VACAPES Outer Continental Shelf Cetacean Study, Virginia Beach, Virginia: 2019 Annual Progress Report

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Cover Photo Credit:

Sperm whale (*Physeter macrocephalus*) 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

AMAPPS	Atlantic Marine Assessment Program for Protected Species
ARS	Area Restricted Search
BSS	Beaufort sea state
ESA	Endangered Species Act
GPS	Global Positioning System
hr	hour(s)
km	kilometer(s)
LIMPET	Low-Impact Minimally Percutaneous Electronic Transmitter
m	meter(s)
min	minute(s)
MMO	marine mammal observer
NM	nautical mile(s)
NSN	Naval Station Norfolk
OPAREA	Operating Area
PAM	passive acoustic monitoring
photo-ID	photo-identification
SPOT	Smart Position and Temperature
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. Since 2012, HDR has worked with the U.S. Navy to carry out vessel-based line transect visual surveys, photo-identification (photo-ID) surveys, and focal-follow surveys, with the goal of determining common bottlenose dolphin (*Tursiops truncatus*) densities and site fidelity (see Engelhaupt et al. 2014, 2015, 2016), as well as humpback whale (*Megaptera novaeangliae*) habitat use (see Aschettino et al. 2015, 2016, 2017, 2018, 2019) within waters adjacent to Naval Station Norfolk (NSN), Joint Expeditionary Base Little Creek-Fort Story, Naval Air Station Oceana Dam Neck Annex, and within and near the W-50 Mine Neutralization Exercise area.

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 United States based on 3 years of surveys conducted by the Cetacean and Turtle Assessment Program (CETAP 1982). More recent, still on-going, broad-scale surveys by the National Marine Fisheries Service, including the Atlantic Marine Assessment Program for Protected Species (AMAPPS) and marine mammal stock-assessment reports (Waring et al. 2016) show the same pattern. Cetacean species known to be common in some seasons 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, sperm whales (*Physeter macrocephalus*), beaked whales (*Ziphius cavirostris*, *Mesoplodo*n spp.), long-finned and short-finned pilot whales (*Globicephala melas* and *Globicephala macrorhynchus*, respectively), Risso's dolphins (*Grampus griseus*), common bottlenose dolphins, 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, 2016; Northridge et al. 1997; Palka et al. 1997; Mead 2009; NEFSC and SEFSC 2012, 2013; Jefferson et al. 2014). 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 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). A separate study focusing on outer continental shelf cetaceans was initiated in July 2016 (Engelhaupt et al. 2017, 2018, 2019). This progress report includes all offshore activities conducted in 2019. The goals of this effort focus on addressing fundamental information gaps related to marine mammal occurrence, exposure, and response as identified the U.S. Navy's Integrated Comprehensive Monitoring Program (DoN 2010) and the follow-up Scientific Advisory Group review (DoN 2011).

In order to address these gaps for offshore waters in the VACAPES OPAREA, a combination of techniques are being used, including: (1) photo-ID and behavioral data collection 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, determine foraging patterns, 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).

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 off the coast of Southeast Virginia and Cape Hatteras, North Carolina, suggests a year-round presence of several species of cetaceans, including Cuvier's beaked whales and short-finned pilot whales, near the continental shelf break (McAlarney et al. 2018a, 2018b). Tagging efforts for this project will provide opportunities to assess movement patterns of additional species and may identify the extent of overlap with 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 to OPAREAS outside of VACAPES, 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 NSN, 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 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 > 50 meters (m) to < 2,500 m.

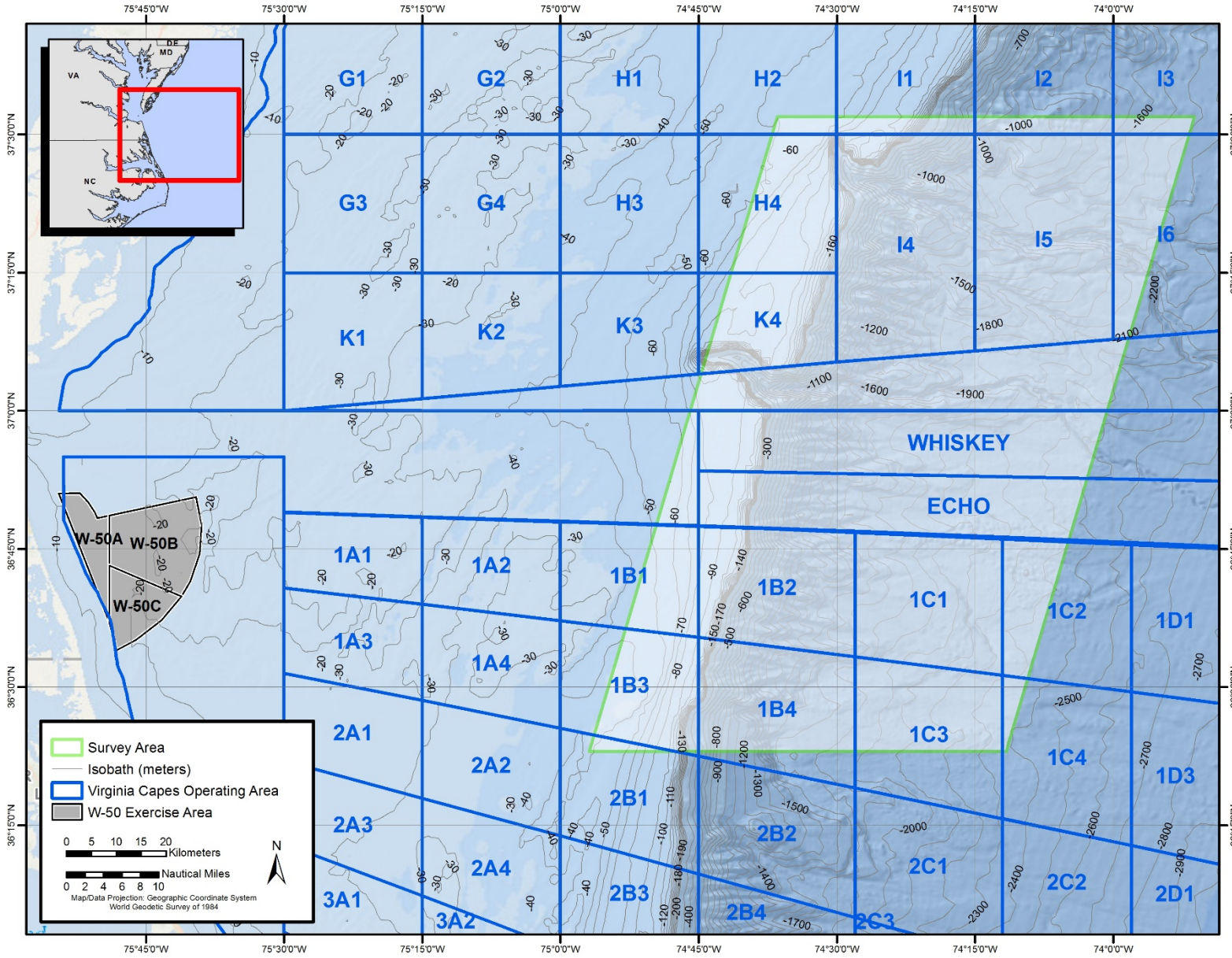

Figure 1. Map of the offshore study area off southeastern Virginia and the VACAPES training range surface grid in the region.

2.1 Survey Operations

Survey departure times were adjusted 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+ 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, 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.

Two offshore charter sport-fishing vessels, the 17.4 m *Capt. Cheryl* and 16.2 m *Top Notch* (**Figure 2)** were the primary vessels used in 2019 to support surveys. Each 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.

Figure 2. One of two sport-fishing vessels chartered for use during offshore surveys, the 16.2 m *Top Notch*.

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, and therefore there were times that area was unavailable.

The scientific crew consisted of a minimum of four marine mammal observers (MMOs), but no more than six, including (at least) one photographer, one data recorder, one tagging specialist, and one biopsy specialist. Roles generally were interchangeable throughout surveys.

In order to maximize achievement of the project's core objectives, departures from the marina were scheduled at approximately sunrise or earlier and up to 12 hr were 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 of 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.

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 10 × 30 hand-held image-stabilized binoculars and unaided eyes. MMOs covered a 270-degree swath of observation area in front of and to the sides of the survey vessel. Once in deep water (>400 m) a directional hydrophone was frequently used to listen for sperm whales. If clicks were heard, every effort was made to localize the detections and maneuver the boat to where the whales were heard. If no clicks were heard, the vessel would continue transiting before stopping approximately 20 to 30 minutes 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 visually 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 worked in the event that higher-priority species were not encountered, although because of the high number of sightings of pilot whales, 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

photographs was limited to confirming species identification, estimating group size, and determining initial behavior.

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

2.2 Photography and Data Logging

Once a sighting was made, one observer focused on data entry, while the others focused on obtaining photo-ID images of the individual(s) using a digital SLR 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, photos 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, the North Atlantic Fin Whale Catalog curated by the Center for Coastal Studies, the North Atlantic and Mediterranean Sperm Whale catalog curated by Whale Watch Azores, the Mid-Atlantic Humpback Whale Catalog currently being developed by the Virginia Aquarium (Mallette et al. 2018b, 2019), the Gotham Whale Humpback Whale Catalog, and multiple other cetacean catalogs maintained by Duke University.

During surveys, the data recorder maintained a log of observers, environmental conditions, and sighting information in COMPASS running on an iPad (**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.

2.3 Biopsy Sample Collection

Biopsy samples were collected from priority species after the survey team finished collecting identification photographs. 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, FL). 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 analysis studies were collected for the University of Groningen, and samples for sperm whale genetic analyses were collected for Oregon State University.

2.4 Satellite Tagging

A combination of Wildlife Computers (Redmond, Washington) Argos-linked location-only Smart Position and Temperature (SPOT-240), Argos-linked time-depth archival (SPLASH10-292 tags), and Argos-linked time-depth archival with Fastloc® GPS technology (SPLASH10-333-F), 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). Two surgical-grade titanium darts measuring 6.8 centimeters in length containing six backwards-facing petals were used to attach tags to the dorsal fin 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 based on expected attachment durations of LIMPET tags on baleen and sperm whales of less than 60 days. 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. All dives were manually inspected, and unrealistic dive durations were removed from the data that could not be verified by both the time series and behavior file output. Additional dive data results were obtained using the statistical software R (R Core Team 2018).

3. Results

We conducted 14 offshore vessel surveys in 2019, covering 4,637 km of trackline during more than 170 hr of effort (**Table 1, Figure 3**). Surveys were conducted at least once per month in all months except April and July, during which weather conditions prevented survey effort.

Surveys resulted in 239 marine mammal sightings and 18 sea turtle sightings (**Figures 4 through 7; Appendix B and C**). Twelve cetacean taxa were identified (in order of decreasing frequency): unidentified pilot whale (*Globicephala* sp.) (*n*=86), common bottlenose dolphin (*n*=43), common dolphin (*n*=38), fin whale (*n*=15), Risso's dolphin (*n*=9), sperm whale (*n*=7), Atlantic spotted dolphin (*n*=7), humpback whale (*n*=4), short-finned pilot whale (*n*=4), striped dolphin (*n*=4), True's beaked whale (*n*=2), Sowerby's beaked whale (*n*=1), and Cuvier's beaked whale (*n*=1). In addition, there were 18 sightings of unconfirmed species: unidentified dolphin (*n*=11), unidentified large whale (*n*=4), unidentified cetacean (*n*=1), unidentified Mesoplodon beaked whale (*n*=1), and unidentified beaked whale (*n*=1). Two sea turtle taxa were identified: loggerhead turtle (*n*=15) and leatherback turtle (*n*=3). Given the study's focus on priority species that do not include pilot whales, combined with the challenge of identifying the genus *Globicephala* down to species from a distance, most pilot whale groups were classed as unidentified pilot whales.

3.1 Photo-ID

Due to priorities and limited windows of opportunity, photo-ID images were collected from 163 of the 239 marine mammal sightings. All photographs of baleen, sperm, and beaked whales were added to HDR's existing catalogs (**Appendix D**). The HDR fin whale catalog now contains 83

unique individuals, the minke whale catalog contains 10 individuals, the North Atlantic right whale catalog contains 6 individuals, and the sei whale catalog contains 2 individuals. Of the 83 identified fin whales, 13 (15.7%) have been re-sighted; 7 (8.4%) of them during different years ranging 247 to 355 between first and last sightings. Locations of all re-sighted fin whales were in water over the continental shelf, less than 200 m depth for all encounters. Distance between re-sight locations ranged from 21.0 to 46.8 km. Humpback whale images were incorporated into the existing nearshore catalog (see Aschettino et al. 2018, 2019), adding 4 new whales.

