Final

Odontocete Tagging in the Virginia Capes Operating Area

Cape Hatteras, NC:

January 2014 – December 2014

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Cover Photo Credit:

Cuvier's beaked whale (*Ziphius cavirostris*) off Cape Hatteras. Photographed by Danielle Waples, Duke University, taken under NOAA Scientific Permit No. 14809 (Douglas Nowacek) and NOAA General Authorization Letter of Confirmation 16185 held by Duke University.

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Acronyms and Abbreviations

F/V	Fishing Vessel
hr	hour(s)
m	meter(s)
NOAA	National Oceanic and Atmospheric Administration
R/V	Research Vessel
SERDP	Strategic Environmental Research and Development Project
U.S.	United States
VHF	Very High Frequency

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. The program began in 2007, with baseline aerial and vessel surveys and a passive acoustic monitoring program in Onslow Bay, North Carolina, and has since expanded to include study areas off Jacksonville, Florida, and Cape Hatteras, North Carolina. Off Cape Hatteras, four years of surveys have provided information on the complex patterns of distribution and diversity of the marine mammals and sea turtles in this highly productive area. The current report builds on this past body of work and describes activities conducted during both the Deep Divers and Satellite Tagging projects conducted off Cape Hatteras between January and December 2014. This constitutes the second year of the Deep Divers project, which focuses on the distribution and ecology of several deep-diving odontocete species, including: beaked whale (Cuvier's beaked whale: *Ziphius cavirostris* and *Mesoplodon* spp.); short-finned pilot whale (*Globicephala macrorhynchus*); and sperm whale (*Physeter macrocephalus*). To achieve a more robust picture of the medium-term movement patterns of these and other odontocete cetaceans in the Cape Hatteras survey area, we began a satellite tagging project during the reporting period. Satellite tagging effort and associated sightings are presented here; preliminary analyses of movement data are available in a separate report generated by the Cascadia Research Collective (see Baird *et al*. 2015). All survey effort in the Cape Hatteras study site this year was dedicated to Deep Divers and Satellite Tagging projects, so we also report ongoing photographic identification work for this area in this report.

2. Methods

2.1 Field Effort

Observers concentrated fieldwork along the shelf break off Cape Hatteras, North Carolina, where previous vessel and aerial surveys demonstrated consistently high densities of deep-diving odontocete species. When conditions permitted, they extended surveys into deeper, pelagic waters beyond the shelf break. This year observers focused field effort in deploying digital acoustic tags (DTag) and satellite tags on several odontocete species.

The observers conducted fieldwork from the Research Vessel (R/V) *Richard T. Barber* from May through October 2014 (**Figure 1**). Observers conducted one additional survey in the Cape Hatteras study area as part of Duke University's Strategic Environmental Research and Development Project (SERDP); sighting and photo-identification data from this project is included in this report.

During these surveys, researchers made observations with naked eye and 7 × 50 binoculars. Two observers (one port and one starboard) scanned constantly from straight ahead to 90 degrees abeam either side of the track. They closed on all sightings of cetaceans, with the exception of bottlenose dolphins (*Tursiops truncatus*), which were extremely abundant in the study area, and not a focal species. Observers recorded the location, size and behavior of each

Figure 1. The R/V *R.T. Barber*.

group. They recorded sea turtles in passing mode, noting the location and species identity of each sighting. They also recorded weather conditions, sea state, depth and sea surface temperature at each sighting and whenever sighting conditions changed. All data were recorded on an iPad tablet linked to a GPS unit.

Whenever possible, observers obtained photographs of odontocete cetaceans for individual photo-identification; observers also used these photographs to confirm species identification at each sighting. They took photographs with Canon or Nikon digital SLR cameras (equipped with 100-400 millimeter zoom lenses) in 24-bit color at a resolution of 3072 × 2048 pixels saved in .jpg format. They also employed remote biopsy sampling methods to collect small skin and blubber samples using a variety of 27- to 68-kilogram pull crossbows, depending on the species and sampling distance. Biopsy samples were collected with specialized 2.5-centimeter stainless-steel biopsy tips attached to a modified bolt, typically fired from the bow of the survey vessel.

Observers selected well-marked animals in discrete groups of whales as focal animals for DTagging; they did not tag whales in groups that included neonates. Prior to tagging the focal animal, observers obtained photographs of all individuals in the group. They tagged each focal whale with a Version 2 DTag (Johnson and Tyack 2003), programmed to remain on the whale for four hours (hr). The DTag is a small, lightweight tag that is attached to whales with four silicon suction cups using a carbon-fiber pole. The DTag is equipped with a pressure sensor, three-axis magnetometer and accelerometers that measure depth, heading, pitch, and roll. The

tag contains two hydrophones that record stereo sound continuously at a sampling rate of 192 kilohertz. The tag is also equipped with a very high frequency (VHF) transmitter that allows observers to track tagged animals at the surface and facilitates re-location of the tag when it is released from the whale. Data are archived on the tag and later downloaded through an infrared port for calibration and analysis. We are able to control the length of tag deployments by programming the release mechanism prior to attachment.

Please refer to Cascadia Research Collective's report (Baird *et al.* 2015) for details of satellite tagging methods.

2.2 Data Analysis

Observers compiled and mapped all vessel survey effort and sighting data using *ArcGIS* 10.2. All sighting data from January 2014 through December 2014 will be contributed to Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations (http://seamap.env.duke.edu/).

2.3 Data Storage

All acoustic, visual survey and photographic data were archived on digital media and backed up on a Duke University network server.

3. Results

3.1 Field Effort

Observers conducted fieldwork on 20 days between May and October 2014. Eleven days were dedicated to the Satellite Tagging project, eight days to the Deep Diver project, and one day to SERDP (**Table 1**). On 16 June 2014, we used two survey vessels – the *R/V R.T. Barber* and the R/V *Exocetus*. In addition, two field days under the Deep Diver project were used attempting to recover a lost DTag.

In total, this fieldwork yielded 921.9 kilometers and 121.7 hr of effort (**Table 1**). We encountered seven species of cetaceans, including 47 sightings of deep-diving odontocetes: short-finned pilot whale (*n*=26), Cuvier's beaked whale (*n*=16), unidentified beaked whales (*n*=3), and two sperm whales. Other sightings included: bottlenose dolphin (*n*=14); Risso's dolphin (*Grampus griseus, n*=1); common dolphin (*Delphinus delphis, n*=4); and Atlantic spotted dolphin (*Stenella frontalis, n*=3); (**Tables 2 and 3**, **Figures 2 through 11**).

Table 1. Effort details for fieldwork in the Cape Hatteras survey area, January 2014 - December 2014.

Date	Sea State	Km Surveyed	Survey Time (hr:min)	At-Sea Time	Project	Platform
12-May-14	2-4	51.8	5:50	9:54	Deep Diver	R/V *R.T. Barber*
13-May-14	2-4	69.7	6:00	10:54	Sat Tagging	R/V *R.T. Barber*
14-May-14	2-3	50.7	5:58	10:18	Sat Tagging	R/V *R.T. Barber*
18-May-14	3-4	59.4	8:19	12:03	Sat Tagging	R/V *R.T. Barber*
26-May-14	2-3	64.8	9:43	14:31	Deep Diver	R/V *R.T. Barber*
27-May-14	4-6+	na	na	8:35	Deep Diver	F/V *Samanna*
29-May-14	5-6+	na	na	8:27	Deep Diver	F/V *Goin' Deep*
7-Jun-14	4	81.5	6:24	11:35	Sat Tagging	R/V *R.T. Barber*
8-Jun-14	0-3	59.1	8:57	12:49	Sat Tagging	R/V *R.T. Barber*
9-Jun-14	3-4	17.2	3:03	8:49	Sat Tagging	R/V *R.T. Barber*
11-Jun-14	2-3	71.5	8:12	11:23	Sat Tagging	R/V *R.T. Barber*
12-Jun-14	2-3	29.8	2:41	7:51	Sat Tagging	R/V *R.T. Barber*
16-Jun-14	1-3	26.4	6:03	11:24	SERDP	R/V *R.T. Barber*
16-Jun-14	1-3	22.9	6:00	11:44	SERDP	R/V *Exocetus*
5-Sep-14	1-3	42.7	5:35	11:07	Deep Diver	R/V *R.T. Barber*
6-Sep-14	3-4	4.5	0:36	5:56	Deep Diver	R/V *R.T. Barber*
11-Sep-14	2-4	52.6	8:01	12:35	Sat Tagging	R/V *R.T. Barber*
13-Sep-14	2-3	50.4	8:01	12:21	Sat Tagging	R/V *R.T. Barber*
16-Sep-14	2-3	57.9	7:45	11:55	Sat Tagging	R/V *R.T. Barber*
6-Oct-14	2	53.6	6:28	11:44	Deep Diver	R/V *R.T. Barber*
7-Oct-14	1-3	55.4	8:03	11:39	Deep Diver	R/V *R.T. Barber*

1 **Table 2. Cetacean sightings observed during fieldwork in the Cape Hatteras survey area, January 2014 - December 2014.**

Date	Time	Latitude	Longitude	Species	Common Name	Group Size	Biopsy Samples	Photo-id images
12-May-14	11:01	35.59116	-74.73872	Unidentified beaked whale		2	0	0
12-May-14	11:20	35.60357	-74.72858	*T. truncatus*	Bottlenose dolphin	200	0	15
12-May-14	12:28	35.62372	-74.73367	*T. truncatus*	Bottlenose dolphin	30	0	50
12-May-14	14:27	35.54945	-74.77359	*Z. cavirostris*	Cuvier's beaked whale	5	0	38
12-May-14	15:26	35.52957	-74.76985	*T. truncatus*	Bottlenose dolphin	6	0	0
13-May-14	10:46	35.54767	-74.78008	*Z. cavirostris*	Cuvier's beaked whale	5	0	22
13-May-14	11:20	35.55651	-74.78113	*T. truncatus*	Bottlenose dolphin	30	0	0
13-May-14	14:54	35.55829	-74.76699	*Z. cavirostris*	Cuvier's beaked whale	3	0	64
13-May-14	16:53	35.62568	-74.78351	*D. delphis*	Common dolphin	330	0	0
13-May-14	16:53	35.62671	-74.78573	*G. macrorhynchus*	Short-finned pilot whale	50	0	40
14-May-14	11:43	35.55371	-74.74841	*T. truncatus*	Bottlenose dolphin	100	0	0
14-May-14	12:23	35.62180	-74.75832	*D. delphis*	Common dolphin	80	0	0
14-May-14	12:24	35.62328	-74.75671	*G. macrorhynchus*	Short-finned pilot whale	23	0	35
14-May-14	13:08	35.63886	-74.74450	*G. macrorhynchus*	Short-finned pilot whale	36	0	180
14-May-14	14:23	35.64682	-74.73279	*Z. cavirostris*	Cuvier's beaked whale	3	0	27
18-May-14	8:38	35.63683	-74.79276	*T. truncatus*	Bottlenose dolphin	32	2	168
18-May-14	12:21	35.64184	-74.77729	*D. delphis*	Common dolphin	160	0	24
18-May-14	12:53	35.66312	-74.77458	*G. macrorhynchus*	Short-finned pilot whale	32	0	94
18-May-14	13:56	35.64798	-74.75583	*Z. cavirostris*	Cuvier's beaked whale	4	0	52
26-May-14	11:13	35.53861	-74.74104	Unidentified beaked whale		1	0	0
26-May-14	12:03	35.55892	-74.72311	*Z. cavirostris*	Cuvier's beaked whale	2	0	33
7-Jun-14	11:30	35.76685	-74.80752	*G. macrorhynchus*	Short-finned pilot whale	18	1	72
7-Jun-14	12:41	35.79627	-74.83556	*G. griseus*	Risso's dolphin	5	0	30
7-Jun-14	13:58	35.76530	-74.85012	*G. macrorhynchus*	Short-finned pilot whale	15	0	37
8-Jun-14	9:10	35.57088	-74.73828	*Z. cavirostris*	Cuvier's beaked whale	3	0	0
8-Jun-14	10:00	35.57151	-74.73761	*S. frontalis*	Atlantic spotted dolphin	5	0	0
8-Jun-14	10:02	35.57151	-74.73761	*T. truncatus*	Bottlenose dolphin	50	0	0

