Vessel Surveys and Visual Species-Verification Trials at the Jacksonville Shallow Water Training Range: 2023 Annual Progress Report

Submitted to:

Naval Facilities Engineering Systems Command Atlantic under Contract No. N62470-20-D-0016, Task Orders 21F4046 issued to HDR, Inc.

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Cover Photo Credit:

False killer whale (*Pseudorca crassidens*) photographed by Josh Meza-Fidalgo (Duke University), taken under General Authorization Letter of Confirmation 19903 held by Andrew Read (Duke University).

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Acronyms and Abbreviations

°N	degrees north
°W	degrees west
AFTT	Atlantic Fleet Training and Testing
AUTEC	Atlantic Undersea Test and Evaluation Center
DCL	detection, classification, and localization
Ggr	*Grampus griseus* (Risso's dolphin)
JSWTR	Jacksonville Shallow Water Training Range
km	kilometer(s)
km^2	square kilometer(s)
M3R	Marine Mammal Monitoring on Navy Ranges
OPAREA	Operating Area
photo-ID	photo-identification
PMRF	Pacific Missile Range Facility
R/V	Research Vessel
Sbr	*Steno bredanensis* (rough-toothed dolphin)
Sfr	*Stenella frontalis* (Atlantic spotted dolphin)
SOAR	Southern California Tactical Training Range
Ttr	*Tursiops truncatus* (bottlenose dolphin)
U.S.	United States

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1. Introduction

This report describes results from vessel surveys and visual species-verification trials conducted at the Jacksonville Shallow Water Training Range (JSWTR) in the Jacksonville Operating Area (OPAREA). This work continues from a multi-institutional monitoring program 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 passive acoustic monitoring within Onslow Bay, North Carolina; it subsequently expanded to include study areas off the coast of Jacksonville, Florida; Cape Hatteras, North Carolina; and Virginia Beach, Virginia. In Onslow Bay, 6 years of monitoring yielded a comprehensive picture of the density, distribution, and abundance of marine mammals and sea turtles as well as provided new insights into residency patterns among pelagic delphinids within this region (Read et al. 2014). Dedicated survey effort within the Onslow Bay site concluded in 2013. More than 9 years of monitoring within the Jacksonville OPAREA 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 and Virginia Beach, more than a decade of surveys and passive acoustic monitoring have also provided information on the complex distribution patterns as well as the marine mammal and sea turtle diversity within this highly productive area.

Although the original standardized line-transect visual surveys and archival passive acoustic monitoring have been discontinued in the Atlantic Fleet Training and Testing (AFTT) OPAREAs, that foundational work has provided a robust baseline for several ongoing tagging and behavioral response projects (see Atlantic Behavioral Response Study, Mid-Atlantic Offshore Cetacean Monitoring, and Mid-Atlantic Nearshore & Mid-shelf Baleen Whale Monitoring). The JSWTR was installed in 2018, and a dedicated passive acoustic marine mammal monitoring system (Marine Mammal Monitoring on Navy Ranges [M3R]) was integrated in 2019. Small vessel surveys resumed on JSWTR in 2018 to support development and calibration of detection and classification algorithms for the M3R system through visual species-verification trials. This report describes vessel monitoring activities, including photo-identification (photo-ID), satellite tagging, biopsy sampling, and visual species verification at the Jacksonville study area in 2023. Fieldwork at Cape Hatteras in 2023 was dedicated to the Atlantic Behavioral Response Study (BRS) Project. Photo-ID work for the BRS and Atlantic Fleet Training and Testing (AFTT) protected species monitoring for Cape Hatteras and Jacksonville is reported separately (Waples and Read 2024).

2. Methods

2.1 Study Area

The study area within the Jacksonville OPAREA is 5,786 square kilometers (km^2), surrounding the JSWTR, which is approximately 1,700 km^2 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**).

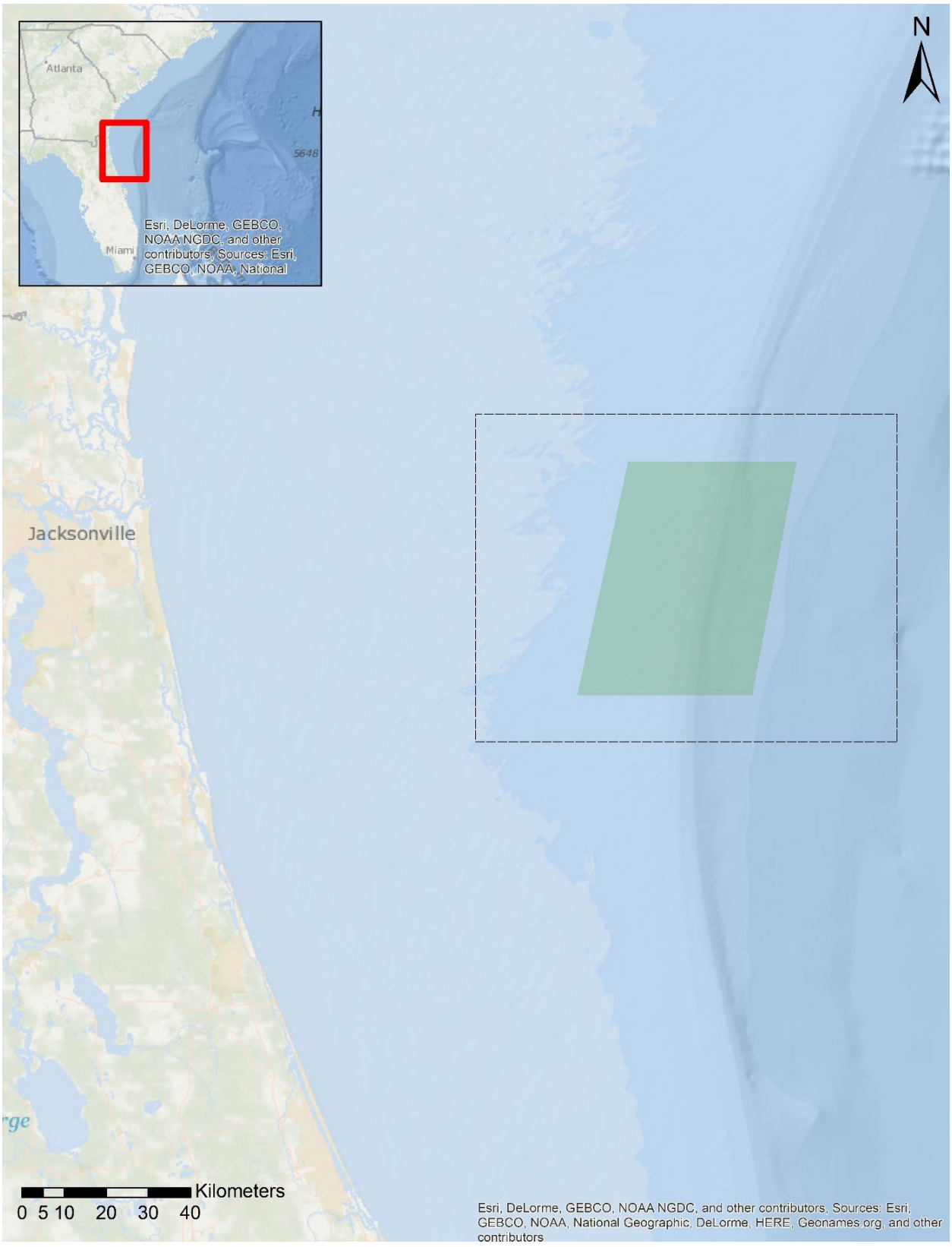

Figure 1. Map of the Jacksonville study area (dashed outline) and the JSWTR site (shaded box).

2.2 Data Collection

In March, October, and December 2023, the study team employed visual survey methods to support species-verification trials in conjunction with the M3R system in coordination with the Naval Undersea Warfare Center, Division Newport (see **Section 5**). The study team conducted surveys from Research Vessel (R/V) *Richard T. Barber* (October) (**Figure 2)** and R/V *Shearwater* (March and December) (**Figure 3**).When the M3R team relayed a possible cetacean location (see Jarvis et al. 2014 for M3R methods), the research vessel transited to the provided location coordinates, and two observers (one port and one starboard) scanned continuously from straight ahead to 90 degrees abeam either side of the trackline. The study team recorded the location, species, and behavior of every cetacean group observed as well as the location and species identity of all sea turtles. The team collected environmental conditions (weather conditions, Beaufort Sea state, depth, and sea-surface temperature) at each sighting and whenever survey conditions changed. Sighting and environmental data were logged on an iPad tablet linked to a Global Positioning System unit.

The study team examined use of the survey area by individual cetaceans using photo-ID, collected biopsy samples for analysis of population structure, and temporarily paint-marked individuals to better understand foraging behavior and group association. The team obtained digital photographs to confirm species identification at each sighting. Photographs were taken with Canon or Nikon digital single-lens reflex 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 used 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-steel biopsy tip attached to a modified bolt, typically fired from the survey vessel's bow. A Kingman Spyder paintball marker and pre-manufactured oil-based marking pellets (Nelson Paint Company, Kingsford, Michigan) were used to mark bottlenose dolphins. Standard 0.68 caliber (0.68-inch/17.3-millimeter diameter) paintballs were discharged between 4 and 30 meters away from the animal at a maximum velocity of 86.9 meters per second (a typical safe operating velocity for human recreational use [Conn et al. 2007] and biopsy collection from marine mammals using crossbows [Sinclair et al. 2015]).

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

Figure 3. The R/V *Shearwater*.

2.3 Data Analysis

Vessel survey effort and sighting data were mapped using ArcGIS Pro 3.02 (Esri, Redlands, California). All sighting data collected will be posted on the data archive Ocean Biodiversity Information System Spatial Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP).

