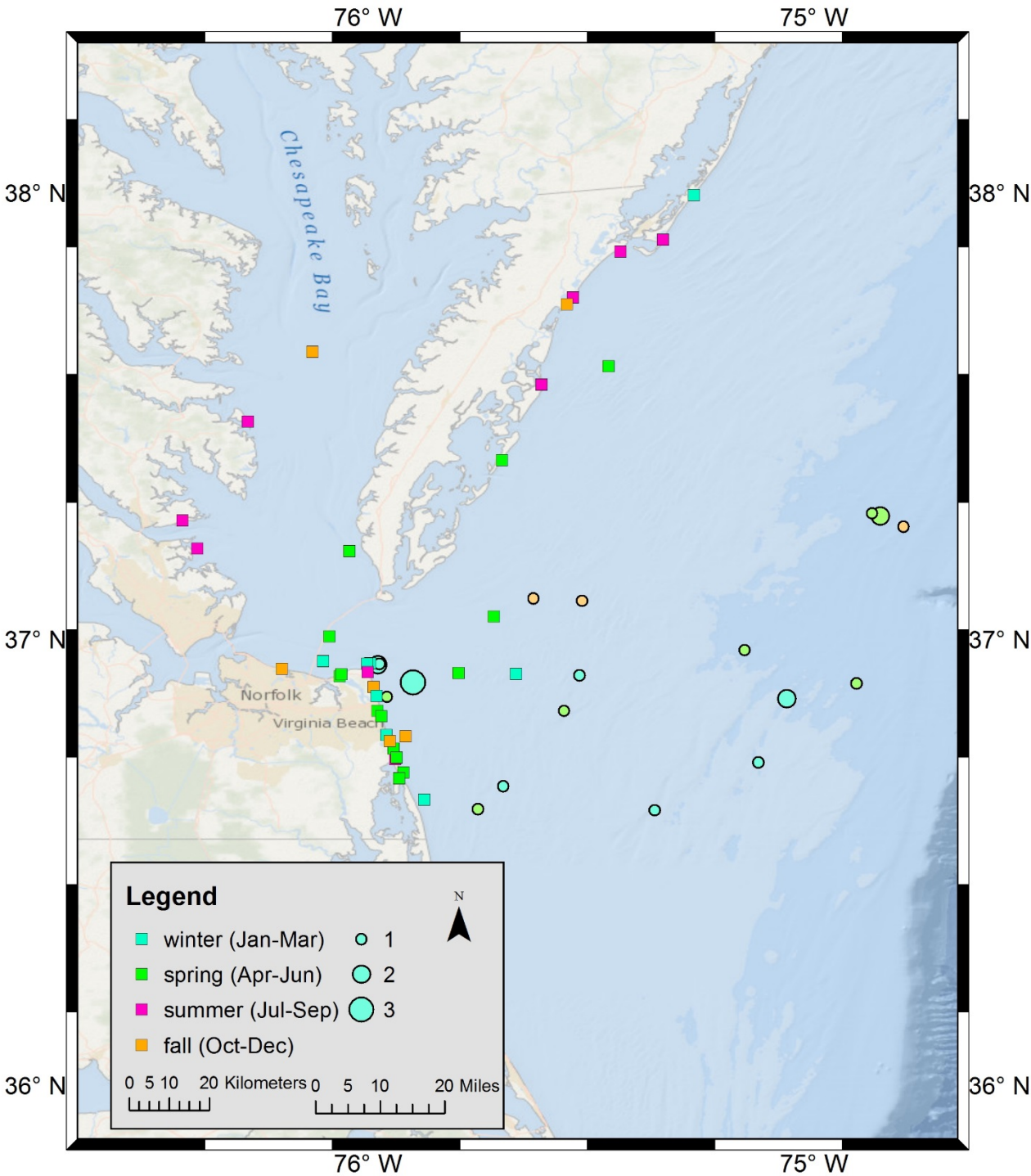

FIGURE 21. HUMPBACK WHALE (*MEGAPTERA NOVAEANGLIAE*) STRANDING LOCATIONS (SQUARE) AND AERIAL SURVEY SIGHTINGS (CIRCLE), BY SEASON. THE SIZE OF THE CIRCLES INDICATES GROUP SIZES.