The HDR sperm whale catalog now contains 89 individuals. Twelve (13.5 percent) were sighted on more than one day, ranging from nine to 428 days between sightings (Mean = 249, Median = 345). All 12 re-sighted sperm whales were photographed at least once within or offshore of Norfolk Canyon, 7 of those 12 were only re-sighted in that area (less than 20 km apart). The maximum distance between any re-sighted individuals was 65.0 km. Photographs of sperm whales also have been provided by Duke University for comparison against individuals sighted in the Cape Hatteras study area (Foley et al. 2016) for which 18 sperm whales have been identified, and two individuals have been matched between the two catalogs to date, seen 446 days and 73 km apart, and 567 days and 143 km apart. Two new identifiable individuals were added to the HDR Sowerby's beaked whale catalog, now containing 8 individuals but no re-sightings have been made. One recognizable Cuvier's beaked whale was photographed. Duke University compared the Cuvier's ID to their existing catalog, but no matches were found. Images of other odontocete species have been archived for future processing.

Table 1. Summary of 2019 offshore survey effort in the VAPACES outer continental shelf study area.

Date	Survey Time (min)	Distance surveyed (km)	# Sightings	# Individuals	Baleen Whales # Sightings/ # Individuals	Deep Diving Whales* # Sightings/ # Individuals	Dolphins # Sightings/ # Individuals	Sea Turtles # Sightings/ # Individuals
04-Jan-19	746	353.7	14	469	1/1	2/30	11/438	0/0
17-Jan-19	703	320.6	11	120	5/7	3/28	3/85	0/0
02-Feb-19	709	318.5	15	130	4/4	0/0	11/126	0/0
26-Feb-19	718	303.7	13	323	3/4	2/19	8/300	0/0
08-Mar-19	805	343	22	333	7/7	8/126	7/200	0/0
07-May-19	768	330	23	729	0/0	2/6	17/719	4/4
07-Jun-19	715	337	14	273	0/0	6/98	8/175	0/0
27-Jun-19	871	361	18	237	0/0	8/87	5/144	5/6
01-Aug-19	762	309	20	275	1/1	11/149	5/122	3/3
05-Aug-19	714	318	24	564	0/0	15/295	8/268	1/1
11-Sep-19	803	353	19	1,311	1/1	11/244	5/1,064	2/2
25-Oct-19	684	325	23	375	0/0	14/227	7/146	2/2
26-Nov-19	748	325	19	915	1/1	7/154	10/759	1/1
22-Dec-19	703	340	22	231	0/0	15/186	7/45	0/0
Totals	**10,449**	**4,637.5**	**257**	**6,285**	**23/26**	**104/1,649**	**112/4,591**	**18/19**

Key: min = minute(s); km = kilometer(s); * sperm whales, pilot whales, and beaked whales

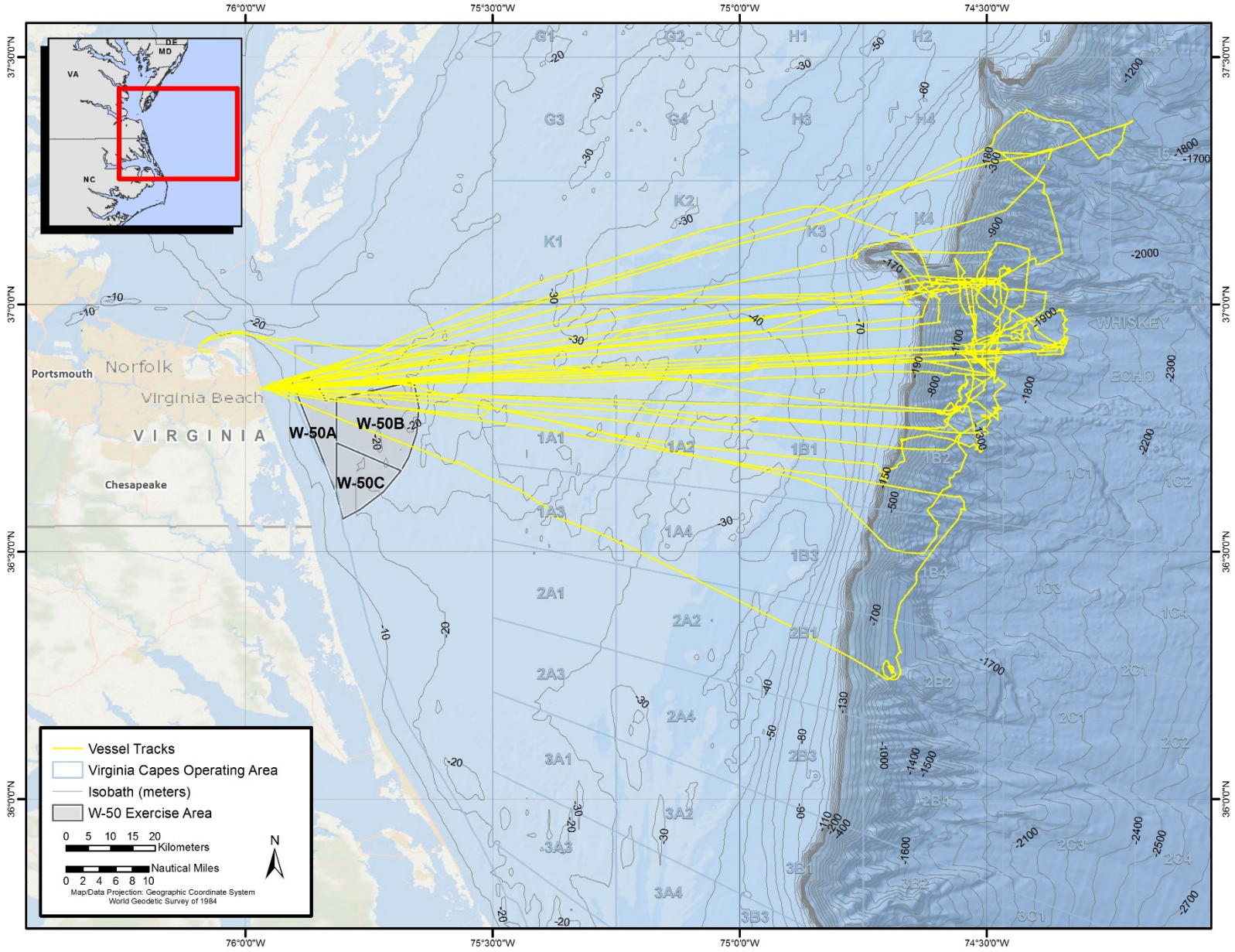

Figure 3. Offshore survey tracks for all surveys conducted in 2019.

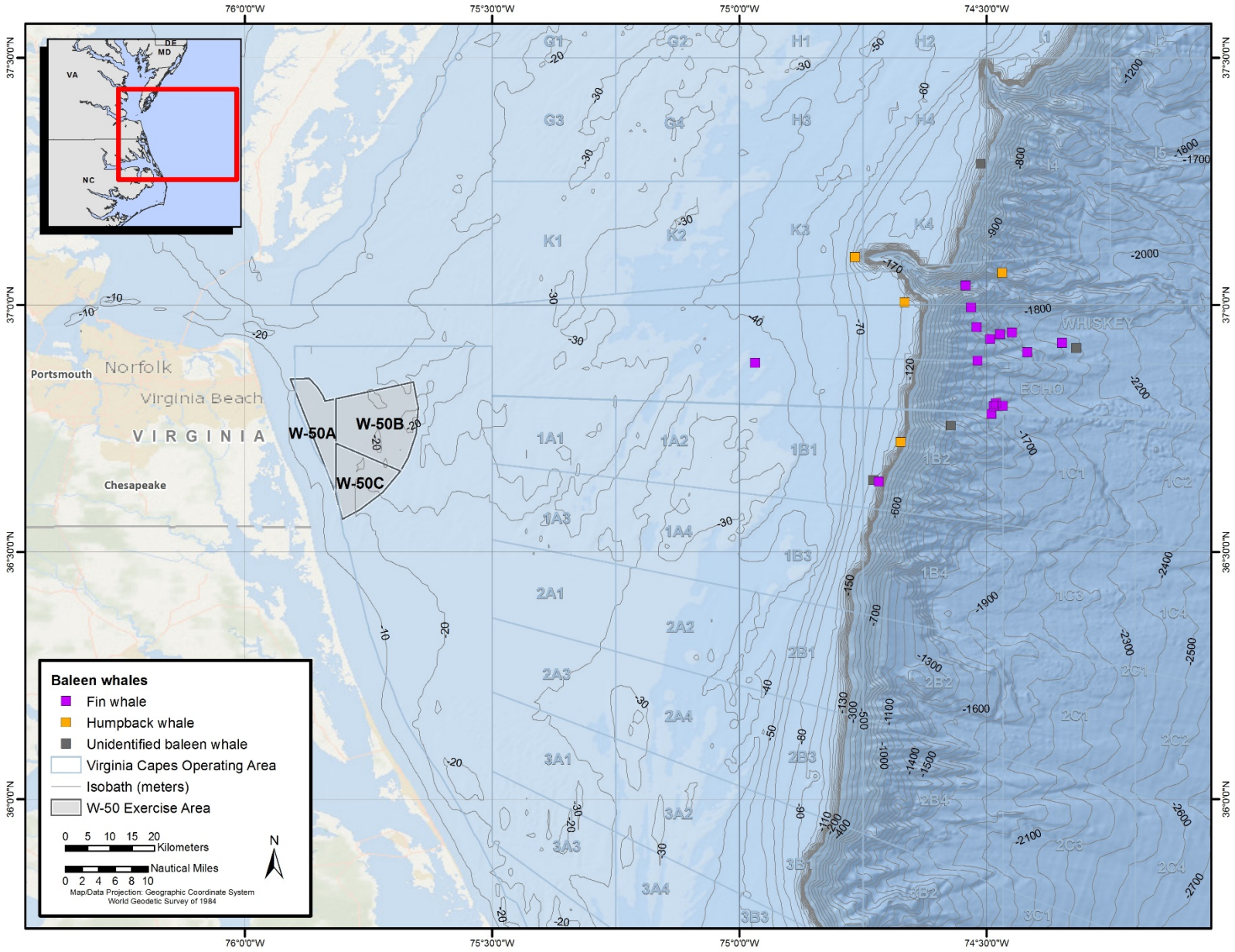

Figure 4. Locations of all baleen whale sightings (*n*=23) in 2019.

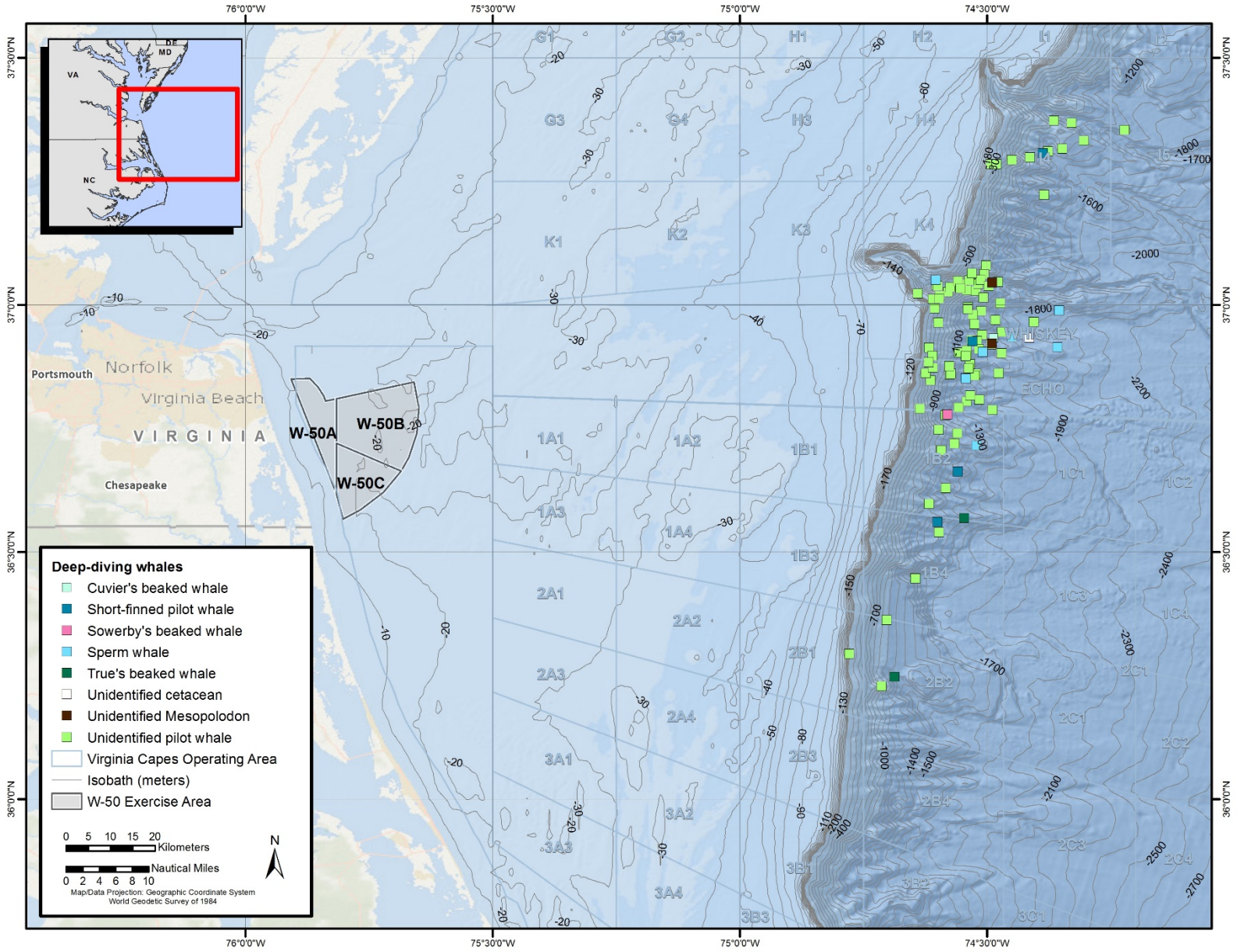

Figure 5. Locations of all deep diving whale sightings (*n*=104) in 2019.