2.4 Data Storage

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

3. Results

3.1 Vessel Survey Effort

During 2023, the study team conducted 9 days of vessel surveys within the Jacksonville study area and 2 additional days of opportunistic surveys during transits from Beaufort, North Carolina, totaling 1,481.5 kilometers (km), and 69.75 hours, of survey effort (**Table 1**). These surveys were conducted in Beaufort sea state 1 to 6, and covered the JSWTR site as well as shelf and pelagic waters between Florida and North Carolina; see **Figure 4** through **Figure 8**.

Table 1. Dates, distances, and durations surveyed during vessel surveys within the Jacksonville survey area in 2023.

Date	Beaufort Sea State	Distance Surveyed (km)	Survey Time (hours:minutes)	At-Sea Time (hours:minutes)	Platform
28-Feb-23	3–4	—	—	4:57	R/V *Shearwater*
1-Mar-23	1–4	75.59	7:19	24:00	R/V *Shearwater*
2-Mar-23	3–4	39.90	4:22	14:27	R/V *Shearwater*
4-Mar-23	3–4	213.11	7:02	17:17	R/V *Shearwater*
5-Mar-23	3–4	208.44	10:28	24:00	R/V *Shearwater*
6-Mar-23	3–4	160.79	10:55	24:00	R/V *Shearwater*
7-Mar-23	3–5	—	—	21:02	R/V *Shearwater*
29-Oct-23	3–4	23.15	1:56	9:38	R/V *R.T. Barber*
30-Oct-23	2–4	77.23	4:01	11:22	R/V *R.T. Barber*
2-Dec-23	6–7	—	—	16:59	R/V *Shearwater*
3-Dec-23	4–6	394.17	4:25	22:45	R/V *Shearwater*
5-Dec-23	3–5	117.73	6:31	17:37	R/V *Shearwater*
7-Dec-23	2–3	58.39	4:36	16:45	R/V *Shearwater*
8-Dec-23	2–3	113.00	8:10	24:00	R/V *Shearwater*
9-Dec-23	2–4	—	—	15:18	R/V *Shearwater*

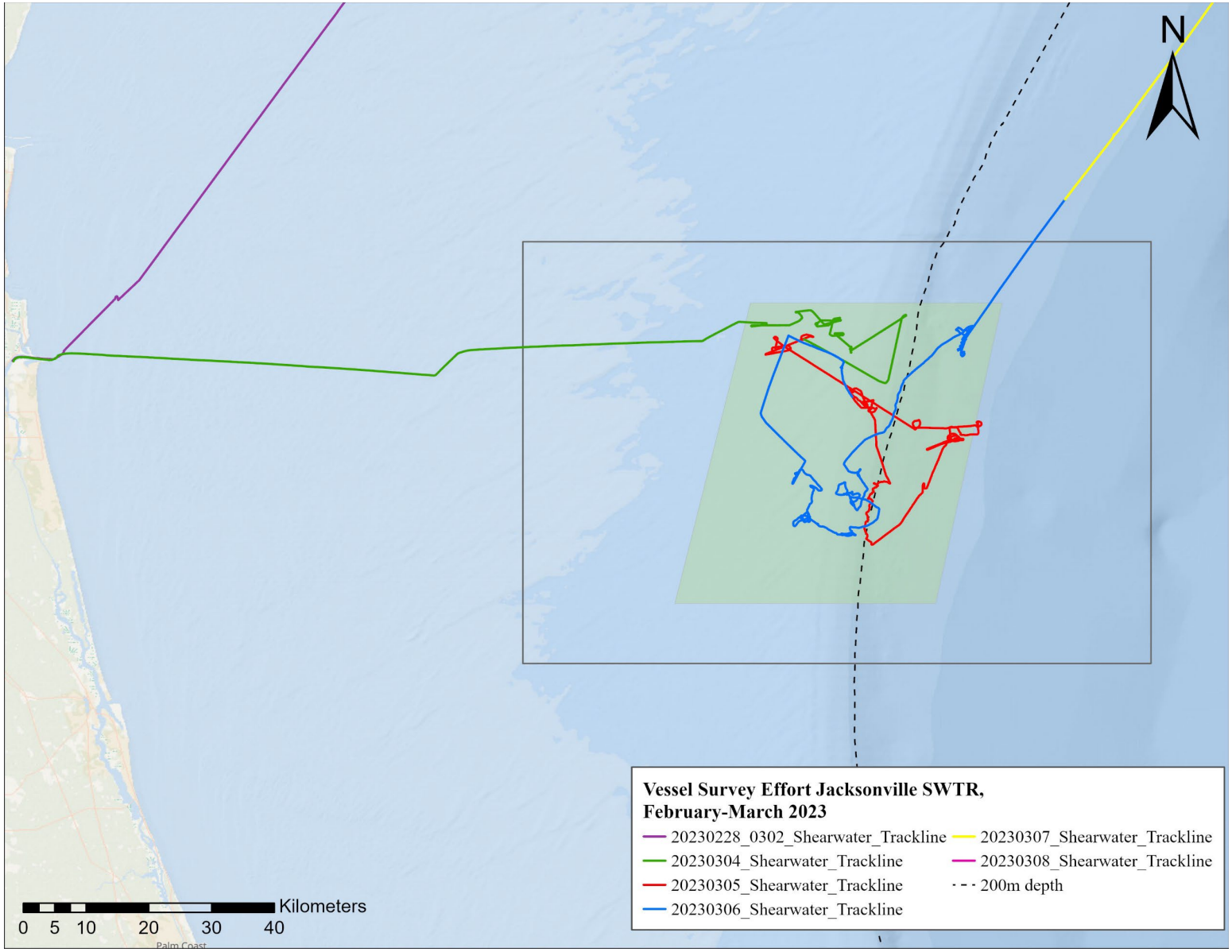

Figure 4. Vessel survey effort conducted by the R/V Shearwater for February-March 2023 within the Jacksonville survey area.

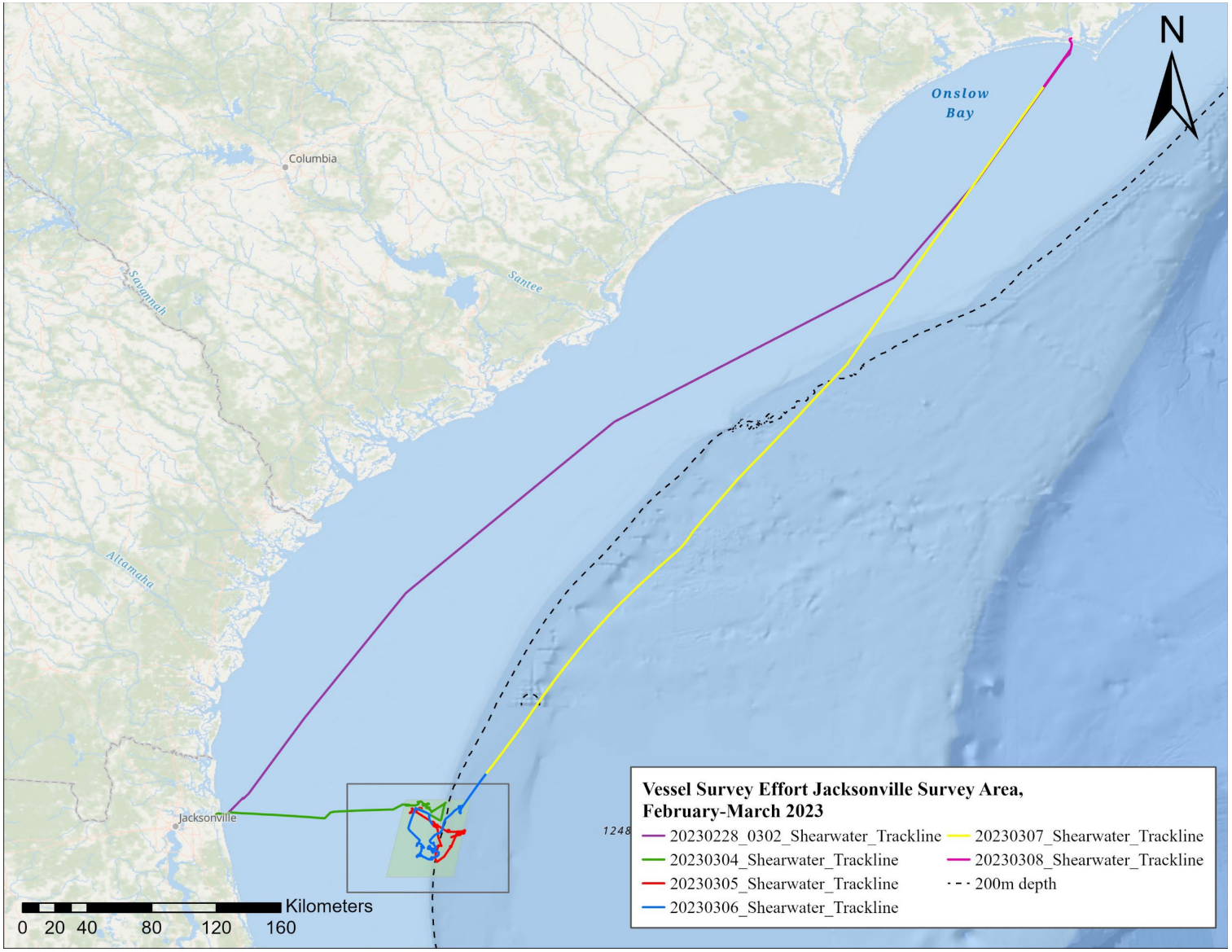

Figure 5. Vessel survey effort conducted by the R/V Shearwater for February-March 2023 during transits and surveys within the Jacksonville survey area.

