VACAPES Outer Continental Shelf Cetacean Study, Virginia Beach, Virginia: 2021 Annual Progress Report

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Cover Photo Credit:

Blue whale (*Balaenoptera musculus*) 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

BSS	Beaufort sea state
COMPASS	Cetacean Observation and Marine Protected Animal Survey Software
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)
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

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1. Introduction and Background

The United States (U.S.) Navy routinely conducts training and testing activities in 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. 2020), 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. 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 separate study focusing on outer continental shelf cetaceans was initiated in July 2016 (Engelhaupt et al. 2017, 2018, 2019, 2020a, 2021).

This progress report includes all offshore monitoring activities conducted in 2021. 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 (sUASs), 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; and (3) satellite-linked tagging techniques to provide information on residency patterns, dive profiles, and habitat use across intermediate time scales (weeks to months). A fourth technique, suction-cup tagging, will be implemented in the near future; however, no data have yet been collected to present in this 2021 report.

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 Southeast 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 in waters off Cape Hatteras, North Carolina (Baird et al. 2018), there is potential to track tagged animals more broadly, including 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 outer continental shelf to the 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 kilometers [km] [50 nautical miles (NM)] to 160 km [85 NM]) off the coast of Virginia (**Figure 1**). The offshore study area includes the outer part of the continental shelf, the shelf break, and slope waters, along with Norfolk and Washington Canyons. Depths within the core study area range from approximately 50 meters (m) to as much as 2,500 m.

2.1 Survey Operations

The offshore charter 16.2-m sport-fishing vessel *Top Notch* (**Figure 2)** was the primary vessel used in 2021 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 the unique characteristics of the region and hold U.S. Coast Guard-approved 100-ton master's licenses. The scientific crew 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.

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 utilize 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 that the vessel would have clearance in the primary study area as often as possible. The K3 and K4 range boxes, which encompass Norfolk Canyon, require clearance to be obtained on the day of surveys; therefore, there were times that area was 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 hrs were allocated for each survey day. Once departing the marina, transit time was approximately 3 hrs 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 in 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.

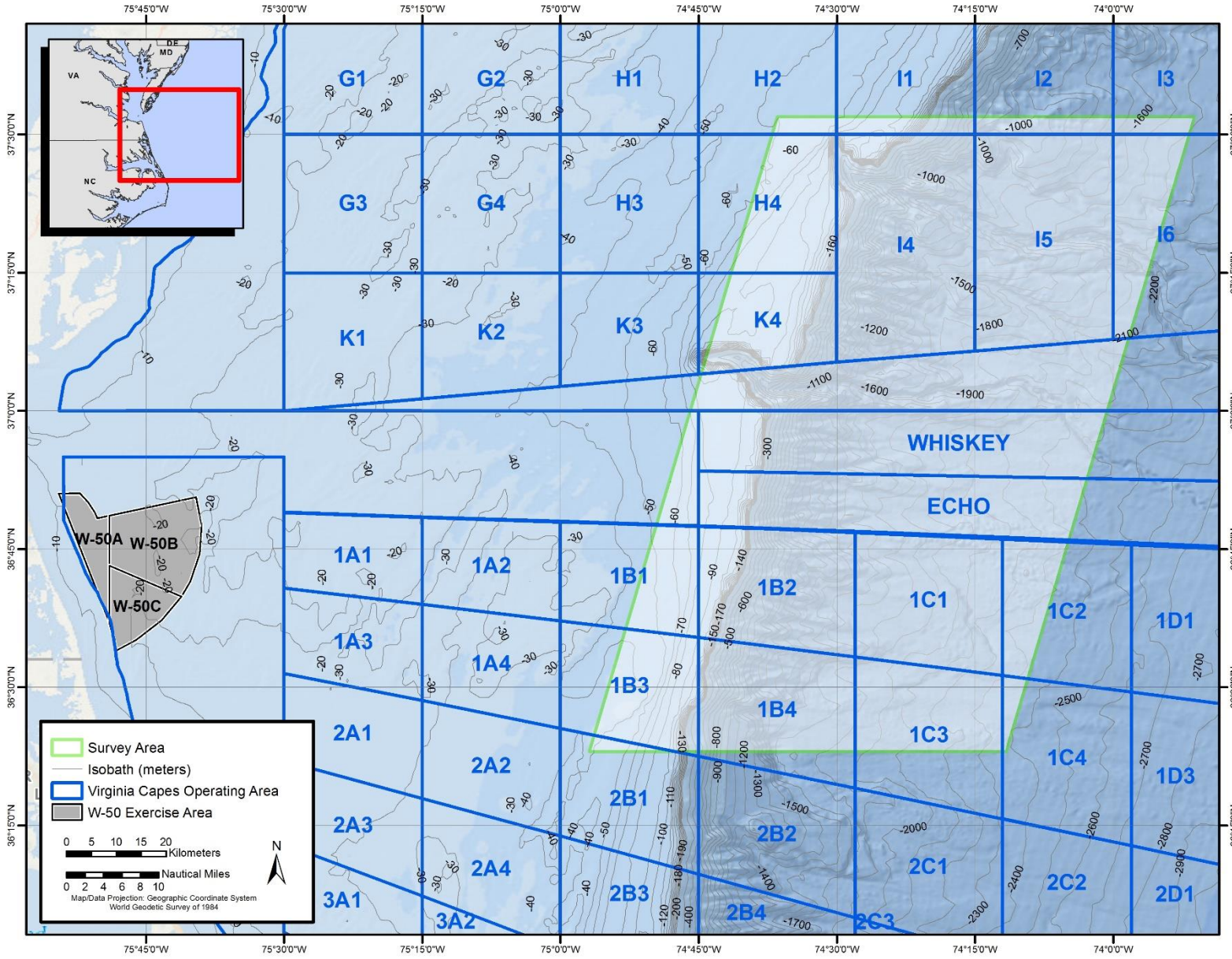

Figure 1. Map of the offshore study area off southeastern Virginia and the VACAPES training range surface grid in the region

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

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 a priority. 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, surveys did not follow line-transect distance-sampling protocols. The vessel maintained a survey speed of approximately 18 to 22 km/hr (10 to 12 knots) during search efforts that often followed a zig-zag pattern to waypoints chosen on the day of survey that would optimize coverage across the depth gradient in the areas that could be accessed that day.

The on-effort MMOs used both 10x30 hand-held image-stabilized binoculars and unaided eyes. MMOs covered a 270-degree swath of observation area in front and to the sides of the survey vessel. Once in deep water (deeper than 400 m), a directional hydrophone was used to listen for sperm whales. If clicks were heard, every effort was made to localize the detections and maneuver the vessel to 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 in a different area.

Once a sighting was made, one MMO focused on data entry using COMPASS (Richlen et al. 2019), the data-recording application 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 biopsy, satellite tagging, and/or digital video-recording. Baleen whales, sperm whales, 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 in 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 defined as high-priority if encountered. Pilot whales and Risso's dolphins were considered medium-priority species and were approached in the event that 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. Other delphinid species were the lowest priority, and effort spent collecting data and 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-IDs 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 identification 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, and Cape Hatteras Short-finned Pilot Whale and Cuvier's Beaked Whale Catalogs maintained by Duke University (Waples and Read 2020, 2021, 2022).

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, to increase precision, HDR recently assembled and installed a custom Light Detection and Ranging (LiDAR) precision altimeter on

the drone (described in Dawson et al. 2017). 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 lengths.

2.3 Biopsy Sample Collection

Biopsy samples were collected from priority species after the survey team finished collecting photo-IDs. 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 subsequently 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; www.dan-inject.com).

The LIMPET design uses two surgical-grade titanium darts, measuring 6.8 centimeters in length 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 attachment durations of LIMPET tags on baleen and sperm whales of less than 60 days. Based on satellite availability in the area, tags were programmed to transmit for 16 hours 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 to be classified as a dive. Locations of tagged individuals were approximated by the Argos system using the Kalman filtering location algorithm (Argos User’s Manual© 2007–2015 Collective Location Services). Using tools provided within Movebank (www.movebank.org), unrealistic locations (e.g., those 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).

3. Results

Nine offshore vessel surveys were conducted between March and October in 2021, covering 2,840 km of trackline during more than 119 hr of effort (**Table 1; Figure 3**). Weather conditions and charter vessel availability limited survey opportunities considerably.

Surveys in 2021 resulted in 125 marine mammal sightings and 18 sea turtle sightings (**Figures 4** through **7; Appendices B** and **C**). Nine cetacean taxa were identified (in order of decreasing frequency): pilot whale (*n*=29), common bottlenose dolphin (*n*=28), common dolphin (*n*=13), fin whale (*n*=12), sperm whale (*n*=12), Atlantic spotted dolphin (*n*=6), humpback whale (n=6), Risso's dolphin (*n*=5), blue whale (*n*=1), and short-finned pilot whale (*n*=1). Additionally, there were 12 sightings of unconfirmed species: unidentified dolphin (*n*=10), unidentified large whale (*n*=1), and unidentified *Mesoplodon* whale (*n*=1). Two sea turtle taxa were identified: loggerhead turtle, *Caretta caretta* (*n*=16) and leatherback turtle, *Dermochelys coriacea* (*n*=2). Because both short- and long-finned pilot whales may occur in 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 52 of the 125 marine mammal sightings. All photographs of baleen and sperm whales were added to HDR's existing catalogs (**Appendix D**). Six unique fin whales were identified in 2021 and added to the HDR fin whale catalog, which now contains 101 individuals. Of the 101 identified fin whales, 14 (13.8 percent) have been re-sighted, with 9 (8.9 percent) of them occurring during different years ranging 248 to 1,801 days between first and last sightings. Locations of all re-sighted fin whales were over the continental shelf, in less than 100 m depth for all encounters. Distance between re-sight locations ranged from 20.0 to 46.8 km.

Twenty-two unique sperm whales were identified in 2021 and added to the HDR sperm whale catalog, which now contains 111 individuals. Fourteen individuals (12.6 percent) were sighted on more than 1 day, ranging from 9 to 1,402 days between first and last sightings (mean = 544, median = 364). Four sperm whales photographed in 2021 were sighted previously in this study: HDRVAPm010 and 012, first documented June 2017, and HDRVAPm050 and 053, first documented August 2018.

The blue whale photograph was sent to Mingan Island Cetacean Study colleagues, who ran it through their North Atlantic blue whale catalog and found no matches. Six humpback whales were identified during these offshore surveys in 2021 and added to HDR's humpback whale catalog, which is summarized in that project's report (Aschettino et al. 2022).

