VACAPES Outer Continental Shelf Cetacean Study, Virginia Beach, Virginia: 2022 Annual Progress Report

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Prepared by

Amy Engelhaupt[1], Jessica M. Aschettino[2], and Dan Engelhaupt[2]

[1]Amy Engelhaupt Consulting
Virginia Beach, Virginia

[2]HDR
Virginia Beach, Virginia

Submitted by:

HDR
Virginia Beach, VA

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Cover Photo Credit:

Cuvier's beaked whale (*Ziphius cavirostris*) off the coast of Virginia. Photographed by Amy Engelhaupt. Photograph taken under National Marine Fisheries Service Scientific Research Permit No. 21482, issued to Dan Engelhaupt.

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Acronyms and Abbreviations

°N	degrees North
°W	degrees West
BSS	Beaufort sea state
COMPASS	Cetacean Observation and Marine Protected Animal Survey Software
DTAG	digital acoustic recording tag
ESA	Endangered Species Act
GPS	Global Positioning System
hr	hour(s)
km	kilometer(s)
LiDAR	Light Detection and Ranging
LIMPET	Low-Impact Minimally Percutaneous Electronic Transmitter
m	meter(s)
min	minute(s)
MMO	marine mammal observer
nm	nautical mile(s)
OCS	Outer Continental Shelf
OPAREA	Operating Area
photo-ID	photo-identification
SPOT	Smart Position and Temperature
SSM	State Space Modeling
sUAS	small Unmanned Aerial System
U.S.	United States
VACAPES	Virginia Capes
VHF	very-high frequency

1. Introduction and Background

The United States (U.S.) Navy routinely conducts training and testing activities within the Virginia Capes (VACAPES) Operating Area (OPAREA) off the mid-Atlantic and Southeast U.S. The region encompassing the deeper waters of the continental shelf, shelf break, and continental slope has been recognized as an important habitat for multiple species of cetaceans. Kenney and Winn (1986) showed that the shelf edge from Cape Hatteras to Georges Bank was the second most intensively used cetacean habitat off the northeastern U.S. based on 3 years of surveys conducted by the Cetacean and Turtle Assessment Program (CETAP 1982). More recent, still ongoing, broad-scale surveys by the National Marine Fisheries Service, including the Atlantic Marine Assessment Program for Protected Species, and marine mammal stock-assessment reports (Hayes et al. 2021), continue to show the same pattern.

Cetacean species known to be common seasonally in outer shelf and slope waters include both baleen whales and odontocetes, such as fin whales (*Balaenoptera physalus*), sei whales (*Balaenoptera borealis*), minke whales (*Balaenoptera acutorostrata*), humpback whales (*Megaptera novaeangliae*), sperm whales (*Physeter macrocephalus*), beaked whales (*Ziphius cavirostris*, *Mesoplodo*n spp.), long- and short-finned pilot whales (*Globicephala melas* and *Globicephala macrorhynchus*, respectively), Risso's dolphins (*Grampus griseus*), common bottlenose dolphins (*Tursiops truncatus*), common dolphins (*Delphinus delphis*), Atlantic white-sided dolphins (*Lagenorhynchus acutus*), Atlantic spotted dolphins (*Stenella frontalis*), and striped dolphins (*Stenella coeruleoalba*) (CETAP 1982; Hain et al. 1985, 1992; Kenney and Winn 1986, 1987; Selzer and Payne 1988; Kenney 1990; Payne and Heinemann 1993; Waring et al. 1993, 2001; Northridge et al. 1997; Palka et al. 1997; Mead 2009; NEFSC and SEFSC 2012, 2013; Jefferson et al. 2014; Hayes et al. 2021). Fin, sei, and sperm whales are all listed as endangered under the U.S. Endangered Species Act (ESA).

Recent aerial and vessel surveys and passive acoustic monitoring studies for the U.S. Navy Marine Species Monitoring Program (Foley et al. 2019; Salisbury et al. 2018; Mallette et al. 2017, 2018a; Cotter 2019) have provided data confirming the overall distribution patterns and suggesting that the outer shelf area off Virginia in the VACAPES OPAREA would be an ideal location for more focused research on the ecology and behavior of several species of cetaceans. Offshore surveys were first conducted in association with the Mid-Atlantic Humpback Whale Monitoring project from April 2015 through June 2016 (Aschettino et al. 2016). Subsequently, a dedicated project focusing on Outer Continental Shelf (OCS) cetaceans was initiated in July 2016 (A. Engelhaupt et al. 2017, 2018, 2019, 2020, 2021, 2022).

This progress report includes all offshore monitoring activities conducted in 2022. The goals of this effort focus on addressing fundamental information gaps related to marine mammal occurrence, exposure, and response as identified by the U.S. Navy's Integrated Comprehensive Monitoring Program (DoN 2010) and recommendations provided by a Scientific Advisory Group review (DoN 2011).

In order to address these informational gaps for offshore waters in the VACAPES OPAREA, a combination of techniques are being used, including: (1) photo-identification (photo-ID), photogrammetry, and behavioral data collection from vessels and small Unmanned Aerial

Systems (sUAS) to provide baseline assessments of animal movement patterns, site fidelity, habitat use, life history, and behavior; (2) biopsy sampling for incorporation into existing genetic studies (where opportunities exist) to identify individuals, establish gender, and assist in delineating stock structure; (3) satellite-linked telemetry tagging techniques to provide information about residency patterns, dive profiles, and habitat use across intermediate time scales (weeks to months); and (4) suction-cup tagging to investigate diving and foraging behavior through collection of high-resolution underwater movement and acoustic data.

Residency and movement patterns are of particular interest given the potential for repeated exposure to U.S. Navy training and testing activities known to occur within the area. Findings from work conducted near the continental shelf break off the coast of southeastern Virginia and Cape Hatteras, North Carolina, suggest a year-round presence of several species of cetaceans, including Cuvier's beaked whales and short-finned pilot whales (McAlarney et al. 2018a, 2018b; Waples and Read 2020, 2021, 2022). Tagging efforts for this project provide opportunities to assess movement patterns of additional species, and may identify the extent of overlap between these animals and offshore training and testing activities conducted within the VACAPES OPAREA. Given the duration of the tag attachments and experience from previous tagging studies within waters off Cape Hatteras, North Carolina (Baird et al. 2018), there is potential to track tagged animals more broadly, including through the Cherry Point OPAREA to the south and the Atlantic City OPAREA to the north.

Taking into consideration the multiple intermediate scientific objectives in the U.S. Navy's Strategic Planning Process (DoN 2013), the goals of this study are to assist the U.S. Navy and regulatory agencies with environmental planning and compliance by addressing the following questions.

- Which cetacean species occur over the OCS east of Naval Station Norfolk, and how does occurrence fluctuate seasonally?
- What are the baseline behaviors and ecological relationships of offshore cetaceans within the study area?
- Do individual cetaceans exhibit site fidelity within specific regions of the study area over periods of weeks, months, or years?
- What is the seasonal extent of cetacean movements within and around U.S. Navy VACAPES training range boxes?
- Do cetaceans spend significant time within or primarily move through areas of U.S. Navy live-fire or Anti-Submarine Warfare training events?

2. Methods

The primary survey area includes the offshore waters (approximately 90 to 160 kilometers [km] [50 to 85 nautical miles (nm)]) off the coast of Virginia (**Figure 1**). The offshore study area includes the OCS, shelf break, slope waters, and Norfolk and Washington Canyons. Depths within the core study area range from approximately 50 meters (m) to as much as 2,500 m.

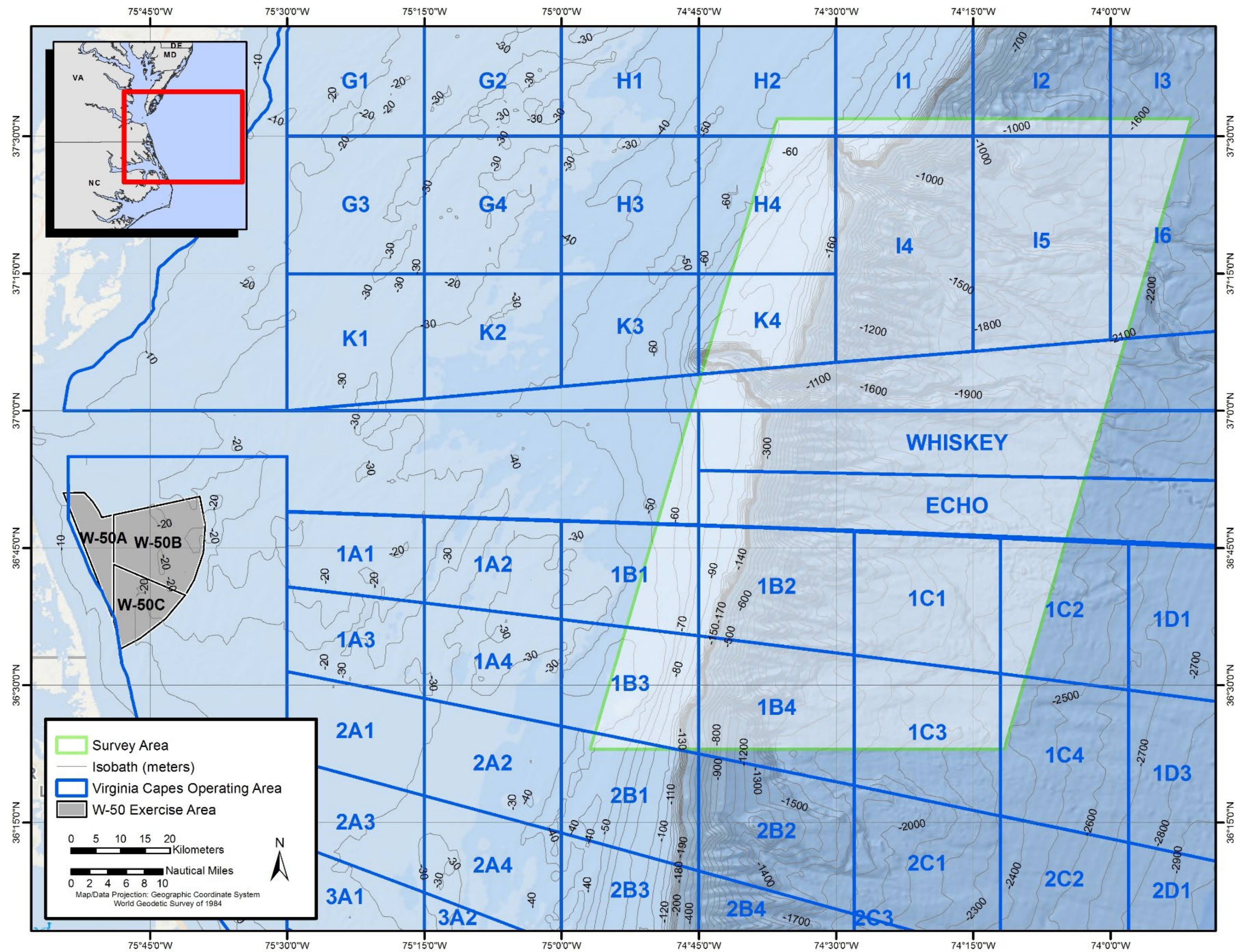

Figure 1. Map of the offshore study area off southeastern Virginia and VACAPES training range surface grid within the region.

2.1 Survey Operations

The 16.2-m offshore charter sport-fishing vessel *Top Notch* (**Figure 2)** was the primary vessel used in 2022 to support surveys. Other similar charter vessels were used when *Top Notch* was not available. Each vessel is equipped with a Global Positioning System (GPS) receiver, marine radio, emergency beacon, life raft, depth sounder, and emergency equipment. All captains are familiar with the Virginia Beach waterways and unique characteristics of the region, and hold U.S. Coast Guard-approved 100-ton master's licenses. The scientific crew typically consisted of a minimum of three marine mammal observers (MMOs), but no more than six, including (at least) one photographer/sUAS operator, one tagging specialist, and one biopsy specialist. Roles generally were interchangeable throughout surveys.

Figure 2. The primary sport-fishing vessel chartered for use during offshore surveys, the 16.2-m *Top Notch*.

Survey departure times were planned to maximize weather and clearance windows, and to take into account the long transit time to reach the survey area (approximately 3 hours [hr] each way when transiting at 20-plus knots). Survey days were planned to use survey time within the area of interest during optimal weather conditions, including good visibility and a Beaufort sea state (BSS) of 3 or lower when possible, as well as access to the VACAPES OPAREA range boxes within the study area (K3, K4, I4, 1B1, 1B2, 1B3, and 1B4; **Figure 1**) so that the research vessels had clearance to operate when training was not being conducted. However, because of frequent range closures and limited weather windows, it was not always possible to conduct surveys within the desired VACAPES OPAREA boxes.

Surveys departed from Rudee Inlet in Virginia Beach, Virginia. Efforts were coordinated with the VACAPES range so the vessel would have clearance within the primary study area as often as possible. The K3 and K4 range boxes, which encompass Norfolk Canyon (**Figure 1**), require clearance to be obtained on the day of a survey; therefore, the area was sometimes unavailable.

In order to maximize achievement of the project's core objectives, departures from the marina were scheduled at approximately sunrise or earlier, and a minimum of 12 hr was allocated for each survey day. Once departing the marina, transit time was approximately 3 hr to reach the study area. MMOs were on-effort during the outbound and inbound transit as long as there was sufficient daylight and a BSS of 4 or lower. Due to the distance from shore and overall effort required to complete each survey day, effort within the primary study area continued until the end of the survey day even if sea states turned unfavorable (BSS 4 to 6), unless conditions were deemed to be unsafe. Every effort was made to avoid such circumstances by following weather forecasts closely before commencing a survey day.