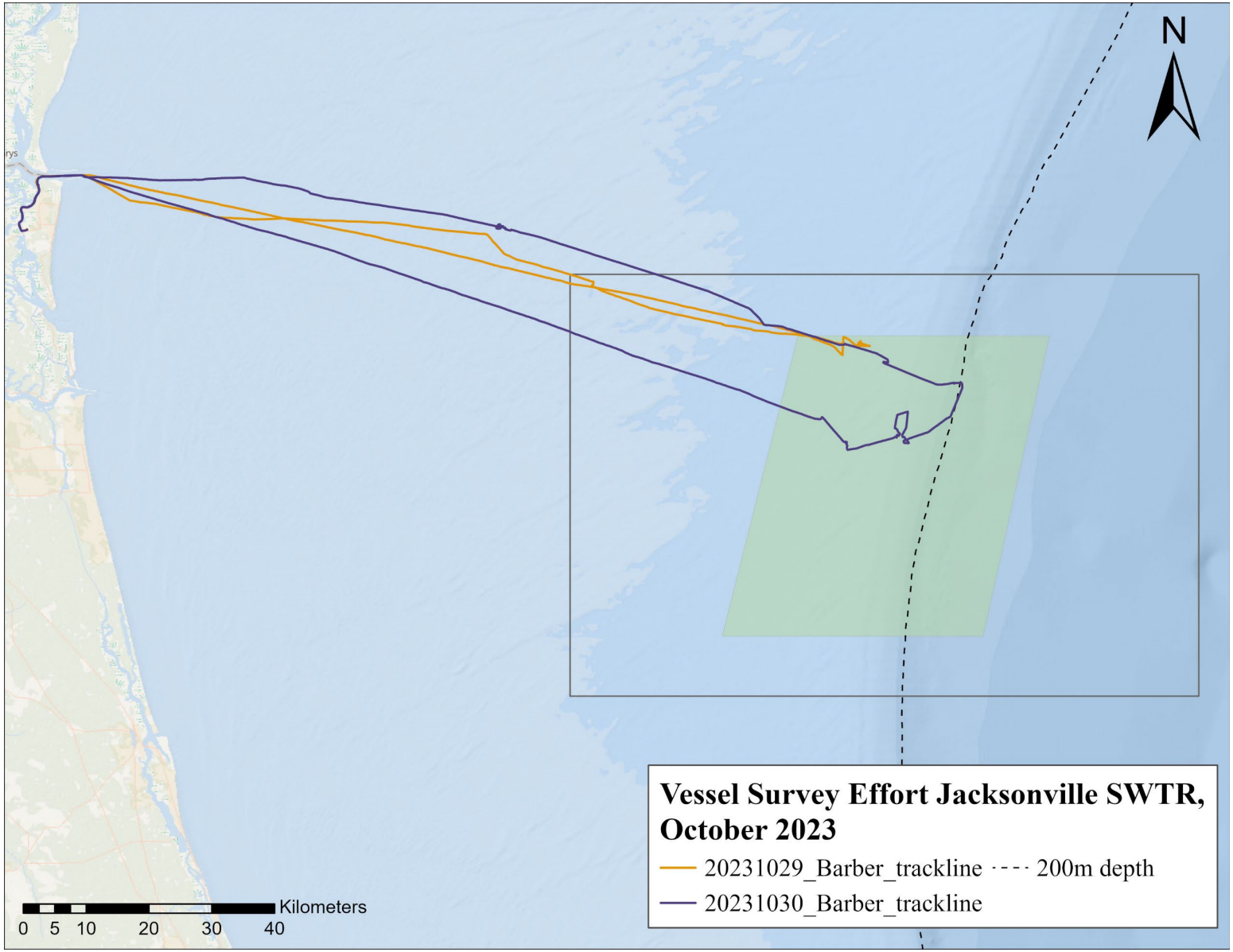

Figure 6. Effort during vessel surveys conducted by the R/V Richard T. Barber within the Jacksonville survey area in October 2023.

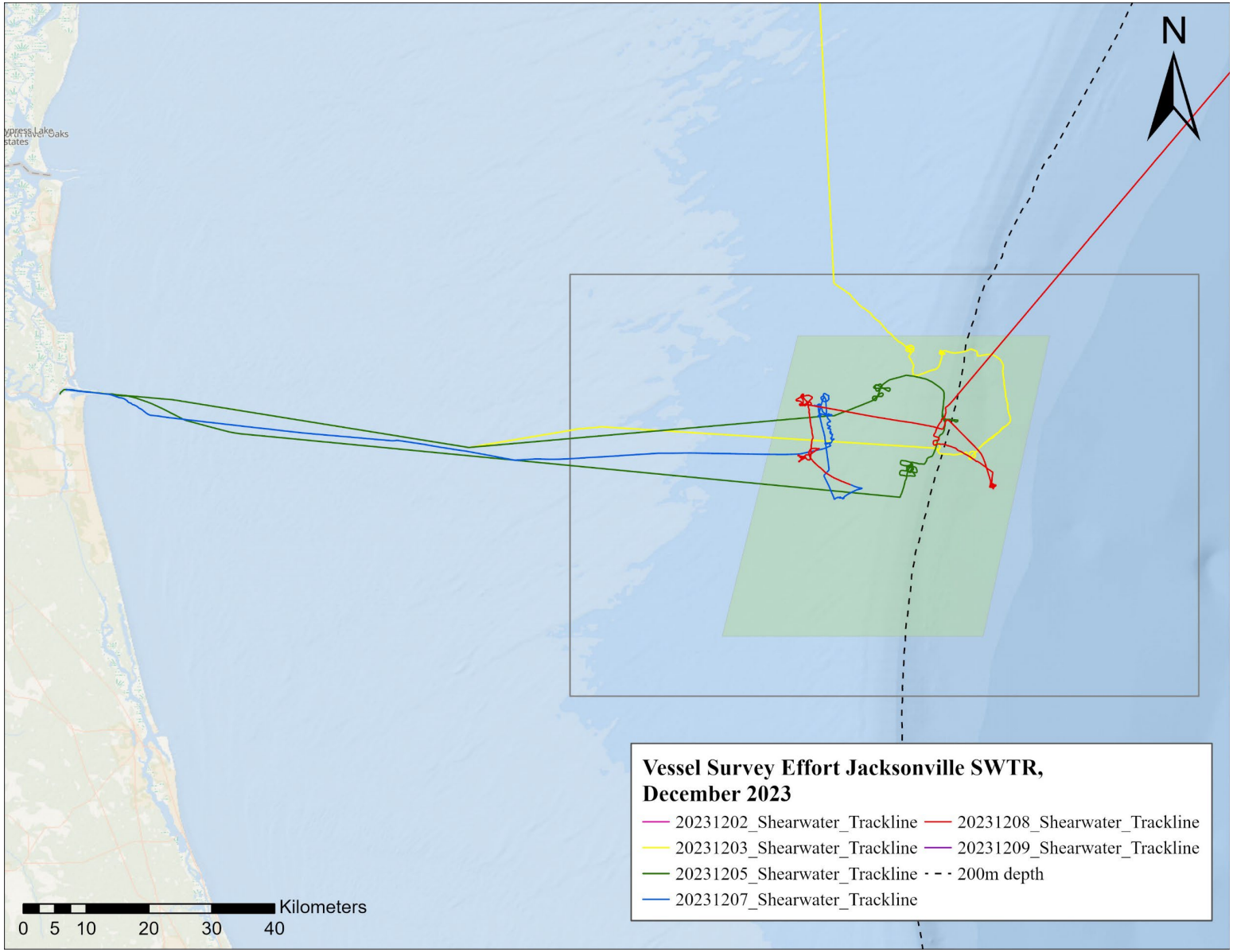

Figure 7. Effort during vessel surveys conducted by the R/V Shearwater within the Jacksonville survey area in December 2023.