Date	Time	Latitude	Longitude	Species	Common Name	Group Size	Biopsy Samples	Photo-id images
8-Jun-14	10:48	35.58174	-74.75351	*G. macrorhynchus*	Short-finned pilot whale	45	0	428
8-Jun-14	12:21	35.58100	-74.74966	*Z. cavirostris*	Cuvier's beaked whale	2	0	6
8-Jun-14	13:59	35.59377	-74.74282	*Z. cavirostris*	Cuvier's beaked whale	4	0	27
8-Jun-14	16:25	35.65514	-74.74079	*G. macrorhynchus*	Short-finned pilot whale	16	0	9
11-Jun-14	8:25	35.71867	-74.78342	*G. macrorhynchus*	Short-finned pilot whale	3	0	20
11-Jun-14	9:36	35.72656	-74.76433	*G. macrorhynchus*	Short-finned pilot whale	15	0	128
11-Jun-14	11:35	35.76019	-74.75061	*S. frontalis*	Atlantic spotted dolphin	65	1	17
11-Jun-14	12:27	35.69999	-74.77590	*T. truncatus*	Bottlenose dolphin	35	0	58
11-Jun-14	13:14	35.73506	-74.81474	*G. macrorhynchus*	Short-finned pilot whale	35	0	79
11-Jun-14	15:49	35.68758	-74.72805	*T. truncatus*	Bottlenose dolphin	40	0	131
12-Jun-14	12:23	35.60637	-74.86647	*D. delphis*	Common dolphin	100	0	227
16-Jun-14	9:19	35.58753	-74.76094	*G. macrorhynchus*	Short-finned pilot whale	100	1	229
16-Jun-14	9:41	35.59122	-74.74673	*T. truncatus*	Bottlenose dolphin	20	0	15
16-Jun-14	10:39	35.61459	-74.75171	*G. macrorhynchus*	Short-finned pilot whale	15	0	69
16-Jun-14	14:03	35.69443	-74.75064	*P. macrocephalus*	Sperm whale	1	1	16
5-Sep-14	11:07	35.56297	-74.69931	*Z. cavirostris*	Cuvier's beaked whale	5	0	2
5-Sep-14	13:05	35.56911	-74.70836	*Z. cavirostris*	Cuvier's beaked whale	4	0	0
5-Sep-14	13:44	35.58351	-74.72105	*Z. cavirostris*	Cuvier's beaked whale	4	0	15
11-Sep-14	8:50	35.57351	-74.78069	Unidentified beaked whale		1	0	0
11-Sep-14	9:28	35.57474	-74.77264	*G. macrorhynchus*	Short-finned pilot whale	15	0	197
11-Sep-14	14:01	35.59576	-74.72007	*G. macrorhynchus*	Short-finned pilot whale	30	1	227
13-Sep-14	7:53	35.71957	-75.27885	*S. frontalis*	Atlantic spotted dolphin	7	1	5
13-Sep-14	9:10	35.56453	-74.80343	*T. truncatus*	Bottlenose dolphin	22	0	40
13-Sep-14	10:02	35.55764	-74.79040	*G. macrorhynchus*	Short-finned pilot whale	20	0	16
13-Sep-14	11:33	35.59670	-74.77691	*G. macrorhynchus*	Short-finned pilot whale	14	0	80
13-Sep-14	12:44	35.65430	-74.77475	*G. macrorhynchus*	Short-finned pilot whale	28	0	108
13-Sep-14	14:12	35.66947	-74.71622	*T. truncatus*	Bottlenose dolphin	18	0	63
13-Sep-14	14:59	35.67565	-74.68077	*P. macrocephalus*	Sperm whale	1	0	0

Date	Time	Latitude	Longitude	Species	Common Name	Group Size	Biopsy Samples	Photo-id images
13-Sep-14	15:07	35.67447	-74.68127	*Z. cavirostris*	Cuvier's beaked whale	3	0	34
13-Sep-14	16:44	35.67266	-74.68819	*Z. cavirostris*	Cuvier's beaked whale	2	0	25
16-Sep-14	8:37	35.56291	-74.80389	*T. truncatus*	Bottlenose dolphin	14	0	91
16-Sep-14	10:37	35.68557	-74.67459	*G. macrorhynchus*	Short-finned pilot whale	55	0	0
16-Sep-14	11:05	35.69535	-74.67203	*T. truncatus*	Bottlenose dolphin	40	0	0
16-Sep-14	11:43	35.68261	-74.71589	*Z. cavirostris*	Cuvier's beaked whale	6	0	303
6-Oct-14	9:52	35.60676	-74.78033	*G. macrorhynchus*	Short-finned pilot whale	25	0	0
6-Oct-14	12:21	35.65323	-74.76073	*G. macrorhynchus*	Short-finned pilot whale	15	1	46
7-Oct-14	10:48	35.61944	-74.75355	*G. macrorhynchus*	Short-finned pilot whale	18	0	50
7-Oct-14	12:24	35.65289	-74.75574	*G. macrorhynchus*	Short-finned pilot whale	8	1	100
7-Oct-14	16:04	35.63518	-74.72124	*G. macrorhynchus*	Short-finned pilot whale	20	0	0
7-Oct-14	16:18	35.61273	-74.72856	*G. macrorhynchus*	Short-finned pilot whale	5	0	0
7-Oct-14	16:38	35.61746	-74.75900	*Z. cavirostris*	Cuvier's beaked whale	4	0	64
7-Oct-14	17:16	35.62865	-74.76073	*G. macrorhynchus*	Short-finned pilot whale	1	0	5

Table 3. Number of cetacean sightings and mean group sizes (± 1 sd) for each species observed during fieldwork in the Cape Hatteras survey area, January 2009 – December 2014. Note that we did not systematically record all groups of bottlenose dolphins in 2014.

Species	Sightings					Mean Group Size
	2009	2011	2012	2013	2014	
Balaenoptera physalus	0	0	1	2	0	2.3±1.2
Delphinus delphis	0	6	11	3	4	164.6±187.4
Globicephala macrorhynchus	9	33	52	35	26	34.2±69.3
Grampus griseus	1	2	2	0	1	9.8±12.2
Mesoplodon spp.	0	0	0	1	0	1.0±0.0
Physeter macrocephalus	0	1	4	3	2	1.6±0.8
Stenella frontalis	0	8	2	3	3	55.6±71.4
Stenella/Delphinus mix	0	1	0	0	0	85.0±0.0
Tursiops truncatus	23	27	54	38	14	20.1±28.6
Tursiops/Stenella mix	0	1	0	0	0	100.0±0.0
Ziphius cavirostris	0	3	1	2	16	3.4±1.3
Unidentified beaked whale	0	0	0	4	3	1.9±1.5
Unidentified delphinid	1	0	3	1	0	4.3±2.6
Total:	**34**	**82**	**130**	**92**	**69**	

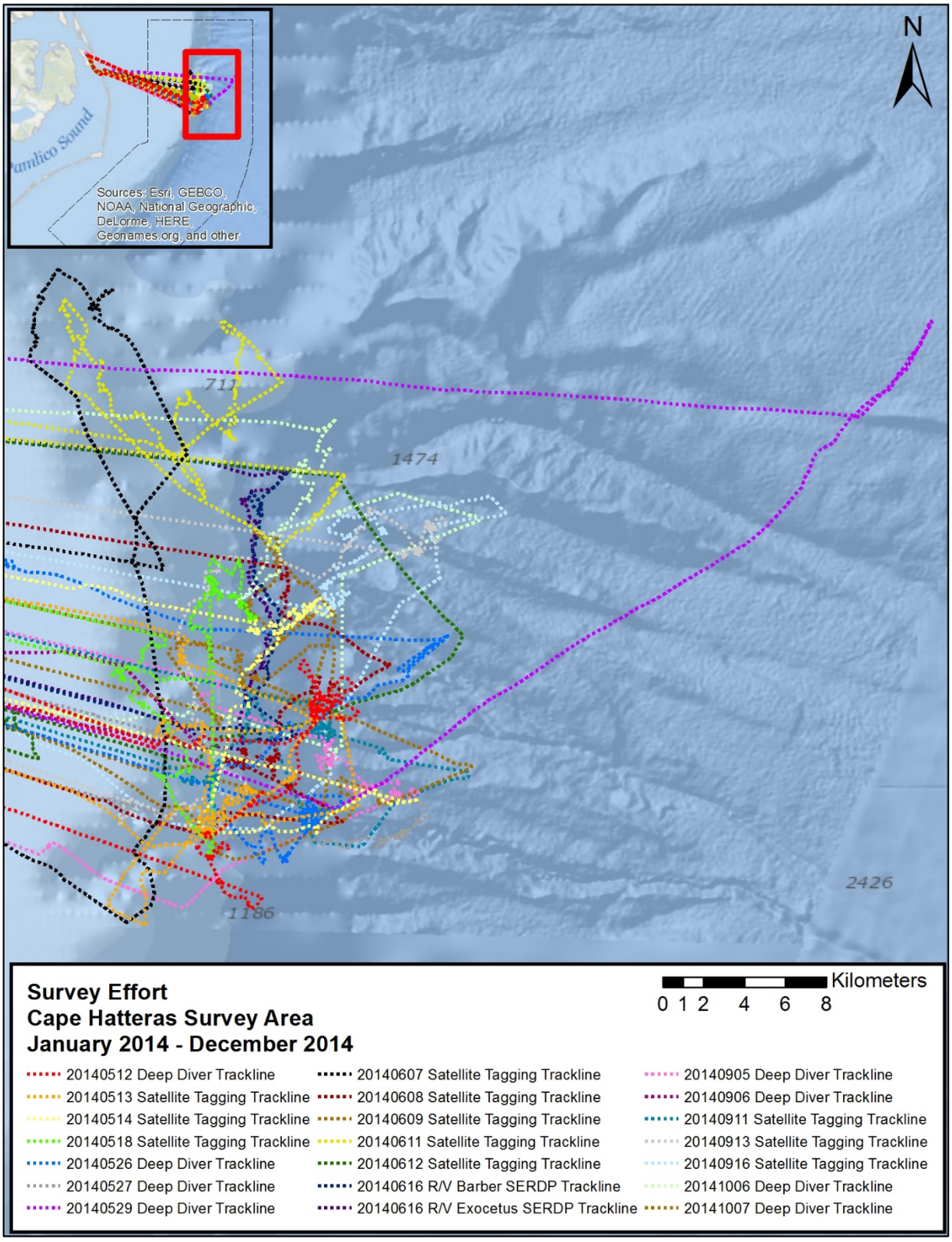

Figure 2. Field effort in the Cape Hatteras survey area, January 2014 – December 2014.

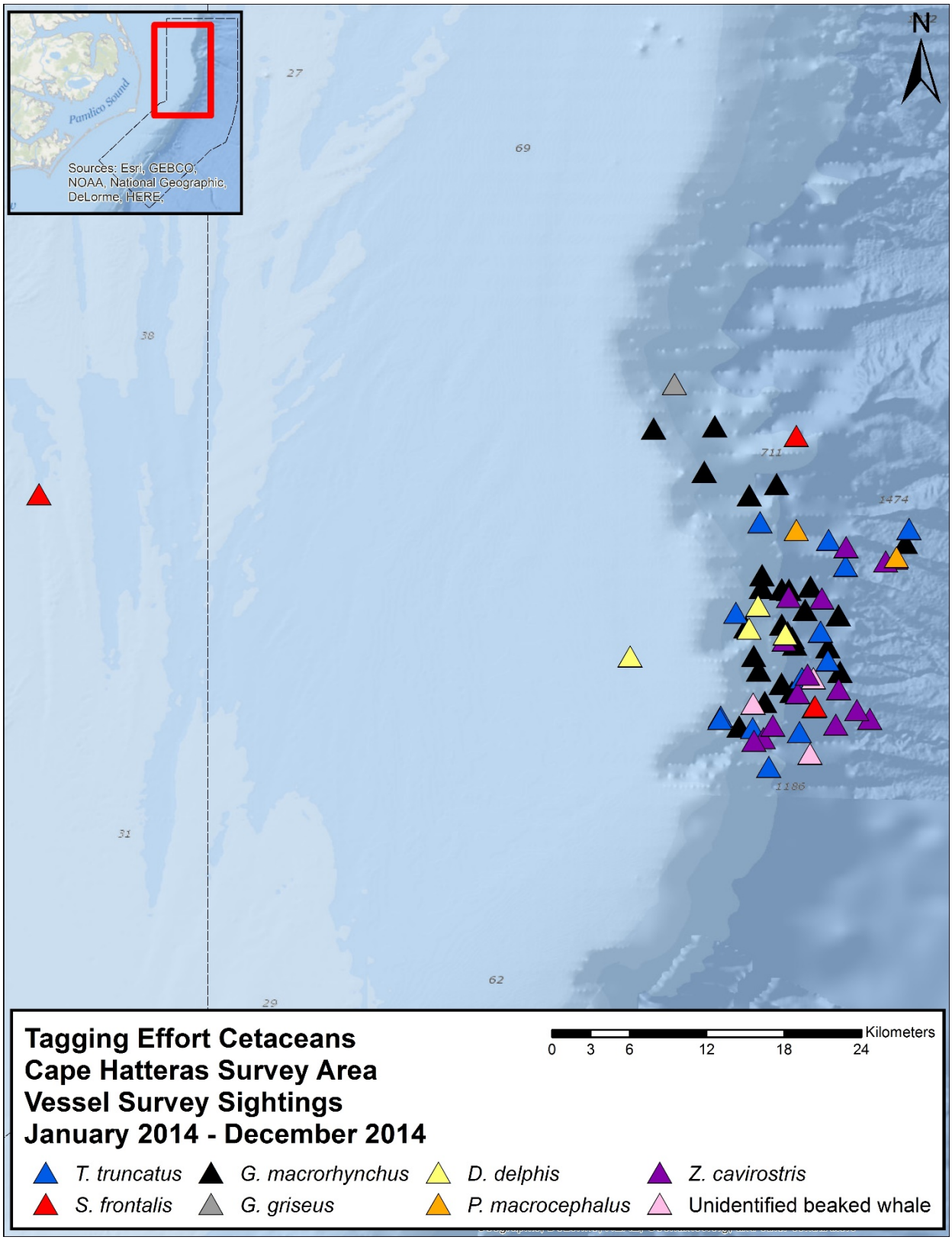

Figure 3. Distribution of all cetacean sightings observed during fieldwork in the Cape Hatteras survey area, January 2014 – December 2014.

