Small-Vessel Surveys for Protected Marine Species in Navy OPAREAs off the U.S. Atlantic Coast: 2018 Annual Progress Report

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Prepared by

Heather J. Foley[1], Danielle M. Waples[1], Zachary T. Swaim[1], and Andrew J. Read[1]

[1]Duke University Marine Laboratory
135 Duke Marine Lab Road,
Beaufort, NC 28516

Submitted by:

Virginia Beach, VA

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Cover Photo Credit:

Short-finned pilot whale (*Globicephala macrorhynchus*). Photographed by Heather Foley, Duke University, taken under General Authorization Letter of Confirmation 19903 held by Duke University.

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Acronyms and Abbreviations

AFTT	Atlantic Fleet Testing and Training
km	kilometer(s)
Photo-ID	photo-identification
R/V	research vessel
U.S.	United States
USWTR	Undersea Warfare Training Range

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1. Introduction

This report describes results of vessel surveys 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, as well as a passive acoustic monitoring component, in Onslow Bay, North Carolina, and has since expanded to include study areas off the coast of 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. More than nine years of monitoring in the Jacksonville Operating Area have provided similar information on the density and distribution of marine mammals and sea turtles (Foley et al. 2019). Off the coast of Cape Hatteras, over eight years of surveys have also provided information on the complex patterns of distribution and diversity of the marine mammals and sea turtles in this highly productive area and serve as a robust baseline for ongoing tagging and behavioral response projects.

This present report describes vessel monitoring activities, including photo-identification (photo-ID), satellite tagging, and biopsy sampling, at the Jacksonville study area in 2018. Fieldwork at Cape Hatteras in 2018 was dedicated to the Satellite-Tagging and Behavioral Response Study Projects, and is reported separately (Baird et al. 2019, Southall et al. 2019), but here we report on photographic identification work for multiple tagging projects and Atlantic Fleet Testing and Training (AFTT) protected species monitoring for Cape Hatteras and Jacksonville.

2. Jacksonville Study Area

2.1 Methods

2.1.1 Study Area

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

2.1.2 Data Collection

Vessel survey effort in Jacksonville during 2018 focused on photo-ID and satellite tagging of deep-diving odontocete cetaceans. Surveys were conducted from the research vessel (R/V) *Richard T. Barber* (**Figure 2**) at speeds of approximately 8 to 15 knots (15 to 28 kilometers [km]/hour), with higher speeds utilized during on-effort transiting within the survey area. Two observers (one port and one starboard) scanned constantly from straight ahead to 90 degrees abeam either side of the trackline. The location, species, and behavior of every cetacean group were recorded. The location and species of all sea turtles were also recorded. Environmental conditions (weather conditions, Beaufort sea state, depth, and sea-surface temperature) were

collected at each sighting and whenever survey conditions changed. Sighting and environmental data were recorded on an iPad tablet linked to a Global Positioning System unit.

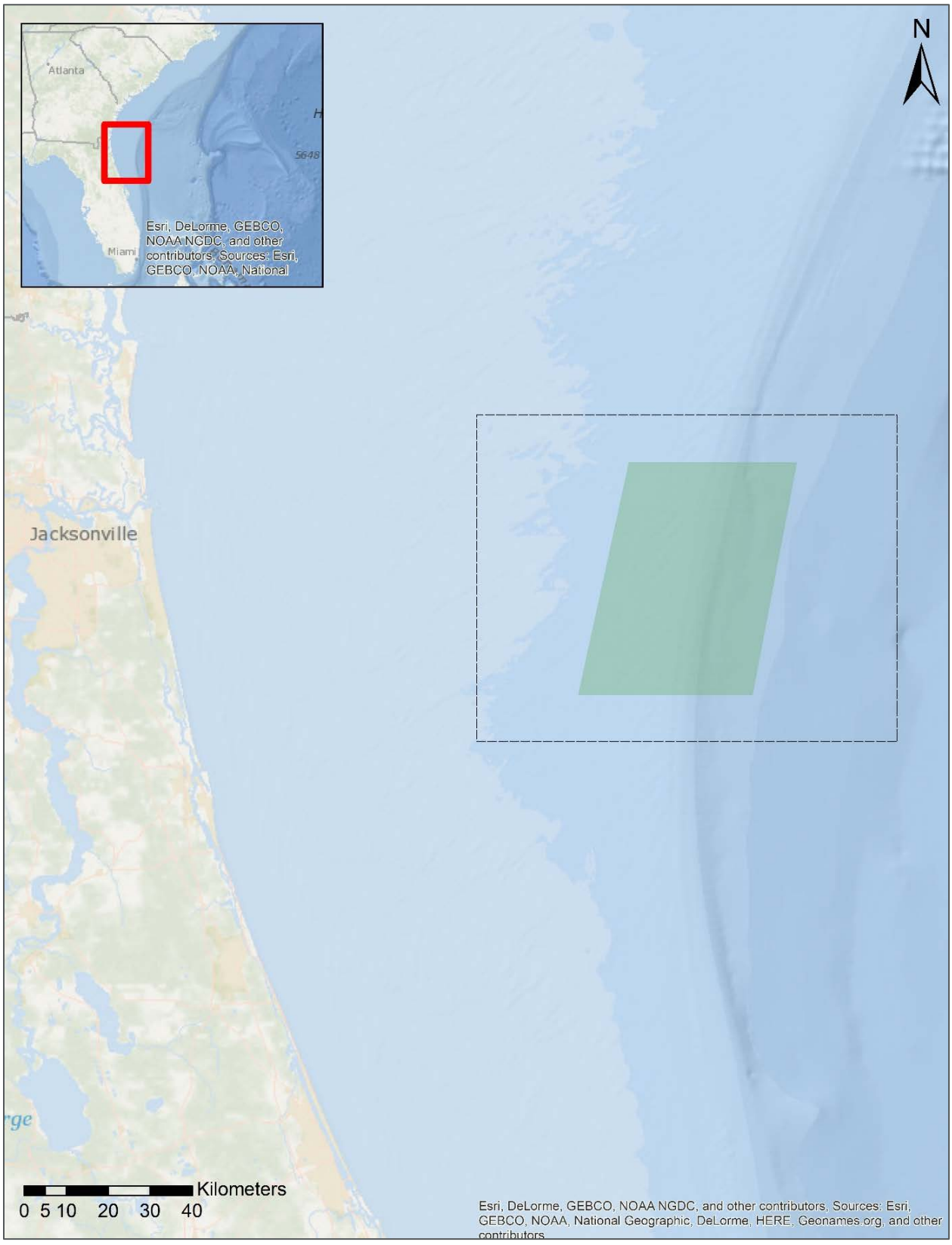

Figure 1. Map of the Jacksonville study area (dashed outline) and the planned USWTR site (shaded box).

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

Use of the survey area by individual cetaceans was examined using photo-ID, and biopsy samples were collected for analysis of population structure. Digital photographs were collected to confirm species identification at each sighting. Photographs were taken with Canon or Nikon digital SLR cameras (equipped with 100- to 400-millimeter zoom lenses) in 24-bit color at a resolution of 6,016 × 4,016 pixels and saved in .jpg format. Remote biopsy-sampling methods were employed 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 a specialized 2.5-centimeter stainless biopsy tip attached to a modified bolt, typically fired from the bow of the survey vessel.

2.1.3 Data Analysis

Vessel survey effort and sighting data were mapped using *ArcGIS* 10.5.2 (Esri, Redlands, CA). All sighting data collected will be posted on the data archive OBIS-SEAMAP (http://seamap.env.duke.edu/). Satellite-tagging data were processed as outlined in Baird *et al.* (2019).

2.1.4 Data Storage

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

2.2 Results

2.2.1 Vessel Survey Effort

Four days of vessel surveys were conducted in the Jacksonville study are during 2018, totaling 315 km, or 15.25 hours, of survey effort (**Table 1**). These surveys were conducted in Beaufort sea state 0 to 4 and covered the proposed USWTR site, including shelf and pelagic waters (**Figure 3**).

Table 1. Dates, distances, and durations surveyed during small-vessel surveys in the Jacksonville survey area in 2018.

Date	Sea State	km Surveyed	Survey Time (hr:min)	At-Sea Time	Platform
07-Nov-18	2-3	150.4	05:41	10:12	R/V *R.T. Barber*
08-Nov-18	4	24.3	00:56	07:17	R/V *R.T. Barber*
09-Nov-18	3	47.0	05:19	11:13	R/V *R.T. Barber*
06-Dec-18	3-4	93.3	03:19	08:37	R/V *R.T. Barber*

2.2.2 Marine Mammal and Sea Turtle Sightings

Five cetacean sightings of two species were recorded during these vessel surveys. Atlantic spotted dolphins (*Stenella frontalis*) (*n*=4) dominated the fauna, in addition to one sighting of short-finned pilot whales (*Globicephala macrorhynchus*) (**Tables 2 and 3**). No sea turtles were recorded in the survey area during 2018.

2.2.3 Distributions and Habitat Associations of Cetaceans

The distribution of marine mammal sightings in the Jacksonville survey area is presented in **Figure 4**. Similar to our observations in previous years, Atlantic spotted dolphins were restricted to shallow shelf waters. Short-finned pilot whales were found offshore of the continental shelf break.

2.2.4 Biopsy Sampling

One biopsy sample was collected in the Jacksonville survey area during 2018 from a satellite-tagged short-finned pilot whale (GmTag219; **Table 4** and **Figure 5**). The skin sample will be analyzed for sex identification. Voucher specimens of these samples are archived with the National Marine Fisheries Service's Southeast Fisheries Science Center laboratory in Lafayette, Louisiana.