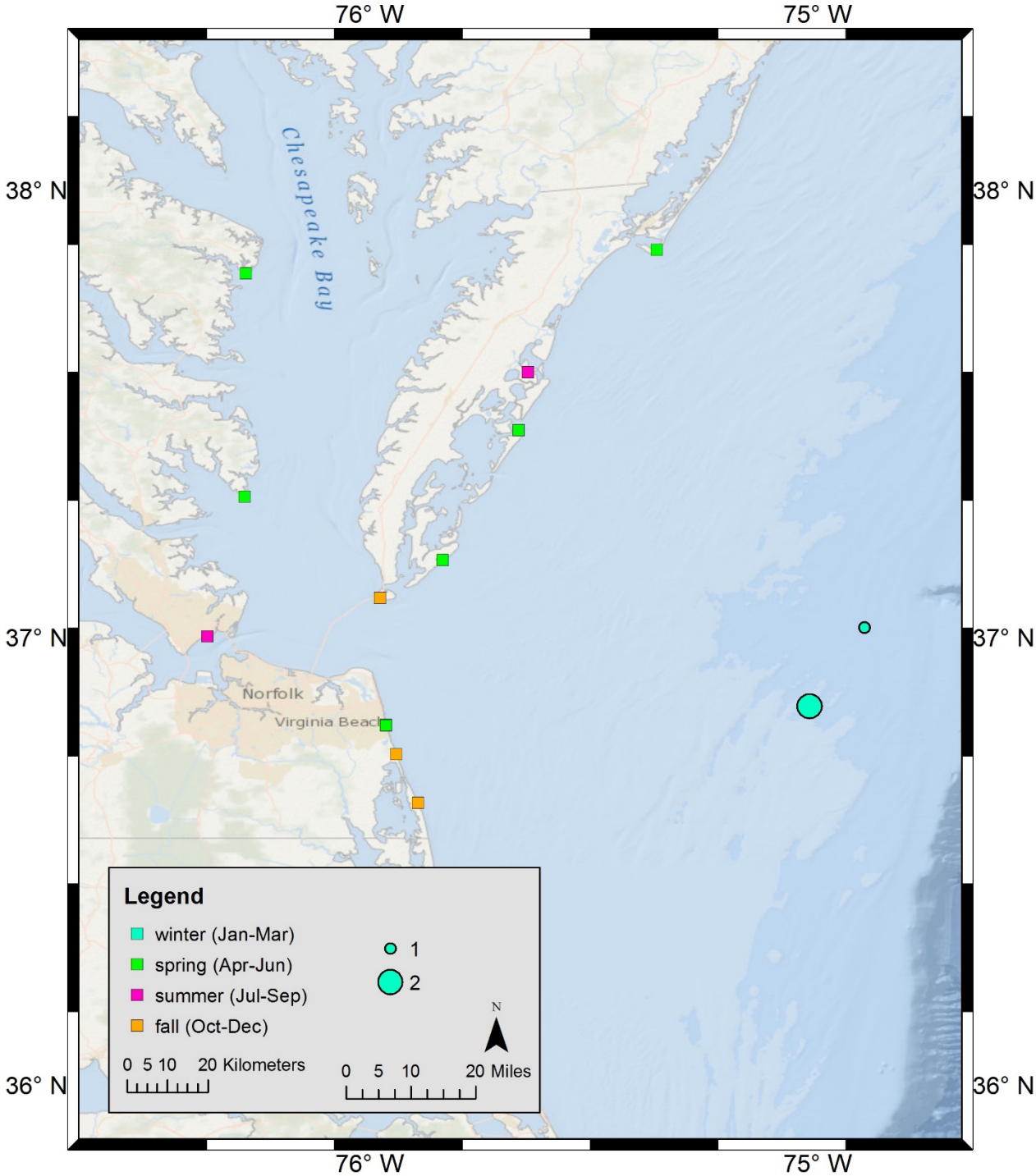

FIGURE 22: MINKE WHALE (*BALEANOPTERA ACUTOROSTRATA*) STRANDING LOCATIONS (SQUARE) AND AERIAL SURVEY SIGHTINGS (CIRCLE), BY SEASON. THE SIZE OF THE CIRCLES INDICATES GROUP SIZES.