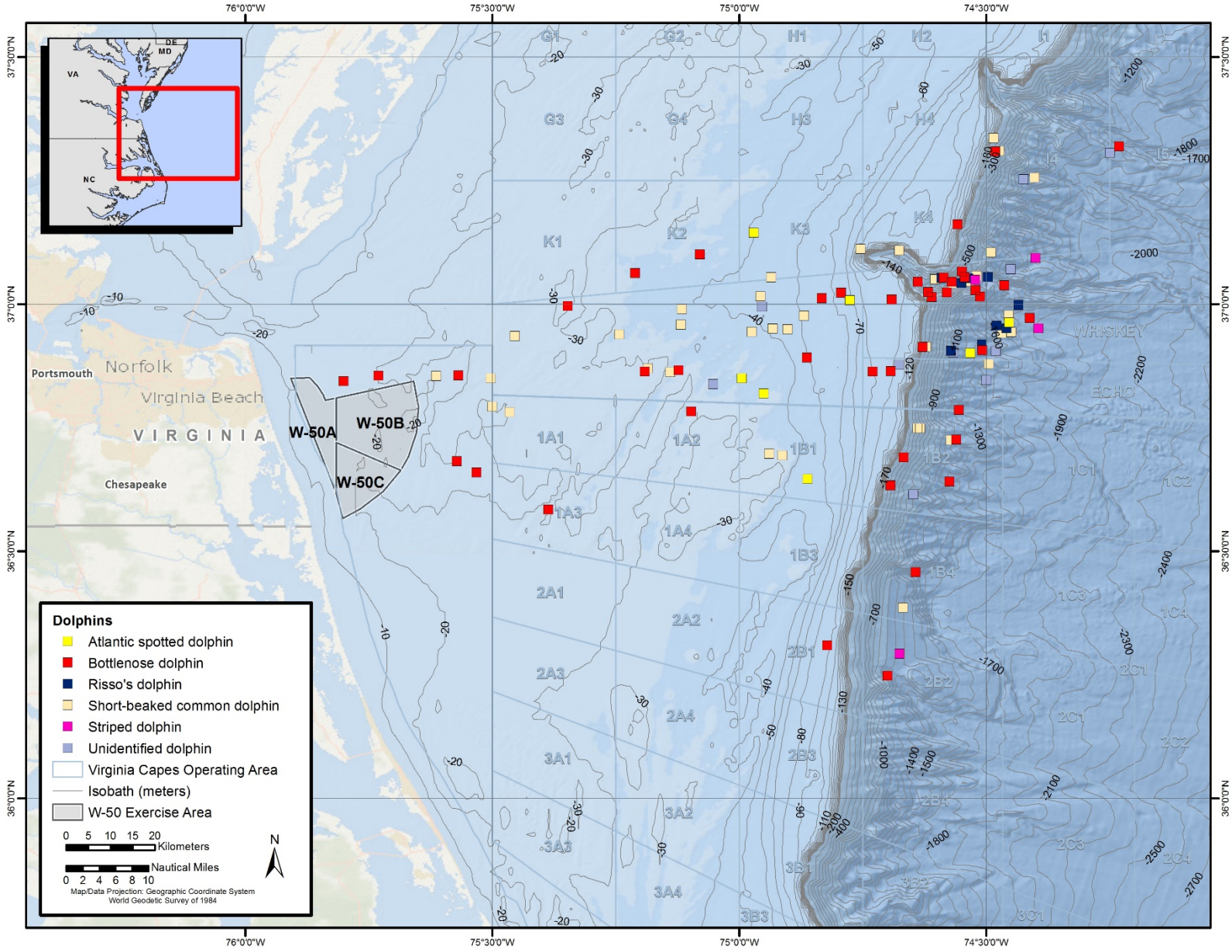

Figure 6. Locations of all dolphin sightings (*n*=112) in 2019.

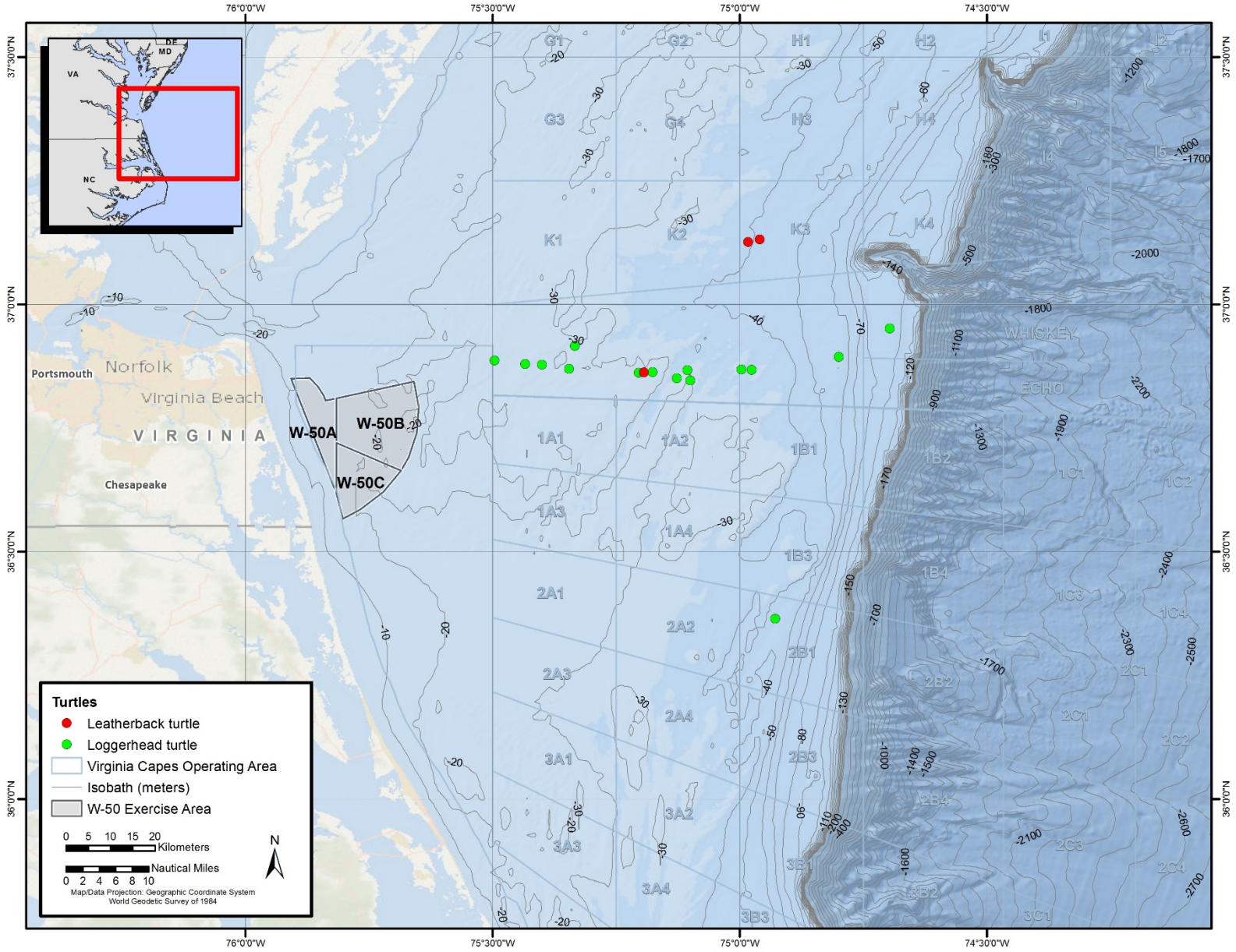

Figure 7. Locations of all sea turtle sightings (*n*=18) in 2019.

3.2 Biopsy Sample Collection & Genetics

Five biopsies were collected from sperm whales in 2019 (**Appendix D**). A single biopsy was collected from a humpback whale, which was added to the nearshore humpback effort (Aschettino et al. 2019). Sperm whale samples are currently being processed. Gender results from sperm whale samples collected in 2017 and 2018 showed 3 were females and 11 were males.

Preliminary mitochondrial DNA results for the 13 sperm whale samples tested to date, provided by OSU, show all samples were classed into the three most common haplotypes (haplotype A = 9, haplotype B = 3, haplotype C = 1). No whales were confirmed as genetic matches to other whales sampled in this study or elsewhere using microsatellite techniques.

3.3 Satellite Tagging

A total of eight satellite tags were successfully deployed in 2019, seven on sperm whales and one on a humpback whale (**Tables 2 and 3**). The humpback tag data will be included in the nearshore humpback project report (Aschettino et al. 2020) and therefore has been excluded from this summary. Four of the seven sperm whale tags were SPLASH-10 tags, which collect location and dive depth/duration information (**Table 4**).

Sperm whale tag duration ranged from 7.2 to 32.2 days (mean=15.2). Movements of tagged individuals were varied, with most individuals showing limited movement from their initial tagging location in the VACAPES OPAREA (**Figures 8 through 14**), and others moving greater distances to the north or east, generally along the continental shelf edge and slope. Movements ranged north through the Atlantic City and Narragansett Bay OPAREAs with one individual crossing into Canadian waters before the tag stopped transmitting. None of the 2019 tagged whales moved south to the Cherry Point OPAREA waters as in previous years. Tagged sperm whales traveled up to 918 km away from initial tag deployment location and had 15 to 100 percent of locations within the VACAPES OPAREA depending on the individual (**Table 3**). Sperm whale maximum dive depth ranged from 1,119 to 1,887 m, and maximum dive duration ranged from 49 to 57 min (**Table 4**).

Table 2. Summary of tag deployment details for all sperm whale tags deployed in 2019.

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)
HDRVAPm038	SPLASH-10	173231	2019-Mar-08 18:05	36.94281327	-74.42875114	1838	2019-Mar-20 01:00	11.14
HDRVAPm061	SPOT-6	180408	2019-Mar-08 18:40	36.95455954	-74.42290133	1849	2019-Mar-24 15:25	15.60
HDRVAPm065	SPLASH-10	177046	2019-Mar-08 20:43	36.922325	-74.399986	1917	2019-Mar-22 03:08	13.24
HDRVAPm082	SPLASH-10	177048	2019-Jun-27 17:24	36.836514	-74.548035	1227	2019-Jul-07 11:38	9.44
HDRVAPm086	SPLASH-10	177049	2019-Aug-05 15:50	36.960632	-74.344925	2032	2019-Aug-13 01:49	7.20
HDRVAPm087	SPOT-6	180411	2019-Aug-05 16:01	36.951672	-74.342094	2044	2019-Sep-07 02:47	32.15
HDRVAPm088	SPOT-6	173179	2019-Aug-05 17:04	36.921104	-74.346069	1964	2019-Aug-23 11:32	17.54

Table 3. Summary of results from satellite tag data for all sperm whale tags deployed in 2019.

Animal ID	Argos ID	No. of Locations Post Filtering	% Within VACAPES OPAREA	Max Distance from Initial Location (km)	Mean Distance from Initial Location (km)
HDRVAPm038	173231	133	100.0	146.6	58.4
HDRVAPm061	180408	135	98.5	155.6	64.0
HDRVAPm065	177046	104	100.0	82.3	37.8
HDRVAPm082	177048	79	89.9	296.5	116.7
HDRVAPm086	177049	53	67.9	224.5	144.0
HDRVAPm087	180411	451	15.1	918.4	359.5
HDRVAPm088	173179	113	88.5	159.7	98.4

Table 4. Summary of dive data for all sperm whale SPLASH-10 tags deployed in 2019.

