

Small Vessel Surveys for Protected Species in Navy OPAREAs off the U.S. Atlantic Coast: 2015 Annual Progress Report

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Bottlenose dolphins (*Tursiops truncatus*). Photographed by Logan Pallin, Duke University, taken under General Authorization Letter of Confirmation 16185 held by Duke University

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Acronyms and Abbreviations

AFTT	Atlantic Fleet Testing and Training
CHSRA	Cape Hatteras Special Research Area
C/V	Charter Vessel
Dtag	digital acoustic tag
F/V	Fishing Vessel
JAX	Jacksonville
km	kilometer(s)
km ²	square kilometer(s)
m	meter(s)
NOAA	National Oceanic and Atmospheric Administration
OPAREA	Operating Area
R/V	Research Vessel
SERDP	Strategic Environmental Research and Development Project
U.S.	United States
USWTR	Undersea Warfare Training Range
VACAPES	Virginia Capes
VHF	Very High Frequency

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1. Introduction

This report describes results from 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 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. In Onslow Bay, six years of monitoring yielded a comprehensive picture of the density, distribution and abundance of marine mammals and sea turtles and provided new insights into residency patterns among pelagic delphinids in this region ([Read et al. 2014](#)). Dedicated survey effort in the Onslow Bay site concluded in 2013; however, two opportunistic surveys were conducted in the area in 2015. More than six years of monitoring in the Jacksonville (JAX) Operating Area (OPAREA) have provided similar information on the density and distribution of marine mammals and sea turtles. Off Cape Hatteras, six 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 present report describes monitoring activities, including photo-identification and biopsy-sampling vessel surveys at all three survey areas between January and December 2015. Additional small vessel fieldwork at Cape Hatteras in 2015 was dedicated to the Deep Diver and Satellite Tagging Projects ([Foley et al. 2016](#) and [Baird et al. 2016](#)), but all photographic identification work and amalgamated summary tables for Cape Hatteras are reported here. Analysis of the satellite-tagging data is in a report from Cascadia Research Collective. In addition to small vessel field work, ongoing line transect aerial surveys were also conducted throughout 2015 at several sites along the U.S. Atlantic coast (see [Cummins et al. 2016](#), [McAlarney et al. 2016](#), [Malette et al. 2016](#))

2. Cape Hatteras Vessel Surveys

2.1 Methods

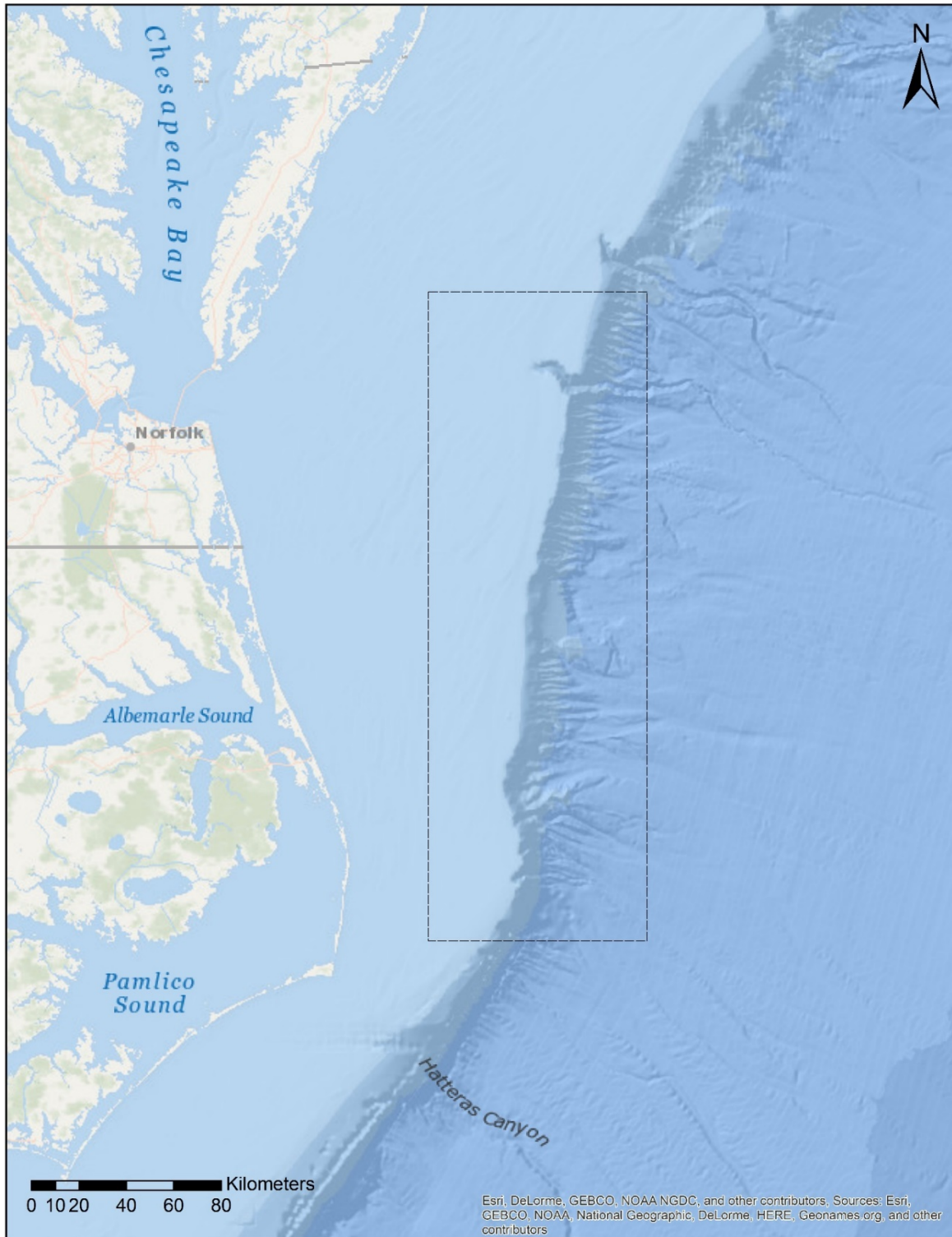
2.1.1 Study Area

The study area within the Virginia Capes (VACAPES) OPAREA is located east of Cape Hatteras, North Carolina. The study area incorporates a large portion of the Cape Hatteras Special Research Area (CHSRA), designated by the National Marine Fisheries Service as a management tool to facilitate research and mitigation of interactions between odontocete cetaceans and a pelagic longline fishery. The study area is approximately 16,300 km² in extent and straddles the continental shelf break, including both shelf and pelagic waters (**Figure 1**).

2.1.2 Data Collection

Vessel survey effort in Cape Hatteras during 2015 focused on supplementing the tagging effort ([Foley et al. 2016](#)) with additional photo-identification and biopsy surveys. Visual surveys were conducted at speeds of approximately 8 to 15 knots (15–28 km/hr), with higher speeds utilized during on-effort transiting within the survey area, from the Research Vessel (R/V) *Richard T. Barber*, a U.S. Coast Guard-approved offshore research vessel outfitted with a bow pulpit,

1 satellite phone, lifeboat and wireless communication system (**Figure 2**). Additional surveys were
2 conducted from the charter vessel (C/V) *Tiki XIV* and fishing vessel (F/V) *Samanna*. Two



3
4 **Figure 1. Map of the Cape Hatteras survey area. Dashed line indicates aerial survey boundaries.**



1

2 **Figure 2. The R/V *Richard T. Barber*.**

3 observers (one port and one starboard) scanned constantly from straight ahead to 90 degrees
4 abeam either side of the trackline. The location, species and behavior of every cetacean group
5 was recorded. Sea turtles were recorded in passing mode, but the location and species of all
6 were recorded.

7 Environmental conditions (weather, sea state, depth and sea-surface temperature) were
8 collected at each sighting and whenever survey conditions changed. Sighting and
9 environmental data were collected on an iPad tablet linked to a geographic positioning system
10 (GPS) unit.

11 Use of the survey area by individual cetaceans was examined using photo-identification and
12 biopsy samples were collected for analysis of population structure. Digital photographs were
13 obtained to confirm species identification at each sighting and to compare identification features
14 with those used by the aerial survey team. Photographs were collected with Canon or Nikon
15 digital SLR cameras (equipped with 100 to 400-millimeter zoom lenses) in 24-bit color at a
16 resolution of 3072 X 2048 pixels and saved in JPEG format. Remote biopsy-sampling methods
17 were employed to collect small skin and blubber samples using a variety of 27- to 68-kilogram
18 pull crossbows, depending on the species and sampling distance. Biopsy samples were
19 obtained with a specialized 2.5-centimeter stainless biopsy tip attached to a modified bolt,
20 typically fired from the bow of the survey vessel.

21 **2.1.3 Data Analysis**

22 Vessel survey effort and sighting data were mapped using *ArcGIS* 10.3.2 (ESRI, Redlands, CA).
23 All vessel sighting data collected from January 2015 through December 2015 will be posted on
24 the data archive OBIS-SEAMAP (<http://seamap.env.duke.edu/>).

1 2.1.4 Data Storage

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

4 2.2 Results

5 2.2.1 Vessel Survey Effort

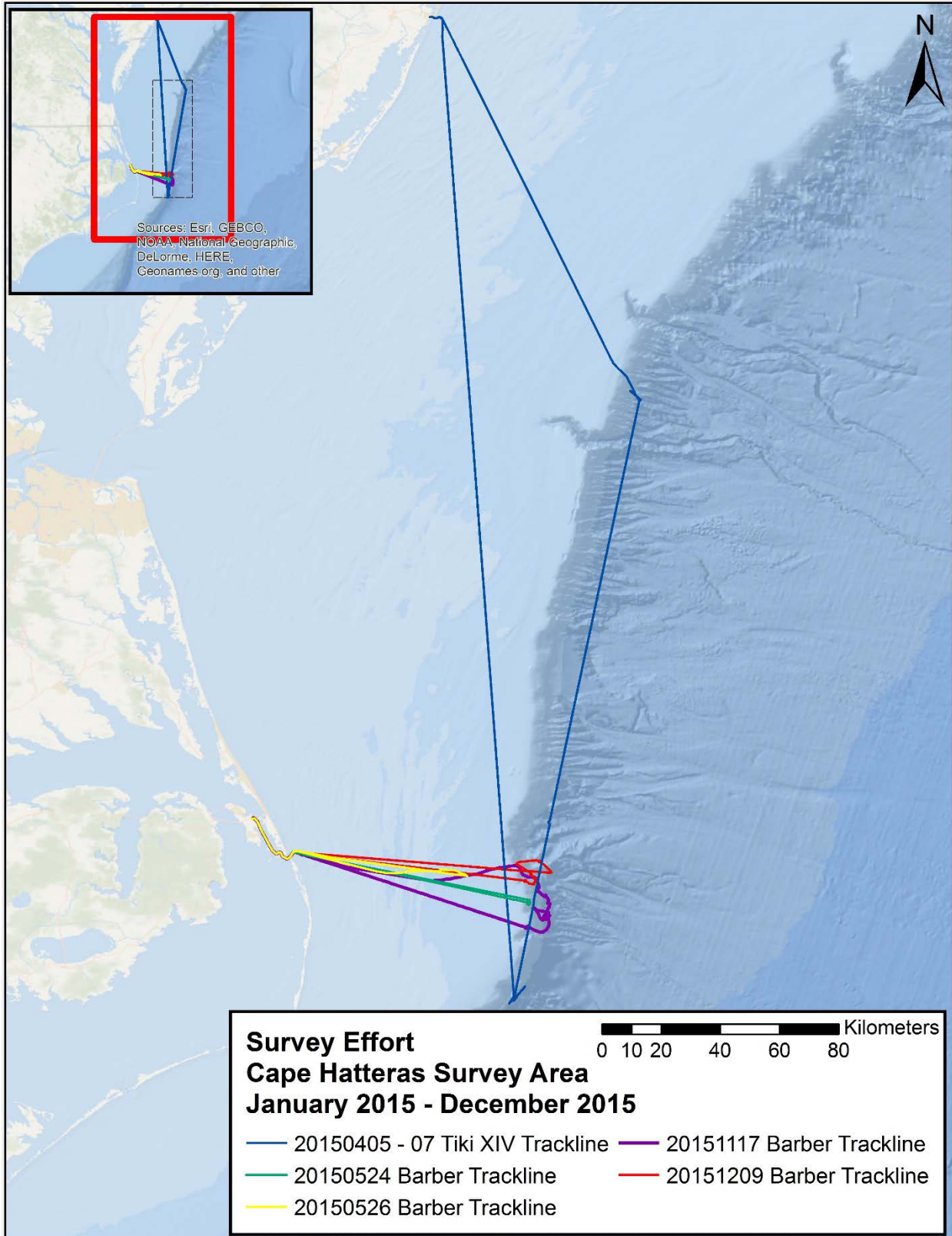
6 Dedicated photo-identification and biopsy vessel surveys were conducted on five days in 2015,
7 totaling 283.2 kilometers (km), or 29.33 hours, of survey effort (**Table 1**). These surveys were
8 executed in Beaufort sea states (BSS) 1 to 5 and covered the south-central portion of the
9 extended Cape Hatteras survey area, including shelf and pelagic waters (**Figure 3**).

10 **Table 1. Dates, distance, and durations surveyed during vessel surveys in the Cape Hatteras**
11 **survey area, January 2015–December 2015.**

Date	Sea State	km Surveyed	Survey Time (hr:min)	At-Sea Time	Platform
6-Apr-15	1-4	108.4	08:36	24:00	C/V <i>Tiki XIV</i>
7-Apr-15	2-3	52.0	04:28	18:47	C/V <i>Tiki XIV</i>
24-May-15	2	19.4	06:11	10:23	R/V <i>R.T. Barber</i>
26-May-15	na	na	na	4:28	R/V <i>R.T. Barber</i>
17-Nov-15	3-5	54.6	04:26	09:10	F/V <i>Samanna</i>
9-Dec-15	0-2	48.8	05:39	09:23	R/V <i>R.T. Barber</i>

12 2.2.2 Marine Mammal and Sea Turtle Sightings

13 Twenty-seven cetacean sightings of seven species were recorded during these vessel surveys.
14 As in previous years, short-finned pilot whales (*Globicephala macrorhynchus*; $n=10$) and
15 bottlenose dolphins (*Tursiops truncatus*; $n=10$) dominated the fauna, along with two sightings of
16 short-beaked common dolphins (*Delphinus delphis*) and single sightings of Risso's dolphins
17 (*Grampus griseus*), sperm whales (*Physeter macrocephalus*), Cuvier's beaked whales (*Ziphius*
18 *cavirostris*) and Atlantic spotted dolphins (*Stenella frontalis*). In addition, one unidentified baleen
19 whale was observed (**Tables 2 and 3**). One sea turtle was recorded in the survey area during
20 2015 (**Table 4**). The distribution of marine mammal and sea turtle sightings in the Cape
21 Hatteras survey area is presented in **Figures 4 through 13**.



1

2 Figure 3. Survey effort during vessel surveys in the Cape Hatteras survey area, January 2015–
3 December 2015.

1 Table 2. Cetacean sightings from vessel surveys in the Cape Hatteras survey area, January 2015–December 2015.

Date	Time	Latitude (N)	Longitude (W)	Species	Common Name	Group Size	Biopsy Samples	Photo-id images	Vessel
6-Apr-15	08:10	35.64340	74.86994	<i>T. truncatus</i>	Bottlenose dolphin	35	0	10	C/V Tiki XIV
6-Apr-15	09:57	35.44673	74.85551	<i>T. truncatus</i>	Bottlenose dolphin	6	0	0	C/V Tiki XIV
6-Apr-15	09:57	35.42228	74.85374	Unidentified baleen whale		1	0	0	C/V Tiki XIV
6-Apr-15	12:45	35.34475	74.85540	<i>T. truncatus</i>	Bottlenose dolphin	6	0	7	C/V Tiki XIV
6-Apr-15	16:24	35.63099	74.78958	<i>G. macrorhynchus</i>	Short-finned pilot whale	3	0	4	C/V Tiki XIV
6-Apr-15	17:04	35.71737	74.77349	<i>P. macrocephalus</i>	Sperm whale	1	0	0	C/V Tiki XIV
6-Apr-15	18:35	35.88642	74.74081	<i>G. macrorhynchus</i>	Short-finned pilot whale	3	0	0	C/V Tiki XIV
7-Apr-15	07:47	37.16638	74.46877	<i>D. delphis</i>	Short-beaked common dolphin	*	0	0	R/V R.T. Barber
24-May-15	08:18	35.64687	74.80033	<i>G. macrorhynchus</i>	Short-finned pilot whale	600	4	1527	R/V R.T. Barber
24-May-15	08:31	35.63686	74.80222	<i>D. delphis</i>	Short-beaked common dolphin	*	1	20	R/V R.T. Barber
24-May-15	11:51	35.63903	74.80584	<i>G. griseus</i>	Risso's dolphin	1	0	18	R/V R.T. Barber
24-May-15	12:06	35.63525	74.80826	<i>T. truncatus</i>	Bottlenose dolphin	10	0	0	R/V R.T. Barber
24-May-15	13:53	35.63381	74.80399	<i>S. frontalis</i>	Atlantic spotted dolphin	20	1	43	R/V R.T. Barber
17-Nov-15	10:43	35.68549	74.77251	<i>T. truncatus</i>	Bottlenose dolphin	10	0	13	F/V Samanna
17-Nov-15	11:17	35.66236	74.75198	<i>T. truncatus</i>	Bottlenose dolphin	15	0	10	F/V Samanna
17-Nov-15	11:37	35.63636	74.73863	<i>T. truncatus</i>	Bottlenose dolphin	35	0	15	F/V Samanna
17-Nov-15	11:47	35.61946	74.74609	<i>T. truncatus</i>	Bottlenose dolphin	30	0	0	F/V Samanna
17-Nov-15	11:59	35.59059	74.75565	<i>G. macrorhynchus</i>	Short-finned pilot whale	100	0	100	F/V Samanna
17-Nov-15	13:14	35.59306	74.74454	<i>T. truncatus</i>	Bottlenose dolphin	40	0	10	F/V Samanna
17-Nov-15	13:44	35.56544	74.81070	<i>G. macrorhynchus</i>	Short-finned pilot whale	18	0	78	F/V Samanna
9-Dec-15	09:17	35.70591	74.81694	<i>G. macrorhynchus</i>	Short-finned pilot whale	8	0	50	R/V R.T. Barber
9-Dec-15	09:40	35.69587	74.78724	<i>G. macrorhynchus</i>	Short-finned pilot whale	10	0	127	R/V R.T. Barber
9-Dec-15	10:18	35.70780	74.77733	<i>Z. cavirostris</i>	Cuvier's beaked whale	5	0	21	R/V R.T. Barber
9-Dec-15	12:31	35.71545	74.78739	<i>G. macrorhynchus</i>	Short-finned pilot whale	6	1	103	R/V R.T. Barber
9-Dec-15	13:01	35.72199	74.79626	<i>G. macrorhynchus</i>	Short-finned pilot whale	6	1	111	R/V R.T. Barber
9-Dec-15	13:34	35.75620	74.83992	<i>G. macrorhynchus</i>	Short-finned pilot whale	6	0	287	R/V R.T. Barber
9-Dec-15	14:08	35.76395	74.77182	<i>T. truncatus</i>	Bottlenose dolphin	100	0	22	R/V R.T. Barber

* group size not estimated due to geographic span not covered by vessel

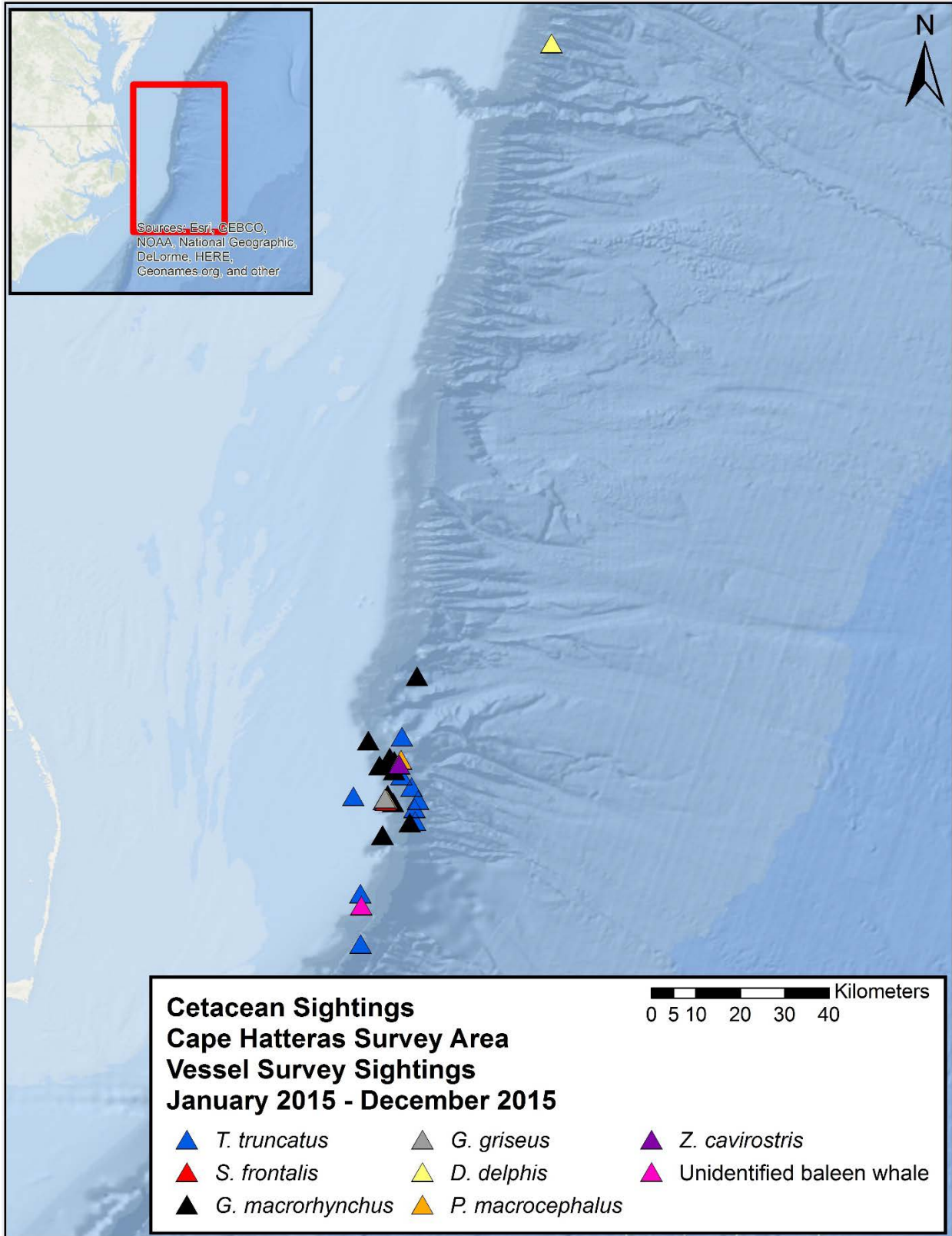
1 **Table 3. Numbers of cetacean sightings for each species observed in the Cape Hatteras survey**
 2 **area, January–December 2015.**