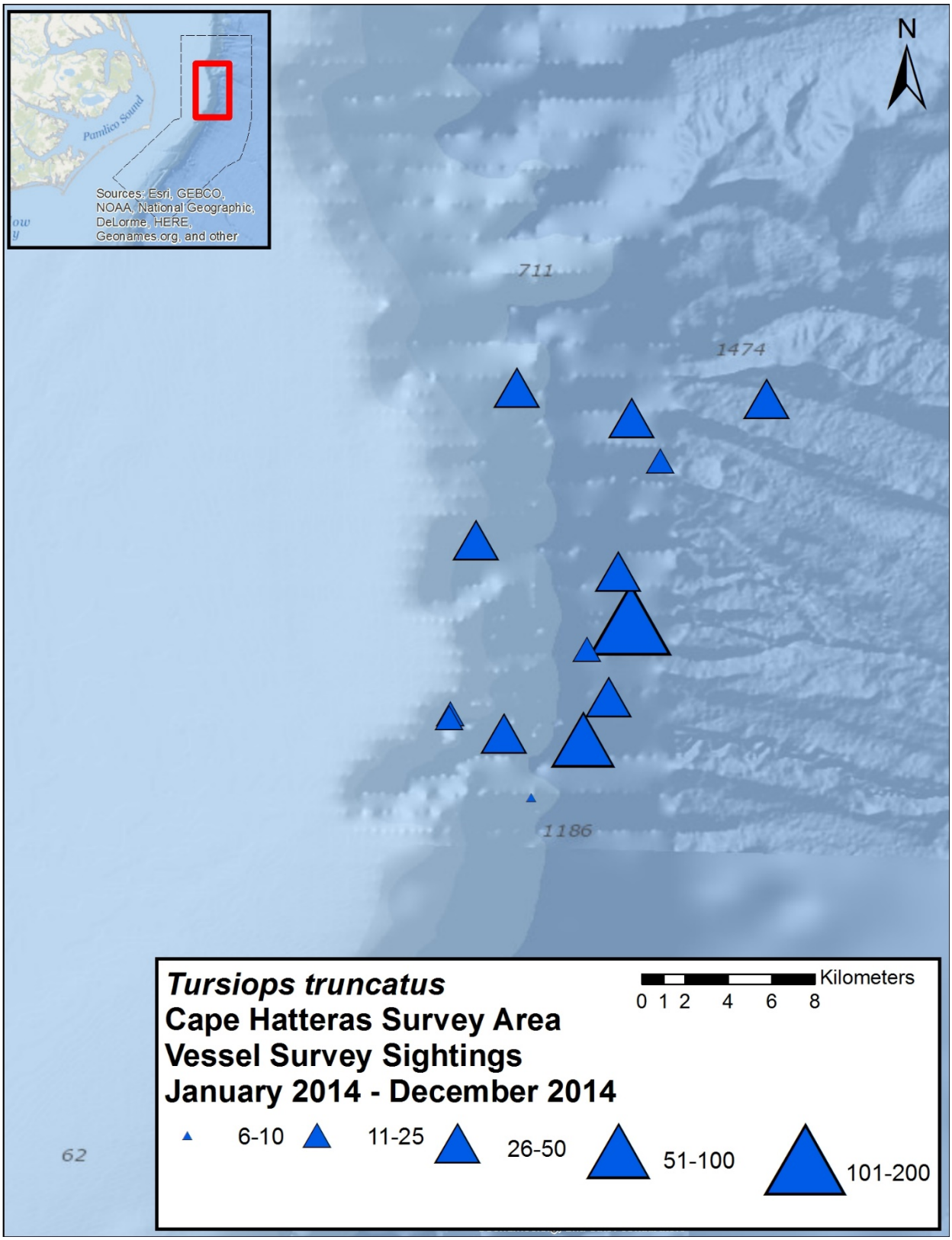

Figure 4. Distribution of bottlenose dolphin sightings indicating group size observed during fieldwork in the Cape Hatteras survey area, January 2014 - December 2014.

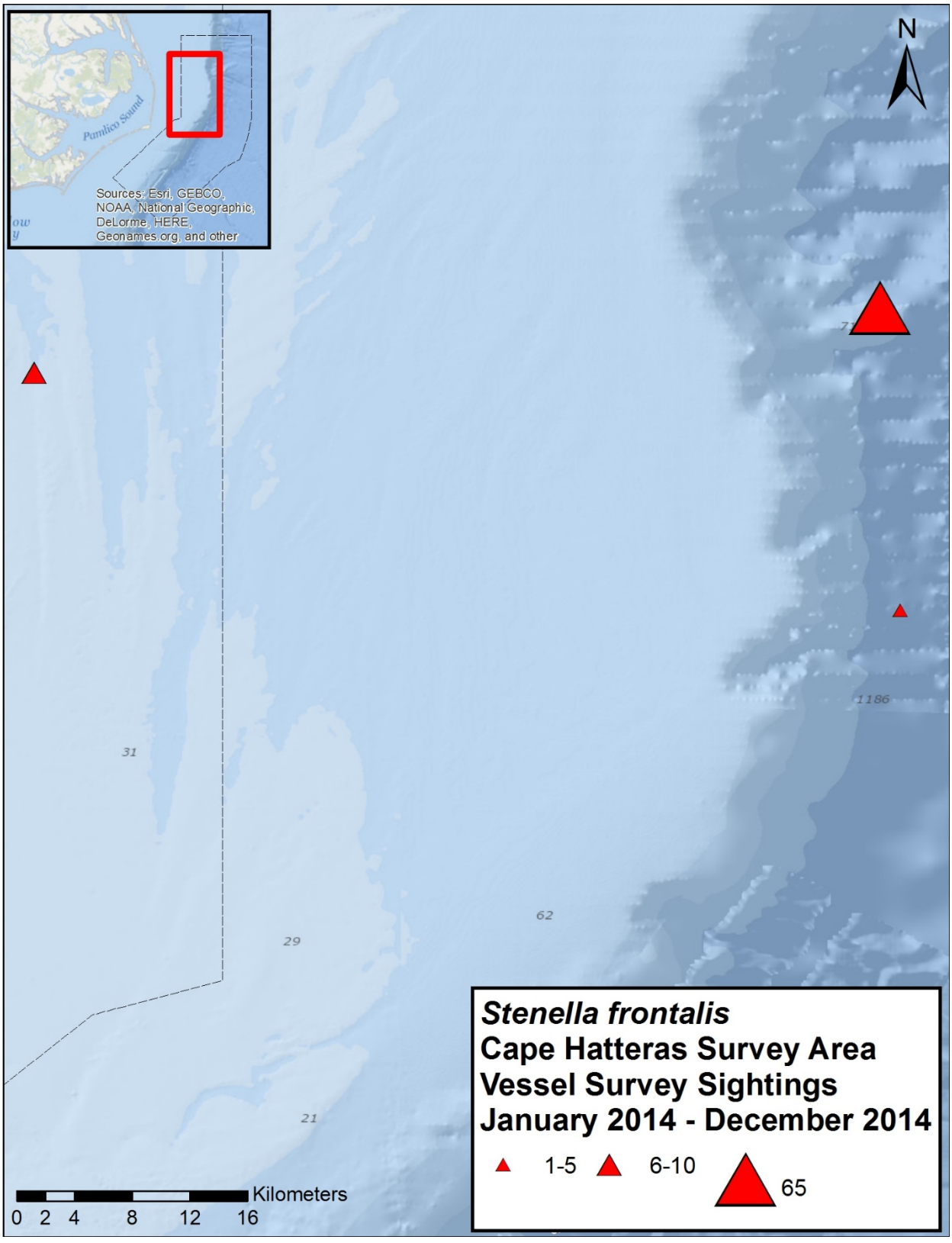

Figure 5. Distribution of Atlantic spotted dolphin sightings indicating group size observed during fieldwork in the Cape Hatteras survey area, January 2014 - December 2014.

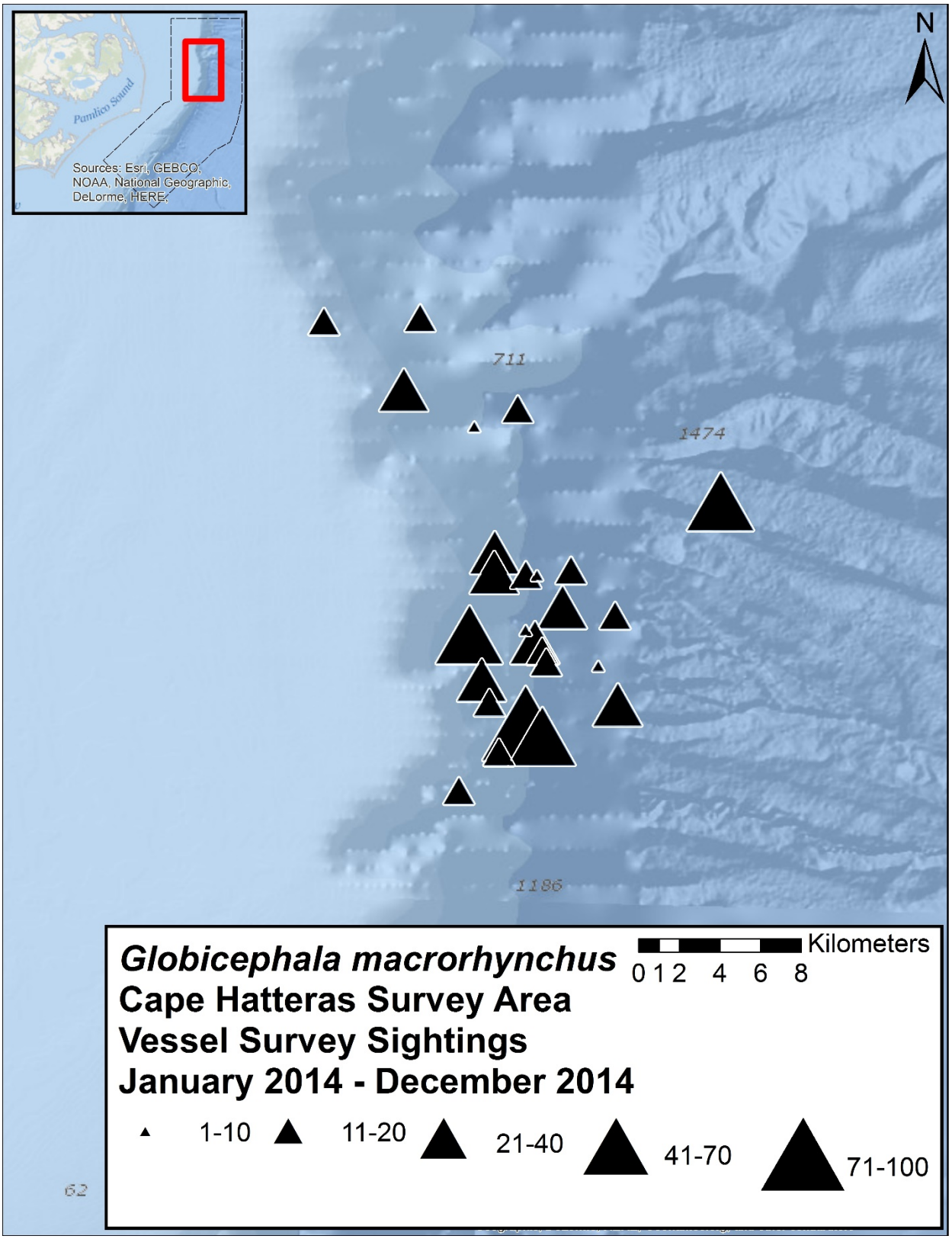

Figure 6. Distribution of short-finned pilot whale sightings indicating group size observed during fieldwork in the Cape Hatteras survey area, January 2014 - December 2014.