Animal ID	Argos ID	No. Dives Logged	Max Dive Depth (m)	Max Dive Duration (mm:ss)
HDRVAPm038	173231	280	1,279	43:25
HDRVAPm065	177046	318	1,119	57:25
HDRVAPm082	177048	164	1,887	49:31
HDRVAPm086	177049	49	1,311	40:35

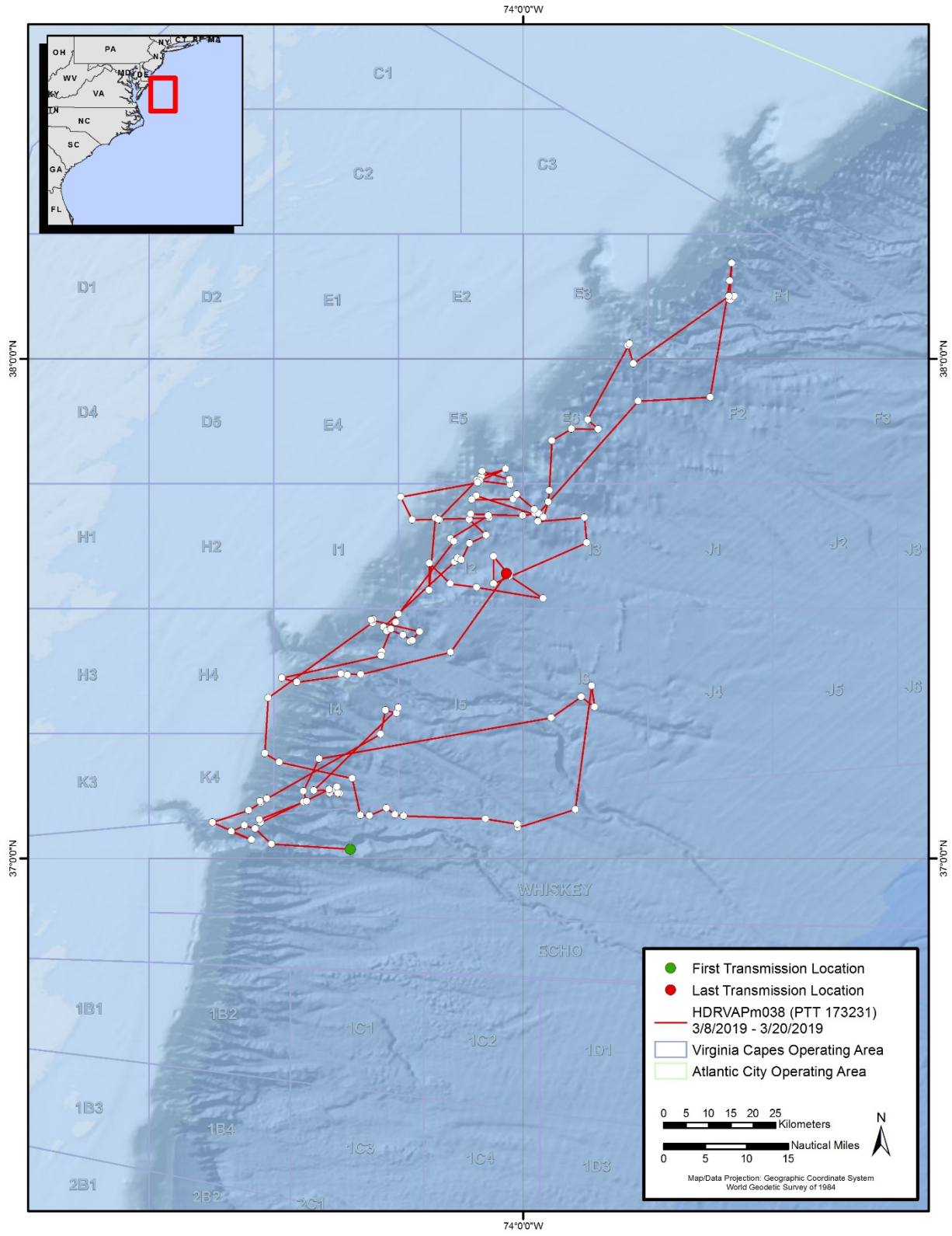

Figure 8. Filtered locations (white dots) and track of sperm whale HDRVAPm038 over 11.1 days.

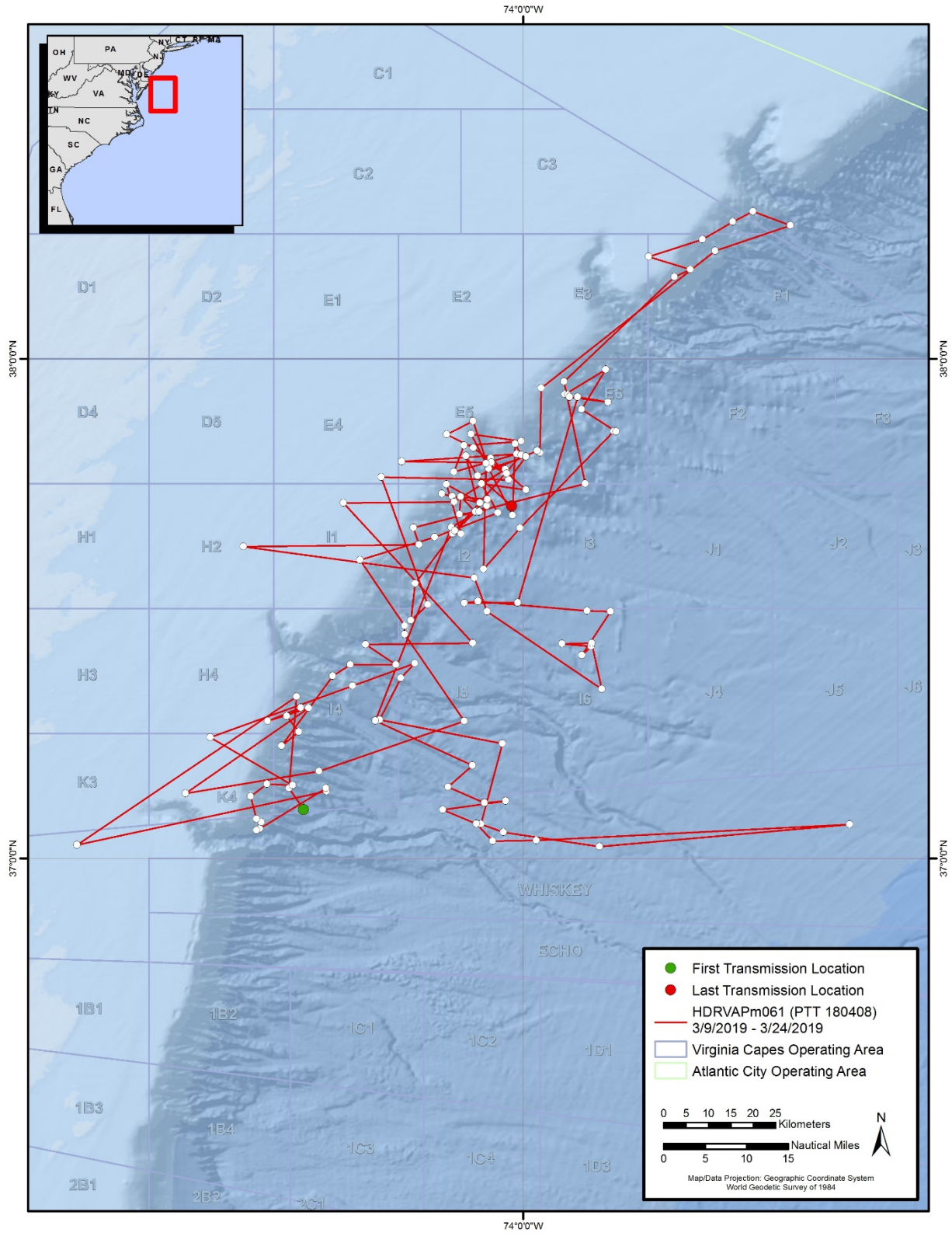

Figure 9. Filtered locations (white dots) and track of sperm whale HDRVAPm061 over 15.6 days.

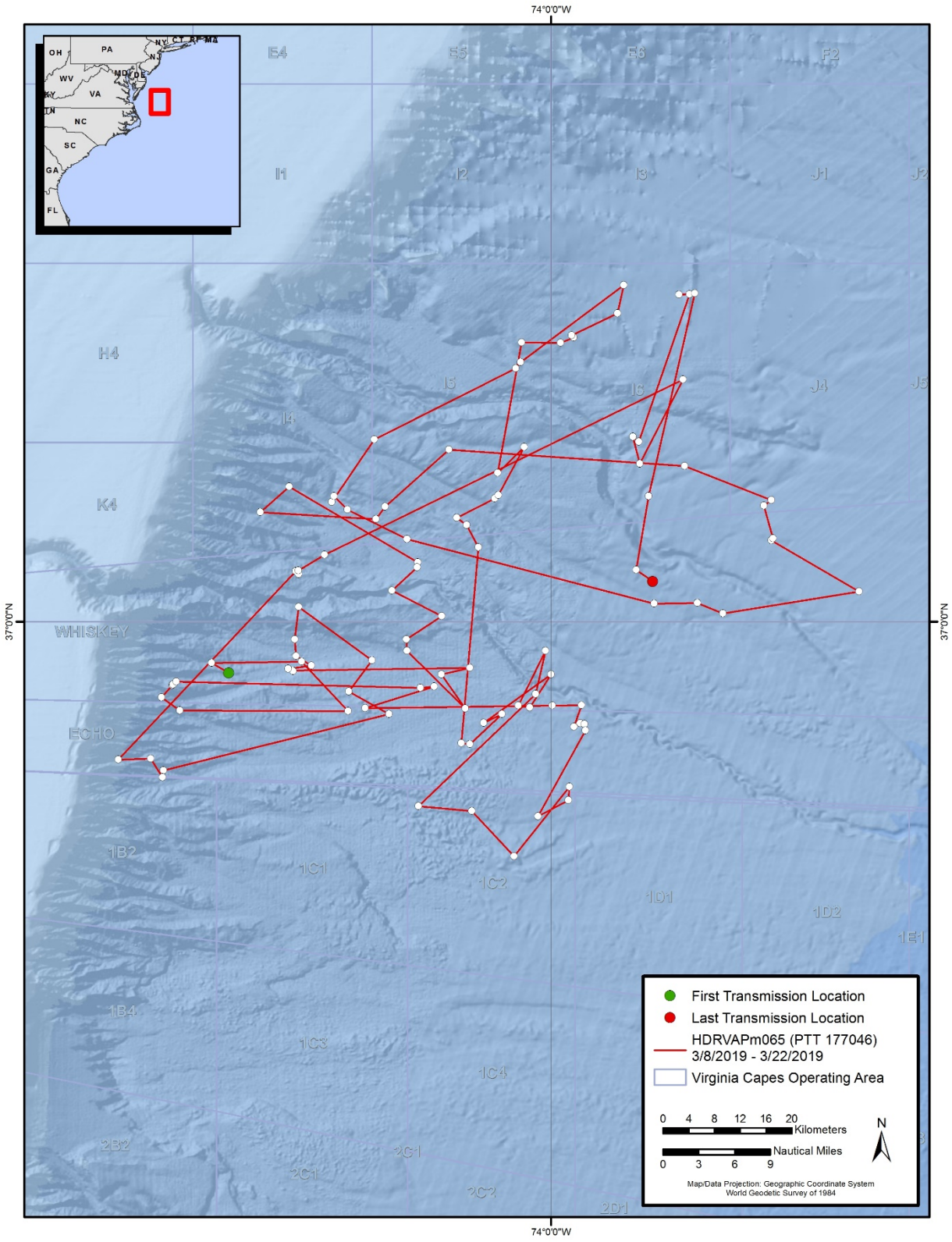

Figure 10. Filtered locations (white dots) and track of sperm whale HDRVAPm065 over 13.2 days.

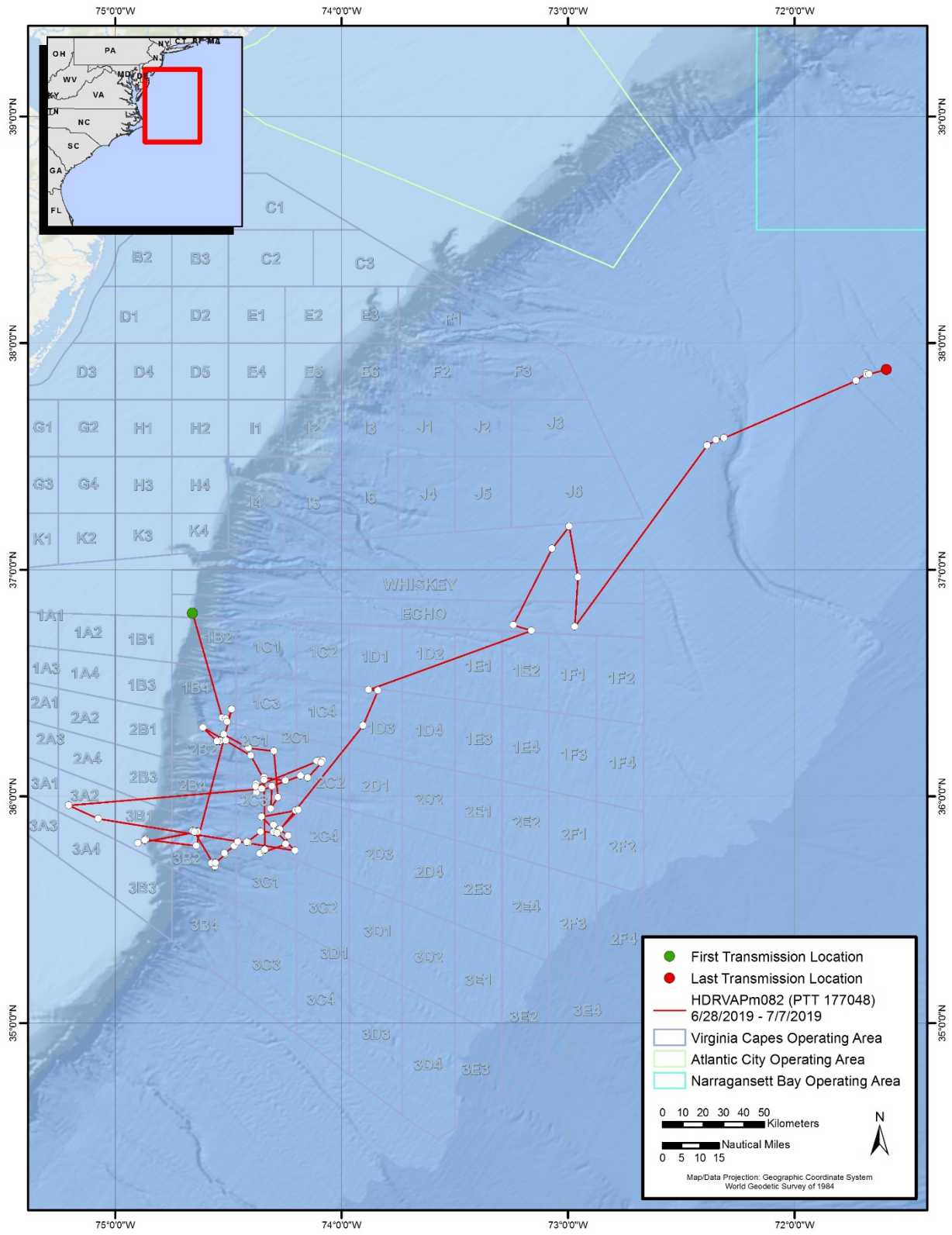

Figure 11. Filtered locations (white dots) and track of sperm whale HDRVAPm082 over 9.4 days.