2.2.5 Satellite Tagging

Four satellite tags were deployed on short-finned pilot whales in Jacksonville on 9 November 2018 (**Table 5** and **Figure 6**). All four tags were deployed in the same large congregation of approximately 50 animals. Tags transmitted up to 46 days. Similar to four short-finned pilot whales tagged in Jacksonville in 2016, all four tagged individuals traveled throughout the slope waters of the Blake Plateau in a clockwise direction, and repeated this loop several times before

tag transmissions ceased (**Figures 7 through 11**). GmTag222, the tag of longest duration, reached Bahamian waters on 25 December 2018 before tag transmission ceased (**Figure 11**).

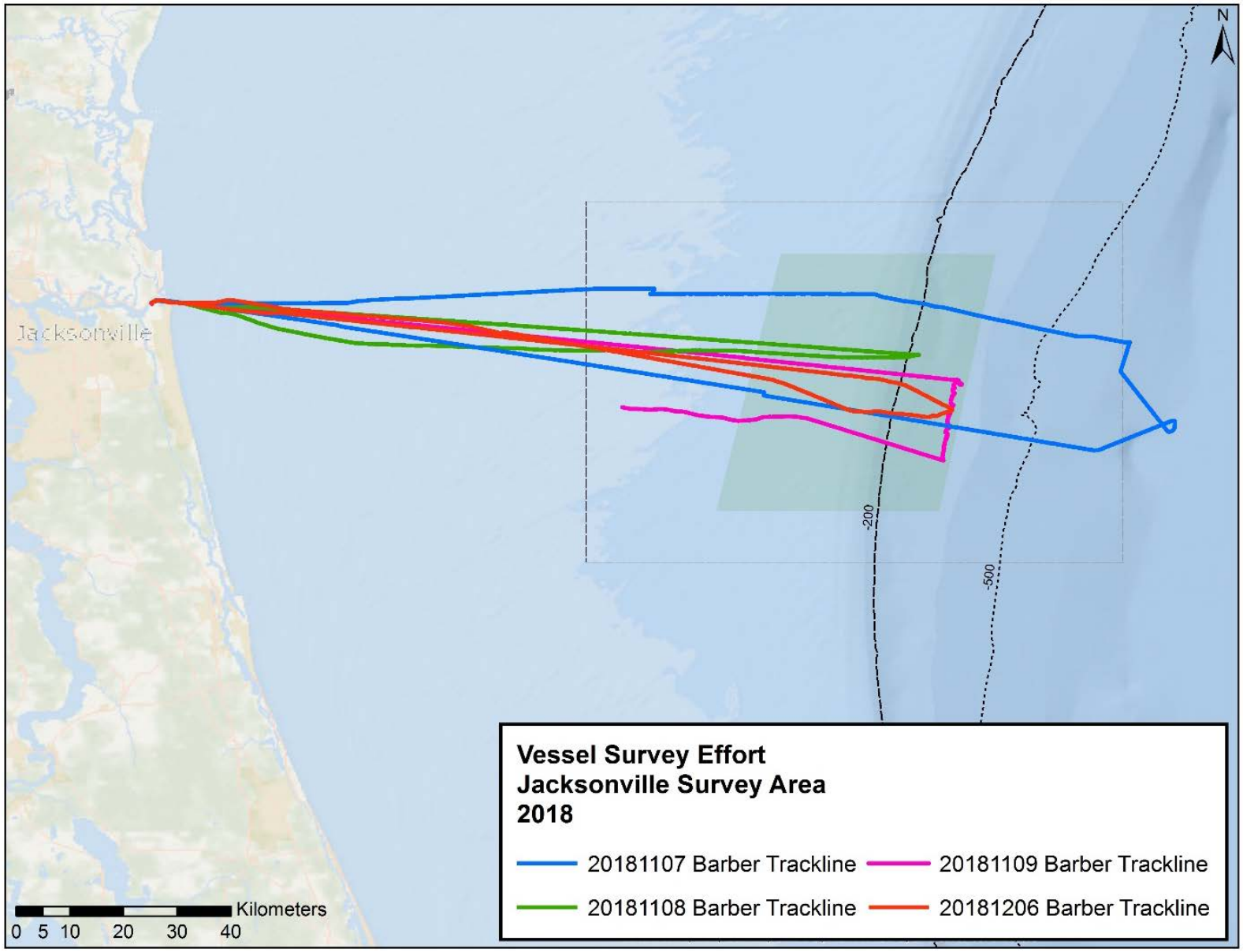

Figure 3. Survey effort during small-vessel surveys in the Jacksonville survey area in 2018.

Table 2. Cetacean sightings from small-vessel surveys in the Jacksonville survey area in 2018.

Date	Time (local)	Latitude (°N)	Longitude (°W)	Species	Common Name	Group Size	Biopsy Samples	Photo-ID images
09-Nov-18	10:10	30.11036	80.09855	*G. macrorhynchus*	Short-finned pilot whale	50	1	1272
06-Dec-18	11:46	30.27389	80.41160	*S. frontalis*	Atlantic spotted dolphin	2	0	0
06-Dec-18	12:11	30.23225	80.29360	*S. frontalis*	Atlantic spotted dolphin	2	0	0
06-Dec-18	14:21	30.29566	80.42626	*S. frontalis*	Atlantic spotted dolphin	12	0	213
06-Dec-18	14:46	30.30888	80.54405	*S. frontalis*	Atlantic spotted dolphin	2	0	0

Table 3. Numbers of cetacean sightings for each species observed in the Jacksonville survey area in 2018.

Species	Sightings 2018
Globicephala macrorhynchus	1
Stenella frontalis	4
Total	**5**

Table 4. Biopsy samples collected in the Jacksonville survey area in 2018.

Date	Time (local)	Latitude (°N)	Longitude (°W)	Species	Sample #
9-Nov-18	13:53	30.25073	80.08764	*G. macrorhynchus*	HJF_18_005

Table 5. Satellite tags deployed in the Jacksonville survey area in 2018.

Date	Time (local)	Latitude (°N)	Longitude (°W)	Species	Tag #	Photo-ID Code
9-Nov-18	10:18	30.12015	80.09819	*G. macrorhynchus*	GmTag219	DU_Gma_031
9-Nov-18	11:01	30.14643	80.10386	*G. macrorhynchus*	GmTag220	Gma_8-003
9-Nov-18	12:44	30.20570	80.09564	*G. macrorhynchus*	GmTag221	Gma_6-011
9-Nov-18	13:09	30.21846	80.09124	*G. macrorhynchus*	GmTag222	Gma_6-014

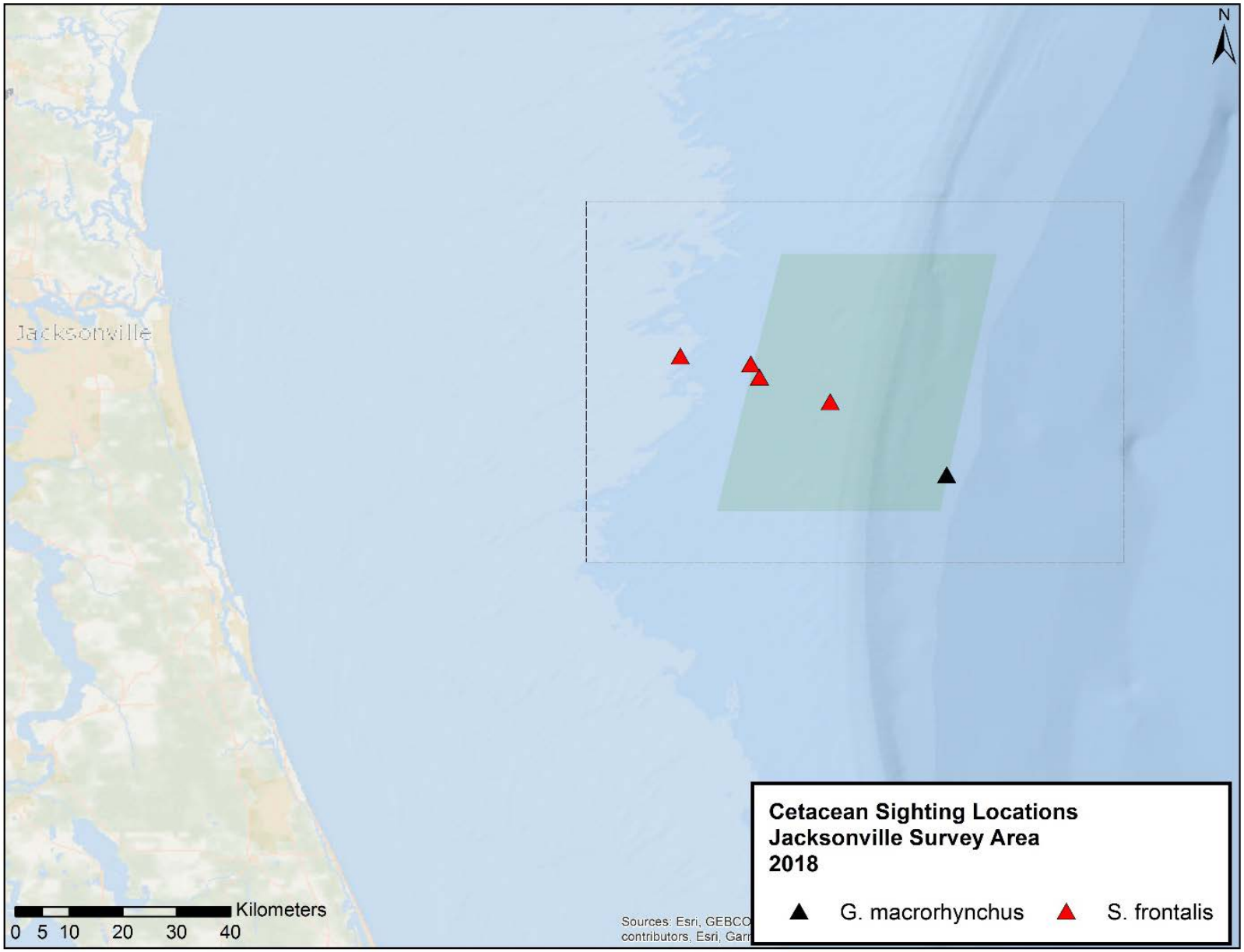

Figure 4. Distribution of all cetacean sightings made during small-vessel surveys in the Jacksonville survey area in 2018.

