Aerial Surveys for Protected Marine Species in the Cape Hatteras Study Area: 2017 Annual Progress Report

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Cover Photo Credit:

Cuvier's beaked whale (*Ziphius cavirostris*). Photo collected by the University of North Carolina Wilmington under National Oceanic and Atmospheric Administration General Authorization for Scientific Research #16185 to Duke University.

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Acronyms and Abbreviations

BSS	Beaufort sea state
km	kilometer(s)
m	meter(s)
SD	standard deviation
U.S.	United States

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1. Introduction

This report forms part of a multi-institutional monitoring project intended to provide information on the species composition, population identity, density, and baseline behavior of marine mammals and sea turtles present in United States (U.S.) Navy range complexes along the U.S. Atlantic Coast. This program began in 2007, with baseline aerial and vessel surveys, as well as a passive acoustic monitoring component in Onslow Bay, North Carolina, and has since expanded to include survey areas off the coasts of Jacksonville, Florida; Cape Hatteras, North Carolina; and Norfolk, Virginia. Over 6 years of surveys at the Cape Hatteras site have provided significant information on the complex patterns of distribution and diversity of the marine mammals and sea turtles in this highly productive area. Abundance estimates of beaked whales in this region are among the highest reported in the published literature (McLellan et al. 2018). Identification of species-specific characteristics observable from the air has shown at least two species of beaked whales (Cuvier's [*Ziphius cavirostris*] and Gervais' [*Mesoplodon europaeus*]) utilize this area. Documentation of individual scarring patterns has also allowed for the construction of a cooperative vessel and aerial photo identification catalogue for Cuvier's beaked whales at this site (Waples et al. 2017). This catalogue has generated short- and long-term matches within and across platforms and has augmented our understanding of the site fidelity of this species. The current report builds on this past body of work and describes monitoring aerial survey monitoring activities at the Cape Hatteras study site in 2017.

2. Summary of Cape Hatteras Aerial Surveys

This document is an annual progress report to the U.S. Department of the Navy on aerial surveys conducted in the Cape Hatteras survey area from January through December 2017. This year, aerial effort off Cape Hatteras was conducted opportunistically in conjunction with flights in the Norfolk Canyon survey area. As these two areas border one another, transition between them is easily accomplished and both locations are accessible from airports in Manteo, North Carolina, or Norfolk, Virginia. Additional survey days were designated to support the vessel-based Behavioral Response Study off Cape Hatteras. Surveys were flown in February, June, July and August, in which 36 tracklines were flown over five days.

Ninety-nine sightings of 3,545 cetaceans were encountered while on-effort during the five days of aerial surveys. Nine species of cetaceans were photo-documented, including bottlenose dolphins (*Tursiops truncatus*; 42 sightings for 800 individuals), common dolphins (*Delphinus delphis*; 8 sightings for 1,719 individuals), Atlantic spotted dolphins (*Stenella frontalis*; 6 sightings for 376 individuals), striped dolphins (*Stenella coeruleoalba*; 3 sightings for 226 individuals), Risso's dolphins (*Grampus griseus*; 2 sightings for 21 individuals), short-finned pilot whales (*Globicephala macrorhynchus*; 23 sightings for 375 individuals), Cuvier's beaked whales (*Ziphius cavirostris*; 10 sightings for 21 individuals), sperm whales (*Physeter macrocephalus*; 3 sightings for 3 individuals), and humpback whale (*Megaptera novaeangliae*; 1 sighting of 1 individual). There was one sighting (3 individuals) where delphinid species identity could not be established with 100 percent certainty, and this sighting is recorded as "unidentified delphinid."

Five off-effort sightings were also recorded, including two sightings of bottlenose dolphins (74 individuals), one sighting of short-finned pilot whales (7 individuals), one sighting of a pair of unidentified mesoplodont beaked whales (*Mesoplodon* sp.; 2 individuals), and one sighting of 3 small odontocetes. These off-effort sightings are included in species sighting maps and tables but are excluded from all other calculations.

Forty sightings of 49 sea turtles were recorded during this survey period. Forty-seven individuals were identified as loggerhead (*Caretta caretta*) and two as leatherback (*Dermochelys coriacea*) turtles. Sea turtles were detected in all four months surveyed.

The majority of survey effort was conducted in low Beaufort sea states (BSS≤3). Past aerial surveys demonstrated that the rate of cetacean sightings is negatively affected by an increase in the BSS (e.g., Gómez de Segura et al. 2006, DeMaster et al. 2001, McAlarney et al. 2013. Effort-corrected cetacean sightings this year off Cape Hatteras followed this general trend—sighting rates dropped from 58.4 to 25.9 sightings per 1,000 kilometers (km) as BSS increased from 1 to 3. Sea turtle sightings showed a more dramatic decrease in corrected sighting rate in BSS greater than 2.

In addition to cetaceans and sea turtles, other pelagic marine vertebrates (e.g., unidentified sharks, manta rays [*Manta birostris*], basking sharks [*Cetorhinus maximus*], spotted eagle rays [*Aetobatus narinari*], and ocean sunfish [*Mola mola*]) were observed. Commercial, military, and recreational vessels were also encountered in the survey area.

All data from this project is made publically available through the Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP).

3. Methods

3.1 Survey Design and Logistics

Aerial survey effort was initiated in the waters off Cape Hatteras, North Carolina, in May 2011 to assess the distribution and abundance of offshore cetacean species and sea turtles, complimenting existing survey in Onslow Bay, North Carolina, and off Jacksonville, Florida. These surveys formed the basis of the U.S. Navy's Atlantic Fleet Training and Testing Monitoring, established to document the distribution and abundance of offshore cetacean species and sea turtles that could potentially be impacted by naval activities. As this is controlled airspace, pilots must contact flight control the morning of planned survey flights for information on area closures or restrictions. A figure with all restricted airspace in the offshore Virginia waters area can be found in the Methodology section in McAlarney et al. 2018 (Norfolk Canyon Annual Report).

The survey area covers approximately 6,438 square kilometers spanning continental shelf waters as well as deeper waters beyond the shelf break (**Table 1, Figure 1**). Placement of the survey area was designed to incorporate a large portion of the Cape Hatteras Special Research Area in support of current research assessing fishery interactions between short-finned pilot whales and the local fisheries. The Cape Hatteras survey area excludes coastal waters to minimize survey effort in areas where the spatial distribution and relative abundance of coastal bottlenose dolphins has previously been established (Torres et al. 2003, 2005). Twelve tracklines, ranging from 73.17 to 75.42 km in length and orientated east to west, were evenly placed across the survey area.

Table 1. Coordinates for trackline end points for the Cape Hatteras survey area.

Transect Line	Western Waypoint		Eastern Waypoint	
Line	Latitude (N)	Longitude (W)	Latitude (N)	Longitude (W)
45	36.122344	75.161133	36.122344	74.333672
44	36.048500	75.161133	36.048500	74.333672
43	35.978439	75.161133	35.978439	74.333672
42	35.906486	75.161133	35.906486	74.333672
41	35.832642	75.161133	35.832642	74.333672
40	35.762581	75.161133	35.762581	74.333672
39	35.690628	75.161133	35.690628	74.333672
38	35.620569	75.161133	35.620569	74.333672
37	35.550508	75.161133	35.550508	74.333672
36	35.480450	75.161133	35.480450	74.333672
35	35.410389	75.161133	35.410389	74.333672
34	35.340331	75.161133	35.340331	74.333672

Survey flights originated from the Fixed-base Operator in the Dare County Regional Airport in Manteo, North Carolina, or Signature Aviation based within the Norfolk International Airport in Norfolk, Virginia. Utilizing both airports allowed for easy transition between the Norfolk Canyon and Cape Hatteras survey areas and maximized “on-effort” survey time.

A more detailed description of survey methods can be found in the Methodology section in Cummings et al. (2017).

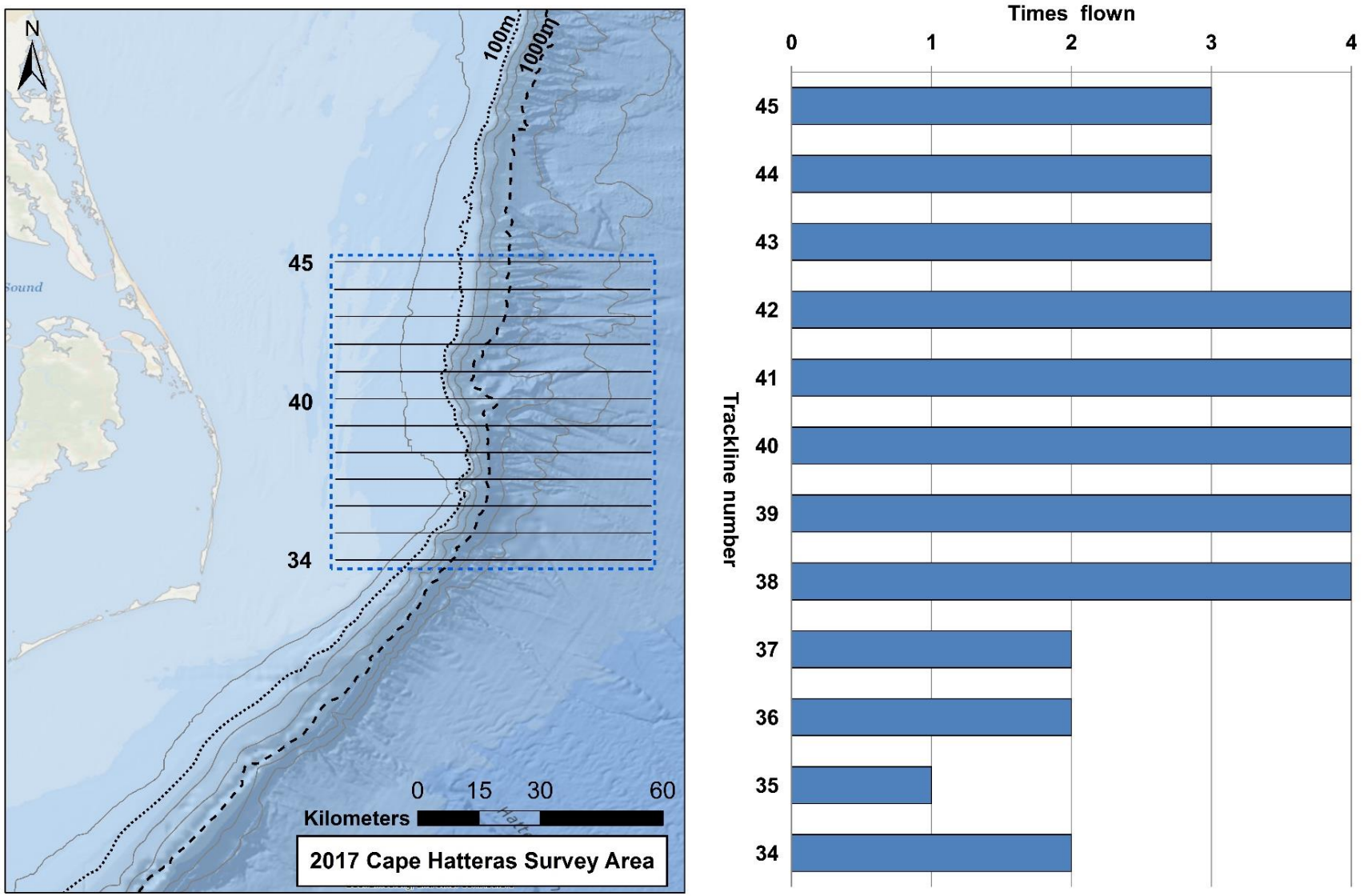

Figure 1. Survey tracklines and realized effort in the Cape Hatteras survey area in 2017.

4. Results

Thirty-six tracklines totaling 2,596 km were surveyed from February through August 2017 (**Table 2**). Conditions during the 5 survey days ranged from BSS 1 to 5, with 93 percent of effort in BSS 3 or lower (BSS 1: 616.10 km [23.74 percent], BSS 2: 811.30 km [31.26 percent], BSS 3: 1003.10 km [38.64 percent], BSS 4: 152.95 km [5.89 percent], and BSS 5: 12.25 km [<1 percent]) (**Figures 2a and 2b**). An average BSS value, weighted by distance flown, was calculated for each day as a way to compare conditions across time (**Figure 2c**).

Table 2. Tracklines, km flown, and Hobbs hours (engine-on time) during aerial surveys of the Cape Hatteras survey area in 2017. Trackline numbers are listed in the order in which they were flown.

Date	Tracklines Flown AM	Tracklines Flown PM	Total km Flown	Hobbs Hours
23-Feb-2017	45 to 42	38 to 41	564.95	5.7
26-Jun-2017	42 to 45	N/A	290.15	2.8
27-Jun-2017	41 to 38	37 to 34	585.65	6.5
19-Jul-2017	45 to 42	41 to 38	569.75	6.6
22-Aug-2017	34, 36 to 38	39 to 42	585.20	6.2
5 Days	**36 Tracklines**		**2595.70**	**27.8**

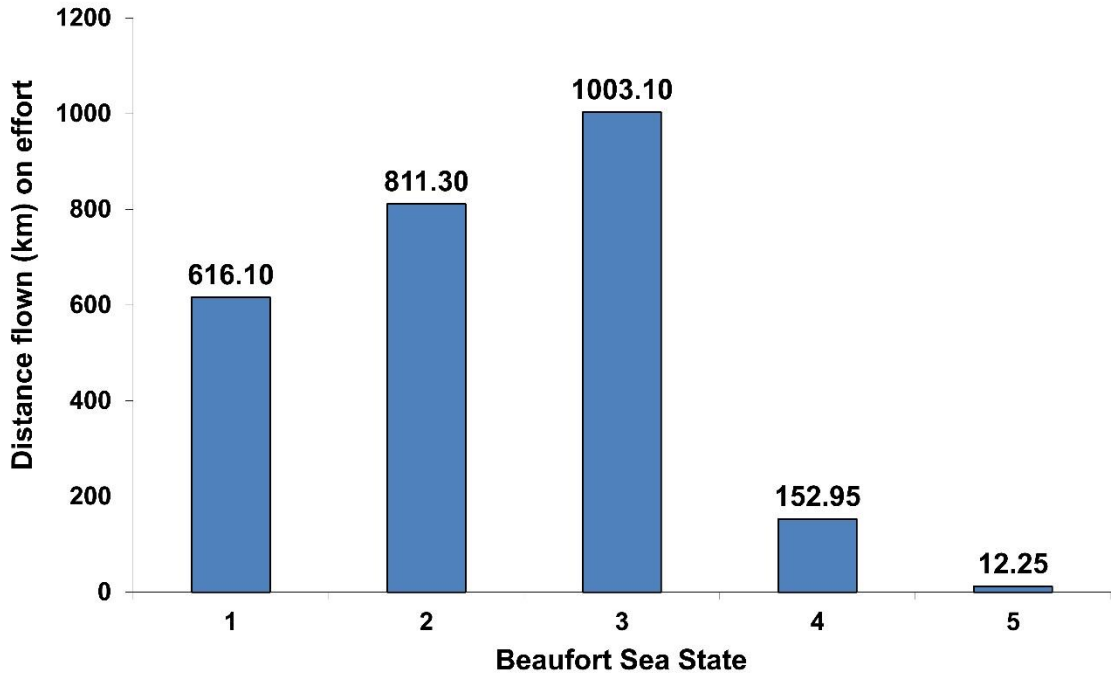

Figure 2a. Total distance surveyed per BSS category during aerial surveys in the Cape Hatteras survey area in 2017.

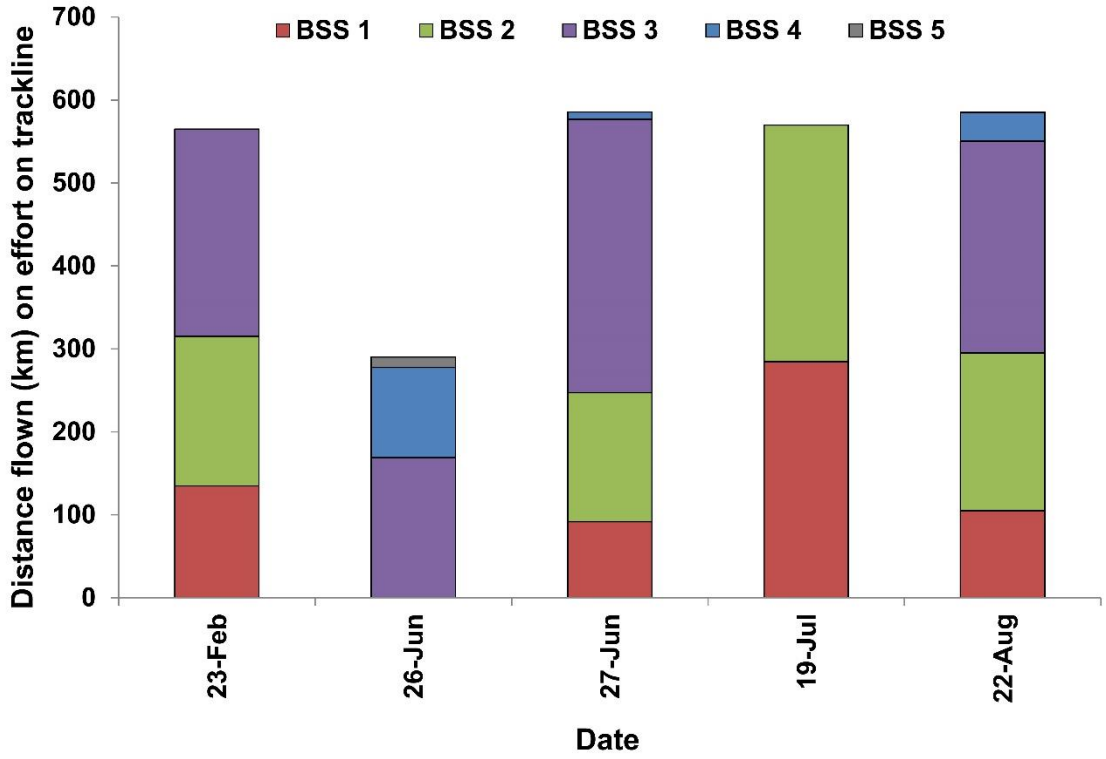

Figure 2b. Effort by BSS category for each survey day during aerial surveys in the Cape Hatteras survey area in 2017.