The survey area for each day was chosen depending on weather conditions, clearance, and reports of high-priority species (e.g., information from recent aerial or vessel surveys). Areas of high U.S. Navy training use, such as the Norfolk Canyon area (**Figure 1**), were priorities. The survey vessel often followed pre-determined tracks that covered high-priority regions; however, because these surveys were intended to maximize the potential for making observations, they did not follow line-transect distance-sampling protocols. The vessel maintained a speed of approximately 18 to 22 km/hr (10 to 12 knots) during search efforts, which often followed a zig-zag pattern to waypoints chosen on the day of survey that would optimize coverage across the depth gradient within the areas that could be accessed that day.

The on-effort MMOs used both unaided eyes and 10x30 hand-held, image-stabilized binoculars. MMOs covered a 270-degree swath of observation area in front and to the sides of the survey vessel. Once in deep water (more than 400 m), a directional hydrophone was also used to listen for sperm whales periodically. If clicks were heard, every effort was made to localize the detections and maneuver the vessel towards where the whales were heard. If no clicks were heard, the vessel would continue transiting before stopping approximately 20 to 30 minutes (min) later to listen within a different area.

Once a sighting was made, one MMO focused on data entry using Cetacean Observation and Marine Protected Animal Survey Software (COMPASS; Richlen et al. 2019) running on an Apple iPad tablet (see **Appendix A**), while others focused on visual tracking and obtaining photo-ID images of the individual or group. In addition to photo-ID, some species were targeted for sUAS data collection, biopsy sampling, satellite tagging, and/or suction-cup tagging. Baleen, sperm, and beaked whales were given highest priority in terms of time and effort spent collecting information and attempting to deploy tags and collect samples. Species not frequently seen within the area, such as killer whales (*Orcinus orca*), false killer whales (*Pseudorca crassidens*), melon-headed whales (*Peponocephala electra*), and pygmy killer whales (*Feresa attenuata*) were also considered high-priority if encountered. Pilot whales and Risso's dolphins were generally medium-priority species and only approached if higher-priority species were not encountered; however, because of the high number of pilot whale sightings, groups were not always approached for identification to species and photo-ID documentation. Other delphinid species were low priority, and effort spent collecting data and conducting photo-ID was limited to confirming species identification, estimating group size, and determining initial behavior if time allowed.

During a high-priority marine mammal sighting, the research vessel would attempt to approach the animal(s) for photo-ID, biopsy sampling, focal-follow data collection, sUAS video collection, and/or tagging. The approach was done in a manner to minimize disturbance to the animals and maximize the crew's abilities to confirm species, estimate group size, and collect photo-IDs and video. The decision on when to end data-collection efforts on a priority species or switch to a different sighting was made by the Chief Scientist.

2.2 Photography, Photogrammetry, and Data Logging

Photo-ID images were collected using a digital single-lens reflex camera (Canon 7D, 7D Mark II, or 1DX Mark II) with a zoom lens (Canon 100- to 400-millimeter). Every effort was made to obtain good quality photos of the flukes and/or dorsal fins of high-priority species encountered. Following each survey day, photographs were cropped and compiled in a format suitable for data sharing with other catalogs. HDR shares images with known regional and local catalogs, including the North Atlantic Right Whale Catalog curated by the New England Aquarium, North Atlantic Fin Whale Catalog curated by the Center for Coastal Studies, North Atlantic and Mediterranean Sperm Whale Catalog curated by Whale Watch Azores, Mid-Atlantic Humpback Whale Catalog curated jointly by HDR and NAVFAC Atlantic (Mallette et al. 2018b; Mallette and Barco 2019), Gotham Whale Humpback Whale Catalog (Brown et al. 2022), and Cape Hatteras Short-finned Pilot Whale and Cuvier's Beaked Whale Catalogs maintained by Duke University (Waples and Read 2020, 2021, 2022, 2023).

During surveys, the data recorder maintained a log of observers, environmental conditions, and sighting information in COMPASS (**Appendix A**). Environmental data were updated whenever sighting conditions changed. When a sighting was made, information regarding the distance and bearing to the sighting, species identification, speed and direction of the animal(s), group size, photographs, and videos was logged when available. Sighting distances were estimated visually. Location data and vessel speed were obtained from a GPS unit feeding directly into the iPad and logging a location every 30 seconds.

The use of sUAS (i.e., drone) was incorporated into the field effort beginning in 2019. A DJI Phantom 4 Pro V2.0 was used to collect morphometric data and assess overall body condition. Data were typically collected at flight heights between 15 and 30 m, depending on the behavior of the focal animal during the time of the encounter. The sUAS collected 4K ultra-high-definition video at 30 frames per second. Initial measurements were made from data using altitude values from the stock barometer (DJI Phantom 4 Pro); however HDR recently assembled and installed a custom Light Detection and Ranging (LiDAR) precision altimeter on the drone (described in Dawson et al. 2017) to increase precision. This upgrade improves accuracy of reading to ±5 centimeters. Open-source software developed by researchers at Duke University (Torres and Bierlich 2020) was used to calculate animal lengths from the video.

2.3 Biopsy Sample Collection

Biopsy samples were collected from priority species after the survey team finished collecting photo-ID images. Biopsy samples were collected with a sampling dart fired from a Paxarms MK24c projector (Paxarms New Zealand Ltd., Cheviot, New Zealand) or Barnett Recurve crossbow (Barnett Outdoors, LLC, Tarpon Springs, Florida). Skin samples were placed in a Whirl-Pak® bag after collection and stored in an ice cooler on the vessel. Samples were then cross-sectioned, placed in the appropriate Cryovial® storage tube, and stored in a freezer until ready for shipment. Samples for fin whale genetic analyses were collected for the University of Groningen, and samples for sperm whale genetic analyses were collected for Oregon State University.

2.4 Satellite Tagging

Three types of tags from Wildlife Computers (Redmond, Washington)—Argos-linked, location-only, Smart Position and Temperature (SPOT-365); Argos-linked time-depth archival (SPLASH10-333); and Argos-linked, time-depth, archival with Fastloc® GPS technology (SPLASH10-F-333), all in the Low-Impact Minimally Percutaneous External-electronics Transmitter (LIMPET) configuration (Andrews et al. 2008)—were deployed on priority species. Tags were deployed remotely with a DAN-INJECT J.M.SP.25 CO_2 projector (DAN-INJECT ApS, Børkop, Denmark).

The LIMPET design uses two surgical-grade titanium darts, measuring 6.8 centimeters long and containing six backwards-facing petals, to attach tags to or just below the dorsal fin. Tags were programmed to maximize the number of transmissions and locations received during attachment rather than to extend battery life, which was based on expected LIMPET tag attachment durations of less than 60 days on baleen and sperm whales. Based on satellite availability within the area, tags were programmed to transmit for 16 hr per day and were limited to 600 transmissions per day.

In order to constitute a “dive” for the behavior and time-series data outputs of the SPLASH10 tags, a dive definition was established for sperm whales in which a submergence needs to be both deeper than 5 m and longer than 5 min. Locations of tagged individuals were tracked by GPS, or estimated by the Argos system using the Kalman filtering location algorithm (Argos User’s Manual© 2007–2015 Collective Location Services). Using tools provided within Movebank, unrealistic locations (e.g., on land) were manually removed prior to a further final Douglas Argos filtering step. Additional dive-data results were obtained using the statistical software R (R Core Team 2018).

2.5 DTAG Methods

The 2022 field season had the first successful suction-cup tag deployments for this project. This short-duration, high-resolution, dive tag component was added to the project with the goal of deploying digital acoustic recording tags (DTAGs; Johnson and Tyack 2003) on sperm whales to assess their fine-scale diving and foraging behavior in the Mid-Atlantic region, specifically in the VACAPES OPAREA. Version 3 DTAGs were deployed using a hand-held carbon fiber pole. DTAGs are equipped with hydrophones and pressure sensors as well as a three-axis accelerometer and magnetometer. The audio sampling rate was set to 240 kilohertz for sperm whales. Programmed release time was set according to conditions and logistics to facilitate best opportunity for tag retrieval. Each tag also contained a very-high frequency (VHF) transmitter that facilitates recovery of the tag using Communications Specialists, Inc. R-1000 VHF receivers with hand-held Yagi antennas (www.com-spec.com) to direct the vessel to the tag location after release from the animal. Tag calibration and data visualization following recovery was completed using a suite of tools found on animaltags.org using MATLAB R2022a.

3. Results

Eleven offshore vessel surveys were conducted between January and October 2022, covering 3,304 km of trackline during more than 137 hr of effort (**Table 1; Figure 3**).

Surveys in 2022 resulted in 105 marine mammal sightings and 3 sea turtle sightings (**Figures 4** through **7; Appendices B** and **C**). Ten cetacean taxa were identified (in order of decreasing frequency): common bottlenose dolphin (*n* = 26), pilot whale (*n* = 22), common dolphin (*n* = 22), sperm whale (*n* = 11), Risso's dolphin (*n* = 9), fin whale (*n* = 5), humpback whale (*n* = 5), blue whale (*n* = 2), Cuvier's beaked whale (*n* = 1), and True's beaked whale (*Mesoplodon mirus; n* = 1). Additionally, there was one sighting of an unidentified beaked whale. One sea turtle species was identified: loggerhead turtle (*Caretta caretta*; *n* = 3). Because both short- and long-finned pilot whales may occur within this region, most sightings of the genus *Globicephala* were not assigned a species unless they were closely approached and could be definitively identified, which was not typically the case.

3.1 Photo-ID and Photogrammetry

Photo-ID images were collected from 41 of the 105 marine mammal sightings. All photographs of baleen and sperm whales were added to HDR's existing catalogs (**Appendix D**). Eight unique fin whales were identified during OCS surveys in 2022 and added to the HDR fin whale catalog, which now contains 113 individuals. Of the 113 identified fin whales, 16 (14.2 percent) have been re-sighted, with 11 (9.7 percent) occurring during different years, ranging from 248 to 2,204 days between first and last sightings. All fin whale re-sightings have been over the continental shelf, in less than 100 m depth. Distance between re-sight locations ranged from 1.4 to 65.7 km. None of the eight individuals identified in 2022 had been previously sighted during this study.

Nineteen unique sperm whales were identified in 2022 and added to the HDR sperm whale catalog, which now contains 129 individuals. Of all cataloged individuals, nineteen (14.7 percent) were sighted on more than 1 day, ranging from 1 to 1,402 days between first and last sightings (mean = 563, median = 364). Three of the sperm whales photographed in 2022 were sighted previously in this study: HDRVAPm015, first documented June 2017, and HDRVAPm037 and 038, first documented May 2018. Drone video was also collected from eight individuals during five sightings of sperm whales. Video stills were compared to the photo-ID catalog to assist with determining identification, and measurement analyses are currently underway.

Blue whale photographs collected from four individuals were sent to Mingan Island Cetacean Study colleagues, who ran them through their North Atlantic Blue Whale Catalog and found no matches. Four humpback whales were identified during these offshore surveys in 2022 and added to HDR's humpback whale catalog, which is summarized in that project's report (Aschettino et al. 2023).

Pilot whale and Cuvier's beaked whale photographs have been provided to Duke University, and comparisons of individuals through 2022 with their Cape Hatteras catalog have been completed (Waples and Read 2023). Waples and Read (2023) added an additional 15 individuals to the Norfolk pilot whale catalog, including 1 new match to the Cape Hatteras catalog. The Norfolk catalog now contains 295 unique pilot whales, and the updated total of matches between Virginia and North Carolina is 15 percent (44 of 295). One of the Cuvier's beaked whales photographed was also matched to the Cape Hatteras catalog, originally seen in 2020 (Waples and Read 2023).

Although not observed during offshore surveys in 2022, HDR's North Atlantic Right Whale Catalog contains 22 individuals, the Minke Whale Catalog contains 10 individuals, and the Sei Whale Catalog contains 2 individuals. Images of the remaining odontocete species have been archived for future processing.

Table 1. Summary of 2022 offshore survey effort and sightings within the VACAPES OCS study area.

Date	Survey Duration (min)	Distance surveyed (km)	No. Sightings	No. Individuals	Baleen Whales No. Sightings/ No. Individuals	Deep Diving Whales[a] No. Sightings/ No. Individuals	Dolphins No. Sightings/ No. Individuals	Sea Turtles No. Sightings/ No. Individuals
13-Jan-22	696	302	13	175	4/6	3/51	6/118	0/0
16-Mar-22	717	223	10	515	1/1	3/154	6/360	0/0
21-Apr-22	820	318	11	104	1/7	4/4	6/93	0/0
23-Apr-22	778	315	14	84	1/1	3/14	10/69	0/0
30-May-22	713	314	11	248	0/0	3/83	6/162	2/3
31-May-22	755	354	7	179	0/0	1/3	5/175	1/1
29-Jun-22	865	250	13	225	0/0	9/100	4/125	0/0
8-Jul-22	764	299	3	107	0/0	1/7	2/100	0/0
19-Aug-22	705	314	11	196	0/0	9/131	2/65	0/0
21-Oct-22	707	300	9	68	4/8	0/0	5/60	0/0
26-Oct-22	711	315	6	83	1/1	0/0	5/82	0/0
Totals	**8,231**	**3,304**	**108**	**1,984**	**12/24**	**36/547**	**57/1,409**	**3/4**