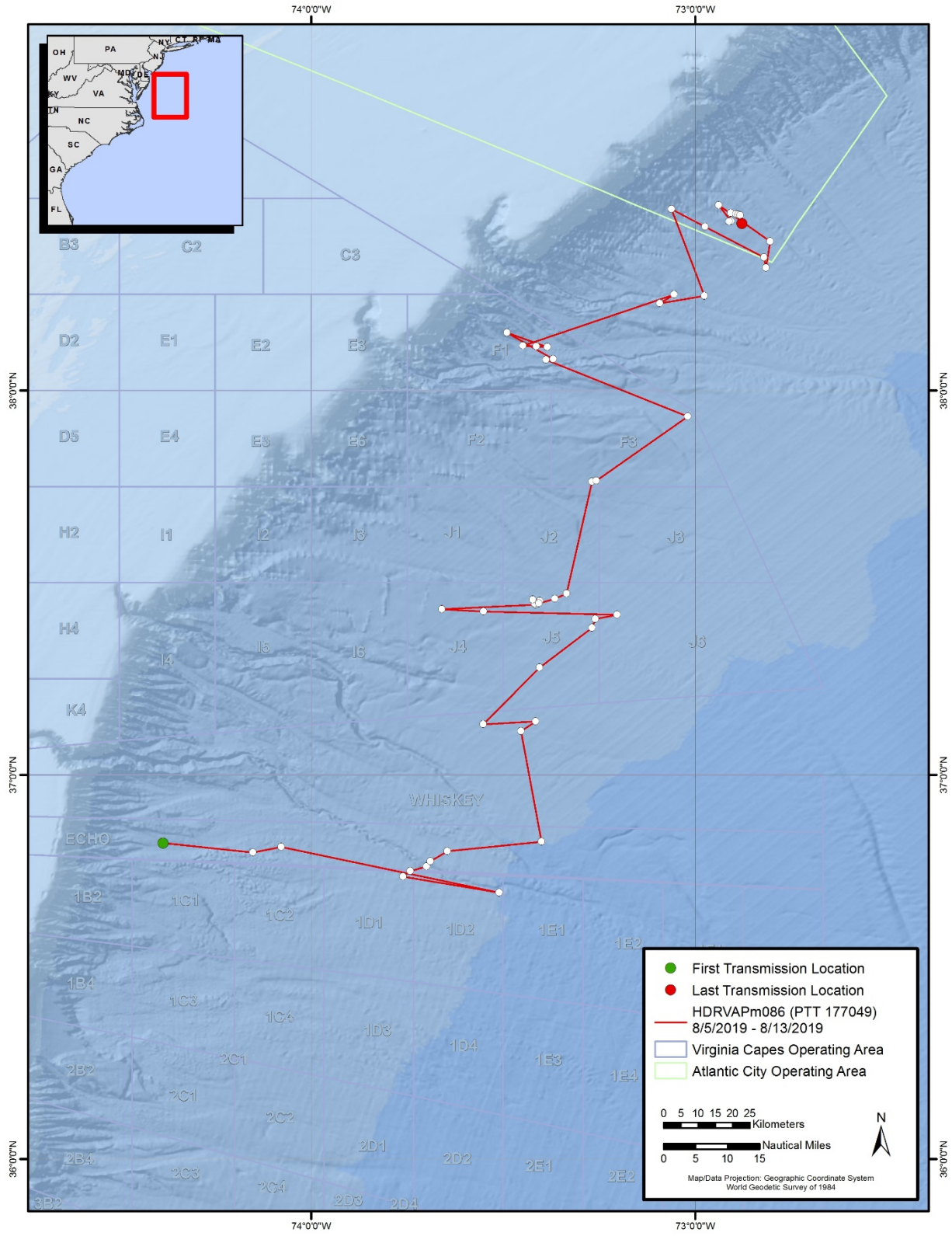

Figure 12. Filtered locations (white dots) and track of sperm whale HDRVAPm086 over 7.2 days.

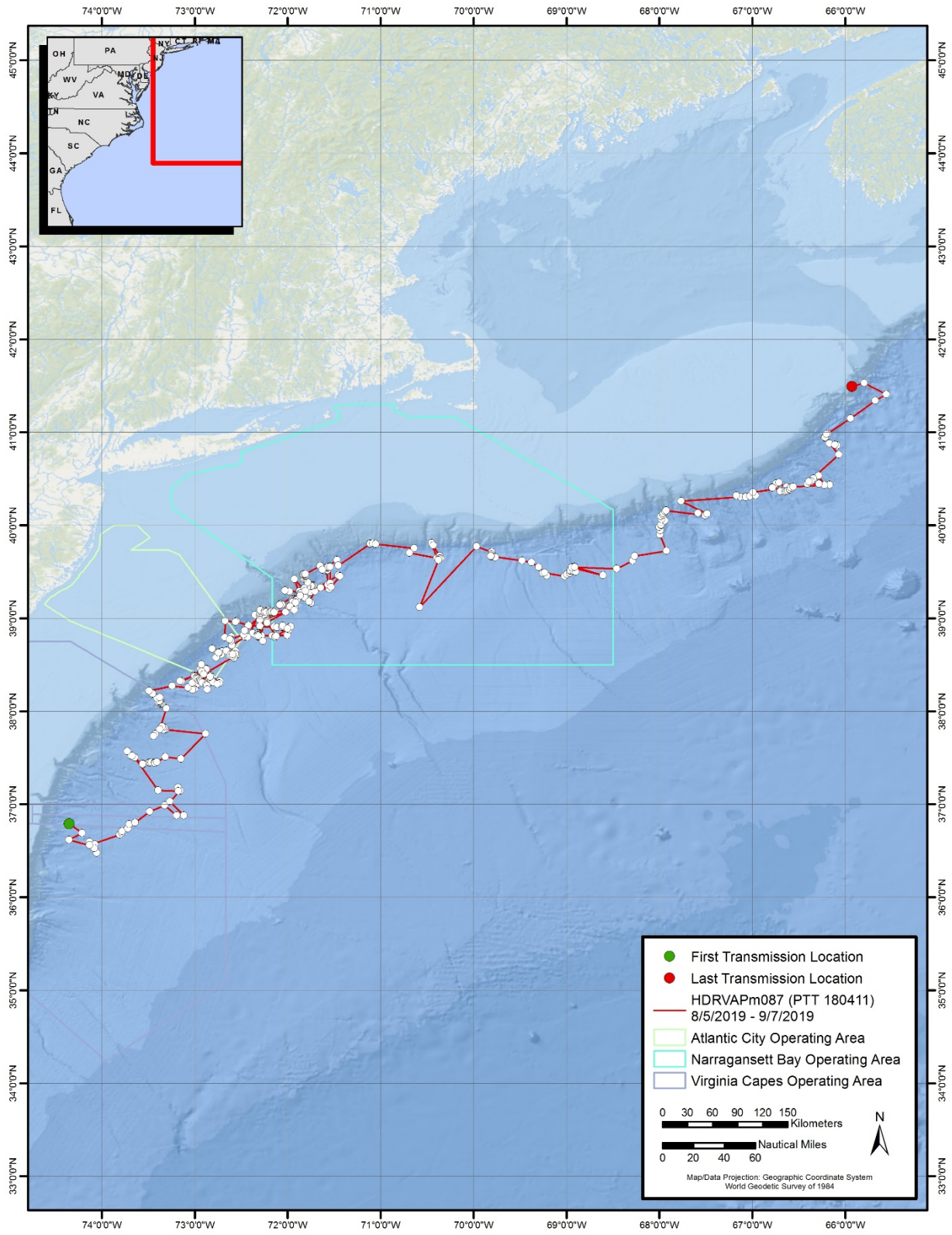

Figure 13. Filtered locations (white dots) and track of sperm whale HDRVAPm087 over 32.2 days.

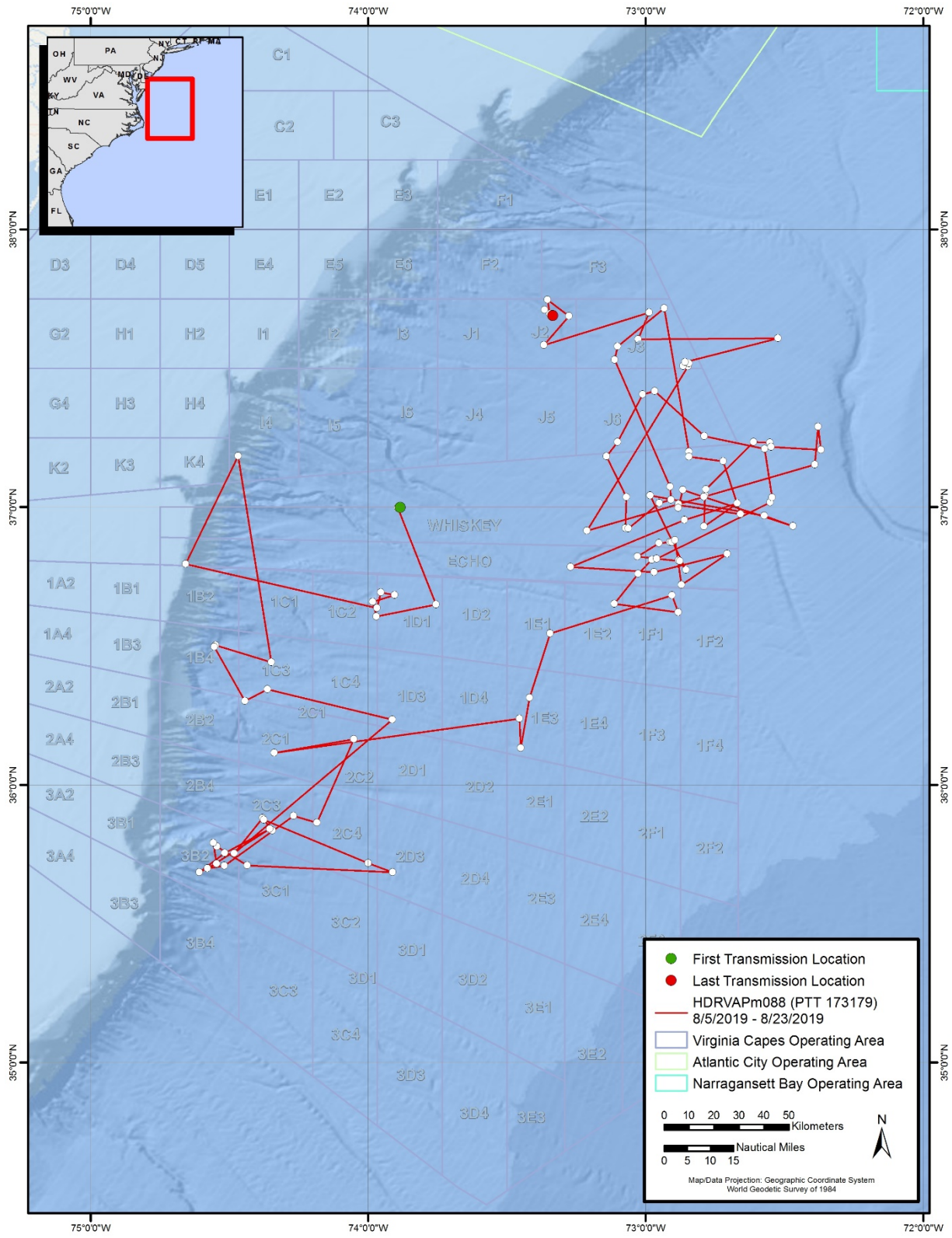

Figure 14. Filtered locations (white dots) and track of sperm whale HDRVAPm088 over 17.5 days.