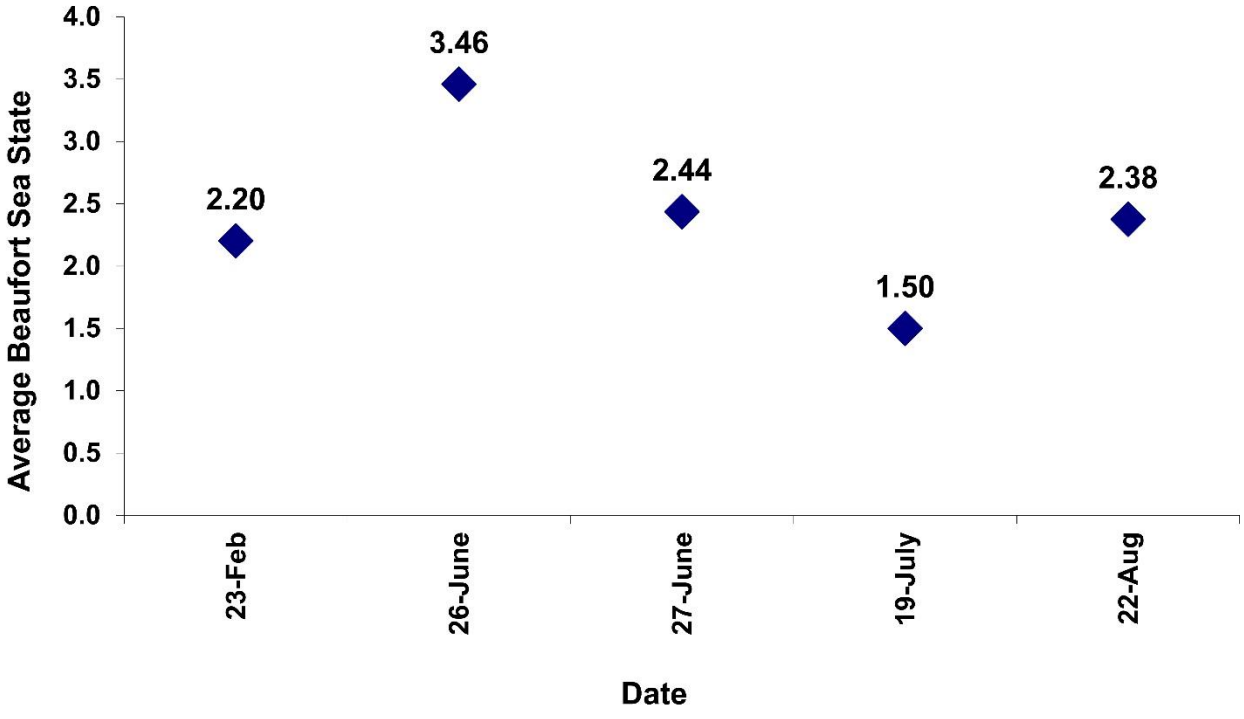

Figure 2c. Average BSS for each survey day during aerial surveys in the Cape Hatteras survey area in 2017. Values are distance-weighted means.

The majority of cetacean sightings (97 percent) occurred in BSS of 3 or less (**Figure 3a**). Cetacean sighting rates decreased as BSS increased, with 58.4 sightings/1,000 km surveyed in BSS 1; 41.9 sightings/1,000 km surveyed in BSS 2; 25.9 sightings/1,000 km surveyed in BSS 3; and 19.6 sightings/1,000 km surveyed in BSS 4 (**Figure 3b**). Sighting rates per day ranged from 13.8 sightings to 56.2. Sighting rates were lowest on 26 June, when sea states were considerably higher than on other survey days (**Figure 3c**).

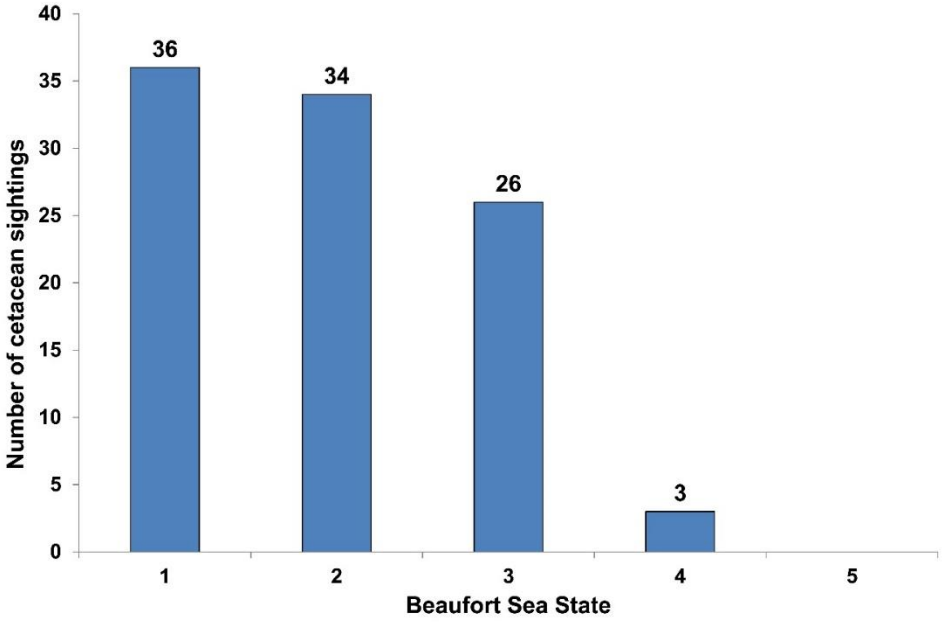

Figure 3a. Number of cetacean sightings per BSS category during aerial surveys in the Cape Hatteras survey area in 2017.

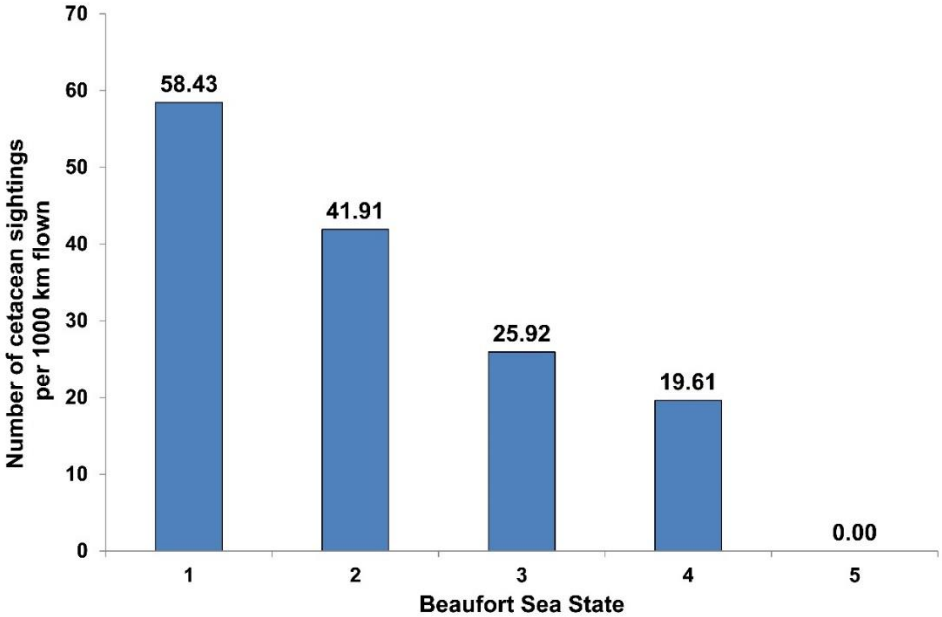

Figure 3b. Cetacean sightings per 1,000 km flown by BSS category during aerial surveys in the Cape Hatteras survey area in 2017.

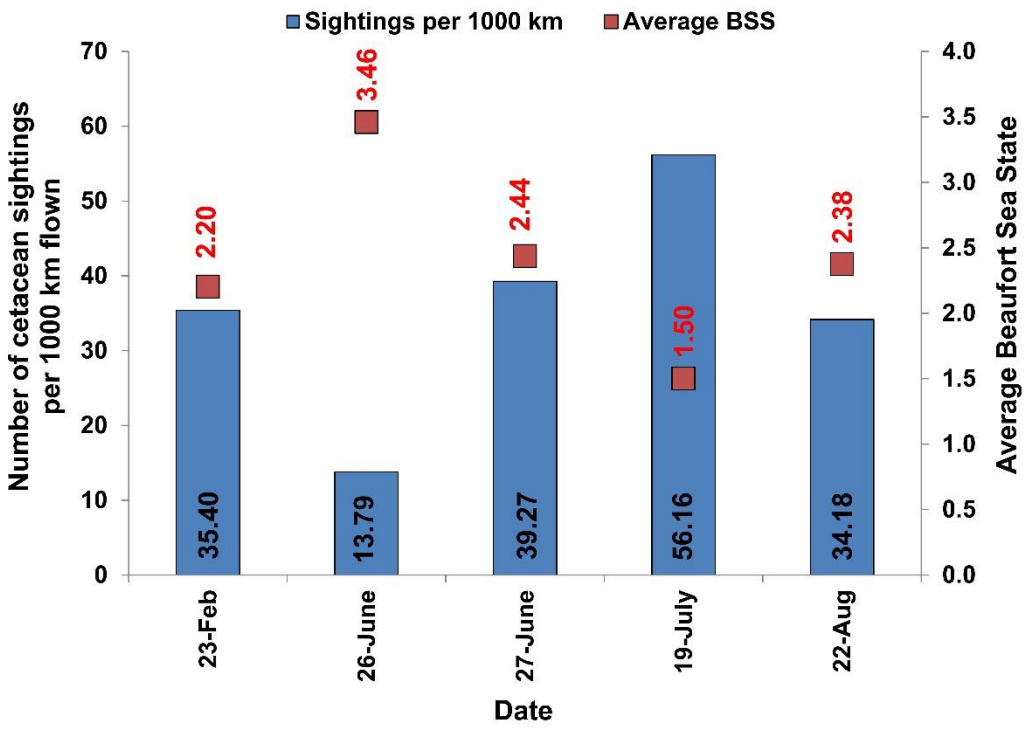

Figure 3c. Cetacean sightings per 1,000 km surveyed and the average BSS per survey day during aerial surveys in the Cape Hatteras survey area in 2017.

Eighty-seven percent of the sightings occurred within 1.2 km of the trackline (**Figure 4a**). Mean sighting distance for all cetacean sightings was 0.83 km (standard deviation [SD]=0.44). Sighting distances across sea states varied by less than 0.2 km (**Figure 4b**). Average sighting distances are normally calculated after removing outliers, defined as any value in excess of three SD from the mean (mean=0.83 km, [SD]=0.44, 0.83+[3×0.44]=2.15 km, Outlier > 2.15 km). Two sighting distances were identified as outliers during this reporting period (BSS 1 – 2.24 km sighting, BSS 1 – 2.42 km sighting). In addition, one sighting did not have associated sighting distance and was excluded from these calculations. The remaining 96 sighting distances are represented in **Figures 4a** and **b**.

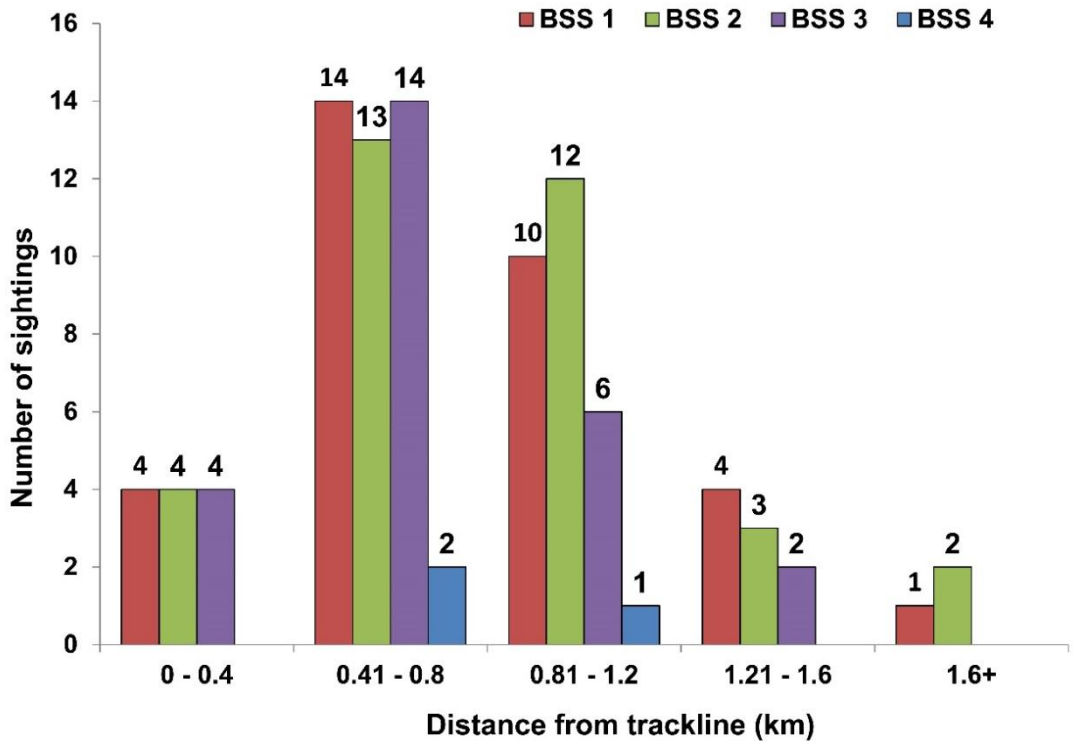

Figure 4a. Sighting distances by BSS category for 96 of 99 on-effort cetacean sightings during aerial surveys in the Cape Hatteras survey area in 2017.

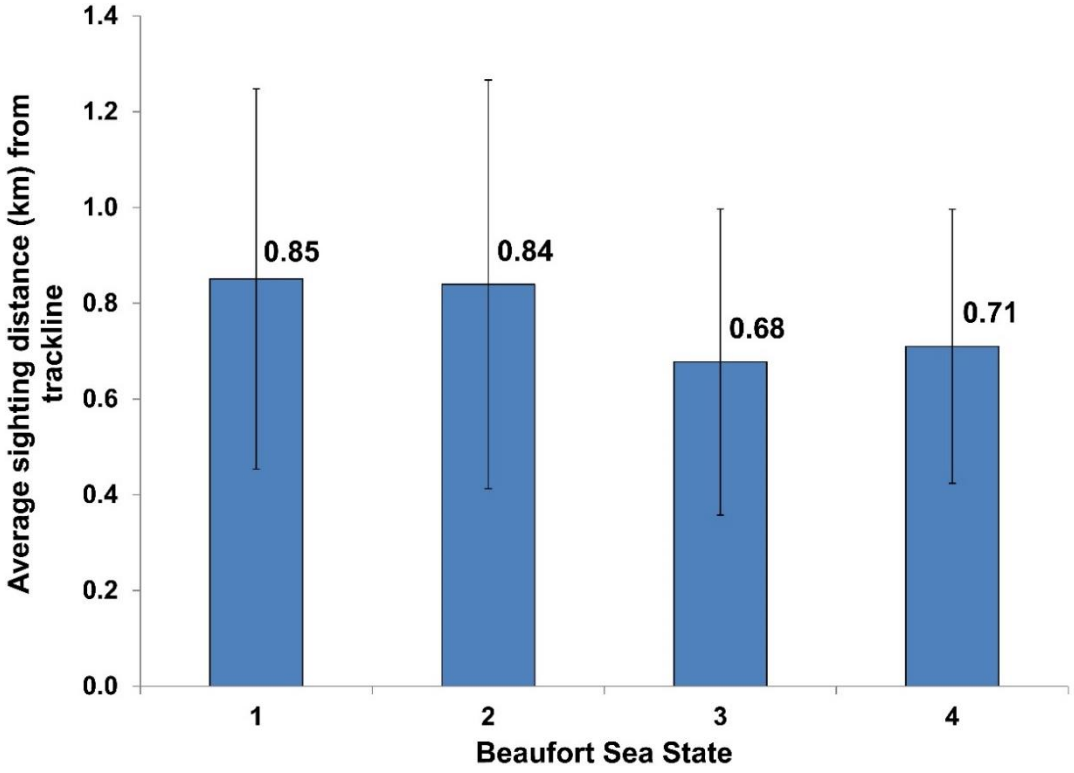

Figure 4b. Average sighting distances by BSS for 96 of 99 on-effort cetacean sightings during aerial surveys in the Cape Hatteras survey area in 2017. Error bars denote standard deviation for each category.

4.1 Marine Mammal Sightings

A total of 99 sightings of 3,545 individual cetaceans representing nine species was observed while on-effort during the reporting period (**Table 3, Figure 5**). Summary information follows below for each species. One endangered species, the sperm whale, was encountered in the survey area. Three cetacean species had additional sightings that were recorded while off-effort. A sighting was considered off-effort if it occurred while transiting to or from the survey area or between tracklines. Any cetaceans the survey team encountered while investigating a separate sighting cue were also labeled off-effort. If two species were seen associated with the same sighting cue, both were considered on-effort. The off-effort sightings are included in the tables and maps for each species but are excluded from any calculations. The total number of individuals listed represents the best estimate of group size. Information on individual sighting summaries are in **appendices A, B, and C**. Daily sightings are summarized in **Appendix D.**

Table 3. Total numbers of on-effort sightings and individuals for each species by month for the Cape Hatteras survey area in 2017.