Key: No. = Number
[a] Sperm, pilot, and beaked whales

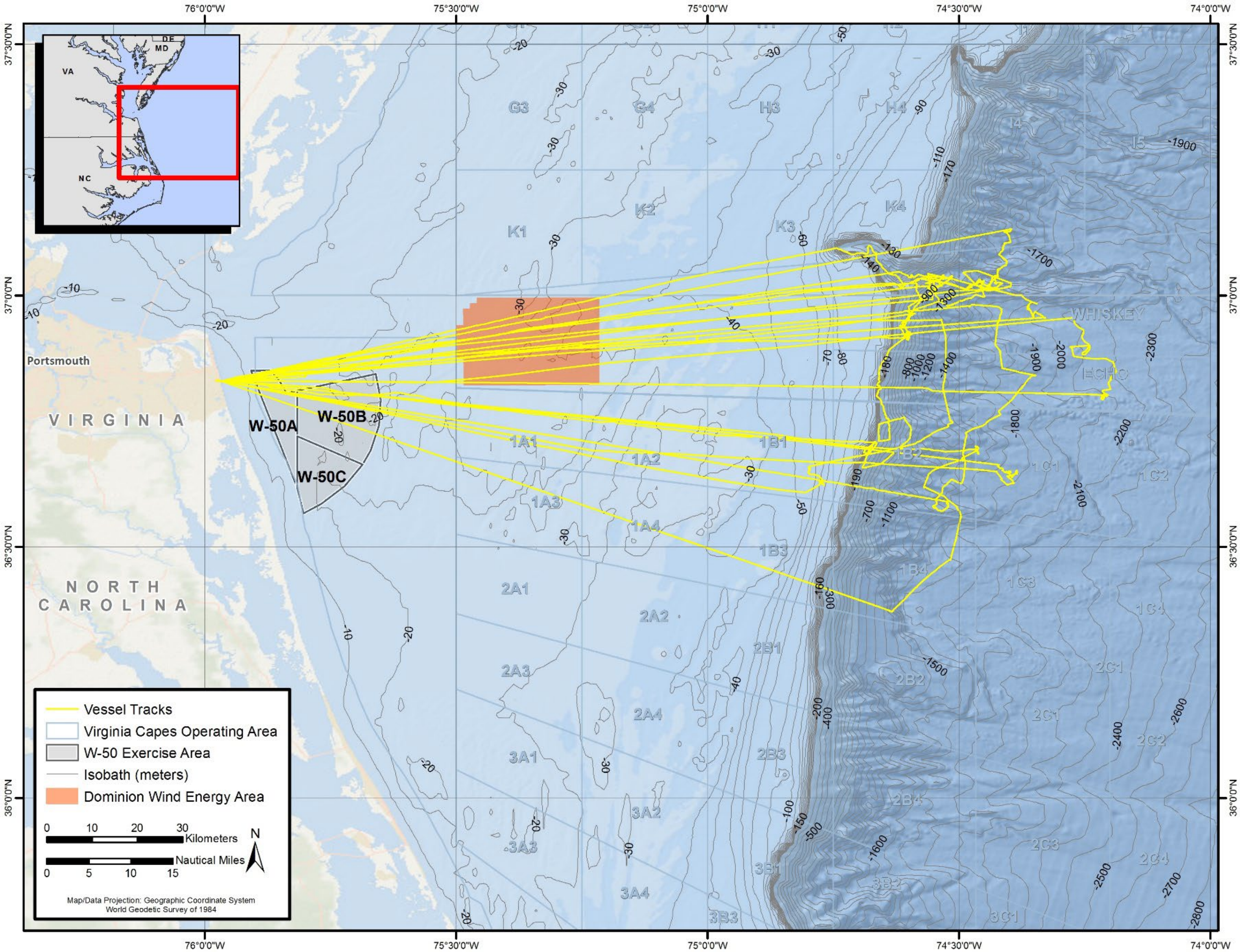

Figure 3. Offshore survey tracks for all surveys conducted in 2022.

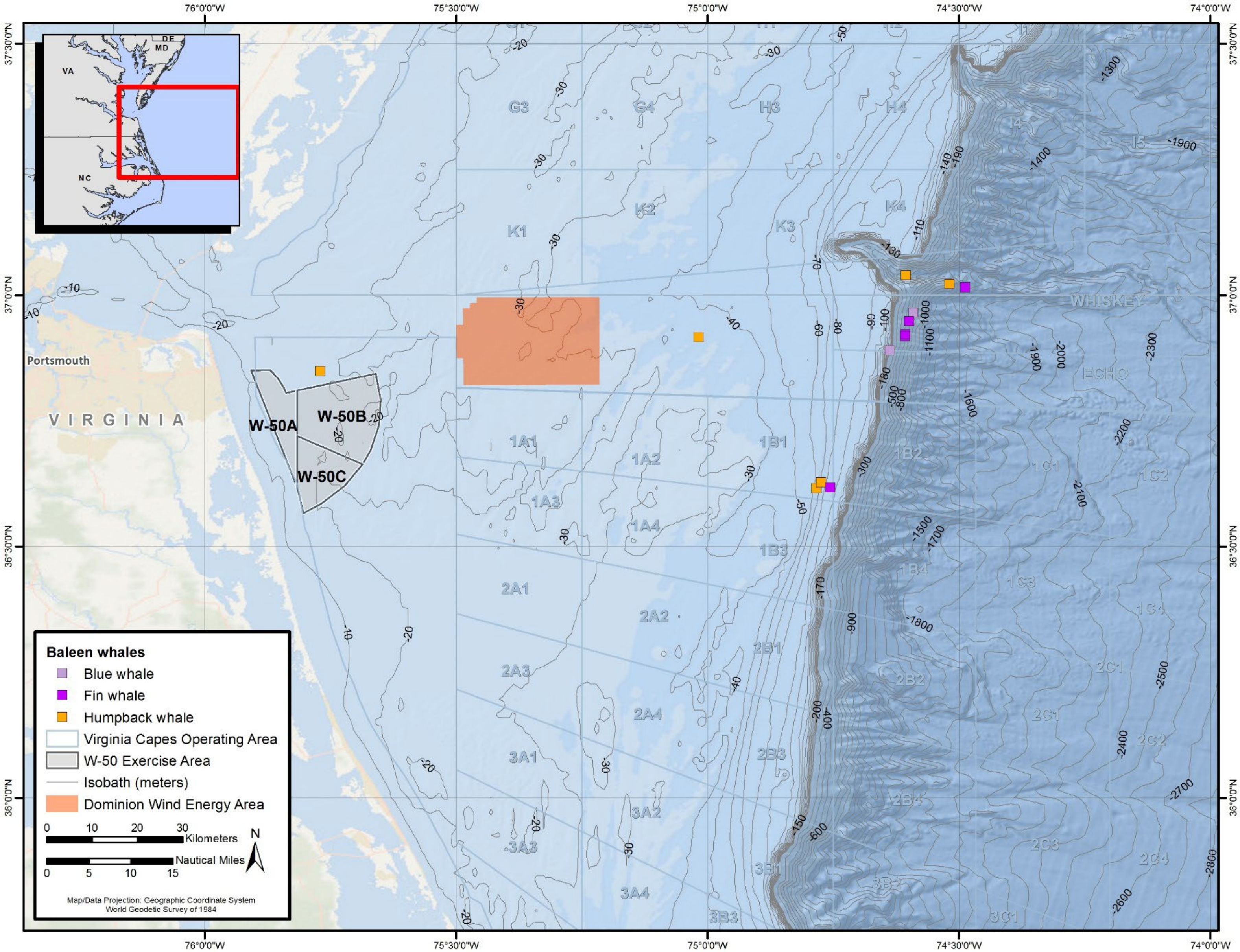

Figure 4. Locations of all baleen whale sightings (*n*=12) in 2022.

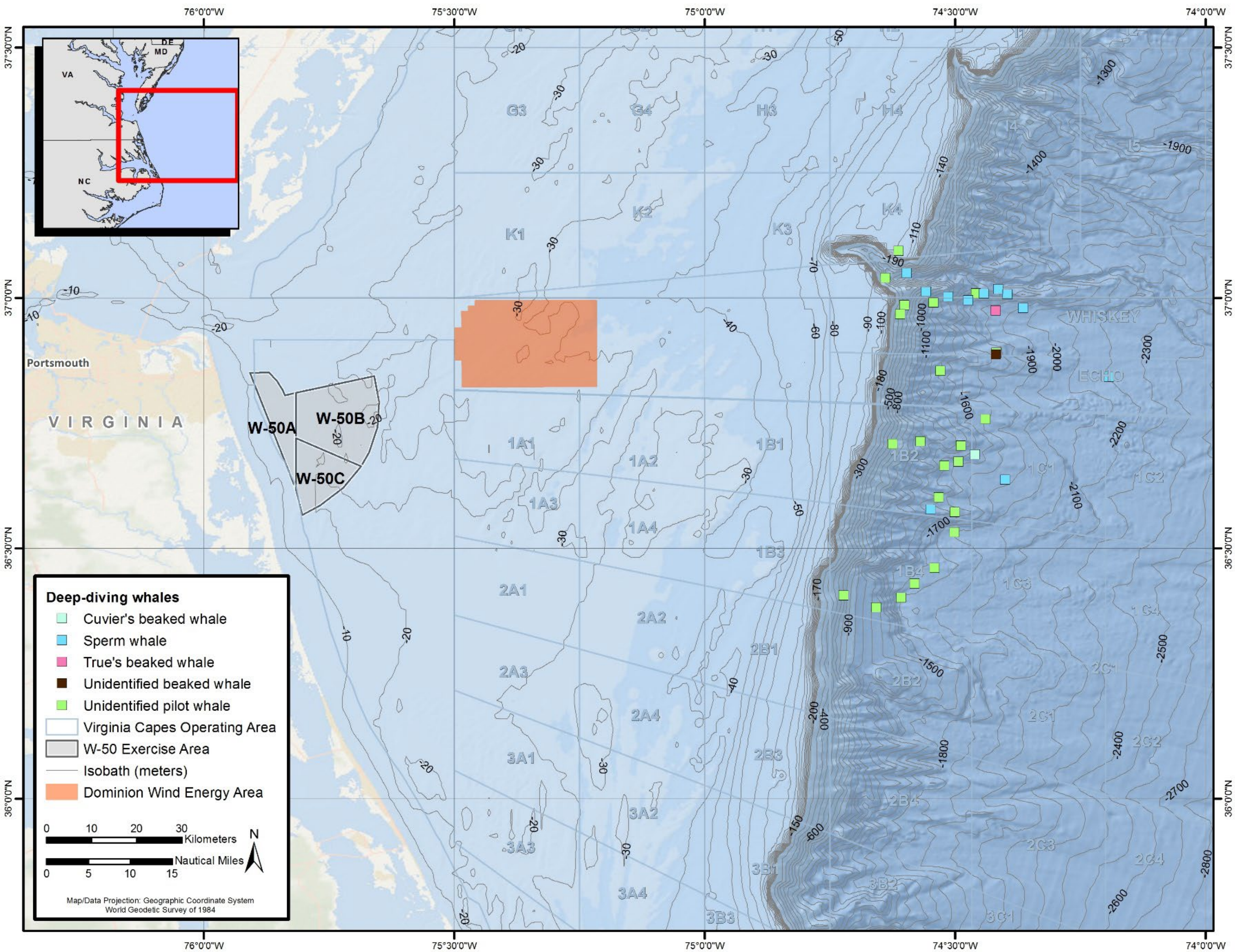

Figure 5. Locations of all deep diving whale sightings (*n*=36) in 2022.

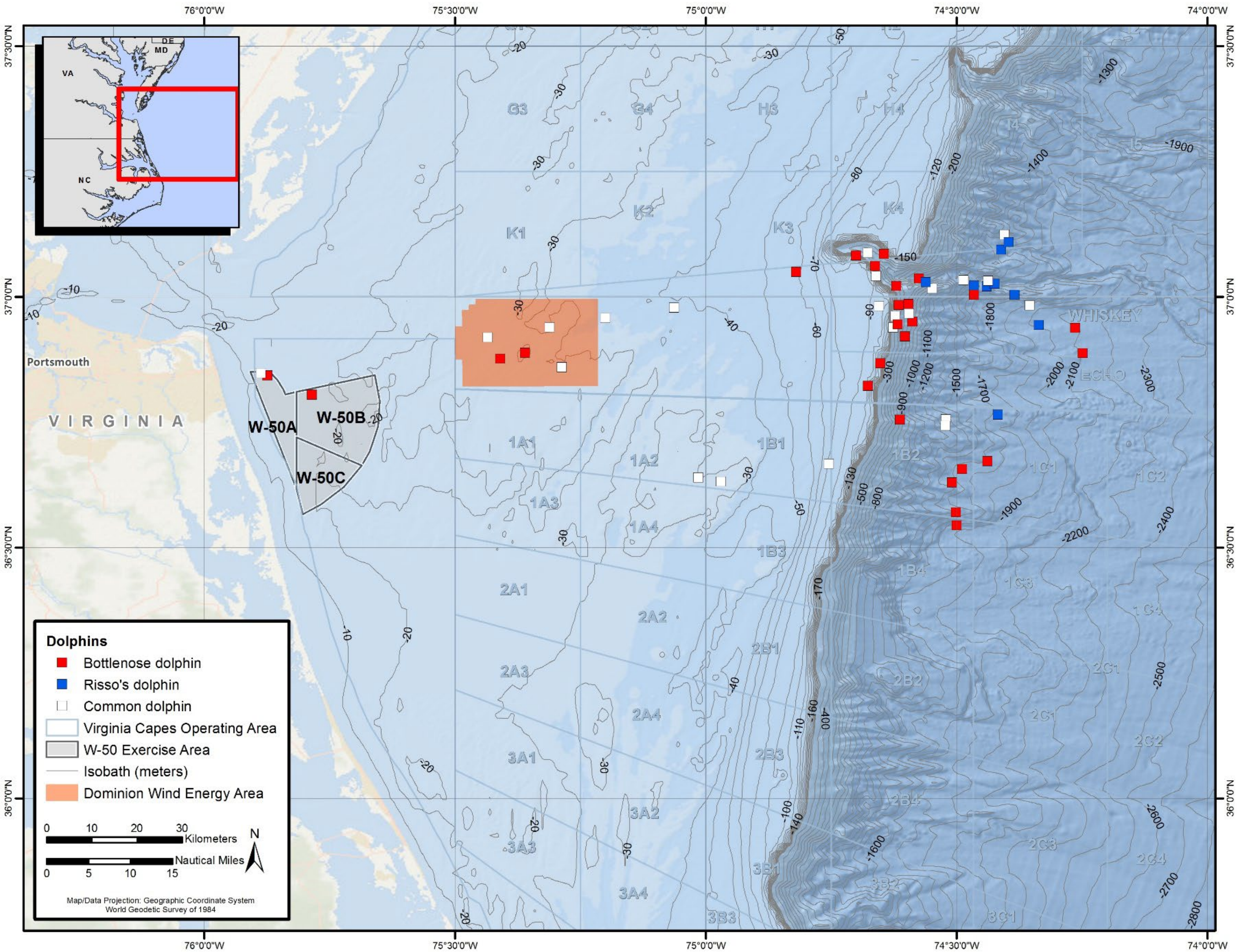

Figure 6. Locations of all dolphin sightings (*n*=57) in 2022.