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 2019 continued to provide coverage in the Norfolk Canyon region spread across seasons, but similar to 2018 survey coverage extended further into deeper waters (>1,500 m) past the shelf break than in previous years (see Engelhaupt et al. 2018, Engelhaupt et al. 2017). Sightings of 12 species of marine mammals and 2 species of sea turtles were made over 14 surveys, showing a wide distribution throughout the study area. Species encountered during 2019 not previously sighted during this study (alive) included True's beaked whales (*Mesoplodon mirus*), bringing 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).

As expected, sightings of deep-diving species including sperm whales, pilot whales, and beaked whales were concentrated near the shelf break and into deeper offshore waters. While baleen whales were encountered both over the shelf and past the shelf break during previous years of this study, the majority of 2019 baleen whale sightings were past the shelf break. Dolphin species were sighted throughout the core study and transit areas, and all sea turtles were sighted over the shelf in waters less than 150 m.

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. It should be noted that the Norfolk Canyon is also an area heavily utilized by both recreational and commercial fishing vessels.

The number of individuals in our photo-ID catalogs continue to increase for baleen and sperm whales. Mark-recapture is a valuable technique but requires a multi-year commitment to accumulate sufficient data to produce meaningful contributions towards site-fidelity and ultimately population consequences. However, results are already becoming evident for some species with 13.5 percent (12) of the 89 cataloged sperm whale individuals being re-sighted, two on three occasions, up to 428 days after initial encounter. Thirteen fin whales (15.7 percent) were photographed on more than one day (between-season re-sightings ranged from 247 to 355 days from initial encounter). Initial sighting locations and those of re-sighted fin whales are all in water over the continental shelf, suggesting an importance of this habitat to the species. HDR will continue to coordinate data sharing with other local and regional researchers and agencies. These comparisons, along with further processing of existing photo-ID data collected to-date for non-priority species, will allow for a better understanding of seasonal movements and residency in the area by some species. Ongoing effort is likely to result in additional re-sightings that, over time, will continue to address questions of seasonal variation, social affiliations, and may eventually address questions related to population-level consequences.

Locations from satellite-tagged whales show movements through multiple VACAPES range boxes beyond the continental slope **(Figures 8** through **14**). Sperm whales continue to show a high percentage of locations within the VACAPES OPAREA range boxes, with six of the seven tags deployed in 2019 having greater than 50% of locations within VACAPES OPAREA—

though this may be biased due to deployment location and tag duration. Individuals show periods of localized movements and of directional travel, with one individual (HDRVAPm087) recorded traveling nearly 918 km in 32 days.

State Space Modeling (SSM) analysis of 2017 sperm whale tag data showed Area Restricted Search (ARS) behavior centered around marine canyons for several individuals (Engelhaupt et al. 2019). While only 7 tags were available for SSM analysis at that time, these results show a strong preference for these environments and are consistent with the known ecology of this species. No ARS home range was identified close to shore for fin whales from 2017 tag data. Variation between animals was high and few cells were identified where home range overlapped for more than two to three animals, suggesting the possibility that individuals are using ephemeral foraging features or foraging patches may be common where animals can spread out to minimize competition for resources. Further SSM analysis is expected on a larger set of tag data at the end of 2020.

In 2019, the research team made considerable progress on presentations and publications. The sighting of an ESA-listed blue whale in 2018 during this study was the first documented off the coast of Virginia and a manuscript with details of the sighting was submitted in September 2019 to Marine Biodiversity Records and is currently in review. The dive data from the first satellite-monitored location dive behavior tag to be deployed on a Sowerby's beaked whale has provided valuable insight with respect to the behavior of this highly cryptic species potentially at higher risk of influence from anthropogenic noise (Cox et al. 2006, Tyack et al. 2011). Further analysis of these data were presented at the World Marine Mammal Conference in 2019 (Engelhaupt et al. 2019), and a manuscript is in preparation and expected to be submitted by May 2020.

Working 60 NM from shore requires exploiting short and infrequent weather window opportunities combined with 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) utilize this critical 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 us to explore questions of intra and inter-seasonal species occurrence and variation. Future planning involves the integration of multi-sensor suction cup tags for deep-diving sperm whales and beaked whales to add fine-scale movement, dive patterns, foraging behavior, and acoustic measurements to the existing medium-duration dataset. Understanding fine-scale baseline data and recording subtle changes in behavior (including acoustic activity), will provide valuable insights on underwater animal behavior and potential impacts from anthropogenic effects. 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 regards 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.

5. Acknowledgements

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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) • Min Group Size • Max 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

***** Upon each entry and 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
2019

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Date	Sighting Time (local)	Scientific Name	Common Name	Group Size	Latitude (°N)	Longitude (°W)
4-Jan-19	7:34		Unidentified dolphin	1	36.99491501	74.95375061
4-Jan-19	8:36	*Delphinus delphis*	Short-beaked common dolphin	30	37.04237366	74.56730652
4-Jan-19	8:51	*Stenella coeruleoalba*	Striped dolphin	75	37.04925537	74.52256775
4-Jan-19	9:35	*Stenella coeruleoalba*	Striped dolphin	25	37.09356308	74.40037537
4-Jan-19	10:44	*Globicephala sp.*	Unidentified pilot whale	22	37.22270584	74.38453674
4-Jan-19	11:08	*Delphinus delphis*	Short-beaked common dolphin	15	37.25620651	74.40242004
4-Jan-19	11:11		Unidentified dolphin	5	37.25289154	74.42419434
4-Jan-19	11:31	*Delphinus delphis*	Short-beaked common dolphin	90	37.30970383	74.47331238
4-Jan-19	11:39	*Tursiops truncatus*	Bottlenose dolphin	30	37.30893707	74.48208618
4-Jan-19	12:08	*Globicephala sp.*	Unidentified pilot whale	8	37.311203	74.37689209
4-Jan-19	13:23	*Tursiops truncatus*	Bottlenose dolphin	2	37.16134644	74.55801392
4-Jan-19	13:50	*Delphinus delphis*	Short-beaked common dolphin	125	37.11159515	74.75495911
4-Jan-19	13:53	*Megaptera novaeangliae*	Humpback whale	1	37.09706879	74.76655579
4-Jan-19	15:04	*Delphinus delphis*	Short-beaked common dolphin	40	37.05410385	74.93577576
17-Jan-19	9:37	*Delphinus delphis*	Short-beaked common dolphin	32	36.94916534	74.90207672
17-Jan-19	10:30	*Globicephala sp.*	Unidentified pilot whale	10	37.01207733	74.60955811
17-Jan-19	10:31	*Tursiops truncatus*	Bottlenose dolphin	13	37.01422119	74.6104126
17-Jan-19	10:59	*Globicephala sp.*	Unidentified pilot whale	8	37.02624512	74.57926178
17-Jan-19	11:41	*Globicephala sp.*	Unidentified pilot whale	10	36.92913437	74.53170013
17-Jan-19	11:54	*Balaenoptera physalus*	Fin whale	1	36.88736725	74.51849365
17-Jan-19	12:44	*Balaenoptera physalus*	Fin whale	2	36.80104065	74.48127747
17-Jan-19	13:03	*Balaenoptera physalus*	Fin whale	1	36.7955513	74.46733856
17-Jan-19	13:45	*Balaenoptera physalus*	Fin whale	2	36.77930832	74.49060059
17-Jan-19	14:33	*Balaenoptera physalus*	Fin whale	1	36.79501724	74.48593903
17-Jan-19	15:45	*Delphinus delphis*	Short-beaked common dolphin	40	36.74855804	74.63922119
2-Feb-19	8:44	*Delphinus delphis*	Short-beaked common dolphin	5	36.94430923	74.97438049
2-Feb-19	8:49	*Delphinus delphis*	Short-beaked common dolphin	12	36.95046234	74.93228149
2-Feb-19	9:00	*Delphinus delphis*	Short-beaked common dolphin	6	36.97681046	74.86908722
2-Feb-19	9:58	*Tursiops truncatus*	Bottlenose dolphin	20	37.05392838	74.58598328
2-Feb-19	10:11	*Tursiops truncatus*	Bottlenose dolphin	16	37.05454636	74.54381561
2-Feb-19	10:31	*Megaptera novaeangliae*	Humpback whale	1	37.06500626	74.4684906
2-Feb-19	10:45		Unidentified dolphin	10	37.07098007	74.45059967

Date	Sighting Time (local)	Scientific Name	Common Name	Group Size	Latitude (°N)	Longitude (°W)
2-Feb-19	12:35	*Stenella coeruleoalba*	Striped dolphin	10	36.9510231	74.39458466
2-Feb-19	13:00		Unidentified whale	1	36.91269684	74.31838226
2-Feb-19	13:01	*Balaenoptera physalus*	Fin whale	1	36.92283249	74.34732819
2-Feb-19	14:53	*Balaenoptera physalus*	Fin whale	1	36.90390396	74.4177475
2-Feb-19	16:25	*Delphinus delphis*	Short-beaked common dolphin	8	36.86996078	75.18521118
2-Feb-19	17:03	*Delphinus delphis*	Short-beaked common dolphin	30	36.85017395	75.50321198
2-Feb-19	17:11	*Tursiops truncatus*	Bottlenose dolphin	7	36.85562897	75.56893158
2-Feb-19	17:15	*Delphinus delphis*	Short-beaked common dolphin	2	36.85464096	75.6135025
26-Feb-19	7:20	*Delphinus delphis*	Short-beaked common dolphin	75	36.79243088	75.50039673
26-Feb-19	7:28	*Delphinus delphis*	Short-beaked common dolphin	20	36.78122711	75.46469116
26-Feb-19	8:39	*Delphinus delphis*	Short-beaked common dolphin	3	36.69746399	74.9395752
26-Feb-19	8:44	*Delphinus delphis*	Short-beaked common dolphin	7	36.69385529	74.91265106
26-Feb-19	9:10	*Balaenoptera physalus*	Fin whale	2	36.64216232	74.71813965
26-Feb-19	11:00	*Megaptera novaeangliae*	Humpback whale	1	36.72297287	74.6735611
26-Feb-19	11:02	*Tursiops truncatus*	Bottlenose dolphin	12	36.69016266	74.66735077
26-Feb-19	12:38	*Delphinus delphis*	Short-beaked common dolphin	150	36.72528076	74.5717392
26-Feb-19	13:21	*Physeter macrocephalus*	Sperm whale	1	36.71532822	74.52174377
26-Feb-19	14:39		Unidentified large whale	1	36.75572205	74.57234192
26-Feb-19	14:59	*Globicephala sp.*	Unidentified pilot whale	18	36.7476387	74.5982666
26-Feb-19	15:06	*Delphinus delphis*	Short-beaked common dolphin	25	36.74856949	74.63387299
26-Feb-19	16:07	*Tursiops truncatus*	Bottlenose dolphin	8	36.78262329	75.09773254
8-Mar-19	7:24	*Delphinus delphis*	Short-beaked common dolphin	75	36.93909454	75.24280548
8-Mar-19	7:43	*Delphinus delphis*	Short-beaked common dolphin	8	36.95828629	75.11805725
8-Mar-19	8:40	*Tursiops truncatus*	Bottlenose dolphin	25	37.00953674	74.69127655
8-Mar-19	8:44	*Megaptera novaeangliae*	Humpback whale	1	37.00540543	74.66577911
8-Mar-19	10:00	*Globicephala sp.*	Unidentified pilot whale	24	37.03911591	74.6021347
8-Mar-19	10:26	*Balaenoptera physalus*	Fin whale	1	37.03935242	74.54262543
8-Mar-19	10:31	*Globicephala sp.*	Unidentified pilot whale	25	37.04217911	74.54985809
8-Mar-19	10:46	*Globicephala sp.*	Unidentified pilot whale	15	37.02971649	74.54134369
8-Mar-19	10:53	*Globicephala sp.*	Unidentified pilot whale	12	36.99548721	74.53852081
8-Mar-19	11:00	*Balaenoptera physalus*	Fin whale	1	36.9949379	74.53151703
8-Mar-19	11:15	*Globicephala sp.*	Unidentified pilot whale	8	36.96125031	74.52529144