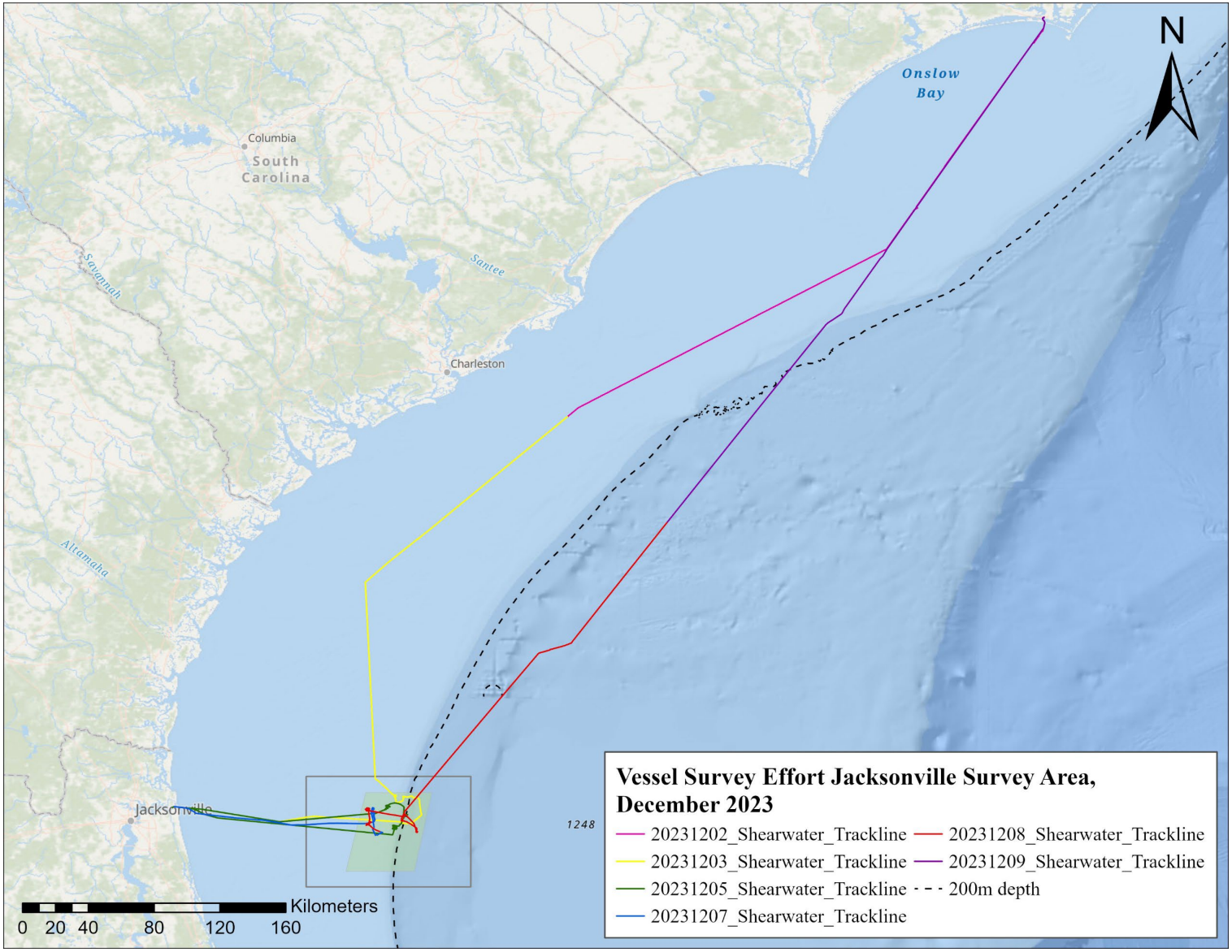

Figure 8. Survey effort conducted by the R/V Shearwater during transits and surveys within the Jacksonville survey area in December 2023.

3.2 Marine Mammal and Sea Turtle Sightings

The study team recorded 40 cetacean sightings during these vessel surveys. Atlantic spotted dolphins (*Stenella frontalis*) (*n*=19) and bottlenose dolphins (*Tursiops truncatus)* (*n*=15) dominated the marine mammal fauna. The team also observed a group of false killer whales (*Pseudorca crassidens)* (*n*=1), a minke whale (*Balaenoptera acutorostrata*) (*n*=1), rough-toothed dolphins (*Steno bredanensis*) (*n*=1), and three unidentified dolphins (**Table 2** and **Table 3**). Loggerhead sea turtles (*Carreta caretta*) (*n*=6) were also seen in the survey area during 2023 (**Table 4)**.

3.3 Distributions and Habitat Associations of Cetaceans

The distributions of marine mammal sightings from North Carolina to Florida and within the Jacksonville survey area are presented in **Figure 9** and **Figure 10,** respectively. As in previous years, Atlantic spotted dolphins were restricted to shallow shelf waters, but bottlenose dolphins were found both in shelf waters and offshore of the continental shelf break. The false killer whales and the minke whale were both observed offshore of the shelf break.

3.4 Biopsy Sampling and Genetic Analyses

The study team collected four biopsy samples within the Jacksonville survey area during 2023. One sample was obtained from a bottlenose dolphin and three samples were obtained from false killer whales (**Table 5** and **Figure 11**). Voucher specimens of these samples are archived at the Duke University Marine Laboratory in Beaufort, North Carolina.

3.5 Paintball Marking and Resighting

The study team temporarily marked four bottlenose dolphins within the Jacksonville survey area with paintballs during 2023 (**Table 6** and **Figure 12**). Using methods recently approved by the National Marine Fisheries Service, the study team confirmed the efficacy of paintball marking as a minimally invasive, short-term aid to resighting and identification. The paint adhered to the skin well, though the duration of the marking varied based on the location on the animal. No dermal irritation was observed. Scientists onboard were able to track marked individuals throughout the initial sighting and subsequent re-sightings later that day. Yellow was the most visible color, followed by orange, then red. Paintball markings were used to complement traditional photo-ID methods to identify individual dolphins.

Table 2. Cetacean sightings from vessel surveys in 2023.

Date	Time (local)	Latitude (°N)	Longitude (°W)	Species	Common Name	Group Size	Biopsy Samples	Photo-ID Images
1-Mar-23	10:13:48	33.18300	78.05087	*Stenella frontalis*	Atlantic spotted dolphin	12	—	0
1-Mar-23	14:33:45	32.84797	78.70137	*Stenella frontalis*	Atlantic spotted dolphin	11	—	0
2-Mar-23	10:25:52	30.75125	81.07407	*Stenella frontalis*	Atlantic spotted dolphin	11	—	0
4-Mar-23	9:48:07	30.38766	80.98127	*Stenella frontalis*	Atlantic spotted dolphin	25	—	98
4-Mar-23	10:56:37	30.41072	80.78548	*Stenella frontalis*	Atlantic spotted dolphin	6	—	0
4-Mar-23	12:00:23	30.42285	80.54489	*Tursiops truncatus*	Bottlenose dolphin	5	—	0
4-Mar-23	12:54:34	30.45079	80.35185	*Stenella frontalis*	Atlantic spotted dolphin	7	—	76
4-Mar-23	13:59:36	30.45227	80.25811	*Tursiops truncatus*	Bottlenose dolphin	2	ZTS-23-001	42
4-Mar-23	14:29:57	30.44971	80.28174	*Tursiops truncatus*	Bottlenose dolphin	5	—	14
4-Mar-23	15:37:47	30.41533	80.23102	*Tursiops truncatus*	Bottlenose dolphin	5	—	0
5-Mar-23	10:13:48	30.30265	80.04975	*Tursiops truncatus*	Bottlenose dolphin	9	—	1
5-Mar-23	12:54:40	30.13505	80.20194	*Pseudorca crassidens*	False killer whale	14	ZTS-23-002, ZTS-23-003, ZTS-23-004	1,372
5-Mar-23	16:40:11	30.35368	80.23209	Unidentified dolphin	Unidentified dolphin	2	—	0
5-Mar-23	17:51:19	30.32899	80.19517	*Stenella frontalis*	Atlantic spotted dolphin	3	—	12
6-Mar-23	7:25:05	30.22809	80.31076	*Tursiops truncatus*	Bottlenose dolphin	11	—	65
6-Mar-23	8:15:51	30.21335	80.27311	*Stenella frontalis*	Atlantic spotted dolphin	6	—	115
6-Mar-23	10:31:42	30.14813	80.22555	*Tursiops truncatus*	Bottlenose dolphin	2	—	8
6-Mar-23	12:01:53	30.20885	80.22991	*Steno bredanensis*	Rough-toothed dolphin	10	—	193
6-Mar-23	12:56:00	30.19160	80.22692	*Tursiops truncatus*	Bottlenose dolphin	6	—	0
6-Mar-23	13:36:57	30.23187	80.21941	*Tursiops truncatus*	Bottlenose dolphin	3	—	13
6-Mar-23	13:50:08	30.24141	80.21791	*Stenella frontalis*	Atlantic spotted dolphin	40	—	200
6-Mar-23	16:24:54	30.43780	80.06507	*Balaenoptera acutorostrata*	Minke whale	1	—	199
7-Mar-23	11:54:54	33.36929	77.59145	*Stenella frontalis*	Atlantic spotted dolphin	7	—	0
29-Oct-23	8:43:00	30.65320	81.22423	*Tursiops truncatus*	Bottlenose dolphin	2	—	0

Date	Time (local)	Latitude (°N)	Longitude (°W)	Species	Common Name	Group Size	Biopsy Samples	Photo-ID Images
29-Oct-23	10:34:00	30.55825	80.67137	*Stenella frontalis*	Atlantic spotted dolphin	6	—	61
29-Oct-23	12:58:00	30.47042	80.28563	*Stenella frontalis*	Atlantic spotted dolphin	3	—	33
29-Oct-23	13:35:00	30.46603	80.29020	*Stenella frontalis*	Atlantic spotted dolphin	1	—	0
30-Oct-23	9:59:00	30.63606	80.80017	*Tursiops truncatus*	Bottlenose dolphin	2	—	79
30-Oct-23	10:41:00	30.63106	80.78549	*Caretta caretta*	Loggerhead sea turtle	1	—	19
30-Oct-23	10:52:00	30.62271	80.74967	*Caretta caretta*	Loggerhead sea turtle	1	—	0
30-Oct-23	15:09:00	30.33722	80.23163	*Stenella frontalis*	Atlantic spotted dolphin	6	—	37
30-Oct-23	15:28:00	30.32193	80.30461	*Stenella frontalis*	Atlantic spotted dolphin	4	—	41
30-Oct-23	15:52:00	30.36339	80.33989	*Stenella frontalis*	Atlantic spotted dolphin	4	—	83
5-Dec-23	10:32:00	32.53311	77.80725	Unidentified dolphin	Unidentified dolphin	5	—	0
5-Dec-23	13:35:00	30.32460	80.22977	*Caretta caretta*	Loggerhead sea turtle	1	—	162
7-Dec-23	9:48:00	30.35853	80.16570	*Stenella frontalis*	Atlantic spotted dolphin	8	—	55
7-Dec-23	11:01:00	30.33792	81.04800	*Stenella frontalis*	Atlantic spotted dolphin	8	—	0
7-Dec-23	11:08:00	30.32172	80.89299	*Caretta caretta*	Loggerhead sea turtle	1	—	0
7-Dec-23	12:29:00	30.31920	80.87705	*Caretta caretta*	Loggerhead sea turtle	1	—	0
7-Dec-23	13:21:00	30.31227	80.53784	Unidentified dolphin	Unidentified dolphin	2	—	67
7-Dec-23	14:59:00	30.32510	80.32954	*Tursiops truncatus*	Bottlenose dolphin	3	—	265
7-Dec-23	16:02:00	30.36629	80.33207	*Tursiops truncatus*	Bottlenose dolphin	6	—	42
7-Dec-23	16:55:00	30.36691	80.34444	*Tursiops truncatus*	Bottlenose dolphin	4	—	37
8-Dec-23	9:48:00	30.24863	80.31843	*Tursiops truncatus*	Bottlenose dolphin	2	—	0
8-Dec-23	10:15:00	30.38686	80.35871	*Caretta caretta*	Loggerhead sea turtle	1	—	35
8-Dec-23	12:25:00	30.38235	80.37063	*Stenella frontalis*	Atlantic spotted dolphin	4	—	202

Key: °N = degrees north; °W = degrees west

Table 3. Numbers of cetacean sightings for each species observed during vessel surveys in 2023.