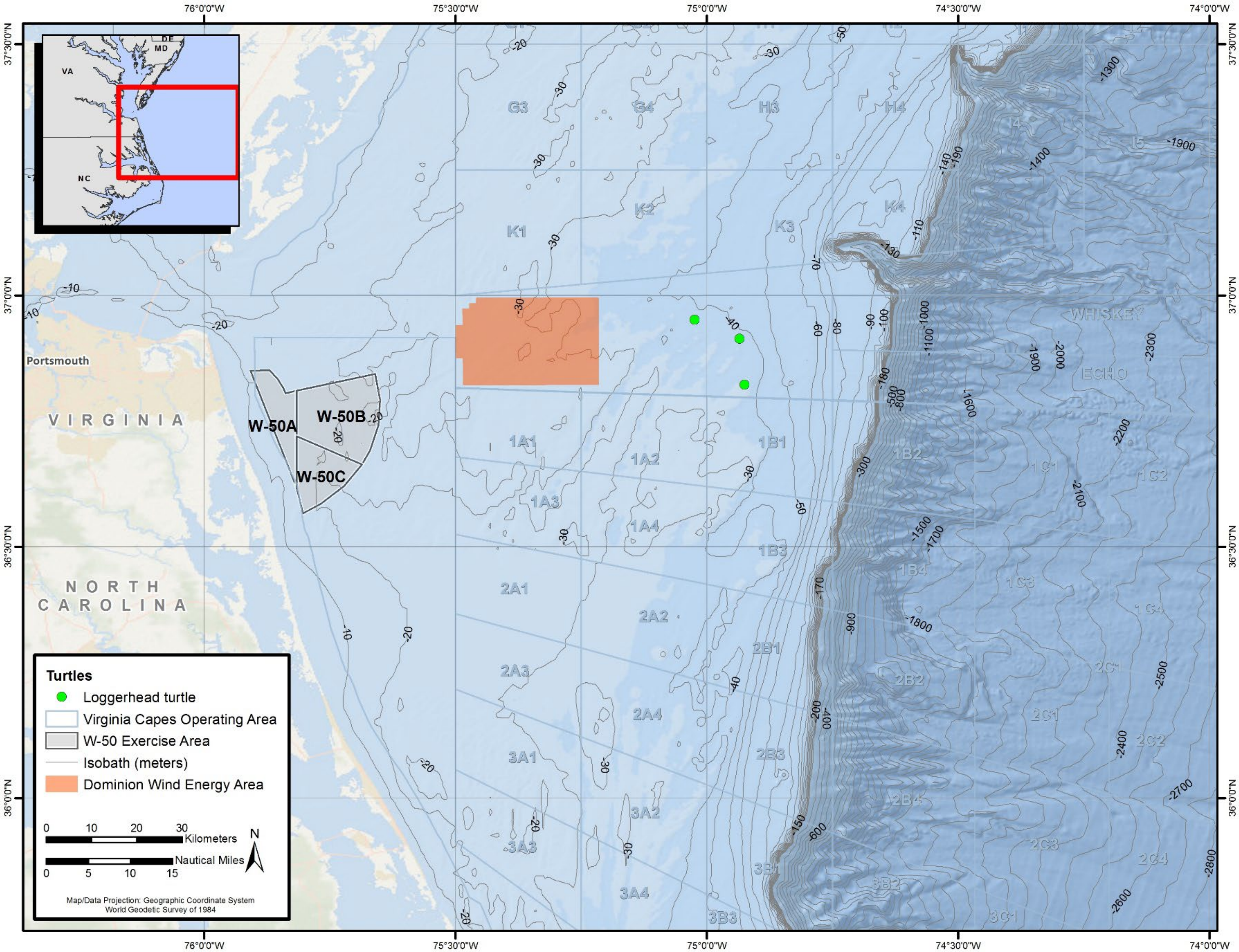

Figure 7. Locations of all sea turtle sightings (*n*=3) in 2022.

3.2 Biopsy Sample Collection and Genetic Analysis

In 2022, four biopsies were collected from sperm whales, and one was collected from a blue whale (**Appendix D**). The 2022 sperm whale samples were processed by Oregon State University along with three samples collected in 2021, and the gender results were two females and five males (all 2022 samples were male). Of 27 unique sperm whale samples collected within the study area through 2022, totals include 5 females and 22 males.

Preliminary mitochondrial DNA results have been provided by Oregon State University for 26 sperm whale samples tested to date (3 individuals were sampled twice and 1 did not have a clear result). All samples were classed into the three most common haplotypes (haplotype A = 16, haplotype B = 5, haplotype C = 5). Microsatellite techniques have not yet been completed to search for genetic matches to other sperm whales sampled in this study or elsewhere.

The blue whale sample is being stored for future processing.

3.3 Satellite Tagging

Seven satellite tags were successfully deployed in 2022: six on sperm whales and one on a blue whale (**Tables 2** through **5**). All tags were SPLASH-10 tags, which collect location and dive depth/duration information (**Tables 6** and **7**).

Tag duration for sperm whales ranged from 8.7 to 17.2 days (mean = 11.5 days). Locations from satellite-tagged sperm whales showed movements through multiple U.S. Navy OPAREAS, mostly along the continental shelf break or beyond the slope. Four of the tagged sperm whales remained within the VACAPES OPAREA for the duration of the tag transmissions (**Figures 8** and **11** through **13**). Two other tagged sperm whales moved along the continental shelf break: one to the north (but still within the VACAPES OPAREA) and then back to the south into the Cherry Point OPAREA (**Figure 9**), and the other individual initially farther to the north (through the Atlantic City OPAREA) to spend time in Hudson Canyon at the edge of the Narragansett Bay OPAREA before turning back south (**Figure 10**).

Tagged sperm whales traveled up to 312 km away from initial tag deployment locations, and 22.5 to 100 percent of their locations were within the VACAPES OPAREA depending on the individual (**Table 4**). Maximum dive depths ranged from 1,247 to 1,855 m, and maximum dive durations ranged from 56 to 69 min (**Table 6**).

The blue whale tag transmission duration was 0.7 day (**Table 5**). Due to the short duration, locations from the tagged blue whale show little movement, all within the same VACAPES Whiskey corridor, approximately 123 km from shore and within 4.8 km of the tagging location (**Figure 14, Table 5**). Maximum dive depth was 237 m, and maximum dive duration was 8.9 min (**Table 7**).

Table 2. Summary of tag deployment details for all sperm whale tags deployed in 2022.

Animal ID	Tag Type	Argos ID	Deployment (GMT)	Deployment Latitude (°N)	Deployment Longitude (°W)	Depth at Tagging Location (m)	Last Transmission (GMT)	Tag Duration (days)
HDRVAPm114	SPLASH-10F	208689	2022-Mar-16 16:39	37.036698	74.533449	1,305	2022-Mar-25 13:55	8.9
HDRVAPm115	SPLASH-10	183921	2022-Apr-21 16:06	36.992872	74.487054	1,638	2022-May-09 02:49	17.2
HDRVAPm117	SPLASH-10	183922	2022-Apr-23 15:36	36.907389	75.155357	1,288	2022-May-02 15:31	8.7
HDRVAPm118	SPLASH-10	183923	2022-May-30 15:46	36.973553	74.36138	2,947	2022-Jun-10 02:58	10.5
HDRVAPm119	SPLASH-10	183924	2022-May-30 16:02	36.967194	74.356685	1,947	2022-Jun-13 04:08	13.4
HDRVAPm121	SPLASH-10	202809	2022-Jun-29 19:26	36.571579	74.532091	1,479	2022-Jul-10 10:53	10.5

Key: ID = Identification; °N = degrees North; °W = degrees West; GMT = Greenwich Mean Time

Table 3. Summary of tag deployment details for the blue whale tag deployed in 2022.

Animal ID	Tag Type	Argos ID	Deployment (GMT)	Deployment Latitude (°N)	Deployment Longitude (°W)	Depth at Tagging Location (m)	Last Transmission (GMT)	Tag Duration (days)
HDRVABm006	SPLASH-10F	177051	2022-Oct-21 17:05	36.918831	74.605117	1,280	2022-Oct-22 15:50	0.7

Key: ID = Identification; °N = degrees North; °W = degrees West; GMT = Greenwich Mean Time

Table 4. Summary of results from satellite-tag data for all sperm whale tags deployed in 2022.

Animal ID	Argos ID	No. of Locations Post Filtering	% Within VACAPES OPAREA	Max Distance from Initial Location (km)	Mean Distance from Initial Location (km)
HDRVAPm114	208689	86	100.0	151.1	88.9
HDRVAPm115	183921	119	85.7	311.9	95.1
HDRVAPm117	183922	80	22.5	307.7	188.9
HDRVAPm118	183923	81	100.0	162.6	110.0
HDRVAPm119	183924	150	100.0	173.5	118.3
HDRVAPm121	202809	85	100.0	38.4	21.0

Key: ID = Identification; Max = Maximum; No. = Number

Table 5. Summary of results from satellite-tag data for the blue whale tag deployed in 2022.

Animal ID	Argos ID	No. of Locations Post Filtering	% Within VACAPES OPAREA	Max Distance from Initial Location (km)	Mean Distance from Initial Location (km)
HDRVABm006	177051	14	100.0	4.8	1.6

Key: ID = Identification; Max = Maximum; No. = Number

Table 6. Summary of dive data for all sperm whale SPLASH-10 tags deployed in 2022.

Animal ID	Argos ID	No. Dives Logged	Mean Dive Depth[a] (m)	Max Dive Depth (m)	Mean Dive Duration[a] (mm.ss)	Max Dive Duration (mm.ss)
HDRVAPm114	208689	154	881.2	1,855	38.57	56.85
HDRVAPm115	183921	297	466.3	1,247	40.71	61.48
HDRVAPm117	183922	229	349.6	1,247	42.33	58.28
HDRVAPm118	183923	112	889.1	1,439	47.51	67.25
HDRVAPm119	183924	232	981.0	1,599	50.01	69.08
HDRVAPm121	202809	165	1,243.1	1,791	48.04	61.28

Key: ID = Identification; Max = Maximum; mm.ss = minutes.seconds; No. = Number

[a] Mean values calculated from maximum dive depth and maximum dive duration values for each tagged individual.

Table 7. Summary of dive data for the blue whale SPLASH-10 tag deployed in 2022.

Animal ID	Argos ID	No. Dives Logged	Mean Dive Depth[a] (m)	Max Dive Depth (m)	Mean Dive Duration (mm.ss)	Max Dive Duration (mm.ss)
HDRVABm006	177051	45	73.24	237	4.44	8.88

Key: ID = Identification; Max = Maximum; mm.ss = minutes.seconds; No. = Number
[a] Mean values calculated from maximum dive depth and maximum dive duration values for each tagged individual.

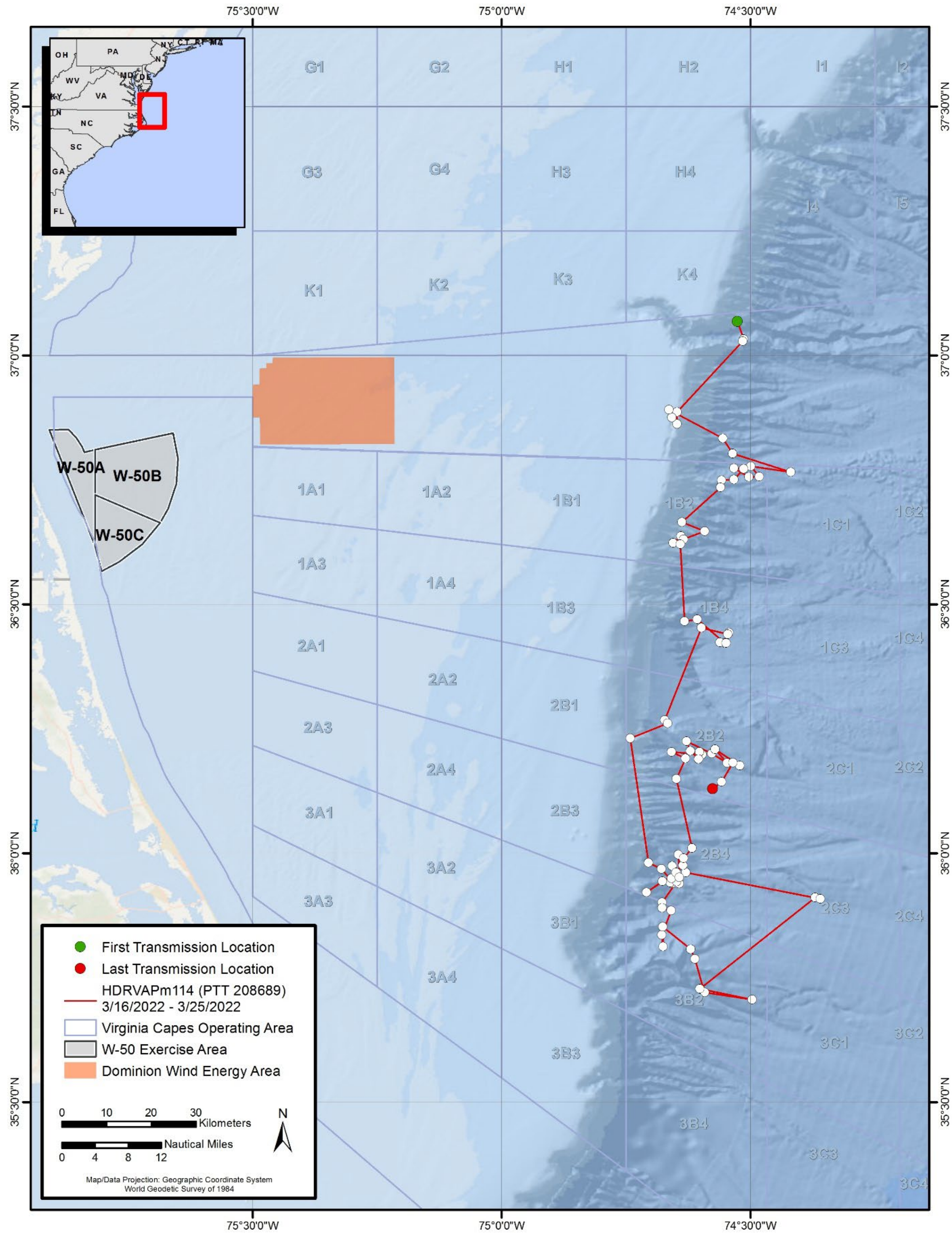

Figure 8. Filtered locations (white dots) and track of sperm whale HDRVAPm114 over 8.9 days.