		2017												Total
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Tursiops truncatus	Sightings	-	6	-	-	-	10	14	12	-	-	-	-	**42**
	Individuals	-	121	-	-	-	104	386	189	-	-	-	-	**800**
Delphinus delphis	Sightings	-	7	-	-	-	1			-	-	-	-	**8**
	Individuals	-	1119	-	-	-	60			-	-	-	-	**1719**
Stenella frontalis	Sightings	-	1	-	-	-	2	1	2	-	-	-	-	**6**
	Individuals	-	35	-	-	-	77	50	214	-	-	-	-	**376**
Stenella coeruleoalba	Sightings	-	3	-	-	-				-	-	-	-	**3**
	Individuals	-	226	-	-	-				-	-	-	-	**226**
Grampus griseus	Sightings	-		-	-	-		2		-	-	-	-	**2**
	Individuals	-		-	-	-		21		-	-	-	-	**21**
Globicephala macrorhynchus	Sightings	-	1	-	-	-	8	10	4	-	-	-	-	**23**
	Individuals	-	7	-	-	-	144	165	59	-	-	-	-	**375**
Ziphius cavirostris	Sightings	-	1	-	-	-	6	2	1	-	-	-	-	**10**
	Individuals	-	1	-	-	-	14	4	2	-	-	-	-	**21**
Physeter macrocephalus	Sightings	-		-	-	-		2	1	-	-	-	-	**3**
	Individuals	-		-	-	-		2	1	-	-	-	-	**3**
Megaptera novaeangliae	Sightings	-	1	-	-	-				-	-	-	-	**1**
	Individuals	-	1	-	-	-				-	-	-	-	**1**
Unidentified delphinid	Sightings	-		-	-	-		1		-	-	-	-	**1**
	Individuals	-		-	-	-		3		-	-	-	-	**3**
	Total sightings		**20**				**27**	**32**	**20**					**99**
	Total individuals		**1510**				**939**	**631**	**465**					**3545**
Caretta caretta	Sightings	-	4	-	-	-	11	20	3	-	-	-	-	**38**
	Individuals	-	5	-	-	-	13	26	3	-	-	-	-	**47**
Dermochelys coriacea	Sightings	-		-	-	-			*2*	-	-	-	-	***2***
	Individuals	-		-	-	-			2	-	-	-	-	**2**
	Total sightings		**4**				**11**	**20**	**5**					**40**
	Total individuals		**5**				**13**	**26**	**5**					**49**

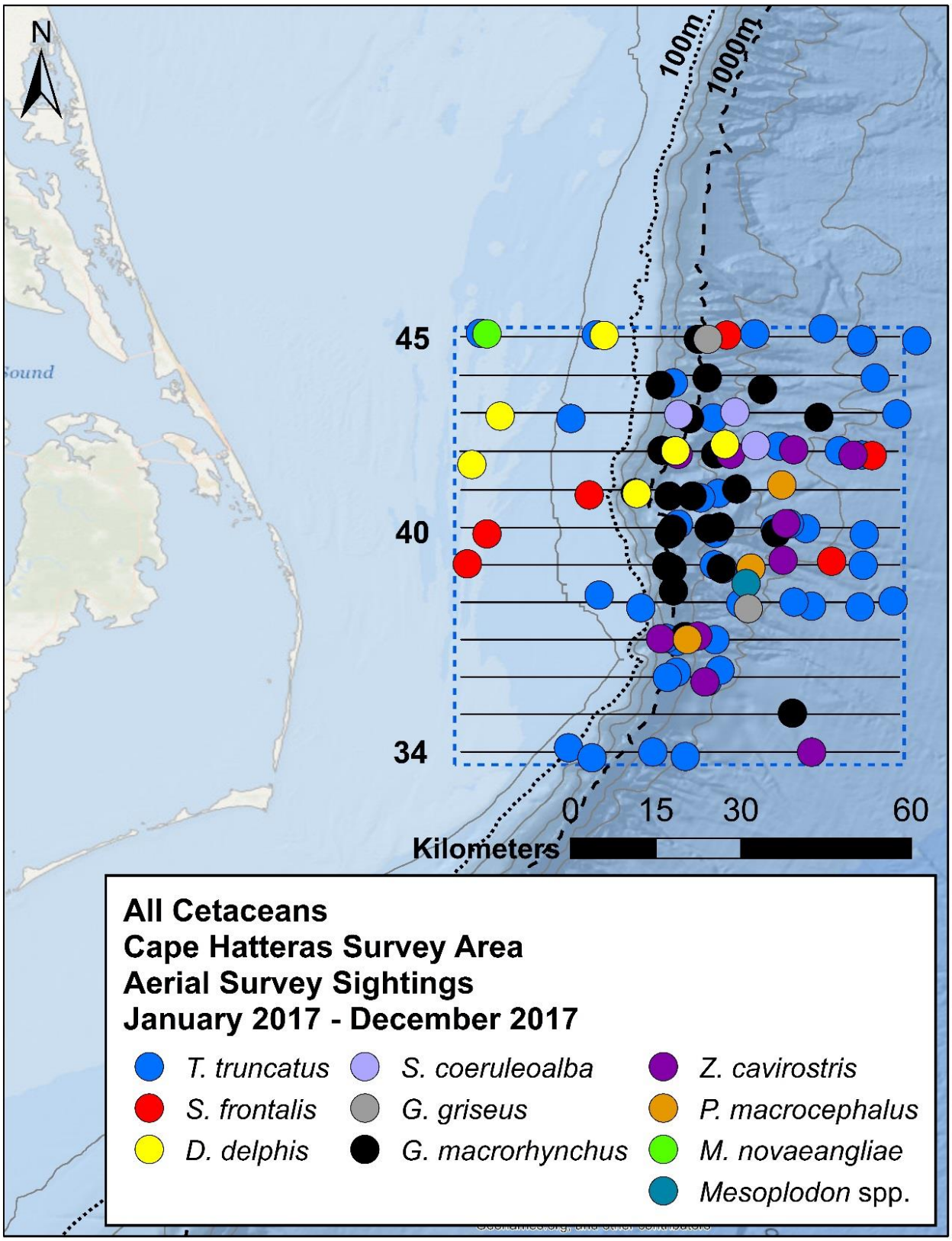

Figure 5. All cetacean sightings during aerial surveys conducted in the Cape Hatteras survey area in 2017.

4.2 Dolphins

4.2.1 Bottlenose dolphin (*Tursiops truncatus*)

Bottlenose dolphins were the most commonly observed cetacean, with 42 sightings totaling 800 individuals (**Table 4, Figure 6**). Bottlenose dolphins were observed in all four months in which survey effort was conducted this reporting period, with groups ranging in size between 1 and 70 individuals (mean=19.05, SD=15.84). Two additional off-effort sightings were observed, one within the survey site and one at the offshore end of trackline 45. The majority of sightings occurred greater than 37 km from shore and in waters beyond the 100-meter (m) isobath. Based on the distance from shore (i.e., greater than 34 km), most of these bottlenose dolphins were likely the offshore ecotype (Torres et al. 2003).

Table 4. Bottlenose dolphin (*Tursiops truncatus*) sightings in the Cape Hatteras survey area in 2017. Asterisk denotes off-effort sightings.

Date	Time	Waypoint	Latitude (N)	Longitude (W)	Track Number	BSS	Angle out	Degree Forward	Best #	Off Effort
23-Feb-2017	9:22:08	5	36.128012	75.125204	45	1	1	90°	5	
23-Feb-2017	9:29:47	9	36.125032	74.906332	45	1	1	60°	6	
23-Feb-2017	9:45:03	17	36.115821	74.405292	45	2	2	90°	45	
23-Feb-2017	9:54:15	22	36.114198	74.301324			2	100°	60	*
23-Feb-2017	10:01:49	26	36.043754	74.379785	44	2	2	90°	40	
23-Feb-2017	10:21:44	34	36.034497	74.760845	44	2	1	100°	10	
23-Feb-2017	11:31:11	65	35.898497	74.405074	42	2	1	90°	15	
27-Jun-2017	9:16:23	14	35.817390	74.709146	41	1	2	45°	7	
27-Jun-2017	9:23:05	18	35.826072	74.675979	41	1	1	90°	1	
27-Jun-2017	9:45:19	29	35.759638	74.510748	40	3	2	90°	6	
27-Jun-2017	9:49:51	33	35.758715	74.568425	40	3	2	90°	4	
27-Jun-2017	10:47:01	67	35.683399	74.667715	39	3	4	90°	7	
27-Jun-2017	13:45:23	87	35.546543	74.754188	37	3	2	90°	17	
27-Jun-2017	13:53:36	95	35.549842	74.682023	37	3	1	90°	14	
27-Jun-2017	14:21:52	102	35.471157	74.696883	36	3	2	100°	5	
27-Jun-2017	15:34:54	125	35.338064	74.799371	34	3	1	90°	12	
27-Jun-2017	15:42:43	129	35.327130	74.914412	34	3	3	90°	31	
19-Jul-2017	9:28:57	15	36.126935	74.607144	45	2	2	60°	18	
19-Jul-2017	9:35:18	19	36.136624	74.477734	45	2	3	60°	70	
19-Jul-2017	9:43:10	23	36.111155	74.402794	45	2	3	60°	20	
19-Jul-2017	10:37:46	46	35.967253	74.954471	43	2	3	90°	12	
19-Jul-2017	10:52:42	54	35.968291	74.685447	43	2	1	60°	50	
19-Jul-2017	11:07:04	59	35.975716	74.338789	43	1	1	90°	8	
19-Jul-2017	11:16:17	65	35.906511	74.447255	42	1	2	90°	60	

Date	Time	Waypoint	Latitude (N)	Longitude (W)	Track Number	BSS	Angle out	Degree Forward	Best #	Off Effort
19-Jul-2017	14:37:21	106	35.748320	74.400174	40	1	1	60°	40	
19-Jul-2017	14:46:49	110	35.768574	74.541431	40	1	2	90°	28	
19-Jul-2017	14:52:31	114	35.750724	74.681547	40	1	1	90°	20	
19-Jul-2017	15:52:17	144	35.611915	74.408258	38	1	1	90°	8	
19-Jul-2017	15:58:55	148	35.613415	74.499790	38	1	1	90°	10	
19-Jul-2017	16:00:55	152	35.620983	74.533088	38	1	1	90°	30	
19-Jul-2017	16:16:54	160	35.609970	74.822384	38	1	1	45°	12	
22-Aug-2017	9:56:43	4	35.346141	74.958956	34	1	1	90°	10	
22-Aug-2017	10:06:41	8	35.329644	74.738325	34	1	2	60°	18	
22-Aug-2017	10:34:27	15	35.492247	74.672611	36	2	1	60°	12	
22-Aug-2017	10:40:25	19	35.488537	74.754697	36	2	1	90°	8	
22-Aug-2017	10:47:13	23	35.478950	74.772253	36	2	1	90°	18	
22-Aug-2017	11:09:07	30	35.552457	74.774258	37	1	1	90°	35	
22-Aug-2017	11:31:40	40	35.622631	74.346125	38	2	1	90°	26	
22-Aug-2017	11:43:15	45	35.618232	74.633686	38	1	3	60°	20	
22-Aug-2017	12:05:17	53	35.633891	74.901204	38	1	1	45°	17	
22-Aug-2017	14:36:25	71	35.691207	74.683314	39	3	1	75°	5	
22-Aug-2017	14:47:04	75	35.690344	74.402399	39	3	2	45°	5	
22-Aug-2017	15:30:37	94	35.767798	74.751527	40	3	2	90°	14	*
22-Aug-2017	16:19:37	106	35.914949	74.561829	42	3	1	90°	15	

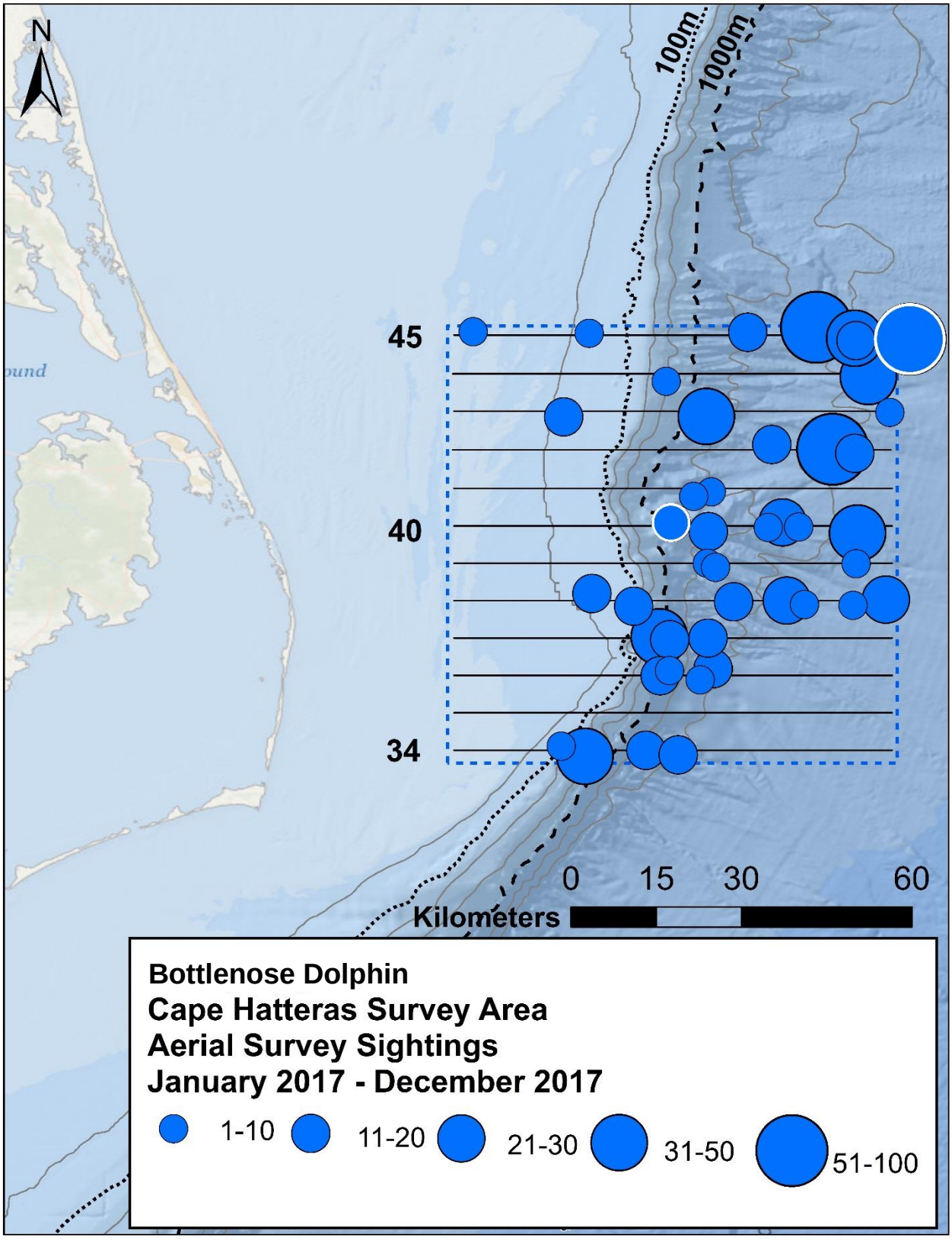

Figure 6. Bottlenose dolphin (*Tursiops truncatus*) sightings indicating group size. White outline denotes off-effort sightings.

4.2.2 Common dolphin (*Delphinus delphis*)

Eight sightings of 1,719 individuals (mean=214.9, SD=277.0) were observed in the northern portion of the survey area, with all but one sighting occurring in the month of February (**Table 5, Figure 7**). Group sizes were highly variable; 3 groups had fewer than 20 animals, while 2 groups contained more than 500 individuals.

Table 5. Common dolphin (*Delphinus delphis*) sightings in the Cape Hatteras survey area in 2017.

Date	Time	Waypoint	Latitude (N)	Longitude (W)	Track Number	BSS	Angle out	Degree Forward	Best #	
23-Feb-2017	10:39:14	40	35.971783	75.087938	43	2	2	90°	200	
23-Feb-2017	10:56:29	48	35.975045	74.750783	43	1	1	90°	17	
23-Feb-2017	11:04:14	52	35.979063	74.644632	43	2	1	90°	12	
23-Feb-2017	11:42:49	73	35.918409	74.663596	42	2	3	60°	100	
23-Feb-2017	11:48:27	77	35.906159	74.756915	42	2	1	90°	700	
23-Feb-2017	12:00:14	83	35.880542	75.141329	42	1	3	45°	75	
23-Feb-2017	15:20:58	111	35.825786	74.829966	41	2	3	90°	15	
26-Jun-2017	10:50:51	32	36.124029	74.891367	45	3	1	90°	600	

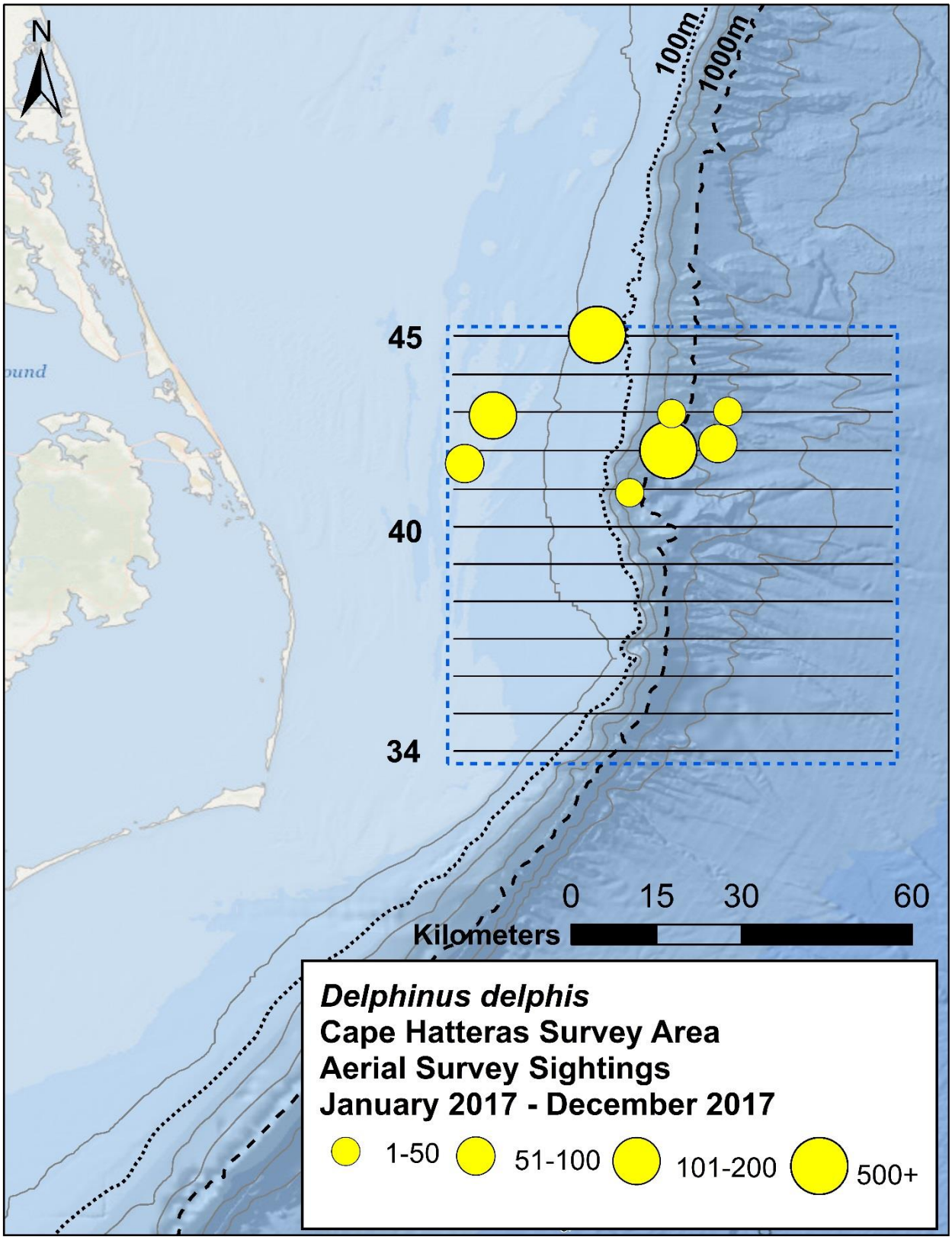

Figure 7. Common dolphin (*Delphinus delphis*) sightings indicating group size

4.2.3 Atlantic spotted dolphin (*Stenella frontalis*)

Six sightings of 376 individuals were observed while on-effort in the Cape Hatteras, North Carolina, survey area. Group size ranged between 34 and 180 (mean=62.7, SD=57.8) (**Table 6, Figure 8**). Spotted dolphins occurred in each of the four months surveyed. There are two distinct forms, or ecotypes, of the Atlantic spotted dolphin in the western North Atlantic: a heavily spotted, larger form that typically occurs on the continental shelf and is most often encountered around the 200 m isobath or in shallower water, and a less spotted and smaller form that occurs farther offshore and around islands (Perrin et al. 1987, 1994). Examination of photographs collected during each sighting suggests that both ecotypes are present within the survey area.