Species	Sightings 2023
Balaenoptera acutorostrata	1
Globicephala macrorhynchus	0
Grampus griseus	0
Pseudorca crassidens	1
Stenella frontalis	19
Steno bredanensis	1
Tursiops truncatus	15
Unidentified	3
Total	**40**

Table 4. Sea turtle sightings from vessel surveys in 2023.

Date	Time (local)	Latitude (°N)	Longitude (°W)	Species	Common Name	Group Size
30-Oct-23	10:41:00	30.63106	80.78549	*Caretta caretta*	Loggerhead sea turtle	1
30-Oct-23	10:52:00	30.62271	80.74967	*Caretta caretta*	Loggerhead sea turtle	1
05-Dec-23	10:32:02	30.32460	80.22977	*Caretta caretta*	Loggerhead sea turtle	1
07-Dec-23	11:01:00	30.32172	80.89299	*Caretta caretta*	Loggerhead sea turtle	1
07-Dec-23	11:08:00	30.31920	80.87705	*Caretta caretta*	Loggerhead sea turtle	1
08-Dec-23	9:48:00	30.38686	80.35871	*Caretta caretta*	Loggerhead sea turtle	1

Key: °N = degrees north; °W = degrees west

Table 5. Biopsy samples collected within the Jacksonville survey area in 2023.

Date	Time (local)	Latitude (°N)	Longitude (°W)	Species	Sample #
4-Mar-23	10:20:17	30.45489	80.24722	*Tursiops truncatus*	ZTS-23-001
5-Mar-23	12:12:58	30.15521	80.21132	*Pseudorca crassidens*	ZTS-23-002
5-Mar-23	9:13:33	30.18532	80.20502	*Pseudorca crassidens*	ZTS-23-003
5-Mar-23	12:26:53	30.22209	80.17494	*Pseudorca crassidens*	ZTS-23-004

Key: °N = degrees north; °W = degrees west

Table 6. Paintball marking locations within the Jacksonville survey area in 2023.

Date	Time (local)	Latitude (°N)	Longitude (°W)	Species	Color
7-Dec-23	13:50:00	30.34103	80.32829	*Tursiops truncatus*	Yellow
7-Dec-23	15:06:00	30.37339	80.34021	*Tursiops truncatus*	Orange
7-Decr-23	15:40:00	30.37765	80.34195	*Tursiops truncatus*	Red
8-Dec-23	13:04:00	30.26377	80.09769	*Tursiops truncatus*	Yellow

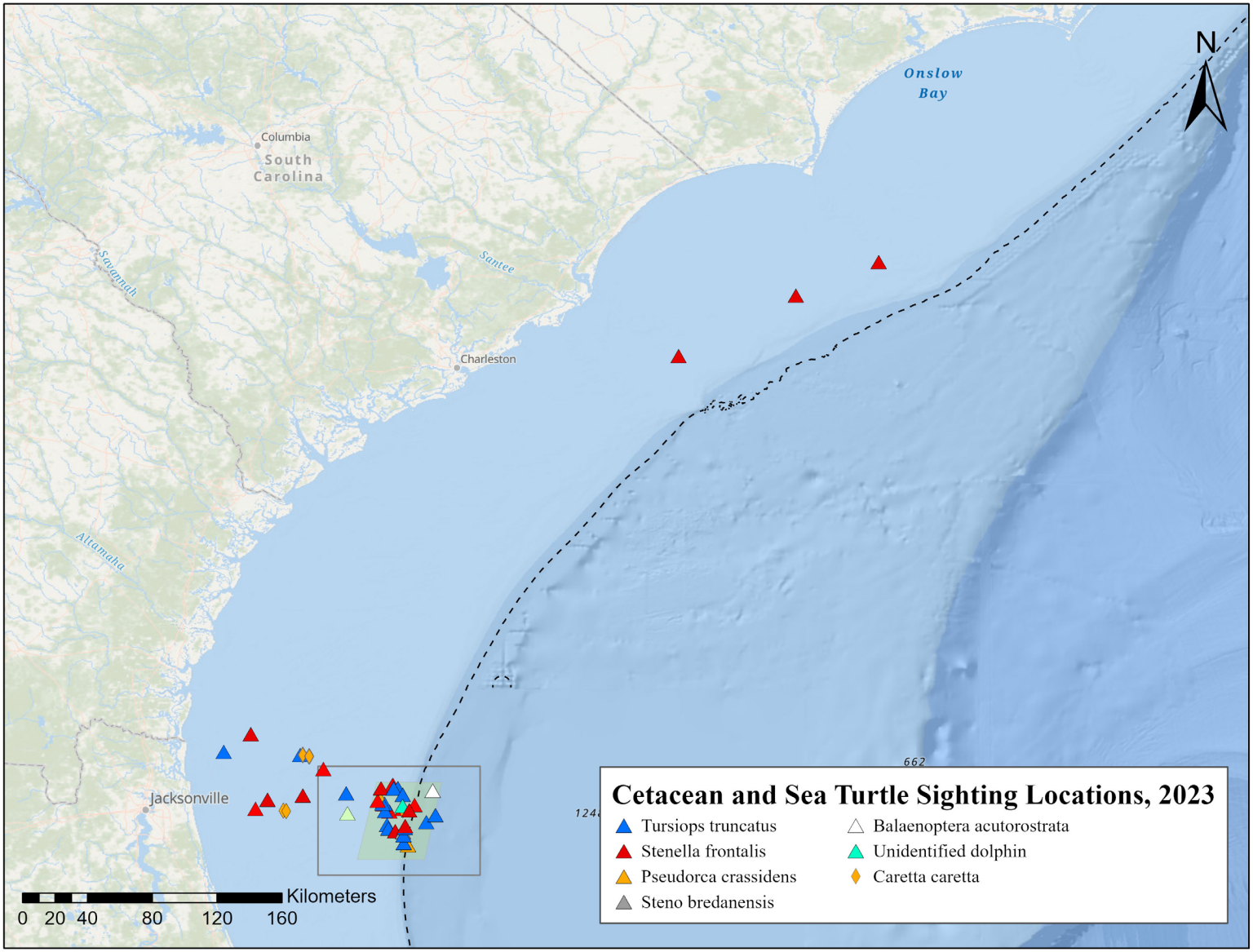

Figure 9. Distribution of all cetacean and sea turtle sightings during vessel surveys in 2023.