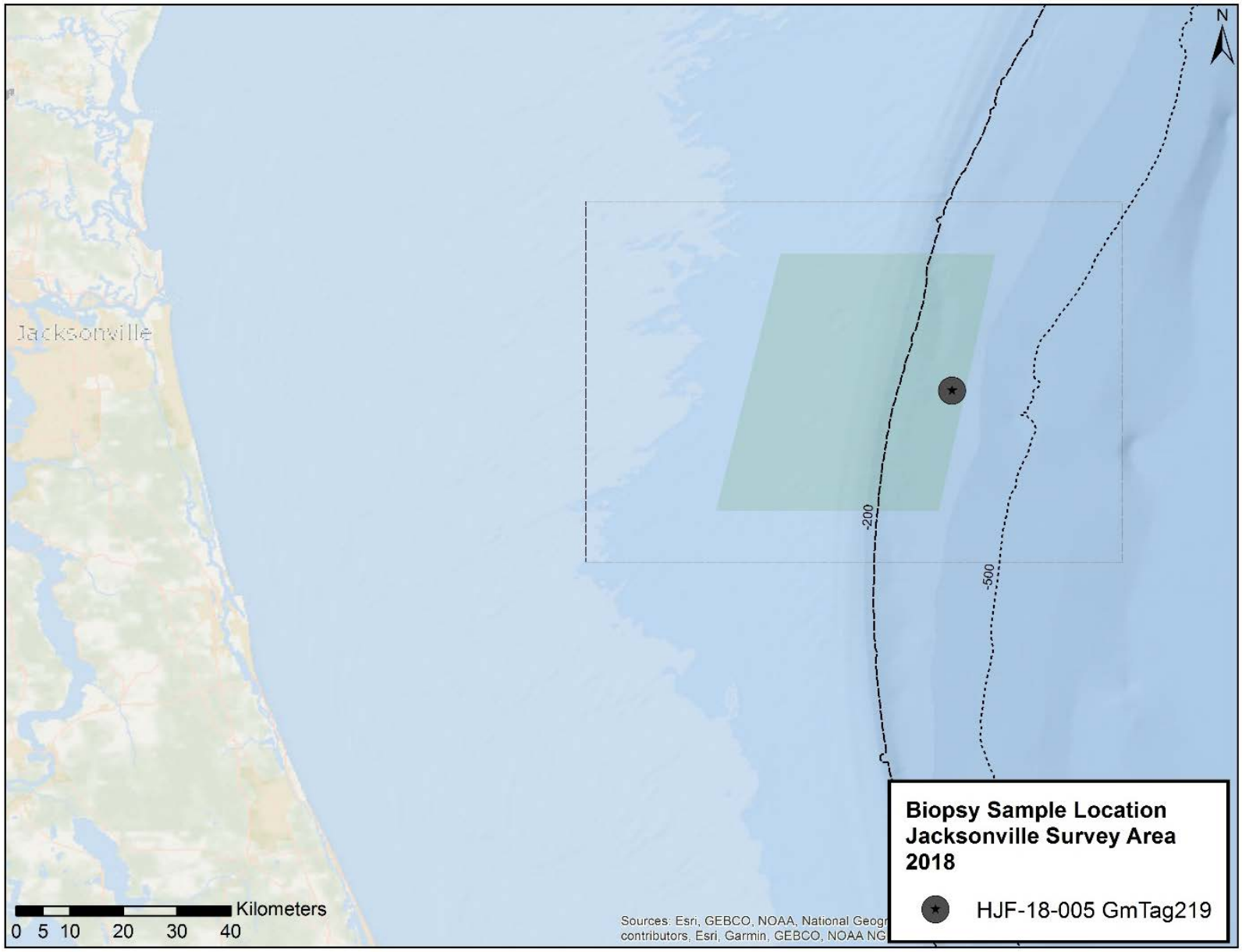

Figure 5. Location of the biopsy sample collected in the Jacksonville survey area in 2018.

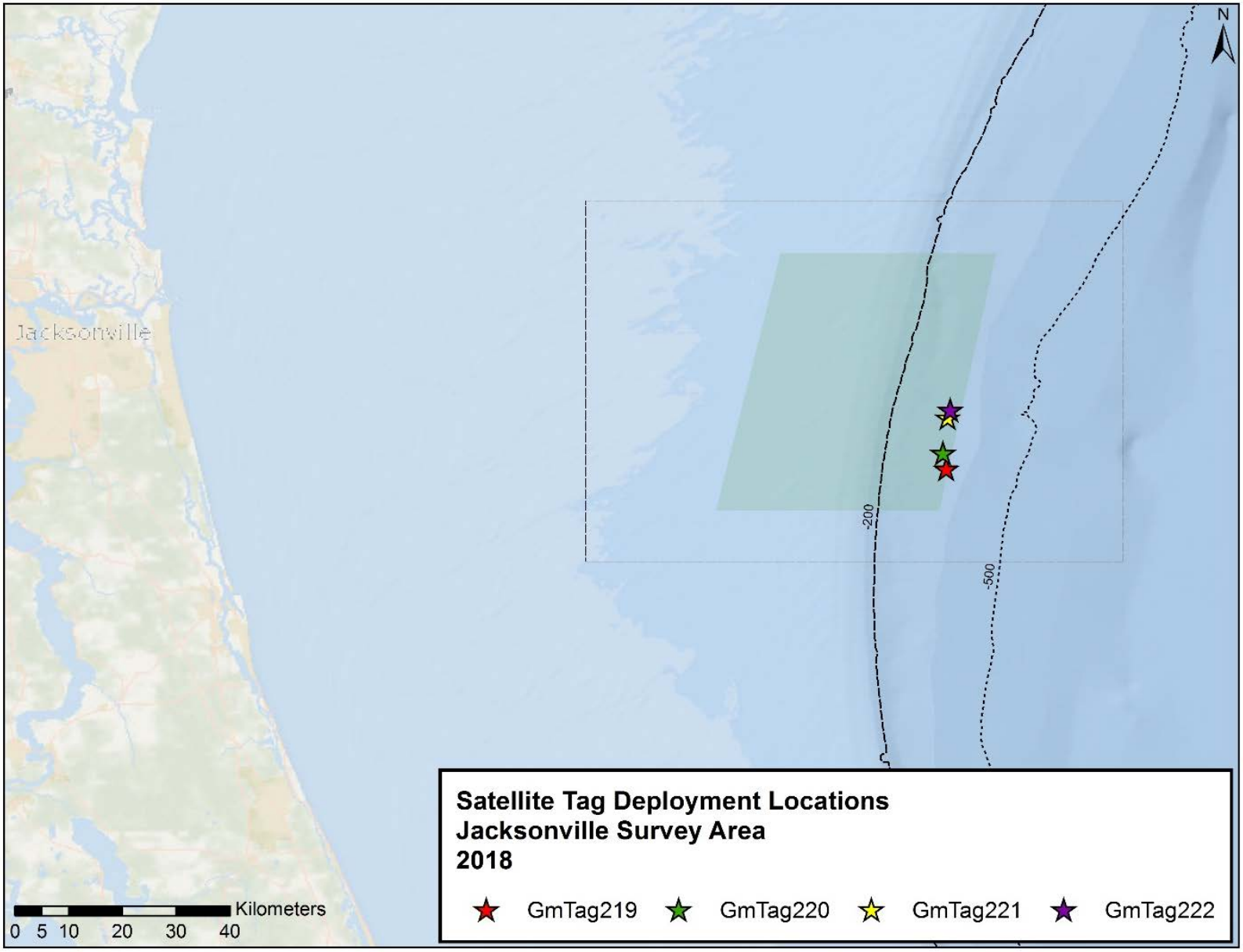

Figure 6. Locations of short-finned pilot whale satellite-tag deployments in the Jacksonville survey area in 2018.