Table 1. Summary of 2021 offshore survey effort in the VACAPES outer continental shelf study area

Date	Survey Duration (min)	Distance surveyed (km)	# Sightings	# Individuals	Baleen Whales # Sightings/ # Individuals	Deep Diving Whales[a] # Sightings/ # Individuals	Dolphins # Sightings/ # Individuals	Sea Turtles # Sightings/ # Individuals
10-Mar-21	881	350	13	301	3/3	0/0	10/298	0/0
18-Apr-21	843	256	19	334	8/10	2/5	8/318	1/1
20-Apr-21	908	274	15	103	4/5	6/7	5/91	0/0
07-May-21	658	299	20	166	0/0	4/53	6/88	10/25
01-Jun-21	813	366	18	698	4/4	6/416	8/278	0/0
28-Jun-21	712	241	13	295	0/0	8/217	3/75	2/3
10-Aug-21	745	348	18	398	0/0	5/134	11/262	2/2
16-Aug-21	885	403	16	215	0/0	8/79	7/135	1/1
24-Oct-21	707	303	11	93	0/0	6/48	3/43	2/2
Totals	**7,152**	**2,840**	**143**	**2,603**	**19/23**	**45/958**	**61/1,588**	**18/34**

Key: min = minute(s); km = kilometer(s);
[a] Sperm, pilot, and beaked whales

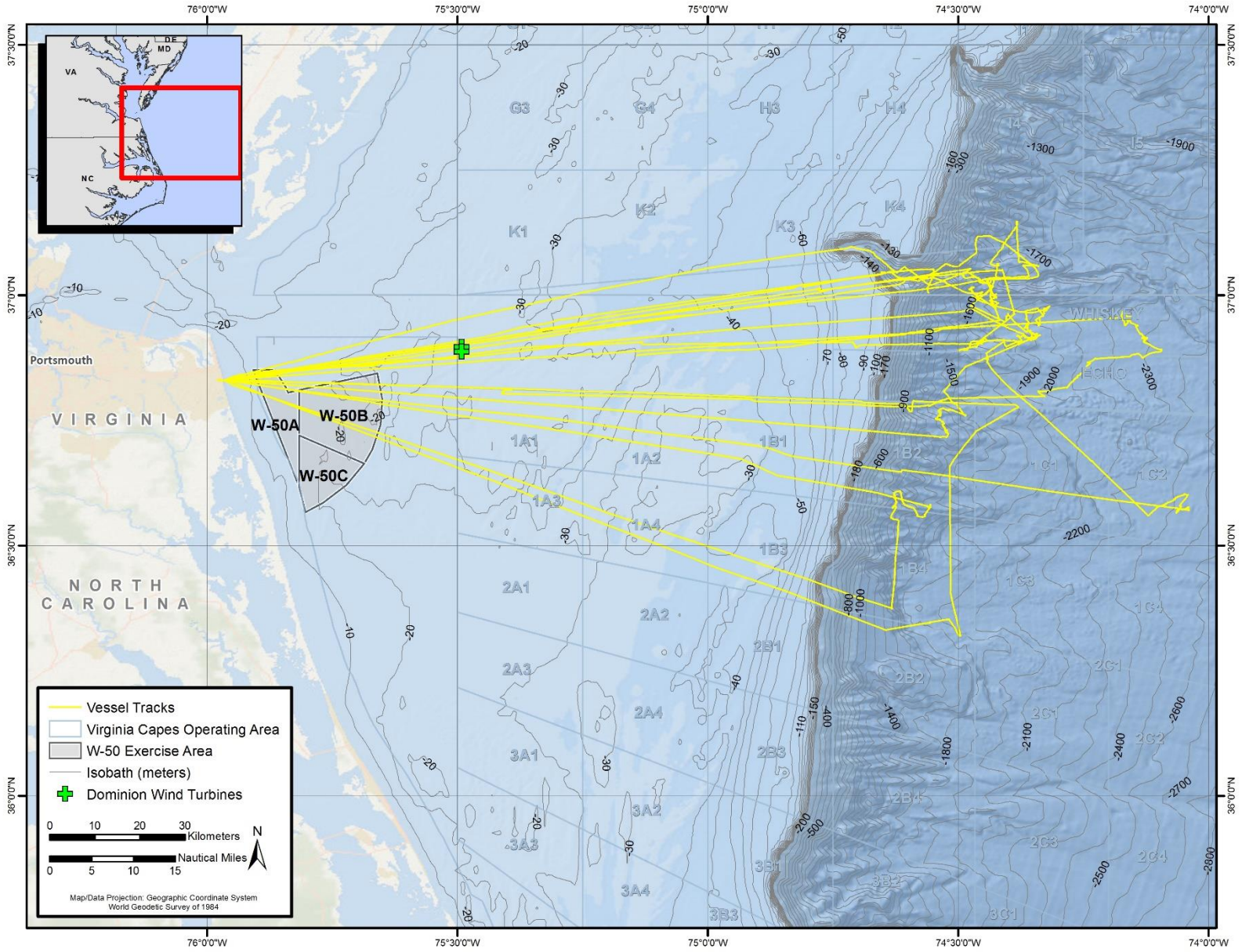

Figure 3. Offshore survey tracks for all surveys conducted in 2021

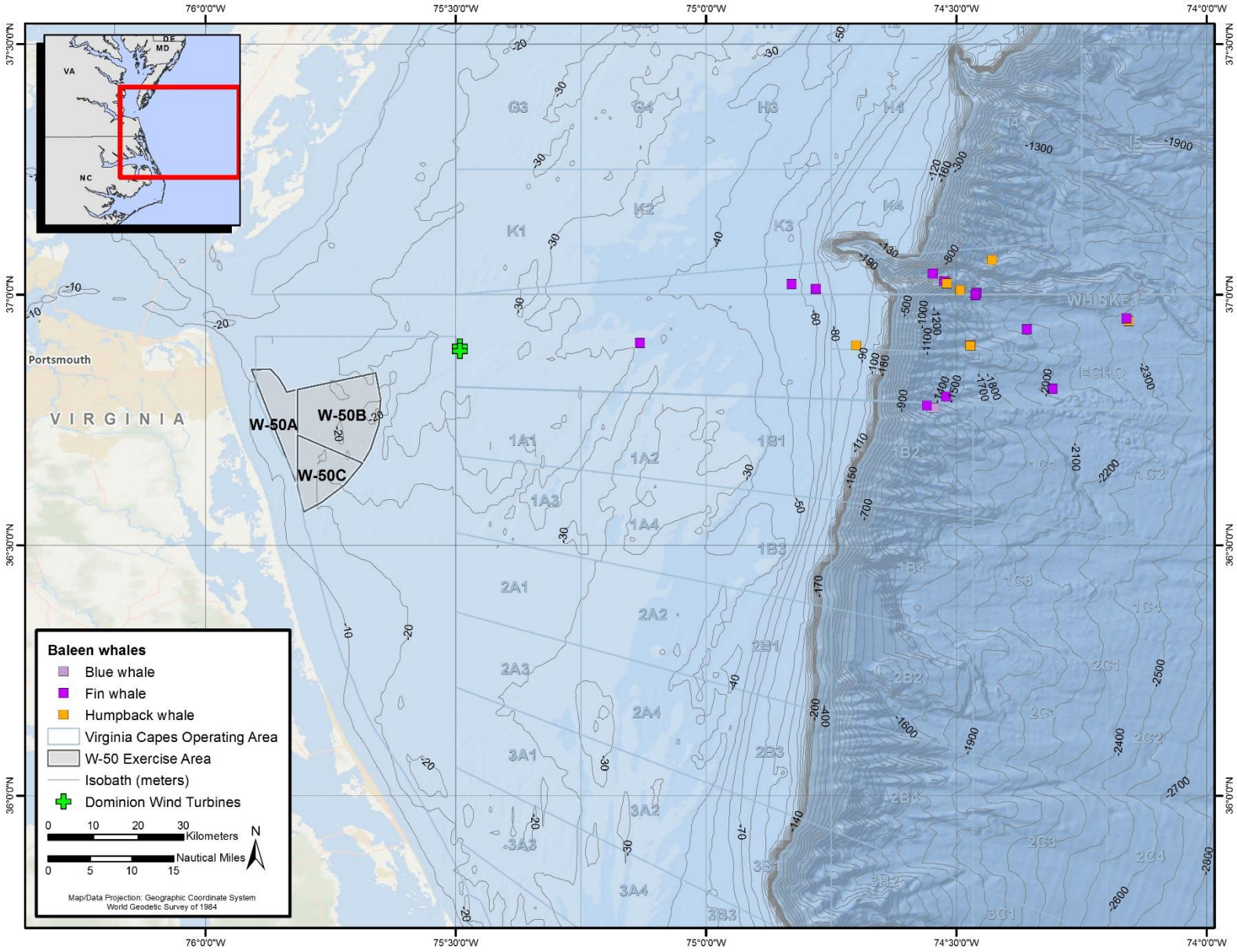

Figure 4. Locations of all baleen whale sightings (*n*=19) in 2021

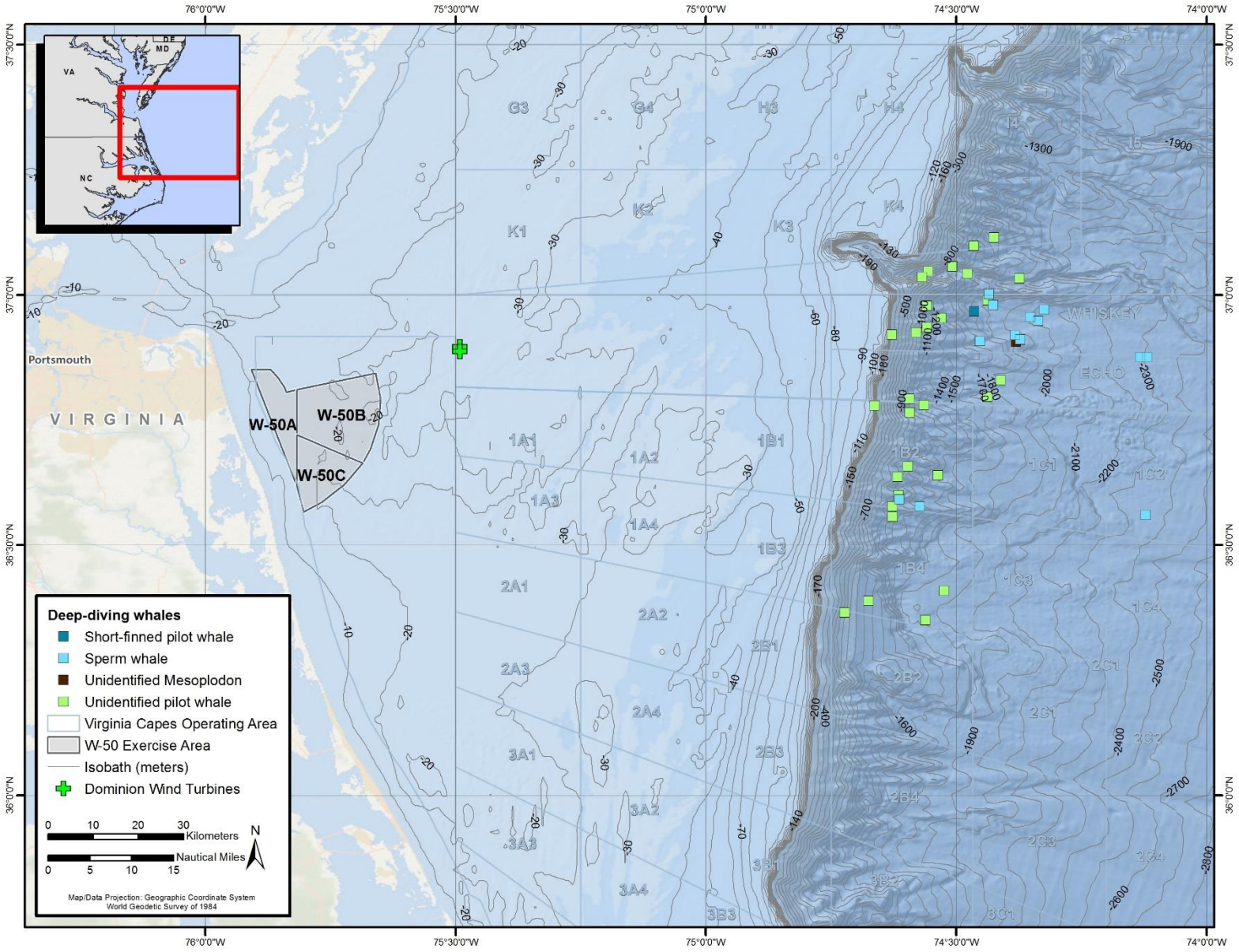

Figure 5. Locations of all deep diving whale sightings (*n*=45) in 2021

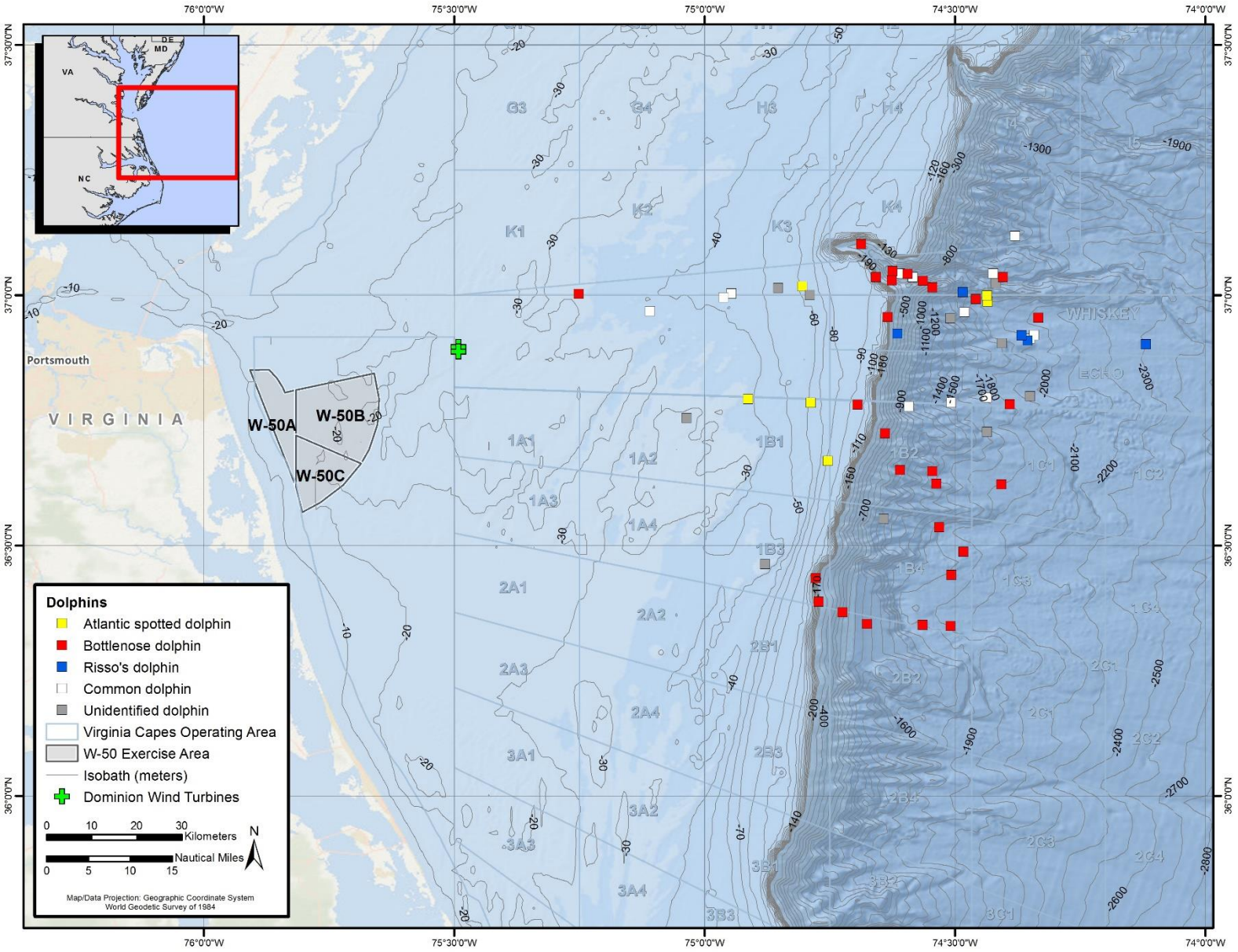

Figure 6. Locations of all dolphin sightings (*n*=61) in 2021

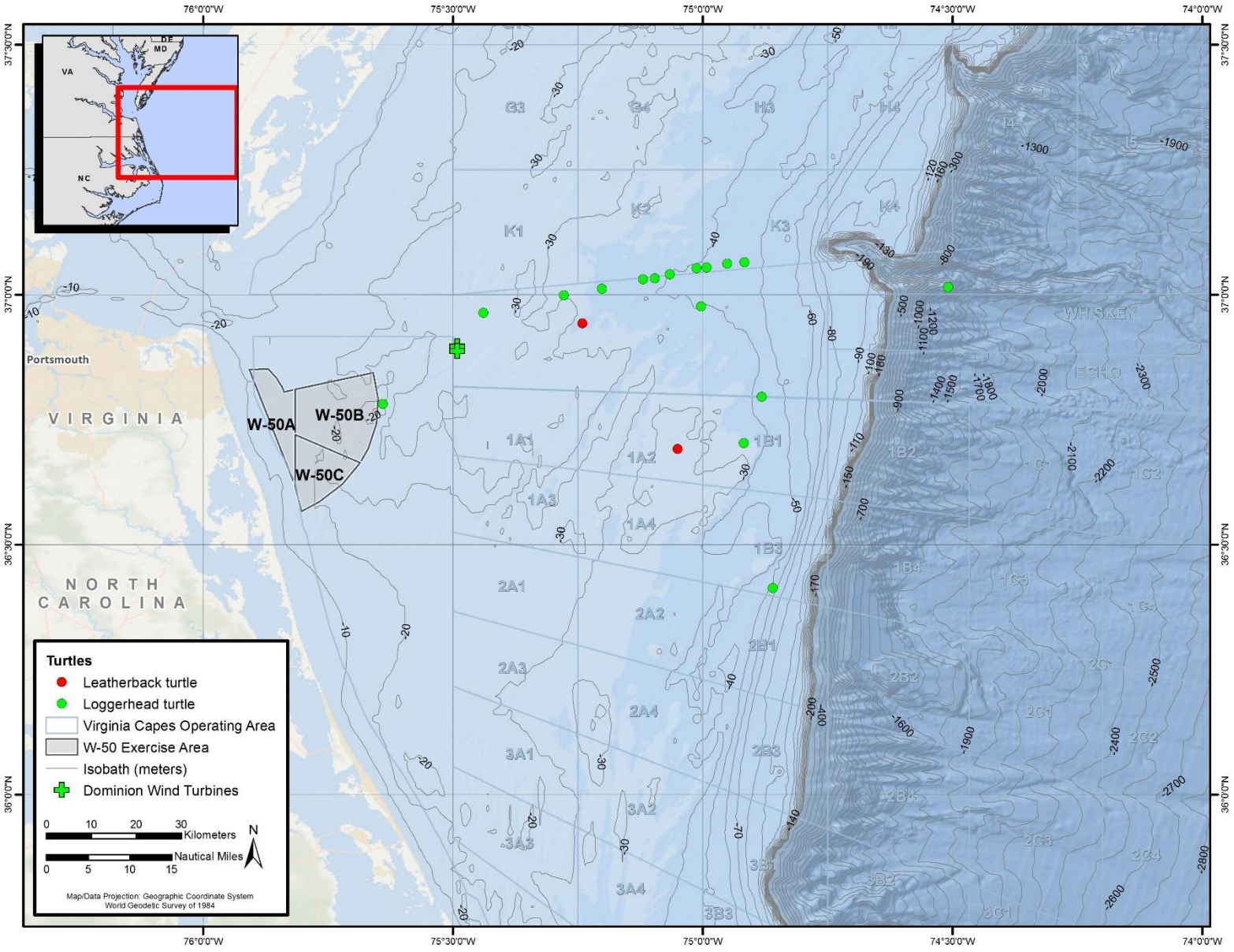

Figure 7. Locations of all sea turtle sightings (*n*=18) in 2021

Pilot whale photographs have been provided to Duke University and comparisons of individuals through 2021 with their Cape Hatteras catalog have been completed (Waples and Read 2022). Waples and Read added an additional 50 individuals to the Norfolk catalog, including 3 new matches to the Cape Hatteras catalog. The Norfolk catalog now contains 280 unique pilot whales and the updated total of matches between Virginia and North Carolina is 15 percent (43 of 280). One individual seen in the study area in 2019 was matched to a sighting more than 11 years prior in 2007, which was also matched to a photograph collected in 2004 in the Gulf of Mexico (Waples and Read 2021).

Although not observed during offshore surveys in 2021, the North Atlantic right whale catalog contains 12 individuals, the minke whale catalog contains 10 individuals, and the sei whale catalog contains 2 individuals. Images of non-pilot whale odontocete species have been archived for future processing.

Drone video was collected from eight individuals during three sightings of sperm whales. These video stills were compared to the photo-ID catalog to assist with determining IDs and measurement analyses are currently underway.

3.2 Biopsy Sample Collection & Genetic Analysis