Table 6. Atlantic spotted dolphin (*Stenella frontalis*) sightings in the Cape Hatteras survey area in 2017.

Date	Time	Waypoint	Latitude (N)	Longitude (W)	Track Number	BSS	Angle out	Degree Forward	Best #	
23-Feb-2017	15:28:35	115	35.823001	74.919660	41	2	1	90°	35	
26-Jun-2017	10:32:20	27	36.124477	74.659967	45	4	2	90°	40	
27-Jun-2017	10:15:12	52	35.749472	75.112794	40	1	2	90°	37	
19-Jul-2017	15:39:46	138	35.698134	74.461894	39	1	1	60°	50	
22-Aug-2017	14:20:40	63	35.692869	75.149890	39	3	1	90°	34	
22-Aug-2017	16:09:46	102	35.897459	74.385449	42	3	2	90°	180	

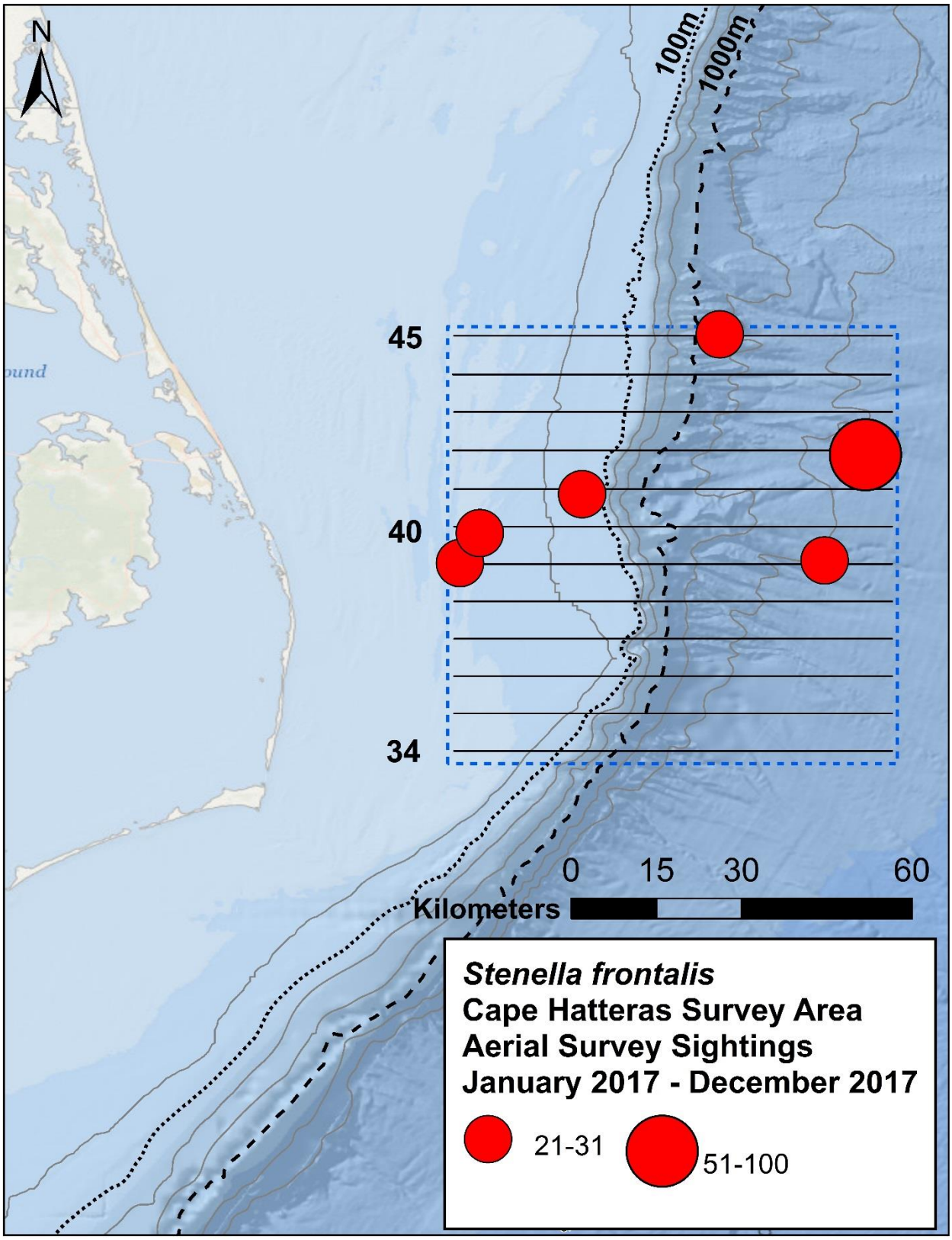

Figure 8. Atlantic spotted dolphin (*Stenella frontalis*) sightings indicating group size.

4.2.4 Striped dolphin (Stenella coeruleoalba)

Three sightings totaling 226 individuals were observed along the shelf break in the northern portion of the survey area. All sightings occurred in February and groups were between 45 and 133 individuals (mean=75.3, SD=50.0) (**Table 7, Figure 9**).

Table 7. Striped dolphin (*Stenella coeruleoalba*) sightings in the Cape Hatteras survey area in 2017.

Date	Time	Waypoint	Latitude (N)	Longitude (W)	Track Number	BSS	Angle out	Degree Forward	Best #	
23-Feb-2017	10:56:29	48	35.975045	74.750783	43	1	1	90°	133	
23-Feb-2017	11:04:14	52	35.979063	74.644632	43	2	1	90°	48	
23-Feb-2017	11:40:22	69	35.915923	74.605508	42	2	2	90°	45	

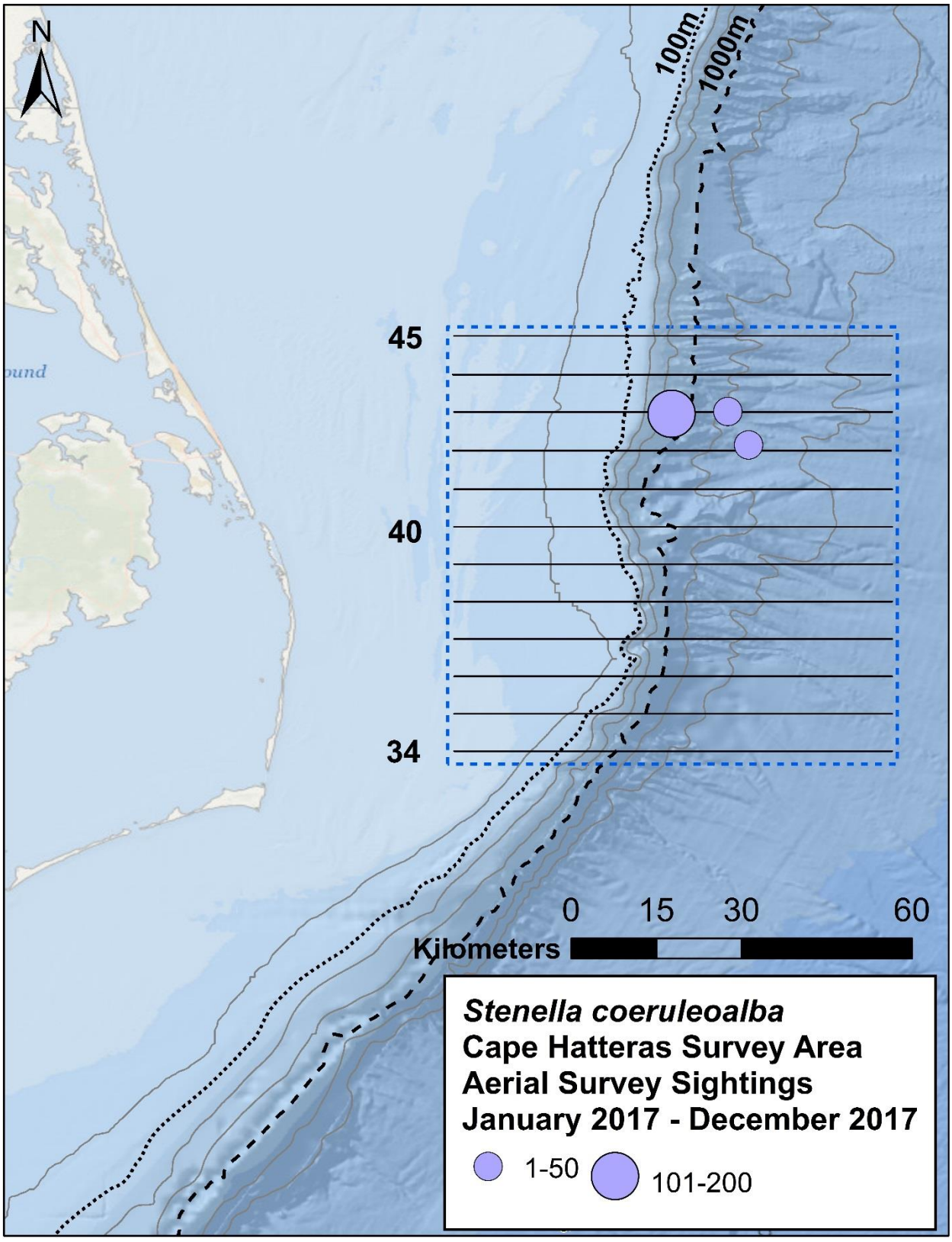

Figure 9. Striped dolphin (*Stenella coeruleoalba*) sightings indicating group size.

4.2.5 Risso's dolphin (*Grampus griseus*)

This species was encountered twice, each in small groups of fewer than 15 individuals (**Table 8, Figure 10**). Both sightings occurred in July beyond the 1,000-m isobath.

Table 8. Risso's dolphin (*Grampus griseus*) sightings in the Cape Hatteras survey area in 2017.

Date	Time (zone)	Waypoint	Latitude (N)	Longitude (W)	Track Number	BSS	Angle out	Degree Forward	Best #	
19-Jul-2017	9:23:39	11	36.116747	74.695793	45	2	1	90°	8	
19-Jul-2017	16:05:51	156	35.608604	74.619563	38	1	2	90°	13	

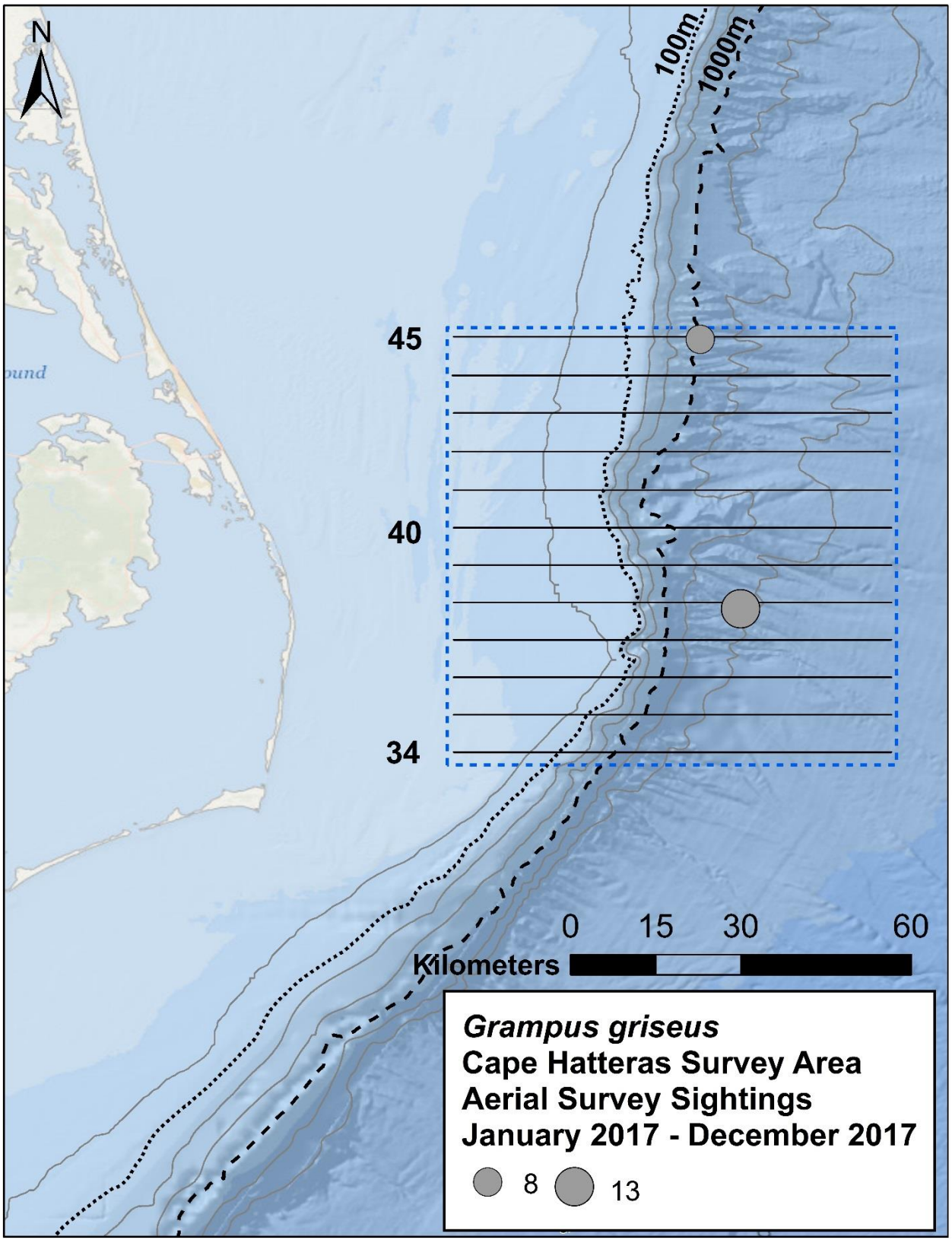

Figure 10. Risso's dolphin (*Grampus griseus*) sightings indicating group size.

4.3 Whales

4.3.1 Short-finned pilot whale (*Globicephala macrorhynchus*)

Short-finned pilot whales were the second most frequently observed cetacean species occurring 23 times for a total of 375 individuals, and seen in all four survey months. Group sizes ranged from 3 to 67 individuals (mean=16.3, SD=14.0) (**Table 9**). One off-effort sighting of 7 individuals was observed within the survey area. Sightings of pilot whales in the western North Atlantic occur primarily near the continental shelf break (Waring et al. 2014), and sightings in the Cape Hatteras survey area followed this pattern. Pilot whales were observed from the 100 m isobath to waters greater than 2,000 m in bottom depth (**Figure 11**). The geographic extent of our survey area encompasses waters shared by both species of *Globicephala* (summarized in Waring et al. 2014). A careful examination of all photographs suggests that all sightings were of short-finned pilot whales.

Table 9. Short-finned pilot whale (*Globicephala macrorhynchus)* sightings in the Cape Hatteras survey area in 2017. Asterisk denotes off-effort sightings.