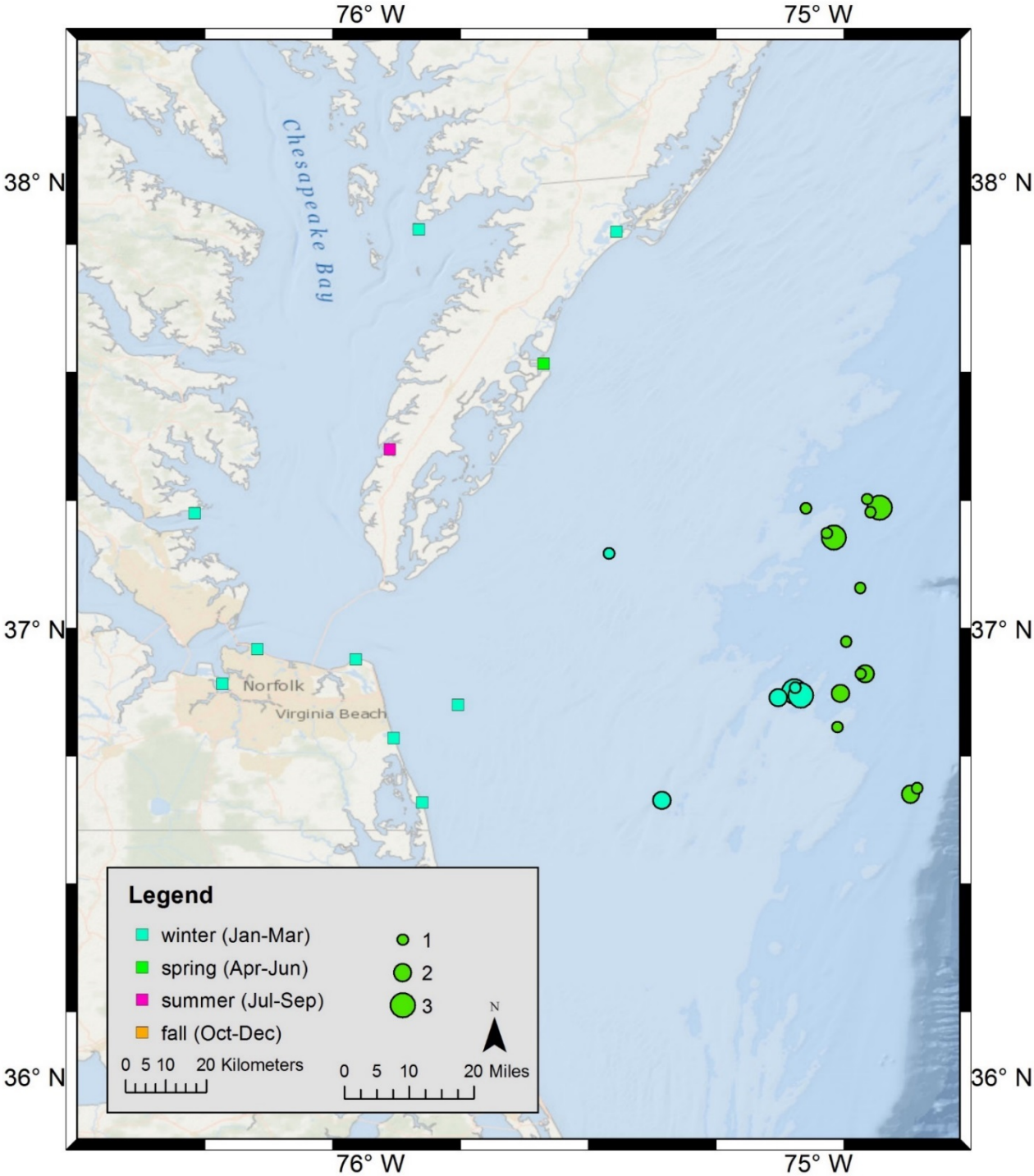

FIGURE 23: FIN WHALE (*BALEANOPTERA PHYSALUS*) STRANDING LOCATIONS (SQUARE) AND AERIAL SURVEY SIGHTINGS (CIRCLE), BY SEASON. THE SIZE OF THE CIRCLES INDICATES GROUP SIZES.