In 2021, three biopsies were collected from sperm whales, and one was collected from a blue whale (**Appendix D**). The 2021 sperm whale samples are currently being processed, and the blue whale sample is being stored for future processing. Gender results from sperm whale samples collected in 2019 and 2020 were all male, making the totals of known sperm whale genders in the region 3 females and 17 males.

Preliminary mitochondrial DNA results have been provided by Oregon State University for 23 sperm whale samples tested to date (three individuals were sampled twice). All samples were classed into the three most common haplotypes (haplotype A = 14, haplotype B = 5, haplotype C = 3). Microsatellite techniques have not yet been completed to search for genetic matches to other sperm whales sampled in this study or elsewhere.

3.3 Satellite Tagging

Six satellite tags were successfully deployed in 2021, five on sperm whales and one on a blue whale (**Tables 2** through **5**). Five of the six tags were SPLASH-10 tags, which collect location and dive depth/duration information (**Tables 6** and **7**).

Tag duration for sperm whales ranged from 0.2 to 58.2 days (mean = 19.0). Locations from satellite-tagged sperm whales showed movements through multiple U.S. Navy OPAREAS, mostly along the continental shelf break or beyond the slope. Although one of the five sperm whale tags did not provide useable locations after filtering (**Table 4**), movements of the other four tagged sperm whales varied. Two individuals remained within the VACAPES OPAREA for the duration of the tag transmissions (**Figures 8** and **9**), while the third moved farther to the northeast, still along the continental shelf edge and slope and through the Atlantic City and Narragansett Bay OPAREAs (**Figure 10**). The fourth moved south into the Cherry Point

OPAREA waters before traveling farther east and northeast to a distance over 700 km from shore (**Figure 11**).

Tagged sperm whales traveled up to 628 km away from initial tag deployment locations and had 18 to 100 percent of locations within the VACAPES OPAREA depending on the individual (**Table 4**). Maximum dive depths ranged from 512 to 2,127 m, and maximum dive durations ranged from 54 to 91 min (**Table 6**).

The blue whale tag duration was 9.6 days (**Table 3**). Locations from the tagged blue whale show movement through multiple VACAPES OPAREA boxes, moving in a loop from where it was tagged south of Norfolk Canyon, approximately 100 km from shore to approximately 170 km from shore (**Figure 12**). All locations were within the OPAREA, distance traveled from tagging location averaged 36.5 km, and the maximum distance from tagging location was 73 km (**Table 5**). Maximum dive depth was 185 m, and maximum dive duration was 11.7 min (**Table 7**).