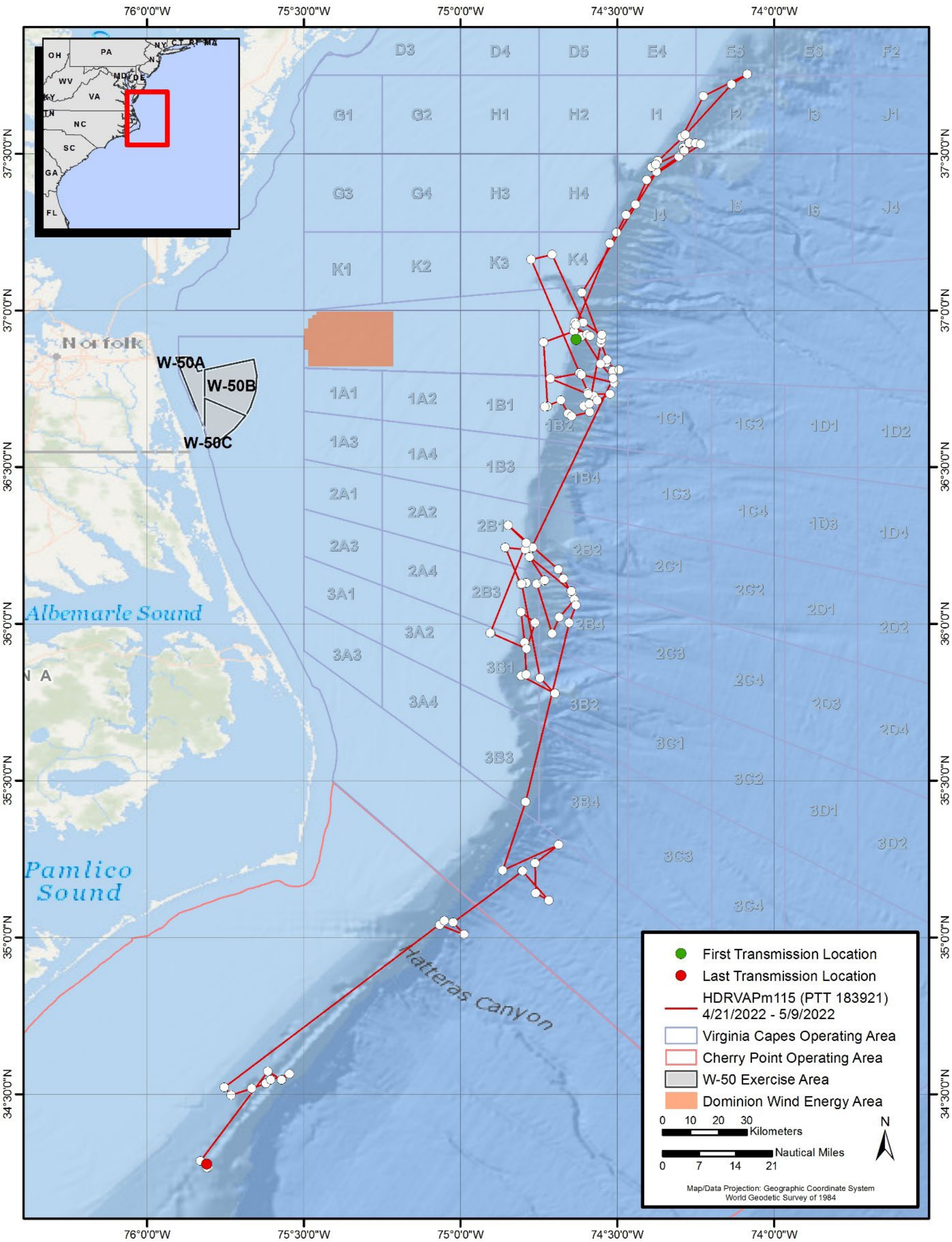

Figure 9. Filtered locations (white dots) and track of sperm whale HDRVAPm115 over 17.2 days.

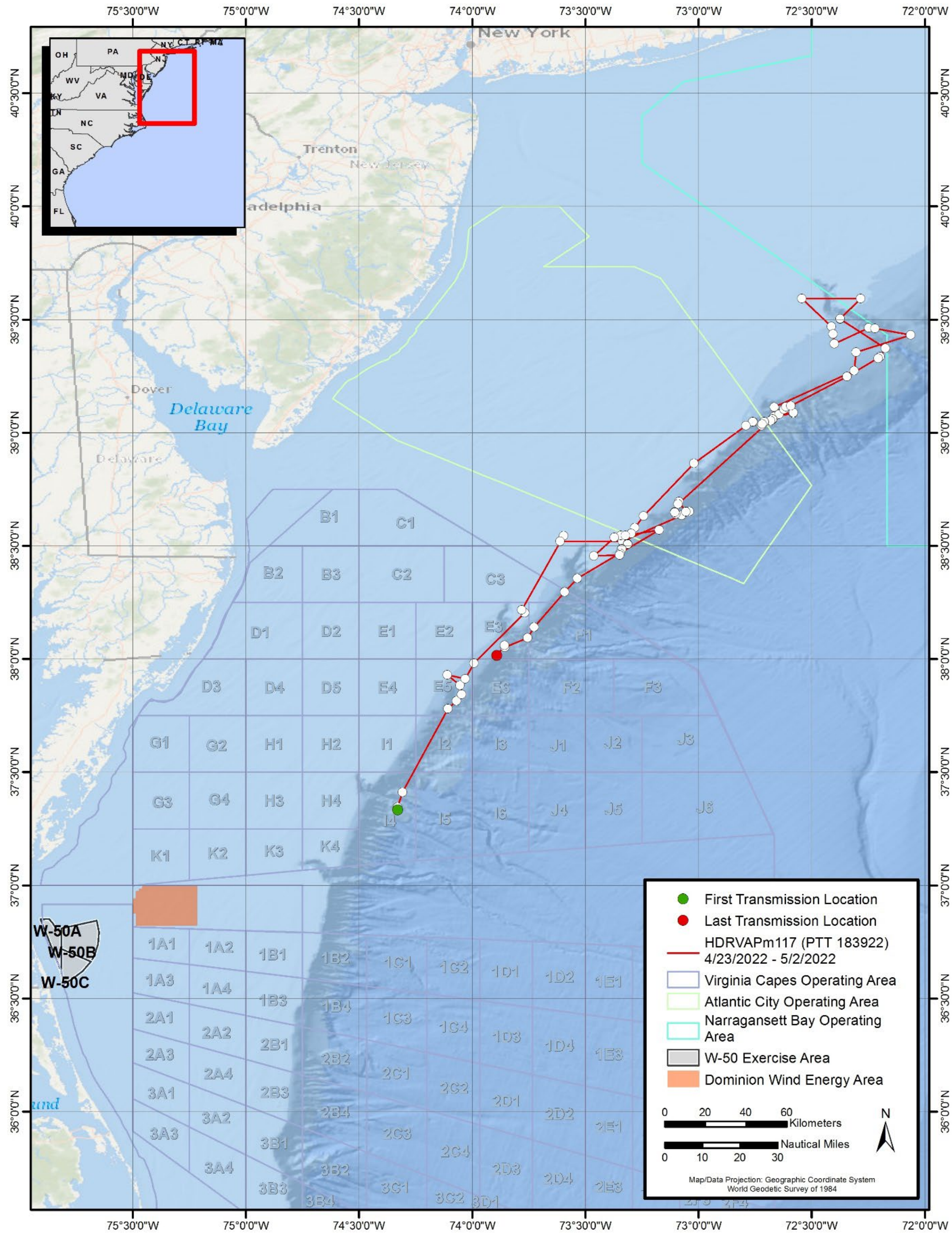

Figure 10. Filtered locations (white dots) and track of sperm whale HDRVAPm117 over 8.7 days.

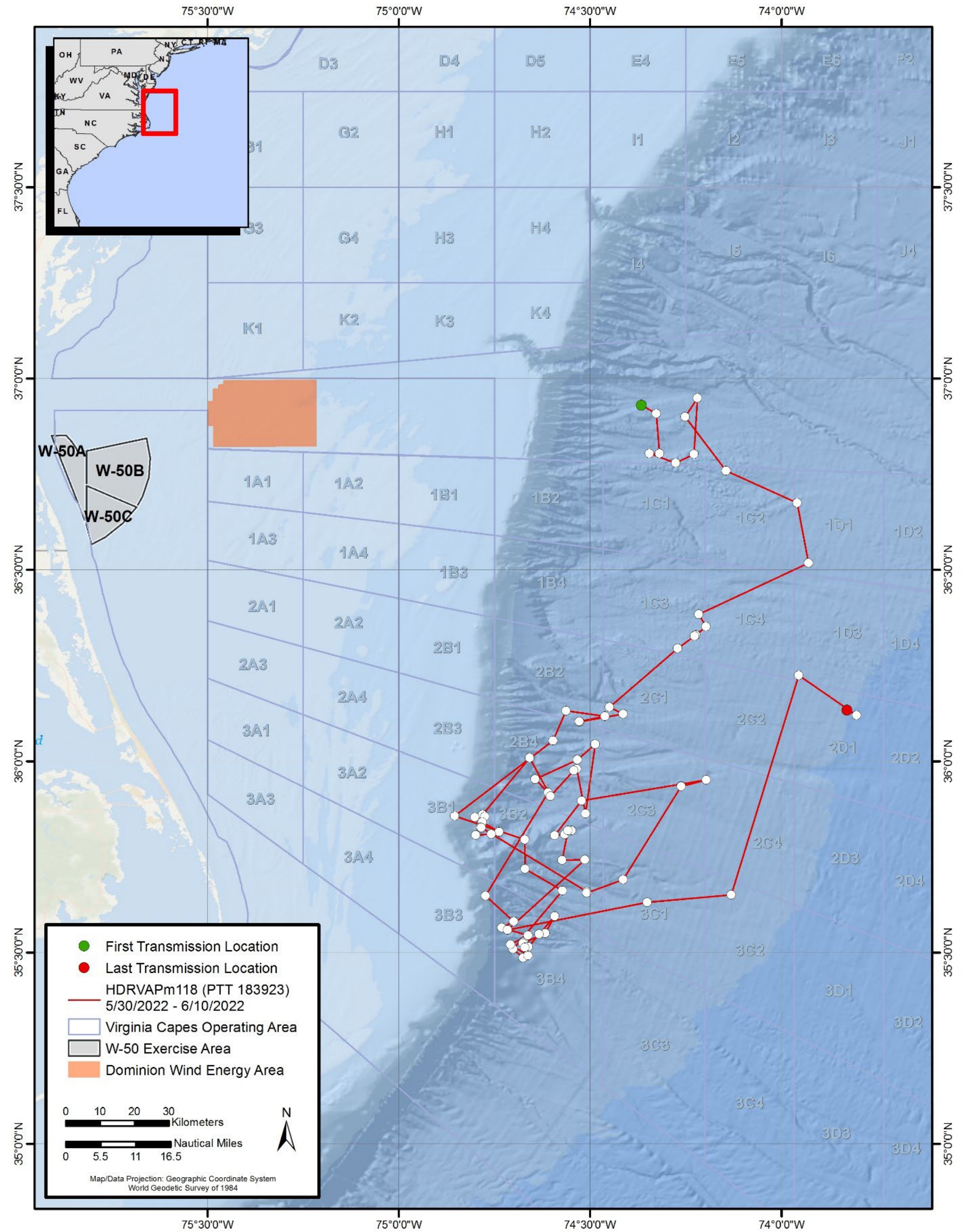

Figure 11. Filtered locations (white dots) and track of sperm whale HDRVAPm118 over 10.5 days.