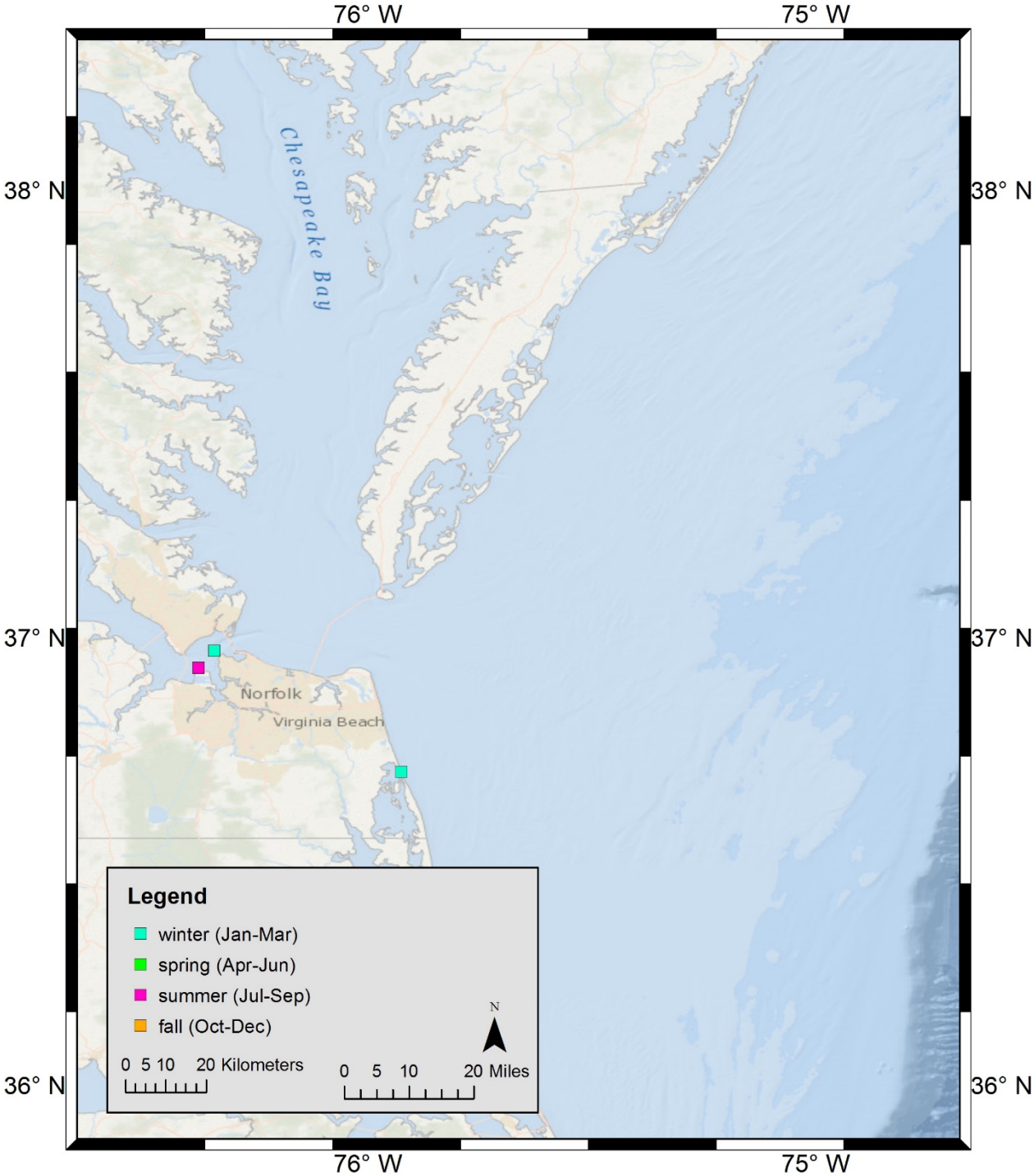

FIGURE 24. SEI WHALE (*BALEANOPTERA BOREALIS*) STRANDING LOCATIONS. THIS SPECIES WAS NOT OBSERVED DURING AERIAL SURVEYS CONDUCTED FROM 2011-2016.

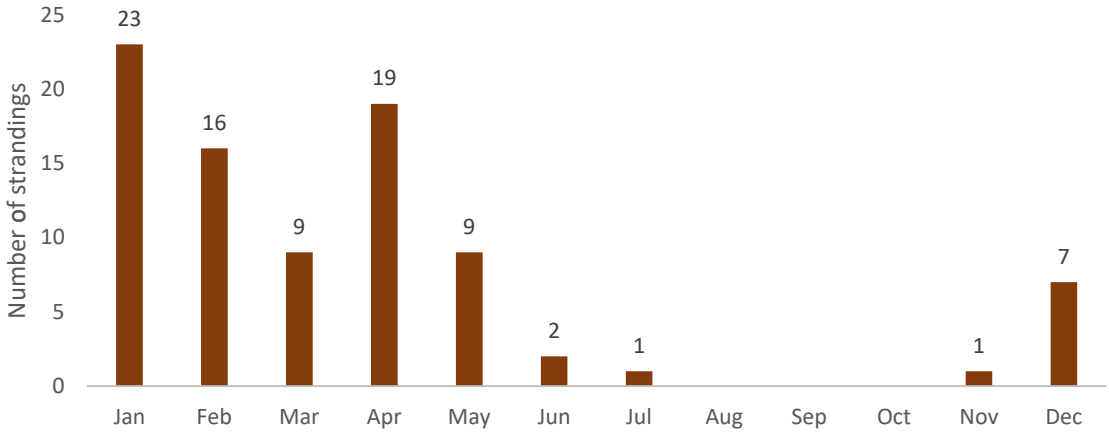

FIGURE 25. MONTHLY FREQUENCY OF HARBOR SEAL STRANDINGS IN VIRGINIA, 1988-2016.