Species	Sightings 2015
<i>Delphinus delphis</i>	2
<i>Globicephala macrorhynchus</i>	10
<i>Grampus griseus</i>	1
<i>Physeter macrocephalus</i>	1
<i>Stenella frontalis</i>	1
<i>Tursiops truncatus</i>	10
<i>Ziphius cavirostris</i>	1
Unidentified baleen whale	1
Total:	27

3 **Table 4. Sea turtle sightings from vessel surveys in the Cape Hatteras survey area, January 2015–**
 4 **December 2015.**

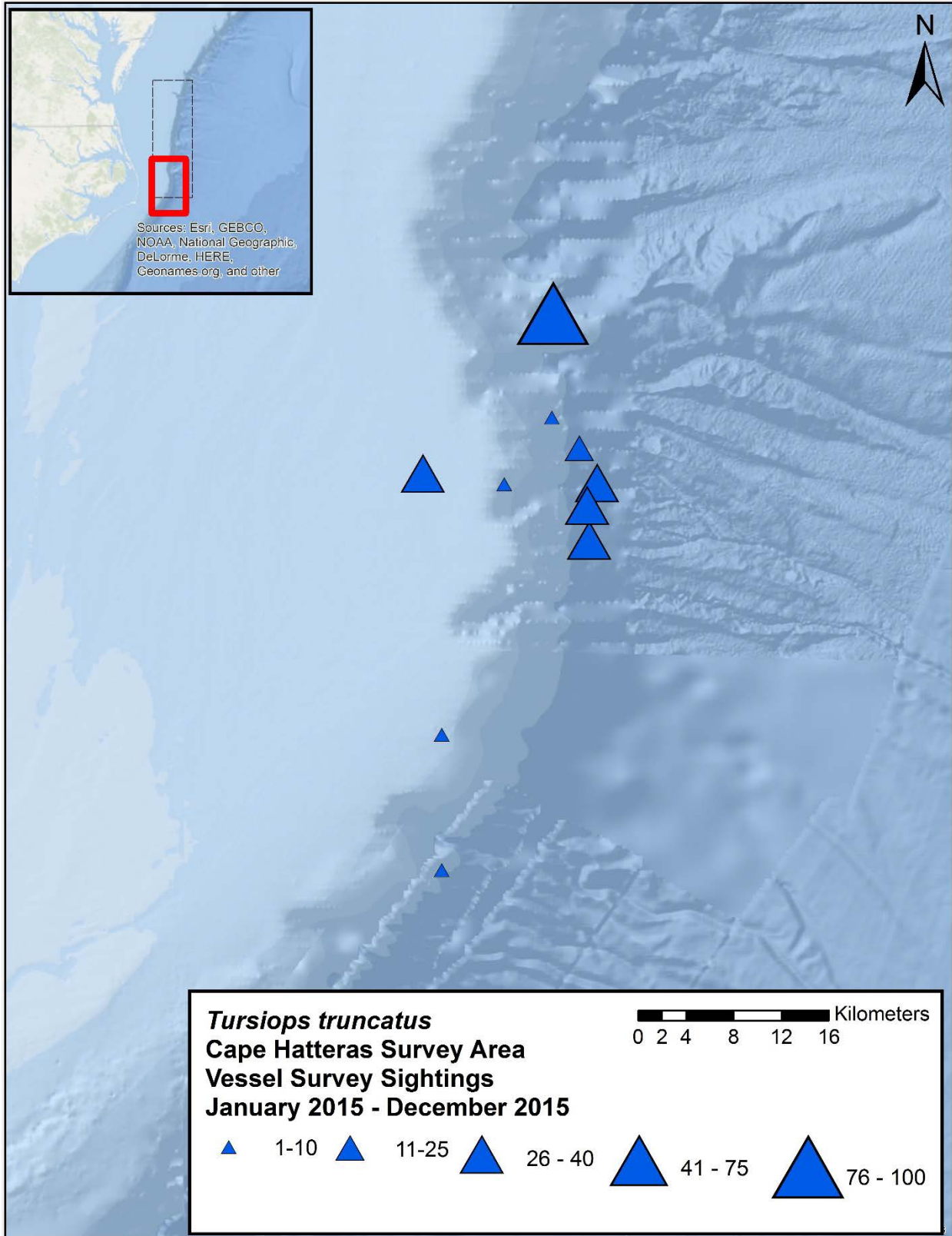
Date	Time	Latitude (N)	Longitude (W)	Species	Common Name	Group Size	Vessel
24-May-15	12:53	35.63851	74.79895	<i>C. caretta</i>	Loggerhead turtle	1	R/V <i>R.T. Barber</i>

5



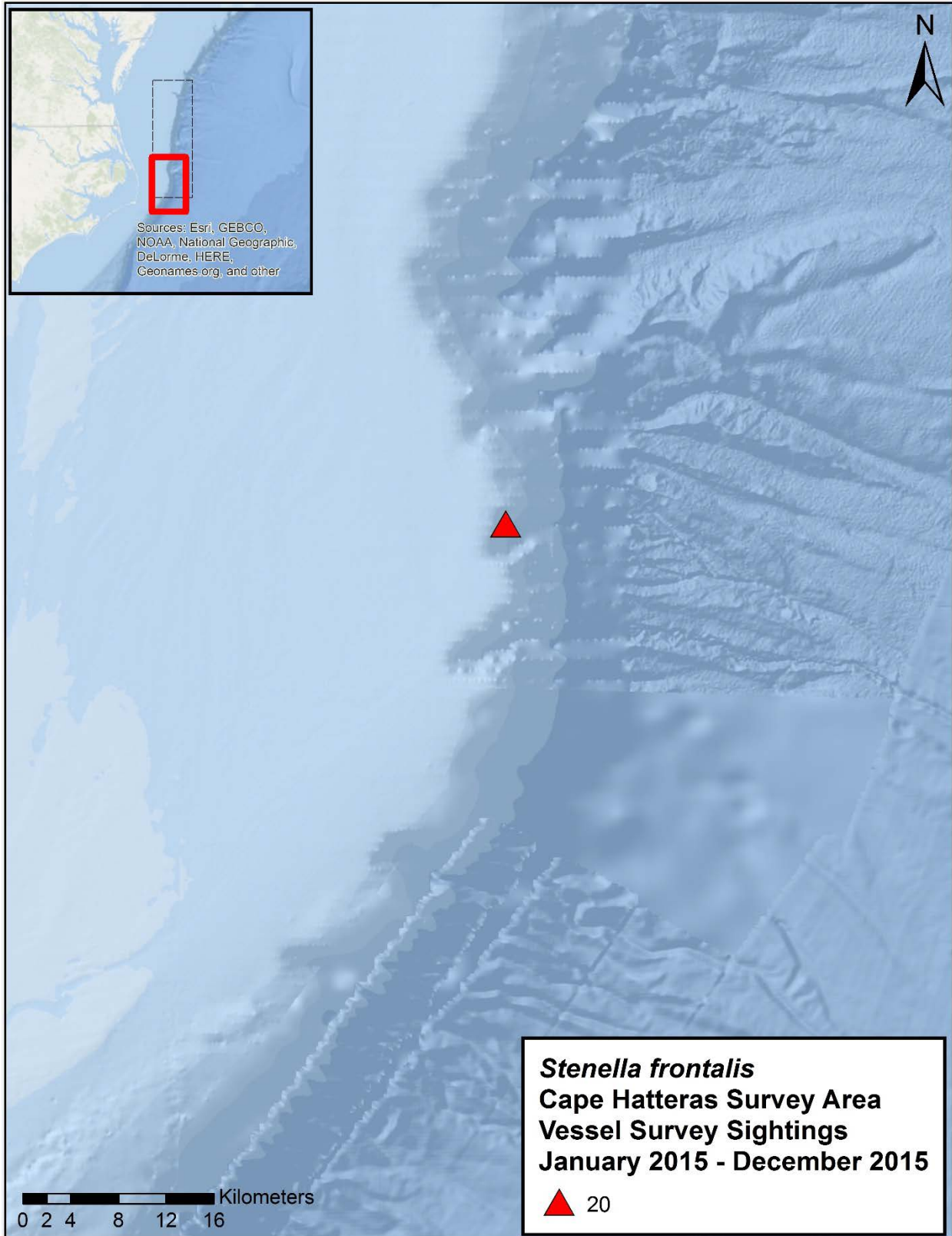
1

2 Figure 4. Distribution of all cetacean sightings made during vessel surveys in the Cape Hatteras
3 survey area, January 2015–December 2015.

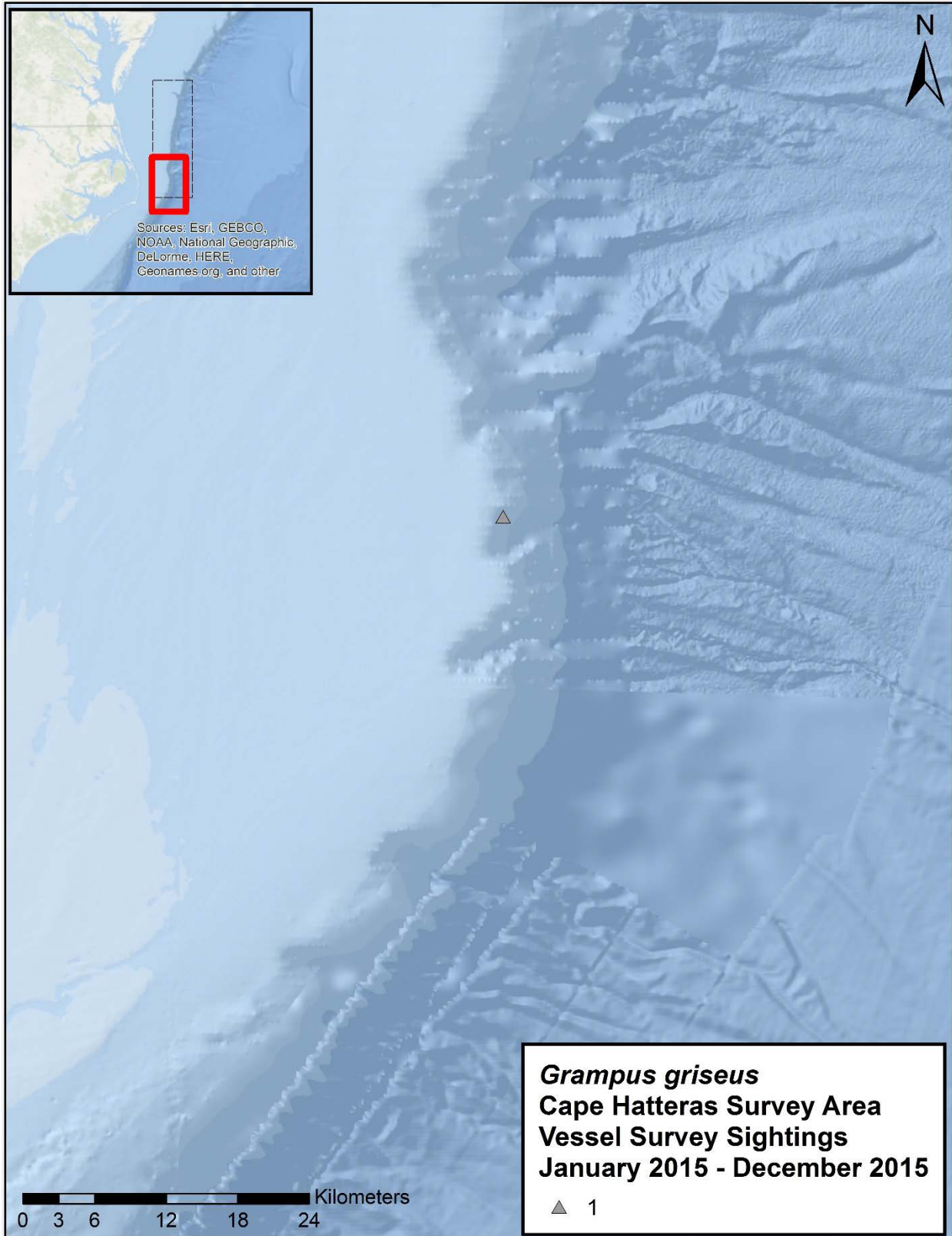


1

2 Figure 5. Distribution of bottlenose dolphin sightings, indicating group size, made during vessel
3 surveys in the Cape Hatteras survey area, January 2015–December 2015.

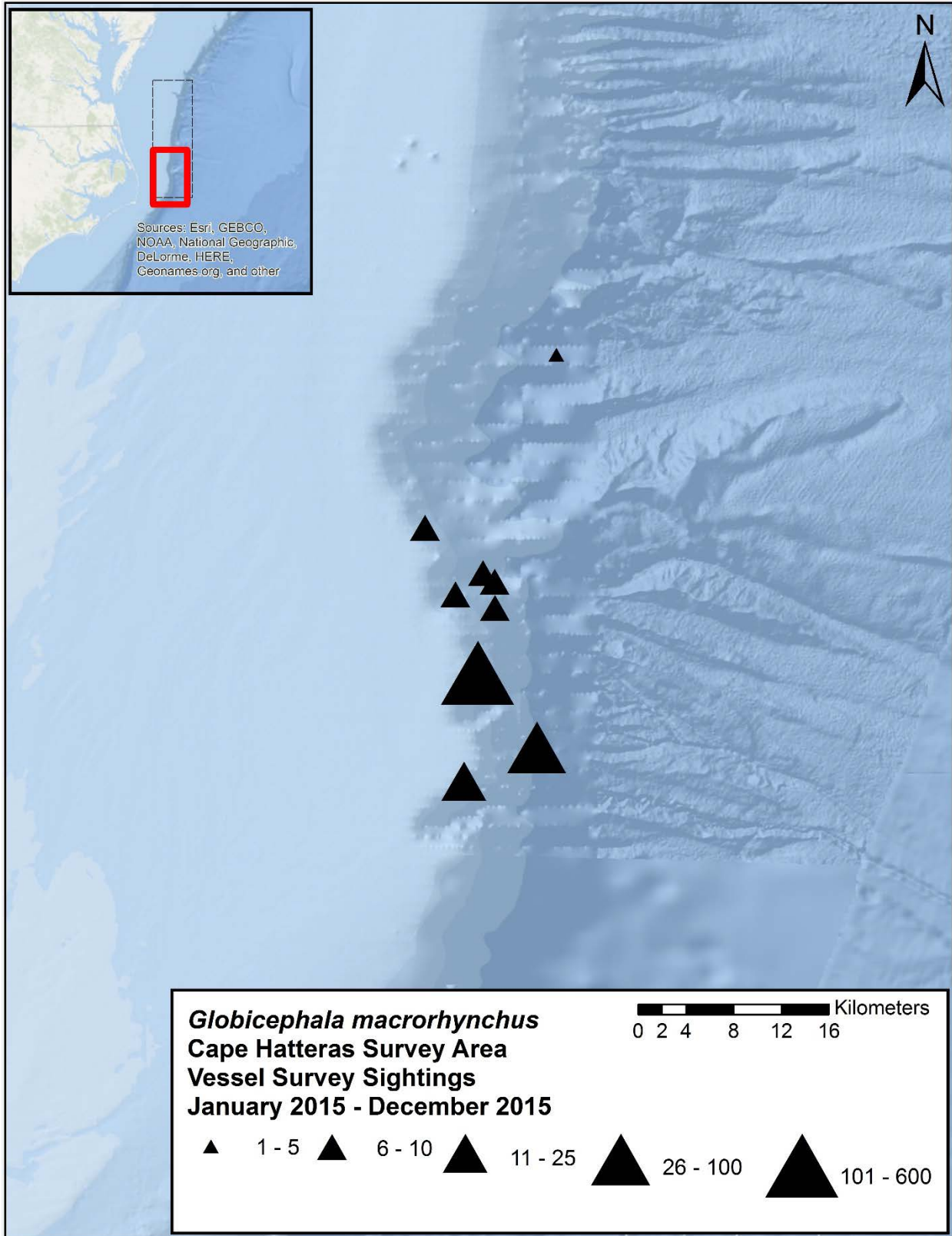


1
2 Figure 6. Distribution of Atlantic spotted dolphin sightings, indicating group size, made during
3 vessel surveys in the Cape Hatteras survey area, January 2015–December 2015.