Table 2. Summary of tag deployment details for all sperm whale tags deployed in 2021

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)
HDRVAPm096	SPLASH-10	183917	2021-Apr-18 17:01	37.0341	74.4374	1481	2021-Apr-23 15:37	4.7
HDRVAPm099	SPLASH-10	183918	2021-Jun-01 16:05	36.9116	74.1286	2326	2021-Jun-08 02:29	5.1
HDRVAPm100	SPLASH-10	183919	2021-Jun-01 16:36	36.9139	74.1307	2317	2021-Jun-02 03:45	0.2
HDRVAPm101	SPOT-6	177041	2021-Jun-01 17:43	36.9401	74.1160	2302	2021-Jul-30 01:14	58.1
HDRVAPm113	SPLASH-10	183920	2021-Oct-24 16:02	36.5837	74.6080	1227	2021-Nov-19 14:35	25.7

Key: °N = degrees North; °W = degrees West; GMT = Greenwich Mean Time; m = meter(s)

Table 3. Summary of tag deployment details for the blue whale tag deployed in 2021

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)
HDRVABm003	SPLASH-10F	183931	2021-Mar-10 19:58	36.7343	74.5264	1267	2021-Mar-20 11:08	9.6

Key: °N = degrees North; °W = degrees West; GMT = Greenwich Mean Time; m = meter(s)

Table 4. Summary of results from satellite tag data for all sperm whale tags deployed in 2021

Animal ID	Argos ID	No. of Locations Post Filtering	% Within VACAPES OPAREA	Max Distance from Initial Location (km)	Mean Distance from Initial Location (km)
HDRVAPm096	183917	56	100.0	118.5	49.2
HDRVAPm099	183918	60	100.0	94.0	35.2
HDRVAPm100	183919	0	n/a	n/a	n/a
HDRVAPm101	177041	655	27.6	334.3	187.8
HDRVAPm113	183920	224	17.9	627.5	360.5

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

Table 5. Summary of results from satellite tag data for the blue whale tag deployed in 2021

Animal ID	Argos ID	No. of Locations Post Filtering	% Within VACAPES OPAREA	Max Distance from Initial Location (km)	Mean Distance from Initial Location (km)
HDRVABm003	183931	188	100.0	73.0	36.5

Key: km = kilometer(s)

Table 6. Summary of dive data for all sperm whale SPLASH-10 tags deployed in 2021

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)
HDRVAPm096	183917	141	939.8	1855	37.82	55.38
HDRVAPm099	183918	116	1,008.9	1471	46.09	55.82
HDRVAPm100	183919	8	246.0	512	40.38	54.05
HDRVAPm113	183920	343	1,049.1	2127	63.21	91.18

Key: m = meter(s); Max = Maximum; mm.ss = minutes.seconds

[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 2021

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)
HDRVABm003	183931	250	32.8	185	5.14	11.68

Key: m = meter(s); Max = Maximum; mm.ss = minutes.seconds

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

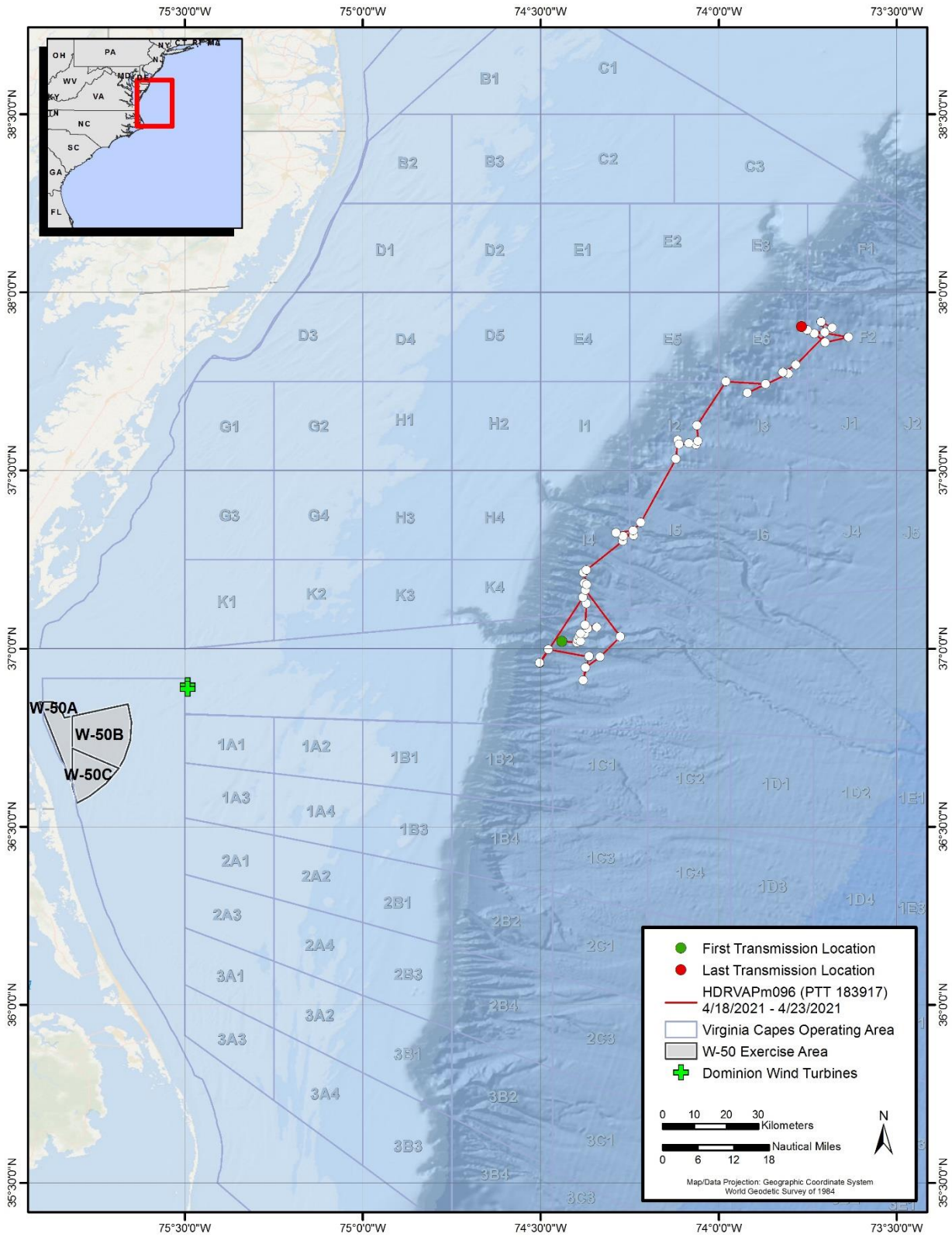

Figure 8. Filtered locations (white dots) and track of sperm whale HDRVAPm096 over 4.7 days

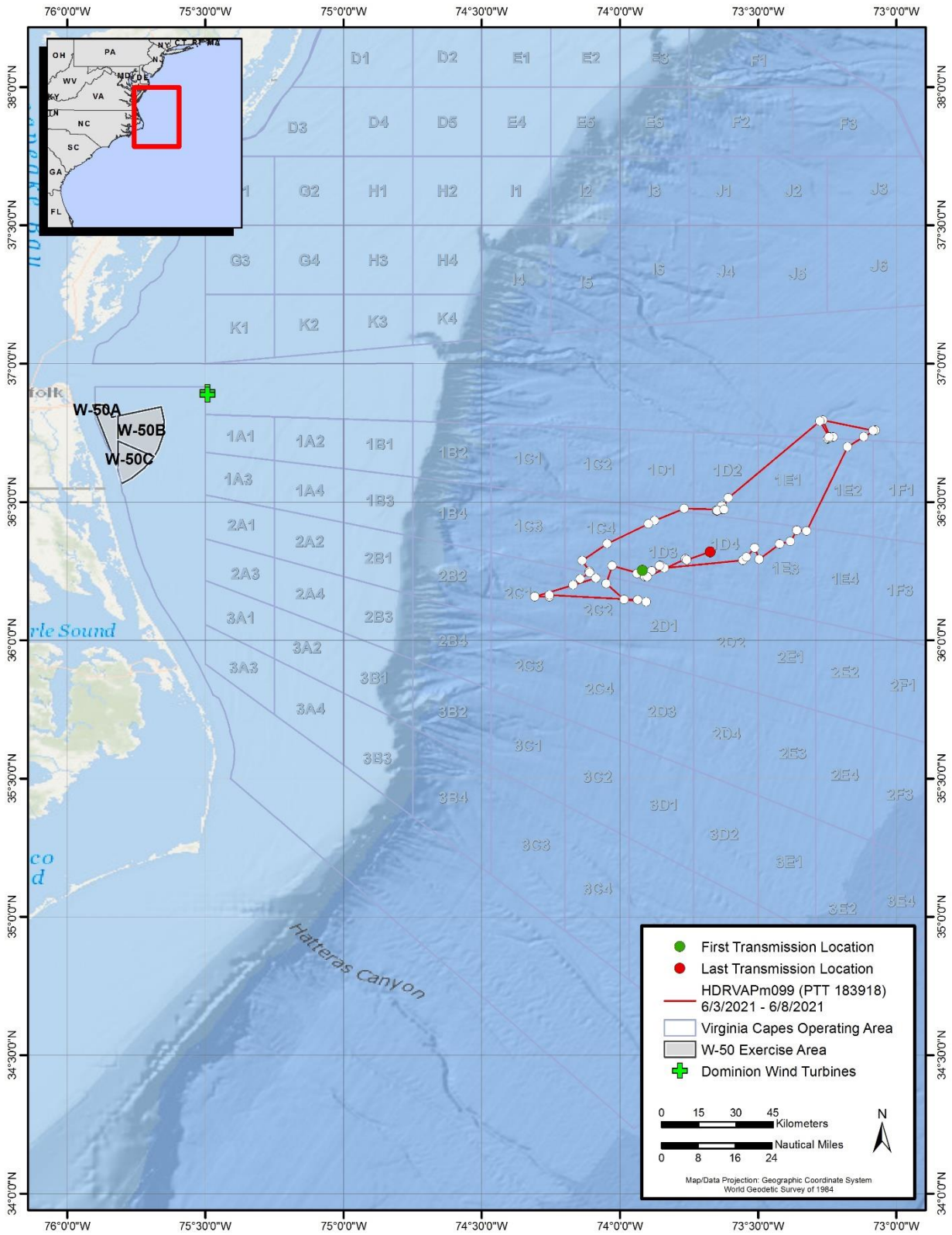

Figure 9. Filtered locations (white dots) and track of sperm whale HDRVAPm099 over 5.1 days

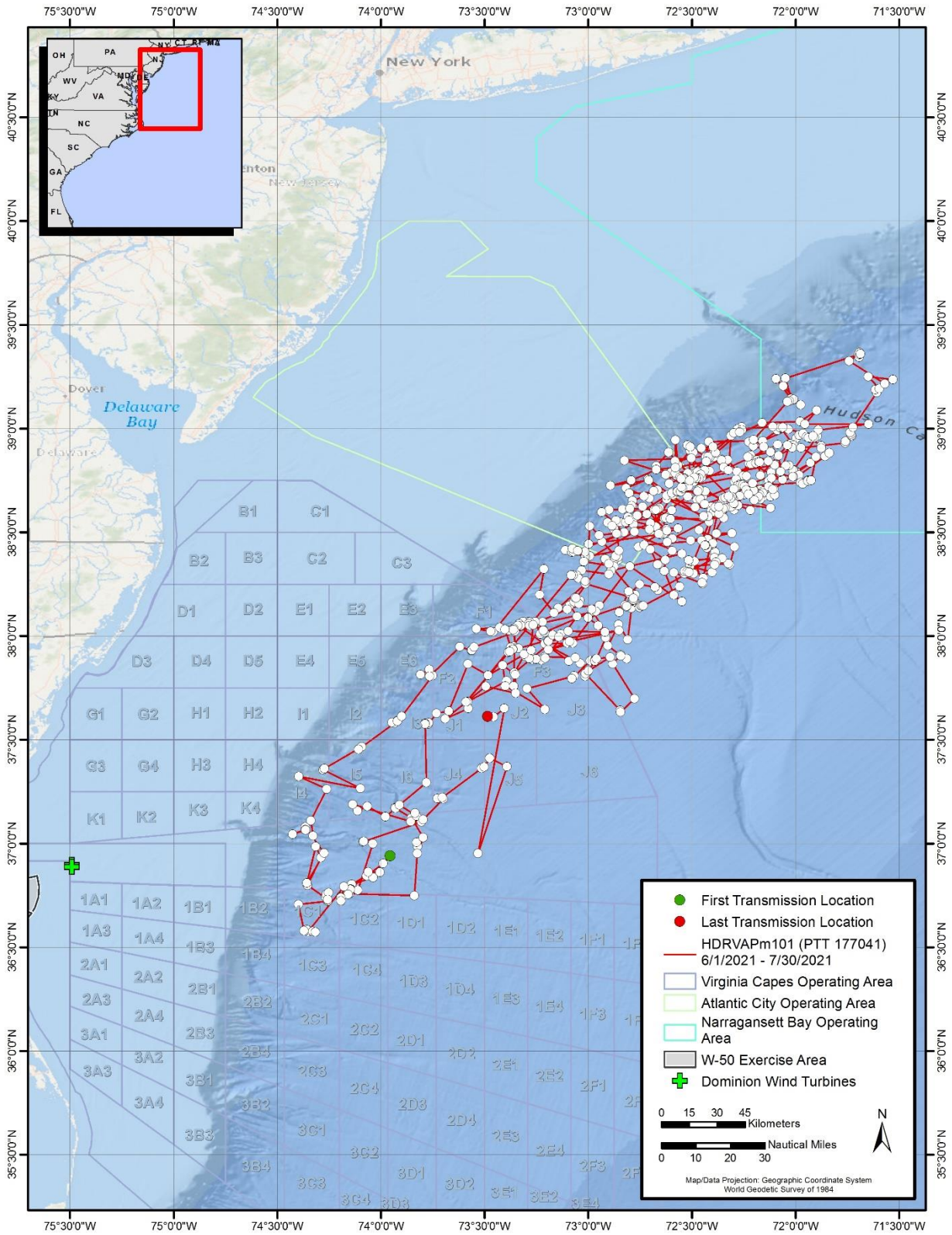

Figure 10. Filtered locations (white dots) and track of sperm whale HDRVAPm101 over 58.1 days