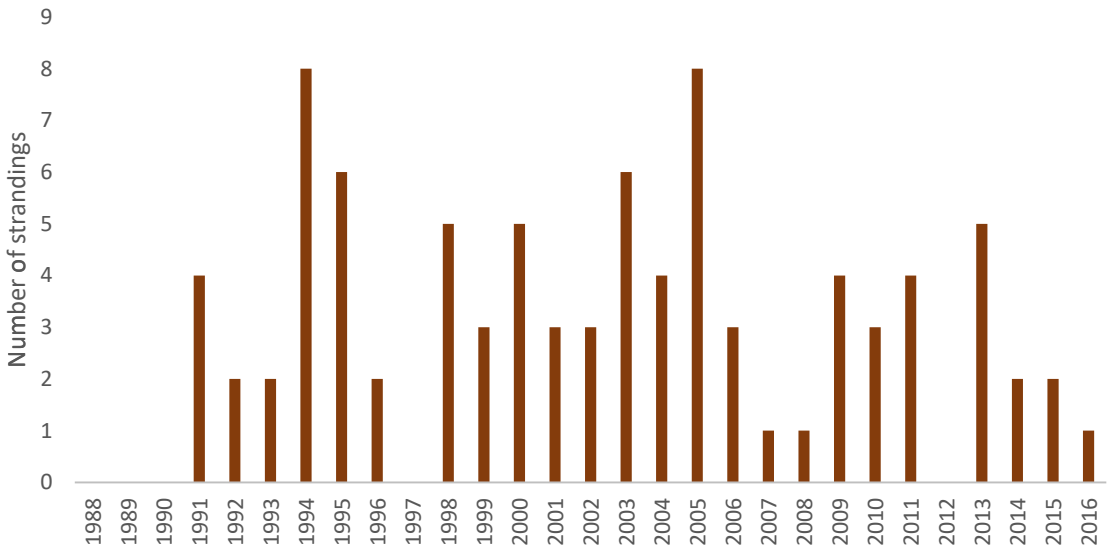

FIGURE 26. ANNUAL FREQUENCY OF HARBOR SEAL (*PHOCA VITULINA*) STRANDINGS IN VIRGINIA.