Date	Time	Waypoint	Latitude (N)	Longitude (W)	Track Number	BSS	Angle out	Degree Forward	Best #	Off Effort
23-Feb-2017	11:12:48	57	35.969343	74.486353	43	2	3	100°	7	
27-Jun-2017	9:03:03	6	35.827148	74.832707	41	1	1	90°	8	
27-Jun-2017	9:10:22	10	35.820837	74.769294	41	1	1	90°	3	
27-Jun-2017	9:26:02	22	35.834201	74.640995	41	2	3	100°	8	
27-Jun-2017	9:52:07	34	35.751504	74.567010	40	3	2	90°	7	*
27-Jun-2017	9:55:59	37	35.762465	74.672965	40	3	1	90°	15	
27-Jun-2017	10:03:25	43	35.749478	74.768317	40	3	3	90°	25	
27-Jun-2017	10:39:24	62	35.688601	74.773193	39	3	1	90°	64	
27-Jun-2017	10:48:38	68	35.684790	74.670403	39	3	4	90°	4	
27-Jun-2017	15:06:23	116	35.411248	74.535825	35	3	1	90°	17	
19-Jul-2017	9:19:19	7	36.116871	74.713602	45	2	2	90°	20	
19-Jul-2017	10:03:23	29	36.021789	74.592516	44	2	3	45°	12	
19-Jul-2017	10:08:08	33	36.044032	74.697023	44	2	1	90°	20	
19-Jul-2017	10:15:35	38	36.030136	74.785152	44	2	2	90°	20	
19-Jul-2017	10:46:17	50	35.966994	74.730179	43	2	2	90°	15	
19-Jul-2017	11:26:50	69	35.900382	74.681068	42	2	1	90°	6	
19-Jul-2017	11:36:29	75	35.906748	74.757983	42	2	1	60°	45	
19-Jul-2017	11:42:18	79	35.907128	74.782205	42	2	2	90°	15	
19-Jul-2017	14:07:21	91	35.820773	74.725254	41	1	3	60°	6	
19-Jul-2017	15:24:31	125	35.683609	74.763001	39	1	1	60°	6	
22-Aug-2017	11:14:21	33	35.556044	74.738648	37	1	1	90°	17	
22-Aug-2017	11:58:41	49	35.641924	74.760818	38	1	1	60°	25	
22-Aug-2017	15:17:57	88	35.759627	74.693590	40	3	2	90°	8	
22-Aug-2017	15:28:40	93	35.758300	74.762069	40	3	2	90°	9	

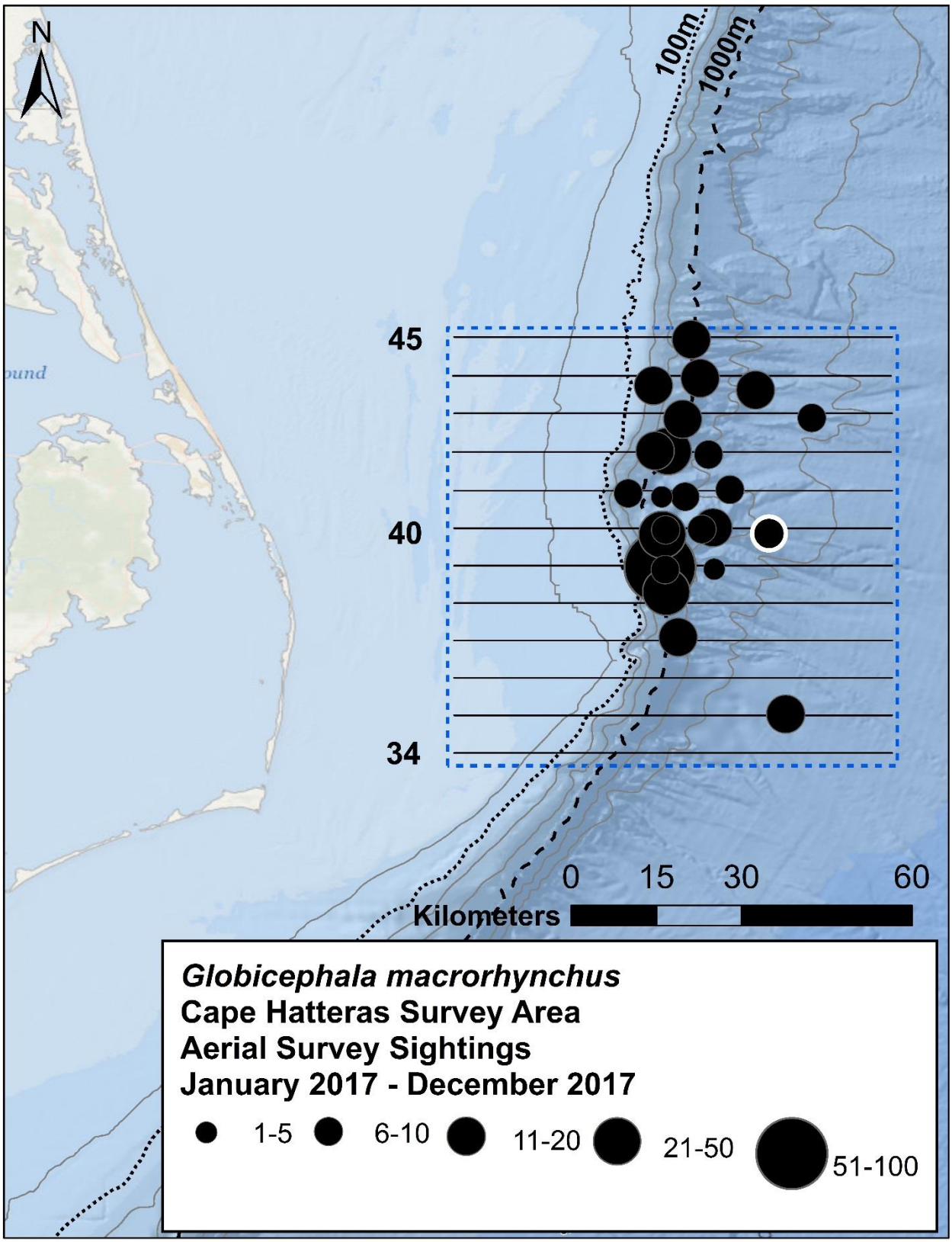

Figure 11. Short-finned pilot whale (*Globicephala macrorhynchus*) sightings indicating group size. White outline denotes off-effort sighting.

4.3.2 Cuvier's beaked whale (*Ziphius cavirostris*)

Ten sightings of 21 individuals occurred in the Cape Hatteras survey area, and this species was observed in all four months surveyed (**Table 10, Figure 12**). Group sizes ranged from single animals up to groups of 5 individuals. Sightings occurred from just inside the 1,000 m isobath to beyond the 2,000 m isobath.

Table 10. Cuvier's beaked whale (*Ziphius cavirostris)* sightings in the Cape Hatteras survey area in 2017.

Date	Time	Waypoint	Latitude (N)	Longitude (W)	Track Number	BSS	Angle out	Degree Forward	Best #	
23-Feb-2017	11:29:15	64	35.898000	74.421157	42	2	1	90°	1	
26-Jun-2017	9:13:16	7	35.899675	74.652720	42	4	1	90°	2	
26-Jun-2017	9:24:34	11	35.908289	74.533566	42	4	1	100°	1	
27-Jun-2017	13:43:37	84	35.551547	74.785029	37	3	1	90°	1	
27-Jun-2017	13:50:09	91	35.556829	74.714727	37	3	2	90°	5	
27-Jun-2017	14:21:15	101	35.470205	74.701305	36	3	2	100°	3	
27-Jun-2017	15:25:06	122	35.337827	74.499704	34	3	1	90°	2	
19-Jul-2017	11:31:37	73	35.899770	74.751692	42	2	1	60°	3	
19-Jul-2017	15:35:19	134	35.699706	74.553767	39	1	2	90°	1	
22-Aug-2017	15:02:32	82	35.768966	74.548481	40	3	1	90°	2	

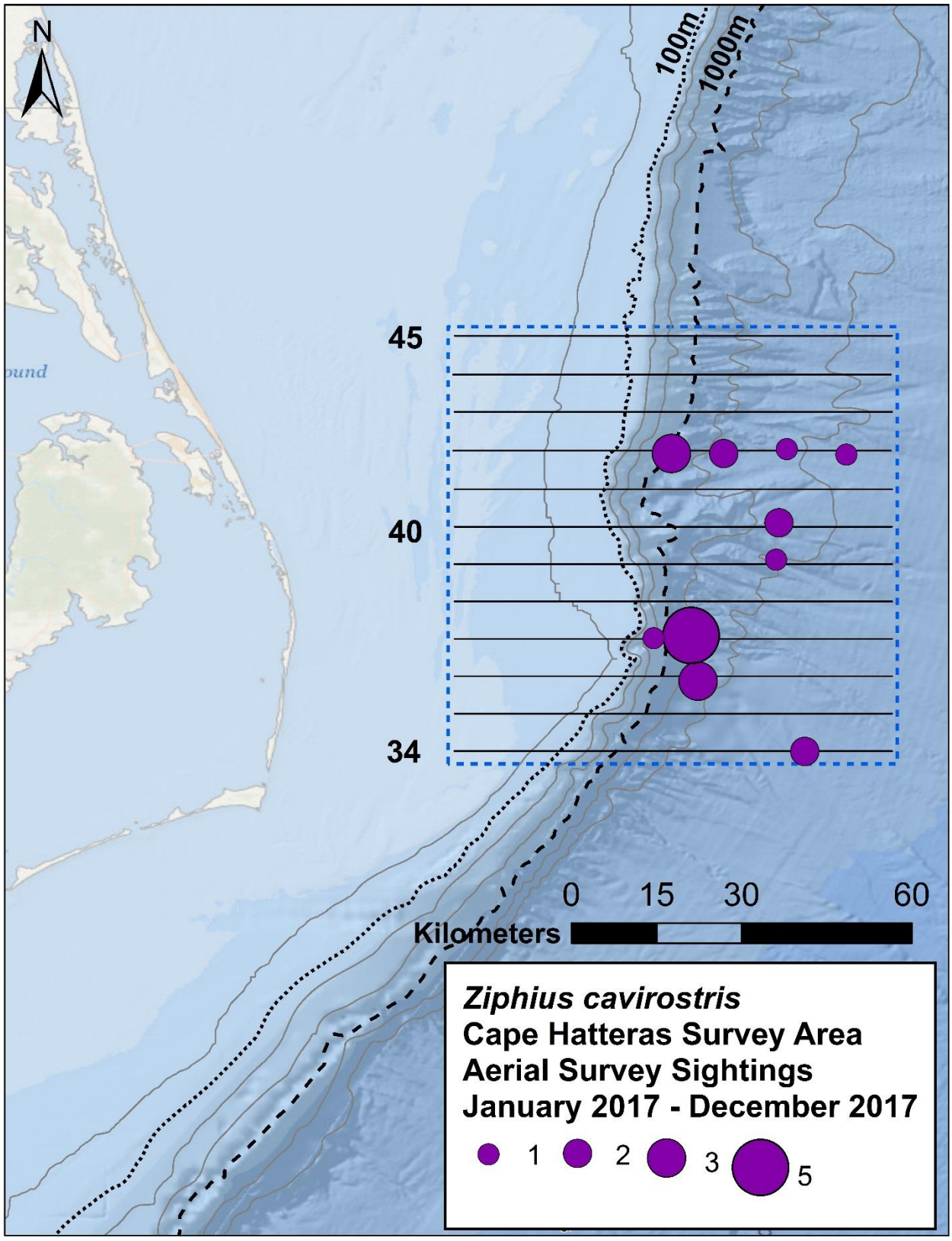

Figure 12. Cuvier's beaked whale (*Ziphius cavirostris*) sightings indicating group size.

4.3.3 Sperm whale (Physeter macrocephalus)

On three occasions, lone sperm whales were observed beyond the 1,000 m isobath in the central portion of the Cape Hatteras survey area (**Table 11, Figure 13**).

Table 11. Sperm whale (*Physeter macrocephalus*) sightings in the Cape Hatteras survey area in 2017.

Date	Time	Waypoint	Latitude (N)	Longitude (W)	Track Number	BSS	Angle out	Degree Forward	Best #	
19-Jul-2017	14:19:19	96	35.841907	-74.556140	41	1	3	60°	1	
19-Jul-2017	15:31:14	130	35.685143	-74.614352	39	1	2	90°	1	
22-Aug-2017	11:14:05	32	35.550231	-74.734316	37	1	1	90°	1	

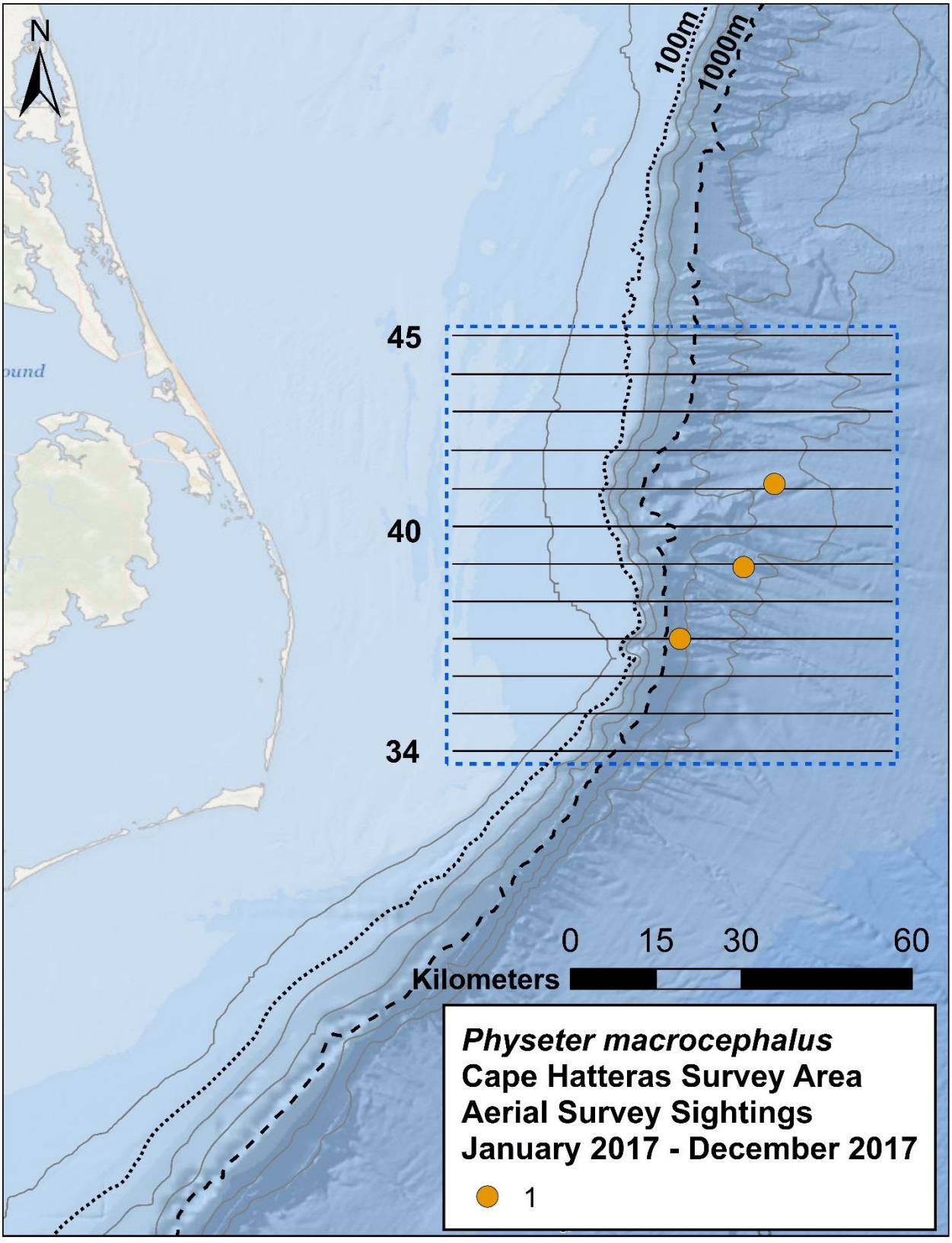

Figure 13. Sperm whale (*Physeter macrocephalus*) sightings.

4.3.4 Humpback whale (Megaptera novaeangliae)

A single humpback whale was observed inside the survey area on the inshore end of trackline 45 (**Table 12, Figure 14**). Since this species has been the focus of current and past photo-identification work, all efforts were made to document any features on the animals that could aid in identifying the individual. These images were shared with teams responsible for maintaining the Atlantic Humpback whale catalogue.

Table 12. Humpback whale (*Megaptera novaeangliae*) sighting in the Cape Hatteras survey area in 2017.

Date	Time	Waypoint	Latitude (N)	Longitude (W)	Track Number	BSS	Angle out	Degree Forward	Best #	
23-Feb-2017	9:20:08	4	36.126916	75.112942	45	1	1	90°	1	

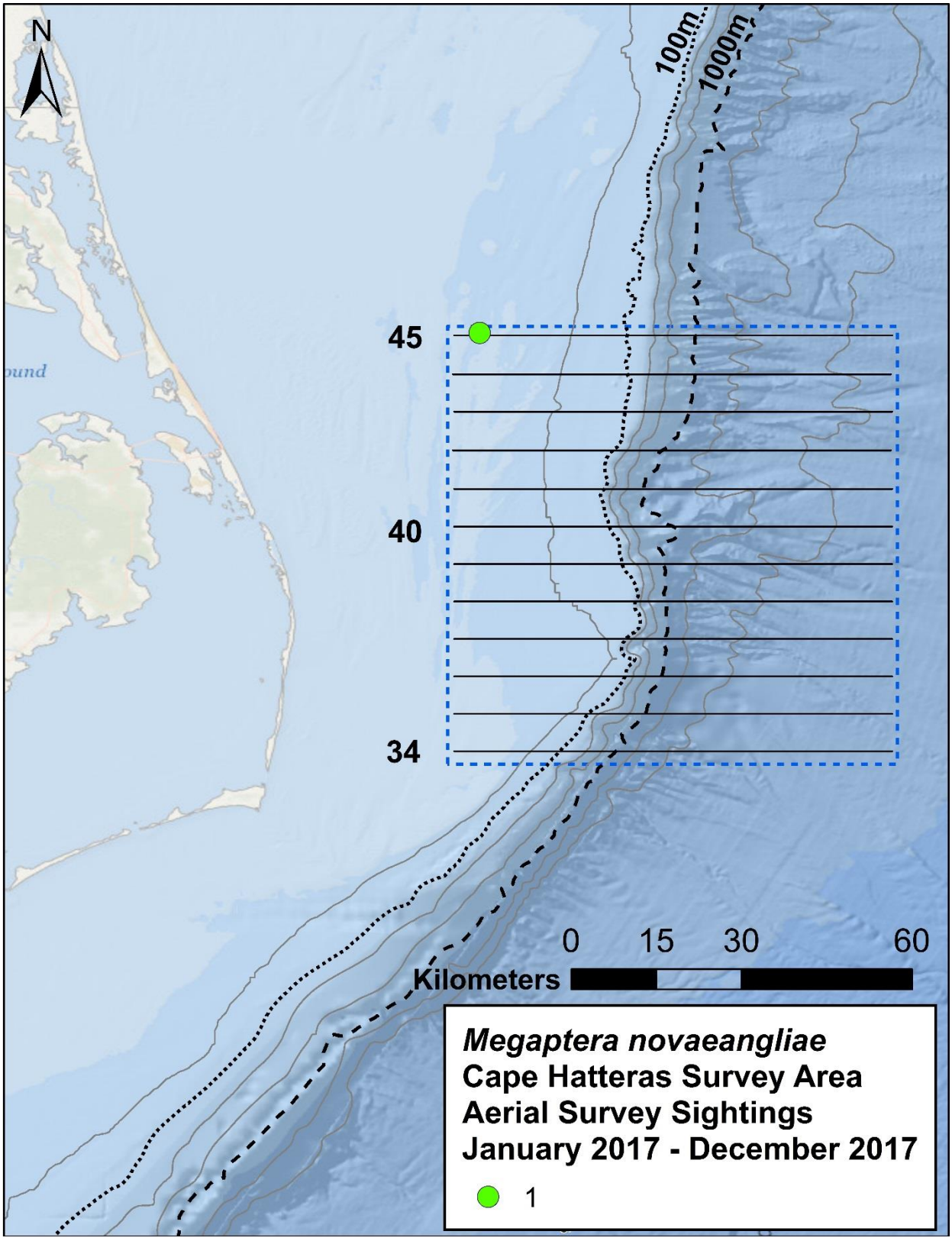

Figure 14. Humpback whale (*Megaptera novaeangliae*) sightings.

4.3.5 Mesoplodont beaked whale (*Mesoplodon* sp.)

One off-effort sighting of a pair of beaked whales were observed, which were determined not to be Cuvier's beaked whales, but could not be positively identified to species (**Table 13, Figure 15**). Since no species identification could be established, the sighting is listed here as *Mesoplodon* sp. This sighting occurred on the 1,000 m isobath.