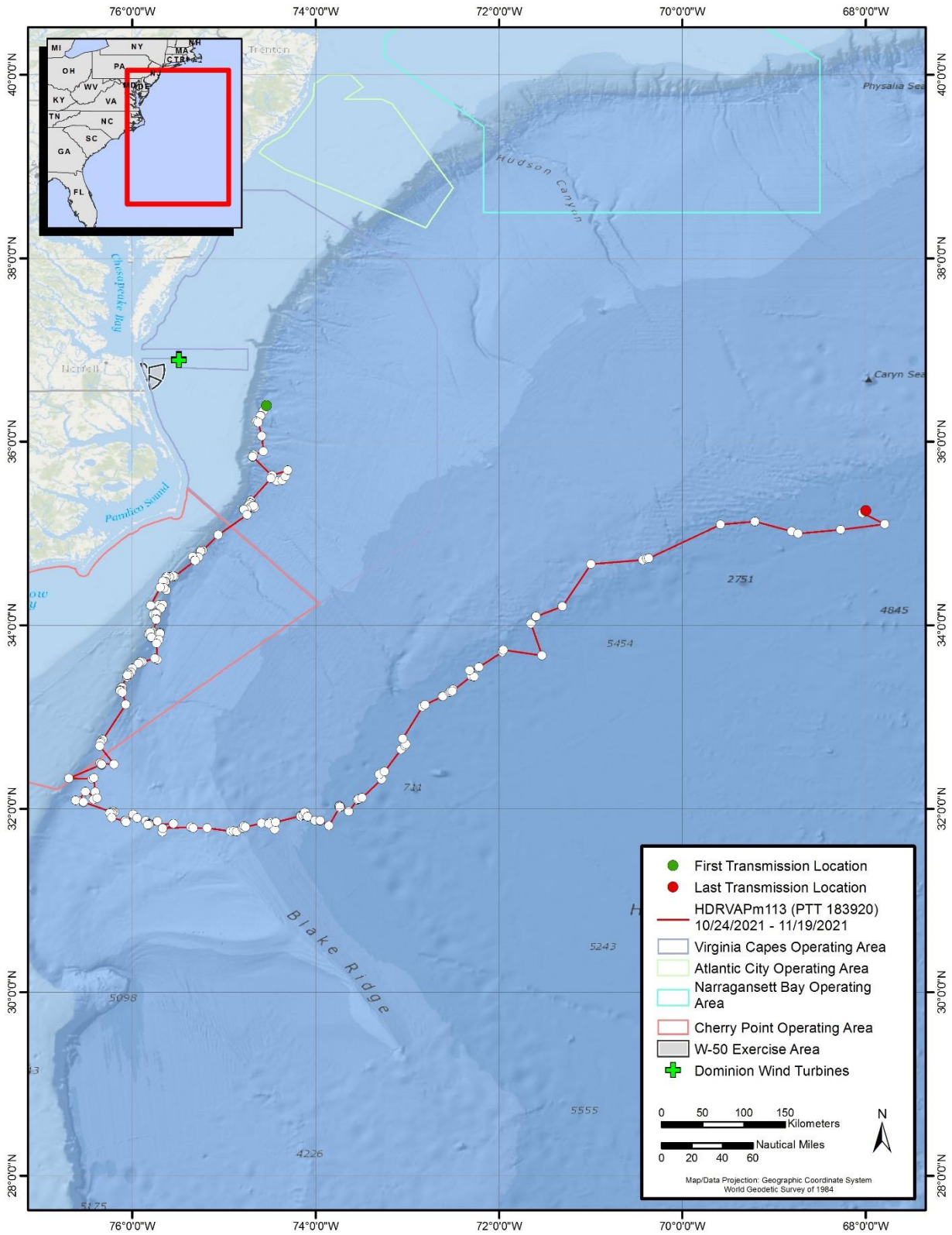

Figure 11. Filtered locations (white dots) and track of sperm whale HDRVAPm113 over 25.7 days

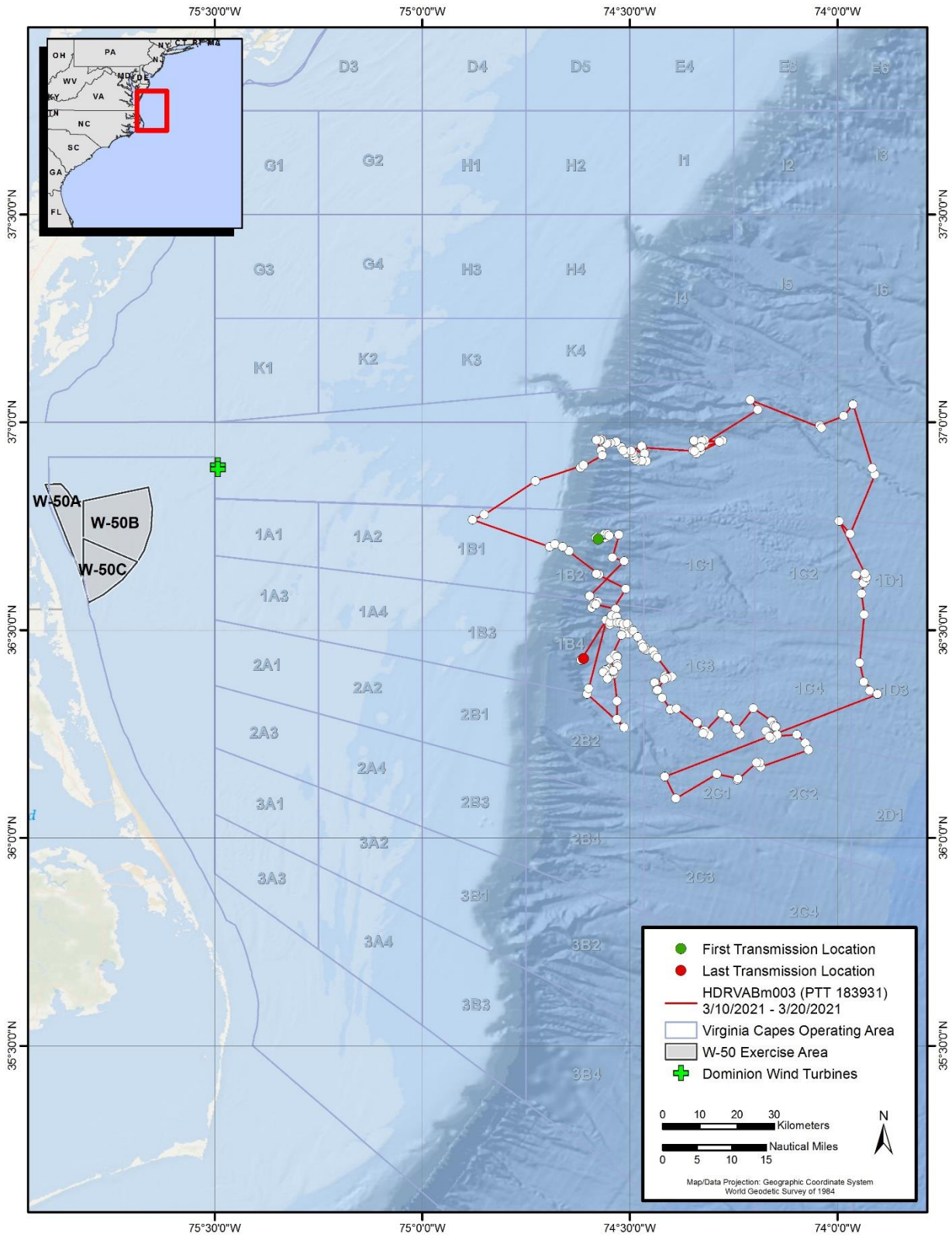

Figure 12. Filtered locations (white dots) and track of blue whale HDRVABm003 over 9.6 days

4. Discussion

Data collection and analyses for this project are ongoing; however, results to date show a high degree of marine mammal diversity in the study area. Surveys conducted in 2021 extended 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 nine species of marine mammals and two species of sea turtles were made over nine surveys, showing a wide distribution throughout the study area. All species encountered during 2021 had previously been sighted during this study, keeping the total number of marine mammal species encountered in the study area over the duration of the project to 20. 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 whales and pilot whales, were concentrated past the shelf break and into deeper offshore waters during the 2021 surveys. Baleen whales were encountered both over the shelf and past the shelf break as they were during previous years of this study, but similar to 2019 and 2020, the majority of baleen whale sightings were past the shelf break. This is in contrast to where baleen whale sightings occurred during surveys in 2016 through 2018. Dolphin species were sighted throughout the core study and transit areas, and only one loggerhead sea turtle was sighted in deep water past the shelf break; the remainder were over the shelf.

Sightings of marine mammal species in 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. Extended coverage during 2021 has resulted in added marine mammal sightings in additional VACAPES boxes, including 1B2, 1B4, 2B2, 1C1, and 1C2.

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 12.6 percent (14 of 111) of cataloged sperm whale individuals being re-sighted, up to 1,402 days after the initial encounter.

Fourteen fin whales (13.8 percent) were photographed on more than 1 day (between-season re-sightings ranged from 248 to 1,801 days from the initial encounter). Initial sighting locations and those of re-sighted fin whales are all in 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 in 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 in the Atlantic and Gulf of Mexico have not yielded any matches, but as additional catalogs are added to photo-ID sharing websites, valuable matches are likely to 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.

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 2021 survey are still being processed; however, previously collected lengths that were calculated using the Duke University software (Torres and Bierlich 2020) showed a mean total length of nearly 9 m for those individuals measured, confirming the designation of immature male or adult female for those sightings estimated in the field.

Locations from satellite-tagged whales show movements through multiple VACAPES range boxes beyond the continental slope **(Figures 8** through **10**). Sperm whales continue to show a high percentage of locations within the VACAPES OPAREA range boxes, with two of the four transmitting tags deployed in 2021 having 100 percent of locations within the VACAPES OPAREA, although this may be biased due to deployment location and tag duration. The other two individuals spent less time in the VACAPES OPAREA, one of which (HDRVAPm113) traveled more than 600 km and beyond any OPAREAs for the majority of transmitted locations.