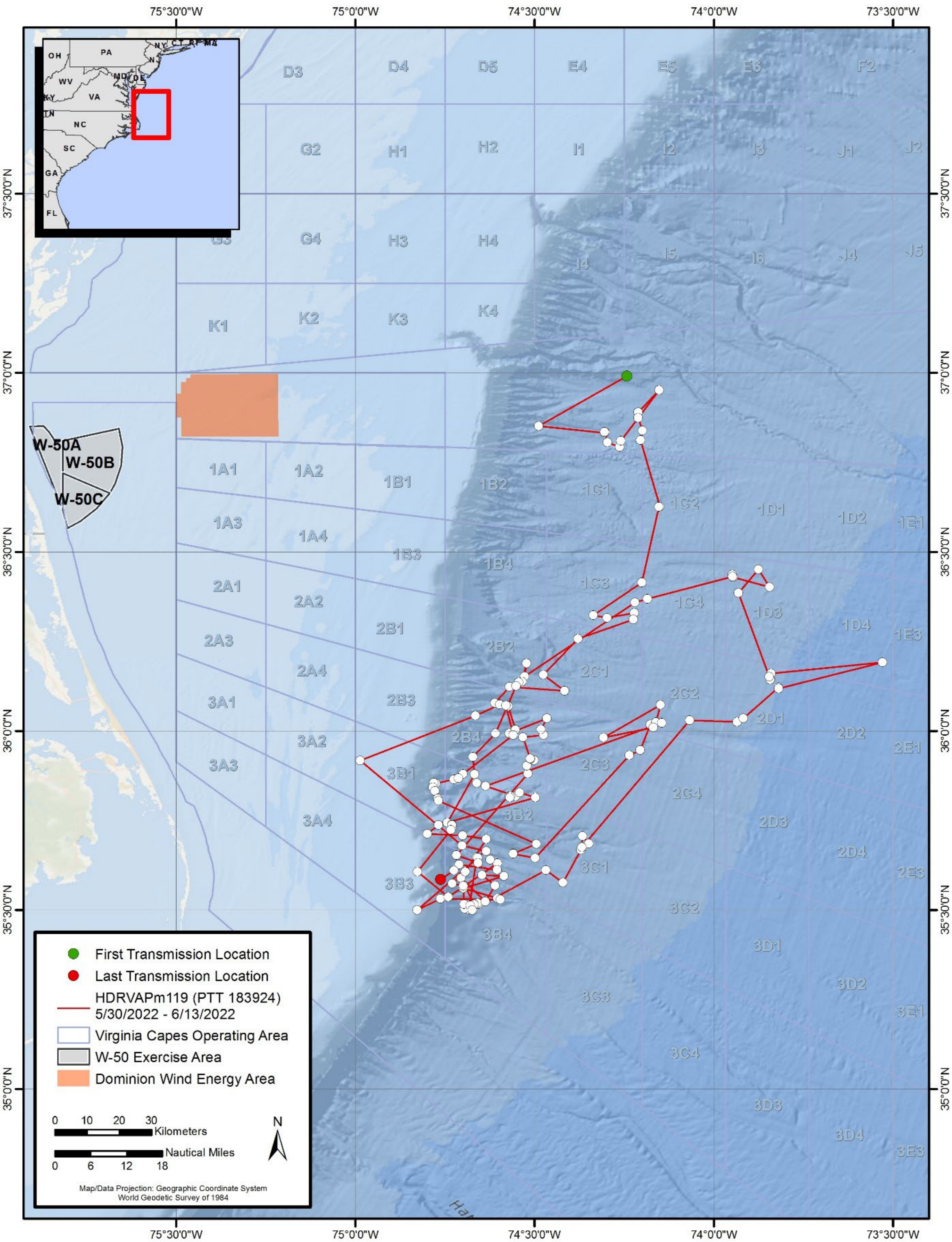

Figure 12. Filtered locations (white dots) and track of sperm whale HDRVAPm119 over 13.4 days.

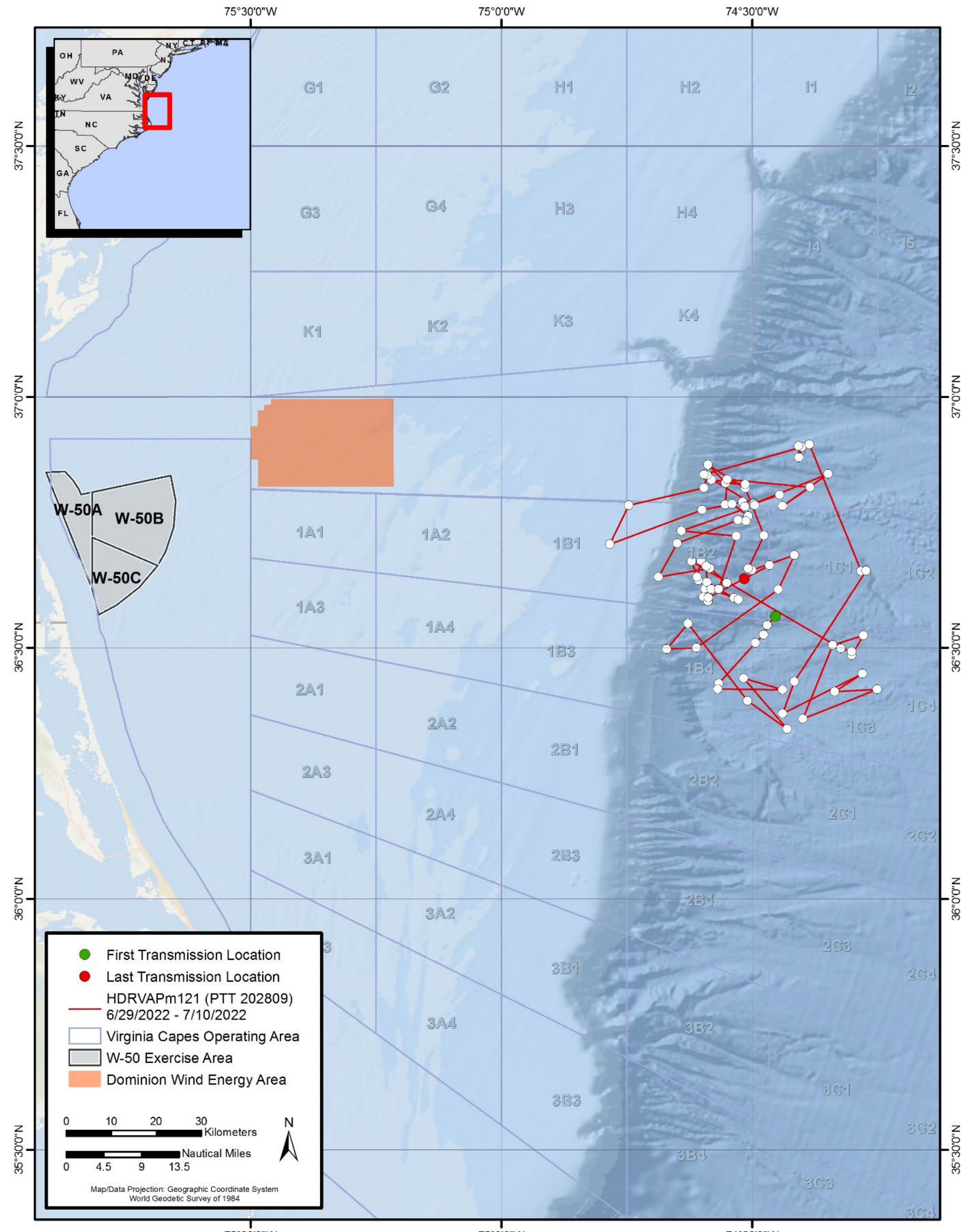

Figure 13. Filtered locations (white dots) and track of sperm whale HDRVAPm121 over 10.5 days.

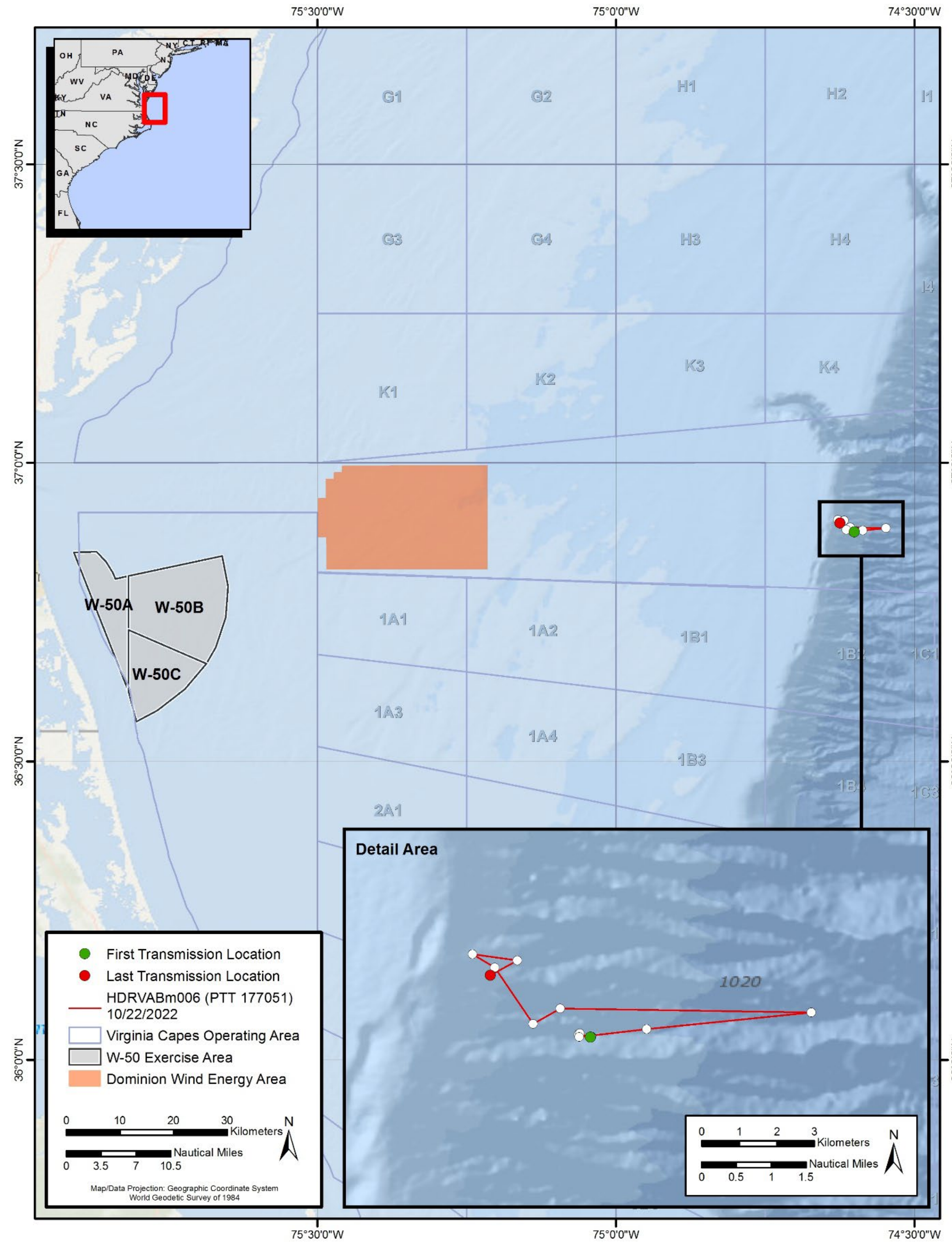

Figure 14. Filtered locations (white dots) and track of blue whale HDRVABm006 over 0.7 days.

3.4 DTAG Results

HDR incorporated the use of DTAGs into this project in 2022 with the first successful sperm whale tag deployment in April. In total, three DTAGs were deployed on sperm whales during 2022 and generated approximately 198, 280, and 135 min of recordings (**Table 8**). Two of the individuals were also satellite tagged and biopsied: HDRVAPm117 and HDRVAPm119. Movement and acoustic data are still being analyzed; however, dive-depth profiles for all individuals are shown in **Figure 15**. The first tagged individual was a solitary male sperm whale, and the tag (pm22_113a) collected data during three dives, which included two dives to depths more than 1,000 m and one dive closer to 600 m. The second tagged individual was also male and seen in a group of three sperm whales. The tag (pm22_150a) was programmed for an overnight deployment but released from the whale slightly more than 300 minutes into the deployment. The dive profile shows that the individual remained at or near the surface for more than 2 hr before it dove (the tag released before that dive was complete). The same three individuals were seen together the following day, when the field team returned to collect the tag, and spent time at the surface and not diving while the research team was present. The third tagged individual is of unknown gender (not sampled) with one other small whale, and the tag (pm22_189a) recorded two dives before the planned same-day release: one dive to approximately 500 m and the other dive to nearly 1,600 m.

Table 8. DTAG deployments on sperm whales during the 2022 field season.

Animal ID	Species	DTAG No./ Deployment ID	Deployment (GMT)	Depth at Tagging (m)	Tag off animal (GMT)	Tag Duration (min)
HDRVAPm117	Sperm whale	321/ pm22_113a	2022-Apr-23 15:36	1,288	2022-Apr-23, 18:55	198
HDRVAPm119	Sperm whale	321/ pm22_150a	2022-May-30 16:02	1,947	2022-May-30, 20:41[a]	280[a]
HDRVAPm116	Sperm whale	346/ pm22_189a	2022-Jul-08 14:56	1,779	2022-Jul-08, 17:08[a]	135[a]

Key: ID = Identification; No. Number; GMT = Greenwich Mean Time
[a] Research team was not present during tag release; the tag-off time and tag duration are estimated.