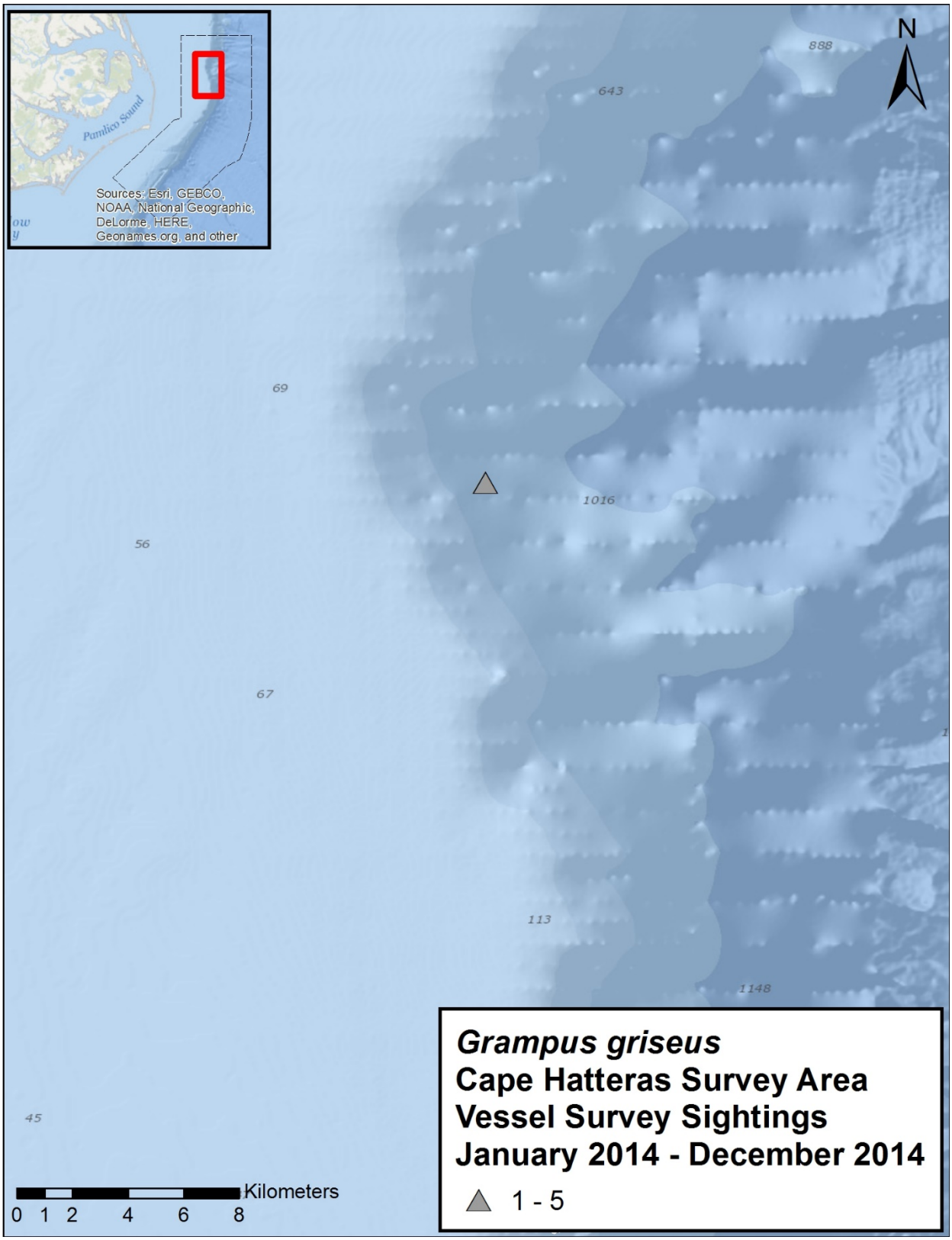

Figure 7. Distribution of Risso's dolphin sightings indicating group size observed during fieldwork in the Cape Hatteras survey area, January 2014 - December 2014.

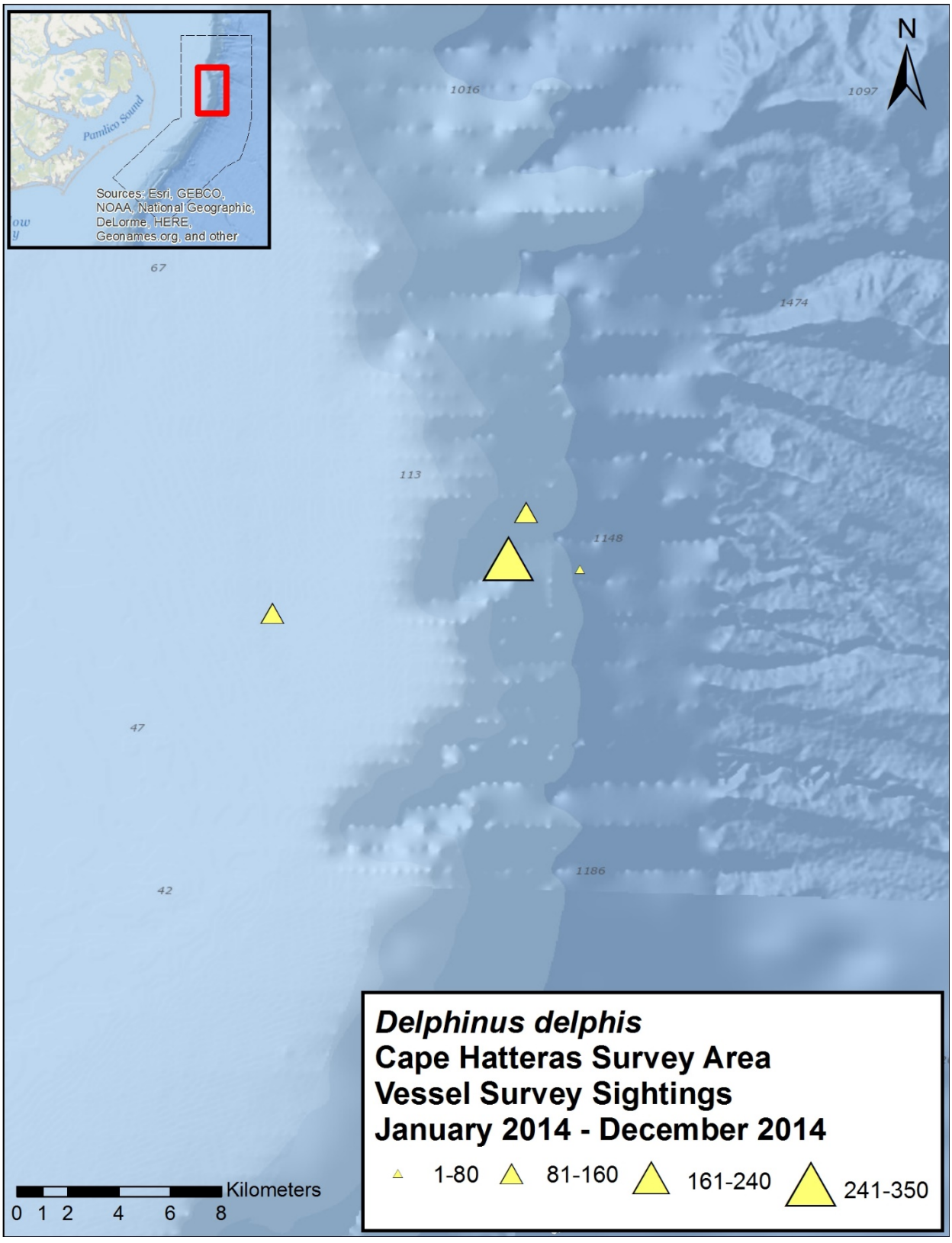

Figure 8. Distribution of common dolphin sightings indicating group size observed during fieldwork in the Cape Hatteras survey area, January 2014 - December 2014.

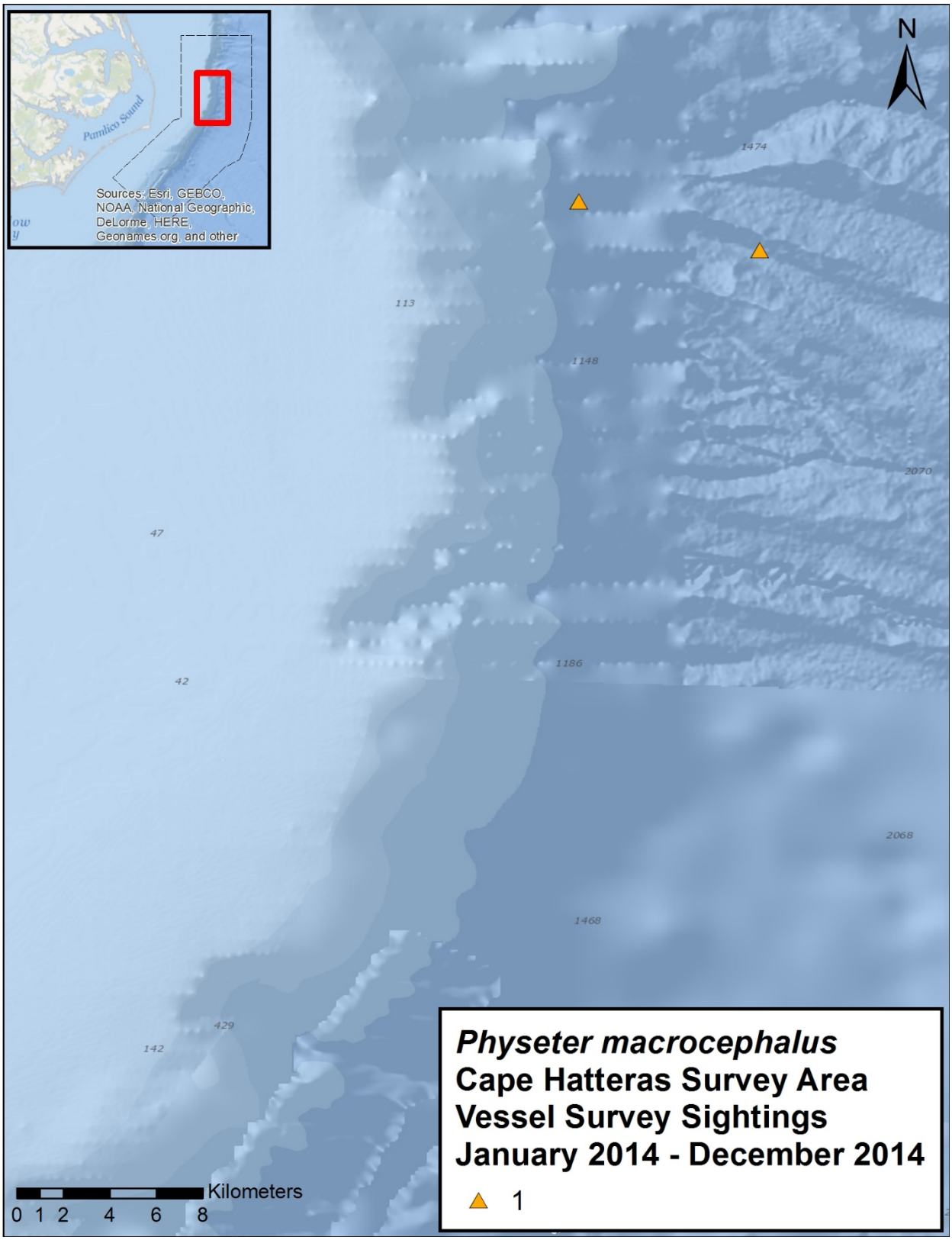

Figure 9. Distribution of sperm whale sightings indicating group size observed during fieldwork in the Cape Hatteras survey area, January 2014 - December 2014.