The satellite tagging of a blue whale during 2021 has added unique insight to the movements of this ESA-listed species, supporting the previously published records of sightings off Virginia documented by this study (Engelhaupt et al. 2020b). Dive depth data collected by the tag have provided interesting insight into the behavior of the species as well. The mean dive depth of 32.8 m and maximum dive depth of 185 m in locations where bottom depth exceeds 1,000 m for the majority of transmitted locations is valuable information for further identifying potential for overlap between these 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. 2019a) is planned for the near future. Manuscripts and presentations 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) utilize 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 will be the priority in 2022 and beyond, with the planned addition of Digital Acoustic Recording Tag (i.e., suction-cup tags) deployments on these deep-diving species. This addition

will allow researchers 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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6. References

Andrews, R.D., R.L. Pitman, and L.T. Balance. 2008. Satellite tracking reveals distinct movement patterns for Type B and Type C killer whales in the southern Ross Sea, Antarctica. *Polar Biology* 31(12):1461–1468. DOI 10.1007/s00300-008-0487-z.

Aschettino, J., D. Engelhaupt, A. Engelhaupt, and M. Richlen. 2016. *Mid-Atlantic Humpback Whale Monitoring, Virginia Beach, VA: 2015/16 Annual Progress Report*. Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, Virginia, under Contract No. N62470-10-3011, Task Orders 03 and 054, and N62470-15-D-8006, Task Order 13, issued to HDR Inc., Virginia Beach, Virginia. 30 August 2016.

Aschettino, J.M., D. Engelhaupt, A. Engelhaupt, M. Richlen, and M. Cotter. 2022. *Mid-Atlantic Baleen Whale Monitoring, Virginia Beach, Virginia: 2020/21 Annual Progress Report.* Draft Report. Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Systems Command Atlantic, Norfolk, Virginia, under Contract N62470-15-8006, Task Order 21F4005, issued to HDR Inc., Virginia Beach, Virginia. March 2022.

Baird, R.W., D.L. Webster, Z.T. Swaim, H.J. Foley, D.B. Anderson, and A.J. Read. 2018*. Spatial Use by Cuvier's Beaked Whales and Short-finned Pilot Whales Satellite Tagged off Cape Hatteras, North Carolina: 2017 Annual Progress Report*. Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, Virginia, under Contract No. N62470-15-D-8006, Task Order 50, issued to HDR Inc., Virginia Beach, Virginia. March 2018.

CETAP (Cetacean and Turtle Assessment Program). 1982. *A Characterization of Marine Mammals and Turtles in the Mid- and North Atlantic Areas of the U. S. Outer Continental Shelf, Final Report.* Submitted to Bureau of Land Management, Washington, D.C. under Contract No. AA551-CT8-48. University of Rhode Island, Kingston, Rhode Island.

Cotter, M.P. 2019. *Aerial Surveys for Protected Marine Species in the Norfolk Canyon Region: 2018–2019 - Final Report*. Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, Virginia, under Contract No. N62470-15-D8006 Task Order 18F4019, issued to HDR Inc., Virginia Beach, Virginia. November 2019.

Dawson S.M., M.H. Bowman, E. Leunissen, and P. Sirguey. 2017. Inexpensive aerial photogrammetry for studies of whales and large marine animals. *Frontiers in Marine Science* 4:366. doi: 10.3389/fmars.2017.00366.

DoN (Department of the Navy). 2010. *United States Navy Integrated Comprehensive Monitoring Program. 2010 update*. U.S. Navy, Chief of Naval Operations Environmental Readiness Division, Washington, D.C.

DoN (Department of the Navy). 2011. *Scientific Advisory Group for Navy Marine Species Monitoring: Workshop Report and Recommendations.* Arlington, Virginia. 10 October 2011.

DoN (Department of the Navy). 2013. *U.S. Navy Strategic Planning Process for Marine Species Monitoring*. Chief of Naval Operations, Operational Readiness Division, Washington, D.C.

Engelhaupt, A., J.M. Aschettino, and D. Engelhaupt. 2017. *VACAPES Outer Continental Shelf Cetacean Study, Virginia Beach, Virginia: 2016 Annual Progress Report*. Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, Virginia, under Contract Nos. N62470-10-3011, Task Orders 03 and 54, and N62470-15-8006, Task Order 35, issued to HDR Inc., Virginia Beach, Virginia. 31 August 2017.

Engelhaupt, A., J.M. Aschettino, and D. Engelhaupt. 2018. *VACAPES Outer Continental Shelf Cetacean Study, Virginia Beach, Virginia: 2017 Annual Progress Report*. Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, Virginia, under Contract No. N62470-15-8006, Task Order 35, issued to HDR Inc., Virginia Beach, Virginia. May 2018.

Engelhaupt, A., J.M. Aschettino, D. Engelhaupt, A. DiMatteo, M. Richlen, and M. Cotter. 2019. *VACAPES Outer Continental Shelf Cetacean Study, Virginia Beach, Virginia: 2018 Annual Progress Report*. Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, Virginia, under Contract No. N62470-15-8006, Task Order 18F4082, issued to HDR Inc., Virginia Beach, Virginia. July 2019.

Engelhaupt, A., J.M. Aschettino, D. Engelhaupt, M. Richlen, and M. Cotter. 2020a. VACAPES Outer Continental Shelf Cetacean Study, Virginia Beach, Virginia: 2019 Annual Progress Report. Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, Virginia, under Contract No. N62470-15-8006, Task Orders 18F4082 and 19F4068, issued to HDR Inc., Virginia Beach, Virginia. April 2020.

Engelhaupt, D.T., T. Pusser, J.M. Aschettino, A.G. Engelhaupt, M.P. Cotter, M.F. Richlen, and J.T. Bell. 2020b. Blue whale (*Balaenoptera musculus*) sightings off the coast of Virginia. *Marine Biodiversity Records* 13(6):1–7.

Engelhaupt, A., J.M. Aschettino, D. Engelhaupt, M. Richlen, and M. Cotter. 2021. *VACAPES Outer Continental Shelf Cetacean Study, Virginia Beach, Virginia: 2020 Annual Progress Report*. Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Systems Command Atlantic, Norfolk, Virginia, under Contract No. N62470-15-8006, Task Order 19F4068, issued to HDR Inc., Virginia Beach, Virginia. February 2021.

Foley, H.J., C.G.M. Paxton, E.W. Cummings, R.J. McAlarney, W.A. McLellan, D.A. Pabst, and A.J. Read. 2019. *Occurrence, Distribution, and Density of Protected Species in the Jacksonville, Florida, Atlantic Fleet Training and Testing (AFTT) Study Area.* Prepared

for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command (NAVFAC) Atlantic, Norfolk, Virginia, under Contract No. N62470-15-D-8006, Task Orders 29 and 48, issued to HDR Inc., Virginia Beach, Virginia. June 2019.

Hain, J.H.W., M.A.M. Hyman, R.D. Kenney, and H.E. Winn. 1985. The role of cetaceans in the shelf-edge region of the northeastern United States. *Marine Fisheries Review* 47:13–17.

Hain, J.H.W., M.J. Ratnaswamy, R.D. Kenney, and H.E. Winn. 1992. The fin whale, *Balaenoptera physalus*, in waters of the northeastern United States continental shelf. *Reports of the International Whaling Commission* 42:653–669.

Hayes S.A., E. Josephson, K. Maze-Foley, P.E. Rosel, and J. Turek, editors. 2021. *U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2020*. NOAA Technical Memorandum NMFS-NE-271. National Marine Fisheries Service, Woods Hole, Massachusetts.

Jefferson, T.A., C.R. Weir, R.C. Anderson, L.T. Balance, J. Barlow, R.D. Kenney, and J.J. Kiszka. 2014. Global distribution of Risso's dolphin *Grampus griseus*: A review and critical evaluation. *Mammal Review* 44:56–68.

Kenney, R.D. 1990. Bottlenose dolphins off the northeastern United States. Pages 369–396 *in*: S. Leatherwood and R.R. Reeves, editors. *The Bottlenose Dolphin.* Academic Press, San Diego, California.

Kenney, R.D., and H.E. Winn. 1986. Cetacean high-use habitats of the northeast United States continental shelf. *Fishery Bulletin* 84:345–357.

Kenney, R.D., and H.E. Winn. 1987. Cetacean biomass densities near submarine canyons compared to adjacent continental shelf/slope areas. *Continental Shelf Research* 7:107–114.

Mallette, S.D., and S.G. Barco. 2019. *Mid-Atlantic & Southeast Humpback Whale Photo-ID Catalog: 2018 Annual Progress Report*. Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, Virginia, under Contract No. N62470-15-8006, Task Order 18F4032, issued to HDR Inc., Virginia Beach, Virginia. March 2019.

Mallette, S.D., R.J. McAlarney, G.G. Lockhart, E.W. Cummings, D.A. Pabst, W.A. McLellan, and S.G. Barco. 2017. *Aerial Survey Baseline Monitoring in the Continental Shelf Region of the VACAPES OPAREA: 2016 Annual Progress Report.* Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, Virginia, under Contract No. N62470-15-D-8006, Task Order 05, issued to HDR Inc., Virginia Beach, Virginia. July 2017.

Mallette, S.D., M. L. Burt, L. Thomas, R.J. McAlarney, G.G. Lockhart, E.W. Cummings, W.A. McLellan, D.A. Pabst, and S.G. Barco. 2018a. *Occurrence of Baleen Whales along the Continental Shelf Region of the VACAPES OPAREA off southern Virginia: Final Report*. Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering

Command Atlantic, Norfolk, Virginia, under Contract No. N62470-15-D-8006, Task Order 48, issued to HDR Inc., Virginia Beach, Virginia. July 2018.

Mallette, S.D., N.H. Mathies, and S.G. Barco. 2018b. *Development of a Web-based Mid-Atlantic Humpback Whale Catalog: 2017 Annual Progress Report*. Final Report. Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, Virginia, under Contract No. N62470-15-8006, Task Order 17F4031, issued to HDR Inc., Virginia Beach, Virginia. March 2018.

McAlarney, R., E. Cummings, W. McLellan, and A. Pabst. 2018a. *Aerial Surveys for Protected Marine Species in the Norfolk Canyon Region: 2017 Annual Progress Report*. Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, Virginia, under Contract No. N62470-15-D-8006 Task Orders 05, 29 and 48, issued to HDR Inc., Virginia Beach, Virginia. April 2018.

McAlarney, R., E. Cummings, B. McLellan, and A. Pabst. 2018b. *Aerial Surveys for Protected Marine Species in the Cape Hatteras Study Area: 2017 Annual Progress Report*. Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, Virginia, under Contract No. N62470-15-D-8006 Task Orders 05, 29 and 48, issued to HDR Inc., Virginia Beach, Virginia. April 2018.

Mead, J.G. 2009. Beaked whales, overview, Ziphiidae. Pages 94–97 *in*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen, editors. *Encyclopedia of Marine Mammals*. 2nd edition. Elsevier/Academic Press, San Diego, California.

NEFSC and SEFSC (Northeast Fisheries Science Center and Southeast Fisheries Science Center). 2012. *Annual Report of a Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in US Waters of the Western North Atlantic*. Prepared by the National Marine Fisheries Service for Bureau of Ocean Energy Management under Interagency Agreement number M10PG00075 and between the U.S. Navy under Interagency Agreement number NEC-11-009. Unpublished report.

NEFSC and SEFSC (Northeast Fisheries Science Center and Southeast Fisheries Science Center). 2013. *Annual Report of a Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in US Waters of the Western North Atlantic*. Prepared by the National Marine Fisheries Service for Bureau of Ocean Energy Management under Interagency Agreement number M10PG00075 and between the U.S. Navy under Interagency Agreement number NEC-11-009.

Northridge, S., M. Tasker, A. Webb, K. Camphuysen, and M. Leopold. 1997. White beaked *Lagenorhynchus albirostris* and Atlantic white-sided dolphin *L. acutus* distributions in northwest European and U.S. Atlantic waters. *Reports of the International Whaling Commission* 47:797–805.