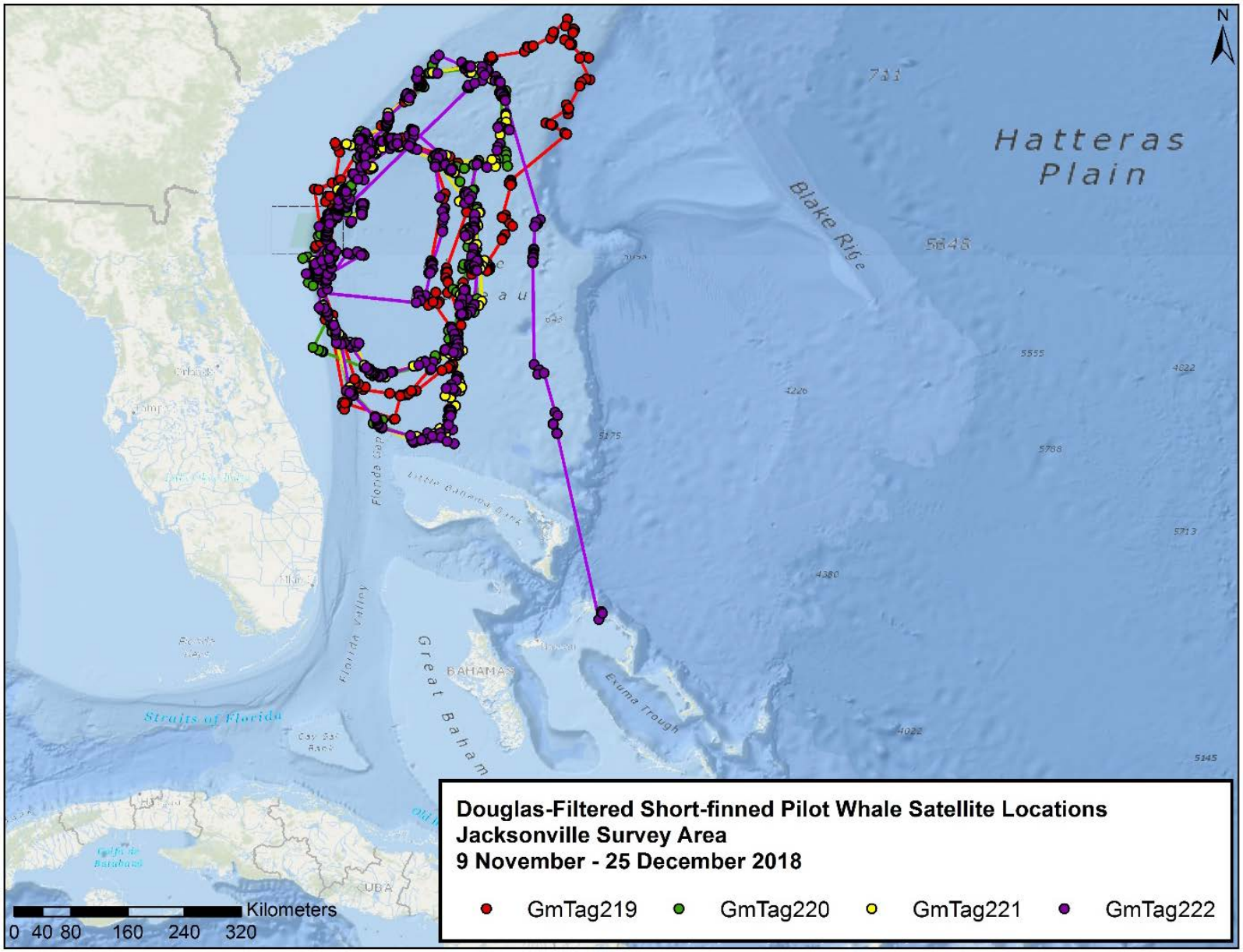

Figure 7. Locations of satellite-tagged short-finned pilot whales tagged in the Jacksonville survey area in 2018.

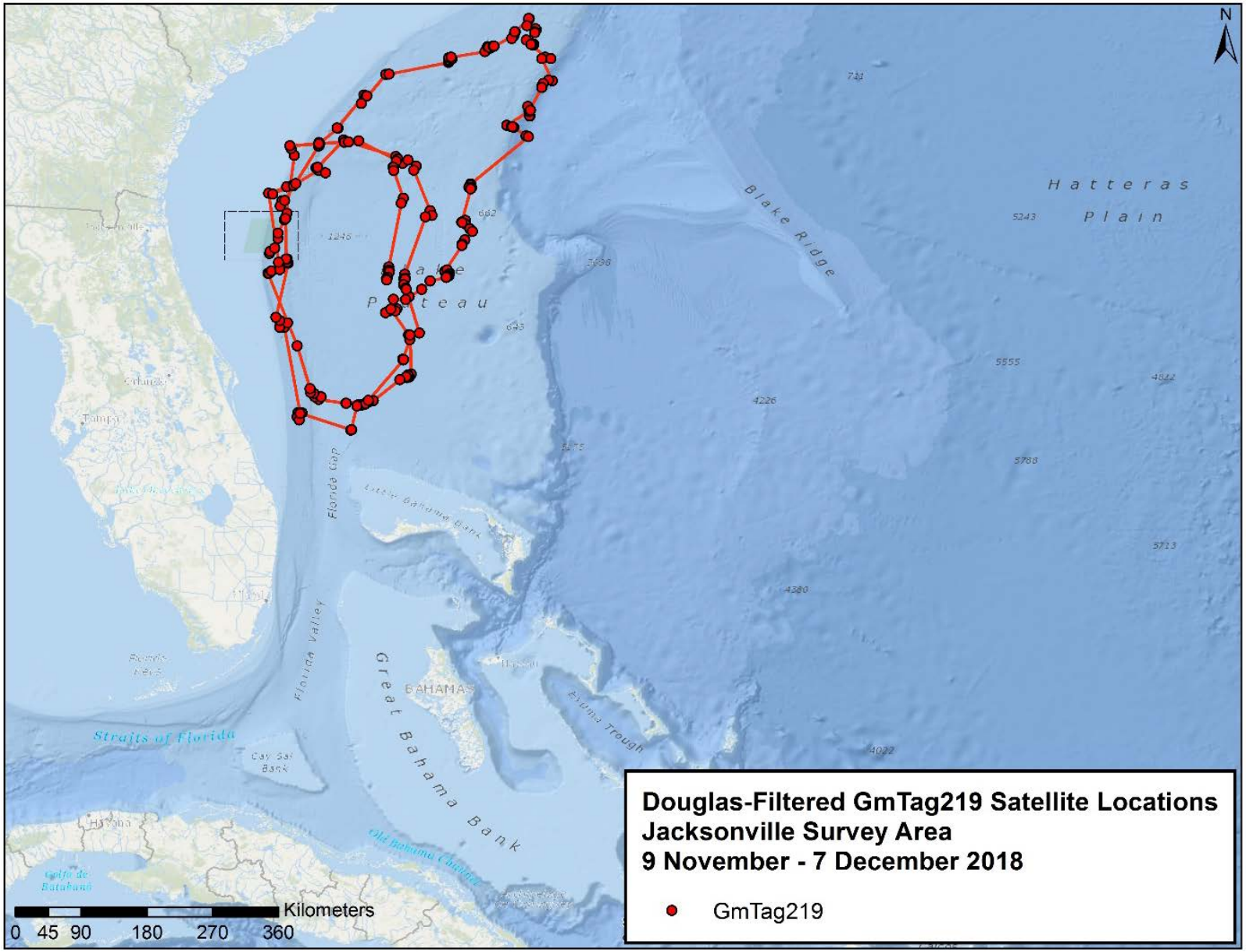

Figure 8. Locations of satellite-tagged short-finned pilot whale GmTag219 in 2018 (28-day duration).

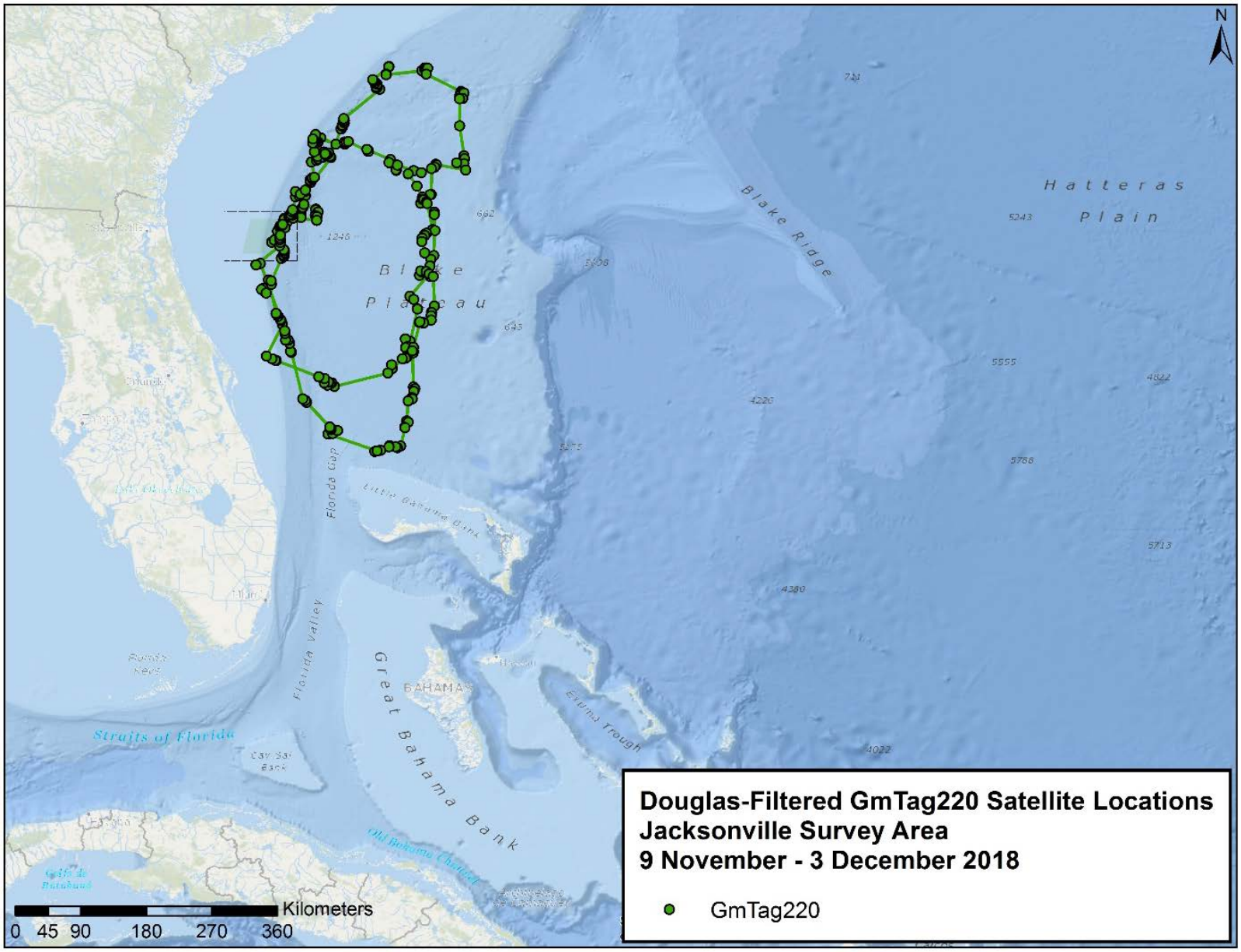

Figure 9. Locations of satellite-tagged short-finned pilot whale GmTag220 in 2018 (24-day duration).