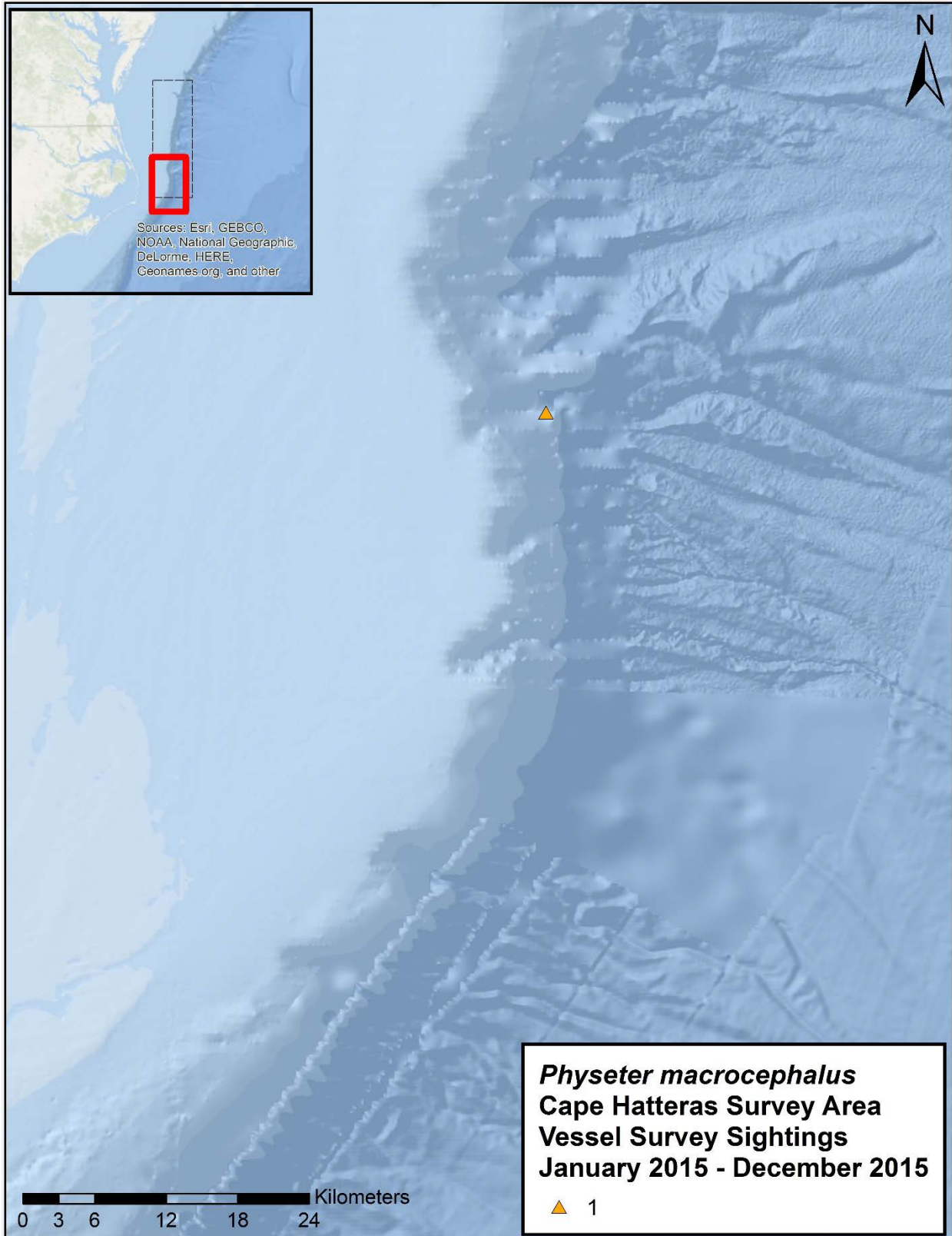


1

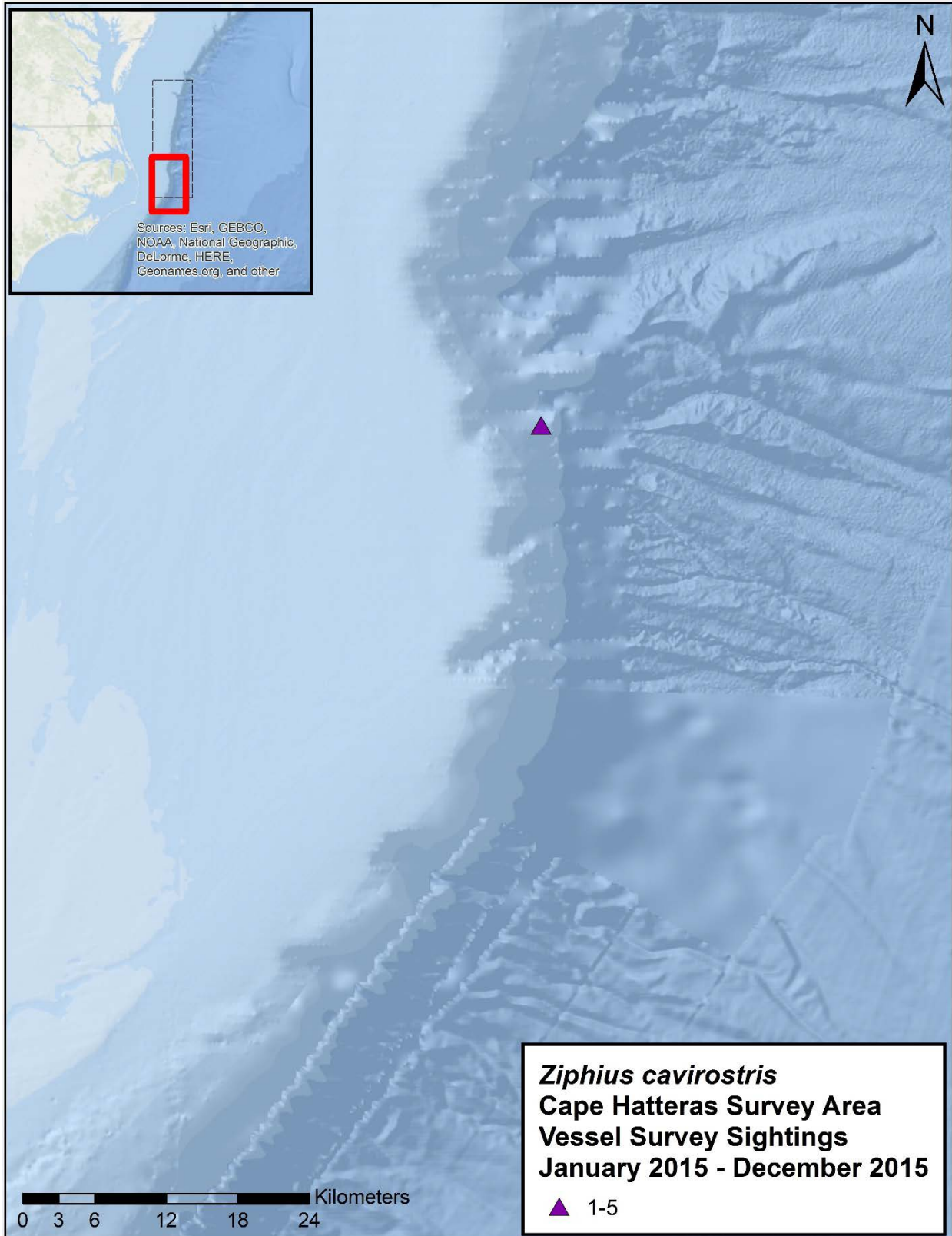
2 Figure 7. Distribution of Risso's dolphin sightings, indicating group size, made during vessel
3 surveys in the Cape Hatteras survey area, January 2015–December 2015.



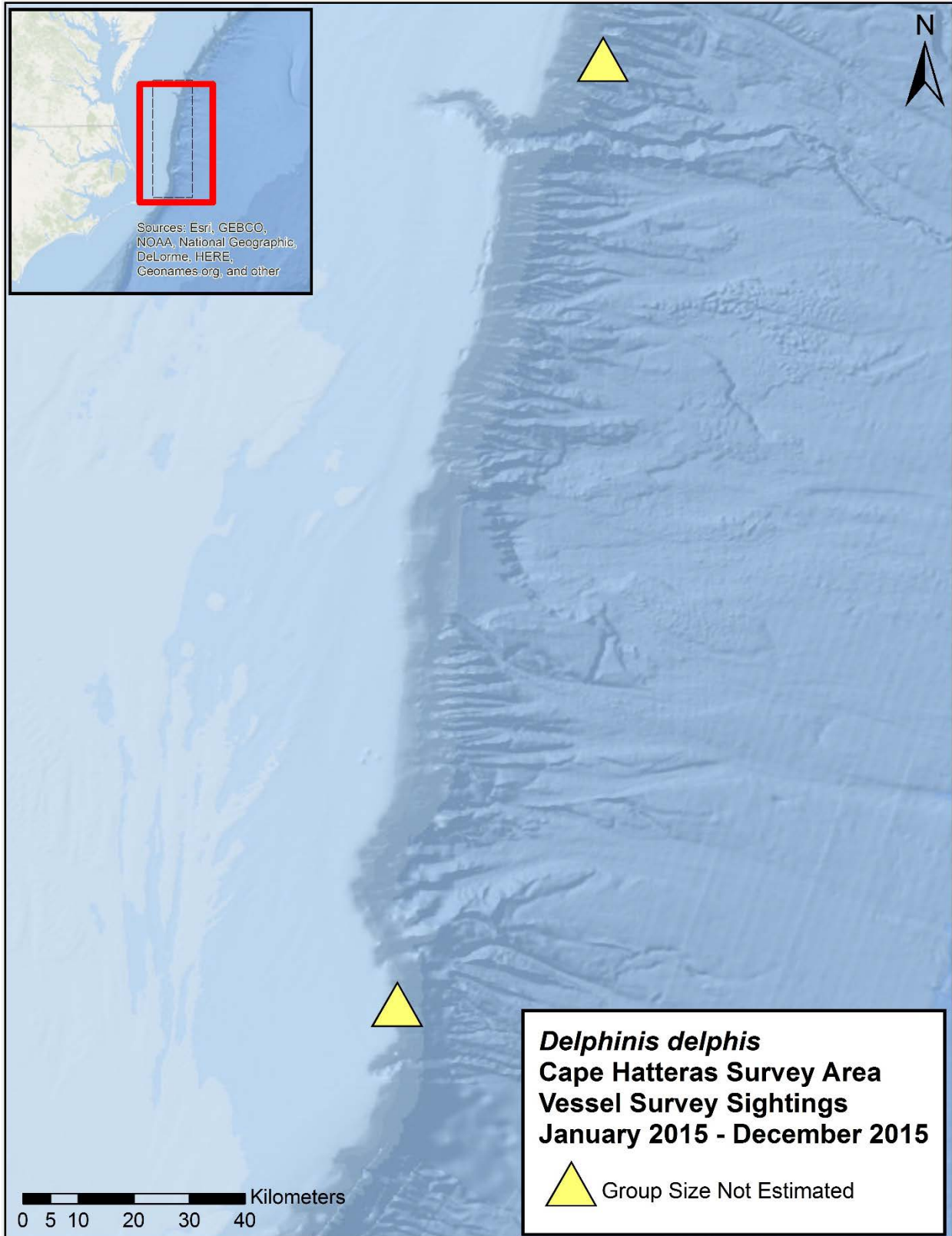
1
2 Figure 8. Distribution of short-finned pilot whale sightings, indicating group size, made during
3 vessel surveys in the Cape Hatteras survey area, January 2015–December 2015.



1
2 Figure 9. Distribution of sperm whale sightings, indicating group size, made during vessel
3 surveys in the Cape Hatteras survey area, January 2015–December 2015.

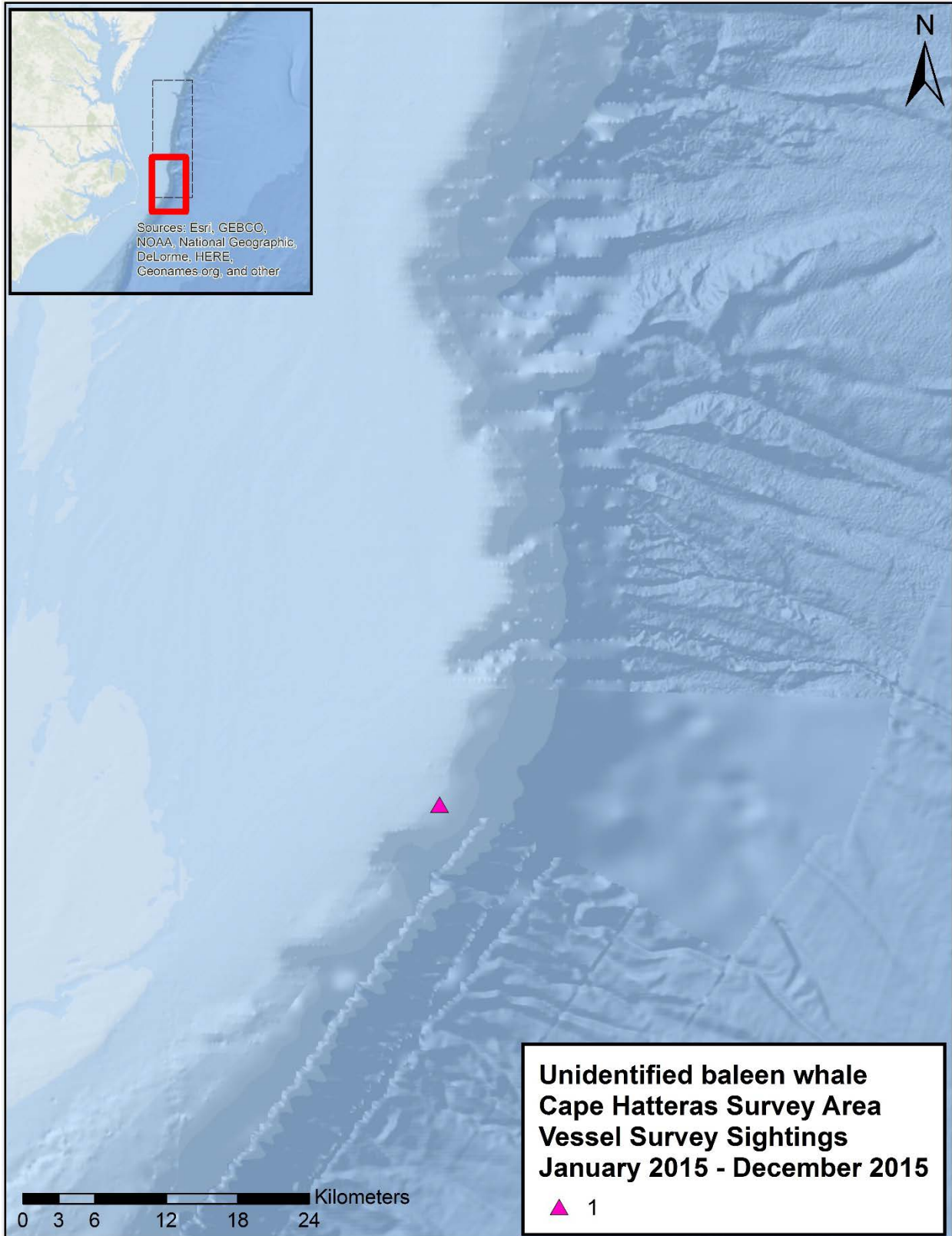


2 Figure 10. Distribution of Cuvier's beaked whale sightings, indicating group, size made during
3 vessel surveys in the Cape Hatteras survey area, January 2015–December 2015.

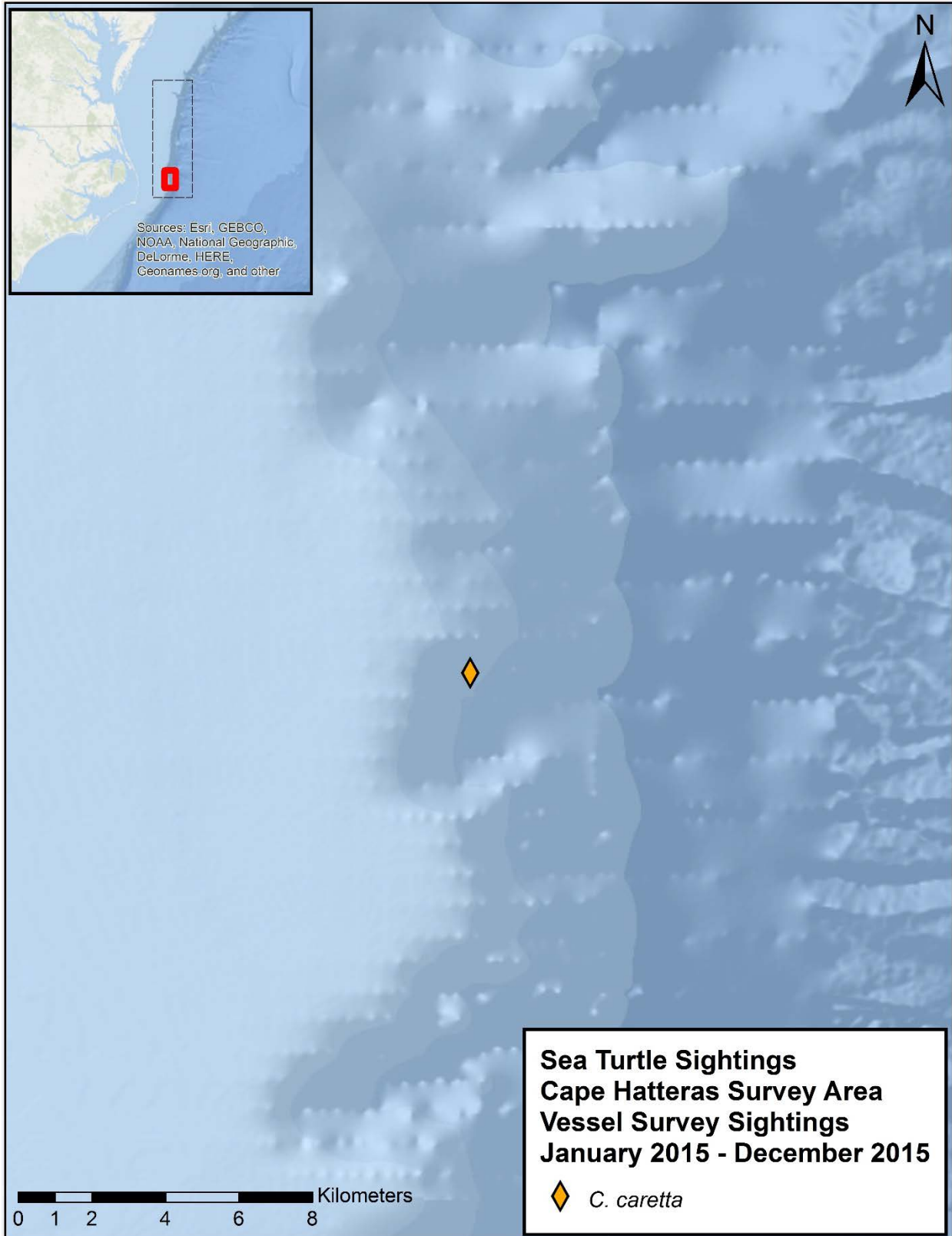


1

2 Figure 11. Distribution of short-beaked common dolphin sightings made during vessel surveys in
3 the Cape Hatteras survey area, January 2015–December 2015.



1
2 Figure 12. Distribution of unidentified baleen whale sightings, indicating group size, made during
3 vessel surveys in the Cape Hatteras survey area, January 2015–December 2015.



1

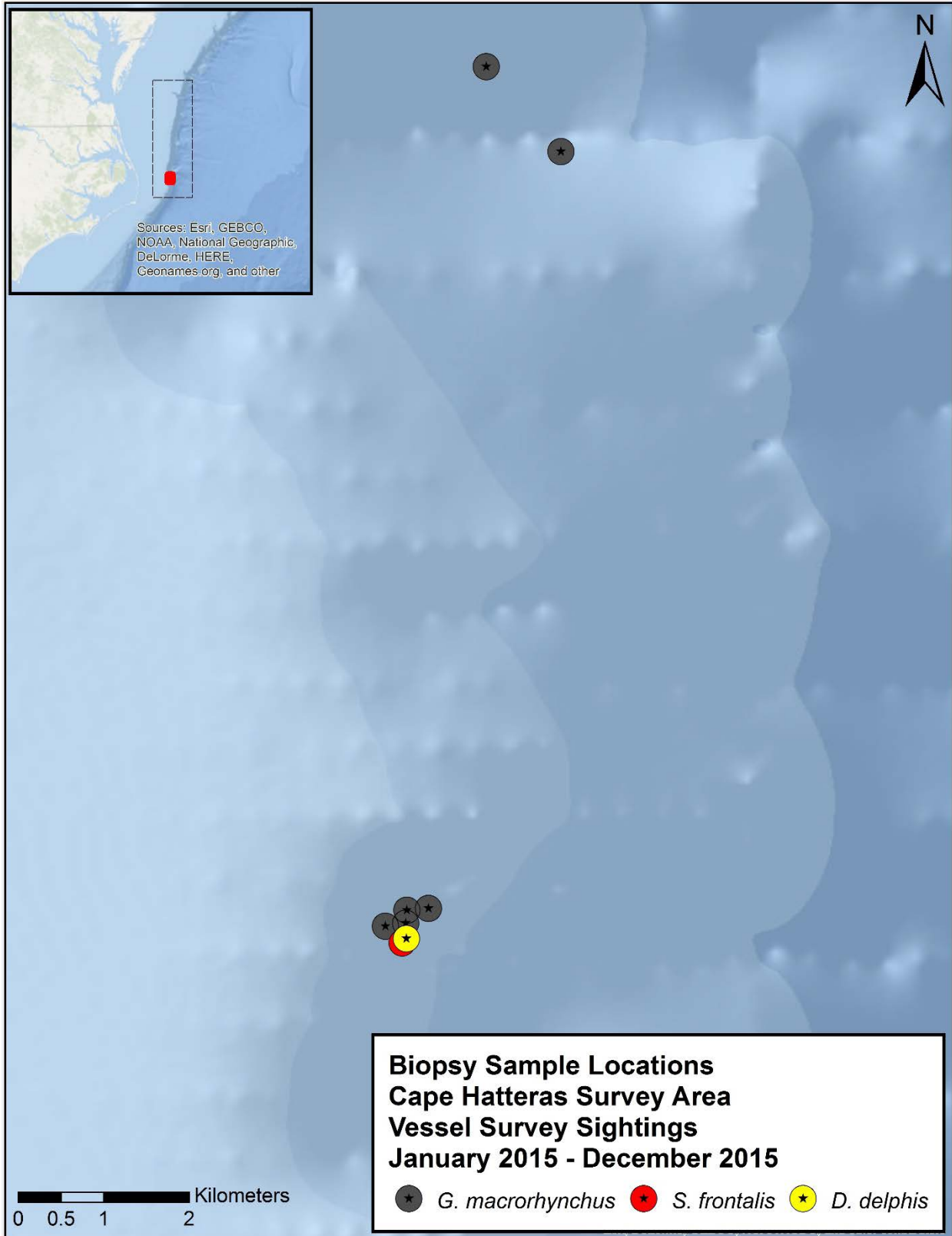
2 Figure 13. Distribution of sea turtle sightings made during vessel surveys in the Cape Hatteras
3 survey area, January 2015–December 2015.

1 2.2.3 Biopsy Sampling

2 Eight biopsy samples were collected in the Cape Hatteras survey area during 2015 from short-
 3 finned pilot whales ($n=6$), Atlantic spotted dolphins ($n=1$) and short-beaked common dolphins
 4 ($n=1$) (**Table 5** and **Figure 14**). Skin samples will be analyzed for sex determination. Voucher
 5 specimens of these samples are archived with the National Marine Fisheries Service's
 6 Southeast Fisheries Science Center in Lafayette, Louisiana.