Palka, D., A. Read, and C. Potter. 1997. Summary of knowledge of white-sided dolphins (*Lagenorhynchus acutus*) from the U.S. and Canadian North Atlantic waters. *Reports of the International Whaling Commission* 47:729–734.

Payne, P.M., and D.W. Heinemann. 1993. The distribution of pilot whales (*Globicephala* spp.) in shelf/shelf edge and slope waters of the north-eastern United States. *Reports of the International Whaling Commission, Special Issue* 14:51–68.

Rafter, M.A., K.E. Frasier, J.S. Trickey, A.C. Rice, J.A. Hildebrand, B.J. Thayre, S.M. Wiggins, A. Širović, S. Baumann-Pickering. 2018. *Passive Acoustic Monitoring for Marine Mammals at Norfolk Canyon April 2016 – June 2017. Final Report*. Marine Physical Laboratory Technical Memorandum 629. Submitted to Naval Facilities Engineering Command (NAVFAC) Atlantic, Norfolk, Virginia, under Contract No. N62470-15-D-8006 Subcontract #383-8476 (MSA2015-1176 Task Order 003) issued to HDR Inc. July 2018.

R Core Team. 2018. R: A Language and Environment for Statistical Computing. R Foundations for Statistical Computing. Vienna, Austria. https://www.R-project.org.

Richlen, M., M. Davis, M. Cooper, M. Cotter, A. Engelhaupt, J. Aschettino, and P. Hille. 2019. *COMPASS – A Survey Toolkit for Marine Species Data Collection: 2018 Annual Progress Report*. Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command (NAVFAC) Atlantic, Norfolk, Virginia, under Contract No. N62470-15-D-8006, Task Order 015, issued to HDR Inc., Virginia Beach, Virginia. March 2019.

Salisbury, D.P., B.J. Estabrook, H. Klinck, A.N. Rice. 2018. *Understanding Marine Mammal Presence in the Virginia Offshore Wind Energy Area.* CS Study BOEM 2019-007. US Department of the Interior, Bureau of Ocean Energy Management, Sterling, Virginia.

Selzer, L.A., and P.M. Payne. 1988. The distribution of white-sided (*Lagenorhynchus acutus*) and common dolphins (*Delphinus delphis*) vs. environmental features of the continental shelf of the northeastern United States. *Marine Mammal Science* 4:141–153.

Torres, W.I. and Bierlich, K. 2020. *MorphoMetriX: a photogrammetric measurement GUI for morphometric analysis of megafauna.* Journal of Open Source Software 5(45):1825. DOI 10.21105/joss.01825.

Waples, D.M., and A.J. Read. 2020. *Photo-Identification Analyses in the Cape Hatteras Study Area: 2019 Annual Progress Report.* Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, Virginia, under Contract No. N62470- 15-D-8006, Task Order 19F4026 issued to HDR Inc., Virginia Beach, Virginia. April 2020.

Waples, D.M., and A.J. Read. 2021. *Photo-Identification Analyses in the Cape Hatteras Study Area: 2020 Annual Progress Report.* Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, Virginia, under Contract No. N62470-15-D-8006, Task Order 19F4026 issued to HDR Inc., Virginia Beach, Virginia. January 2021.

Waples, D.M. and A.J. Read. 2022. *Photo-Identification Analyses in the Cape Hatteras Study Area: 2021 Annual Progress Report.* Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Systems Command Atlantic, Norfolk, Virginia,

under Contract No. N62470-20-D-0016, Task Order 21F4035 issued to HDR, Inc., Virginia Beach, Virginia. February 2022.

Waring, G.T., C.P. Fairfield, C.M. Ruhsam, and M. Sano. 1993. Sperm whales associated with Gulf Stream features off the northeastern USA shelf*. Fisheries Oceanography* 2:101–105.

Waring, G.T., T. Hamazaki, D. Sheehan, G. Wood, and S. Baker. 2001. Characterization of beaked whale (Ziphiidae) and sperm whale (*Physeter macrocephalus*) summer habitat in shelf-edge and deeper waters off the northeast U.S. *Marine Mammal Science* 17:703–717.

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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/Rec Boat within 500 m? (Y/N) • Within 500 m of Shipping Channel? (Y/N) • Notes • Photos 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

Note: Upon each entry, time stamp and GPS 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
2021

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Date	Sighting Time (local)	Scientific Name	Common Name	Group Size	Latitude (°N)	Longitude (°W)
10-Mar-21	7:00	*Delphinus delphis*	Common dolphin	15	37.003329	74.946515
10-Mar-21	8:06	*Delphinus delphis*	Common dolphin	80	37.036001	74.583983
10-Mar-21	9:11	n/a	Unidentified dolphin	14	37.024444	74.419207
10-Mar-21	9:20	*Tursiops truncatus*	Bottlenose dolphin	8	36.992240	74.458177
10-Mar-21	9:28	*Delphinus delphis*	Common dolphin	35	36.966021	74.480842
10-Mar-21	10:17	*Balaenoptera physalus*	Fin whale	1	36.930572	74.358914
10-Mar-21	10:35	*Delphinus delphis*	Common dolphin	30	36.920191	74.342132
10-Mar-21	11:16	*Delphinus delphis*	Common dolphin	28	36.913511	74.350567
10-Mar-21	12:25	*Balaenoptera physalus*	Fin whale	1	36.796638	74.520346
10-Mar-21	12:35	*Delphinus delphis*	Common dolphin	60	36.785523	74.507439
10-Mar-21	13:38	*Balaenoptera musculus*	Blue whale	1	36.774195	74.543556
10-Mar-21	15:54	*Tursiops truncatus*	Bottlenose dolphin	18	36.724124	74.639956
10-Mar-21	16:45	n/a	Unidentified delphinid	10	36.754761	75.035642
18-Apr-21	7:05	*Delphinus delphis*	Common dolphin	12	36.967931	75.109128
18-Apr-21	7:30	*Delphinus delphis*	Common dolphin	3	36.995551	74.962193
18-Apr-21	7:47	n/a	Unidentified dolphin	7	37.014097	74.852880
18-Apr-21	7:52	*Balaenoptera physalus*	Fin whale	1	37.020883	74.828882
18-Apr-21	8:07	*Stenella frontalis*	Atlantic spotted dolphin	25	37.017509	74.805138
18-Apr-21	8:37	*Tursiops truncatus*	Bottlenose dolphin	6	37.035736	74.657888
18-Apr-21	8:53	*Delphinus delphis*	Common dolphin	220	37.043156	74.609740
18-Apr-21	9:11	*Balaenoptera physalus*	Fin whale	1	37.041828	74.547342
18-Apr-21	9:19	*Megaptera novaeangliae*	Humpback whale	2	37.025463	74.522486
18-Apr-21	9:23	*Balaenoptera physalus*	Fin whale	1	37.026774	74.523910
18-Apr-21	9:31	*Megaptera novaeangliae*	Humpback whale	1	37.009201	74.492986
18-Apr-21	9:36	*Grampus griseus*	Risso's dolphin	35	37.005840	74.484089
18-Apr-21	9:43	*Balaenoptera physalus*	Fin whale	2	37.003396	74.459680
18-Apr-21	10:46	*Balaenoptera physalus*	Fin whale	1	36.998650	74.462126
18-Apr-21	10:59	*Physeter macrocephalus*	Sperm whale	1	36.979711	74.426207
18-Apr-21	11:33	*Stenella frontalis*	Atlantic spotted dolphin	10	36.987074	74.434605
18-Apr-21	11:52	*Physeter macrocephalus*	Sperm whale	4	37.001062	74.434543
18-Apr-21	15:22	*Balaenoptera physalus*	Fin whale	1	37.010929	74.781002
20-Apr-21	7:56	*Tursiops truncatus*	Bottlenose dolphin	4	37.015598	74.545046
20-Apr-21	8:22	*Tursiops truncatus*	Bottlenose dolphin	55	37.035963	74.404127
20-Apr-21	9:06	*Delphinus delphis*	Common dolphin	15	37.118177	74.379908
20-Apr-21	9:41	*Megaptera novaeangliae*	Humpback whale	1	37.069482	74.428732
20-Apr-21	10:21	*Delphinus delphis*	Common dolphin	5	37.043271	74.423910
20-Apr-21	11:18	*Physeter macrocephalus*	Sperm whale	1	36.970796	74.324153

Date	Sighting Time (local)	Scientific Name	Common Name	Group Size	Latitude (°N)	Longitude (°W)
20-Apr-21	11:57	*Physeter macrocephalus*	Sperm whale	1	36.948197	74.336107
20-Apr-21	12:06	*Physeter macrocephalus*	Sperm whale	2	36.955301	74.351108
20-Apr-21	12:20	*Tursiops truncatus*	Bottlenose dolphin	12	36.955158	74.333904
20-Apr-21	13:51	*Physeter macrocephalus*	Sperm whale	1	36.919487	74.382471
20-Apr-21	13:54	*Physeter macrocephalus*	Sperm whale	1	36.910535	74.372302
20-Apr-21	14:15	*Megaptera novaeangliae*	Humpback whale	1	36.898452	74.472092
20-Apr-21	15:44	*Physeter macrocephalus*	Sperm whale	1	36.907680	74.452965
20-Apr-21	16:24	*Megaptera novaeangliae*	Humpback whale	2	36.898977	74.699443
20-Apr-21	17:42	*Balaenoptera physalus*	Fin whale	1	36.903563	75.131492
7-May-21	7:40	*Tursiops truncatus*	Bottlenose dolphin	18	37.042760	74.594793
7-May-21	8:16	*Globicephala* sp.	Unidentified pilot whale	10	37.042734	74.477524
7-May-21	10:34	n/a	Unidentified dolphin	20	36.953845	74.509252
7-May-21	10:41	*Globicephala* sp.	Unidentified pilot whale	15	36.954002	74.529459
7-May-21	11:03	*Globicephala* sp.	Unidentified pilot whale	18	36.978768	74.558250
7-May-21	11:23	*Tursiops truncatus*	Bottlenose dolphin	35	37.028733	74.564208
7-May-21	11:43	*Globicephala* sp.	Unidentified pilot whale	10	37.047365	74.555989
7-May-21	12:03	*Tursiops truncatus*	Bottlenose dolphin	2	37.048131	74.624958
7-May-21	12:44	*Tursiops truncatus*	Bottlenose dolphin	5	37.101747	74.687269
7-May-21	14:03	*Tursiops truncatus*	Bottlenose dolphin	8	37.002706	75.251095
1-Jun-21	7:08	*Stenella frontalis*	Atlantic spotted dolphin	40	36.792517	74.913450
1-Jun-21	7:26	*Stenella frontalis*	Atlantic spotted dolphin	120	36.784967	74.787817
1-Jun-21	7:38	*Tursiops truncatus*	Bottlenose dolphin	10	36.781283	74.694800
1-Jun-21	7:44	*Globicephala* sp.	Unidentified pilot whale	60	36.779030	74.663300
1-Jun-21	7:54	*Delphinus delphis*	Common dolphin	35	36.778300	74.592167
1-Jun-21	8:00	*Globicephala* sp.	Unidentified pilot whale	275	36.779600	74.564467
1-Jun-21	8:05	*Balaenoptera physalus*	Fin whale	1	36.778917	74.558867
1-Jun-21	8:39	*Globicephala* sp.	Unidentified pilot whale	55	36.795967	74.437417
1-Jun-21	8:43	*Delphinus delphis*	Common dolphin	15	36.795750	74.436350
1-Jun-21	9:06	n/a	Unidentified dolphin	35	36.798420	74.349630
1-Jun-21	9:33	*Balaenoptera physalus*	Fin whale	1	36.812133	74.308050
1-Jun-21	11:08	*Physeter macrocephalus*	Sperm whale	1	36.875517	74.132117
1-Jun-21	11:33	*Grampus griseus*	Risso's dolphin	8	36.901980	74.118750
1-Jun-21	11:33	*Physeter macrocephalus*	Sperm whale	7	36.875517	74.118750
1-Jun-21	13:11	*Megaptera novaeangliae*	Humpback whale	1	36.946967	74.156400
1-Jun-21	13:16	*Balaenoptera physalus*	Fin whale	1	36.952483	74.159867
1-Jun-21	15:14	*Globicephala* sp.	Unidentified pilot whale	18	36.925200	74.580017
1-Jun-21	15:19	*Grampus griseus*	Risso's dolphin	15	36.922817	74.615200