Table 13. Unidentified Mesoplodon sightings in the Cape Hatteras survey area in 2017. Astricks denotes off-effort sighting.

Date	Time (zone?)	Waypoint	Latitude (N)	Longitude (W)	Track Number	BSS	Angle out	Degree Forward	Best #	Off Effort
22-Aug-2017	11:49:47	46	35.656075	74.623699	38	1	2	90°	2	*

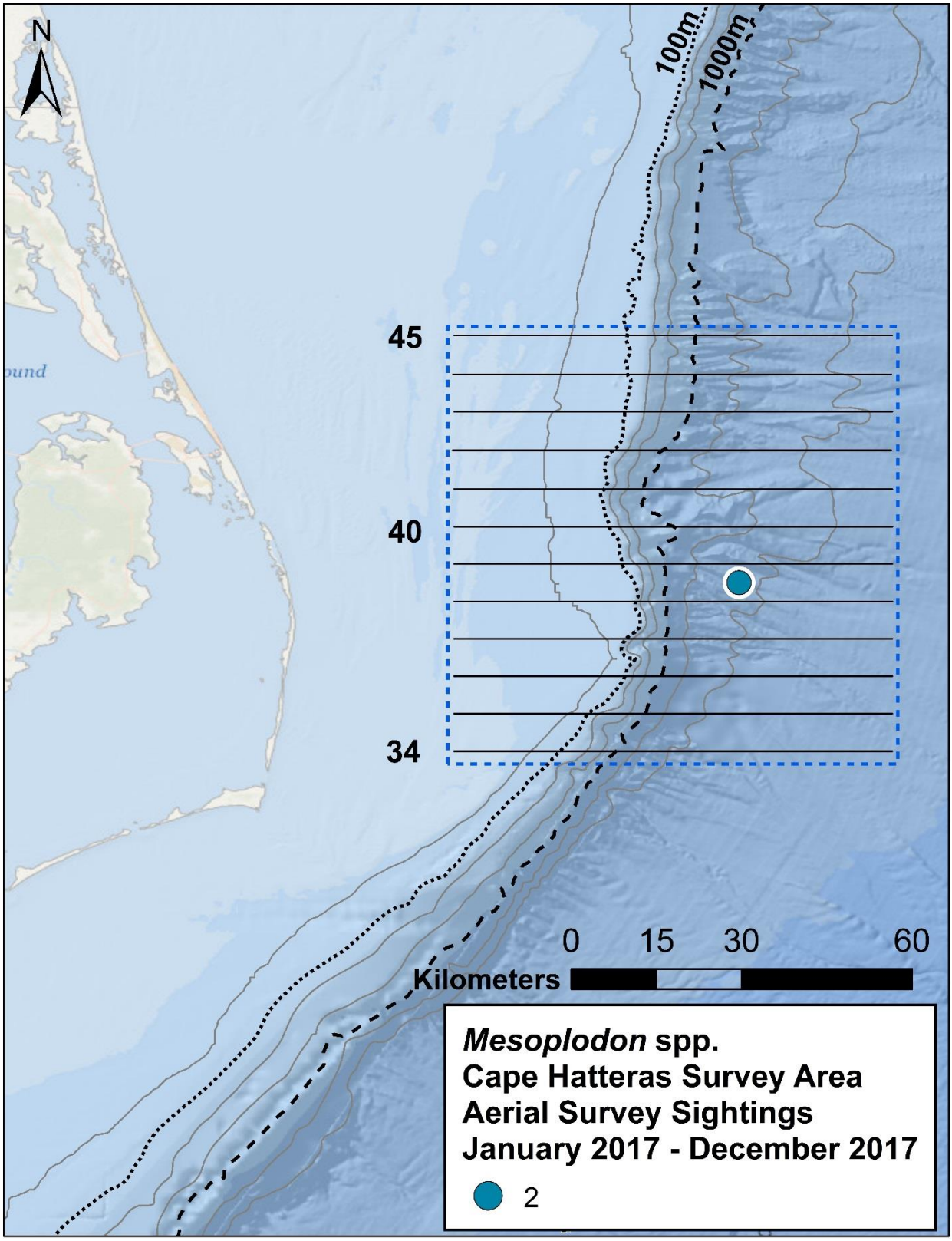

Figure 15. Unidentified *Mesoplodon* sighting. White outline denotes off-effort sighting.

4.4 Sea Turtles

There were 40 sightings totaling 49 individuals of 2 sea turtle species during the reporting period (see **Tables 14 and 15, Figures 17 and 18** in **Sections 4.4.1 and 4.4.2**, respectively). Sighting rates were negatively correlated with BSS, with rates sharply declining at BSS higher than 2 (**Figures 16a and b**). Sea turtles were recorded in all four months surveyed, with the highest sightings in July (**Figure 16c**). Loggerhead sea turtles represented the majority (96 percent) of total sea turtles sighted. The only other sea turtle species identified in the Cape Hatteras survey area was the leatherback sea turtle (4 percent of total sea turtles sighted).

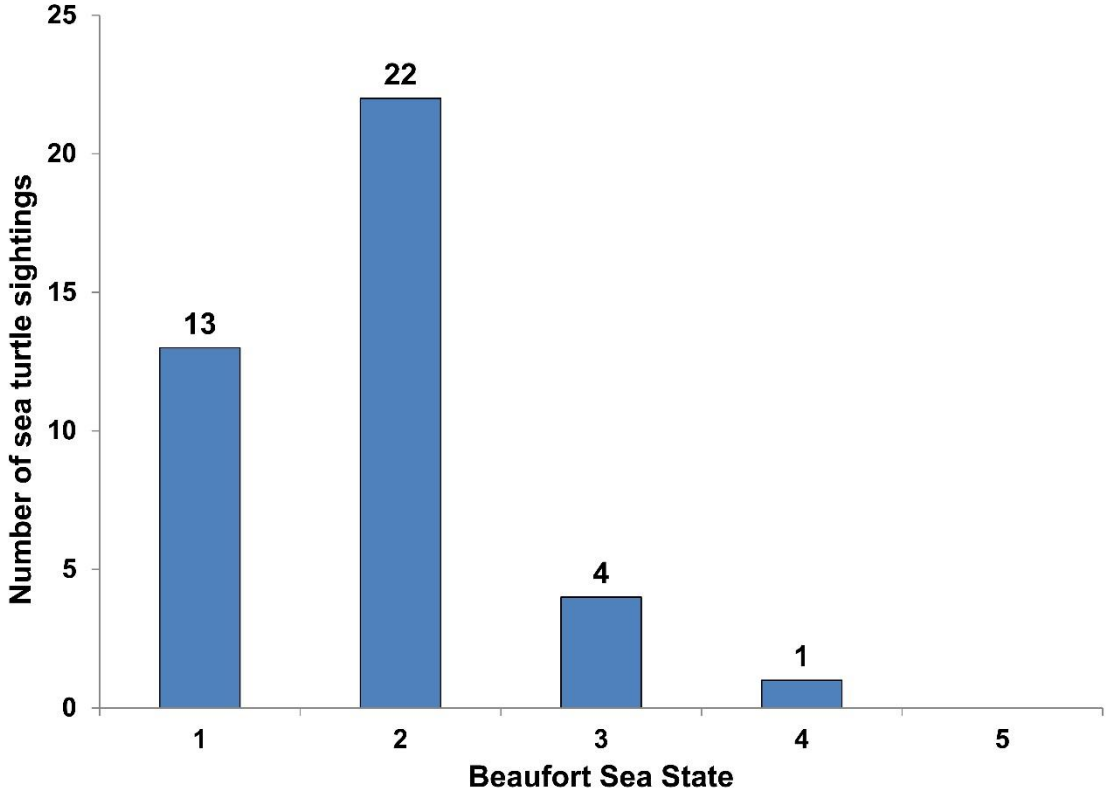

Figure 16a. Total number of sea turtle sightings by Beaufort sea state category in the Cape Hatteras survey area in 2017.

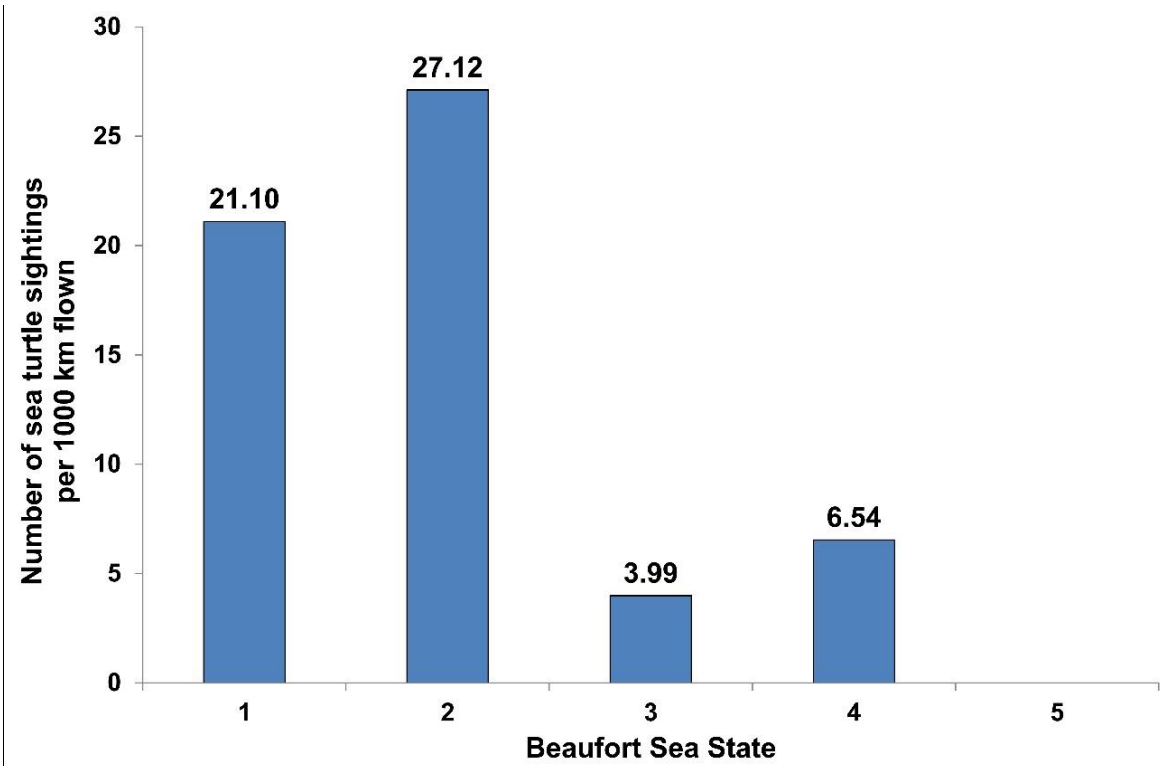

Figure 16b. Sea turtle sightings per 1,000 km flown by BSS category in the Cape Hatteras survey area in 2017.

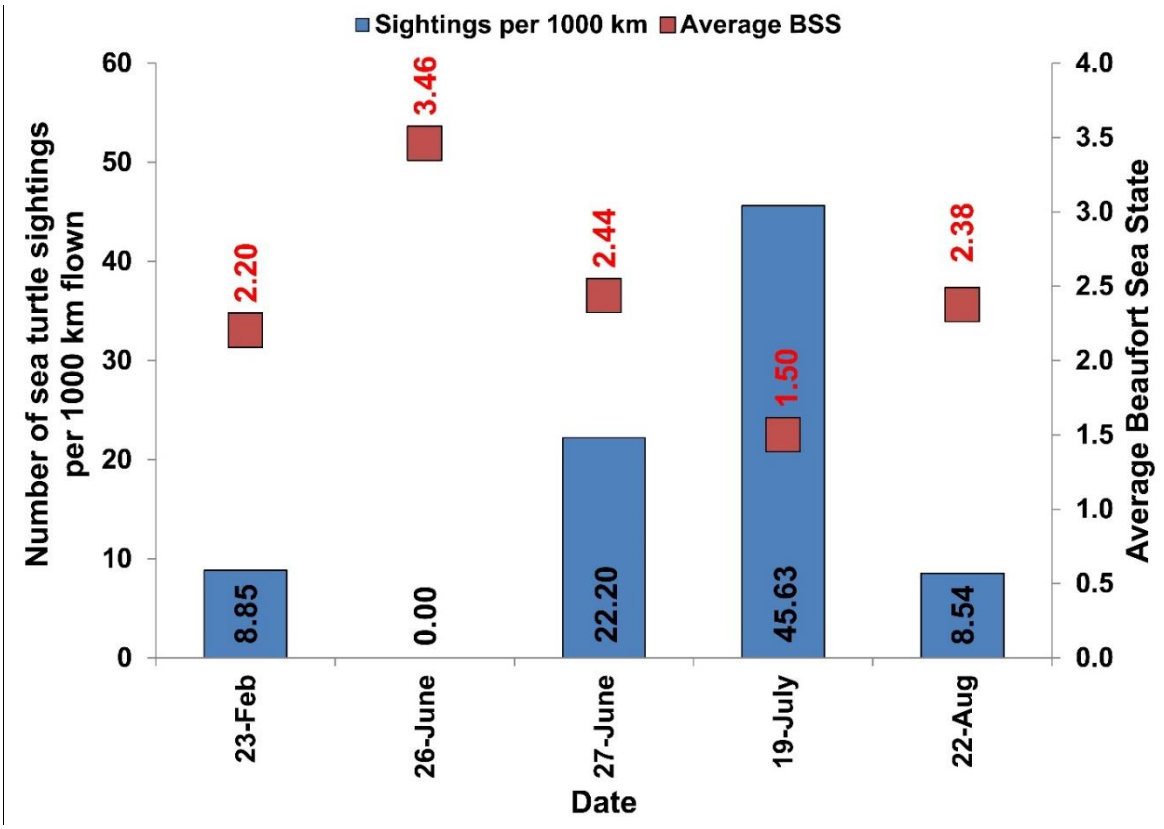

Figure 16c. Sea turtle sightings per 1,000 km surveyed and the average BSS per month in the Cape Hatteras survey area in 2017.

4.4.1 Loggerhead sea turtle (*Caretta caretta*)

Sightings of loggerhead sea turtles occurred in all surveyed months with a peak in July, for a total of 47 animals (**Table 14, Figure 17**). The vast majority of sightings were over the continental shelf and inshore of the 100 m isobath.

Table 14. Loggerhead sea turtle (*Caretta caretta)* sightings in the Cape Hatteras survey area in 2017.

Date	Time	Waypoint	Latitude (N)	Longitude (W)	Track Number	BSS	Angle out	Degree Forward	Best #
23-Feb-2017	13:57:17	56	35.620213	74.896245	38	3	2	90°	1
23-Feb-2017	14:41:05	100	35.758839	75.106650	40	2	1	90°	2
23-Feb-2017	14:52:34	105	35.758394	74.808494	40	3	1	90°	1
23-Feb-2017	15:35:07	118	35.825162	75.080923	41	2	1	60°	1
27-Jun-2017	8:53:47	3	35.827492	75.148317	41	1	2	90°	1
27-Jun-2017	8:55:16	4	35.827106	75.089573	41	1	1	90°	1
27-Jun-2017	8:55:37	3	35.827536	75.075921	41	1	1	90°	2
27-Jun-2017	8:57:05	4	35.827693	75.018879	41	1	1	90°	2
27-Jun-2017	10:08:58	49	35.756659	74.966898	40	2	1	90°	1
27-Jun-2017	10:11:03	29	35.756437	75.046981	40	2	1	90°	1
27-Jun-2017	10:29:30	57	35.689403	74.969368	39	2	2	90°	1
27-Jun-2017	11:17:02	43	35.618546	74.874581	38	3	1	90°	1
27-Jun-2017	13:29:39	80	35.552058	75.098098	37	1	2	90°	1
27-Jun-2017	14:38:11	65	35.475422	74.901454	36	2	1	90°	1
27-Jun-2017	14:41:49	66	35.474949	75.041347	36	2	1	90°	1
19-Jul-2017	9:09:25	3	36.120771	75.044592	45	2	2	90°	1
19-Jul-2017	9:09:38	3	36.120885	75.035904	45	2	2	90°	1
19-Jul-2017	9:11:31	4	36.121065	74.958014	45	2	3	90°	1
19-Jul-2017	10:24:15	25	36.041558	74.977268	44	2	2	90°	1
19-Jul-2017	10:25:03	41	36.041356	75.007713	44	2	2	90°	1
19-Jul-2017	10:25:21	26	36.041398	75.019707	44	2	1	90°	1
19-Jul-2017	10:34:13	30	35.974061	75.041339	43	2	2	90°	2
19-Jul-2017	10:34:57	44	35.974243	75.011533	43	2	1	90°	1
19-Jul-2017	11:48:24	82	35.903551	74.943751	42	2	1	90°	1
19-Jul-2017	11:50:37	51	35.903257	75.030676	42	2	2	90°	1
19-Jul-2017	11:51:04	52	35.903189	75.048109	42	2	2	90°	1
19-Jul-2017	11:53:49	53	35.902888	75.155495	42	2	3	90°	2
19-Jul-2017	13:56:39	87	35.827139	75.123631	41	1	1	90°	2
19-Jul-2017	13:57:04	58	35.827551	75.107612	41	2	2	90°	1
19-Jul-2017	13:57:52	59	35.827401	75.075107	41	2	2	90°	2
19-Jul-2017	13:58:06	88	35.827586	75.065676	41	1	1	90°	1
19-Jul-2017	13:59:25	60	35.827579	75.011318	41	2	2	90°	2
19-Jul-2017	15:05:57	79	35.756620	74.969091	40	1	2	90°	1
19-Jul-2017	15:08:10	80	35.756507	75.056928	40	1	2	90°	1
19-Jul-2017	15:18:08	123	35.689430	74.963937	39	1	1	90°	2
22-Aug-2017	10:49:35	16	35.483275	74.862291	36	1	1	90°	1
22-Aug-2017	10:53:14	17	35.479835	75.008474	36	1	1	90°	1
22-Aug-2017	16:38:05	109	35.907338	75.063842	42	4	1	90°	1