Date	Sighting Time (local)	Scientific Name	Common Name	Group Size	Latitude (°N)	Longitude (°W)
8-Mar-19	11:21	*Balaenoptera physalus*	Fin whale	1	36.95544052	74.52062988
8-Mar-19	11:48	*Balaenoptera physalus*	Fin whale	1	36.93097687	74.49269104
8-Mar-19	12:06	*Balaenoptera physalus*	Fin whale	1	36.94081879	74.47274017
8-Mar-19	12:14	*Physeter macrocephalus*	Sperm whale	7	36.93582916	74.44960785
8-Mar-19	13:20	*Delphinus delphis*	Short-beaked common dolphin	30	36.94325256	74.44949341
8-Mar-19	13:24	*Balaenoptera physalus*	Fin whale	1	36.94380951	74.44860077
8-Mar-19	13:37		Unidentified cetacean	8	36.93347931	74.41473389
8-Mar-19	14:18	*Physeter macrocephalus*	Sperm whale	20	36.91442871	74.35794067
8-Mar-19	16:21	*Globicephala sp.*	Unidentified pilot whale	15	36.91362381	74.61730957
8-Mar-19	16:21	*Delphinus delphis*	Short-beaked common dolphin	50	36.91373444	74.6213913
8-Mar-19	16:22	*Tursiops truncatus*	Bottlenose dolphin	4	36.91337967	74.62843323
7-May-19	7:45	*Tursiops truncatus*	Bottlenose dolphin	2	36.99619293	75.347229
7-May-19	8:57	*Tursiops truncatus*	Bottlenose dolphin	25	37.0116272	74.83278656
7-May-19	9:08	*Stenella frontalis*	Atlantic spotted dolphin	18	37.00786209	74.77610779
7-May-19	10:10	*Delphinus delphis*	Short-beaked common dolphin	1	37.05074692	74.60393524
7-May-19	10:10	*Physeter macrocephalus*	Sperm whale	1	37.05074692	74.60393524
7-May-19	10:20	*Grampus griseus*	Risso's dolphin	16	37.05301285	74.59068298
7-May-19	10:38	*Grampus griseus*	Risso's dolphin	30	37.04291153	74.55036163
7-May-19	10:46	*Delphinus delphis*	Short-beaked common dolphin	20	37.04545593	74.53275299
7-May-19	10:51	*Grampus griseus*	Risso's dolphin	12	37.05211639	74.53578186
7-May-19	11:00	*Delphinus delphis*	Short-beaked common dolphin	50	37.0576973	74.5196228
7-May-19	11:21	*Delphinus delphis*	Short-beaked common dolphin	300	37.10468674	74.49050903
7-May-19	12:45	*Grampus griseus*	Risso's dolphin	2	36.99791336	74.43503571
7-May-19	12:54	*Delphinus delphis*	Short-beaked common dolphin	50	36.97758102	74.45417023
7-May-19	13:14	*Delphinus delphis*	Short-beaked common dolphin	125	36.94139099	74.46815491
7-May-19	13:32	*Grampus griseus*	Risso's dolphin	10	36.91866302	74.50865173
7-May-19	13:33	*Physeter macrocephalus*	Sperm whale	5	36.90465927	74.50859833
7-May-19	14:02	*Delphinus delphis*	Short-beaked common dolphin	8	36.8788414	74.49506378
7-May-19	15:59		Unidentified dolphin	24	36.87771988	74.67679596
7-May-19	16:58	*Tursiops truncatus*	Bottlenose dolphin	15	36.86660004	75.12303162
7-Jun-19	10:13	*Tursiops truncatus*	Bottlenose dolphin	18	37.04525757	74.56997681
7-Jun-19	10:24	*Delphinus delphis*	Short-beaked common dolphin	30	37.04624176	74.53302002

Date	Sighting Time (local)	Scientific Name	Common Name	Group Size	Latitude (°N)	Longitude (°W)
7-Jun-19	10:30		Unidentified dolphin	2	37.05243301	74.51731873
7-Jun-19	10:47	*Grampus griseus*	Risso's dolphin	7	37.05470276	74.49661255
7-Jun-19	10:54	*Globicephala sp.*	Unidentified pilot whale	10	37.04645538	74.47789001
7-Jun-19	11:56	*Tursiops truncatus*	Bottlenose dolphin	80	36.97240448	74.41196442
7-Jun-19	12:15	*Grampus griseus*	Risso's dolphin	20	36.9508934	74.45922852
7-Jun-19	12:34	*Globicephala sp.*	Unidentified pilot whale	35	36.92000198	74.4916153
7-Jun-19	12:56	*Globicephala sp.*	Unidentified pilot whale	4	36.89950943	74.54115295
7-Jun-19	13:03		Unidentified dolphin	12	36.90221024	74.56724548
7-Jun-19	13:14	*Globicephala sp.*	Unidentified pilot whale	24	36.88015366	74.53484344
7-Jun-19	13:58	*Tursiops truncatus*	Bottlenose dolphin	6	36.78604126	74.55526733
7-Jun-19	14:08	*Mesoplodon bidens*	Sowerby's beaked whale	7	36.77825546	74.58026886
7-Jun-19	15:11	*Globicephala sp.*	Unidentified pilot whale	18	36.79283142	74.55751801
27-Jun-19	8:43	*Stenella frontalis*	Atlantic spotted dolphin	24	36.64656448	74.86190033
27-Jun-19	10:09	*Globicephala macrorhynchus*	Short-finned pilot whale	15	36.56060791	74.60048676
27-Jun-19	10:29	*Globicephala sp.*	Unidentified pilot whale	8	36.5972023	74.61736298
27-Jun-19	10:42	*Globicephala sp.*	Unidentified pilot whale	10	36.62907791	74.58352661
27-Jun-19	10:47	*Tursiops truncatus*	Bottlenose dolphin	25	36.64100266	74.57432556
27-Jun-19	10:56	*Globicephala macrorhynchus*	Short-finned pilot whale	22	36.66288376	74.55968475
27-Jun-19	11:27	*Tursiops truncatus*	Bottlenose dolphin	25	36.72586823	74.56056213
27-Jun-19	11:50	*Globicephala sp.*	Unidentified pilot whale	9	36.77661896	74.58460999
27-Jun-19	12:04	*Globicephala sp.*	Unidentified pilot whale	10	36.80498886	74.54153442
27-Jun-19	12:27		Unidentified dolphin	20	36.84605408	74.50013733
27-Jun-19	12:51	*Physeter macrocephalus*	Sperm whale	5	36.85135651	74.5431366
27-Jun-19	16:01	*Globicephala sp.*	Unidentified pilot whale	8	36.78987503	74.63589478
27-Jun-19	16:49	*Stenella frontalis*	Atlantic spotted dolphin	50	36.81917572	74.95072174
1-Aug-19	8:52	*Globicephala sp.*	Unidentified pilot whale	20	37.02274704	74.64020538
1-Aug-19	9:07	*Globicephala sp.*	Unidentified pilot whale	30	37.03879166	74.59981537
1-Aug-19	9:15	*Globicephala sp.*	Unidentified pilot whale	8	37.03585815	74.57444763
1-Aug-19	9:26	*Globicephala sp.*	Unidentified pilot whale	25	37.04859161	74.55909729
1-Aug-19	9:32	*Globicephala sp.*	Unidentified pilot whale	8	37.05002594	74.53586578
1-Aug-19	9:37	*Globicephala sp.*	Unidentified pilot whale	18	37.04275513	74.51764679
1-Aug-19	9:43	*Mesoplodon sp.*	Unidentified Mesopolodon	1	37.04537201	74.48970032

Date	Sighting Time (local)	Scientific Name	Common Name	Group Size	Latitude (°N)	Longitude (°W)
1-Aug-19	10:09	*Globicephala sp.*	Unidentified pilot whale	12	37.02791977	74.52274323
1-Aug-19	10:12	*Tursiops truncatus*	Bottlenose dolphin	25	37.02831268	74.52152252
1-Aug-19	10:41	*Tursiops truncatus*	Bottlenose dolphin	40	37.03792191	74.46331787
1-Aug-19	11:23	*Grampus griseus*	Risso's dolphin	15	36.9562645	74.47951508
1-Aug-19	11:34	*Ziphius cavirostris*	Cuvier's beaked whale	1	36.93299866	74.486763
1-Aug-19	12:45	*Mesoplodon sp.*	Unidentified Mesopolodon	4	36.92155075	74.4903717
1-Aug-19	14:40		Unidentified dolphin	40	36.90475845	74.48066711
1-Aug-19	15:16	*Globicephala sp.*	Unidentified pilot whale	22	36.90376282	74.55712891
1-Aug-19	15:54	*Tursiops truncatus*	Bottlenose dolphin	2	36.89179993	74.86312103
1-Aug-19	16:07	*Balaenoptera physalus*	Fin whale	1	36.88274384	74.96805573
5-Aug-19	7:18		Unidentified dolphin	20	36.83853531	75.05288696
5-Aug-19	7:25	*Stenella frontalis*	Atlantic spotted dolphin	60	36.84987259	74.99475861
5-Aug-19	8:01	*Tursiops truncatus*	Bottlenose dolphin	20	36.8637886	74.72986603
5-Aug-19	8:06	*Tursiops truncatus*	Bottlenose dolphin	7	36.86440277	74.69326019
5-Aug-19	8:16	*Globicephala sp.*	Unidentified pilot whale	9	36.86190414	74.62422943
5-Aug-19	8:17	*Globicephala sp.*	Unidentified pilot whale	25	36.84733582	74.61447144
5-Aug-19	8:19	*Globicephala sp.*	Unidentified pilot whale	18	36.87287903	74.60987091
5-Aug-19	8:24	*Globicephala sp.*	Unidentified pilot whale	22	36.85909271	74.57489777
5-Aug-19	8:34	*Globicephala sp.*	Unidentified pilot whale	4	36.86094666	74.57331085
5-Aug-19	8:44	*Globicephala sp.*	Unidentified pilot whale	30	36.85752106	74.52462769
5-Aug-19	8:48	*Globicephala sp.*	Unidentified pilot whale	8	36.86023331	74.5229187
5-Aug-19	9:16	*Stenella frontalis*	Atlantic spotted dolphin	110	36.90100098	74.53205872
5-Aug-19	9:21	*Globicephala sp.*	Unidentified pilot whale	45	36.90795517	74.54133606
5-Aug-19	9:33	*Globicephala sp.*	Unidentified pilot whale	15	36.92705536	74.52056122
5-Aug-19	9:38	*Globicephala sp.*	Unidentified pilot whale	12	36.93945694	74.51065063
5-Aug-19	9:53	*Globicephala sp.*	Unidentified pilot whale	22	36.94524765	74.46976471
5-Aug-19	9:58	*Stenella frontalis*	Atlantic spotted dolphin	25	36.96274567	74.45376587
5-Aug-19	10:14	*Globicephala sp.*	Unidentified pilot whale	6	36.96570206	74.40529633
5-Aug-19	10:25	*Physeter macrocephalus*	Sperm whale	9	36.98876953	74.35464478
5-Aug-19	13:43	*Tursiops truncatus*	Bottlenose dolphin	21	36.90671158	74.50774384
5-Aug-19	13:47	*Globicephala sp.*	Unidentified pilot whale	25	36.89608765	74.5434494
5-Aug-19	13:53	*Grampus griseus*	Risso's dolphin	5	36.90533066	74.57110596

Date	Sighting Time (local)	Scientific Name	Common Name	Group Size	Latitude (°N)	Longitude (°W)
5-Aug-19	13:57	*Globicephala sp.*	Unidentified pilot whale	45	36.89688492	74.61068726
11-Sep-19	7:21	*Tursiops truncatus*	Bottlenose dolphin	3	37.06313705	75.21099854
11-Sep-19	7:40	*Tursiops truncatus*	Bottlenose dolphin	10	37.10092926	75.07963562
11-Sep-19	9:27	*Delphinus delphis*	Short-beaked common dolphin	1000	37.33616638	74.48512268
11-Sep-19	10:31	*Globicephala sp.*	Unidentified pilot whale	35	37.37307358	74.36499023
11-Sep-19	10:41	*Globicephala sp.*	Unidentified pilot whale	20	37.3685379	74.32876587
11-Sep-19	11:01	*Globicephala sp.*	Unidentified pilot whale	22	37.3327179	74.30458069
11-Sep-19	11:38		Unidentified small dolphin	1	37.30664825	74.24939728
11-Sep-19	12:21	*Tursiops truncatus*	Bottlenose dolphin	16	37.31955338	74.23143768
11-Sep-19	12:33	*Globicephala sp.*	Unidentified pilot whale	40	37.35385895	74.22190094
11-Sep-19	13:41	*Globicephala sp.*	Unidentified pilot whale	18	37.31636047	74.34818268
11-Sep-19	13:50	*Globicephala macrorhynchus*	Short-finned pilot whale	30	37.30692291	74.38694763
11-Sep-19	13:59	*Globicephala sp.*	Unidentified pilot whale	15	37.29880142	74.41338348
11-Sep-19	14:14	*Globicephala sp.*	Unidentified pilot whale	12	37.29298401	74.4500351
11-Sep-19	14:22	*Globicephala sp.*	Unidentified pilot whale	18	37.28477478	74.48136139
11-Sep-19	14:25	*Globicephala sp.*	Unidentified pilot whale	18	37.28463745	74.49288177
11-Sep-19	14:49	*Balaenoptera sp.*	Unidentified Balaenoptera sp.	1	37.28528595	74.51210022
11-Sep-19	15:42	*Stenella frontalis*	Atlantic spotted dolphin	50	37.14432907	74.97071075
25-Oct-19	7:32	*Tursiops truncatus*	Bottlenose dolphin	13	36.86371994	75.19126129
25-Oct-19	7:39	*Delphinus delphis*	Short-beaked common dolphin	37	36.86242676	75.13964844
25-Oct-19	8:49	*Globicephala sp.*	Unidentified pilot whale	35	36.8838501	74.6184082
25-Oct-19	9:03	*Globicephala sp.*	Unidentified pilot whale	18	36.87609863	74.57654572
25-Oct-19	9:15	*Globicephala sp.*	Unidentified pilot whale	30	36.87133026	74.53720093
25-Oct-19	9:30	*Globicephala sp.*	Unidentified pilot whale	10	36.86181259	74.47653961
25-Oct-19	9:53	*Globicephala sp.*	Unidentified pilot whale	6	36.90252686	74.47071838
25-Oct-19	10:23	*Globicephala sp.*	Unidentified pilot whale	15	36.9695282	74.48291779
25-Oct-19	10:37	*Globicephala sp.*	Unidentified pilot whale	4	36.98751831	74.51191711
25-Oct-19	10:45	*Tursiops truncatus*	Bottlenose dolphin	35	37.01526642	74.51281738
25-Oct-19	11:03	*Globicephala sp.*	Unidentified pilot whale	7	37.0506134	74.51303864
25-Oct-19	11:17	*Globicephala sp.*	Unidentified pilot whale	8	37.0621376	74.50585938
25-Oct-19	11:22	*Globicephala sp.*	Unidentified pilot whale	16	37.07950974	74.50195313
25-Oct-19	12:31	*Delphinus delphis*	Short-beaked common dolphin	25	37.1088295	74.67624664