Date	Sighting Time (local)	Scientific Name	Common Name	Group Size	Latitude (°N)	Longitude (°W)
28-Jun-21	8:30	*Globicephala* sp.	Unidentified pilot whale	26	36.920401	74.628500
28-Jun-21	8:50	*Globicephala* sp.	Unidentified pilot whale	40	36.935048	74.558436
28-Jun-21	10:13	*Globicephala* sp.	Unidentified pilot whale	12	36.988903	74.437104
28-Jun-21	10:18	*Stenella frontalis*	Atlantic spotted dolphin	40	36.999472	74.436117
28-Jun-21	11:04	*Globicephala* sp.	Unidentified pilot whale	14	37.033323	74.373302
28-Jun-21	12:21	*Globicephala* sp.	Unidentified pilot whale	30	37.114634	74.424533
28-Jun-21	12:47	*Globicephala* sp.	Unidentified pilot whale	30	37.097733	74.465174
28-Jun-21	13:16	*Globicephala* sp.	Unidentified pilot whale	43	37.057135	74.507396
28-Jun-21	13:48	*Globicephala* sp.	Unidentified pilot whale	22	37.035671	74.568395
28-Jun-21	14:08	*Tursiops truncatus*	Bottlenose dolphin	25	37.029475	74.626127
28-Jun-21	14:29	n/a	Unidentified dolphin	10	36.999743	74.789966
10-Aug-21	7:44	*Tursiops truncatus*	Bottlenose dolphin	25	36.387789	74.771917
10-Aug-21	7:51	*Tursiops truncatus*	Bottlenose dolphin	4	36.366701	74.724681
10-Aug-21	7:52	*Globicephala* sp.	Unidentified pilot whale	35	36.365764	74.723128
10-Aug-21	7:59	*Tursiops truncatus*	Bottlenose dolphin	6	36.343225	74.675439
10-Aug-21	8:33	*Tursiops truncatus*	Bottlenose dolphin	15	36.341393	74.564564
10-Aug-21	8:34	*Globicephala* sp.	Unidentified pilot whale	13	36.350163	74.561957
10-Aug-21	8:56	*Tursiops truncatus*	Bottlenose dolphin	20	36.339635	74.508815
10-Aug-21	9:43	*Globicephala* sp.	Unidentified pilot whale	35	36.409097	74.524258
10-Aug-21	9:54	*Tursiops truncatus*	Bottlenose dolphin	75	36.441557	74.506957
10-Aug-21	10:21	*Tursiops truncatus*	Bottlenose dolphin	4	36.487409	74.483052
10-Aug-21	10:50	*Tursiops truncatus*	Bottlenose dolphin	58	36.536356	74.531632
10-Aug-21	11:21	*Tursiops truncatus*	Bottlenose dolphin	25	36.623170	74.537109
10-Aug-21	12:24	n/a	Unidentified dolphin	10	36.727354	74.436120
10-Aug-21	12:45	*Tursiops truncatus*	Bottlenose dolphin	20	36.782005	74.390502
10-Aug-21	13:44	*Globicephala* sp.	Unidentified pilot whale	7	36.792893	74.593351
10-Aug-21	13:52	*Globicephala* sp.	Unidentified pilot whale	44	36.765239	74.592760
16-Aug-21	7:49	*Tursiops truncatus*	Bottlenose dolphin	3	36.956408	74.634471
16-Aug-21	8:19	*Globicephala macrorhynchus*	Short-finned pilot whale	10	36.966792	74.464008
16-Aug-21	8:49	*Grampus griseus*	Risso's dolphin	30	36.920092	74.367217
16-Aug-21	9:11	*Grampus griseus*	Risso's dolphin	14	36.909491	74.355156
16-Aug-21	9:20	*Mesoplodon* sp.	Unidentified Mesopolodon	1	36.905849	74.380670
16-Aug-21	9:53	n/a	Unidentified dolphin	20	36.904088	74.405878
16-Aug-21	10:50	*Globicephala* sp.	Unidentified pilot whale	8	36.829458	74.411936
16-Aug-21	12:02	*Physeter macrocephalus*	Sperm whale	6	36.597154	74.077304
16-Aug-21	15:32	*Tursiops truncatus*	Bottlenose dolphin	25	36.622286	74.407508
16-Aug-21	15:51	*Globicephala* sp.	Unidentified pilot whale	10	36.639496	74.536149

Date	Sighting Time (local)	Scientific Name	Common Name	Group Size	Latitude (°N)	Longitude (°W)
16-Aug-21	15:53	*Tursiops truncatus*	Bottlenose dolphin	30	36.648232	74.545133
16-Aug-21	16:00	*Globicephala* sp.	Unidentified pilot whale	20	36.657081	74.596358
16-Aug-21	16:02	*Tursiops truncatus*	Bottlenose dolphin	8	36.650740	74.609758
16-Aug-21	16:03	*Globicephala* sp.	Unidentified pilot whale	4	36.636858	74.616950
16-Aug-21	16:24	*Stenella frontalis*	Atlantic spotted dolphin	25	36.668932	74.753635
24-Oct-21	8:07	n/a	Unidentified dolphin	1	36.462690	74.879078
24-Oct-21	8:21	*Tursiops truncatus*	Bottlenose dolphin	12	36.434581	74.777757
24-Oct-21	8:50	*Globicephala* sp.	Unidentified pilot whale	8	36.389006	74.675042
24-Oct-21	10:21	*Globicephala* sp.	Unidentified pilot whale	2	36.556258	74.627278
24-Oct-21	10:32	n/a	Unidentified dolphin	30	36.553755	74.642571
24-Oct-21	10:40	*Globicephala* sp.	Unidentified pilot whale	11	36.578041	74.627561
24-Oct-21	11:46	*Physeter macrocephalus*	Sperm whale	1	36.591435	74.613246
24-Oct-21	12:51	*Physeter macrocephalus*	Sperm whale	1	36.577992	74.573007
24-Oct-21	13:40	*Globicephala* sp.	Unidentified pilot whale	25	36.600291	74.615054

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

C

Sea Turtle Sightings 2021

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Date	Sighting Time (local)	Scientific Name	Common Name	Group Size	Latitude (°N)	Longitude (°W)
18-Apr-21	9:29	*Caretta caretta*	Loggerhead turtle	1	37.015029	74.508308
7-May-21	13:19	*Caretta caretta*	Loggerhead turtle	2	37.064603	74.916151
7-May-21	13:23	*Caretta caretta*	Loggerhead turtle	1	37.061879	74.950875
7-May-21	13:29	*Caretta caretta*	Loggerhead turtle	3	37.054252	74.991998
7-May-21	13:31	*Caretta caretta*	Loggerhead turtle	2	37.052778	75.012106
7-May-21	13:38	*Caretta caretta*	Loggerhead turtle	3	37.040686	75.065569
7-May-21	13:42	*Caretta caretta*	Loggerhead turtle	3	37.032480	75.095842
7-May-21	13:45	*Caretta caretta*	Loggerhead turtle	3	37.030455	75.119275
7-May-21	13:56	*Caretta caretta*	Loggerhead turtle	4	37.011880	75.201676
7-May-21	14:07	*Caretta caretta*	Loggerhead turtle	3	36.998977	75.278118
7-May-21	14:28	*Caretta caretta*	Loggerhead turtle	1	36.963279	75.439235
28-Jun-21	14:57	*Caretta caretta*	Loggerhead turtle	2	36.976637	75.003474
28-Jun-21	15:28	*Dermochelys coriacea*	Leatherback turtle	1	36.942579	75.240567
10-Aug-21	7:32	*Caretta caretta*	Loggerhead turtle	1	36.413103	74.859803
10-Aug-21	14:42	*Caretta caretta*	Loggerhead turtle	1	36.795578	74.881884
16-Aug-21	16:48	*Caretta caretta*	Loggerhead turtle	1	36.702934	74.918016
24-Oct-21	14:48	*Dermochelys coriacea*	Leatherback turtle	1	36.691194	75.050418
24-Oct-21	16:11	*Caretta caretta*	Loggerhead turtle	1	36.781443	75.640136

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

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D

Photo-identified Priority Species Individuals 2021

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HDR ID #	Species	Sighting Date(s)	Biopsy?	Satellite Tag?/Argos ID
HDRVABp098	*Balaenoptera physalus*	10-Mar-21	No	No
HDRVABp099	*Balaenoptera physalus*	10-Mar-21	No	No
HDRVABm089	*Balaenoptera musculus*	10-Mar-21	Yes	SPLASH-10F/183917
HDRVABp100	*Balaenoptera physalus*	18-Apr-21	No	No
HDRVAMn210	*Megaptera novaeangliae*	18-Apr-21	No	No
HDRVABp101	*Balaenoptera physalus*	18-Apr-21	No	No
HDRVAPm010	*Physeter macrocephalus*	18-Apr-21	Previously biopsied (2017)	Previously tagged (2017/168234; 2018/173233)
HDRVAPm012	*Physeter macrocephalus*	18-Apr-21	Previously biopsied (2018)	Previously tagged (2018/171884)
HDRVAPm096	*Physeter macrocephalus*	18-Apr-21	No	SPLASH-10/183917
HDRVAMn211	*Megaptera novaeangliae*	20-Apr-21	No	No
HDRVAPm050	*Physeter macrocephalus*	20-Apr-21	No	No
HDRVAPm097	*Physeter macrocephalus*	20-Apr-21	No	No
HDRVAMn212	*Megaptera novaeangliae*	20-Apr-21	No	No
HDRVAPm053	*Physeter macrocephalus*	20-Apr-21	No	No
HDRVAMn213	*Megaptera novaeangliae*	20-Apr-21	No	No
HDRVAMn214	*Megaptera novaeangliae*	20-Apr-21	No	No
HDRVABp102	*Balaenoptera physalus*	01-Jun-21	No	No
HDRVAPm098	*Physeter macrocephalus*	01-Jun-21	No	No
HDRVAPm099	*Physeter macrocephalus*	01-Jun-21	Yes	SPLASH-10/183918
HDRVAPm100	*Physeter macrocephalus*	01-Jun-21	No	SPLASH-10/183919
HDRVAPm101	*Physeter macrocephalus*	01-Jun-21	Yes	SPOT-6/177041
HDRVAPm102	*Physeter macrocephalus*	01-Jun-21	No	No
HDRVAPm103	*Physeter macrocephalus*	01-Jun-21	No	No
HDRVAPm104	*Physeter macrocephalus*	01-Jun-21	No	No
HDRVAPm105	*Physeter macrocephalus*	01-Jun-21	No	No
HDRVAMn217	*Megaptera novaeangliae*	01-Jun-21	No	No
HDRVABp103	*Balaenoptera physalus*	01-Jun-21	No	No
HDRVAPm106	*Physeter macrocephalus*	16-Aug-21	No	No
HDRVAPm107	*Physeter macrocephalus*	16-Aug-21	No	No
HDRVAPm108	*Physeter macrocephalus*	16-Aug-21	No	No
HDRVAPm109	*Physeter macrocephalus*	16-Aug-21	No	No
HDRVAPm110	*Physeter macrocephalus*	16-Aug-21	No	No
HDRVAPm111	*Physeter macrocephalus*	16-Aug-21	No	No
HDRVAPm112	*Physeter macrocephalus*	16-Aug-21	No	No
HDRVAPm113	*Physeter macrocephalus*	24-Oct-21	Yes	SPLASH-10 / 183920

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