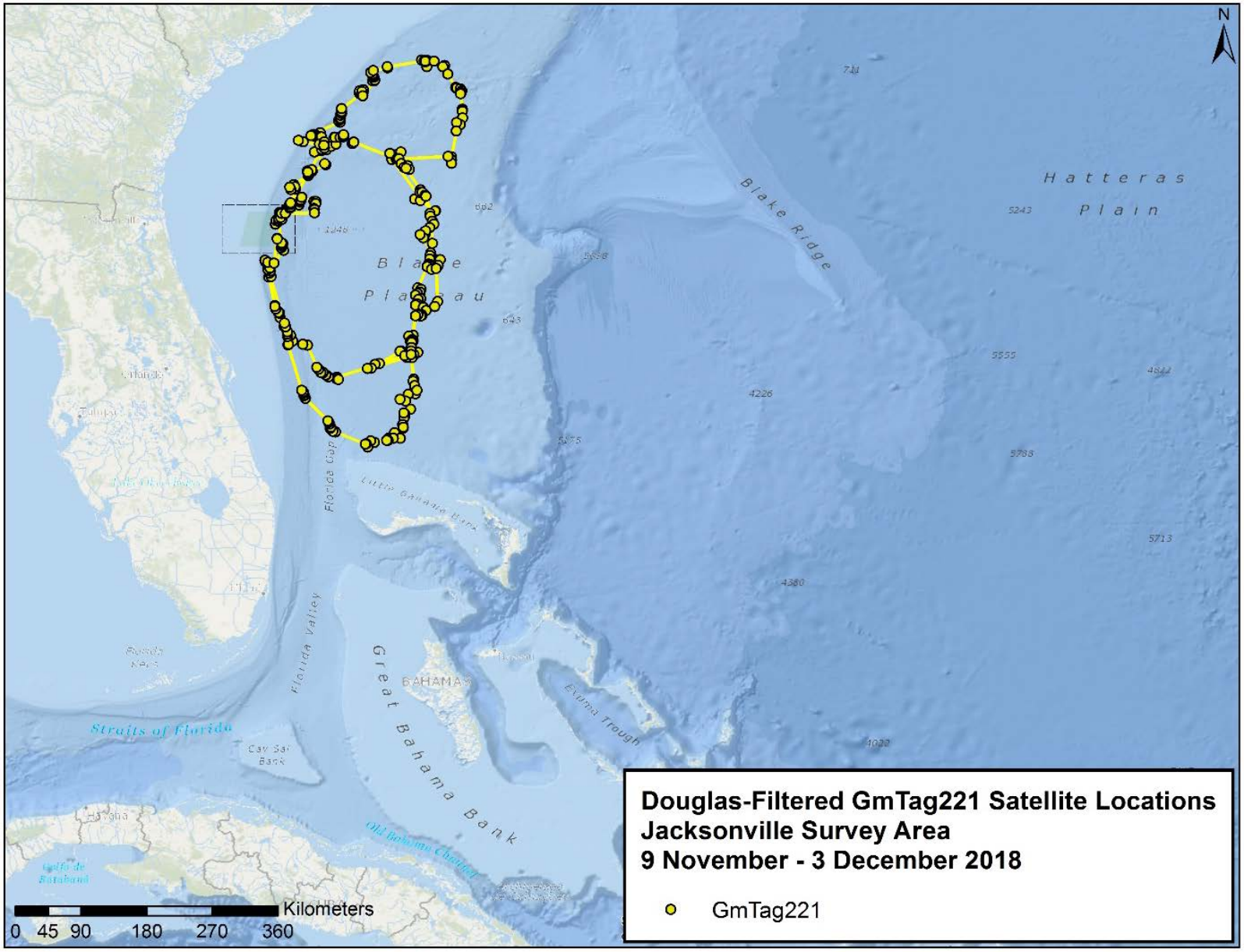

Figure 10. Locations of satellite-tagged short-finned pilot whale GmTag221 in 2018 (24-day duration).

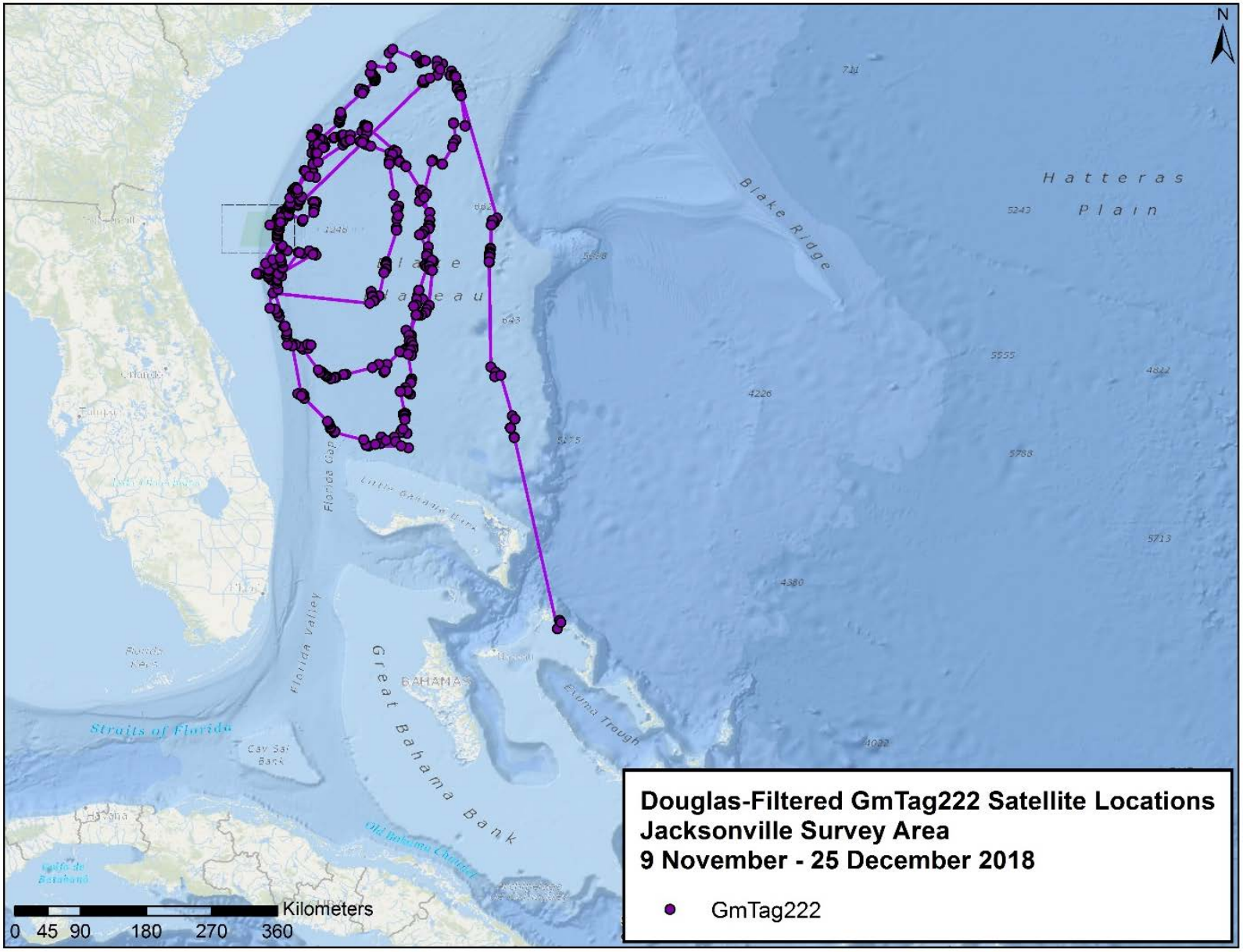

Figure 11. Locations of satellite-tagged short-finned pilot whale GmTag222 in 2018 (46-day duration).

2.2.6 Photographic Effort

Nearly 1,500 digital images were collected for species confirmation and individual identification during 2018, and 28 newly identified dolphins were cataloged (**Table 6**). Photo-ID catalogs for bottlenose (*Tursiops truncatus*) and Atlantic spotted dolphins in the Jacksonville survey area consist of 132 and 204 individuals, respectively. Twenty-three new individuals were added to the Jacksonville short-finned pilot whale catalog in 2018 for a catalog size of 52. The Risso's dolphin catalog includes 56 unique individuals while the rough-toothed dolphin catalog consists of 54 individuals.

Table 6. Summary of photographs taken of animals in the Jacksonville survey area in 2018, with photo-ID catalog sizes and total number of matches to date.