7 **Table 5. Biopsy samples collected in the Cape Hatteras survey area, January 2015–December**
 8 **2015.**

Date	Time	Latitude (N)	Longitude (W)	Species	Sample #
24-May-15	08:41	35.63406	74.80441	<i>D. delphis</i>	ZTS_15_07
24-May-15	09:02	35.63567	74.80447	<i>G. macrorhynchus</i>	ZTS_15_08
24-May-15	09:29	35.63724	74.80207	<i>G. macrorhynchus</i>	ZTS_15_09
24-May-15	11:18	35.63705	74.80436	<i>G. macrorhynchus</i>	ZTS_15_10
24-May-15	13:46	35.63537	74.80661	<i>G. macrorhynchus</i>	HJF_15_01
24-May-15	14:03	35.63361	-74.80486	<i>S. frontalis</i>	ZTS_15_11
9-Dec-15	12:40	35.71690	74.78812	<i>G. macrorhynchus</i>	ZTS_15_27
9-Dec-15	13:12	35.72586	74.79599	<i>G. macrorhynchus</i>	ZTS_15_28



1

2 Figure 14. Locations of biopsy samples collected in the Cape Hatteras survey area, January 2015–
3 December 2015.

1 2.2.4 Photographic Effort

2 Over 10,000 digital images were obtained to determine species confirmation and identify
 3 individual animals during fieldwork in 2015. Images of 203 newly identified animals were added
 4 to seven existing catalogs of bottlenose dolphins, Atlantic spotted dolphins, short-finned pilot
 5 whales, sperm whales, Cuvier's beaked whales, short-beaked common dolphins, and Risso's
 6 dolphins. In 2015, a new photo-ID catalog was established for *Kogia* spp. observed in the Cape
 7 Hatteras study area. To date, photo-ID catalogs for 10 species have been assembled from both
 8 small vessel surveys and tagging field work, with 76 individuals re-sighted across all species
 9 (**Table 6**).

10 **Table 6. Summary of images collected during all fieldwork in the Cape Hatteras survey area,**
 11 **January 2015–December 2015, with photo-identification catalog sizes and total matches to date.**

Species	Images 2015	Catalog Size	Matches
<i>Balaenoptera physalus</i>	0	1	0
<i>Delphinus delphis</i>	20	30	1
<i>Globicephala macrorhynchus</i>	8068	367	61
<i>Grampus griseus</i>	39	8	0
<i>Kogia</i> spp.	77	1	0
<i>Megaptera novaeangliae</i>	0	2	0
<i>Physeter macrocephalus</i>	345	13	1
<i>Stenella frontalis</i>	52	24	0
<i>Tursiops truncatus</i>	938	221	9
<i>Ziphius cavirostris</i>	807	42	4

12 Photo-analysis of the images taken in the Cape Hatteras area is ongoing. To date, nine
 13 bottlenose dolphins have been photographed on multiple occasions, spanning several years
 14 (**Table 7**). Bottlenose dolphin Ttr 1-001 was first photographed on 20 July 2009, re-sighted on
 15 30 May 2011, and then photographed for a third time on 27 June 2011. Ttr 6-018 and Ttr 9-013
 16 were photographed together in both March 2012 and May 2013. Ttr 6-020 was observed in May
 17 2011 and then again in October 2013. Ttr 7-031 and Ttr 7-038 were photographed on two
 18 separate occasions in 2011, and Ttr 7-058 was observed twice within 2013. Ttr 9-016 was
 19 initially photographed in 2011 and then again in June 2014. Ttr 9-027, first observed on 11 June
 20 2014 (TtTag015), was observed a second time on 16 June 2014.

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

1 **Table 7. Photo-identification matches of individual odontocete cetaceans, excluding pilot whales,**
 2 **in the Cape Hatteras survey area.**

ID	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
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-001r								X		X
Zca-003r (ZcTag029)									X ^m	
Zca-005r									X ^y	
Zca-006 (ZcTag040)									X	X

^m - re-sighted within same month

^y - re-sighted within same year

[^]Observed together in multiple sightings

3 A single sperm whale match has been made; Pma-004 was observed on 27 and 29 May in
 4 2013.

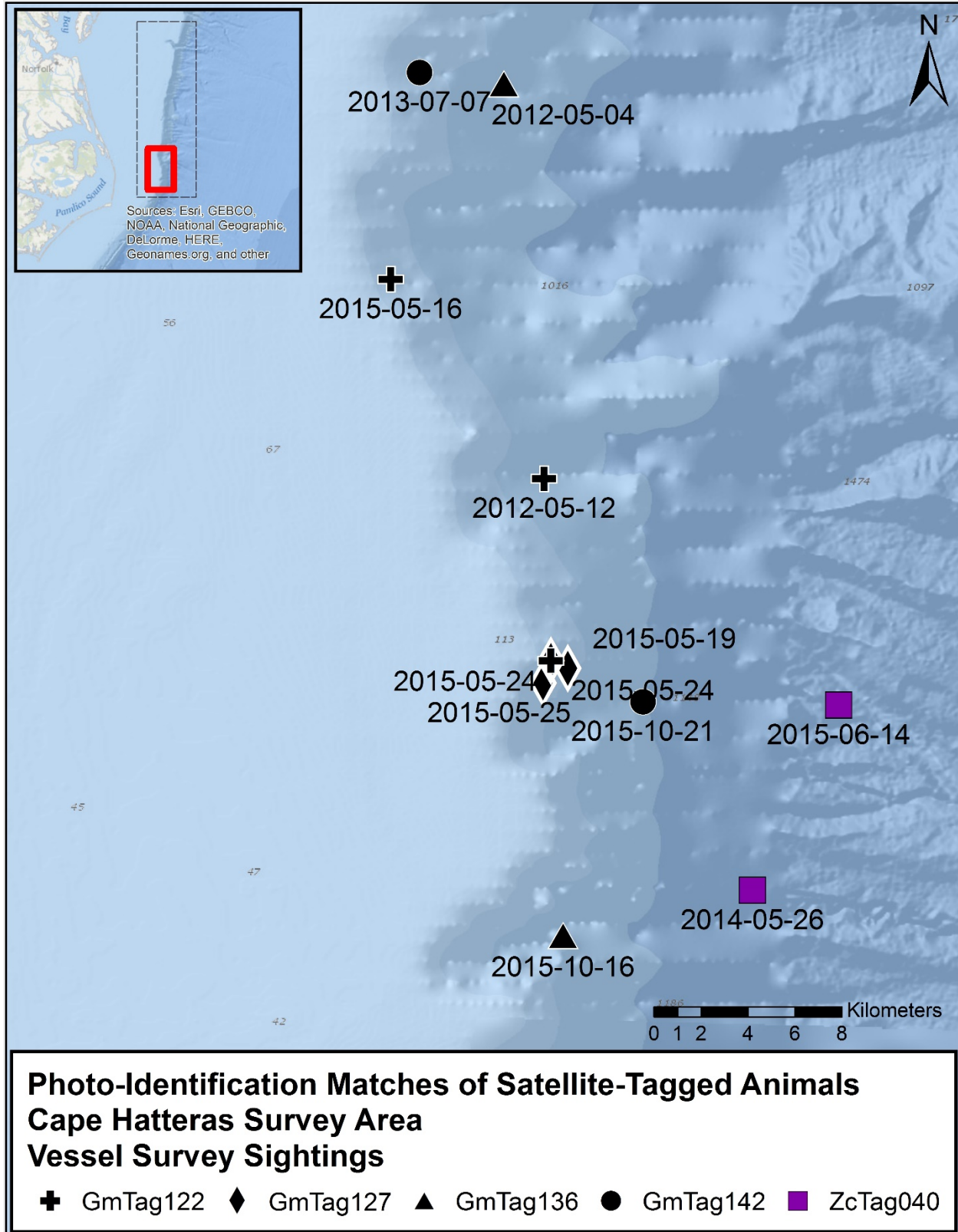
5 Four beaked whale matches have been made to date; two were made during this reporting
 6 period. Zca_003r, was satellite-tagged on 13 May 2014 (ZcTag029) and photographed again
 7 five days later. Zca_005r was photographed in May and October of 2014. Zca_006 was first
 8 photographed on 26 May 2014 and was Dtagged at that time, although the tag was never
 9 recovered. On 14 June 2015 it was re-sighted and satellite-tagged (ZcTag040) (**Figures 15 and**
 10 **16**). The final match is individual Zca_001r who was photographed in a group of four animals on
 11 05 October 2013 and was photographed again on 14 June 2015 in a group of five to seven
 12 whales. This individual represents our longest re-sight of a beaked whale and is also an inter-
 13 seasonal match (**Table 7**).

14 Observers continue to be surprised by the relatively high re-sighting rate of short-finned pilot
 15 whales in the Hatteras study area. To date more than 16 percent (61 of 367) of the pilot whales
 16 in the catalog have been re-sighted, compared to 2014 when the re-sight rate of pilot whales
 17 was only 10 percent (25 of 229).



1

2 **Figure 15. Photo-identification match of a 2015 satellite-tagged Cuvier's beaked whale observed**
3 **during fieldwork in the Cape Hatteras survey area.**



1
2 Figure 16. Photo-identification matches of 2015 satellite-tagged animals, with dates sighted,
3 observed during fieldwork in the Cape Hatteras survey area.

1 Four of the 19 short-finned pilot whales equipped with satellite tags in 2015 were either re-
 2 sighted or matched to the existing catalog. GmTag127 was satellite-tagged on 19 May 2015 and
 3 then re-sighted on both 24 and 25 May. GmTag136 was Dtagged in May of 2012, re-sighted for
 4 the first time in May of 2015 and subsequently re-sighted and satellite-tagged in October of
 5 2015. GmTag142 was first photographed in July of 2010; it was seen again in July of 2013 and
 6 then satellite-tagged in October of 2015. GmTag 122 was first seen in May of 2012; it was
 7 satellite-tagged on 16 May of 2015 and then sighted for a third time on 24 May 2015.
 8 Interestingly, Gma_2-011 (a female) was seen in the same three sightings as GmTag122 over
 9 the three-year span (**Figures 16 and 17**).



10
 11 **Figure 17. Photo-identification matches of 2015 satellite-tagged short-finned pilot whales**
 12 **observed in the Cape Hatteras survey area.**

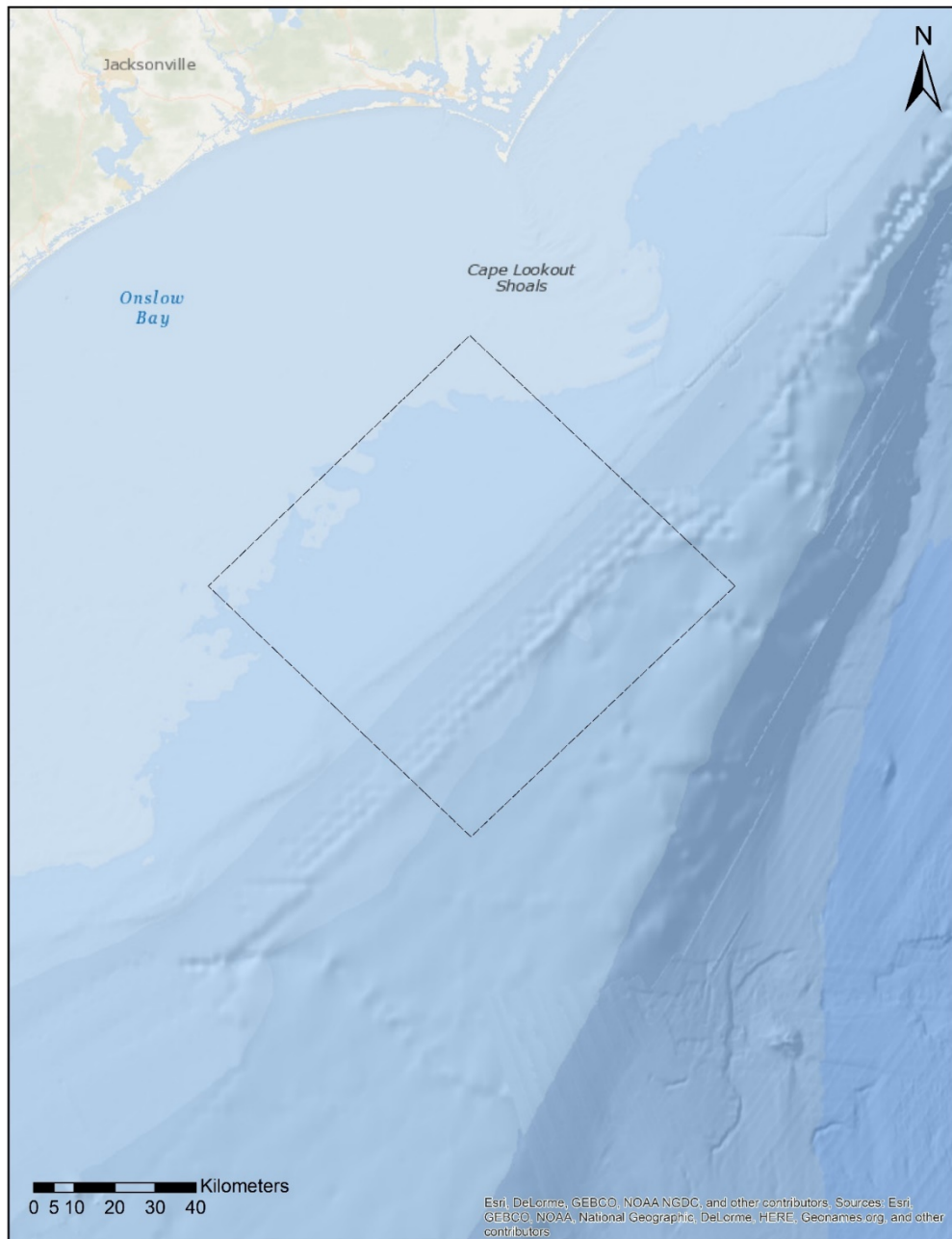
13 Re-sightings of short-finned pilot whales span up to nearly nine years, with several individuals
 14 observed on multiple occasions and in different seasons. One pair, Gma_151d and Gma_7-138,
 15 were photographed in the same sighting in May of 2007 and in another sighting over six years
 16 later in October of 2013. In addition, the longest match to date was recently made, with
 17 Gma_008d initially sighted in September of 2006 and re-sighted in May of 2015. This year a
 18 match was also made to an individual, Gma_9-027, who has been photographed in five
 19 separate sightings between May of 2008 and May of 2015.

1 3. Onslow Bay Vessel Surveys

2 3.1 Methods

3 3.1.1 Study Area

4 The Onslow Bay study area is approximately 5,560 square kilometers (km²). The study area
5 straddles the continental shelf break, including some of the Blake Plateau, and includes both
6 shelf and pelagic waters (**Figure 18**).



7
8 **Figure 18. Map of the Onslow Bay study area.**

1 3.1.2 Data Collection

2 Vessel survey effort in Onslow Bay during 2015 consisted of two opportunistic surveys aboard
 3 the Research Vessel (R/V) *Richard T. Barber*, a U.S. Coast Guard-approved offshore research
 4 vessel outfitted with a bow pulpit, satellite phone, lifeboat and wireless communication system.
 5 One survey was focused on testing the feasibility of deploying a four-element distributed
 6 hydrophone array from the research vessel. This array enables the localization of vocalizations
 7 produced by delphinids. The ability to localize vocalizations to groups of animals, observed at
 8 the surface, will allow ascription of vocal events to surface behaviors. In addition, the array will
 9 provide species-specific voucher recordings for use in ongoing research in the classification of
 10 whistles and clicks. This type of adaptable array, used in conjunction with tagging studies, will
 11 help to better analyze and provide context to acoustic recordings obtained from tag data. The
 12 array functioned as intended and recordings were obtained from both bottlenose dolphins and
 13 Atlantic spotted dolphins. The second survey occurred following two consecutive days of
 14 reported fin whale sightings within a few miles of the Beaufort Inlet. An opportunistic vessel
 15 survey was conducted in an attempt to collect photo-id images and a biopsy sample. However,
 16 deteriorating weather conditions precluded observers from locating the whale.

17 Use of the survey area by individual cetaceans was examined using photo-identification. Digital
 18 photographs were obtained to confirm species identification at each sighting. Photographs were
 19 collected with Canon or Nikon digital SLR cameras (equipped with 100 to 400-millimeter zoom
 20 lenses) in 24-bit color at a resolution of 3072 X 2048 pixels and saved in JPEG format.

21 3.1.3 Data Analysis

22 Vessel survey effort and sighting data were mapped using *ArcGIS* 10.3.2. All vessel sighting
 23 data collected from January 2015 through December 2015 will be posted on the data archive
 24 OBIS-SEAMAP (<http://seamap.env.duke.edu/>).

25 3.1.4 Data Storage

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

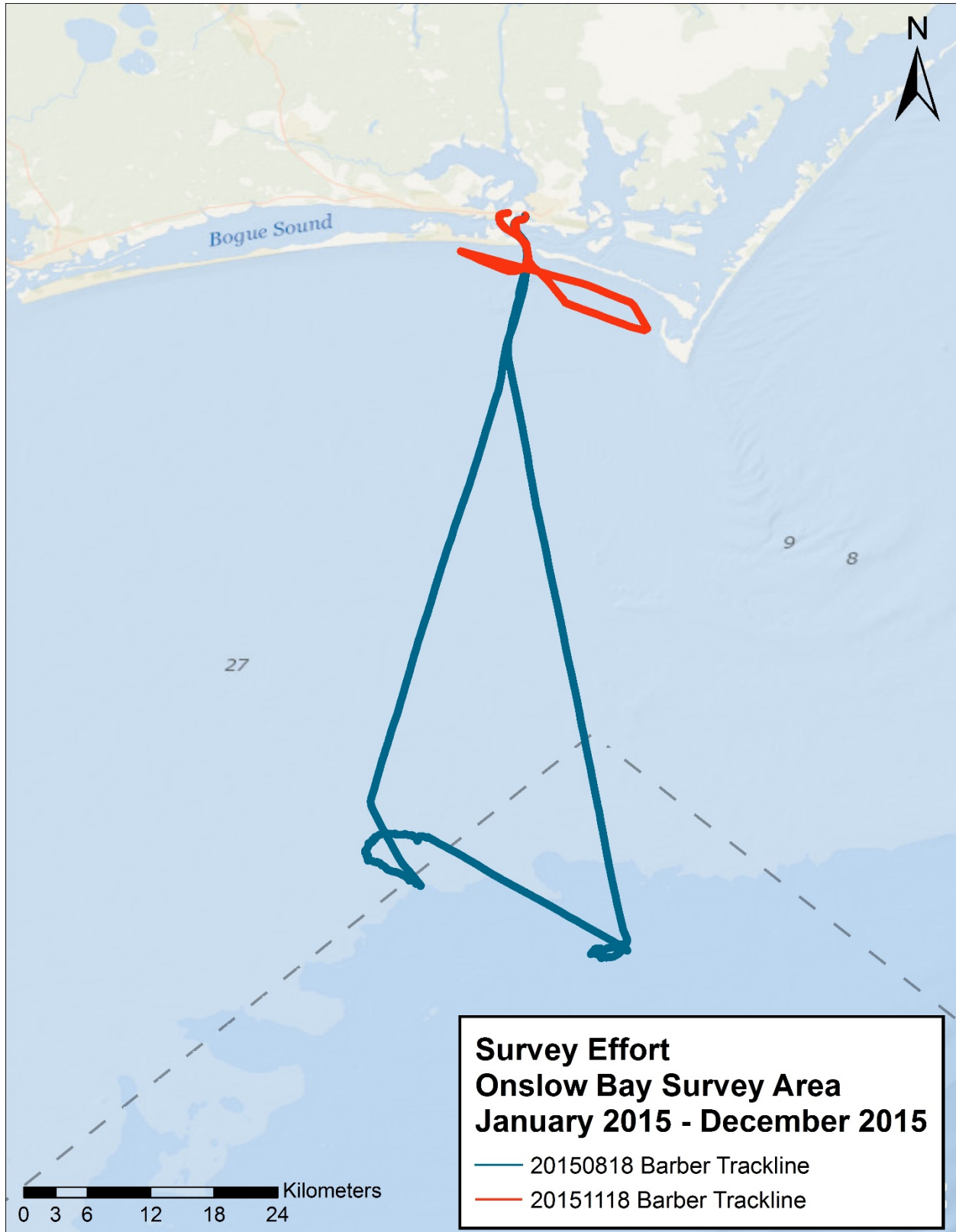
28 3.2 Results

29 3.2.1 Vessel Survey Effort

30 Two vessel surveys were conducted in 2015, totaling 122.1 kilometers (km), or 9.08 hours, of
 31 survey effort (**Table 8**). These surveys were conducted in Beaufort sea states (BSS) 0 to 5 and
 32 covered a small portion of the Onslow Bay survey area and surrounding coastal waters (**Figure**
 33 **19**).