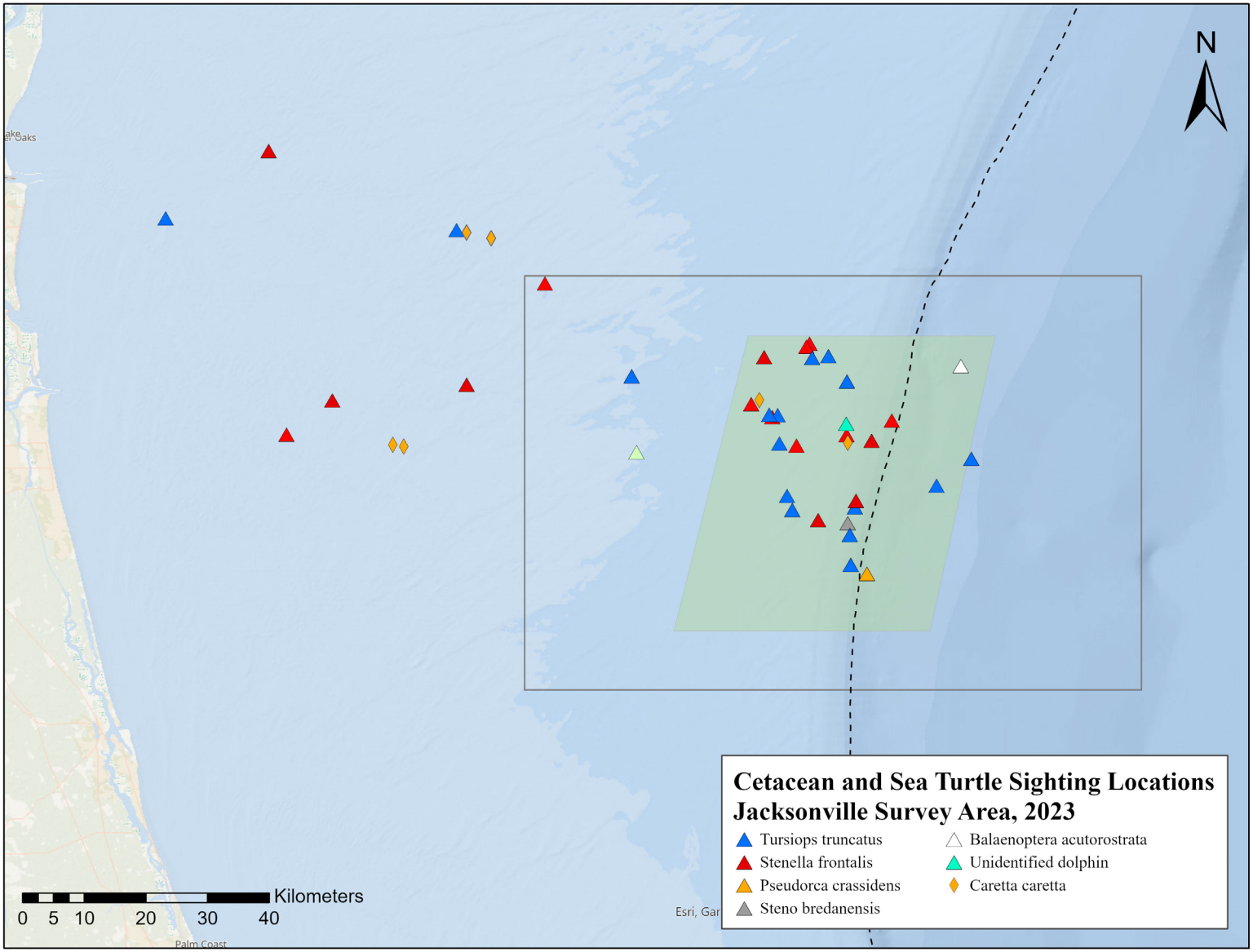

Figure 10. Distribution of all cetacean and sea turtle sightings during vessel surveys within the Jacksonville survey area in 2023.

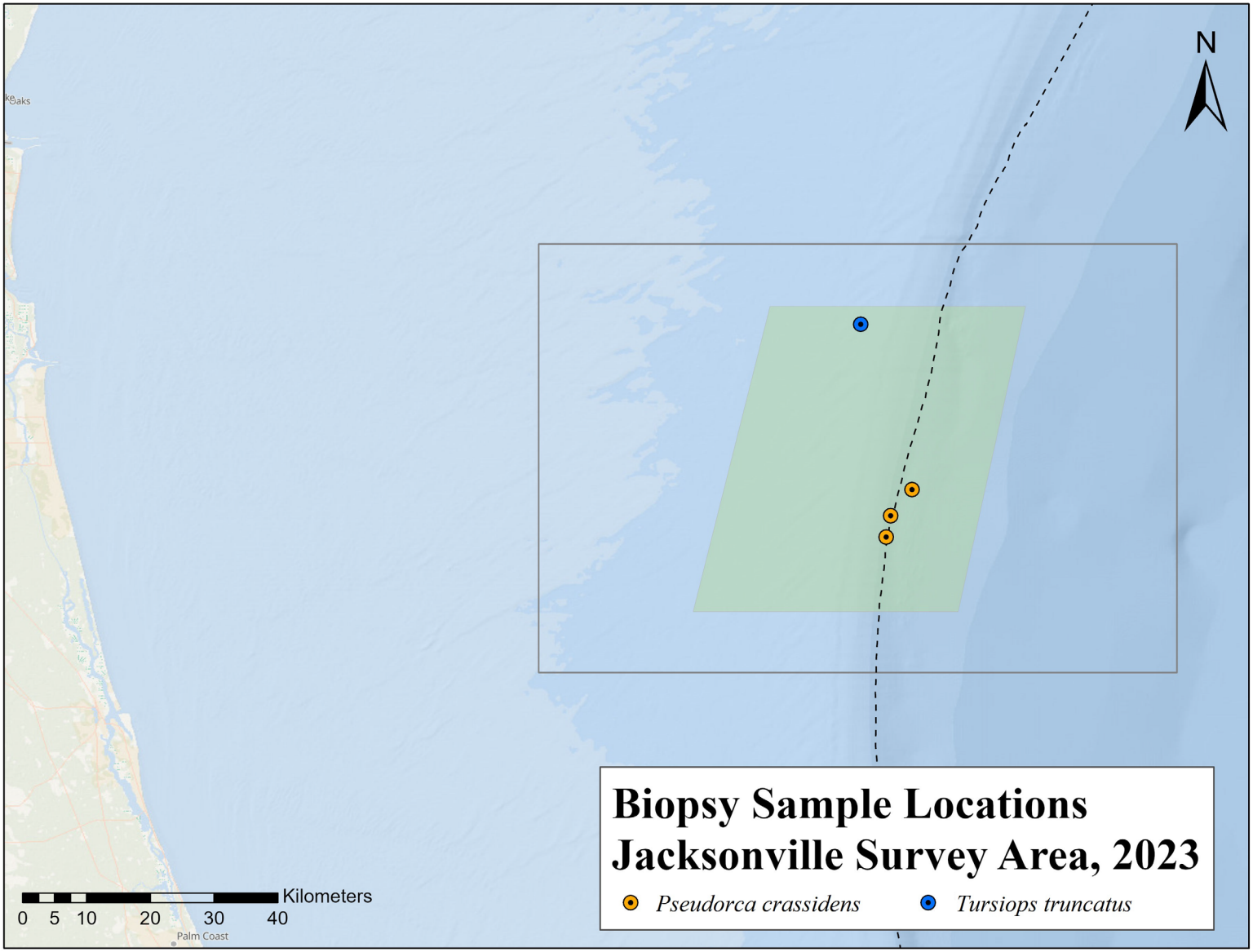

Figure 11. Locations of biopsy samples collected within the Jacksonville survey area in 2023.

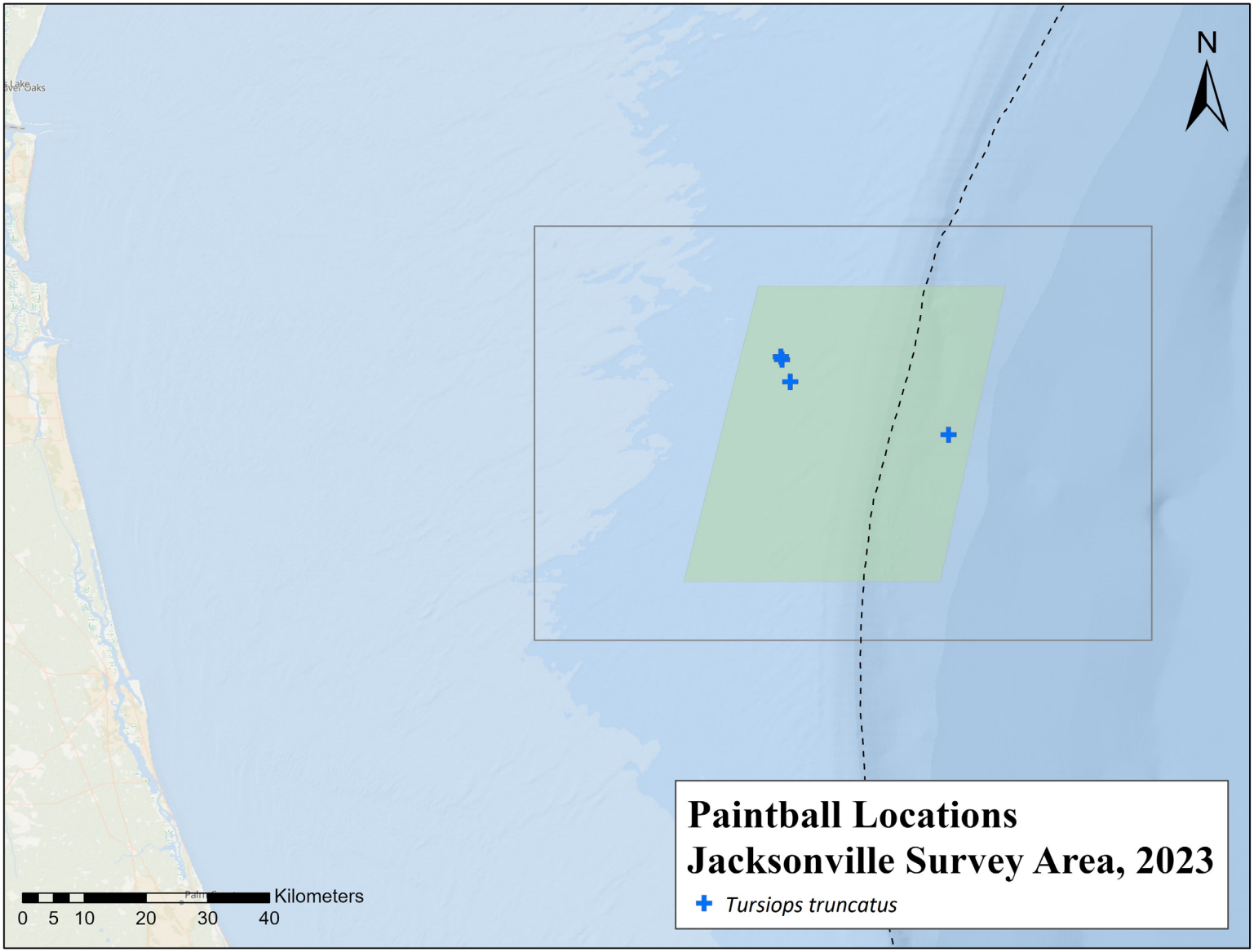

Figure 12. Locations of paintball markings within the Jacksonville survey area in 2023

3.6 Satellite Tagging

In October 2023, the survey team attempted to deploy satellite tags in collaboration with Jessica Aschettino from HDR, Inc., but did not encounter any suitable target species during this trip.