Species	Common Name	Images 2018	Catalog Size	Matches To Date
G. macrorhynchus	Short-finned pilot whale	1272	52	0
G. griseus	Risso's dolphin	0	56	0
S. frontalis	Atlantic spotted dolphin	213	204	22
T. truncatus	Bottlenose dolphin	0	132	8
S. bredanensis	Rough-toothed dolphin	0	54	8

To date, 22 individual Atlantic spotted dolphins, or 10.8% of the catalogued individuals, have been re-sighted within the Jacksonville survey area (**Figure 12**). Sfr 7-008 and 9-011 were first observed together in 2013. In 2016, 7-008 was observed without 9-011, but they were again photographed together in July 2017, making Sfr 7-008 the first individual to be sighted three times within the Jacksonville survey area since surveys commenced in 2009. Eight Atlantic spotted dolphins were observed on consecutive days this year in July (**Table 7**). Three of these eight individuals also had been observed together in July of 2014, for a total of four Atlantic spotted dolphin individuals sighted three times. One pair of dolphins (Sfr 8-037 and Sfr DU 8-014) was seen together in consecutive months this year, in addition to the first trio (Sfr 6-024, Sfr 7-035, and Sfr 9-040) match documented, photographed together in both 2016 and 2017. By identifying an internal match within our catalog this year, we recorded our second-longest re-sighting within the Jacksonville survey area, with Sfr 6-010 being seen in October 2010 and again in November 2017, for over seven years between sightings.

Eight bottlenose dolphins have been re-sighted in Jacksonville. Two pairs of bottlenose dolphins have been re-sighted together: one in January 2012 and July 2013 and another (Ttr 6-037 and 6-038) in September 2013 and February 2017. Ttr 6-007, first cataloged in 2013, was re-sighted in 2017. There has also been one bottlenose dolphin trio re-sighted in the Jacksonville survey area, first seen together in 2015 and again in 2017 (**Table 7** and **Figure 12**). One individual from this trio (Ttr 7-030) was also observed in April 2015, before the trio was first documented, but photo quality prevents us from determining if the two other individuals could have been part of the initial sighting.

We have not identified any re-sights within either the short-finned pilot whale or the Risso's dolphin (*Grampus griseus*) catalog, although pilot whale matches have been made to multiple

adjacent study areas (see below). Eight individual rough-toothed dolphins (*Steno bredanensis*) have been re-sighted, seen on consecutive days in September 2016 (**Table 7**).

1 **Table 7. Photo-ID matches of delphinids observed in the Jacksonville survey area.**

ID[1]	Year									
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Ttr 6-007					X				X	
Ttr 6-010^				X	X					
Ttr 6-036^				X	X					
Ttr 6-037^					X				X	
Ttr 6-038^					X				X	
Ttr 7-022^							X		X	
Ttr 7-030^							X[y]		X	
Ttr 7-031^							X		X	
Sfr 2-002		X							X	
Sfr 2-006				X				X		
Sfr 3-001		X	X							
Sfr 7-008^					X			X	X	
Sfr 9-011^					X				X	
Sfr 7-010					X				X	
Sfr 7-015						X			X	
Sfr 8-005			X[m]							
Sfr 8-037^									X[y]	
Sfr DU 8-014^									X[y]	
Sfr 6-006^						X			X[m]	
Sfr 7-013^						X			X[m]	
Sfr 7-014^						X			X[m]	
Sfr 8-038^									X[m]	
Sfr 9-037^									X[m]	
Sfr DU 1-003^									X[m]	
Sfr DU 6-010^									X[m]	
Sfr DU 7-008^									X[m]	
Sfr 6-024^								X	X	
Sfr 7-035^								X	X	
Sfr 9-040^								X	X	
Sfr 6-010		X							X	
Sbr 1-001								X[m]		
Sbr 1-002								X[m]		
Sbr 6-001								X[m]		
Sbr 6-002								X[m]		
Sbr 7-001								X[m]		
Sbr 7-002								X[m]		
Sbr 7-003								X[m]		
Sbr 7-004								X[m]		

[1] Sfr=*Stenella frontalis* (Atlantic spotted dolphin); Ttr=*Tursiops truncatus* (bottlenose dolphin); Sbr = *Steno bredanensis* (rough-toothed dolphin)

^ – Observed together in multiple sightings

[m] – re-sighted within same month

y – re-sighted within same year

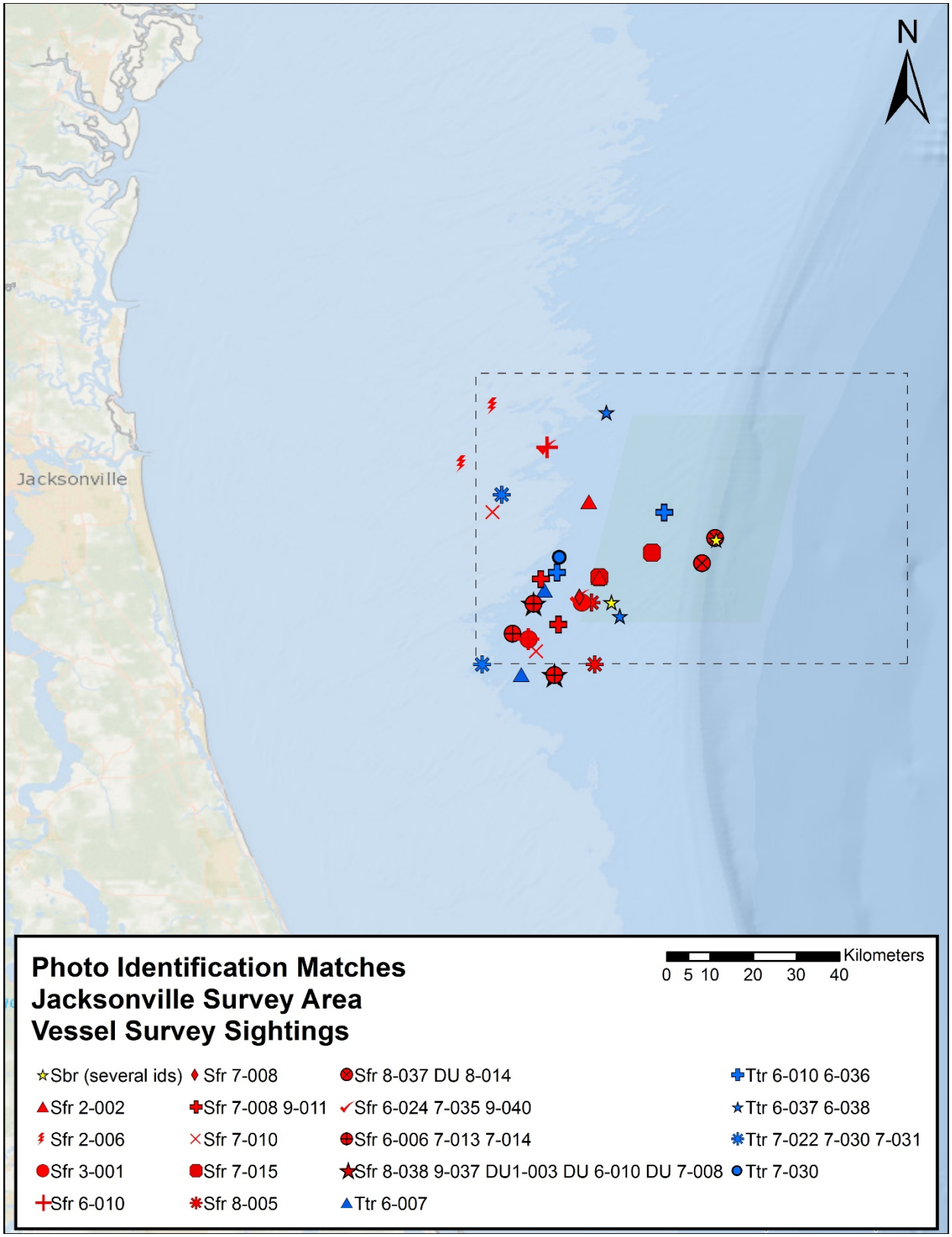

Figure 12. Locations of photo-matched dolphins within the Jacksonville survey area.

The Jacksonville short-finned pilot whale photo-identification catalog had been compared previously to both the Onslow Bay and Cape Hatteras short-finned pilot whale photo-ID catalogs, and no matches had been identified. However, the new 2018 short-finned pilot whale IDs made in Jacksonville have not yet been compared to the Cape Hatteras and Onslow Bay catalogs.

As reported in Foley et al. (2017), seven short-finned pilot whales from the Jacksonville catalog were observed in both the Bahamas in 2007 and the Jacksonville survey area in 2009. Three of these seven individuals were re-sighted again in the Bahamas in 2015. In addition, five short-finned pilot whales first photographed together in the Bahamas in June 2009 were re-sighted in Onslow Bay two months later.

Based on the movement of GmTag222, tagged 9 November 2018 in Jacksonville, who moved into Bahamian waters just before tag transmission ceased, all short-finned pilot whale IDs from 2018 in Jacksonville will also be compared to the Bahamas catalog in the coming year.

3. Cape Hatteras Study Area

3.1 Photographic Effort

Over 28,300 digital images were obtained to confirm species, identify individual animals, and conduct follow-up monitoring of satellite-tagged animals during fieldwork supporting the Atlantic Behavioral Response Study in 2018 (Baird et al. 2019, Southall et al. 2019). Images of 36 newly identified animals were added to five existing photo-identification catalogs of bottlenose dolphins, short-finned pilot whales, sperm whales (*Physeter macrocephalus*), Cuvier's beaked whales (*Ziphius cavirostris*), and common dolphins (*Delphinus delphis*). To date, photo-ID catalogs for 11 species have been assembled across multiple AFTT marine species monitoring projects, with 413 individuals re-sighted across all species (**Table 8**).

Table 8. Summary of images collected during fieldwork in the Cape Hatteras study area in 2018, with photo-ID catalog sizes and total matches to date.