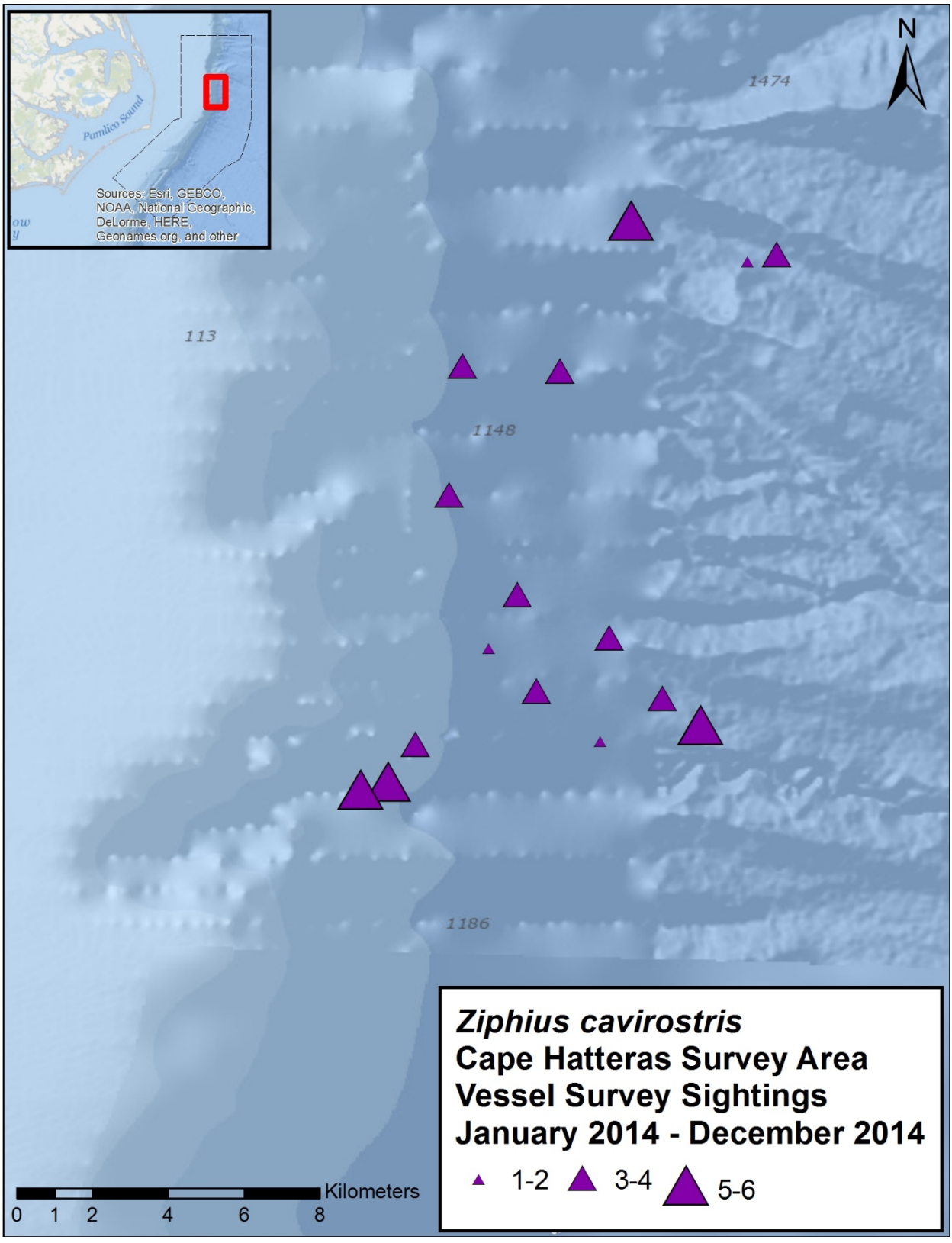

Figure 10. Distribution of Cuvier's beaked whale sightings indicating group size observed during fieldwork in the Cape Hatteras survey area, January 2014 - December 2014.

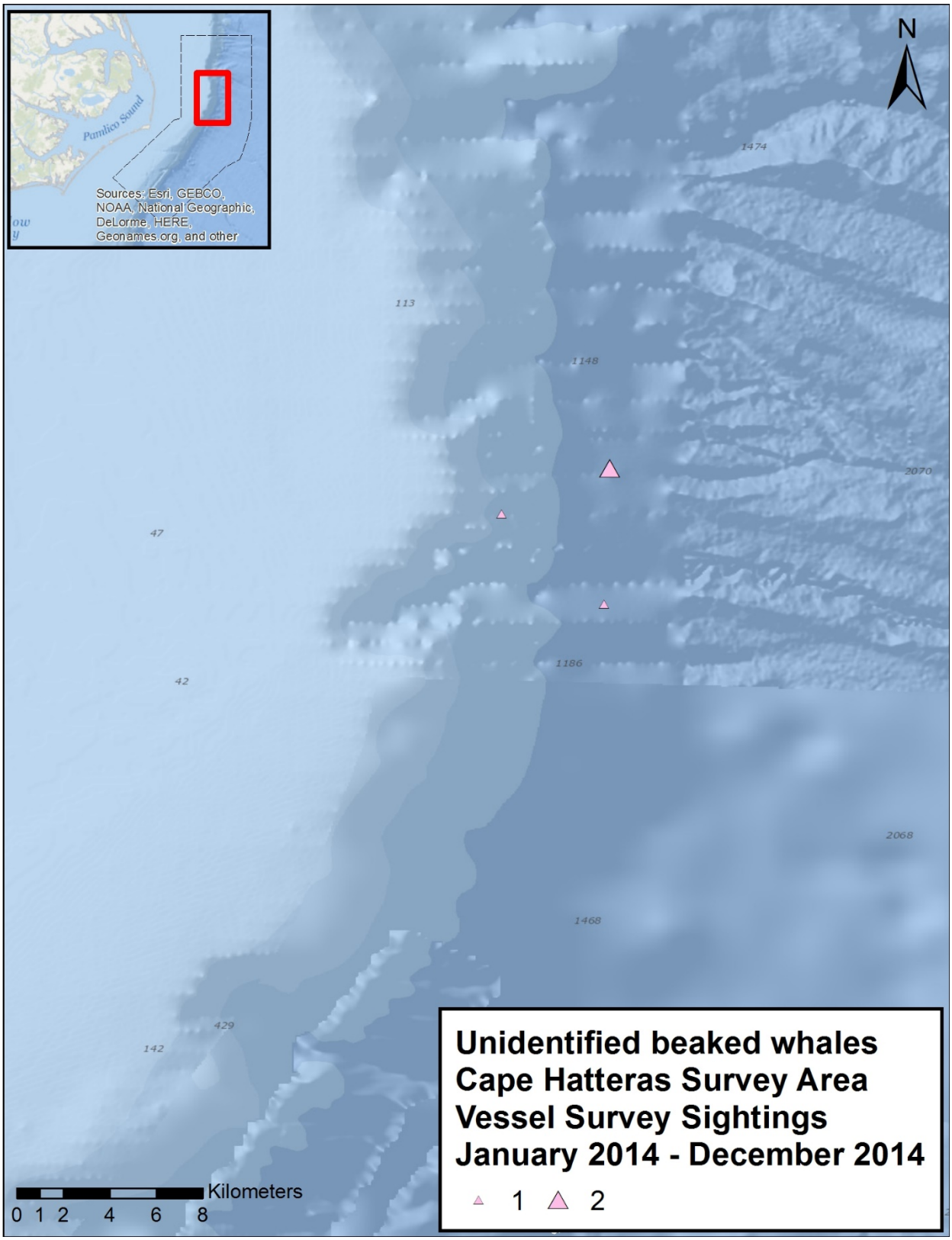

Figure 11. Distribution of unidentified beaked whale sightings indicating group size observed during fieldwork in the Cape Hatteras survey area, January 2014 - December 2014

3.2 Tagging

Observers deployed four DTags in the reporting period: two on Cuvier's beaked whales and two on short-finned pilot whales (**Table 4**, **Figure 12**).

On 12 May 2014 at 14:50 Eastern Standard Time (EST), observers successfully approached and tagged a Cuvier's beaked whale. However, the tag was immediately shed from the animal. They tagged an adult male Cuvier's beaked whale on 26 May 2014 at 12:25 EST in waters with a bottom depth of approximately 1,500 meters (m). Observers followed the whale through three cycles of deep foraging dives, followed by five dives of shorter duration (<30 minutes), for nine surfacing bouts. The tag was programmed to jettison from the whale after four hr of deployment, or no later than 17:25 EST, but it never detached from the animal. Observers continued to receive VHF signals from the animal at the surface until approximately 18:15 EST, at which point they returned ashore due to deteriorating weather conditions. Observers chartered the F/V *Samanna* on 27 May 2014 in an attempt to relocate the tag using the VHF radio signal, but did not hear any signals. Conditions were very poor, with high winds and heavy seas (Beaufort Sea State 6+). On 29 May 2014, observers chartered a second offshore fishing vessel, and searched for the tag from the Atlantic Fleet Training and Testing survey aircraft equipped with radio-tracking gear. These searches were also conducted in very poor weather conditions. However, neither the vessel nor the plane received any signals, and the tag is considered lost. Observers deployed the tag at the inner front of the Gulf Stream and tracked the whale as it foraged along this frontal system. They assume when the tag eventually detached from the whale it entered the Gulf Stream and was advected out of the study area. In discussions with engineers from Woods Hole Oceanographic Institution, observers learned that other researchers experience similar challenges with this species as shedding skin can interfere with the tag release mechanism.

Observers deployed DTags on two short-finned pilot whales on 6 and 7 October 2014, respectively, and conducted focal follows on both animals. Gm_14_279a completed a series of deep (>500 m) dives throughout the focal follow, and was descending when the tag was shed (**Figure 13**). After an initial dive to nearly 100 m, Gm_14_280a executed an extended series of shallow dives for the remainder of the tag's duration (**Figure 14**). Researchers obtained biopsy samples from each of the tagged individuals, and both tags were successfully recovered. The R/V *Marcus G. Langseth*, a seismic survey vessel from the Lamont-Doherty Earth Observatory at Columbia University, was in the Cape Hatteras study area during both days and relatively close during both tag deployments. Initial review of the acoustic data did not result in any indication of seismic activity on the tags. Researchers will compare these recordings with the operations schedule of the vessel, which they requested from Dr. Donna Shillington of Lamont-Doherty Earth Observatory, Chief Scientist on this leg of their cruise.

Table 4. Tag deployments on odontocete cetaceans in the Cape Hatteras survey area, January – December 2014.

Date	Time	Latitude	Longitude	Species	Common Name	Sighting #	Tag Type	Tag #
12-May-14	14:51	35.54102	-74.77291	*Z. cavirostris*	Cuvier's beaked whale	4	DTag	na
13-May-14	10:47	35.54843	-74.77867	*Z. cavirostris*	Cuvier's beaked whale	1	satellite - Mk10	ZcTag029
14-May-14	13:40	35.64364	-74.73569	*G. macrorhynchus*	Short-finned pilot whale	4	satellite - SPOT	GmTag084
14-May-14	16:00	35.64008	-74.75403	*G. macrorhynchus*	Short-finned pilot whale	4	satellite - Mk10	GmTag085
14-May-14	16:18	35.64005	-74.75636	*G. macrorhynchus*	Short-finned pilot whale	4	satellite - SPOT	GmTag086
18-May-14	9:23	35.62209	-74.81373	*T. truncatus*	Bottlenose dolphin	1	satellite - SPOT	TtTag014
18-May-14	13:51	35.65379	-74.76897	*G. macrorhynchus*	Short-finned pilot whale	3	satellite - SPOT	GmTag087
26-May-14	12:25	35.55792	-74.73331	*Z. cavirostris*	Cuvier's beaked whale	1	DTag	Zc_14_146a
7-Jun-14	11:46	35.77384	-74.81699	*G. macrorhynchus*	Short-finned pilot whale	1	satellite - SPOT	GmTag088
8-Jun-14	10:59	35.58190	-74.76134	*G. macrorhynchus*	Short-finned pilot whale	4	satellite - Mk10	GmTag089
8-Jun-14	11:39	35.58100	-74.75847	*G. macrorhynchus*	Short-finned pilot whale	4	satellite - SPOT	GmTag090
8-Jun-14	12:01	35.58645	-74.75807	*G. macrorhynchus*	Short-finned pilot whale	4	satellite - Mk10	GmTag091
11-Jun-14	10:52	35.76191	-74.75979	*G. macrorhynchus*	Short-finned pilot whale	2	satellite - SPOT	GmTag092
11-Jun-14	11:17	35.77323	-74.76722	*G. macrorhynchus*	Short-finned pilot whale	2	satellite - Mk10	GmTag093
11-Jun-14	13:36	35.74864	-74.82162	*G. macrorhynchus*	Short-finned pilot whale	5	satellite - SPOT	GmTag094
11-Jun-14	14:37	35.78301	-74.83783	*G. macrorhynchus*	Short-finned pilot whale	5	satellite - SPOT	GmTag095
11-Jun-14	15:58	35.69171	-74.72464	*T. truncatus*	Bottlenose dolphin	6	satellite - SPOT	TtTag015
11-Jun-14	16:23	35.70817	-74.71454	*T. truncatus*	Bottlenose dolphin	6	satellite - Mk10	TtTag016
12-Jun-14	13:02	35.58755	-74.85061	*D. delphis*	Common dolphin	1	satellite - SPOT	DdTag001
11-Sep-14	9:44	35.57424	-74.77396	*G. macrorhynchus*	Short-finned pilot whale	2	satellite - SPOT	GmTag096
11-Sep-14	14:09	35.59483	-74.72061	*G. macrorhynchus*	Short-finned pilot whale	3	satellite - SPOT	GmTag097
11-Sep-14	14:41	35.59733	-74.72698	*G. macrorhynchus*	Short-finned pilot whale	3	satellite - Mk10	GmTag098
11-Sep-14	15:43	35.59227	-74.72209	*G. macrorhynchus*	Short-finned pilot whale	3	satellite - SPOT	GmTag099
11-Sep-14	16:03	35.59730	-74.72276	*G. macrorhynchus*	Short-finned pilot whale	3	satellite - Mk10	GmTag100
13-Sep-14	15:33	35.59676	-74.77700	*G. macrorhynchus*	Short-finned pilot whale	4	satellite - SPOT	GmTag101
13-Sep-14	15:53	35.60639	-74.77818	*G. macrorhynchus*	Short-finned pilot whale	4	satellite - SPOT	GmTag102
13-Sep-14	17:22	35.66672	-74.76895	*G. macrorhynchus*	Short-finned pilot whale	5	satellite - SPOT	GmTag103