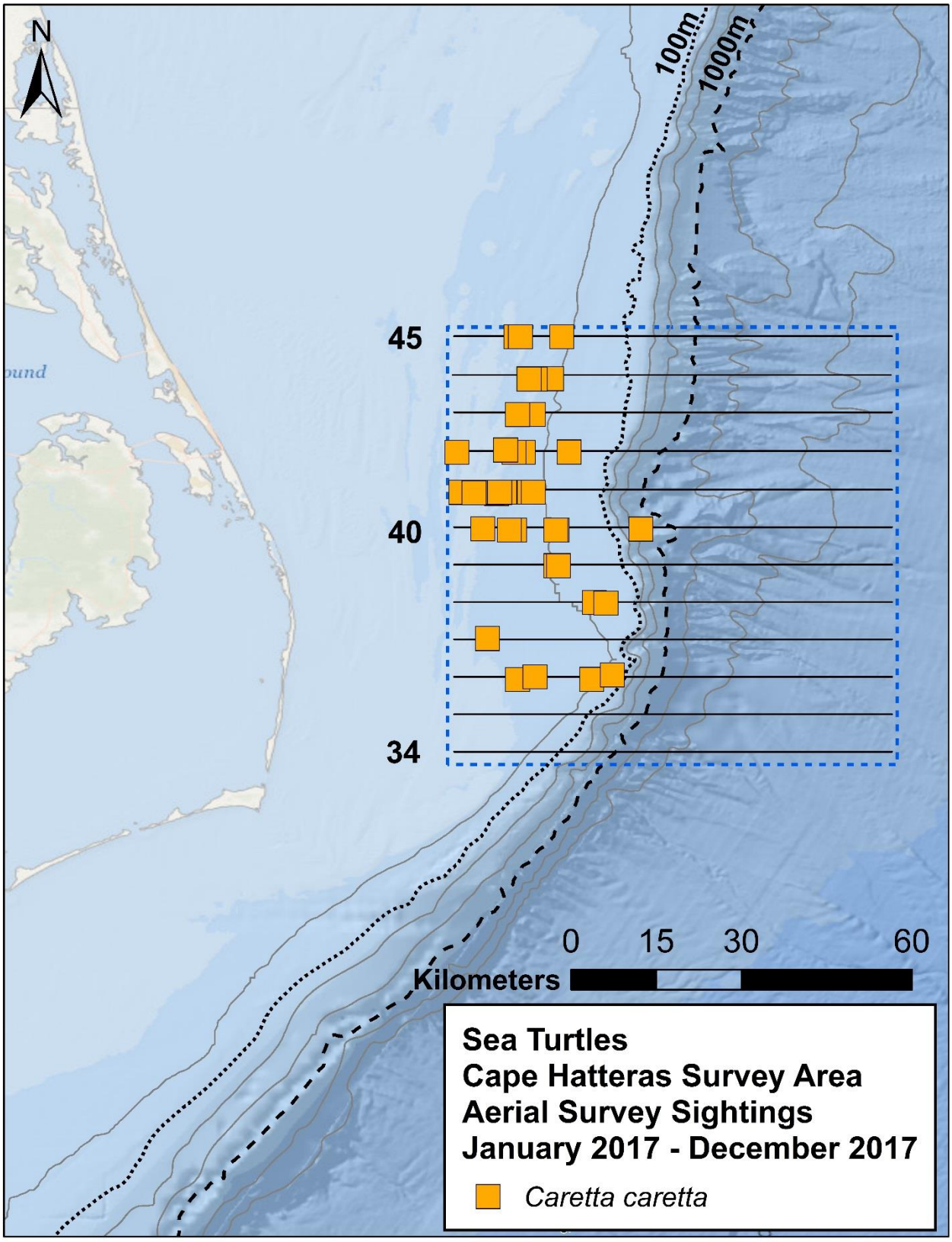

Figure 17. Loggerhead sea turtle (*Caretta caretta*) sightings.

4.4.1 Leatherback sea turtle (*Dermochelys coriacea*)

Two sightings of lone leatherback sea turtles were observed from the inshore of the 100 m isobaths (**Table 15, Figure 18**).

Table 15. Leatherback sea turtle (*Dermochelys coriacea)* sightings in the Cape Hatteras survey area in 2017.

Date	Time	Waypoint	Latitude (N)	Longitude (W)	Track Number	BSS	Angle out	Degree Forward	Best #	
22-Aug-2017	10:56:10	18	35.479607	75.126775	36	1	1	90°	1	
22-Aug-2017	14:30:22	69	35.689844	74.854061	39	3	1	90°	1	

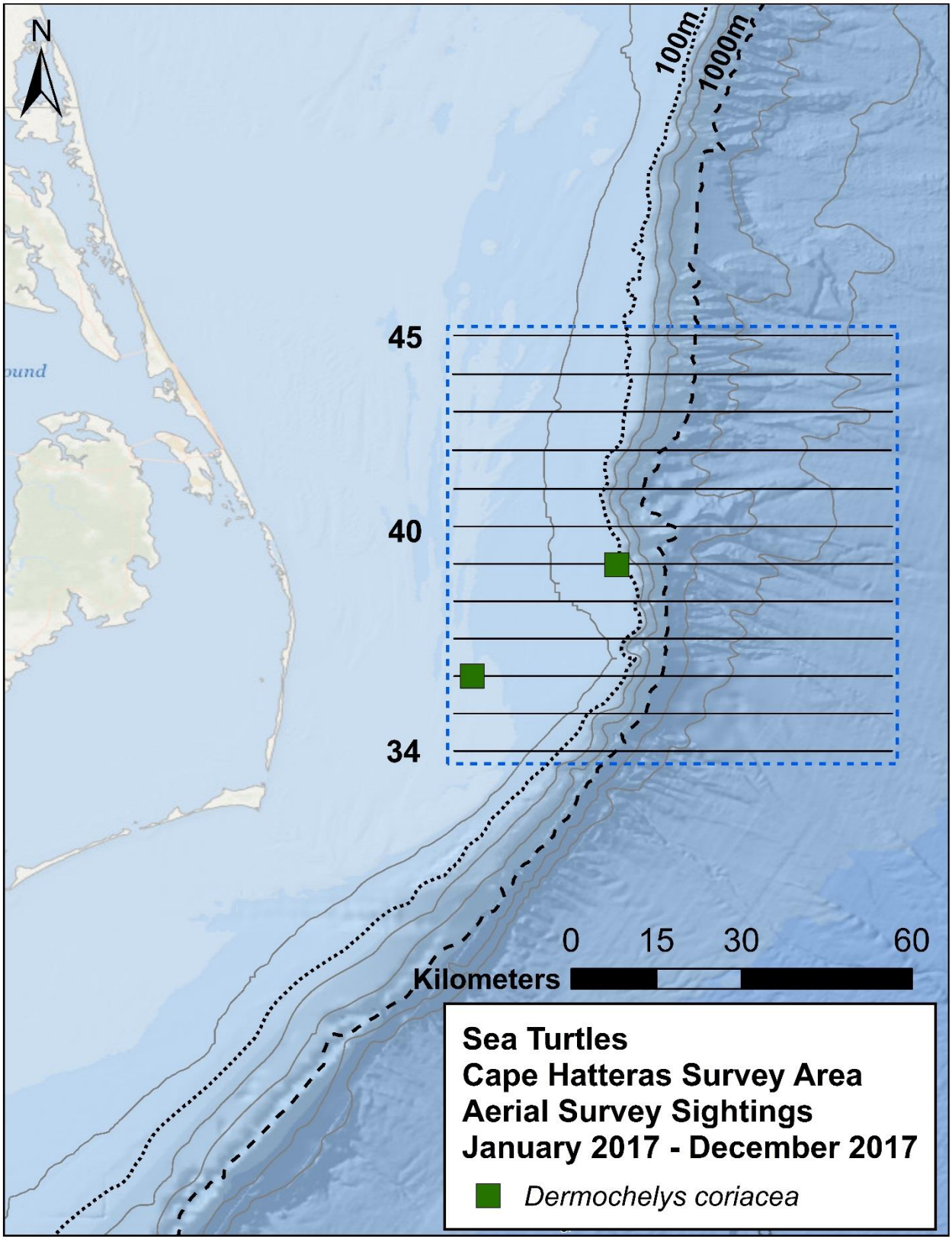

Figure 18. Leatherback sea turtle (*Dermochelys coriacea)* sightings.

4.5 Other Marine Vertebrate Sightings

4.5.1 Chondrichthyan fishes

Two hundred and thirty-six unidentified sharks were recorded during the reporting period inshore of the 100 m isobath. Manta rays, basking sharks, and a spotted eagle ray were also documented. All sightings are represented in **Table 16 and Figure 19**.

Table 16. Chondrichthyan fish sightings in the Cape Hatteras survey area in 2017.

Date	Time	Waypoint	Latitude (N)	Longitude (W)	Track Number	BSS	Angle out	Degree Forward	Best #	Comments
23-Feb-2017	10:44:20	44	35.973886	75.006674	43	2	2	90°	1	Basking shark
23-Feb-2017	11:52:35	49	35.909472	74.816980	42	1	1	90°	1	Basking shark
23-Feb-2017	13:58:36	90	35.620578	74.847782	38	3	1	90°	3	Hammerheads
23-Feb-2017	14:27:22	93	35.687724	74.796584	39	3	2	100°	1	Manta ray
23-Feb-2017	14:30:06	94	35.687109	74.902994	39	3	1	100°	6	
23-Feb-2017	14:30:18	60	35.686941	74.911723	39	3	2	90°	7	
23-Feb-2017	14:31:00	95	35.686900	74.937689	39	3	2	100°	19	
19-Jul-2017	14:01:48	61	35.827684	74.912181	41	2	1	90°	1	Hammerhead
26-Jun-2017	10:44:59	30	36.120126	74.767569	45	3	1	90°	1	Manta ray
27-Jun-2017	10:32:58	59	35.689358	74.837396	39	3	3	90°	1	Manta ray
19-Jul-2017	14:59:37	77	35.756917	74.861575	40	1	2	90°	200	
19-Jul-2017	15:28:38	128	35.689602	74.676979	39	1	1	90°	1	Manta ray
22-Aug-2017	11:03:14	29	35.553086	75.010603	37	1	2	90°	1	Spotted eagle ray
22-Aug-2017	15:12:56	56	35.765152	-74.696733	40	3	2	90°	1	Manta ray

4.5.2 Other fishes

Eight ocean sunfish were recorded, with the majority occurring in February. (**Table 17, Figure 19**).

Table 17. Ocean sunfish (*Mola mola)* sightings in the Cape Hatteras survey area in 2017.

Date	Time	Waypoint	Latitude (N)	Longitude (W)	Track Number	BSS	Angle out	Degree Forward	Best #
23-Feb-2017	9:27:25	5	36.121520	74.953257	45	2	3	90°	1
23-Feb-2017	10:11:11	32	36.042614	74.651429	44	2	1	90°	1
23-Feb-2017	10:43:17	43	35.967138	75.045679	43	2	1	90°	1
23-Feb-2017	10:54:24	46	35.974900	74.796708	43	1	2	90°	1
23-Feb-2017	11:14:59	60	35.975223	74.452215	43	2	1	100°	1
23-Feb-2017	11:52:14	80	35.908803	74.799756	42	2	1	90°	1
27-Jun-2017	11:23:43	74	35.617774	75.124641	38	2	1	90°	1
19-Jul-2017	10:26:46	27	36.041234	75.073948	44	2	1	90°	1

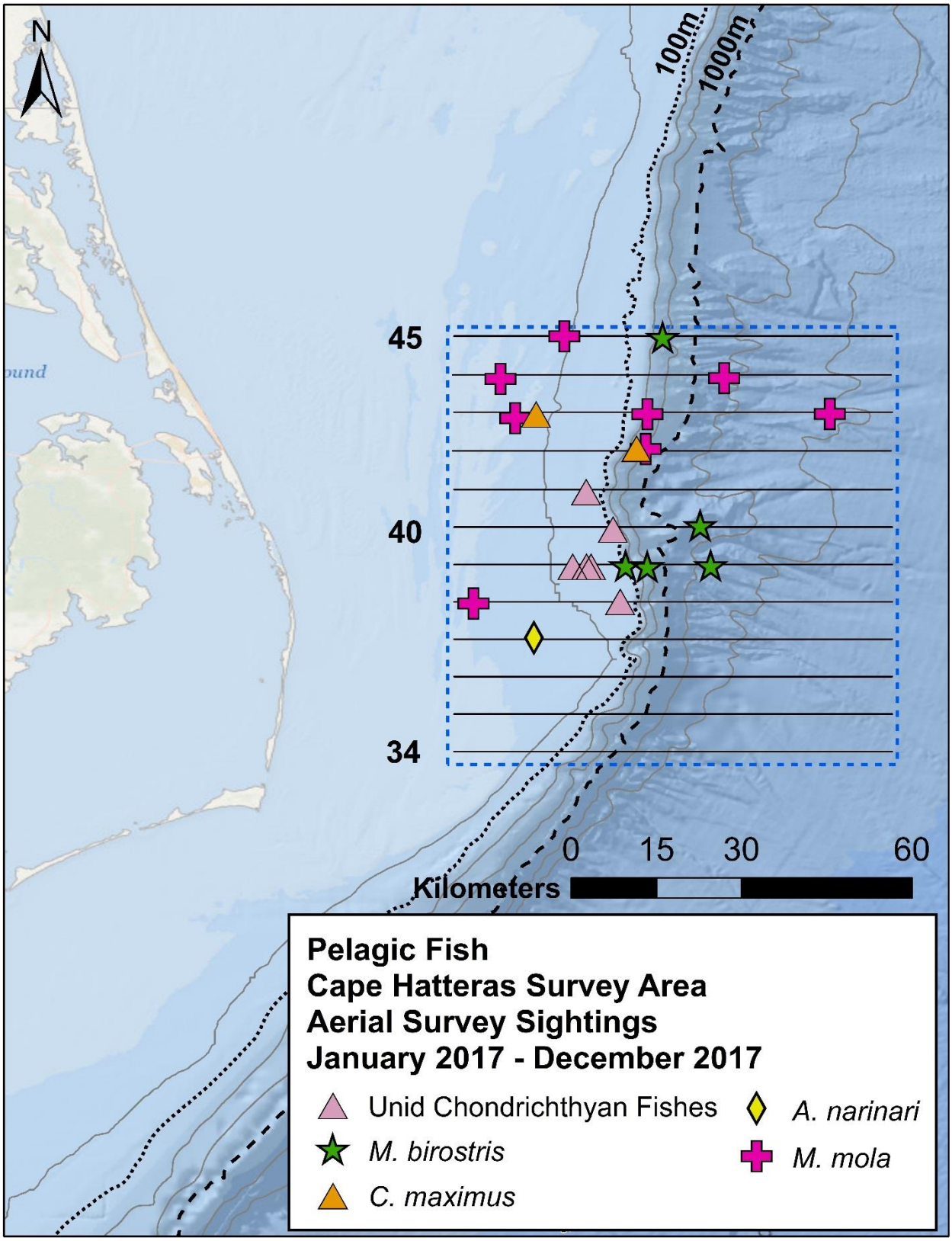

Figure 19. Unidentified chondrichthyan fish, manta ray (*Manta birostris*), basking shark (*Cetorhinus maximus*), spotted eagle ray (*Aetobatus narinari*), and ocean sunfish (*Mola mola*) sightings.

4.6 Vessel Sightings

4.6.1 Commercial

Eight commercial vessels (e.g., car carrier, fishing and cargo vessels) were observed in the survey area (**Table 18, Figure 20**).

Table 18. Commercial vessel sightings in the Cape Hatteras survey area in 2017.

Date	Time	Waypoint	Latitude (N)	Longitude (W)	Track Number	BSS	Angle out	Degree Forward	Best #	Comments
23-Feb-2017	10:10:35	18	36.042569	74.629340	44	2	2	90°	1	Cargo vessel
23-Feb-2017	10:12:30	20	36.042650	74.700323	44	3	1	90°	1	Cargo vessel
23-Feb-2017	14:23:55	59	35.687703	74.658420	39	3	3	60°	1	Cargo vessel
23-Feb-2017	14:34:10	96	35.686602	75.063173	39	3	1	45°	1	Commercial fishing vessel
23-Feb-2017	14:34:56	97	35.686224	75.093506	39	3	3	45°	1	Car carrier
26-Jun-2017	9:30:43	9	35.904166	74.424723	42	4	3	90°	1	Cargo vessel
27-Jun-2017	13:33:32	81	35.550838	74.952550	37	1	1	90°	1	Cargo vessel
22-Aug-2017	14:52:57	78	35.763127	74.378845	40	3	1	90°	1	Cargo vessel

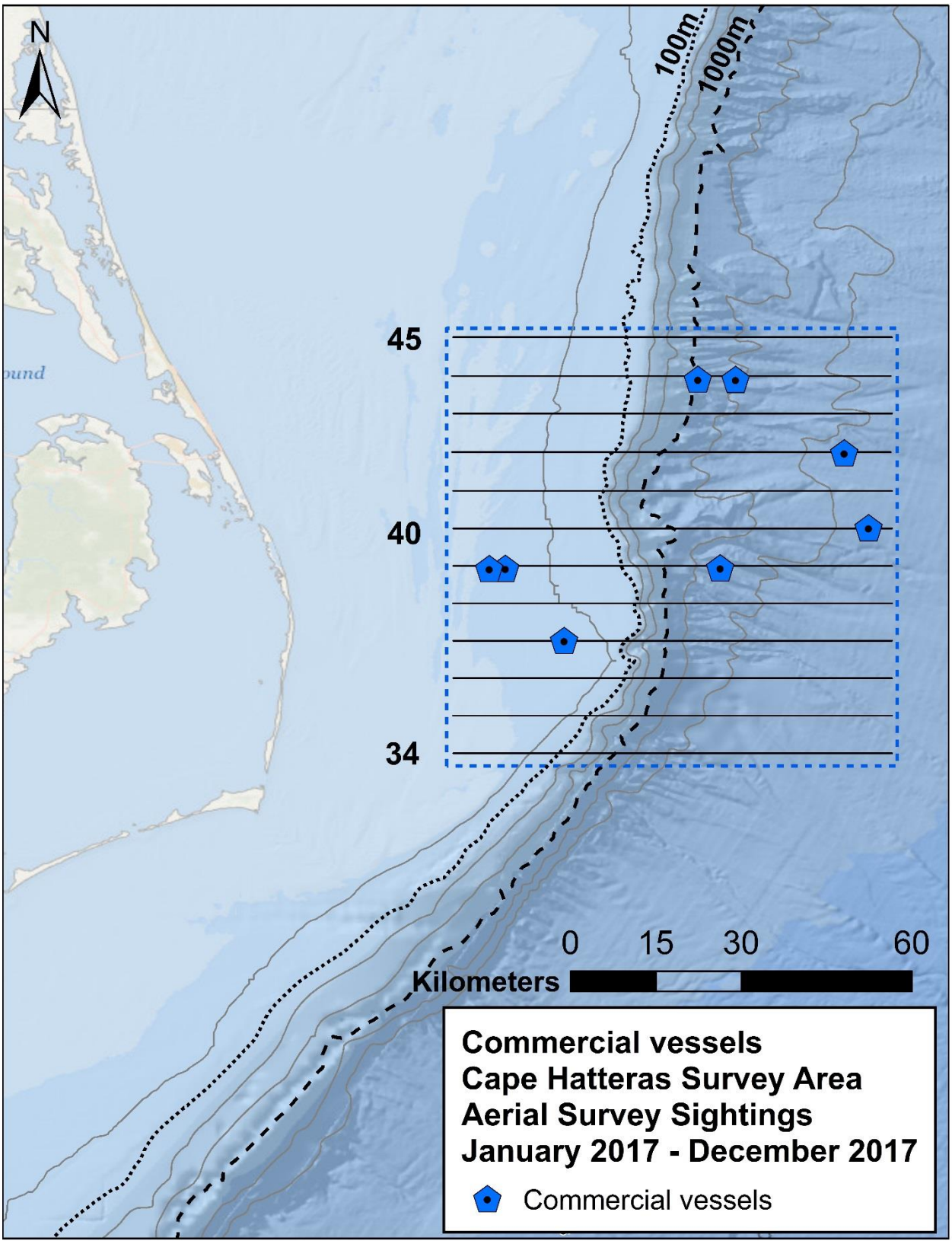

Figure 20. Commercial vessel sightings.