34 **Table 8. Dates, distance, and durations surveyed during vessel surveys in the Onslow Bay survey**
 35 **area, January 2015–December 2015.**

Date	Sea State	km Surveyed	Survey Time (hr:min)	At-Sea Time	Platform
18-Aug-15	0-2	87.1	06:50	08:55	R/V <i>R. T. Barber</i>
18-Nov-15	3-5	35.0	02:15	03:32	R/V <i>R. T. Barber</i>



1

2 Figure 19. Survey effort during vessel surveys in the Onslow Bay survey area, January 2015–
3 December 2015.

3.2.2 Marine Mammal and Sea Turtle Sightings

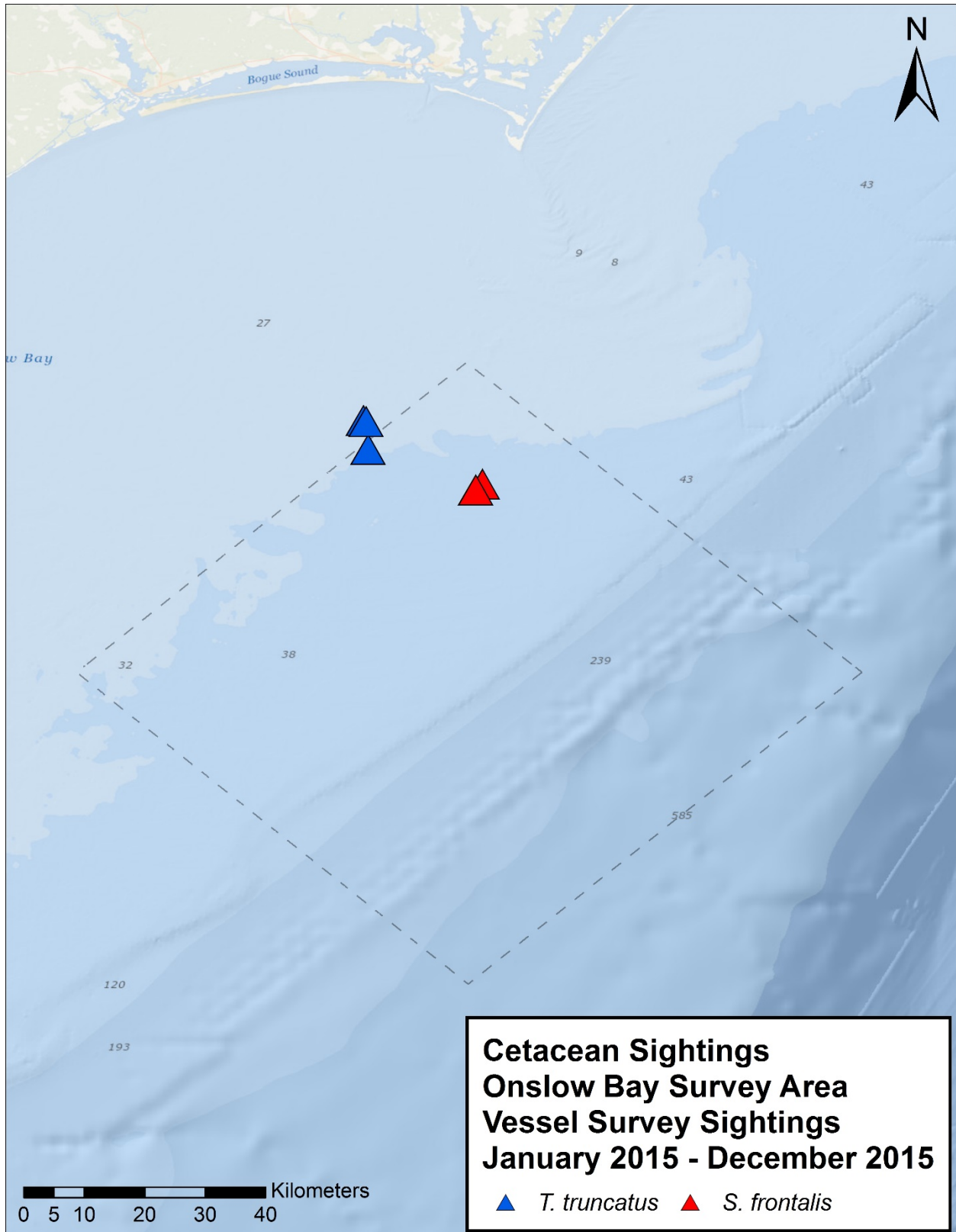
Five cetacean sightings of two species were recorded during these vessel surveys: bottlenose dolphins ($n=3$) and Atlantic spotted dolphins ($n=2$) (**Tables 9 and 10**). No sea turtles were sighted during these vessel surveys. The distribution of marine mammal sightings in the Onslow Bay survey area is presented in **Figures 20** through **22**.

Table 9. Cetacean sightings from vessel surveys in the Onslow Bay survey area, January 2015–December 2015.

Date	Time	Latitude (N)	Longitude (W)	Species	Common Name	Group Size	Biopsy Samples	Photo-id images	Vessel
18-Aug-15	09:52	34.14769	76.75981	<i>T. truncatus</i>	Bottlenose dolphin	6	0	71	R/V R.T. Barber
18-Aug-15	12:22	34.19082	76.76697	<i>T. truncatus</i>	Bottlenose dolphin	4	0	23	R/V R.T. Barber
18-Aug-15	12:28	34.18922	76.76289	<i>T. truncatus</i>	Bottlenose dolphin	7	0	75	R/V R.T. Barber
18-Aug-15	13:36	34.09587	76.58967	<i>S. frontalis</i>	Atlantic spotted dolphin	4	0	24	R/V R.T. Barber
18-Aug-15	14:02	34.08719	76.59951	<i>S. frontalis</i>	Atlantic spotted dolphin	13	0	102	R/V R.T. Barber

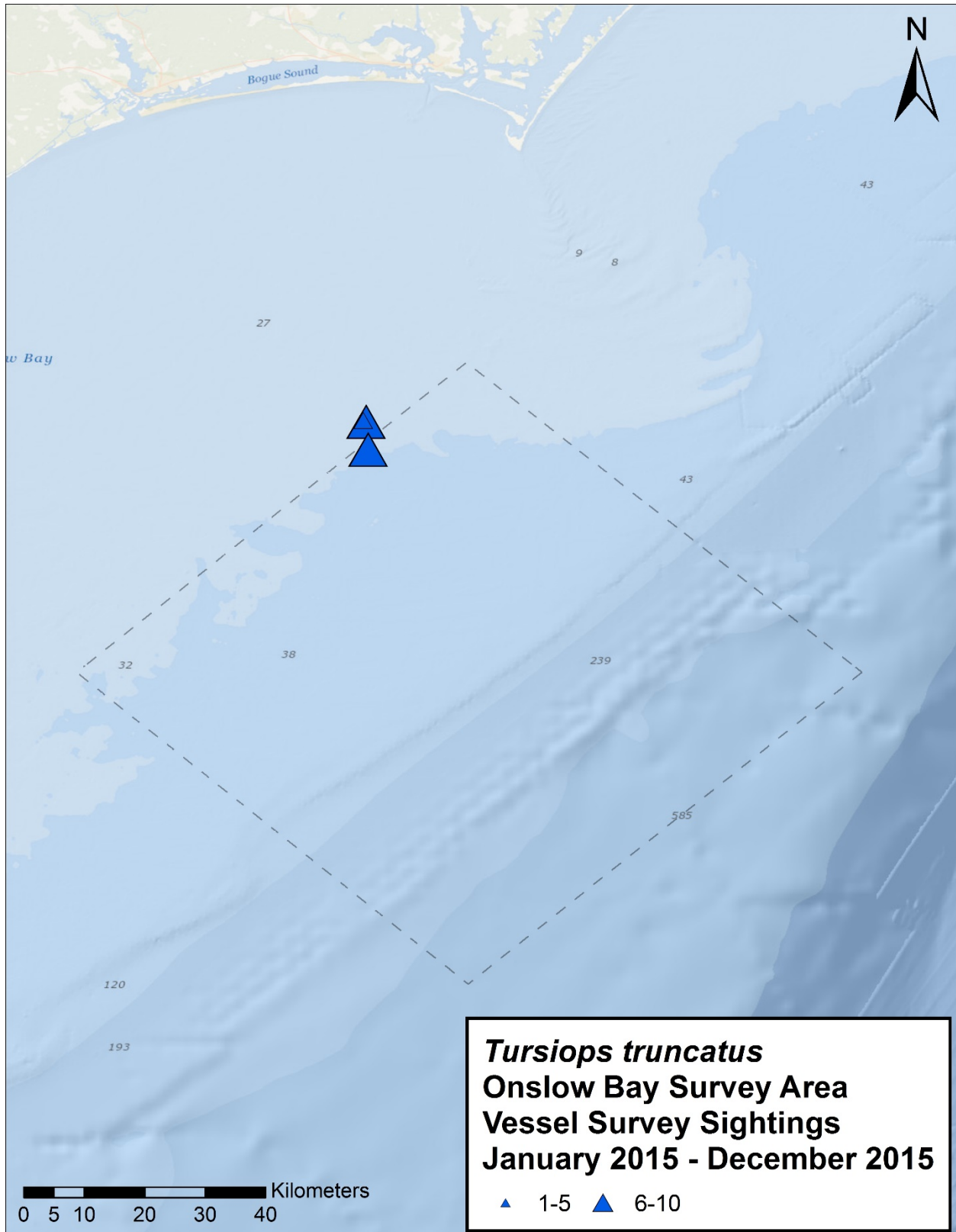
Table 10. Numbers of cetacean sightings for each species observed in the Onslow Bay survey area, January–December 2015.

Species	Sightings 2015
<i>Stenella frontalis</i>	2
<i>Tursiops truncatus</i>	3
Total:	5



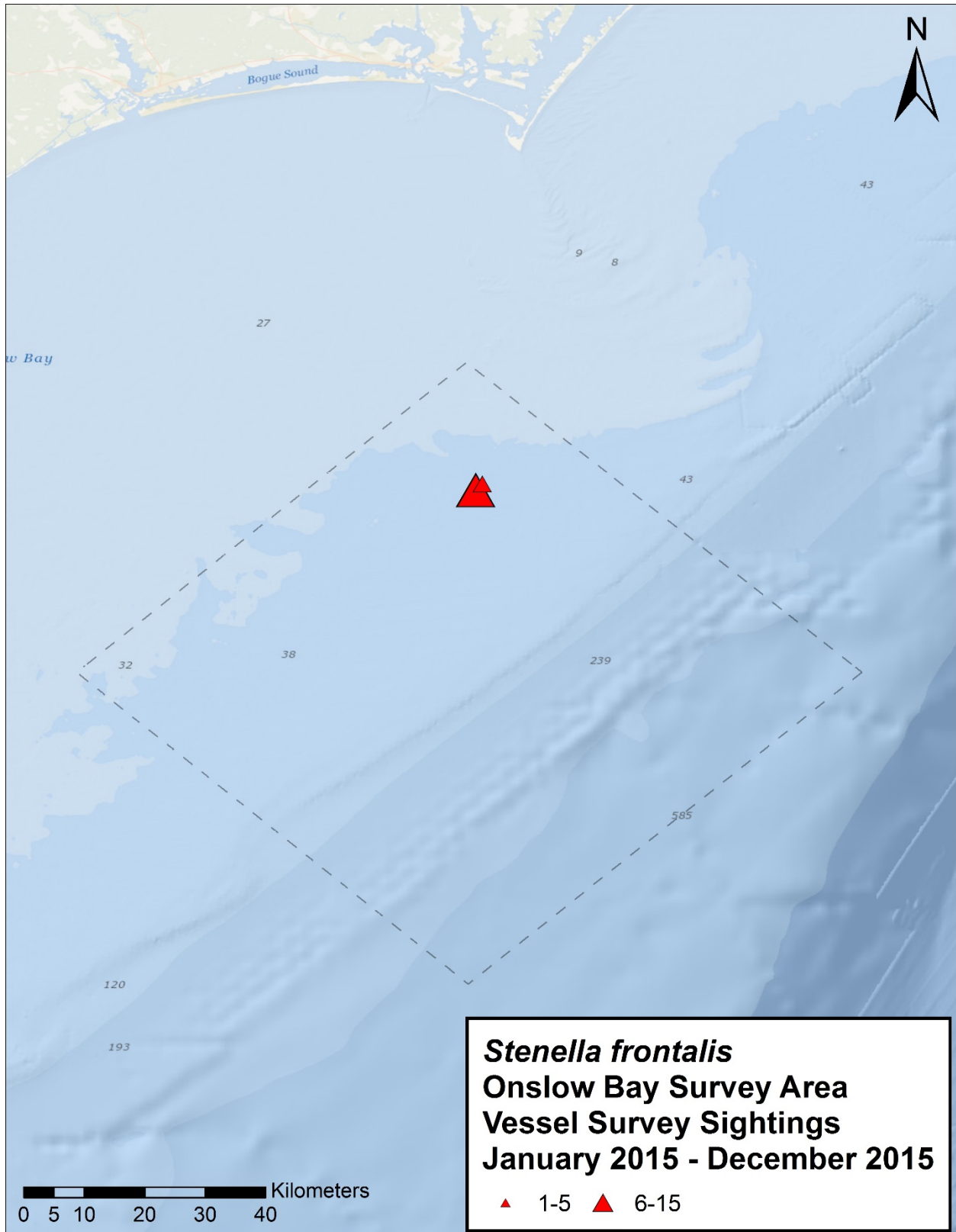
1

2 Figure 20. Distribution of all cetacean sightings made during vessel surveys in the Onslow Bay
3 survey area, January 2015–December 2015.



1

2 Figure 21. Distribution of bottlenose dolphin sightings, indicating group size, made during vessel
3 surveys in the Onslow Bay survey area, January 2015–December 2015.



1

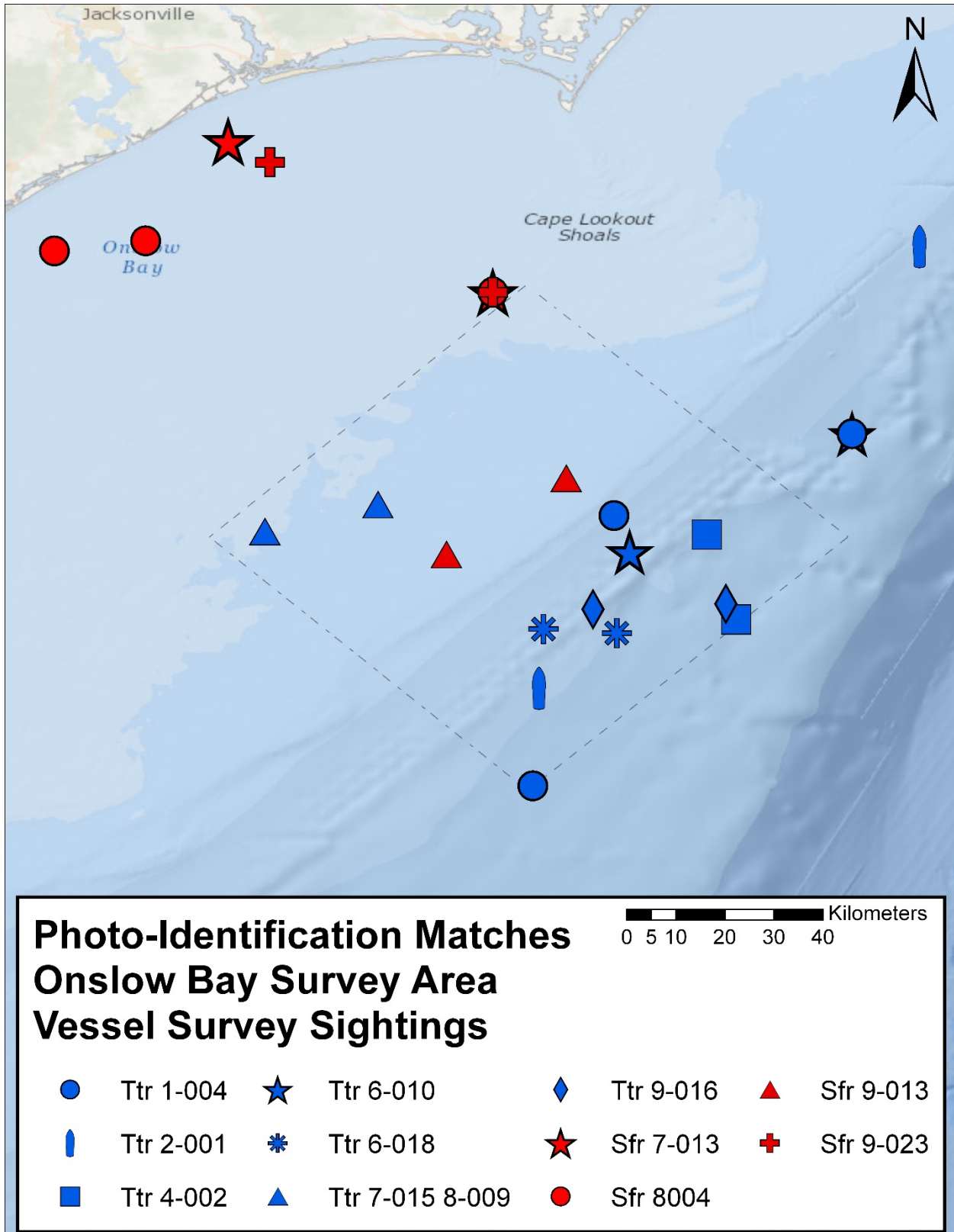
2 Figure 22. Distribution of Atlantic spotted dolphin sightings, indicating group size, made during
3 vessel surveys in the Onslow Bay survey area, January 2015–December 2015.

1 3.2.3 Photographic Effort

2 Since the inception of the monitoring program in Onslow Bay in 2007, eight bottlenose dolphins
 3 and four Atlantic spotted dolphins have been re-sighted (**Table 11 and Figure 23**), representing
 4 approximately 6% of the catalog for bottlenose dolphins (8 of 133) and 5% (4 of 86) for Atlantic
 5 spotted dolphins. Re-sightings of bottlenose dolphins and Atlantic spotted dolphins in Onslow
 6 Bay span up to six and ten years, respectively. Two bottlenose dolphins (Ttr_7-015 and Ttr_8-
 7 009) were seen together in both April 2009 and 2010. One bottlenose dolphin (Ttr_1-004) has
 8 now been photographed on three separate occasions, in October 2009, April 2010 and January
 9 2012. Furthermore, one Atlantic spotted dolphin (Sfr_8004) biopsied and photographed on 12
 10 September 2011 was matched to an animal photographed on 28 June 2001 and on 24 June
 11 2002 during surveys conducted in near-shore coastal waters of Onslow Bay. An additional
 12 Atlantic spotted dolphin from the same 12 September 2011 group was matched to Sfr_9-
 13 023_MCB, photographed a month earlier on 19 August 2011 during surveys in the coastal
 14 waters off Marine Corps Base Camp Lejeune, North Carolina. Spotted dolphin Sfr 7-013 was
 15 first observed during an offshore vessel survey in Onslow bay on 12 September 2011 and was
 16 re-sighted on 25 July 2013 during an acoustic vessel survey in coastal waters of Camp Lejeune.
 17 These numerous re-sightings over multiple years and across seasons supports the existence of
 18 considerable fine-scale population structure and some degree of residency for both bottlenose
 19 and spotted dolphins in Onslow Bay. To date, no individuals of any other species have been re-
 20 sighted, although the number of sightings and catalog sizes for these species are very small.
 21 Images of the dorsal fins of stranded pelagic cetaceans in North Carolina are regularly
 22 compared with our photo-identification catalogs for Onslow Bay, but to date there have been no
 23 matches.

24 **Table 11. Summary of photographs taken of animals in the Onslow Bay survey area, January**
 25 **2015–December 2015, with photo-identification catalog sizes and total number of matches to date.**

Species	Common Name	Images 2015	Catalog Size	Matches
<i>Globicephala macrorhynchus</i>	Short-finned pilot whale	0	23	0
<i>Grampus griseus</i>	Risso's dolphin	0	22	0
<i>Stenella frontalis</i>	Atlantic spotted dolphin	126	86	4
<i>Tursiops truncatus</i>	Bottlenose dolphin	169	133	8
<i>Steno bredanensis</i>	Rough-toothed dolphin	0	12	0



1

2 Figure 23. Locations of matched dolphins within the Onslow Bay survey area.

1 4. Jacksonville Vessel Surveys

2 4.1 Methods

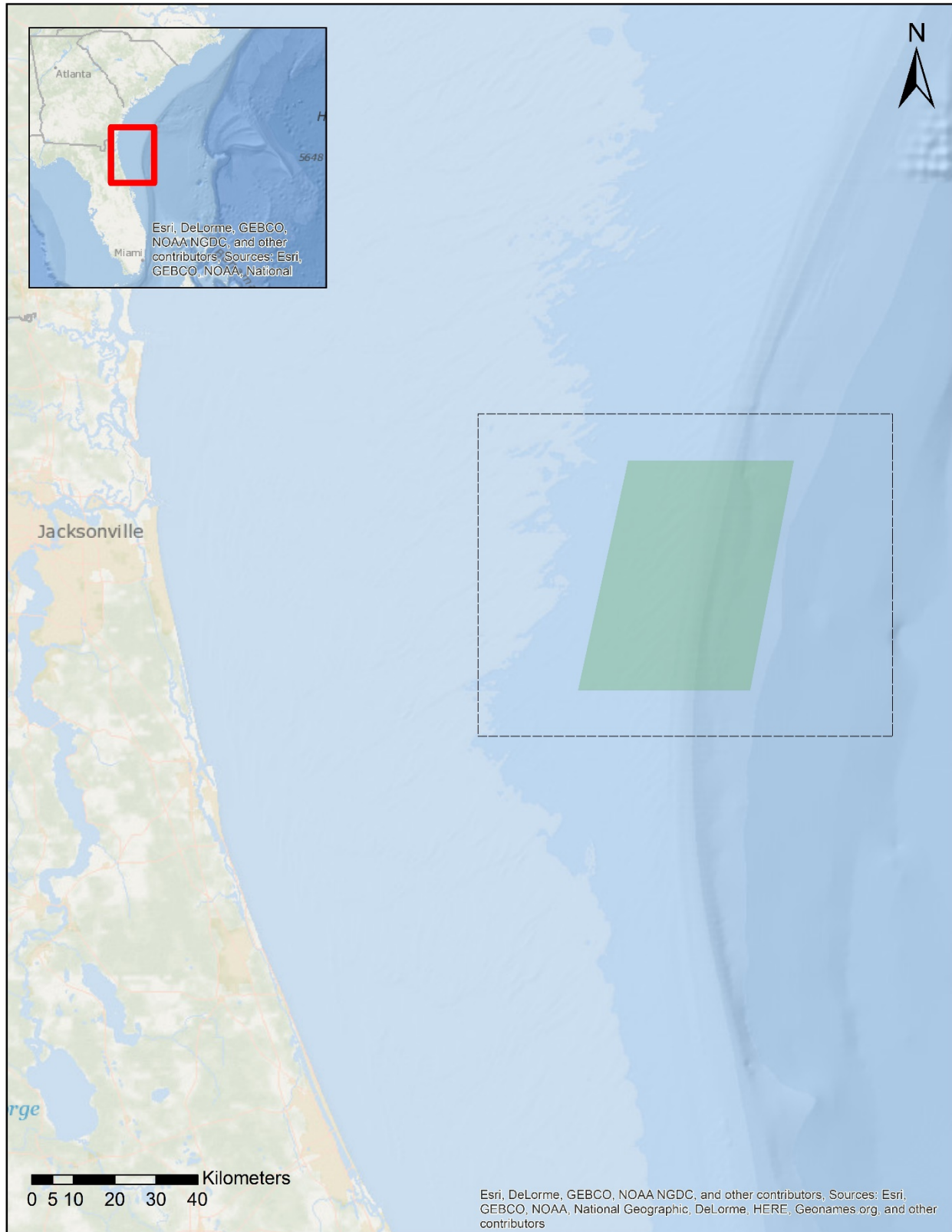
3 4.1.1 Study Area

4 The study area within JAX OPAREA is 5,786 square kilometers (km²), surrounding the planned
5 Undersea Warfare Training Range (USWTR), which is approximately 1,700 km² in area. The
6 study area straddles the continental shelf break, including some of the Blake Plateau, and
7 includes both shelf and pelagic waters (**Figure 24**).