Date	Time	Latitude	Longitude	Species	Common Name	Sighting #	Tag Type	Tag #
13-Sep-14	18:43	35.69113	-74.70475	*T. truncatus*	Bottlenose dolphin	6	satellite - SPOT	TtTag017
16-Sep-14	8:40	35.56203	-74.80464	*T. truncatus*	Bottlenose dolphin	1	satellite - Mk10	TtTag018
16-Sep-14	13:32	35.66437	-74.71452	*Z. cavirostris*	Cuvier's beaked whale	4	satellite - Mk10	ZcTag030
16-Sep-14	15:21	35.65198	-74.71688	*Z. cavirostris*	Cuvier's beaked whale	4	satellite - SPOT	ZcTag031
6-Oct-14	12:41	35.65982	-74.75118	*G. macrorhynchus*	Short-finned pilot whale	2	DTag	Gm_14_279a
7-Oct-14	12:31	35.64991	-74.75674	*G. macrorhynchus*	Short-finned pilot whale	2	DTag	Gm_14_280a

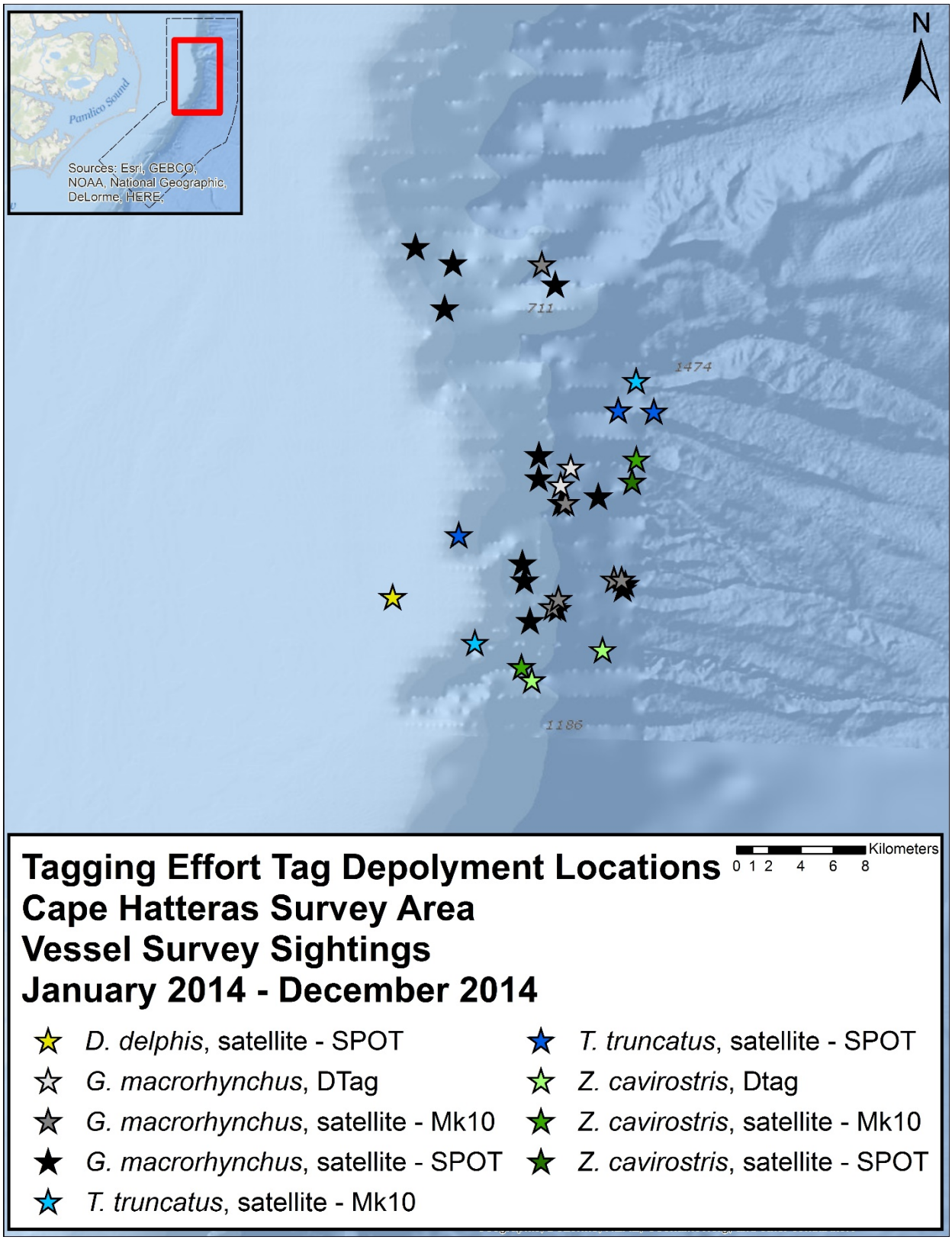

Figure 12. Locations of tag deployments in the Cape Hatteras survey area, January 2014 – December 2014.

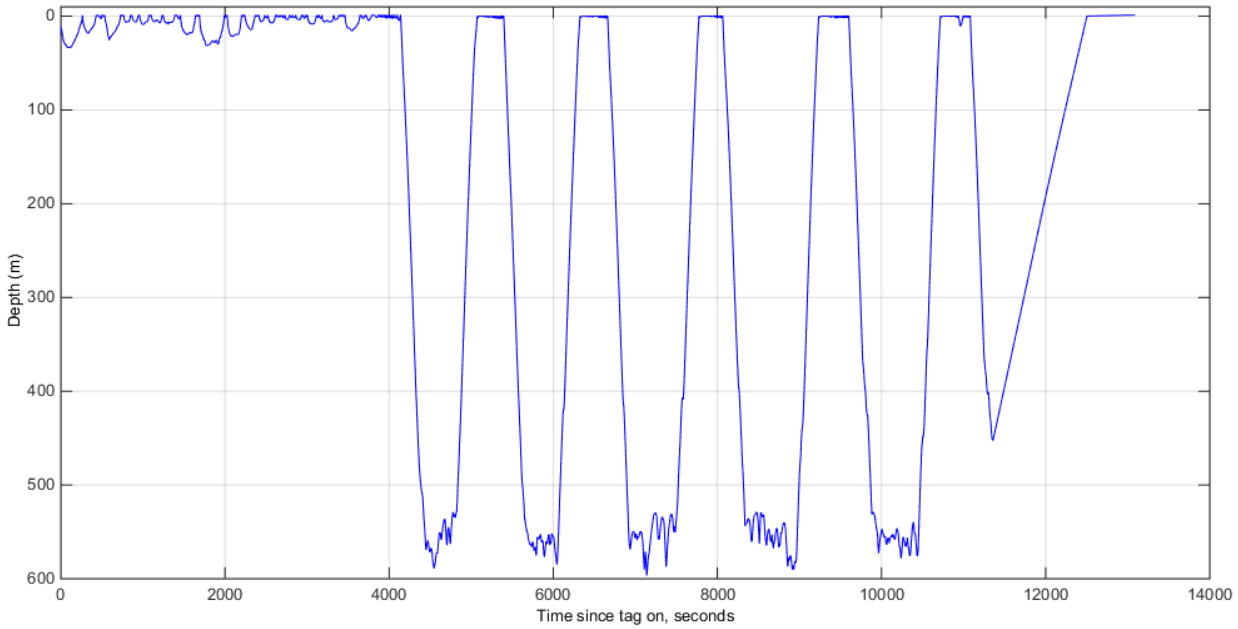

Figure 13. Dive profile of Gm_14_279a from 6 October 2014 DTag record.

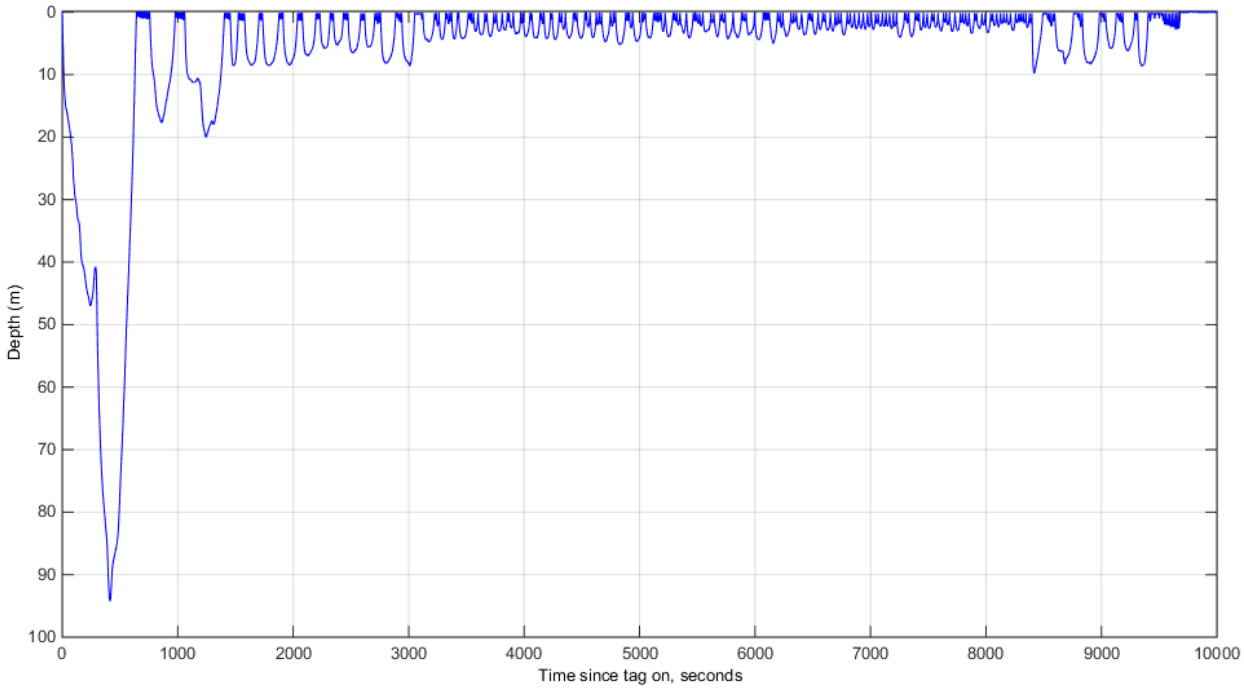

Figure 14. Dive profile of Gm_14_280a from 7 October 2014 DTag record.

Working with the Cascadia Research Collective, observers deployed 29 satellite tags on four species of odontocete cetaceans in the Cape Hatteras survey area in 2014. These tags were deployed on 20 short-finned pilot whales, five bottlenose dolphins, three Cuvier's beaked whales, and one short-beaked common dolphin (**Table 4**, **Figure 12**). They deployed 10 tags that transmitted dive data (Wildlife Computers, Mk-10 tags): two on Cuvier's beaked whales, six on short-finned pilot whales, and two on bottlenose dolphins. All others were location-only (Wildlife Computers, Smart Position and Temperature [SPOT] tags). A summary of these deployments is provided in **Table 5**, but please refer to Cascadia Research Collective's report for a full analysis of the data obtained from the satellite-tagged individuals (Baird *et al*. 2015). .

Table 5. Summary of satellite tag deployments in the Cape Hatteras survey area, January – December 2014.