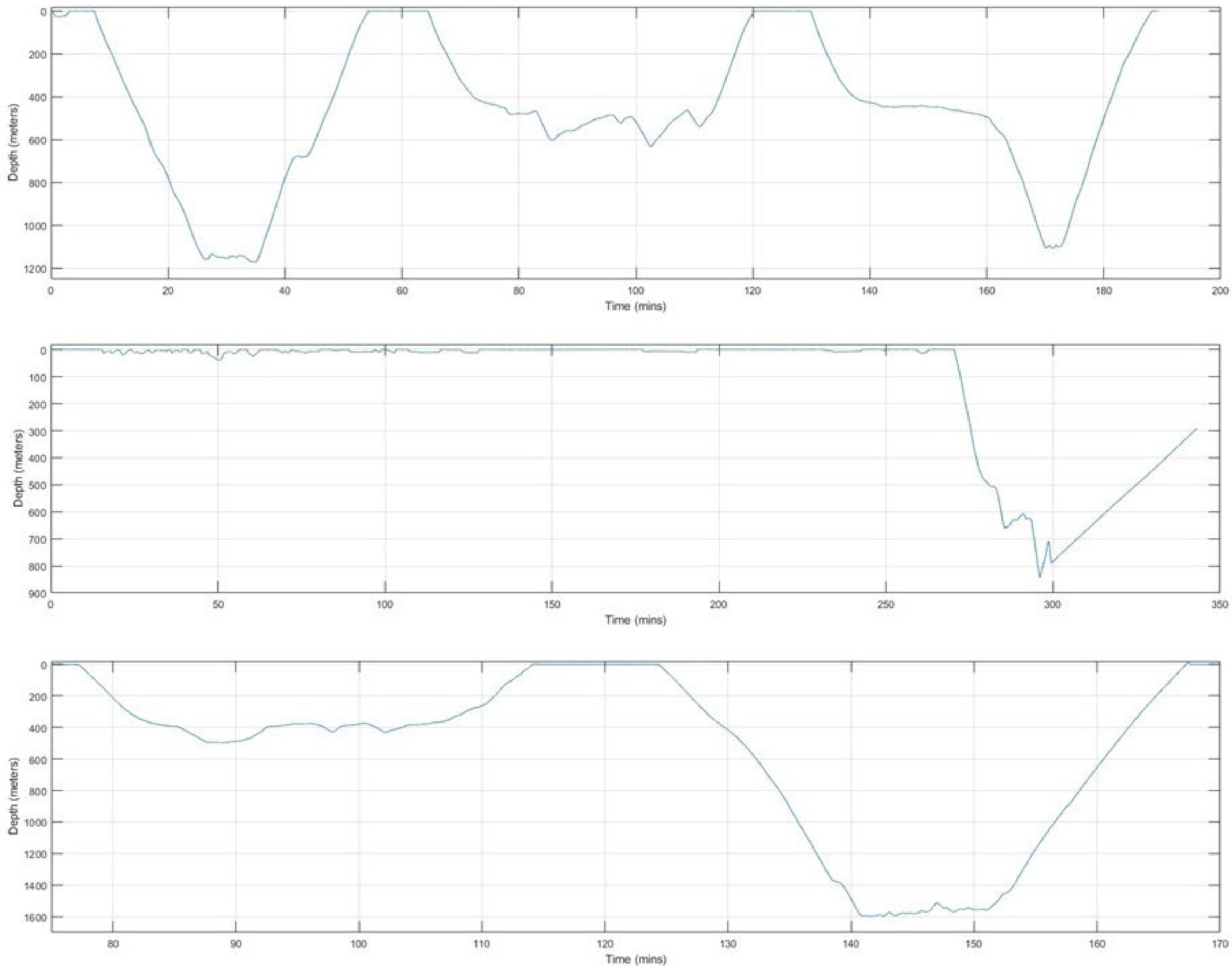

Figure 15. Dive depth profile (in m) for sperm whales, DTAG pm22_113a (top), DTAG pm22_150a (center), and DTAG pm22_189a (bottom). The uniform depth change after 300 min for pm22_150a is after the tag released from the whale. Note that the X and Y axes are different scales for each individual.

4. Discussion

Data collection and analyses for this project are ongoing; however, results to date show a high degree of marine-mammal diversity within the study area. Surveys conducted in 2022 continued coverage to the east of Norfolk Canyon and to the southern extent of the study area, continuing to survey waters deeper than 1,500 m to increase chances for detections of deep-diving cetaceans. Sightings of 10 species of marine mammals and 1 species of sea turtle were made over 11 surveys, showing a wide distribution throughout the study area. All species encountered during 2022 had previously been sighted during this study, keeping the total number of marine mammal species encountered within the study area over the project duration to 20. Previous aerial survey and passive acoustic monitoring data from the region show similar species diversity (Cotter 2019; McAlarney et al. 2018a, 2018b; Rafter et al. 2018).

Sightings of deep-diving species, including sperm and pilot whales, were concentrated beyond the shelf break and into deeper offshore waters during the 2022 surveys, similar to previous years. Baleen whales were encountered both over the shelf and past the shelf break, although the majority were past the shelf break, similar to 2019 through 2021. This is in contrast to baleen whale sightings made during surveys in 2016 through 2018, which were primarily over the shelf. Dolphin species were sighted throughout the core study and transit areas, and loggerhead sea turtle sightings were all over the shelf.

Sightings of marine mammal species within U.S. Navy range boxes in and around the Norfolk Canyon (K3, K4, and I4) have been frequent throughout the duration of this multi-year study, suggesting a high probability for overlap between these species and U.S. Navy training activities.

The number of individuals in the photo-ID catalogs continues to increase for baleen and sperm whales. This valuable tool requires a multi-year commitment to accumulate sufficient data to produce meaningful insights into site-fidelity information and ultimately to address population consequences. However, results are already becoming evident for some species, with 14.7 percent (19 of 129) of cataloged sperm whale individuals being re-sighted up to 1,402 days after the initial encounter.

Using photos collected during this study and the Mid-Atlantic Nearshore and Mid-Shelf Baleen Whale Monitoring project (Aschettino et al. 2023), 16 fin whales (14.2 percent) were photographed on more than 1 day (between-season re-sightings ranged from 248 to 2,204 days from the initial encounter). Initial sighting locations and those of re-sighted fin whales are all within water over the continental shelf, which not only shows emerging evidence of site fidelity displayed by an ESA-listed species whose movements were previously poorly understood within this region, but also supports the importance of this habitat to the species.

Additionally, the importance of the Norfolk Canyon to ESA-listed sperm whales has also become evident through re-sightings and tagged whale movements. To date, comparison of the catalog to existing sperm whale catalogs within the Atlantic Ocean and Gulf of Mexico have not yielded any matches, but as additional catalogs are added to photo-ID sharing websites, valuable matches may emerge. Re-sightings within the study area and outside regions will continue to address questions of seasonal variation and social affiliations and may eventually address questions related to population-level consequences of disturbance.

The addition of sUAS video collection has proven valuable to the overall project, not only in collecting data to improve age-class assessments, assess body condition, and document associations of priority species, but has often proven valuable in improving the success rate of satellite-tagging efforts by informing the research team of animal movements before they could be detected from the surface. Data from the 2022 surveys are still being processed; however, previously estimated sperm whale lengths that were calculated using the Duke University software (Torres and Bierlich 2020) showed a mean length of nearly 9 m, confirming the designation of immature male or adult female for those sightings estimated in the field (Engelhaupt et al. 2021).

Satellite-tagged whales show movements through multiple VACAPES range boxes beyond the continental slope **(Figures 8** through **13**). Sperm whales continue to show a high percentage of locations within the VACAPES OPAREA range boxes, with four of the six transmitting tags deployed in 2022 having 100 percent of locations within the VACAPES OPAREA, although this may be biased due to deployment location and relatively short tag durations. The other two individuals initially spent time in the VACAPES OPAREA, then continued out of the area, both initially to the north before turning back south, but one individual (HDRVAPm117) continued farther north, to Hudson Canyon, before changing direction. The other, HDRVAPm115, traveled the farthest from the tagging location, nearly 312 km, but to the south within the Cherry Point OPAREA.

Sightings of four individual blue whales and the successful satellite tagging of one individual during 2022 has significantly added to the limited knowledge of this ESA-listed species. Seven blue whales have been identified within the study area to date, and two individuals have been satellite tagged. Data collected during 2021 and 2022 support the previously published records of sightings off Virginia documented by this study (D.T. Engelhaupt et al. 2020), providing unique insight into the movements of the species. Though brief, the 2022 dive-depth data had a maximum dive depth of 237 m in locations where bottom depth exceeded 1,000 m, similar to the 2021 tag (Aschettino et al. 2022, Engelhaupt et al. 2022). Tag location data also further support the potential for overlap between both species and U.S. Navy training activities.

Analyses of movement and dive data for both fin and sperm whales are ongoing, with results showing similarities and variability within and between individuals of each species. Additional State Space Modeling (SSM) analyses of sperm whale tag data with a larger dataset than included in the 2018 report (Engelhaupt et al. 2019) is planned for the near future. Manuscripts in preparation include “Diving Behavior and Movement Pattern of a Sowerby’s Beaked Whale Tagged Offshore Virginia,” and “Movements and Dive Behavior of a Blue Whale Tagged off Virginia.”

Working 60 to 90 nm from shore requires exploiting short and infrequent weather-window opportunities as well as limited access to restricted U.S. Navy training areas. With every survey completed, this project provides a more comprehensive understanding of how numerous species (including ESA-listed ones) use this important offshore habitat.

As more surveys are completed and tags are deployed, the HDR team of researchers continues to expand their coverage across multiple seasons, which allows researchers to explore questions of intra- and inter-seasonal species occurrence and variation. Providing a more detailed understanding of both fine- and medium-scale foraging ecology of sperm and beaked whales is now the priority. And with the implementation of suction-cup tag deployments on deep-diving species, researchers will work to better detail fine-scale movement, dive patterns, foraging behavior, and acoustic activity to add to the existing medium-duration telemetry dataset. Understanding fine-scale baseline data and recording subtle changes in behavior (including acoustic activity) will provide valuable insights on animal behavior and potential impacts from anthropogenic stressors. The results of this multi-year effort are expected to provide the U.S. Navy with the level of detailed information required to make informed decisions with regard to future training and testing mitigation measures within the survey area as a means to minimize potential impacts on both marine mammals and sea turtles.

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A

Data Fields Recorded in COMPASS

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Data Fields to be Recorded

Placement	Field/Attribute	
Survey/ Environmental	• Date/Time • Platform • Survey ID • Beaufort Scale • Visibility • Wind Direction	• Swell • Percent Cloud Cover • Effort Status • Personnel • Leg Notes
Sighting	• Sighting Number • Date/Time • Latitude/Longitude • Relative Bearing • Angle to Sighting • Distance to Animal • Animal's Heading • Species Name (Common) • Species Name (Scientific) • Minimum Group Size • Maximum Group Size • Best Group Size • Count (Calves) • Count (Juveniles) • Behavior State • Multiple Sightings • Recorder • Observer • Reaction • Depth • Temperature	• Navy Ship within 500 m? (Y/N) • Cargo Ship within 500 m? (Y/N) • Fishing/Recreation Boat within 500 m? (Y/N) • Within 500 m of Shipping Channel? (Y/N) • Notes • Photographs Taken (Y/N) (If Yes – frame numbers, camera, photographer) • Video (Y/N) (If Yes – frame numbers, camera, photographer) • Biopsy (Y/N) (If Yes – shooter, hit/miss, sample location, reaction, others present/reacting, sample, sample name, comments) • Tagging (Y/N) (If Yes – shooter, hit/miss, tag location, reaction, others present/reacting, tag number, tag type, comments) • Maximum Distance between Nearest Neighbor • Minimum Distance between Nearest Neighbor
Focal (Related to Focal Individual Only)	• Date/Time • Latitude/Longitude • Group ID • Behavioral State (Travel, Feed, Mill, Social, Rest, Log, Unknown) • Behavioral Event (Blow, Dive/Peduncle Arch, FUD, FDD, Side fluke, Lunge, Tail Slap, Pec Slap, Spy Hop, Breach, Bubbles, Start Follow, Stop Follow, Footprint WP, First Surfacing, Head Slap, Peduncle Slap, Chase, Brood Side Display, Head Lunge, Linear Bubble Trail, Charge)	• Bearing • Distance to Sighting • Heading of the Animal • Relative Movement of Vessel and Animal's Bearing • Sighting Notes

Key: ID = Identification; m = meter(s); Y = Yes; N = No; FUD = Fluke Up Dive; FDD = Fluke Down Dive; Pec = Pectoral; WP = Waypoint

Note: Upon each entry, time stamp and Global Positioning System coordinate is recorded for the position of the vessel. Variables may be modified as deemed necessary by the Chief Scientist.

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B

Marine Mammal Sightings
2022

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Date	Sighting Time (local)	Scientific Name	Common Name	Group Size	Latitude (°N)	Longitude (°W)
13-Jan-22	8:30	*Delphinus delphis*	Common dolphin	6	36.639679	75.015169
13-Jan-22	8:37	*Delphinus delphis*	Common dolphin	9	36.631931	74.970065
13-Jan-22	9:01	*Megaptera novaeangliae*	Humpback whale	2	36.616429	74.783144
13-Jan-22	9:08	*Balaenoptera physalus*	Fin whale	1	36.617495	74.755724
13-Jan-22	9:32	*Megaptera novaeangliae*	Humpback whale	2	36.627791	74.774218
13-Jan-22	11:43	*Globicephala sp.*	Unidentified pilot whale	22	36.708368	74.624746
13-Jan-22	12:04	*Globicephala sp.*	Unidentified pilot whale	23	36.713749	74.568980
13-Jan-22	12:24	*Delphinus delphis*	Common dolphin	25	36.743196	74.522179
13-Jan-22	12:35	*Delphinus delphis*	Common dolphin	60	36.755975	74.521409
13-Jan-22	13:15	*Globicephala* sp.	Unidentified pilot whale	6	36.854305	74.529460
13-Jan-22	14:00	*Tursiops truncatus*	Common bottlenose dolphin	13	36.950366	74.588069
13-Jan-22	16:03	*Tursiops truncatus*	Bottlenose dolphin	5	36.876393	75.409610
13-Jan-22	16:51	*Megaptera novaeangliae*	Humpback whale	1	36.849604	75.769808
16-Mar-22	7:28	*Delphinus delphis*	Common dolphin	60	36.847705	75.886622
16-Mar-22	7:30	*Tursiops truncatus*	Bottlenose dolphin	12	36.843702	75.873850
16-Mar-22	8:33	*Delphinus delphis*	Common dolphin	30	36.919287	75.434745
16-Mar-22	10:22	*Delphinus delphis*	Common dolphin	250	37.041231	74.660648
16-Mar-22	10:26	*Globicephala sp.*	Unidentified pilot whale	50	37.039982	74.639021
16-Mar-22	10:36	*Physeter macrocephalus*	Sperm whale	3	37.049855	74.596710
16-Mar-22	10:37	*Megaptera novaeangliae*	Humpback whale	1	37.040159	74.605988
16-Mar-22	12:53	*Physeter macrocephalus*	Sperm whale	1	37.012528	74.558433
16-Mar-22	17:02	*Delphinus delphis*	Common dolphin	7	36.957709	75.200559
16-Mar-22	17:19	*Delphinus delphis*	Common dolphin	1	36.939439	75.311533
21-Apr-22	7:57	*Delphinus delphis*	Common dolphin	20	36.978648	75.062970
21-Apr-22	9:06	*Tursiops truncatus*	Bottlenose dolphin	25	37.021861	74.620108
21-Apr-22	9:28	*Tursiops truncatus*	Bottlenose dolphin	5	37.036468	74.575018
21-Apr-22	10:08	*Balaenoptera physalus*	Fin whale	6	37.015520	74.487338
21-Apr-22	11:52	*Physeter macrocephalus*	Sperm whale	1	36.995784	74.473684
21-Apr-22	13:15	*Delphinus delphis*	Common dolphin	20	37.016132	74.549093
21-Apr-22	14:39	*Grampus griseus*	Risso's dolphin	2	37.020752	74.440064
21-Apr-22	15:07	*Grampus griseus*	Risso's dolphin	1	37.026450	74.424190
21-Apr-22	15:24	*Physeter macrocephalus*	Sperm whale	1	37.007558	74.395923
21-Apr-22	15:26	*Physeter macrocephalus*	Sperm whale	1	37.017457	74.414020
21-Apr-22	15:52	*Physeter macrocephalus*	Sperm whale	1	37.002714	74.514045
23-Apr-22	7:54	*Megaptera novaeangliae*	Humpback whale	1	36.916366	75.017881
23-Apr-22	8:58	*Delphinus delphis*	Common dolphin	12	36.961802	74.622239
23-Apr-22	9:15	*Globicephala sp.*	Unidentified pilot whale	8	36.990695	74.542860