8 4.1.2 Data Collection

9 Vessel survey effort in JAX during 2015 focused on questions of residency and population
10 structure of odontocete cetaceans. Visual surveys were conducted at speeds of approximately 8
11 to 15 knots (15–28 km/hr), with higher speeds utilized during on-effort transiting within the
12 survey area, from the R/V *Richard T. Barber*, a U.S. Coast Guard-approved offshore research
13 vessel outfitted with a bow pulpit, satellite phone, lifeboat and wireless communication system
14 (**Figure 25**). Surveys were also conducted from the Fishing Vessels (F/V) *Jodie Lynn I* and
15 *Jodie Lynn II* during four offshore vessel days. Two observers (one port and one starboard)
16 scanned constantly from straight ahead to 90 degrees abeam either side of the trackline. All
17 cetacean sightings were closed, with the location, species and behavior of every cetacean
18 group recorded. Turtles were surveyed in passing mode, with the location and species of all sea
19 turtles recoded. Environmental conditions (weather, BSS, depth and sea-surface temperature)
20 were collected at each sighting and whenever survey conditions changed. Sighting and
21 environmental data were recoded on an iPad tablet linked to a GPS unit.

22 Use of the survey area by individual cetaceans was examined using photo-identification, and
23 biopsy samples were collected for analysis of population structure. Digital photographs were
24 collected to confirm species identification at each sighting. Photographs were obtained with
25 Canon or Nikon digital SLR cameras (equipped with 100 to 400-millimeter zoom lenses) in 24-
26 bit color at a resolution of 3072 X 2048 pixels and saved in JPEG format. Remote biopsy-
27 sampling methods were employed to collect small skin and blubber samples using a variety of
28 27- to 68-kilogram pull crossbows, depending on the species and sampling distance. Biopsy
29 samples were collected with a specialized 2.5-centimeter stainless biopsy tip attached to a
30 modified bolt, typically fired from the bow of the survey vessel.



1
2 **Figure 24. Map of the Jacksonville study area (dashed outline) and the planned USWTR site**
3 **(shaded box).**



1
2 Figure 25. The R/V *Richard T. Barber*.

3 **4.1.3 Data Analysis**

4 Vessel survey effort and sighting data were mapped using *ArcGIS* 10.3.2. All vessel sighting
5 data collected from January 2015 through December 2015 will be posted on the data archive
6 OBIS-SEAMAP (<http://seamap.env.duke.edu/>).

7 **4.1.4 Data Storage**

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

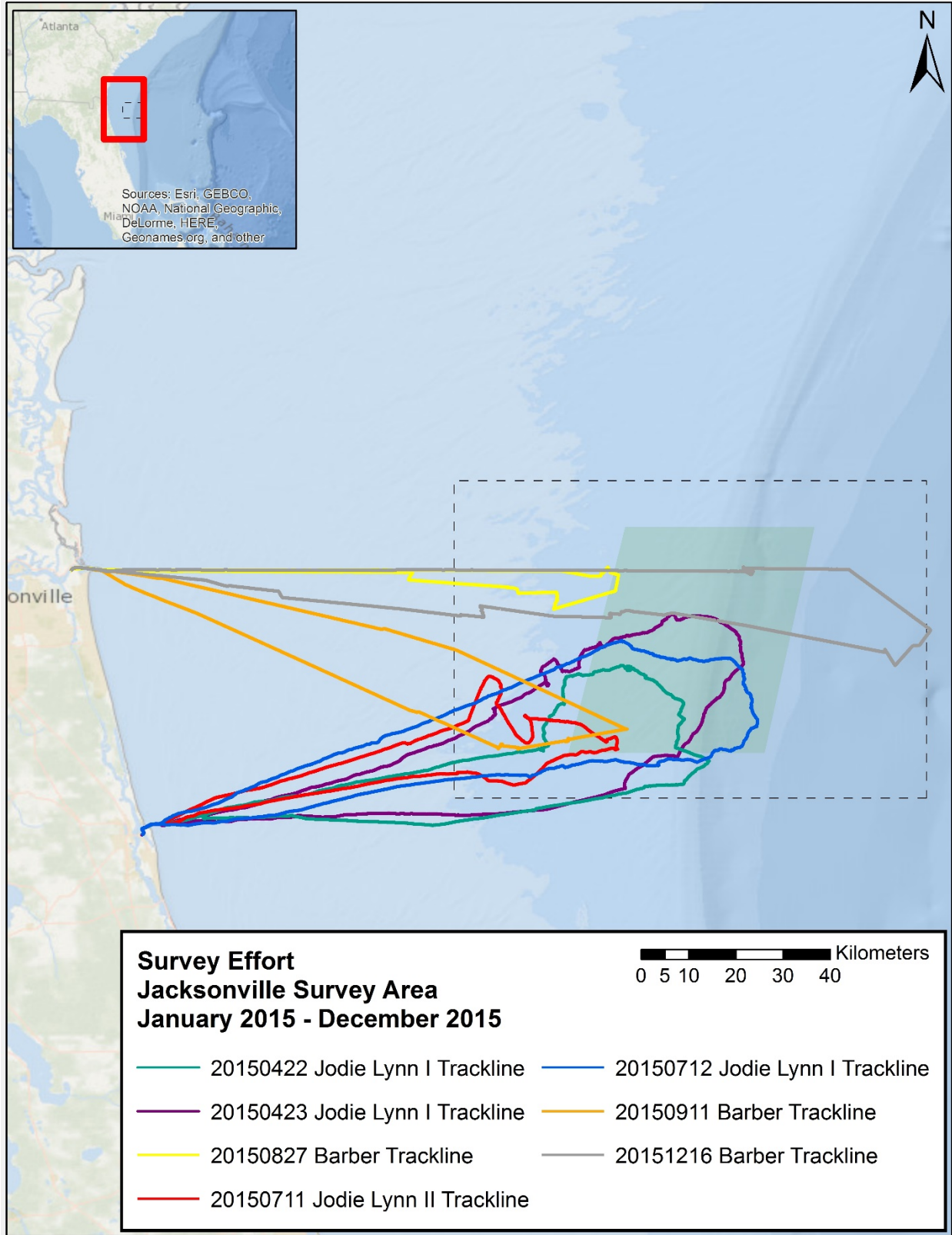
10 **4.2 Results**

11 **4.2.1 Vessel Survey Effort**

12 Seven days of vessel surveys were conducted in 2015, totaling 858.2 kkm, or 44.2 hr, of survey
13 effort (**Table 12**). These surveys were conducted in BSS 0 to 5 and covered the USWTR site
14 and surrounding survey area, including shelf and pelagic waters (**Figure 26**).

15 **Table 12. Dates, distance and durations surveyed during vessel surveys in the Jacksonville**
16 **survey area, January 2015–December 2015.**

Date	Sea State	km Surveyed	Survey Time (hr:min)	At-Sea Time	Platform
22-Apr-15	2-4	126.0	07:33	11:05	F/V <i>Jodie Lynn I</i>
23-Apr-15	1-4	143.0	08:34	12:07	F/V <i>Jodie Lynn I</i>
11-Jul-15	2-3	96.0	04:12	07:23	F/V <i>Jodie Lynn II</i>
12-Jul-15	3-5	139.0	07:00	10:36	F/V <i>Jodie Lynn I</i>
27-Aug-15	2-3	67.1	04:06	07:14	R/V <i>R.T. Barber</i>
11-Sep-15	3-5	89.1	05:46	10:03	R/V <i>R.T. Barber</i>
16-Dec-15	0-2	198.0	07:01	10:04	R/V <i>R.T. Barber</i>



1
 2 Figure 26. Survey effort during vessel surveys in the Jacksonville survey area, January 2015–
 3 December 2015.

1 **4.2.2 Marine Mammal and Sea Turtle Sightings**

2 Seventeen cetacean sightings of three species were recorded during these vessel surveys. As
3 in previous years, bottlenose ($n=8$) and Atlantic spotted dolphins ($n=8$) dominated the fauna, in
4 addition to a single sighting of Risso's dolphins (**Tables 13 and 14**). Twenty-five sea turtles
5 were recorded in the survey area during 2015. As in the past, the loggerhead sea turtle (*Caretta*
6 *caretta*; $n=23$) was by far the most frequently recorded species, with a small number of sightings
7 of leatherback sea turtles (*Dermochelys coriacea*; $n=2$) (**Table 15**).

1 Table 13. Cetacean sightings from vessel surveys in the Jacksonville survey area, January 2015–December 2015.

Date	Time	Latitude (N)	Longitude (W)	Species	Common Name	Group Size	Biopsy Samples	Photo-id images	Vessel
22-Apr-15	11:34	30.20758	80.36966	<i>S. frontalis</i>	Atlantic spotted dolphin	3	0	39	R/V R.T. Barber
22-Apr-15	14:16	30.06419	80.52141	<i>T. truncatus</i>	Bottlenose dolphin	6	1	41	R/V R.T. Barber
23-Apr-15	14:38	30.18529	80.52711	<i>T. truncatus</i>	Bottlenose dolphin	5	1	63	R/V R.T. Barber
23-Apr-15	15:38	30.13396	80.62591	<i>T. truncatus</i>	Bottlenose dolphin	6	0	52	R/V R.T. Barber
11-Jul-15	14:21	30.05792	80.39022	<i>T. truncatus</i>	Bottlenose dolphin	2	0	12	R/V R.T. Barber
12-Jul-15	10:25	30.05410	80.17439	<i>T. truncatus</i>	Bottlenose dolphin	1	0	0	R/V R.T. Barber
12-Jul-15	13:18	30.26232	80.37985	<i>S. frontalis</i>	Atlantic spotted dolphin	3	0	0	R/V R.T. Barber
12-Jul-15	14:02	30.21595	80.49517	<i>S. frontalis</i>	Atlantic spotted dolphin	2	0	0	R/V R.T. Barber
27-Aug-15	12:36	30.35599	80.50649	<i>S. frontalis</i>	Atlantic spotted dolphin	4	0	35	R/V R.T. Barber
27-Aug-15	14:26	30.40215	80.40936	<i>S. frontalis</i>	Atlantic spotted dolphin	6	0	31	R/V R.T. Barber
11-Sep-15	9:35	30.28610	80.83566	<i>S. frontalis</i>	Atlantic spotted dolphin	3	1	15	R/V R.T. Barber
11-Sep-15	13:10	30.07301	80.48314	<i>S. frontalis</i>	Atlantic spotted dolphin	6	0	37	R/V R.T. Barber
11-Sep-15	14:36	30.06610	80.61040	<i>S. frontalis</i>	Atlantic spotted dolphin	8	2	223	R/V R.T. Barber
16-Dec-15	08:58	30.31533	80.64642	<i>T. truncatus</i>	Bottlenose dolphin	9	1	161	R/V R.T. Barber
16-Dec-15	10:00	30.30862	80.40207	<i>T. truncatus</i>	Bottlenose dolphin	5	1	108	R/V R.T. Barber
16-Dec-15	10:18	30.32060	80.37577	<i>T. truncatus</i>	Bottlenose dolphin	2	1	93	R/V R.T. Barber
16-Dec-15	13:49	30.40357	80.15061	<i>G. griseus</i>	Risso's dolphin	40	0	367	R/V R.T. Barber

1 **Table 14. Numbers of cetacean sightings for each species observed in the Jacksonville survey**
 2 **area, January–December 2015.**

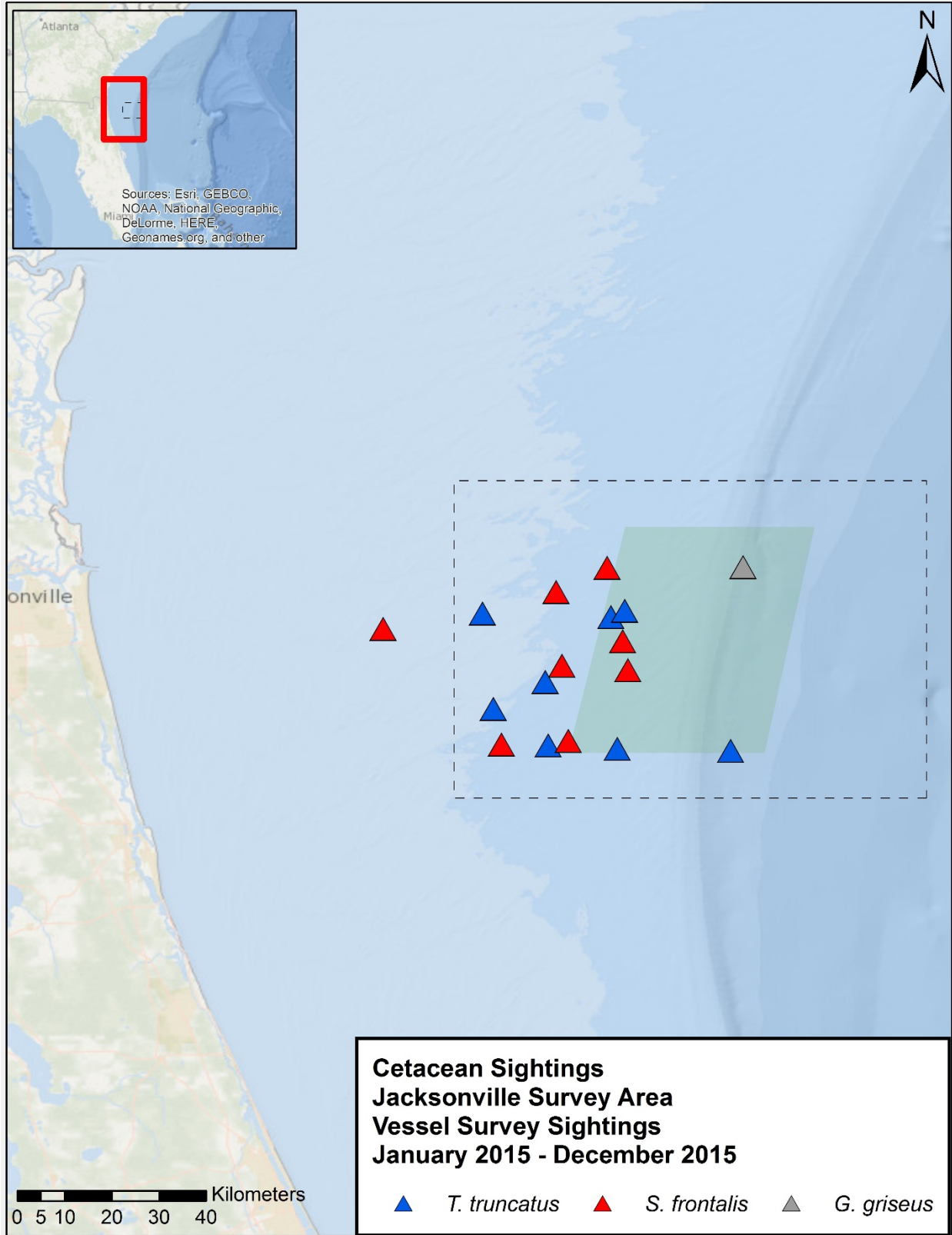
Species	Sightings 2015
<i>Grampus griseus</i>	1
<i>Stenella frontalis</i>	8
<i>Tursiops truncatus</i>	8
Total:	17

3 **Table 15. Sea turtle sightings from vessel surveys in the Jacksonville survey area, January 2015–**
 4 **December 2015.**

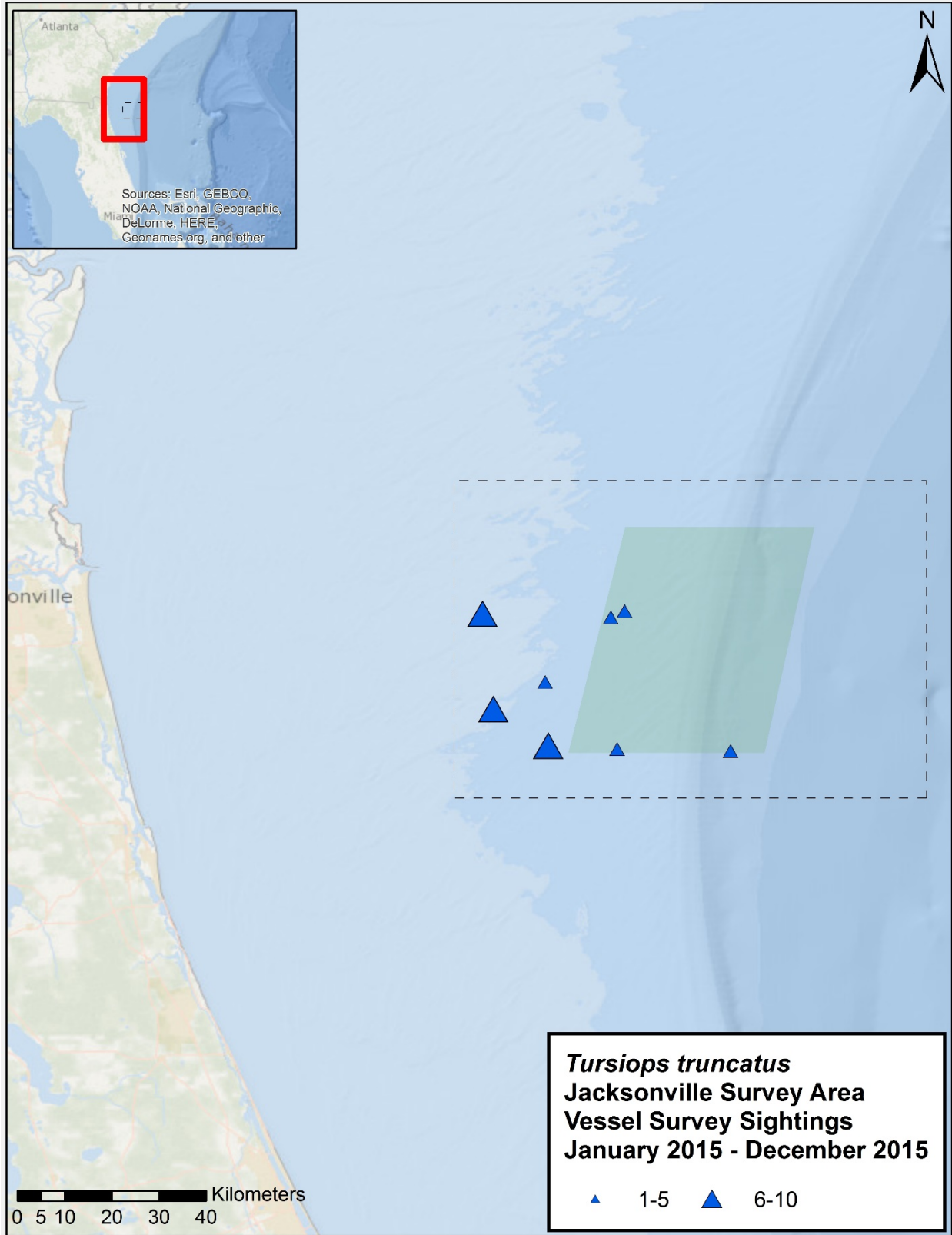
Date	Time	Latitude (N)	Longitude (W)	Species	Common Name	Group Size	Vessel
22-Apr-15	13:43	30.13291	80.50695	<i>C. caretta</i>	Loggerhead turtle	1	R/V <i>R.T. Barber</i>
23-Apr-15	12:30	30.28205	80.32833	<i>C. caretta</i>	Loggerhead turtle	1	R/V <i>R.T. Barber</i>
23-Apr-15	13:43	30.22239	80.46337	<i>C. caretta</i>	Loggerhead turtle	1	R/V <i>R.T. Barber</i>
11-Jul-15	13:31	30.01015	80.65487	<i>C. caretta</i>	Loggerhead turtle	1	R/V <i>R.T. Barber</i>
11-Jul-15	13:32	30.00703	80.64851	<i>C. caretta</i>	Loggerhead turtle	1	R/V <i>R.T. Barber</i>
11-Jul-15	14:04	30.04600	80.48593	<i>C. caretta</i>	Loggerhead turtle	1	R/V <i>R.T. Barber</i>
11-Jul-15	14:15	30.05573	80.41659	<i>D. coriacea</i>	Leatherback turtle	1	R/V <i>R.T. Barber</i>
12-Jul-15	08:47	30.02727	80.47443	<i>C. caretta</i>	Loggerhead turtle	1	R/V <i>R.T. Barber</i>
12-Jul-15	13:39	30.24790	80.42552	<i>C. caretta</i>	Loggerhead turtle	1	R/V <i>R.T. Barber</i>
12-Jul-15	14:35	30.16180	80.62597	<i>C. caretta</i>	Loggerhead turtle	1	R/V <i>R.T. Barber</i>
12-Jul-15	14:46	30.13969	80.67757	<i>C. caretta</i>	Loggerhead turtle	1	R/V <i>R.T. Barber</i>
12-Jul-15	14:47	30.13897	80.67943	<i>D. coriacea</i>	Leatherback turtle	1	R/V <i>R.T. Barber</i>
27-Aug-15	12:03	30.36560	80.59907	<i>C. caretta</i>	Loggerhead turtle	2	R/V <i>R.T. Barber</i>
27-Aug-15	13:51	30.34974	80.42352	<i>C. caretta</i>	Loggerhead turtle	1	R/V <i>R.T. Barber</i>
11-Sep-15	11:04	30.17969	80.55370	<i>C. caretta</i>	Loggerhead turtle	1	R/V <i>R.T. Barber</i>
11-Sep-15	13:49	30.06620	80.53316	<i>C. caretta</i>	Loggerhead turtle	1	R/V <i>R.T. Barber</i>
16-Dec-15	09:45	30.30988	80.50655	<i>C. caretta</i>	Loggerhead turtle	1	R/V <i>R.T. Barber</i>
16-Dec-15	09:49	30.30986	80.48633	<i>C. caretta</i>	Loggerhead turtle	1	R/V <i>R.T. Barber</i>
16-Dec-15	09:53	30.30905	80.45280	<i>C. caretta</i>	Loggerhead turtle	1	R/V <i>R.T. Barber</i>
16-Dec-15	10:39	30.31726	80.34166	<i>C. caretta</i>	Loggerhead turtle	1	R/V <i>R.T. Barber</i>
16-Dec-15	10:58	30.30280	80.20539	<i>C. caretta</i>	Loggerhead turtle	1	R/V <i>R.T. Barber</i>
16-Dec-15	13:21	30.39968	79.98407	<i>C. caretta</i>	Loggerhead turtle	1	R/V <i>R.T. Barber</i>
16-Dec-15	15:09	30.39723	80.37405	<i>C. caretta</i>	Loggerhead turtle	1	R/V <i>R.T. Barber</i>
16-Dec-15	15:17	30.39750	80.44651	<i>C. caretta</i>	Loggerhead turtle	1	R/V <i>R.T. Barber</i>