Date	Sighting Time (local)	Scientific Name	Common Name	Group Size	Latitude (°N)	Longitude (°W)
25-Oct-19	13:01	*Tursiops truncatus*	Bottlenose dolphin	8	37.04517365	74.63826752
25-Oct-19	13:17	*Globicephala sp.*	Unidentified pilot whale	7	37.01864243	74.59587097
25-Oct-19	13:19	*Globicephala sp.*	Unidentified pilot whale	9	37.01226425	74.59722137
25-Oct-19	13:24	*Globicephala sp.*	Unidentified pilot whale	37	36.99312973	74.60554504
25-Oct-19	13:36	*Globicephala sp.*	Unidentified pilot whale	25	36.96413422	74.59892273
25-Oct-19	16:23	*Tursiops truncatus*	Bottlenose dolphin	20	36.8555069	75.73068237
25-Oct-19	16:33	*Tursiops truncatus*	Bottlenose dolphin	8	36.84410858	75.80116272
26-Nov-19	7:11	*Tursiops truncatus*	Bottlenose dolphin	5	36.68239594	75.57219696
26-Nov-19	7:19	*Tursiops truncatus*	Bottlenose dolphin	1	36.65949249	75.53203583
26-Nov-19	7:42	*Tursiops truncatus*	Bottlenose dolphin	20	36.58449936	75.38648224
26-Nov-19	9:12	*Tursiops truncatus*	Bottlenose dolphin	9	36.3091774	74.82215118
26-Nov-19	9:22	*Globicephala sp.*	Unidentified pilot whale	50	36.29395676	74.77912903
26-Nov-19	9:49	*Globicephala sp.*	Unidentified pilot whale	20	36.22851181	74.71343231
26-Nov-19	9:52	*Mesoplodon mirus*	True's beaked whale	1	36.24735641	74.68769073
26-Nov-19	11:24	*Tursiops truncatus*	Bottlenose dolphin	25	36.24812698	74.69956207
26-Nov-19	12:32	*Stenella coeruleoalba*	Striped dolphin	14	36.29277039	74.67562103
26-Nov-19	13:02	*Globicephala sp.*	Unidentified pilot whale	50	36.36230087	74.70288849
26-Nov-19	13:10	*Delphinus delphis*	Short-beaked common dolphin	400	36.38579941	74.66875458
26-Nov-19	13:32	*Globicephala sp.*	Unidentified pilot whale	10	36.44632339	74.64507294
26-Nov-19	13:41	*Tursiops truncatus*	Bottlenose dolphin	13	36.45782471	74.64321899
26-Nov-19	14:10	*Globicephala sp.*	Unidentified pilot whale	20	36.53980255	74.59741211
26-Nov-19	14:23	*Mesoplodon mirus*	True's beaked whale	3	36.56857681	74.54614258
26-Nov-19	15:41		Unidentified dolphin	250	36.61476517	74.64730835
26-Nov-19	15:45	*Tursiops truncatus*	Bottlenose dolphin	22	36.63308334	74.69376373
26-Nov-19	15:52		Unidentified large whale	1	36.64543915	74.7289505
22-Dec-19	7:59	*Delphinus delphis*	Short-beaked common dolphin	8	36.9356041	75.454422
22-Dec-19	8:46	*Delphinus delphis*	Short-beaked common dolphin	6	36.98989105	75.11620331
22-Dec-19	9:08	*Delphinus delphis*	Short-beaked common dolphin	12	37.0160141	74.95720673
22-Dec-19	9:30	*Tursiops truncatus*	Bottlenose dolphin	2	37.02289581	74.79364014
22-Dec-19	9:57	*Tursiops truncatus*	Bottlenose dolphin	3	37.0246048	74.61753082
22-Dec-19	10:12	*Tursiops truncatus*	Bottlenose dolphin	4	37.02350616	74.57958984
22-Dec-19	10:22	*Globicephala sp.*	Unidentified pilot whale	33	37.03322601	74.55443573

Date	Sighting Time (local)	Scientific Name	Common Name	Group Size	Latitude (°N)	Longitude (°W)
22-Dec-19	10:43	*Globicephala sp.*	Unidentified pilot whale	4	37.03807449	74.49671936
22-Dec-19	11:02	*Globicephala sp.*	Unidentified pilot whale	25	37.00355148	74.47328949
22-Dec-19	11:13	*Globicephala sp.*	Unidentified pilot whale	9	37.01493454	74.50708771
22-Dec-19	11:28	*Tursiops truncatus*	Bottlenose dolphin	10	37.06594086	74.5490799
22-Dec-19	11:34	*Globicephala sp.*	Unidentified pilot whale	8	37.06441116	74.53106689
22-Dec-19	12:27	*Globicephala sp.*	Unidentified pilot whale	5	36.99144745	74.53926849
22-Dec-19	12:33	*Globicephala sp.*	Unidentified pilot whale	15	36.98004913	74.52895355
22-Dec-19	12:55	*Globicephala macrorhynchus*	Short-finned pilot whale	1	36.92668915	74.52931976
22-Dec-19	12:58	*Globicephala sp.*	Unidentified pilot whale	25	36.91041946	74.51664734
22-Dec-19	13:44	*Globicephala sp.*	Unidentified pilot whale	8	36.81680679	74.53424835
22-Dec-19	13:59	*Globicephala sp.*	Unidentified pilot whale	5	36.80849457	74.51557922
22-Dec-19	14:07	*Globicephala sp.*	Unidentified pilot whale	8	36.78754044	74.48878479
22-Dec-19	14:46	*Globicephala sp.*	Unidentified pilot whale	8	36.74065018	74.55986786
22-Dec-19	14:53	*Globicephala sp.*	Unidentified pilot whale	8	36.71915436	74.56594849
22-Dec-19	15:02	*Globicephala sp.*	Unidentified pilot whale	24	36.70592499	74.59275055

C

Sea Turtle Sightings 2019

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Date	Sighting Time (local)	Scientific Name	Common Name	Group Size	Latitude (°N)	Longitude (°W)
7-May-19	17:08	*Dermochelys coriacea*	Leatherback turtle	1	36.86231232	75.19420624
11-Sep-19	7:54	*Dermochelys coriacea*	Leatherback turtle	1	37.12607193	74.98310089
11-Sep-19	7:58	*Dermochelys coriacea*	Leatherback turtle	1	37.1312294	74.95983887
7-May-19	16:56	*Caretta caretta*	Loggerhead turtle	1	36.8666954	75.10593414
7-May-19	17:06	*Caretta caretta*	Loggerhead turtle	1	36.86293411	75.17638397
7-May-19	17:09	*Caretta caretta*	Loggerhead turtle	1	36.86193848	75.20451355
27-Jun-19	17:12	*Caretta caretta*	Loggerhead turtle	1	36.84583282	75.09978485
27-Jun-19	18:05	*Caretta caretta*	Loggerhead turtle	1	36.86975479	75.3456955
27-Jun-19	18:12	*Caretta caretta*	Loggerhead turtle	1	36.87786484	75.40047455
27-Jun-19	18:17	*Caretta caretta*	Loggerhead turtle	1	36.87963867	75.43413544
27-Jun-19	18:25	*Caretta caretta*	Loggerhead turtle	2	36.885693	75.496552
1-Aug-19	7:16	*Caretta caretta*	Loggerhead turtle	1	36.91592789	75.33355713
1-Aug-19	15:47	*Caretta caretta*	Loggerhead turtle	1	36.89365768	74.7996521
1-Aug-19	16:21	*Caretta caretta*	Loggerhead turtle	1	36.86827469	74.99655914
5-Aug-19	7:09	*Caretta caretta*	Loggerhead turtle	1	36.85085297	75.12755585
25-Oct-19	8:01	*Caretta caretta*	Loggerhead turtle	1	36.86759186	74.97626495
25-Oct-19	14:08	*Caretta caretta*	Loggerhead turtle	1	36.95101929	74.6968689
26-Nov-19	8:55	*Caretta caretta*	Loggerhead turtle	1	36.3645134	74.92826843

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D

Photo-identified Priority Species Individuals 2019

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HDR ID #	Species	Sighting Date(s)	Biopsy?	Satellite Tag? / Argos ID
HDRVABp077	*Balaenoptera physalus*	17-Jan-19	No	No
HDRVABp078	*Balaenoptera physalus*	17-Jan-19	No	No
HDRVABp079	*Balaenoptera physalus*	2-Feb-19	No	No
HDRVABp080	*Balaenoptera physalus*	2-Feb-19	No	No
HDRVABp081	*Balaenoptera physalus*	26-Feb-19	No	No
HDRVABp082	*Balaenoptera physalus*	26-Feb-19	No	No
HDRVABp083	*Balaenoptera physalus*	8-Mar-19	No	No
HDRVABp084	*Balaenoptera physalus*	8-Mar-19	No	No
HDRVAPm038	*Physeter macrocephalus*	8-Mar-19, 7-May-19	No	SPLASH-10 / 173231
HDRVAPm060	*Physeter macrocephalus*	8-Mar-19	No	No
HDRVAPm061	*Physeter macrocephalus*	8-Mar-19	Yes	SPOT-6 / 180408
HDRVAPm062	*Physeter macrocephalus*	8-Mar-19	No	No
HDRVAPm063	*Physeter macrocephalus*	8-Mar-19	No	No
HDRVAPm064	*Physeter macrocephalus*	8-Mar-19	No	No
HDRVAPm065	*Physeter macrocephalus*	8-Mar-19	Yes	SPLASH-10 / 177046
HDRVAPm066	*Physeter macrocephalus*	8-Mar-19	No	No
HDRVAPm067	*Physeter macrocephalus*	8-Mar-19	No	No
HDRVAPm068	*Physeter macrocephalus*	8-Mar-19	No	No
HDRVAPm069	*Physeter macrocephalus*	8-Mar-19	No	No
HDRVAPm070	*Physeter macrocephalus*	8-Mar-19	No	No
HDRVAPm071	*Physeter macrocephalus*	8-Mar-19	No	No
HDRVAPm072	*Physeter macrocephalus*	8-Mar-19	No	No
HDRVAPm073	*Physeter macrocephalus*	8-Mar-19	No	No
HDRVAPm074	*Physeter macrocephalus*	8-Mar-19	No	No
HDRVAPm075	*Physeter macrocephalus*	8-Mar-19	No	No
HDRVAPm076	*Physeter macrocephalus*	8-Mar-19	No	No
HDRVAPm077	*Physeter macrocephalus*	8-Mar-19	No	No
HDRVAPm078	*Physeter macrocephalus*	8-Mar-19	No	No
HDRVAPm079	*Physeter macrocephalus*	8-Mar-19	No	No
HDRVAPm080	*Physeter macrocephalus*	8-Mar-19	No	No

HDR ID #	Species	Sighting Date(s)	Biopsy?	Satellite Tag? / Argos ID
HDRVAPm039	*Physeter macrocephalus*	7-May-19	No	Previously tagged (2018) 173175
HDRVAPm081	*Physeter macrocephalus*	7-May-19	No	No
HDRVAMb007	*Mesoplodon bidens*	7-Jun-19	No	No
HDRVAMb008	*Mesoplodon bidens*	7-Jun-19	No	No
HDRVAPm082	*Physeter macrocephalus*	27-Jun-19	No	SPLASH-10 / 177048
HDRVAPm083	*Physeter macrocephalus*	27-Jun-19	No	No
HDRVAPm084	*Physeter macrocephalus*	27-Jun-19	No	No
HDRVAPm085	*Physeter macrocephalus*	27-Jun-19	No	No
HDRVABp085	*Balaenoptera physalus*	1-Aug-19	No	No
HDRVAPm044	*Physeter macrocephalus*	5-Aug-19	No	No
HDRVAPm049	*Physeter macrocephalus*	5-Aug-19	No	No
HDRVAPm050	*Physeter macrocephalus*	5-Aug-19	No	No
HDRVAPm053	*Physeter macrocephalus*	5-Aug-19	No	No
HDRVAPm086	*Physeter macrocephalus*	5-Aug-19	Yes	SPLASH-10 / 177049
HDRVAPm087	*Physeter macrocephalus*	5-Aug-19	Yes	SPOT-6 / 180411
HDRVAPm088	*Physeter macrocephalus*	5-Aug-19	Yes	SPOT-6 / 173179
HDRVAPm089	*Physeter macrocephalus*	5-Aug-19	No	No