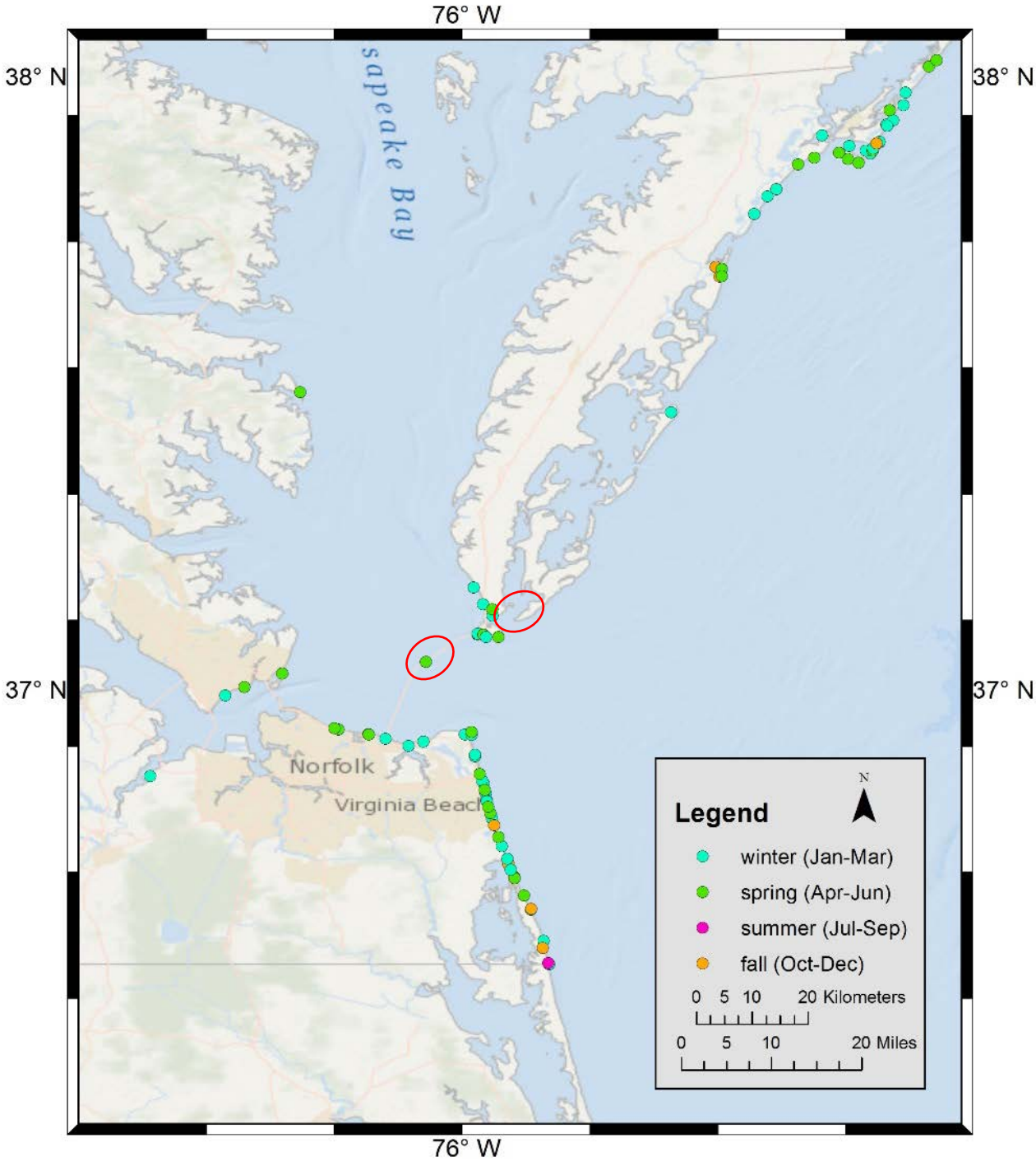

FIGURE 27. VIRGINIA HARBOR SEAL (*PHOCA VITULINA*) STRANDING LOCATIONS, BY SEASON, FROM 1988-2016. THIS SPECIES WAS NOT OBSERVED DURING AERIAL SURVEYS CONDUCTED FROM 2011-2016. TWO WINTER/SPRING HARBOR SEAL HAUL OUTS HAVE BEEN DOCUMENTED IN VIRGINIA 2014, AND THE APPROXIMATE LOCATIONS ARE INDICATED BY RED CIRCLES.