4.6.2 Military Vessels

Nine military vessels were observed at the survey area (**Table 19, Figure 21**).

Table 19. Military vessel sightings in the Cape Hatteras survey area in 2017.

Date	Time	Waypoint	Latitude (N)	Longitude (W)	Track Number	BSS	Angle out	Degree Forward	Best #	Comments
23-Feb-2017	9:37:31	9	36.121765	-74.644100	45	3	2	90°	2	Military vessel - exchange
23-Feb-2017	10:10:12	30	36.042452	-74.615404	44	3	3	60°	1	Military
23-Feb-2017	10:13:01	21	36.042880	-74.720166	44	3	1	90°	1	Military
23-Feb-2017	15:14:24	69	35.827599	-74.601570	41	3	1	90°	3	Military vessel - exchange
19-Jul-2017	14:02:23	89	35.827866	-74.887623	41	1	2	45°	1	Military
19-Jul-2017	14:56:48	76	35.756850	-74.752550	40	1	2	60°	1	Navy flat deck

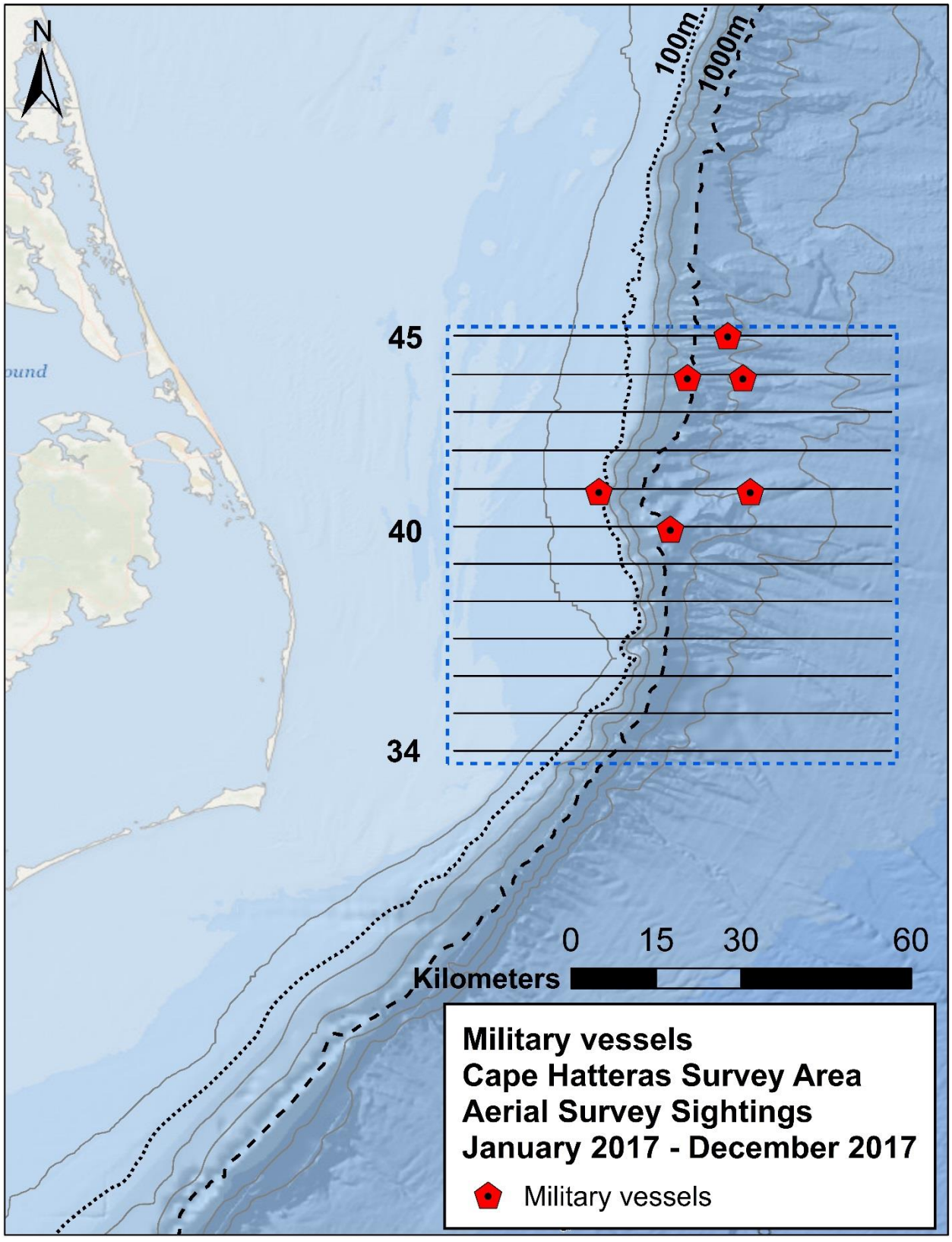

Figure 21. Military vessel sightings.

4.6.3 Other Vessels

A total of 75 other vessels was recorded in the survey area (**Table 20, Figure 22**). With the exception of one yacht, all vessel sightings were categorized as recreational sport-fishing vessels (Rec. F/V).

Table 20. Other vessel sightings in the Cape Hatteras survey area in 2017.

Date	Time	Waypoint	Latitude (N)	Longitude (W)	Track Number	BSS	Angle out	Degree Forward	Best #	Comments
23-Feb-2017	14:41:46	101	35.758931	75.082453	40	2	3	90°	1	Rec. F/V
23-Feb-2017	14:47:05	63	35.758163	74.891189	40	2	2	60°	1	Rec. F/V
23-Feb-2017	14:48:22	102	35.759371	74.840836	40	2	3	45°	1	Rec. F/V
23-Feb-2017	14:53:03	106	35.758285	74.788277	40	3	2	90°	18	Rec. F/Vs
23-Feb-2017	14:53:09	66	35.758347	74.782933	40	3	1	90°	2	Rec. F/Vs
26-Jun-2017	9:06:11	4	35.904518	74.806774	42	3	3	90°	3	Rec. F/Vs
27-Jun-2017	9:00:35	5	35.827935	74.883359	41	1	4	45°	1	Rec. F/V
27-Jun-2017	9:08:23	8	35.822092	74.812120	41	2	3	90°	3	Rec. F/Vs
27-Jun-2017	10:04:36	46	35.757689	74.801546	40	3	2	90°	2	Rec. F/Vs
27-Jun-2017	10:05:43	28	35.756920	74.844500	40	2	2	90°	2	Rec. F/Vs
27-Jun-2017	10:05:52	47	35.756818	74.849957	40	3	2	90°	1	Rec. F/V
27-Jun-2017	10:33:28	34	35.689463	74.818442	39	2	3	90°	10	Rec. F/Vs
27-Jun-2017	10:33:51	60	35.689716	74.804119	39	3	2	90°	1	Rec. F/V
27-Jun-2017	10:43:48	65	35.689089	74.747624	39	3	1	90°	1	Rec. F/V
27-Jun-2017	13:36:25	49	35.551646	74.841668	37	1	2	90°	6	Rec. F/Vs
27-Jun-2017	14:35:29	108	35.475819	74.801361	36	3	2	60°	5	Rec. F/Vs
27-Jun-2017	14:36:01	64	35.476895	74.821427	36	2	1	90°	6	Rec. F/Vs
19-Jul-2017	9:12:30	4	36.121159	74.917883	45	2	1	90°	1	Rec. F/V
19-Jul-2017	9:15:39	5	36.121260	74.789980	45	2	1	90°	1	Rec. F/V
19-Jul-2017	10:12:43	36	36.041487	74.735347	44	2	3	45°	1	Rec. F/V
19-Jul-2017	14:10:36	94	35.834210	74.633711	41	1	1	90°	1	Yacht
19-Jul-2017	15:10:20	120	35.756086	75.142695	40	1	4	40°	4	Rec. F/Vs
19-Jul-2017	16:25:25	103	35.618098	75.062638	38	1	2	90°	1	Rec. F/V
22-Aug-2017	14:24:24	66	35.690303	75.061178	39	3	1	90°	2	Rec. F/Vs

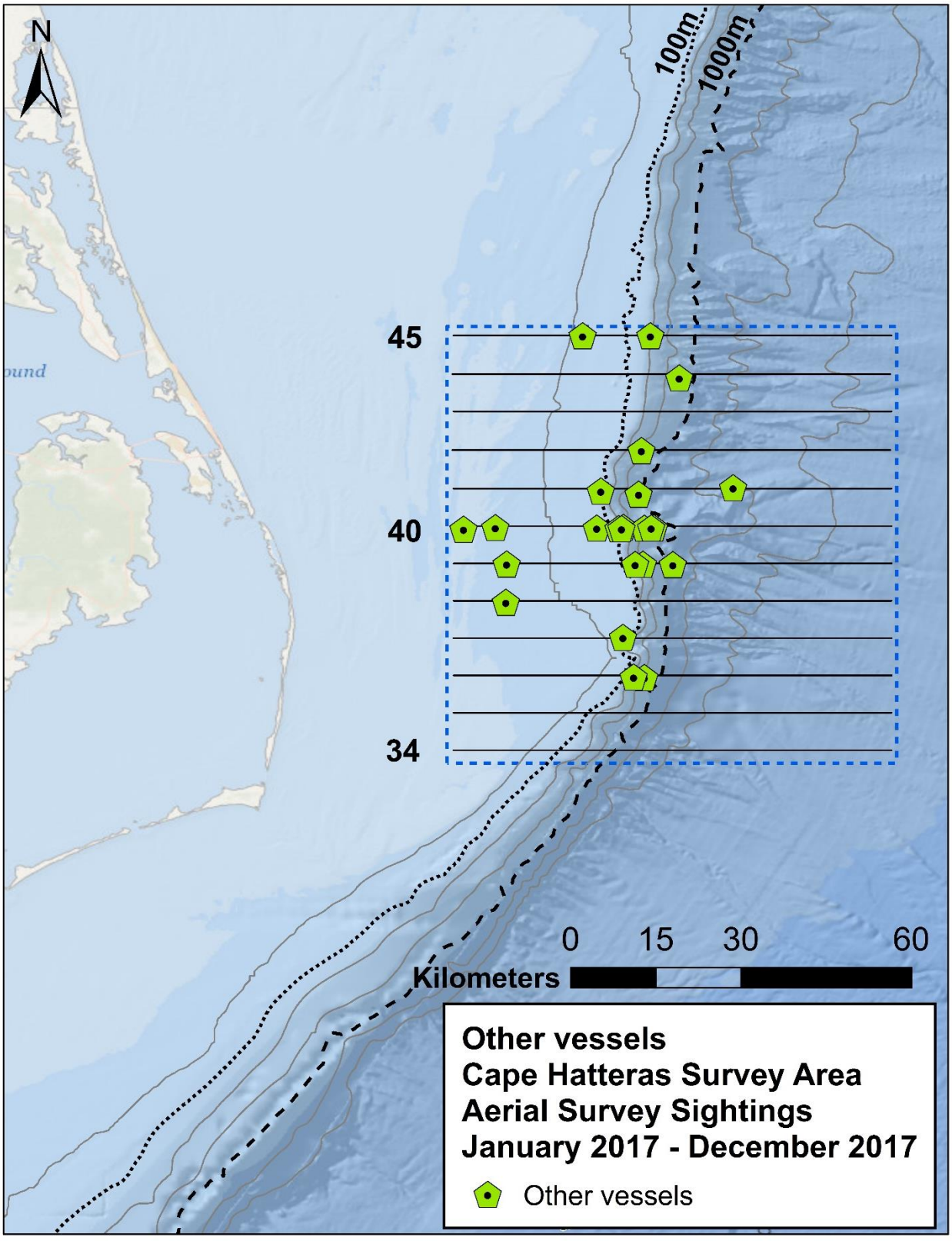

Figure 22. Other vessel sightings.

5. Acknowledgements

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A

Aerial Survey Data Sheet

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AERIAL SURVEY DATA SHEET

Appendix A

Date:_____ **Observer Side:**_____ **GPS#:**_____ **Page__ of___**

Pilot/Co-Pilot_____ **Observers Left/Right:**_____ **Hobbs:**_____

Time	Waypoint #	Event	Heading	Track #	Observer R / L	Visibility	BSS	Cloud	Glare L	Glare R	Vertical Angle	Horizontal degree	Sighting Cue	Species	Reliability	Min #	Max #	Best Est	Comments

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B

Event Codes and Species List

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Codes for Variables on USWTR Aerial Survey Data Sheet

Date: Month, Day, Year

Track#: opportunistic track line=99

Event:

1.1 = On effort/on track
1.2 = Off effort

3.1 = Change in environmental conditions

10.0 = Opportunistic sighting(s)
PF = Preflight
XB = Cross Beach
WU = Wheels Up
WD = Wheels Down
TE = Transit Leg on Effort

2.0 = Sighting-breaking track/off effort (real time)
2.3 = Vessel sighting

2.4 = Sighting of marine mammal (real location)
2.41 = Location of Sighting Cue, No Animals sighted
2.42 = Break from sighting

2.7 = Sighting of sea turtle (real location)
2.8 = Sighting of large vessel (Military, commercial, etc.)
2.9 = Unidentified sighting, requires comments

Confidence of cue
1 = definite
2 = probable
3 = possible/unsure

Beaufort Sea State:
0 = slick, calm, mirror-like
1 = small waves
2 = whitecaps 0-33%, waves 1-2 feet
3 = whitecaps 33-50%, waves 2-3 feet
4 = whitecaps 50-65%, waves 3-5 feet
5 = whitecaps >65%, waves >5 feet
6 = too rough too survey

Cloud Cover:
01 = clear
02 = partly cloudy
03 = continuous layer of clouds
04 = rain
05 = haze
99 = other, requires comments

Glare
0 = No glare
1 = 0-25 %
2 = 25 -50 %
3 = >50%

Visibility:
1 = clear to horizon
2 = half the distance to the horizon
3 = less than half the distance to the horizon

Sighting Cues:
1 = Blow
2 = Splash
3 = Body Part
4 = Breach
5 = Other (needs comments)

Vertical Angle is given in rough increments of 20 degrees with 1 being directly on the trackline and 4 being anything outside of survey wide to horizon

Horizontal Angle is given assuming the nose of the plane is 0 degrees and directly off the wing is 90 degrees – measurements are taken from 1-180 on each side of the plane.

Species List for Aerial Surveys		
Common Name	**Scientific Name**	**Species Code**
Cetaceans		
North Atlantic right whale	*Eubalaena glacialis*	Egl
Minke whale	*Balaenoptera acutorostrata*	Bac
sei whale	*Balaenoptera borealis*	Bbo
fin whale	*Balaenoptera physalus*	Bph
Brydes whale	*Balaenoptera edeni*	Bed
humpback whale	*Megaptera novaeangliae*	Mno
unidentified balaenopterid	Family *Balaenopteridae*	BALA
sperm whale	*Physeter macrocephalus*	Pma
pygmy sperm whale	*Kogia breviceps*	Kbr
dwarf sperm whale	*Kogia sima*	Ksi
unidentified Kogia	*Kogia* spp.	KOGI
Northern bottlenose whale	*Hyperoodon ampullatus*	Ham
Cuvier's beaked whale	*Ziphius cavirostris*	Zca
Mesoplodon beaked whale	Genus *Mesoplodon*	MESO
unidentified beaked whale	Family *Ziphiidae*	ZIPH
harbor porpoise	*Phocoena phocoena*	Pph
killer whale	*Orcinus orca*	Oor
melon-headed whale	*Peponocephala electra*	Pel
pygmy killer whale	*Feresa attenuata*	Fat
false killer whale	*Pseudorca crassidens*	Pcr
Risso's dolphin	*Grampus griseus*	Ggr
long-finned pilot whale	*Globicephala melas*	Gme
short-finned pilot whale	*Globicephala macrorhynchus*	Gma
unidentified pilot whale	Genus *Globicephala*	GLOB
rough-toothed dolphin	*Steno bredanensis*	Sbr
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	Lac
Fraser's dolphin	*Lagenodelphis hosei*	Lho
common dolphin	*Delphinus delphis*	Dde
bottlenose dolphin	*Tursiops truncatus*	Ttr
spotted dolphin	*Stenella frontalis*	Sfr
striped dolphin	*Stenella coeruleoalba*	Sco
spinner dolphin	*Stenella longirostris*	Scl
unidentified *Stenella*	Genus *Stenella*	STEN
unidentified delphinid	Family *Delphinidae*	DELP
unidentified cetacean		CETA
Pinnipeds		
gray seal	*Halichoerus grypus*	Hgr
harbor seal	*Phoca vitulina*	Pvi
harp seal	*Phoca groenlandica*	Pgr
hooded seal	*Cystophora cristata*	Ccr
unidentified phocid	Family *Phocidae*	PHOC
Sea Turtles		
loggerhead	*Caretta caretta*	Cca
leatherback	*Dermochelys coriacea*	Dco
green	*Chelonia mydas*	Cmy
Kemp's ridley	*Lepidochelys kempii*	Lke
hawksbill	*Eretmochelys imbricata*	Eim
unidentified sea turtle		TURT
Other interesting sightings		
ocean sunfish	*Mola mola*	Mmo
basking shark	*Cetorhinus maximus*	Cma
whale shark	*Rhincodon typus*	Rty
manta ray	*Manta birostris*	Mbi
cownose rays	*Rhinoptera bonasus*	Rbo