1 **4.2.3 Distributions and Habitat Associations of Cetaceans and Sea Turtles**

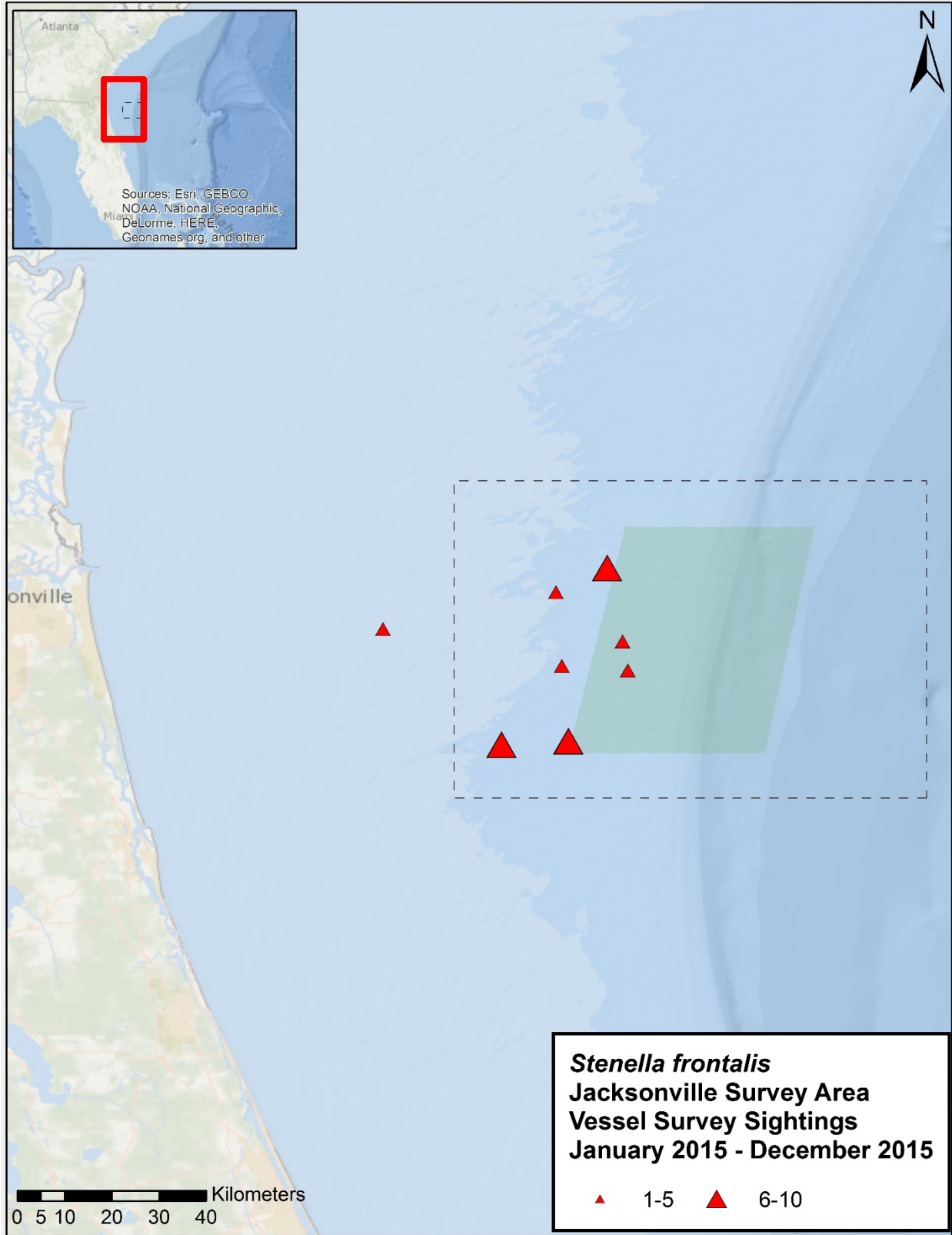
2 The distribution of marine mammal and sea turtle sightings in the Jacksonville survey area is
3 presented in **Figures 27** through **31**. Similar to our observations in previous years, bottlenose
4 dolphins were encountered throughout the survey area, including deeper pelagic waters (**Figure**
5 **28**), whereas Atlantic spotted dolphins were restricted to the relatively shallow shelf waters
6 (**Figure 29**) and Risso's dolphins were found in large groups in deeper pelagic waters (**Figure**
7 **30**). All sea turtles were observed over the continental shelf (**Figure 31**).



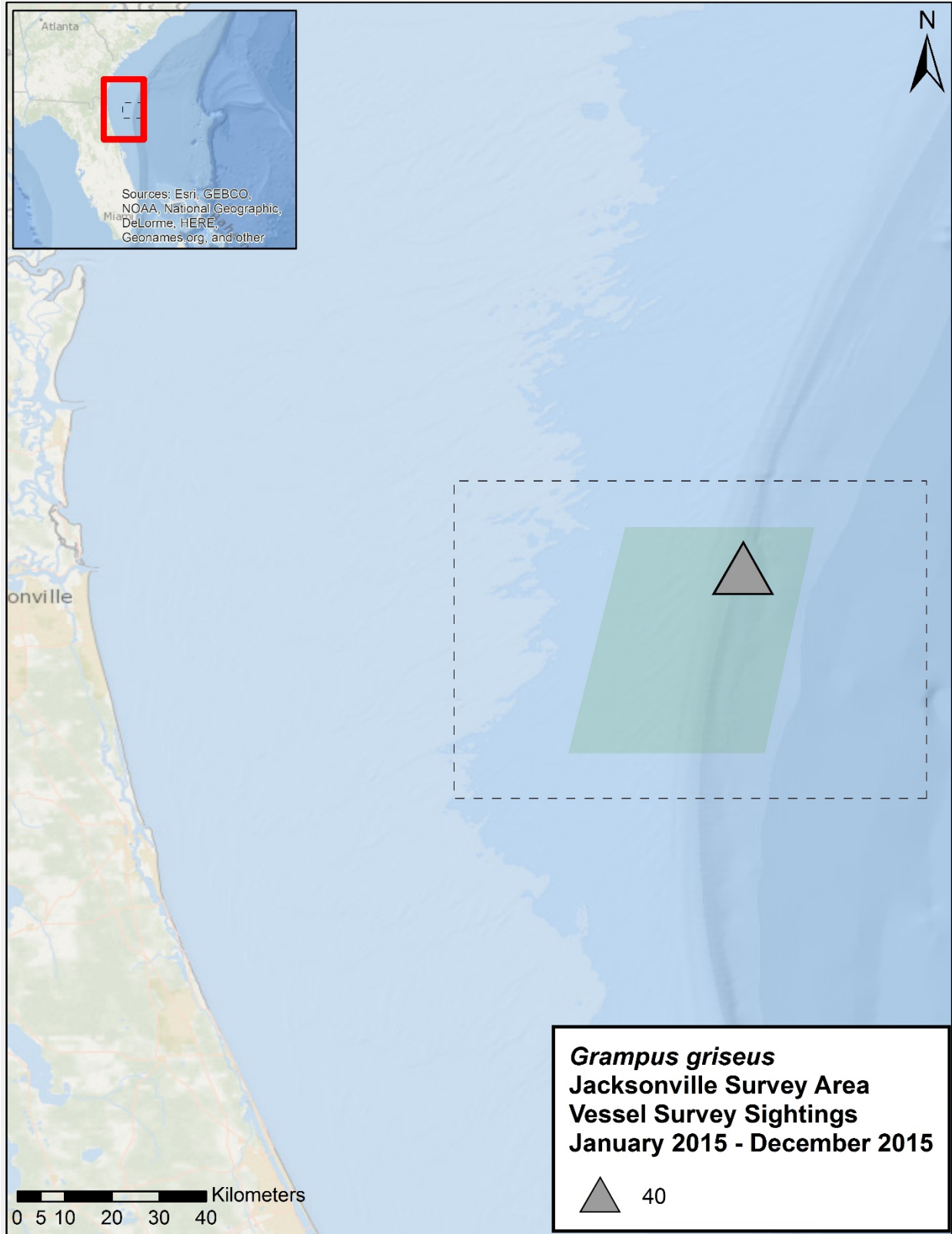
1
2 Figure 27. Distribution of all cetacean sightings made during vessel surveys in the Jacksonville
3 survey area, January 2015–December 2015.



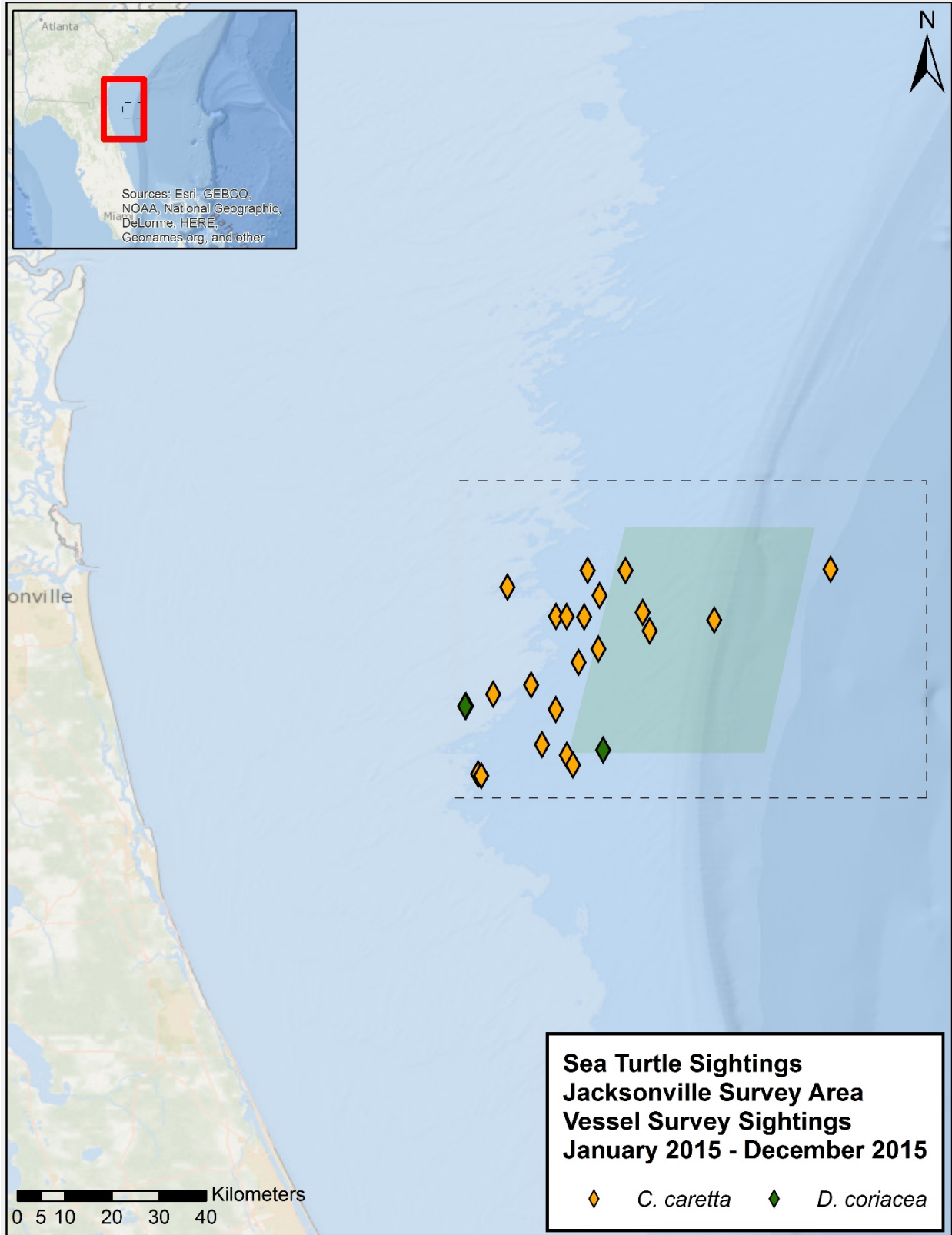
1
2 Figure 28. Distribution of bottlenose dolphin sightings, indicating group size, made during vessel
3 surveys in the Jacksonville survey area, January 2015–December 2015.



1
2 Figure 29. Distribution of Atlantic spotted dolphin sightings, indicating group size, made during
3 vessel surveys in the Jacksonville survey area, January 2015–December 2015.



1
2 Figure 30. Distribution of Risso's dolphin sightings, indicating group size, made during vessel
3 surveys in the Jacksonville survey area, January 2015–December 2015.



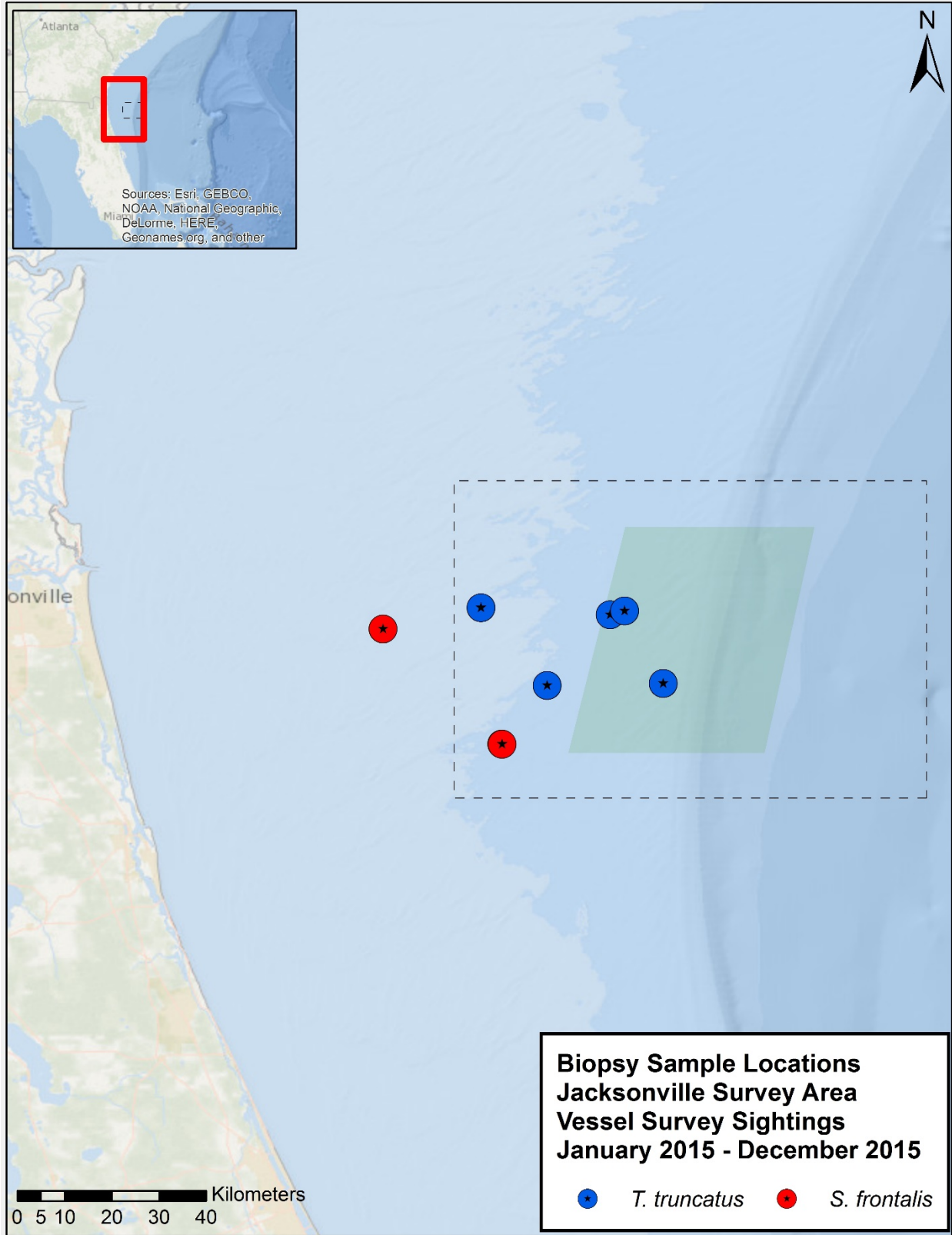
1
2 Figure 31. Distribution of sea turtle sightings made during vessel surveys in the Jacksonville
3 survey area, January 2015–December 2015.

1 4.2.4 Biopsy Sampling

2 Eight biopsy samples were collected in the Jacksonville survey area during 2015 from Atlantic
 3 spotted dolphins ($n=3$) and bottlenose dolphins ($n=5$) (**Table 16** and **Figure 32**). Skin samples
 4 will be analyzed for sex determination. Voucher specimens of these samples are archived with
 5 the National Marine Fisheries Service's Southeast Fisheries Science Center in Lafayette,
 6 Louisiana.

7 **Table 16. Biopsy samples collected in the Jacksonville survey area, January 2015–December**
 8 **2015.**

Date	Time	Latitude (N)	Longitude (W)	Species	Sample #
22-Apr-15	14:22	30.17852	80.52339	<i>T. truncatus</i>	ZTS-15-01
23-Apr-15	14:55	30.18258	80.30241	<i>T. truncatus</i>	ZTS-15-02
11-Sep-15	9:40	30.28610	80.83568	<i>S. frontalis</i>	ZTS-15-24
11-Sep-15	14:44	30.06744	80.60983	<i>S. frontalis</i>	ZTS-15-25
11-Sep-15	14:48	30.06694	80.60913	<i>S. frontalis</i>	ZTS-15-26
16-Dec-15	09:15	30.32629	80.64908	<i>T. truncatus</i>	ZTS-15-29
16-Dec-15	10:08	30.31304	80.40348	<i>T. truncatus</i>	ZTS-15-30
16-Dec-15	10:29	30.32060	80.37577	<i>T. truncatus</i>	ZTS-15-31



1
2 Figure 32. Locations of biopsy samples collected in the Jacksonville survey area, January 2015–
3 December 2015.

1 4.2.5 Photographic Effort

2 Nearly 1300 digital images for species confirmation and individual identification were collected
 3 during 2015. Forty newly identified dolphins were added to existing catalogs (**Table 17**). Photo-
 4 identification catalogs for bottlenose and Atlantic spotted dolphins in JAX currently consist of
 5 100 and 118 individuals, respectively. We have re-sighted two individual spotted dolphins within
 6 the JAX study area (**Figure 33**). Sfr 3-001 was observed first on 10 October 2010 and again on
 7 19 March 2011; Sfr 8-005 was photographed during surveys on two consecutive days: 18 March
 8 2011 and 19 March 2011 (**Table 18**). In addition, we re-sighted two bottlenose dolphins together
 9 on 25 January 2012 and 18 July 2013 (**Table 18** and **Figure 33**). The Risso's dolphin catalog
 10 consists of 36 individuals, but we have not identified any re-sightings through 2015.