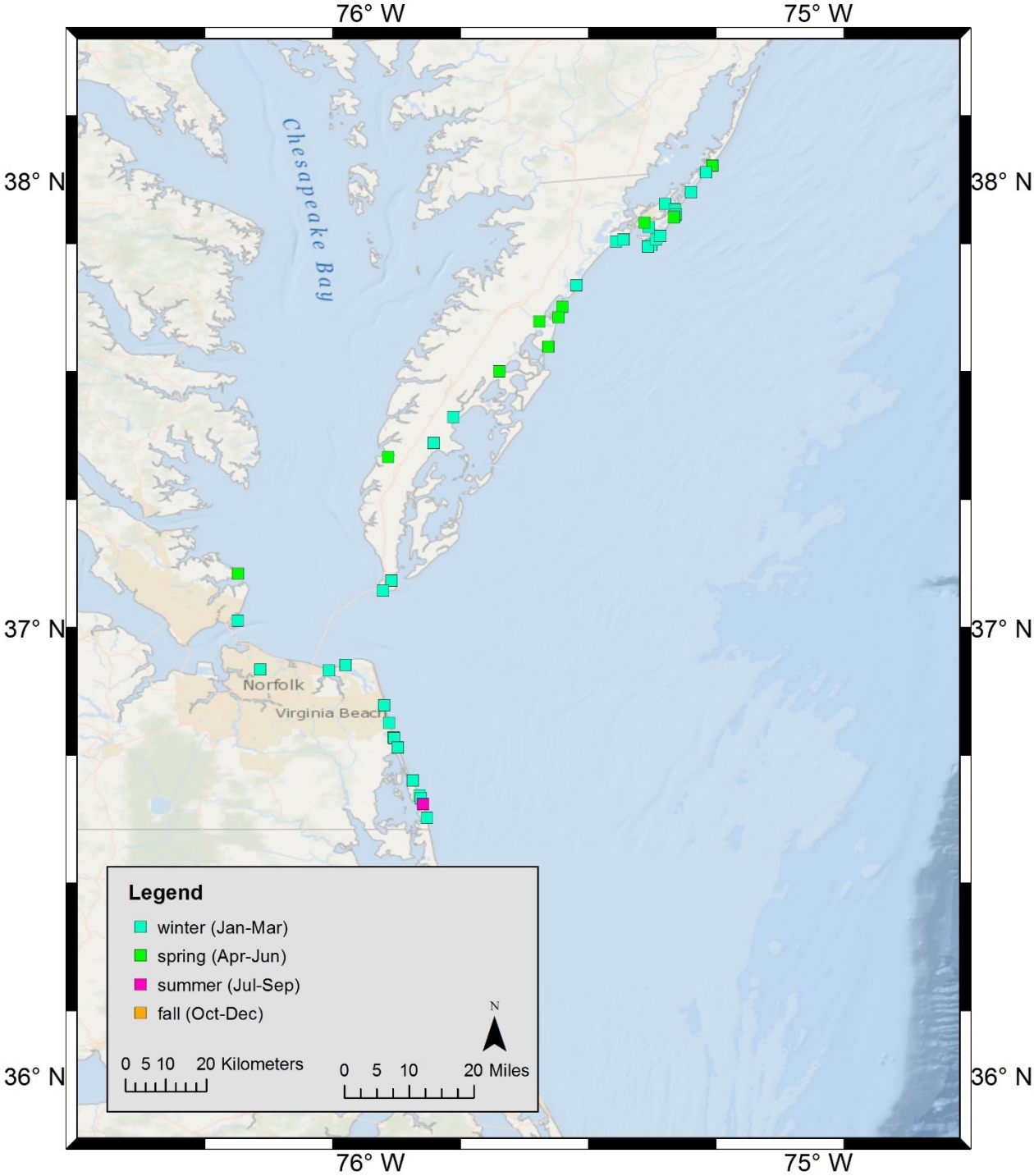

FIGURE 28. VIRGINIA HARP SEAL (*PAGOPHILIS GROENLAENDICA*) STRANDING LOCATIONS, BY SEASON, FROM 1988-2016. THIS SPECIES WAS NOT OBSERVED DURING AERIAL SURVEYS CONDUCTED FROM 2011-2016.

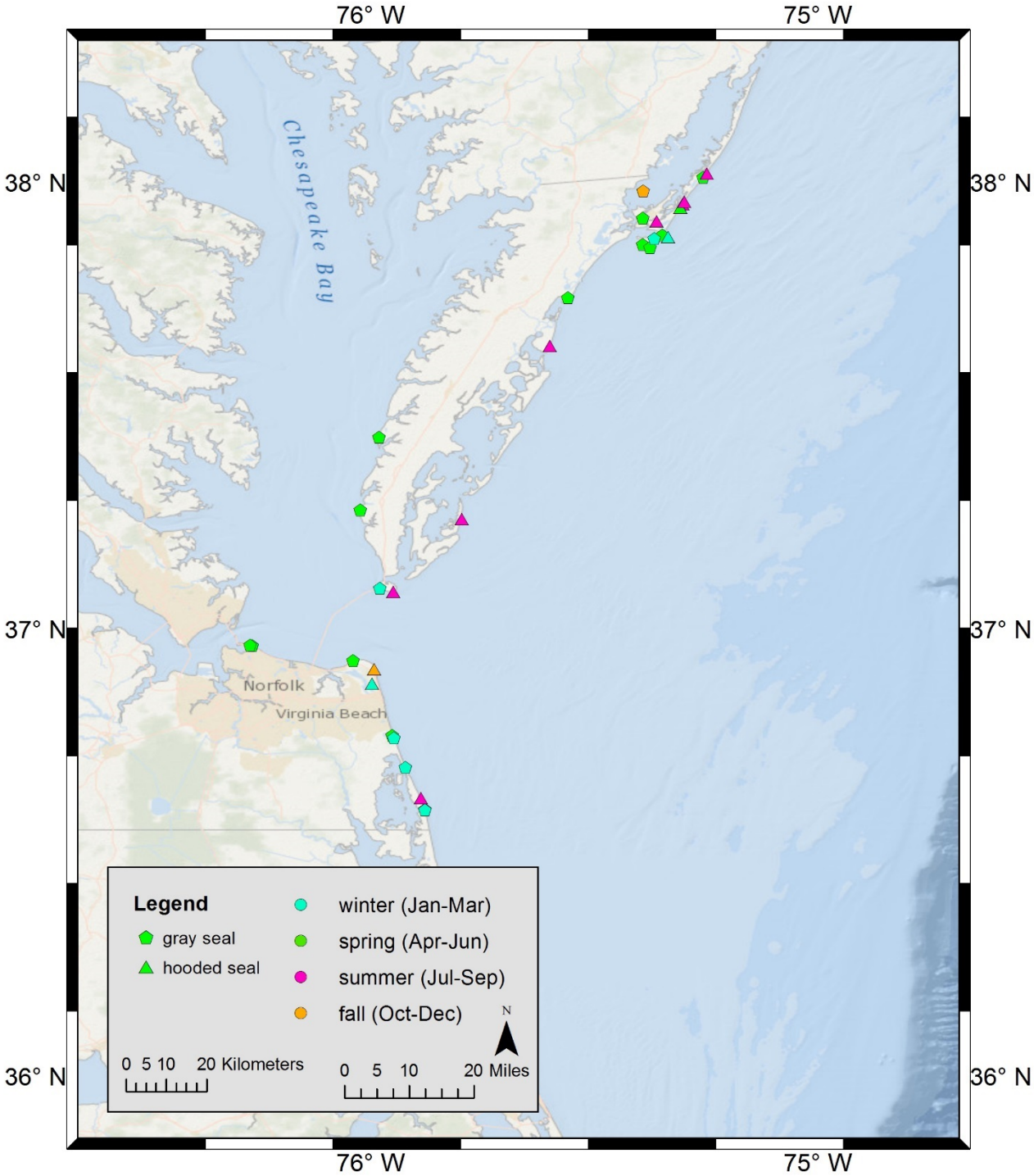

FIGURE 29. VIRGINIA GRAY (HALIC*HOERUS GRYPUS*) AND HOODED SEAL (*CYSTOPHORA CRISTATA*) STRANDING LOCATIONS, BY SEASON, FROM 1988-2016. THESE SPECIES WERE NOT OBSERVED DURING AERIAL SURVEYS CONDUCTED FROM 2011-2016.