Deployment	Animal ID	Tag Type	ARGOS Id	Last Transmission
13-May-14	Zc029	Mk-10	102465	12-Jul-14
14-May-14	Gm084	SPOT	94808	15-May-14
14-May-14	Gm085	Mk-10	53644	21-Jun-14
14-May-14	Gm086	SPOT	94788	1-Aug-14
18-May-14	Gm087	SPOT	98362	28-Nov-14
18-May-14	Tt014	SPOT	53652	2-Jun-14
7-Jun-14	Gm088	SPOT	102471	24-Sep-14
8-Jun-14	Gm089	Mk-10	94810	Failed immediately
8-Jun-14	Gm090	SPOT	94796	2-Aug-14
8-Jun-14	Gm091	Mk-10	102464	Failed immediately
11-Jun-14	Gm092	SPOT	94817	30-Jul-14
11-Jun-14	Gm093	Mk-10	94805	29-Jun-14
11-Jun-14	Gm094	SPOT	94804	3-Sep-14
11-Jun-14	Gm095	SPOT	53651	3-Sep-14
11-Jun-14	Tt015	SPOT	109822	29-Jun-14
11-Jun-14	Tt016	Mk-10	72534	28-Jun-14
12-Jun-14	Dd001	SPOT	94806	22-Jul-14
11-Sep-14	Gm096	SPOT	94814	12-Sep-14
11-Sep-14	Gm097	SPOT	98369	13-Oct-14
11-Sep-14	Gm098	Mk-10	98358	9-Oct-14
11-Sep-14	Gm099	SPOT	102473	14-Nov-14
11-Sep-14	Gm100	MK-10	53553	6-Oct-14
13-Sep-14	Gm101	SPOT	94794	15-Oct-14
13-Sep-14	Gm102	SPOT	102466	23-Sep-14
13-Sep-14	Gm103	SPOT	94793	5-Jan-15
13-Sep-14	Tt017	SPOT	98359	30-Sep-14
16-Sep-14	Tt018	Mk-10	94797	29-Sep-14
16-Sep-14	Zc030	Mk-10	77246	25-Oct-14
16-Sep-14	Zc031	SPOT	98368	19-Oct-14

3.3 Biopsy Sampling

Observers collected biopsy samples from four species of cetaceans, including two deep-diving odontocetes: short-finned pilot whales (*n*=5) and a sperm whale (*n*=1). They also collected samples from bottlenose dolphins (*n*=2) and Atlantic spotted dolphins (*n*=2) (**Table 6**, **Figure 15**). Genetic analysis of extracted deoxyribonucleic acid (DNA) from bottlenose dolphin biopsy samples collected in the Cape Hatteras study area between May 2011 and July 2013 confirmed that all of the sampled dolphins were of the offshore ecotype, suggesting there is limited overlap between coastal and offshore populations in the study area. Voucher specimens of these samples have been or will be archived with the Southeast Fisheries Science Center in Lafayette, Louisiana.

Table 6. Biopsy samples collected from animals during fieldwork in the Cape Hatteras survey area, January 2014 - December 2014.

Date	Time	Latitude	Longitude	Species	Sample #
18-May-14	9:34	35.62204	-74.81515	*T. truncatus*	ZTS_14_14
18-May-14	9:48	35.61964	-74.81217	*T. truncatus*	ZTS_14_15
7-Jun-14	12:05	35.78173	-74.82315	*G. macrorhynchus*	ZTS_14_16
11-Jun-14	11:39	35.76019	-74.75061	*S. frontalis*	ZTS_14_17
16-Jun-14	13:29	35.67314	-74.75402	*G. macrorhynchus*	AJR_14_01
16-Jun-14	14:05	35.69452	-74.75011	*P. macrocephalus*	ZTS_14_18
11-Sep-14	15:45	35.59227	-74.72209	*G. macrorhynchus*	DMW_14_01
13-Sep-14	7:53	35.71964	-75.27887	*S. frontalis*	ZTS_14_26
6-Oct-14	15:46	35.72256	-74.72520	*G. macrorhynchus*	ZTS_14_27
7-Oct-14	14:51	35.66936	-74.74401	*G. macrorhynchus*	ZTS_14_28

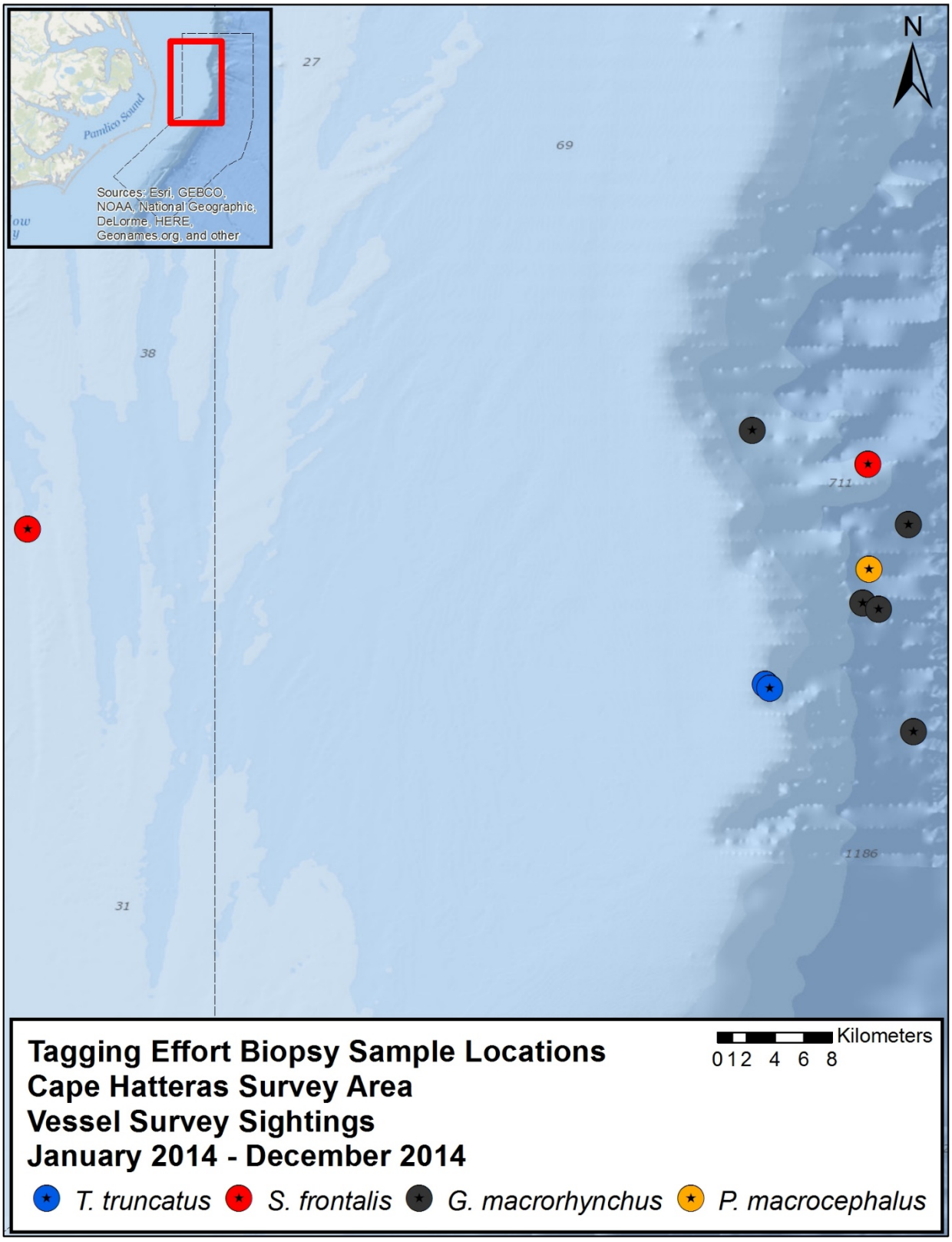

Figure 15. Distribution of biopsy sample locations collected during fieldwork in the Cape Hatteras survey area, January 2014 - December 2014.

3.4 Photographic Effort

Researchers obtained 4,120 digital images to determine species confirmation and identify individual animals during fieldwork in 2014. They added images of 130 newly identified animals to seven existing catalogs of bottlenose dolphins, Atlantic spotted dolphins, short-finned pilot whales, sperm whales, Cuvier's beaked whales, short-beaked common dolphins, and Risso's dolphins. In 2014, two new photo-ID catalogs were established for humpback whales (*Megaptera novaeangliae*) and fin whales (*Balaenoptera physalus*) that were observed from prior years in the Cape Hatteras study area (humpback whales were previously photographed in 2007 and 2012, and fin whale in 2013). To date, photo-ID catalogs for nine species have been assembled, with nearly 40 individuals re-sighted across all species (**Table 7**). In addition, the photo-ID catalogs of bottlenose dolphins, Atlantic spotted dolphins (through 2013) and short-finned pilot whales (through 2014) from the Cape Hatteras study area have been compared to the Jacksonville and Onslow Bay photo-ID catalogs, but no matches have been identified to date.

Table 7. Summary of images collected during fieldwork in the Cape Hatteras survey area, January 2014 - December 2014, with photo-identification catalog sizes and total matches to date.

Species	Images	Catalog Size	Matches
	2014		
Balaenoptera physalus	0	1	0
Delphinus delphis	451	27	1
Globicephala macrorhynchus	2249	229	25
Grampus griseus	30	7	0
Megaptera novaeangliae	0	3	0
Physeter macrocephalus	16	5	1
Stenella frontalis	22	23	0
Tursiops truncatus	631	198	9
Ziphius cavirostris	721	13	2

Photo-analysis of the images taken in the Cape Hatteras area is ongoing. To date, nine bottlenose dolphins have been photographed on multiple occasions, spanning several years (**Table 8**). Bottlenose dolphin Ttr 1-001 was first photographed on 20 July 2009, re-sighted on 30 May 2011, and then photographed for a third time on 27 June 2011. Ttr 6-018 and Ttr 9-013 were photographed together in both March 2012 and May 2013. Ttr 6-020 was observed in May 2011 and then again in October 2013. Ttr 7-031 and Ttr 7-038 were photographed on two separate occasions in 2011 and Ttr 7-058 was observed twice within 2013. Ttr 9-016 was initially photographed in 2011 and then again in June 2014. Ttr 9-027, satellite tagged this year on 11 June 2014 (TtTag015), was observed a second time on 16 June 2014 (**Figures 16 and 17**).

Table 8. Photo-identification matches of odontocete cetaceans in the Cape Hatteras survey area.

ID	2006	2007	2008	2009	2010	2011	2012	2013	2014
Ttr 1-001				X		X[y]			
Ttr 6-018^							X	X	
Ttr 6-020						X		X	
Ttr 7-031						X[y]			
Ttr 7-038						X[y]			
Ttr 7-058								X[y]	
Ttr 9-013^							X	X	
Ttr 9-016						X			X
Ttr 9-027 (TtTag015)									X[m]
Dde 7-002		X					X		
Pma-004								X[m]	
Zca-003r (ZcTag029)									X[m]
Zca-005r									X[y]

[m] - re-sighted within same month

[y] - re-sighted within same year

^Observed together in multiple sightings

Figure 16. Photo-identification matches of satellite-tagged bottlenose dolphins (top row) and Cuvier's beaked whales (bottom row) observed during fieldwork in the Cape Hatteras survey area.