3.7 Photographic Effort

More than 3,600 digital images were collected for species confirmation and individual identification during 2023. All images have been coded and graded for distinctiveness and photographic quality. A new false killer whale catalog was created with 16 identified individuals. Photo-ID analysis identified 19 new Atlantic spotted dolphins, 12 new bottlenose dolphins, and 7 new rough-toothed dolphins; these individuals have been added to the existing catalogs (**Table** 7). Despite nearly 200 high-quality photographs, the minke whale did not have any distinguishing markings, so a catalog was not created for this species.

Table 7. Summary of photographs taken of animals within the Jacksonville survey area in 2023, with photo-ID catalog sizes and total numbers of matches within the catalog to date.

Species	Common Name	Images	Catalog Size	Matches to Date
Globicephala macrorhynchus	Short-finned pilot whale	0	52	0
Grampus griseus	Risso's dolphin	0	73	1
Stenella frontalis	Atlantic spotted dolphin	1,013	285	27
Tursiops truncatus	Bottlenose dolphin	833	233	33
Steno bredanensis	Rough-toothed dolphin	193	85	11
Pseudorca crassidens	False killer whale	1,372	16	0

To date, 27 individual Atlantic spotted dolphins, or approximately 10 percent of the cataloged individuals, have been re-sighted within the Jacksonville survey area (**Figure 13**). The study's longest match of a pair of Atlantic spotted dolphins was made during 2021. First observed together during October 2014, Sfr 8-027 and Sfr 1-008 were seen together again in 2021 within the Jacksonville survey area after 6 years and 7 months. Another pair, Sfr 7-008 and Sfr 9-011, were first observed together in 2013. During 2016, Sfr 7-008 was observed without Sfr 9-011, but they were again photographed together in July 2017. Eight Atlantic spotted dolphins were observed on consecutive days in July 2017 (**Table 8**). Three of these eight individuals were observed together in July 2014. One pair of Atlantic spotted dolphins (Sfr 8-037 and Sfr DU 8-014) was seen together in consecutive months of 2017. One trio (Sfr 6-024, Sfr 7-035, and Sfr 9-040) match has been documented, photographed together during 2016 and 2017. Sfr 8-052, an Atlantic spotted dolphin identified in 2021, was observed on both 22 and 24 May 2021, with different individuals at each sighting (**Table 8**).

During 2023, one bottlenose dolphin was re-sighted from previous years. Ttr 6-043 was first sighted in April 2021, re-sighted for the first time in December 2022, and then seen again in December 2023. Ttr 7-010 has the longest re-sighting interval in the Jacksonville bottlenose dolphin catalog at 10 years and 8 months. It was first identified in March 2012, then re-sighted

for the first time in December 2022. Another multi-year re-sighting was made for Ttr 6-029, first seen in February 2016, then again in December 2022. Three bottlenose dolphins were first cataloged in 2022, then re-sighted within the same month. In May 2021, 15 bottlenose dolphins were first cataloged, then resighted on the same day or the day following initial identification. The remaining eight bottlenose dolphin matches have been from re-sightings within the Jacksonville survey area across 2 or more years. Two pairs of bottlenose dolphins have been re-sighted together. Ttr 6-010 and Ttr 6-036 were observed together in January 2012, and again in July 2013. Ttr 6-037 and Ttr 6-038 were observed together first in September 2013, and again in February 2017. Ttr 6-007, the first cataloged individual in 2013, was re-sighted in 2017. One bottlenose dolphin trio (Ttr 7-022, Ttr 7-030, and Ttr 7-031) has been re-sighted within the Jacksonville survey area, seen together first in 2015, and again in 2017 (**Table 8** and **Figure 13**). One individual from this trio (Ttr 7-030) was also observed in April 2015, before the trio was first documented; however, photograph quality prevented the study team from determining if the two other individuals were part of the initial sighting. Another pair, Ttr 7-060 and Ttr 8-034, was identified and re-sighted together on the same day in December 2023.

One Risso's dolphin was re-sighted in May 2021 within the Jacksonville survey area, the only re-sighting for this catalog. Ggr 1-013 was observed first in June 2017, and again 3 years and 11 months later.

Eleven individual rough-toothed dolphins have been re-sighted. Sbr 7-029 was first seen in April 2021 and re-sighted for the first time in March 2023. Unique shading/pigmentation on its dorsal fin remained consistent between the two sightings and aided in confirming the match. Two individuals were re-sighted in 2021, after several years. Sbr 7-007 was observed originally in September 2016, and again in April 2021. Sbr 7-019 was originally observed in July 2017 and re-sighted in April 2021 (**Table 8**). Additionally, eight rough-toothed dolphins were seen on consecutive days in September 2016.

A new false killer whale catalog was created after 16 distinct individuals were identified from March 2023. The study team plans to share this new catalog with research groups working in adjacent study areas.

The study team has not yet identified any re-sightings for short-finned pilot whales. Despite no matches within the Jacksonville catalogs, short-finned pilot whale matches have been made to multiple near-by study areas. The study team has previously compared the Jacksonville short-finned pilot whale photo-ID catalog to both the Onslow Bay and Cape Hatteras catalogs, but no matches have been identified. However, as reported in Foley et al. (2017), seven short-finned pilot whales were observed in the Bahamas in 2007, then within the Jacksonville survey area in 2009. Three of these seven individuals were re-sighted again in the Bahamas in 2015. Additionally, five short-finned pilot whales first photographed together in the Bahamas in June 2009 were re-sighted within Onslow Bay 2 months later.

Table 8. Photo-ID matches of delphinids observed within the Jacksonville survey area.

ID[a]	Year												
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2021	2022	2023
Ttr 1-017											X[m]		
Ttr 1-018											X[m]		
Ttr 1-023											X[m]		
Ttr 6-007					X				X				
Ttr 6-010[b]				X	X								
Ttr 6-029								X				X	
Ttr 6-036[b]				X	X								
Ttr 6-037[b]					X				X				
Ttr 6-038[b]					X				X				
Ttr 6-043											X	X	X
Ttr 6-047											X[m]		
Ttr 6-048											X[m]		
Ttr 6-050											X[m]		
Ttr 6-051											X[m]		
Ttr 7-010				X								X	
Ttr 7-022[b]							X		X				
Ttr 7-030[b]							X[y]		X				
Ttr 7-031[b]							X		X				
Ttr 7-042											X[m]		
Ttr 7-043											X[m]		
Ttr 7-047											X[m]		
Ttr 7-051												X[m]	
Ttr 7-053												X[m]	
Ttr 7-060													X[b]
Ttr 8-018											X[m]		
Ttr 8-034													X[b]
Ttr 9-025											X[m]		
Ttr 9-028												X[m]	
Ttr DU 1-001											X[m]		
Ttr DU 7-028											X[m]		
Ttr DU 8-011											X[m]		
Sfr 1-008						X					X		
Sfr 1-022											X	X	
Sfr 2-002		X							X				
Sfr 2-006				X				X					
Sfr 3-001		X	X										
Sfr 6-024[b]								X	X				
Sfr 6-006[b]						X			X[m]				

ID[a]	Year												
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2021	2022	2023
Sfr 6-010		X							X				
Sfr 7-008[b]					X			X	X				
Sfr 7-010					X				X				
Sfr 7-013[b]						X			X[m]				
Sfr 7-014[b]						X			X[m]				
Sfr 7-015						X			X				
Sfr 7-035[b]								X	X				
Sfr 7-040											X	X	
Sfr 8-005			X[m]										
Sfr 8-027						X					X		
Sfr 8-037[b]									X[y]				
Sfr 8-038[b]									X[m]				
Sfr 8-052											X[m]		
Sfr 9-011[b]					X				X				
Sfr 9-037[b]									X[m]				
Sfr 9-040[b]								X	X				
Sfr DU 1-003[b]									X[m]				
Sfr DU 6-010[b]									X[m]				
Sfr DU 7-008[b]									X[m]				
Sfr DU 8-014[b]									X[y]				
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]					
Sbr 7-007								X			X		
Sbr 7-019									X		X		
Sbr 7-029											X		X
Ggr 1-013									X		X		

[a] Sfr = *Stenella frontalis* (Atlantic spotted dolphin); Ttr = *Tursiops truncatus* (bottlenose dolphin); Sbr = *Steno bredanensis* (rough-toothed dolphin); Ggr = *Grampus griseus* (Risso's dolphin)