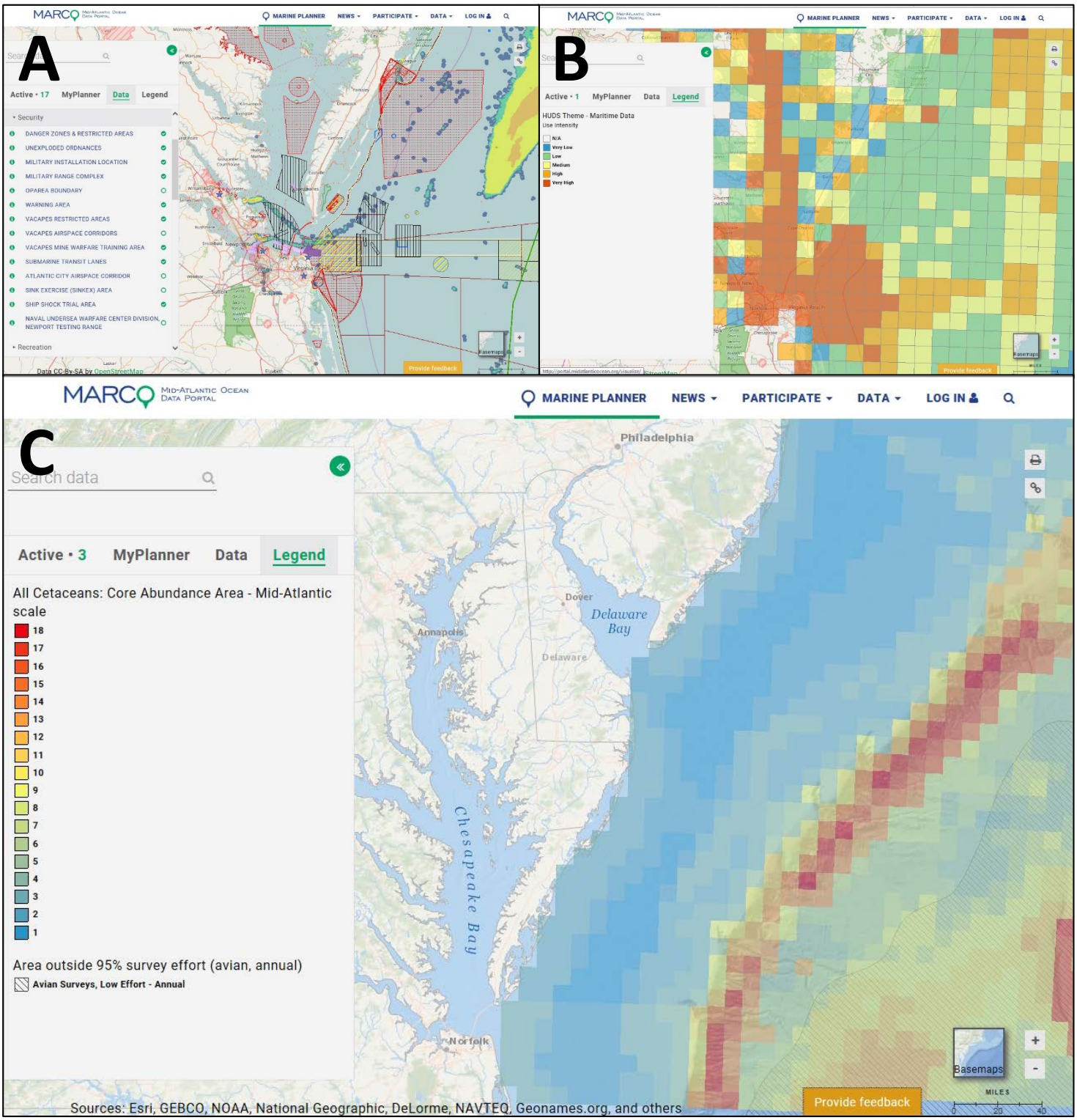

FIGURE 30. EXAMPLES OF HUMAN USE OF OCEAN HABITAT THAT COULD LEAD TO CONFLICT WITH MARINE MAMMALS. (A) INDIVIDUAL MARITIME SECURITY CONCERNS WHICH WERE COMBINED WITH OTHER HUMAN USE TO CREATE A HEAT MAP (B) OF ALL HUMAN MARITIME ACTIVITIES. HUMAN USE CAN BE COMPARED WITH CORE MARINE MAMMAL OCCURRENCE (C) TO PREDICT POTENTIAL CONFLICT. MARCO OCEAN DATA PORTAL (7/11/2017).