Species	Images 2018	Catalog Size	Matches To Date
Balaenoptera physalus	0	1	0
Delphinus delphis	199	46	1
Globicephala macrorhynchus	14,463	1,156	358
Grampus griseus	0	47	6
Kogia sp.	0	1	0
Megaptera novaeangliae	0	2	0
Physeter macrocephalus	225	20	1
Stenella clymene	0	3	0
Stenella frontalis	8	24	0
Tursiops truncatus	422	329	17
Ziphius cavirostris	13,055	127	30

Analysis of the images taken in the Cape Hatteras survey area is ongoing. To date, 17 bottlenose dolphins have been re-sighted, with multiple years between re-sights for 13 of the 17 dolphins (**Table 9**). The longest time between re-sights spans more than five years, with Ttr_7-024 first photographed in May 2007 and then re-sighted in June 2012. Another individual, Ttr_9-016, was photographed on three occasions during a five-year period, with sightings in May 2011, June 2014, and August 2016. We have also photographed bottlenose dolphins associating in the same groups over multiple years. Ttr_6-018 and Ttr_9-013 were photographed together in March 2012 and May 2013. Ttr_6-102 and Ttr_8-024 were seen in the same group in September 2013 and then observed together almost three years later in May 2016. Ttr_7-076 and Ttr_8-032 were photographed together three times over a two-year period, with sightings in May 2014 and in March and August of 2016. Ttr_6-099 was also present in the groups in May 2014 and August 2016.

A single match of a common dolphin has been made; Dde 7-002 was first photographed on 27 May 2007 and then re-sighted nearly five years later on 15 March 2012. A single sperm whale match has been made; Pma-004 was observed on 27 and 29 May in 2013. Six Risso's dolphins (including GgTag017) were sighted together on two consecutive days in August 2016.

Photo-ID efforts for Cuvier's beaked whales during this reporting period were focused on the satellite-tagged animals (Baird et al. 2019). To date, 42 Cuvier's beaked whales have been satellite-tagged off Cape Hatteras and 19 (45%) of them have been re-sighted, with 15 animals re-sighted during the 2018 season (**Table 9**). Eight re-sights during this reporting period were of Cuvier's beaked whales tagged during 2018, but the remaining seven re-sights were of animals tagged in previous years. The first Cuvier's beaked whale to be satellite-tagged in the Cape Hatteras area, Zca-003r (ZcTag029), was initially sighted and tagged on 13 May 2014. It was subsequently re-sighted five days later and then seen again four years later, on 12 May 2018. The tagging site appears to be well healed. Another Cuvier's beaked whale, Zca-015 (ZcTag039), was first observed and tagged in June 2015. It was re-sighted over three years later in August 2018 when it was satellite-tagged for a second time (ZcTag077). Zca-008r (ZcTag047) was initially sighted in May and October of 2014 with a dependent calf. It was re-sighted and satellite-tagged in May of 2016, and has been re-sighted seven times since, including four re-sights during 2018.

Thirteen Cuvier's beaked whales were tagged in 2018 and seven of those individuals were matched to the photo-id catalog. Zca-002 was first observed in October of 2013 in a group of three whales and it was re-sighted in August 2018 and tagged (ZcTag074). As mentioned above, Zca-015 (ZcTag039_ZcTag077) was first sighted and tagged in June 2015 and then re-sighted and re-tagged in August 2018. Zca-035 (ZcTag076) was first seen in June of 2017 and next seen and subsequently tagged in August of 2018. Zca-071r was first photographed in August of 2017 and was re-sighted and tagged in August of 2018. The remaining three beaked whales were photographed for the first time in 2018 and were observed and tagged later in the 2018 field season.

Table 9. Photo-ID matches of individual odontocete cetaceans, excluding short-finned pilot whales, in the Cape Hatteras survey area.

ID[1]	Year												
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Ttr 1-001				X		X[y]							
Ttr 6-018^							X	X					
Ttr 6-020						X		X					
Ttr 6-038								X			X		
Ttr 6-099^									X		X		
Ttr 6-102^								X			X		
Ttr 7-024		X					X						
Ttr 7-031						X[y]							
Ttr 7-038						X[y]							
Ttr 7-058								X[y]					
Ttr 7-076^									X		X[y]		
Ttr 8-024^								X			X		
Ttr 8-032^									X		X[y]		
Ttr 9-013^							X	X					
Ttr 9-016						X			X		X		
Ttr 9-027 (TtTag015)									X[m]				
Ttr 9-036										X		X	
Dde 7-002		X					X						
Pma-004								X[m]					
Ggr 6-002											X[m]		
Ggr 6-004											X[m]		
Ggr 6-005											X[m]		
Ggr 6-006 (GgTag017)											X[m]		
Ggr 7-004											X[m]		
Ggr 9-002											X[m]		
Zca-001r								X		X			
Zca-002 (ZcTag074)								X					X

ID[1]	Year												
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Zca-003r (ZcTag029)									X[m]				X
Zca-005									X	X		X	
Zca-006 (ZcTag040)									X	X		X	X
Zca-008r (ZcTag047)									X[y]		X[m]	X[y]	X[y]
Zca-019 (ZcTag043)									X	X			
Zca-024 (ZcTag046)											X	X	
Zca-029 (ZcTag054)												X[y]	
Zca-030 (ZcTag055)												X[y]	
Zca-035 (ZcTag076)												X	X[y]
Zca-035r (ZcTag048)											X		X
Zca-037 (ZcTag068)												X[y]	
Zca-040												X[y]	
Zca-042 (ZcTag062)												X[y]	
Zca-050 (ZcTag078)													X[y]
Zca-050r (ZcTag057)												X	X
Zca-051 (ZcTag069)												X[y]	
Zca-051r (ZcTag058)												X[y]	X
Zca-053 (ZcTag075)													X[m]
Zca-053r												X[m]	
Zca-054 (ZcTag080)													X[m]
Zca-054r												X[y]	
Zca-056r												X[m]	

ID[1]	Year												
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Zca-071r (ZcTag081)												X	X[m]
Zca-079r (ZcTag073)													X[y]
M-001 (ZcTag030)									X[y]				
M-002									X	X			
M-003									X	X			
M-004								X				X	

[1] Dde=*Delphinus delphis* (common dolphin); Ggr= *Grampus griseus* (Risso's dolphin) Pma=*Physeter macrocephalus* (sperm whale); Ttr=*Tursiops truncatus* (bottlenose dolphin); Zca=*Ziphius cavirostris* (Cuvier's beaked whale); M=aerial-vessel match

m – re-sighted within same month

y – re-sighted within same year

^Observed together in multiple sightings

With increased tagging effort in the Cape Hatteras study area in the last few years and the dramatic increase in number of photographs taken (28,372 images this year compared to approximately 6,000 in 2017), there is an increase in the number of Cuvier's beaked whales that have been sighted over multiple years. To date, 16 of the 30 matched Cuvier's beaked whales have been seen across multiple years. As mentioned above, Zca-002 was first seen in October of 2013 and was re-sighted almost five years later in August of 2018 (ZcTag074); based on photographs of its erupted teeth this animal is an adult male and represents the Cuvier's beaked whale with the longest time interval between re-sights. Zca-005 was initially sighted in May of 2014, was re-sighted in June of 2015, and was sighted a third time in June 2017. Zca-006 was first photographed in May 2014 and was D-Tagged at that time, although the tag was never recovered. In June 2015, Zca-006 was re-sighted and satellite-tagged (ZcTag040) and it was sighted again in August 2017 and for a fourth time in May of 2018. Zca-008r was first observed in May 2014, and was seen again in October 2014 with a small calf, confirming that she is an adult female. She was satellite-tagged in May 2016 (ZcTag047) and seen two days after tagging. During 2017, we photographed her on two occasions, in June and August, and in 2018, she was photographed on four occasions in May and August. This female represents the Cuvier's beaked whale that has the most re-sights in the Cape Hatteras area, with 10 sightings over four years.

We are also beginning to document individual Cuvier's beaked whales associating over time. Zca-024 and Zca-008r were satellite tagged in the same group in May 2016 (ZcTag046 and ZcTag047, respectively) and were seen together again in June 2017. We have confirmed that Zca-008r is an adult female and believe that Zca-024 is an adult male, due to the heavy amount of scarring on its body.

Photo-ID efforts for short-finned pilot whales during this reporting period were focused on the satellite-tagged animals (Baird et al. 2019). Nine of the 18 short-finned pilot whales that were tagged in 2018 were matched to our existing catalog. Gma_6-055 was observed in May of 2008, photographed in 2014, 2015 and 2017, and it was both seen and satellite tagged in May of 2018 (GmTag197), 10 years after its initial sighting. Gma_6-078 was photographed on three occasions in May and August of 2007, during two sightings in May of 2008 and May of 2015 and finally was satellite tagged in August of 2018 (GmTag218), more than 11 years after its first sighting. One short-finned pilot whale tagged in 2018 in the Hatteras area was matched to the catalog for Onslow Bay. Gma_8-165 was seen in Onslow Bay, North Carolina, in a group of 40 short-finned pilot whales in August of 2007 and re-sighted and satellite tagged (GmTag209) in the Cape Hatteras area 11 years later in August of 2018. Two other short-finned pilot whales were also photographed with Gma_8-165 in both of these two sightings. These three photo-ID matches are the first short-finned pilot whale matches documented between the Cape Hatteras and Onslow Bay catalogs.

Twenty-five of the 74 (34%) short-finned pilot whales that have been satellite-tagged in the Hatteras study area between 2014 and 2018 have been re-sighted during subsequent field efforts, and 14 of those 25 animals were seen in 2018 (**Table 10**). Nine of the 14 re-sights in 2018 were of pilot whales tagged during that year, but the other five re-sights in 2018 were of short-finned pilot whales that had been tagged in previous years. Gma_7-127 was first photographed in May of 2008, and it was seen again in July of 2010 and May and June of 2012.