Date	Sighting Time (local)	Scientific Name	Common Name	Group Size	Latitude (°N)	Longitude (°W)
23-Apr-22	9:31	*Tursiops truncatus*	Bottlenose dolphin	2	37.003933	74.465298
23-Apr-22	10:04	*Grampus griseus*	Risso's dolphin	5	37.022577	74.465289
23-Apr-22	10:12	*Delphinus delphis*	Common dolphin	12	37.033376	74.486032
23-Apr-22	11:28	*Physeter macrocephalus*	Sperm whale	1	37.008627	74.442587
23-Apr-22	11:59	*Delphinus delphis*	Common dolphin	24	37.031950	74.437533
23-Apr-22	13:50	*Grampus griseus*	Risso's dolphin	1	37.094037	74.411406
23-Apr-22	14:22	*Grampus griseus*	Risso's dolphin	3	37.108805	74.396056
23-Apr-22	14:36	*Delphinus delphis*	Common dolphin	1	37.124128	74.404798
23-Apr-22	15:27	*Globicephala sp.*	Unidentified pilot whale	5	37.093970	74.612980
23-Apr-22	15:31	*Tursiops truncatus*	Bottlenose dolphin	2	37.085700	74.644826
23-Apr-22	15:55	*Tursiops truncatus*	Bottlenose dolphin	7	37.049882	74.819803
30-May-22	7:25	*Caretta caretta*	Loggerhead turtle	1	36.951534	75.023867
30-May-22	8:15	*Delphinus delphis*	Common dolphin	45	36.981725	74.654482
30-May-22	8:26	*Tursiops truncatus*	Bottlenose dolphin	15	36.983596	74.615434
30-May-22	8:30	*Globicephala sp.*	Unidentified pilot whale	70	36.985534	74.601260
30-May-22	9:05	*Grampus griseus*	Risso's dolphin	4	37.029670	74.561608
30-May-22	10:06	*Globicephala sp.*	Unidentified pilot whale	10	37.009359	74.458150
30-May-22	10:25	*Grampus griseus*	Risso's dolphin	18	37.003885	74.384225
30-May-22	10:40	*Delphinus delphis*	Common dolphin	30	36.983206	74.354531
30-May-22	11:15	*Physeter macrocephalus*	Sperm whale	3	36.979635	74.364051
30-May-22	14:00	*Delphinus delphis*	Common dolphin	50	36.938888	74.626400
30-May-22	14:40	*Caretta caretta*	Loggerhead turtle	2	36.914088	74.934735
31-May-22	7:19	*Delphinus delphis*	Common dolphin	10	36.859598	75.287365
31-May-22	9:31	*Grampus griseus*	Risso's dolphin	11	36.943624	74.336046
31-May-22	9:53	*Tursiops truncatus*	Bottlenose dolphin	65	36.937966	74.263973
31-May-22	10:26	*Tursiops truncatus*	Bottlenose dolphin	75	36.887943	74.249022
31-May-22	11:43	*Physeter macrocephalus*	Sperm whale	3	36.841868	74.192457
31-May-22	15:17	*Tursiops truncatus*	Bottlenose dolphin	14	36.822244	74.676916
31-May-22	15:50	*Caretta caretta*	Loggerhead turtle	1	36.822491	74.924877
29-Jun-22	8:32	*Globicephala sp.*	Unidentified pilot whale	30	36.967485	74.609582
29-Jun-22	8:35	*Delphinus delphis*	Common dolphin	75	36.967043	74.594453
29-Jun-22	9:19	*Mesoplodon mirus*	True's beaked whale	2	36.974923	74.419084
29-Jun-22	10:48	*Globicephala sp.*	Unidentified pilot whale	33	36.890337	74.417596
29-Jun-22	10:58	N/A	Unidentified beaked whale	1	36.887085	74.418151
29-Jun-22	12:16	*Grampus griseus*	Risso's dolphin	12	36.765288	74.417750
29-Jun-22	12:29	*Globicephala sp.*	Unidentified pilot whale	5	36.758012	74.439249
29-Jun-22	13:03	*Globicephala sp.*	Unidentified pilot whale	4	36.705239	74.488207

Date	Sighting Time (local)	Scientific Name	Common Name	Group Size	Latitude (°N)	Longitude (°W)
29-Jun-22	13:16	*Globicephala sp.*	Unidentified pilot whale	20	36.672792	74.493312
29-Jun-22	13:22	*Tursiops truncatus*	Bottlenose dolphin	10	36.656728	74.488633
29-Jun-22	13:36	*Tursiops truncatus*	Bottlenose dolphin	28	36.630303	74.508941
29-Jun-22	13:59	*Globicephala sp.*	Unidentified pilot whale	3	36.601788	74.532990
29-Jun-22	14:29	*Physeter macrocephalus*	Sperm whale	2	36.577797	74.549123
8-Jul-22	8:05	*Delphinus delphis*	Common dolphin	90	36.667294	74.754893
8-Jul-22	9:35	*Physeter macrocephalus*	Sperm whale	7	36.637448	74.400095
8-Jul-22	14:23	*Tursiops truncatus*	Bottlenose dolphin	10	36.672438	74.438604
19-Aug-22	8:19	*Globicephala sp.*	Unidentified pilot whale	3	36.406444	74.722912
19-Aug-22	8:29	*Globicephala sp.*	Unidentified pilot whale	20	36.382099	74.657286
19-Aug-22	8:54	*Globicephala sp.*	Unidentified pilot whale	13	36.401333	74.607815
19-Aug-22	9:14	*Globicephala sp.*	Unidentified pilot whale	25	36.429931	74.580886
19-Aug-22	9:32	*Globicephala sp.*	Unidentified pilot whale	30	36.461142	74.541262
19-Aug-22	10:12	*Globicephala sp.*	Unidentified pilot whale	25	36.531914	74.501051
19-Aug-22	10:17	*Tursiops truncatus*	Bottlenose dolphin	5	36.544498	74.499892
19-Aug-22	10:36	*Tursiops truncatus*	Bottlenose dolphin	60	36.570936	74.501403
19-Aug-22	10:38	*Globicephala sp.*	Unidentified pilot whale	7	36.572362	74.501015
19-Aug-22	11:41	*Globicephala sp.*	Unidentified pilot whale	6	36.664926	74.521374
19-Aug-22	12:10	*Ziphius cavirostris*	Cuvier's beaked whale	2	36.687449	74.459994
21-Oct-22	8:36	*Tursiops truncatus*	Bottlenose dolphin	4	37.082056	74.700149
21-Oct-22	8:45	*Delphinus delphis*	Common dolphin	20	37.087662	74.677518
21-Oct-22	9:03	*Tursiops truncatus*	Bottlenose dolphin	1	37.061121	74.662766
21-Oct-22	10:28	*Tursiops truncatus*	Bottlenose dolphin	22	36.985393	74.595736
21-Oct-22	10:38	*Balaenoptera musculus*	Blue whale	4	36.965515	74.590778
21-Oct-22	11:32	*Balaenoptera physalus*	Fin whale	1	36.948505	74.599446
21-Oct-22	12:56	*Balaenoptera physalus*	Fin whale	1	36.918281	74.607325
21-Oct-22	13:36	*Balaenoptera physalus*	Fin whale	2	36.922476	74.606633
21-Oct-22	16:03	*Tursiops truncatus*	Bottlenose dolphin	13	36.888711	75.360245
26-Oct-22	9:32	*Tursiops truncatus*	Bottlenose dolphin	10	36.945406	74.617774
26-Oct-22	9:39	*Tursiops truncatus*	Bottlenose dolphin	30	36.920787	74.603285
26-Oct-22	9:42	*Balaenoptera musculus*	Blue whale	1	36.890223	74.637655
26-Oct-22	10:02	*Tursiops truncatus*	Bottlenose dolphin	5	36.867597	74.652042
26-Oct-22	12:37	*Tursiops truncatus*	Bottlenose dolphin	25	36.755269	74.612908
26-Oct-22	17:02	*Tursiops truncatus*	Bottlenose dolphin	12	36.805153	75.784887

Key: °N = degrees North; °W = degrees West; N/A = not applicable

C

Sea Turtle Sightings 2022

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Date	Sighting Time (local)	Scientific Name	Common Name	Group Size	Latitude (°N)	Longitude (°W)
30-May-22	7:25	*Caretta caretta*	Loggerhead turtle	1	36.951544	75.023900
30-May-22	2:40	*Caretta caretta*	Loggerhead turtle	2	36.914090	74.934715
31-May-22	3:50	*Caretta caretta*	Loggerhead turtle	1	36.822491	74.924862

Key: °N = degrees North; °W = degrees West

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D

Photo-identified Priority Species Individuals 2022

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HDR ID	Species	Sighting Date	Biopsy?	Satellite Tag?/Argos ID
HDRVAMn073	*Megaptera novaeangliae*	22-Jan-13	No	No
HDRVAMn240	*Megaptera novaeangliae*	22-Jan-13	No	No
HDRVAMn241	*Megaptera novaeangliae*	22-Jan-13	No	No
HDRVAMn242	*Megaptera novaeangliae*	22-Jan-13	No	No
HDRVABp105	*Balaenoptera physalus*	13-Jan-22	No	No
HDRVAPm037	*Physeter macrocephalus*	16-Mar-22	No	No
HDRVAPm038	*Physeter macrocephalus*	16-Mar-22	No	No
HDRVAPm114	*Physeter macrocephalus*	16-Mar-22	No	SPLASH-10F/208689
HDRVABp107	*Balaenoptera physalus*	21-Apr-22	No	No
HDRVABp108	*Balaenoptera physalus*	21-Apr-22	No	No
HDRVABp109	*Balaenoptera physalus*	21-Apr-22	No	No
HDRVAPm115	*Physeter macrocephalus*	21-Apr-22	Yes	SPLASH-10/183921
HDRVAMn254	*Megaptera novaeangliae*	23-Apr-22	No	No
HDRVAPm117	*Physeter macrocephalus*	23-Apr-22	Yes	SPLASH-10/183922; DTAG/321
HDRVAPm118	*Physeter macrocephalus*	30-May-22	Yes	SPLASH10/183923
HDRVAPm119	*Physeter macrocephalus*	30-May-22	Yes	SPLASH10/183924; DTAG/321
HDRVAPm120	*Physeter macrocephalus*	30-May-22	No	No
HDRVAPm121	*Physeter macrocephalus*	29-Jun-22	No	SPLASH10/202809
HDRVAPm122	*Physeter macrocephalus*	29-Jun-22	No	No
HDRVAPm015	*Physeter macrocephalus*	08-Jul-22	No	No
HDRVAPm116	*Physeter macrocephalus*	08-Jul-22	No	DTAG/346
HDRVAPm123	*Physeter macrocephalus*	08-Jul-22	No	No
HDRVAPm124	*Physeter macrocephalus*	08-Jul-22	No	No
HDRVAPm125	*Physeter macrocephalus*	08-Jul-22	No	No
HDRVAPm126	*Physeter macrocephalus*	08-Jul-22	No	No
HDRVAPm127	*Physeter macrocephalus*	08-Jul-22	No	No
HDRVAPm128	*Physeter macrocephalus*	08-Jul-22	No	No
HDRVAPm129	*Physeter macrocephalus*	08-Jul-22	No	No
HDRVAZc003	*Ziphius cavirostris*	19-Aug-22	No	No
HDRVAZc004	*Ziphius cavirostris*	19-Aug-22	No	No
HDRVABp110	*Balaenoptera physalus*	21-Oct-22	No	No
HDRVABp111	*Balaenoptera physalus*	21-Oct-22	No	No
HDRVABp112	*Balaenoptera physalus*	21-Oct-22	No	No
HDRVABp113	*Balaenoptera physalus*	21-Oct-22	No	No
HDRVABm004	*Balaenoptera musculus*	21-Oct-22	No	No
HDRVABm005	*Balaenoptera musculus*	21-Oct-22	No	No
HDRVABm006	*Balaenoptera musculus*	21-Oct-22	Yes	SPLASH10F/177051

HDR ID	Species	Sighting Date	Biopsy?	Satellite Tag?/Argos ID
HDRVABm007	*Balaenoptera musculus*	21-Oct-22	No	No
HDRVABm007	*Balaenoptera musculus*	26-Oct-22	No	No

Key: ID = Identification; DTAG = digital acoustic recording tag

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