11 **Table 17. Summary of photographs taken of animals in the Jacksonville survey area, January**
 12 **2015–December 2015, with photo-identification catalog sizes and total number of matches to date.**

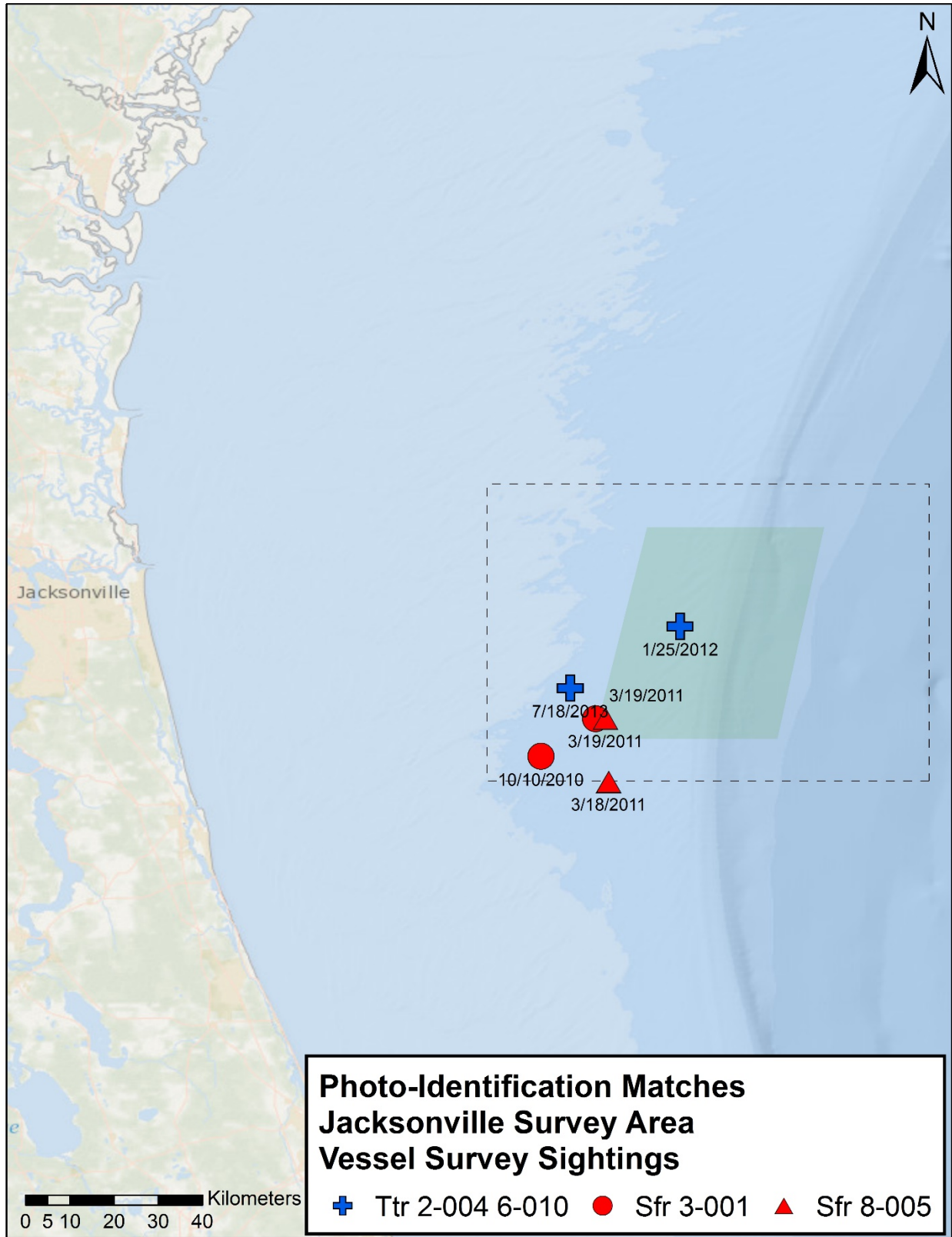
Species	Common Name	Images 2015	Catalog Size	Matches
<i>G. macrorhynchus</i>	Short-finned pilot whale	0	12	0
<i>G. griseus</i>	Risso's dolphin	367	36	0
<i>S. frontalis</i>	Atlantic spotted dolphin	380	118	2
<i>T. truncatus</i>	Bottlenose dolphin	530	100	2

13 **Table 18. Photo-identification matches of bottlenose dolphins and Atlantic spotted dolphins**
 14 **observed in the Jacksonville survey area.**

ID	Jacksonville, FL					
	2009	2010	2011	2012	2013	2014
Ttr 2-004 [^]				X	X	
Ttr 6-010 [^]				X	X	
Sfr 3-001		X	X			
Sfr 8-005			X ^m			

[^]Observed together in multiple sightings

^mRe-sighted within same month



1

2 Figure 33. Locations of matched dolphins within the Jacksonville survey area.

1 4.3 Summary Tables

2 Total survey effort conducted since the beginning of the monitoring program, including all AFTT
 3 protected species monitoring and Deep Diver tagging effort in each survey area is reported in
 4 **Tables 19 through 21**. The annual numbers of sightings by species for both cetaceans and sea
 5 turtles in each survey area are presented in **Tables 22 through 27**. The number of biopsy
 6 samples collected to date in each survey area is reported in **Tables 28 through 39**. **Tables 31**
 7 **through 33** summarize the catalog sizes and matches by species to date and images taken
 8 during the reporting period in the survey areas.

9 **Table 19. Duration and distance surveyed during Year 1 (July 2009–December 2010), Year 2**
 10 **(January–December 2011), Year 3 (January–December 2012), Year 4 (January–December 2013),**
 11 **Year 5 (January–December 2014), and Year 6 (January–December 2015) in the Cape Hatteras**
 12 **survey area.**

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Total
Survey Hours	26.3	179.9	86.8	63.2	121.7	134.5	612.43
km Surveyed	296.4	1097.4	1049.4	878.7	921.9	990.8	5234.6

13 **Table 20. Duration and distance surveyed during Year 1 (June 2007–June 2008), Year 2 (July 2008–**
 14 **June 2009), Year 3 (July 2009–June 2010), Year 4 (July 2010–December 2011), Year 5 (January**
 15 **2012–December 2012), Year 6 (January 2013–December 2013), and Year 8 (January 2015–**
 16 **December 2015) in the Onslow Bay survey area.**

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 8	Total
Survey Hours	170.7	109.0	105.7	53.6	31.5	14.6	9.08	494.18
km Surveyed	2333.6	1742.4	1555.8	754.1	496.8	185.6	122.1	7190.4

17 **Table 21. Duration and distance surveyed during Year 1 (July 2009–December 2010), Year 2**
 18 **(January–December 2011), Year 3 (January–December 2012), Year 4 (January–December 2013),**
 19 **Year 5 (January–December 2014), and Year 6 (January–December 2015) in the Jacksonville**
 20 **survey area.**

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Total
Survey Hours	127.1	20.9	58.6	58.7	66.8	44.2	376.3
km Surveyed	2073.5	345.7	937.4	1021.7	1227.4	858.2	6463.9

1 **Table 22. Number of cetacean sightings for each species observed during Year 1 (July 2009–**
 2 **December 2010), Year 2 (January 2011–December 2011), Year 3 (January 2012–December 2012),**
 3 **Year 4 (January 2013–December 2013), Year 5 (January 2014–December 2014) and Year 6 (January**
 4 **2015–December 2015) of vessel surveys in the Cape Hatteras survey area.**

Species	Sightings					
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
<i>Balaenoptera physalus</i>	0	0	1	2	0	0
<i>Delphinus delphis</i>	0	6	11	3	4	4
<i>Globicephala macrorhynchus</i>	9	33	52	35	26	53
<i>Grampus griseus</i>	1	2	2	0	1	2
<i>Kogia</i> sp.	0	0	0	0	0	1
<i>Mesoplodon</i> sp.	0	0	0	1	0	0
<i>Physeter macrocephalus</i>	0	1	4	3	2	4
<i>Stenella frontalis</i>	0	8	2	3	3	3
<i>Stenella/Delphinus</i> mix	0	1	0	0	0	0
<i>Tursiops truncatus</i>	23	27	54	38	14	47
<i>Tursiops/Stenella</i> mix	0	1	0	0	0	0
<i>Ziphius cavirostris</i>	0	3	1	2	16	13
Unidentified baleen whale	0	0	0	0	0	1
Unidentified beaked whale	0	0	0	4	3	1
Unidentified small whale	0	0	0	0	0	1
Unidentified delphinid	1	0	3	1	0	1
Total:	34	82	130	92	69	131

5 **Table 23. Numbers of cetacean sightings for each species observed during Year 1 (June 2007–**
 6 **June 2008), Year 2 (July 2008–June 2009), Year 3 (July 2009–June 2010), Year 4 (July 2010–**
 7 **December 2011), Year 5 (January 2012–December 2012), Year 6 (January 2013–December 2013),**
 8 **and Year 8 (January 2015–December 2015) in the Onslow Bay survey area.**

Species	Sightings						
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 8
<i>Globicephala macrorhynchus</i>	1	0	2	0	0	1	0
<i>Grampus griseus</i>	3	0	3	0	1	0	0
<i>Mesoplodon</i> sp.	0	0	0	0	2	0	0
<i>Stenella frontalis</i>	6	17	17	9	1	0	2
<i>Steno bredanensis</i>	0	0	1	0	0	0	0
<i>Tursiops truncatus</i>	23	14	29	7	7	6	3
Unidentified delphinid	3	2	3	0	0	0	0
Unidentified small whale	0	0	0	0	1	0	0
Total:	36	33	55	16	12	7	5

1 Table 24. Numbers of cetacean sightings for each species observed during Year 1 (July 2009–
 2 December 2010), Year 2 (January–December 2011), Year 3 (January–December 2012), Year 4
 3 (January–December 2013), Year 5 (January–December 2014), and Year 6 (January–December 2015)
 4 in the Jacksonville survey area.

Species	Sightings					
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
<i>Eubalaena glacialis</i>	0	0	0	0	1	0
<i>Globicephala macrorhynchus</i>	3	0	0	0	0	0
<i>Grampus griseus</i>	2	0	0	1	1	1
<i>Stenella frontalis</i>	35	6	14	9	20	10
<i>Tursiops truncatus</i>	19	6	23	15	18	10
<i>Tursiops/Stenella</i> mix	0	0	0	0	1	0
Unidentified delphinid	13	0	4	3	4	0
Total:	72	12	41	28	45	21

5 Table 25. Number of sea turtle sightings for each species observed during Year 1 (July 2009–
 6 December 2010), Year 2 (January 2011–December 2011), Year 3 (January 2012–December 2012),
 7 Year 4 (January 2013–December 2013), Year 5 (January 2014–December 2014) and Year 6 (January
 8 2015–December 2015) of vessel surveys in the Cape Hatteras survey area.

Species	Sightings					
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
<i>Caretta caretta</i>	2	0	2	7	0	2
<i>Chelonia mydas</i>	0	0	0	1	0	0
<i>Dermochelys coriacea</i>	0	0	0	0	0	4
Unidentified sea turtle	0	0	1	0	0	0
Total:	2	0	3	8	0	6

9 Table 26. Number of sea turtle sightings for each species observed during Year 1 (June 2007–
 10 June 2008), Year 2 (July 2008–June 2009), Year 3 (July 2009–June 2010), Year 4 (July 2010–
 11 December 2011), Year 5 (January 2012–December 2012), Year 6 (January 2013–December 2013),
 12 and Year 8 (January 2015–December 2015) in the Onslow Bay survey area.

Species	Sightings						
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 8
<i>Caretta caretta</i>	19	49	47	3	2	1	0
<i>Dermochelys coriacea</i>	0	0	2	0	0	0	0
Unidentified sea turtle	1	0	1	0	0	0	0
Total:	20	49	50	3	2	1	0

1 Table 27. Numbers of sea turtle sightings for each species observed during Year 1 (July 2009–
 2 December 2010), Year 2 (January–December 2011), Year 3 (January–December 2012), Year 4
 3 (January–December 2013), Year 5 (January–December 2014), and Year 6 (January–December 2015)
 4 in the Jacksonville survey area.

Species	Sightings					
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
<i>Caretta caretta</i>	52	20	41	33	31	22
<i>Dermochelys coriacea</i>	8	3	4	1	3	2
<i>Lepidochelys kempii</i>	1	0	1	0	0	0
Unidentified sea turtle	8	3	3	1	0	0
Total:	69	26	49	35	34	24

5 Table 28. Biopsy samples collected to date during Year 2 (January 2011–December 2011), Year 3
 6 (January 2012–December 2012), Year 4 (January 2013–December 2013), Year 5 (January 2014–
 7 December 2014) and Year 6 (January 2015–December 2015) of vessel surveys in the Cape Hatteras
 8 survey area.

Species	Year 2	Year 3	Year 4	Year 5	Year 6	Total
<i>Balaenoptera physalus</i>	0	0	3	0	0	3
<i>Delphinus delphis</i>	0	5	2	0	1	8
<i>Globicephala macrorhynchus</i>	4	33	10	5	14	66
<i>Grampus griseus</i>	0	0	2	0	0	2
<i>Physeter macrocephalus</i>	0	0	1	1	0	2
<i>Stenella frontalis</i>	6	0	2	2	2	12
<i>Tursiops truncatus</i>	14	10	13	2	1	40
<i>Ziphius cavirostris</i>	0	0	2	0	2	4

9 Table 29. Biopsy samples collected during Year 4 (July 2010–December 2011), Year 5 (January
 10 2012–December 2012), Year 6 (January 2013–December 2013), and Year 8 (January 2015–
 11 December 2015) in the Onslow Bay survey area.

Species	Year 4	Year 5	Year 6	Year 8	Total
<i>Globicephala macrorhynchus</i>	0	0	3	0	3
<i>Grampus griseus</i>	0	5	0	0	5
<i>Stenella frontalis</i>	2	2	0	0	4
<i>Tursiops truncatus</i>	0	8	7	0	15

12 Table 30. Biopsy samples collected during Year 1 (July 2009–December 2010), Year 2 (January–
 13 December 2011), Year 3 (January–December 2012), Year 4 (January–December 2013), Year 5
 14 (January–December 2014), and Year 6 (January–December 2015) in the Jacksonville survey area.

Species	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Total
<i>Grampus griseus</i>	0	0	0	1	2	0	3
<i>Stenella frontalis</i>	0	0	19	6	19	3	44
<i>Tursiops truncatus</i>	0	0	12	5	10	5	27

1 **Table 31. Summary of images collected during all vessel surveys in the Cape Hatteras survey**
 2 **area, January 2009–December 2015, with photo-identification catalog sizes and matches to date.**

Species	2009-2014		2015	
	Catalog Size	Matches	Catalog Size	Matches
<i>Balaenoptera physalus</i>	1	0	1	0
<i>Delphinus delphis</i>	27	1	30	1
<i>Globicephala macrorhynchus</i>	229	25	367	61
<i>Grampus griseus</i>	7	0	8	0
<i>Kogia</i> sp.	0	0	1	0
<i>Megaptera novaeangliae</i>	3	0	2	0
<i>Physeter macrocephalus</i>	5	1	13	1
<i>Stenella frontalis</i>	23	0	24	0
<i>Tursiops truncatus</i>	198	9	221	9
<i>Ziphius cavirostris</i>	13	2	42	4

3 **Table 32. Summary of images collected during all vessel surveys in the Onslow Bay survey area,**
 4 **June 2007–December 2015, with photo-identification catalog sizes and matches to date.**

Species	Year 1		Year 2		Year 3		Year 4		Year 5		Year 6		Year 8	
	Catalog Size	Matches	Catalog Size	Matches	Catalog Size	Matches	Catalog Size	Matches	Catalog Size	Matches	Catalog Size	Matches	Catalog Size	Matches
<i>G. macrorhynchus</i>	8	0	8	0	16	0	16	0	16	0	23	0	23	0
<i>G. griseus</i>	5	0	5	0	7	0	7	0	22	0	22	0	22	0
<i>S. frontalis</i>	3	0	29	0	49	1	68	2	78	3	78	4	86	4
<i>S. bredanensis</i>	0	0	0	0	12	0	12	0	12	0	12	0	12	0
<i>T. truncatus</i>	52	0	78	0	106	5	112	5	139	7	126	8	133	8

5 **Table 33. Summary of images collected during all vessel surveys in the Jacksonville survey area,**
 6 **January 2009–December 2015, with photo-identification catalog sizes and matches to date.**

Species	Year 1		Year 2		Year 3		Year 4		Year 5		Year 6	
	Catalog Size	Matches	Catalog Size	Matches	Catalog Size	Matches	Catalog Size	Matches	Catalog Size	Matches	Catalog Size	Matches
<i>G. macrorhynchus</i>	0	0	0	0	0	0	12	0	12	0	12	0
<i>G. griseus</i>	1	0	1	0	1	0	7	0	22	0	36	0
<i>S. frontalis</i>	0	0	41	0	60	2	77	2	111	2	118	2
<i>T. truncatus</i>	0	0	21	0	41	0	52	2	80	2	100	2

1 5. Analysis of Biopsy Samples

2 5.1 Introduction

3 The ability to obtain tissue samples from live cetaceans using remote biopsy techniques
4 provides an opportunity to augment longitudinal sampling of population demographics, such as
5 the photo-identification work described above, with detailed information on reproductive events.
6 All mammals employ endocrine hormone systems, including two circulating steroids,
7 testosterone and progesterone (Wasser *et al.* 1994). Levels of these steroids can be used to
8 determine reproductive condition of individuals, such as sexual maturity and reproductive status.
9 If a sufficient number of samples are collected, it is possible to estimate these parameters at the
10 population level (Wasser *et al.* 1994, Pereira *et al.* 2006). Recent research has shown that
11 these hormones are also found in the blubber of cetaceans (Mansour *et al.* 2002).

12 5.2 Methods

13 Skin and blubber biopsy samples (Noren & Mocklin 2012) were collected from free-ranging
14 cetaceans along the east coast of the U.S. from Cape Hatteras, North Carolina to Jacksonville,
15 Florida. Blubber progesterone analyses were conducted from biopsy samples from females
16 sampled from 2008. Species tested included: short finned pilot whales ($n=20$); bottlenose
17 dolphins ($n=26$); and a single Atlantic spotted dolphin. A subsample of 50 to 150 mg of blubber
18 from each biopsy was used to determine pregnancy status. The blubber was hormone-extracted
19 following the methods outlined in Trego *et al.* 2013. The resulting hormone residue was frozen
20 at -20°C while awaiting the progesterone assay analysis. A progesterone immunoassay was
21 conducted according to the protocol outlined in Trego *et al.* 2013. Samples were run in duplicate
22 at a re-constitution of 1 mL in 1M phosphate-buffered saline and a further dilution of 1/100. The
23 assays used in this analysis had a progesterone detection capability of 15 to 500 ng/mL. Thus,
24 samples with concentrations larger than the upper detection limit were diluted again and re-run
25 on a following assay. Samples were compared to values from stranded individuals of known
26 reproductive status or from values in the literature. During the extraction process an efficiency
27 protocol was set up by spiking blubber from a known stranded non-pregnant individual with
28 150ng of progesterone solution. After the extraction was complete and the assay was run, it was
29 possible to determine the extraction efficiency. For the purposes of this project, extraction
30 efficiency above 65% was considered appropriate (Kellar *et al.* 2006).

31 5.3 Results

32 Pregnancy was defined by progesterone values greater than 30ng/g. Females were considered
33 non-pregnant by progesterone values of less than 5ng/g (Kellar *et al.* 2006). Values that fall
34 between this range were considered to be of unknown status. Only one of the 20 sampled pilot
35 whales was pregnant, and two fell in the indeterminate range (**Table 34**). Four of the twenty-six
36 female bottlenose dolphins were pregnant, and two fell in the indeterminate range (**Table 35**).
37 The one spotted dolphin analyzed was not pregnant.

1 **Table 34. Progesterone values (ng of P4/g of blubber) for female pilot whales from the study area.**

Pregnant	
Average	41.75
<i>n</i>	1
Non-pregnant	
Average	1.87 ± 0.25
Maximum	3.84
Minimum	0.67
<i>n</i>	17
Indeterminate	
Average	8.00 ± 0.89
Maximum	8.89
Minimum	7.11
<i>n</i>	2
Pregnant Controls (Stranded)	
Average	137.77 ± 15.58
Maximum	177.56
Minimum	112.18
<i>n</i>	4
Non-Pregnant Controls (Stranded)	
Average	1.84 ± 0.07
<i>n</i>	2
Males (Stranded)	
Average	1.49 ± 0.05
<i>n</i>	2.00

2 **Table 35. Progesterone values (ng of P4/g of blubber) for female bottlenose dolphins from the**
 3 **study area.**

Pregnant	
Average	89.65 ± 90.28
Maximum	227.57
Minimum	33.03
<i>n</i>	4
Non-pregnant	
Average	2.24 ± 0.29
Maximum	6.04
Minimum	0.92
<i>n</i>	20
Indeterminate	
Average	19.13 ± 1.76
Maximum	20.89
Minimum	17.37
<i>n</i>	2

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