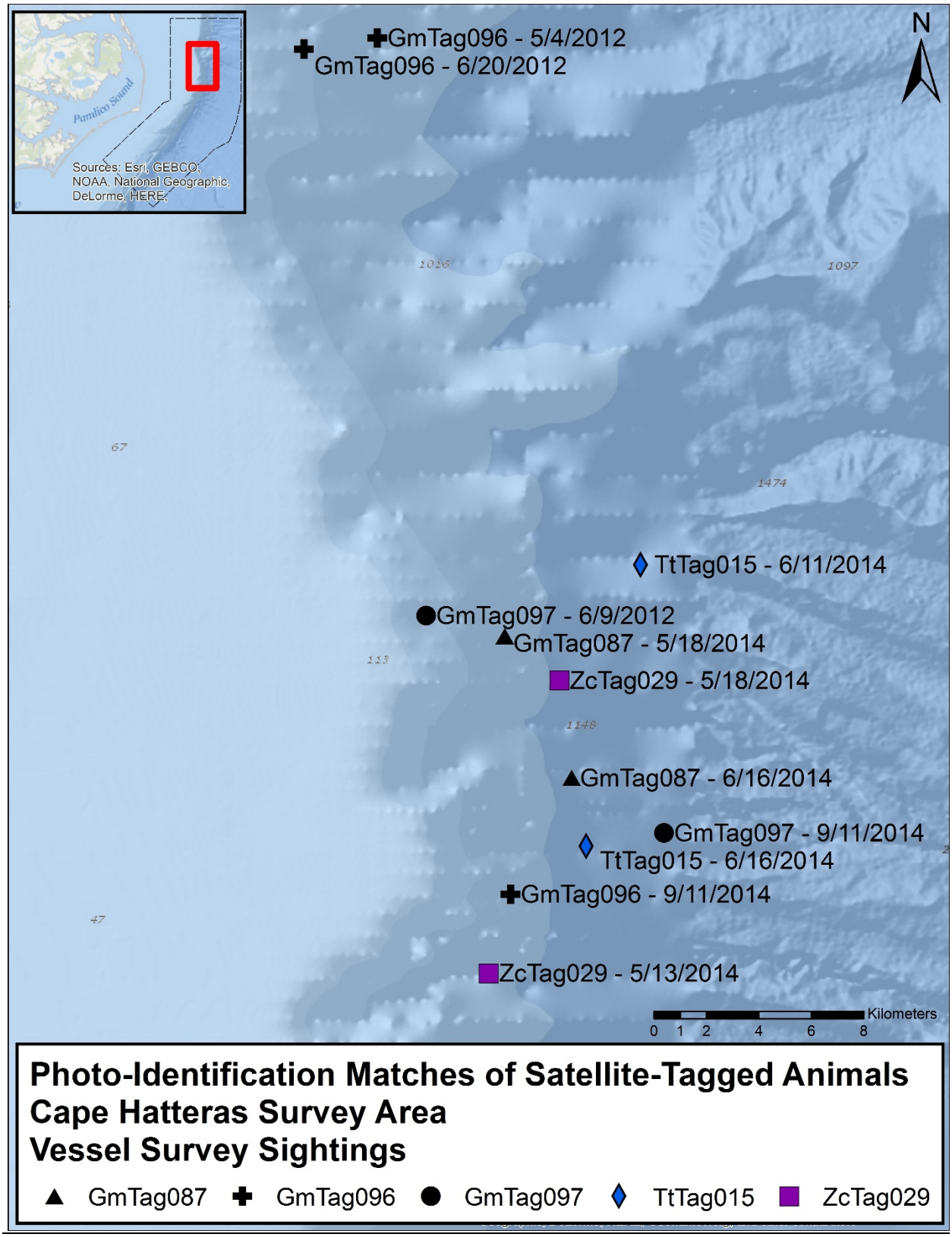

Figure 17. Photo-identification matches of satellite-tagged animals, with dates sighted, observed during fieldwork in the Cape Hatteras survey area.

Researchers made a single match of a common dolphin off Cape Hatteras; Dde 7-002 was first photographed on 27 May 2007 and then re-sighted nearly five years later on 15 March 2012 (**Table 8**).

Researchers made their first sperm whale and beaked whale matches during this reporting period; Pma-004 was observed on 27 and 29 May in 2013. Zca_003r, satellite-tagged on 13 May 2014 (ZcTag029), was first photographed during satellite tag deployment and again five days later (**Figures 16 and 17**). Zca_005r was photographed in May and October of 2014 (**Table 8**).

Observers continue to be surprised by the relatively high re-sighting rate of short-finned pilot whales in the Hatteras study area. To date, they have re-sighted more than 10 percent (25 of 229) of the pilot whales in their catalog (**Table 9**). Re-sightings of this species span up to six years, and several individuals were observed on multiple occasions and in different seasons. Three of the 20 short-finned pilot whales equipped with satellite tags in 2014 were either re-sighted or matched to their existing catalog. GmTag087 was tagged on 18 May 2014 and re-sighted on 16 June 2014 during a SERDP survey (**Figures 17 and 18**). GmTag096, satellite-tagged in September 2014, was previously observed in May and June of 2012; it was also DTagged in June of 2012 during a SERDP project, as well as biopsied. Genetic analysis confirms this animal is female. GmTag097, also satellite-tagged in September of 2014, was matched to existing catalog individual Gma 7-016, previously recorded in June of 2012 (**Table 9**, **Figures 17 and 18**).

Table 9. Photo-identification matches of short-finned pilot whales in the Cape Hatteras survey area.

ID	Sex	2006	2007	2008	2009	2010	2011	2012	2013	2014
Gma_1-001								X[y]		
Gma_1-002							X	X		
Gma_6-001	M						X	X		
Gma_6-006	M		X					X		
Gma_6-026	M			X				X		
Gma_6-033	M							X[m]		
Gma_7-002	M	X		X				X		
Gma_7-003		X						X[m]		
Gma_7-007	M	X[m]								
Gma_7-009							X	X		
Gma_7-012								X[y]		
Gma_7-014								X[m]		
Gma_7-016 (GmTag097)								X		X
Gma_7-017								X[m]		
Gma_7-018								X[m]		
Gma_7-026								X[m]		
Gma_7-027								X[m]		
Gma_7-055	F		X[y]							
Gma_7-071	M			X				X[m]		
Gma_7-084	F							X[y]		
Gma_7-085	F							X[y]		
Gma_8-007								X[m]		
Gma_8-016			X			X				
GmTag087										X[y]
GmTag096	F							X[y]		X

[m] - re-sighted within same month

[y] - re-sighted within same year

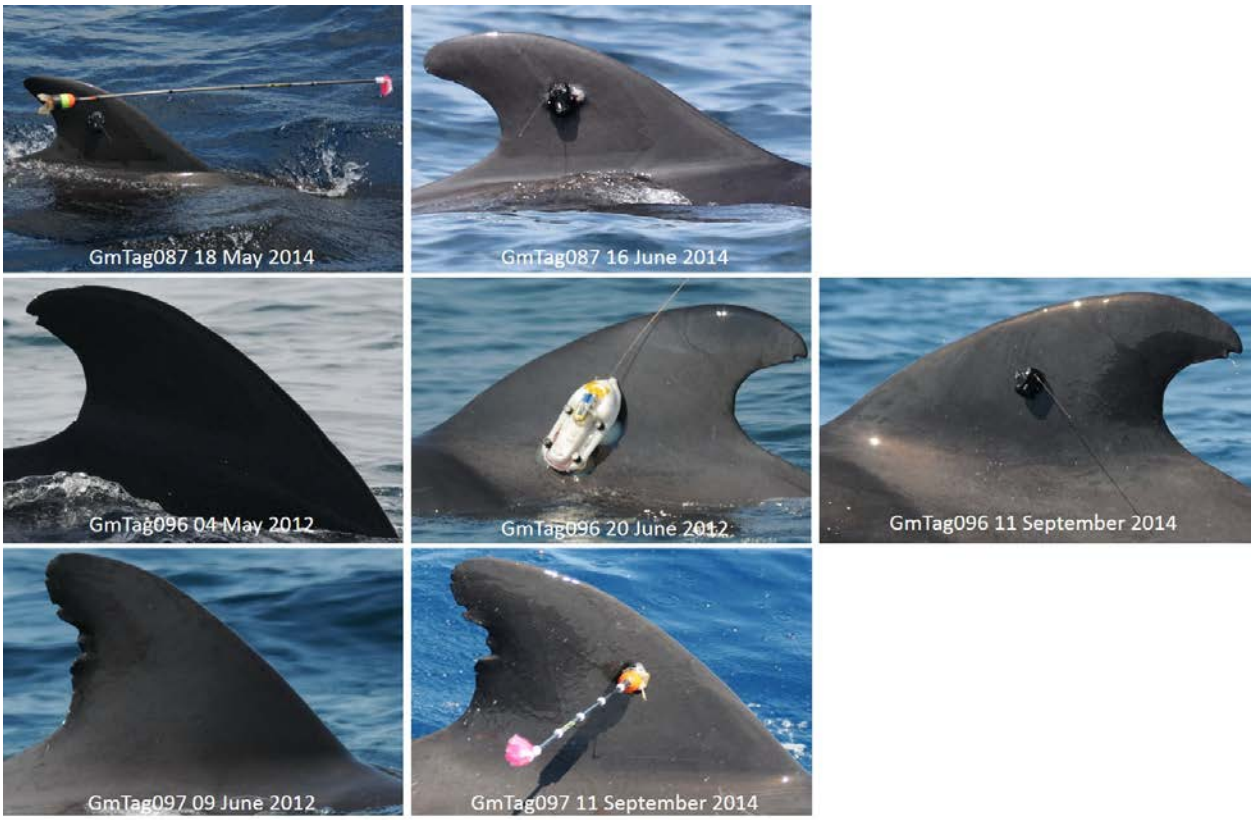

Figure 18. Photo-identification matches of short-finned pilot whales observed in the Cape Hatteras survey area.

3.5 Summary Tables

Total survey effort conducted since the inception of the monitoring program in the Cape Hatteras survey area is presented in **Table 10**. The total number of sightings and mean group size by species for both cetaceans and sea turtles are presented in **Tables 11 and 12**, respectively. The number of biopsy samples collected to date is presented in **Table 13**. **Table 14** summarizes the catalog sizes and matches by species to date and images taken during the reporting period in the Cape Hatteras survey area.

Table 10. Duration and distance surveyed during Year 1 (July 2009 – December 2010), Year 2 (January 2011 – December 2011), Year 3 (January 2012 – December 2012), Year 4 (January 2013 – December 2013) and Year 5 (January 2014 – December 2014) in the Cape Hatteras survey area.

	2009-2010	2011	2012	2013	2014	Total	
Survey Hours	26.3	179.9	86.8	63.2	121.7	477.9	
Km Surveyed	296.4	1097.4	1049.4	878.7	921.9	4243.8	

Table 11. Number of cetacean sightings and mean group size for each species observed during Year 1 (July 2009 – December 2010), Year 2 (January 2011 – December 2011), Year 3 (January 2012 – December 2012), Year 4 (January 2013 – December 2013) and Year 5 (January 2014 – December 2014) of vessel surveys in the Cape Hatteras survey area.

Species	Sightings					Mean Group Size
	2009	2011	2012	2013	2014	
Balaenoptera physalus	0	0	1	2	0	2.3±1.2
Delphinus delphis	0	6	11	3	4	164.6±187.4
Globicephala macrorhynchus	9	33	52	35	26	34.2±69.3
Grampus griseus	1	2	2	0	1	9.8±12.2
Mesoplodon spp.	0	0	0	1	0	1.0±0.0
Physeter macrocephalus	0	1	4	3	2	1.6±0.8
Stenella frontalis	0	8	2	3	3	55.6±71.4
Stenella/Delphinus mix	0	1	0	0	0	85.0±0.0
Tursiops truncatus	23	27	54	38	14	20.1±28.6
Tursiops/Stenella mix	0	1	0	0	0	100.0±0.0
Ziphius cavirostris	0	3	1	2	16	3.4±1.3
Unidentified beaked whale	0	0	0	4	3	1.9±1.5
Unidentified delphinid	1	0	3	1	0	4.3±2.6
Total:	**34**	**82**	**130**	**92**	**69**	

Table 12. Number of sea turtle sightings and mean group sizes (± 1sd) for each species observed during vessel surveys in the Cape Hatteras survey area, January 2009 – December 2014.

Species	Sightings					Mean Group Size
	2009	2011	2012	2013	2014	
Caretta caretta	2	0	2	7	0	1.0±0.0
Chelonia mydas	0	0	0	1	0	1.0±0.0
Unidentified sea turtle	0	0	1	0	0	1.0±0.0
Total:	**2**	**0**	**3**	**0**	**0**	

Table 13. Biopsy samples collected to date in the Cape Hatteras survey area.

Species	2011	2012	2013	2014	Total
Balaenoptera physalus	0	0	3	0	3
Delphinus delphis	0	5	2	0	7
Globicephala macrorhynchus	4	33	10	5	52
Grampus griseus	0	0	2	0	2
Physeter macrocephalus	0	0	1	1	2
Stenella frontalis	6	0	2	2	10
Tursiops truncatus	14	10	13	2	39
Ziphius cavirostris	0	0	2	0	2

Table 14. Summary of images collected during all vessel surveys in the Cape Hatteras survey area, January 2009 - December 2014, with photo-identification catalog sizes and matches to date.

Species	2009-2013		2014	
	Catalog Size	Matches	Catalog Size	Matches
Balaenoptera physalus	0	0	1	0
Delphinus delphis	20	1	27	1
Globicephala macrorhynchus	229	22	229	25
Grampus griseus	3	0	7	0
Megaptera novaeangliae	0	0	3	0
Physeter macrocephalus	3	0	5	1
Stenella frontalis	13	0	23	0
Tursiops truncatus	107	3	198	9
Ziphius cavirostris	1	0	13	2

4. Acknowledgements

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