Table 10. Photo-ID sighting histories of short-finned pilot whales in the Cape Hatteras survey area and re-sighted after tagging. A red X denotes the year when satellite tagging occurred.

ID	Year											
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
GmTag087								X[y]				
GmTag089								X	X			
GmTag091	X							X	X			
GmTag096		X		X		X[y]		X			X	X
GmTag097		X				X		X	X			
GmTag122						X			X[m]			
GmTag127									X[m]			
GmTag134^									X			X
GmTag135^									X[y]			X
GmTag136						X			X[y]			X
GmTag140									X		X	
GmTag157										X	X	
GmTag172											X[m]	
GmTag175						X					X[m]	
GmTag179											X	X
GmTag182											X[m]	
GmTag197		X						X	X		X	X[y]
GmTag201												X[y]
GmTag204									X			X[y]
GmTag205												X[y]
GmTag206												X[y]
GmTag207					X[y]	X	X		X			X[m]
GmTag208												X[y]
GmTag216												X[m]
GmTag218	X[y]	X[m]							X[m]			X[m]
Gma_1-005						X						X
Gma_1-019								X				X
Gma_1-044									X[y]			X
Gma_1-062		X		X	X[y]							X
Gma_1-097											X	X
Gma_2-011		X			X[m]	X			X[m]			X
Gma_2-044					X							X
Gma_299d	X											X
Gma_6-011					X[y]	X	X		X			X

Gma_6-024	X[m]							X				X[m]
Gma_6-063							X					X
Gma_6-072					X[m]				X[m]			X
Gma_6-075									X			X
Gma_6-108									X			X
Gma_6-114									X			X
Gma_6-138									X			X
Gma_6-142									X			X
Gma_6-192		X									X	X[m]
Gma_6-343		X							X[y]			X
Gma_7-208									X[y]			X
Gma_7-211									X[y]			X
Gma_7-225		X[m]							X[y]			X
Gma_7-298									X			X[m]
Gma_7-438						X						X
Gma_8-063		X[m]										X[m]
Gma_9-152					X							X

m – re-sighted within same month

y – re-sighted within same year

^Observed together in multiple sightings

It was satellite tagged in September of 2014 (GmTag096) and re-sighted in May of 2017 and finally in August of 2018, four years after it was satellite tagged. Gma_242du, Gma_6-116 and Gma_6-032 were all satellite tagged in October of 2015 (GmTag134, GmTag135, and GmTag136, respectively) and all three were re-sighted in 2018. Gma_7-424 was satellite tagged in May of 2017 (GmTag179) and was re-sighted one year later in May of 2018. As with the satellite-tagged Cuvier's beaked whales, photo-ID can provide a means to document and assess the long-term effects of tagging on individual short-finned pilot whales. In addition to the 14 satellite tagged pilot whales that were resighted in 2018, another 26 pilot whales were also resighted during the 2018 field season (Table 10).

The high re-sighting rate of short-finned pilot whales in the Hatteras study area continued during 2018. More than 130 short-finned pilot whales have been seen on three or more occasions and two animals have been photographed on nine separate days. Gma_6-055 (GmTag097) was sighted nine times between May 2008 and June 2018, and Gma_6-078 (GmTag218) was photographed nine times between May 2007 and August 2018. We are also documenting individual short-finned pilot whales returning to the Cape Hatteras area over extended periods. Twelve pilot whales have spans of 10 or more years between their first and last sightings. Gma_6-078 has the longest interval between sightings, with its initial sighting in May 2007 and

its most recent sightings 11 years later in August 2018, when it was satellite tagged (GmTag218).

We continue to document individual short-finned pilot whales in association over relatively long times. Gma_8-075 and Gma_9-094 were first photographed in the same group in May 2007 and were later seen together in December 2015. Four pilot whales (Gma_1-023, Gma_1-030, Gma_7-016, and Gma_7-112) were observed together in May of 2008 and again in May of 2015. Another two pilot whales (Gma_9-010 and Gma_9-118) were photographed in the same group four times between 2007 and 2014. Gma_242du and Gma_6-116 (GmTag134 and GmTag135) were photographed in May 2015 with five other distinct pilot whales, and all seven were seen in the same group in August of 2018. As mentioned above, three short-finned pilot whales were seen together in Onslow Bay in 2007 and re-sighted together off Cape Hatteras in 2018. We will continue exploring short-finned pilot whale social structure in the coming year.

4. Summary Tables

Total small-vessel survey effort conducted since the beginning of the monitoring program in the Jacksonville study area, including all AFTT protected species monitoring and tagging effort, is reported in **Table 11**. The annual numbers of sightings by species for both cetaceans and sea turtles in Jacksonville are presented in **Tables 12 and 13**. The number of biopsy samples collected to date is reported in **Table 14**. **Table 15** summarizes the photo-ID catalog sizes and matches by species to date and images taken during the reporting period in the Jacksonville survey area. For information on Cape Hatteras survey effort and sighting information, please refer to Southall et al. (2019). The number of biopsy samples collected to date in the Cape Hatteras area is reported in **Table 16**.

Table 11. Small-vessel survey effort from July 2009 through December 2018 in the Jacksonville survey area.

	2009-10	2011	2012	2013	2014	2015	2016	2017	2018	Total
Survey Hours	127.1	20.9	58.6	58.7	66.8	44.2	130.7	66.1	15.3	588.4
km Surveyed	2,073.5	345.7	937.4	1,021.7	1,227.4	858.2	2,135.5	1424.2	315.0	10,338.6

Table 12. Cetacean sightings by species from July 2009 through December 2018 during small-vessel surveys in the Jacksonville survey area.

Species	Sightings								
	2009-10	2011	2012	2013	2014	2015	2016	2017	2018
Eubalaena glacialis	0	0	0	0	1	0	0	0	0
Globicephala macrorhynchus	3	0	0	0	0	0	5	0	1
Grampus griseus	2	0	0	1	1	1	0	2	0
Stenella attenuata	0	0	0	0	0	0	2	0	0
Stenella frontalis	35	6	14	9	20	10	10	18	4
Steno bredanensis	0	0	0	0	0	0	2	1	0
Tursiops truncatus	19	6	23	15	18	10	18	16	0
Tursiops/Stenella mix	0	0	0	0	1	0	0	0	0
Unidentified delphinid	13	0	4	3	4	0	5	0	0
Total	**72**	**12**	**41**	**28**	**45**	**21**	**42**	**37**	**5**

Table 13. Sea turtle sightings by species from July 2009 through December 2018 during small-vessel surveys in the Jacksonville survey area.

Species	Sightings								
	2009-10	2011	2012	2013	2014	2015	2016	2017	2018
Caretta caretta	52	20	41	33	31	22	22	24	0
Dermochelys coriacea	8	3	4	1	3	2	4	2	0
Lepidochelys kempii	1	0	1	0	0	0	0	0	0
Unidentified sea turtle	8	3	3	1	0	0	0	3	0
Total	**69**	**26**	**49**	**35**	**34**	**24**	**26**	**29**	**0**

Table 14. Biopsy samples collected from July 2009 through December 2018 during small-vessel surveys in the Jacksonville survey area.

Species	2009-10	2011	2012	2013	2014	2015	2016	2017	2018	Total
Globicephala macrorhynchus	0	0	0	0	0	0	5	0	1	6
Grampus griseus	0	0	0	1	2	0	0	0	0	3
Stenella attenuata	0	0	0	0	0	0	1	0	0	1
Stenella frontalis	0	0	19	6	19	3	7	8	0	62
Steno bredanensis	0	0	0	0	0	0	4	2	0	6
Tursiops truncatus	0	0	12	5	10	5	5	2	0	39
Total	**0**	**0**	**31**	**12**	**31**	**8**	**22**	**12**	**1**	**117**

Table 15. Summary of images collected during all small-vessel surveys in the Jacksonville survey area from 2009 through 2018, with photo-identification catalog sizes and matches to date.

Species	2009-10		2011		2012		2013		2014		2015		2016		2017		2018	
	Catalog Size	Matches	Catalog Size	Matches	Catalog Size	Matches	Catalog Size	Matches	Catalog Size	Matches	Catalog Size	Matches	Catalog Size	Matches	Catalog Size	Matches	Catalog Size	Matches
G. macrorhynchus	0	0	0	0	0	0	12	0	12	0	12	0	29	0	29	0	52	0
G. griseus	1	0	1	0	1	0	7	0	22	0	36	0	36	0	56	0	56	0
S. frontalis	0	0	41	0	60	2	77	2	111	2	118	2	154	3	199	20	204	22
T. truncatus	0	0	21	0	41	0	52	2	80	2	100	2	114	2	132	8	132	8
S. bredanensis	0	0	0	0	0	0	0	0	0	0	0	0	43	8	54	8	54	8

Table 16. Biopsy samples collected 2011 through 2018 from vessel surveys in the Cape Hatteras survey area.

Species	2011	2012	2013	2014	2015	2016	2017	2018	Total
Balaenoptera physalus	0	0	3	0	0	0	0	0	3
Delphinus delphis	0	5	2	0	1	0	0	0	8

Globicephala macrorhynchus	4	33	10	5	14	4	3	15	88
Grampus griseus	0	0	2	0	0	0	0	0	2
Physeter macrocephalus	0	0	1	1	0	0	0	1	3
Stenella frontalis	6	0	2	2	2	0	0	0	12
Tursiops truncatus	14	10	13	2	1	0	0	0	40
Ziphius cavirostris	0	0	2	0	2	0	1	7	12
Total	**24**	**48**	**35**	**10**	**20**	**4**	**5**	**23**	**146**

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