[b] Observed together in multiple sightings

[m] Re-sighted within same month

[y] Re-sighted within same year

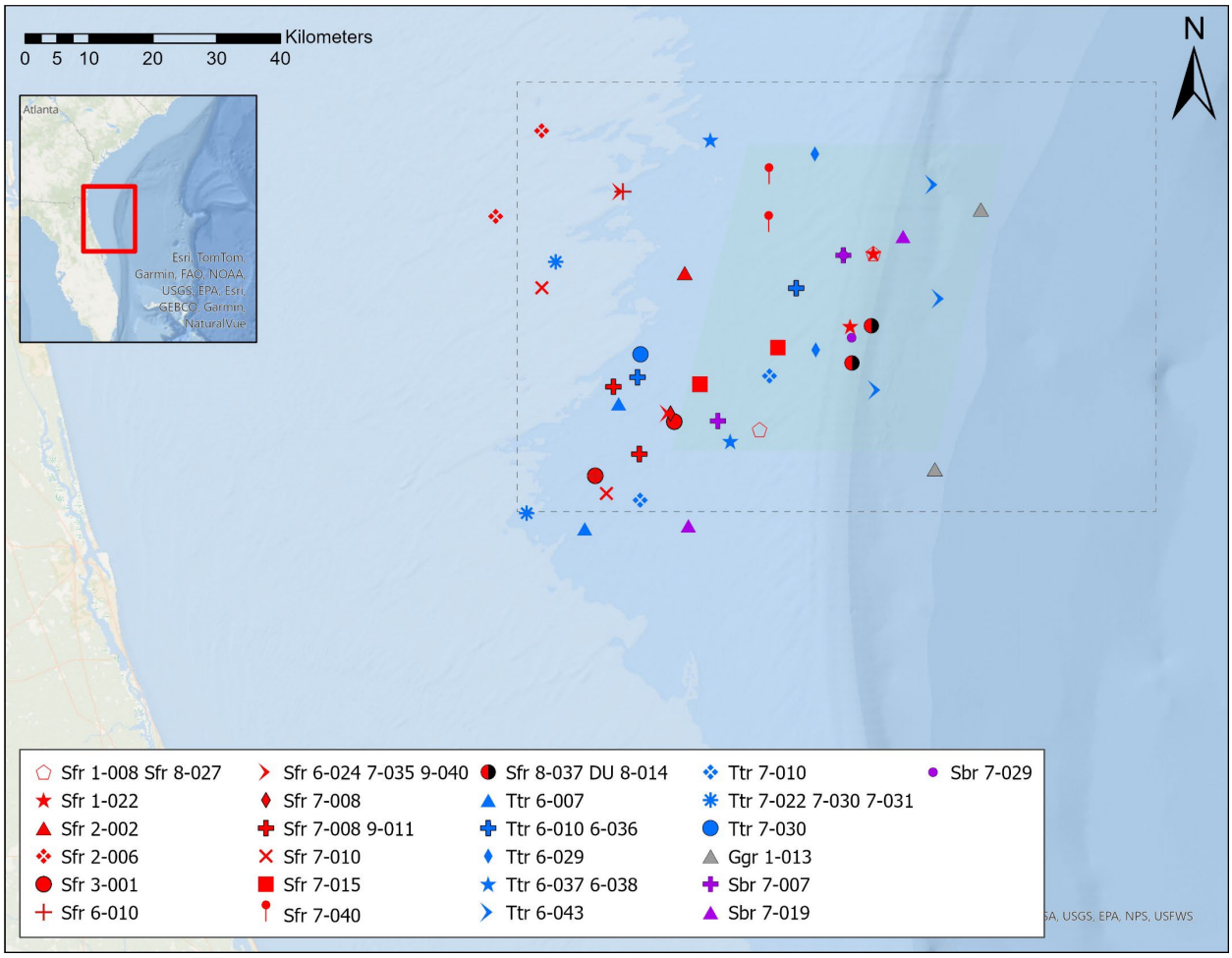

Figure 13. Locations of photo-matched dolphins within the Jacksonville survey area, excluding same-day or next-day re-sightings.

4. Summary: 2009–2023

Total survey effort conducted since the beginning of the monitoring program within the Jacksonville study area, including all AFTT-protected species monitoring and tagging effort, is reported in **Table 9**. The annual numbers of sightings by species for both cetaceans and sea turtles within the Jacksonville survey area are presented in **Table 10** and **Table 11**. A summary of biopsy samples collected to date is reported in **Table 12**. **Table 13** summarizes the photo-ID catalog sizes and matches by species to date as well as images taken during the reporting period within the Jacksonville survey area.

Table 9. Vessel survey effort from July 2009 through December 2023 within the Jacksonville survey area.

Effort	2009–2010	2011	2012	2013	2014	2015	2016	2017	2018	2021	2022	2023	Total
Survey Hours	127.1	20.9	58.6	58.7	66.8	44.2	130.7	66.1	15.3	123.6	78.3	69.8	**860.1**
Survey Distance (km)	2,074	346	937	1,022	1,227	858	2,136	1,424	315	3,942	475	1,481	**16,237**

Table 10. Cetacean sightings by species from July 2009 through December 2023 during vessel surveys within the Jacksonville survey area.

Species	Sightings											
	2009–2010	2011	2012	2013	2014	2015	2016	2017	2018	2021	2022	2023
Balaenoptera acutorostrata	0	0	0	0	0	0	0	0	0	0	0	1
Eubalaena glacialis	0	0	0	0	1	0	0	0	0	0	0	0
Globicephala macrorhynchus	3	0	0	0	0	0	5	0	1	0	0	0
Grampus griseus	2	0	0	1	1	1	0	2	0	3	0	0
Pseudorca crassidens	0	0	0	0	0	0	0	0	0	0	0	1
Stenella attenuata	0	0	0	0	0	0	2	0	0	0	0	0
Stenella frontalis	35	6	14	9	20	10	10	18	4	41	8	19
Steno bredanensis	0	0	0	0	0	0	2	1	0	2	0	1
Tursiops truncatus	19	6	23	15	18	10	18	16	0	38	21	15
Tursiops/Stenella mix	0	0	0	0	1	0	0	0	0	0	0	0
Unidentified delphinid	13	0	4	3	4	0	5	0	0	1	5	3
Total	**72**	**12**	**41**	**28**	**45**	**21**	**42**	**37**	**5**	**85**	**34**	**40**

Table 11. Sea turtle sightings by species from July 2009 through December 2023 during surveys within the Jacksonville survey area.

Species	Sightings											
	2009–2010	2011	2012	2013	2014	2015	2016	2017	2018	2021	2022	2023
Caretta caretta	52	20	41	33	31	22	22	24	0	7	3	6
Dermochelys coriacea	8	3	4	1	3	2	4	2	0	0	0	0
Lepidochelys kempii	1	0	1	0	0	0	0	0	0	0	0	0
Unidentified sea turtle	8	3	3	1	0	0	0	3	0	1	0	0
Total	**69**	**26**	**49**	**35**	**34**	**24**	**26**	**29**	**0**	**8**	**3**	**6**

Table 12. Biopsy samples collected from July 2009 through December 2023 during vessel surveys within the Jacksonville survey area.

Species	2009–2010	2011	2012	2013	2014	2015	2016	2017	2018	2021	2022	2023	Total
Globicephala macrorhynchus	0	0	0	0	0	0	5	0	1	0	0	0	**6**
Grampus griseus	0	0	0	1	2	0	0	0	0	0	0	0	**3**
Pseudorca crassidens	0	0	0	0	0	0	0	0	0	0	0	3	**3**
Stenella attenuata	0	0	0	0	0	0	1	0	0	0	0	0	**1**
Stenella frontalis	0	0	19	6	19	3	7	8	0	1	0	0	**63**
Steno bredanensis	0	0	0	0	0	0	4	2	0	0	0	0	**6**
Tursiops truncatus	0	0	12	5	10	5	5	2	0	12	5	1	**57**
Total	**0**	**0**	**31**	**12**	**31**	**8**	**22**	**12**	**1**	**13**	**5**	**4**	**139**

Table 13. Summary of images collected during all vessel surveys within the Jacksonville survey area from 2009 through 2023, with photo-ID catalog sizes and matches to date.

Species	2009–2010		2011		2012		2013		2014		2015		2016		2017		2018		2021		2022		2023	
	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	Catalog Size	Matches	Catalog Size	Matches	Catalog Size	Matches
Globicephala macrorhynchus	0	0	0	0	0	0	12	0	12	0	12	0	29	0	29	0	52	0	52	0	52	0	52	0
Grampus griseus	1	0	1	0	1	0	7	0	22	0	36	1	36	0	56	0	56	0	73	0	73	0	73	0
Stenella frontalis	21	0	36	0	58	2	74	2	109	2	117	2	153	3	199	20	204	22	257	3	266	2	285	0
Tursiops truncatus	19	0	25	0	43	0	53	2	80	2	102	2	113	2	131	8	131	0	186	14	221	6	233	3
Steno bredanensis	0	0	0	0	0	0	0	0	0	0	0	0	43	0	54	8	54	0	78	3	78	0	85	1
Pseudorca crassidens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0

5. Marine Mammal Monitoring on Navy Ranges Species-Verification Trials

The M3R program began in 2000, with the development of a system to use the bottom-mounted hydrophones of the U.S. Navy's test and training ranges to detect, classify, localize, and monitor marine mammals in real-time by listening for their vocalizations. Each of the ranges has 100 to 200-plus widely spaced hydrophones, and the systems consist of rack-mounted computer nodes and monitoring displays connected with Gigabit networks. The M3R system is currently installed at the Atlantic Undersea Test and Evaluation Center (AUTEC), Southern California Tactical Training Range (SOAR), Pacific Missile Range Facility (PMRF), JSWTR, and Canadian Forces Maritime Experimental and Test Ranges Nanoose Range. The M3R program collects continuous archive data and periodic recordings from each of these ranges; it uses these data, along with field tests, for collaborative studies on marine mammal behavior, distribution, abundance, foraging, and habitat use. These data are useful for understanding the effects of U.S. Navy activities and the long-term health of the populations as well as for the development of detection, classification, localization, and density estimation algorithms.

JSWTR has 223 active hydrophones mounted at depths ranging from 25 to 255 meters over a span of 2,000 km^2 (**Figure 14**), making it the largest M3R system to date. In contrast to the AUTEC, PMRF, and SOAR deep-water ranges on which the M3R system is deployed, JSWTR is a shallow-water range that is likely to have different species present than those typically found on the deep-water ranges. The M3R system runs nearly continuously year-round, archiving data from all range hydrophones simultaneously in real time, when no range activities would preclude its operation. Detection, classification, and localization (DCL) reports are stored to binary archive files for later playback and analysis. The M3R system employs three detector/classifiers: a Fast Fourier Transform-based detector, a Class-Specific Support Vector Machine (CS-SVM) detector/classifier, and a Blainville's beaked whale foraging click matched filter (Jarvis et al. 2008). The CS-SVM classifier currently has six classes at JSWTR: Blainville's beaked whale foraging and buzz clicks, Cuvier's beaked whale foraging and buzz clicks, sperm whale clicks, and "generalized dolphin" clicks.

The M3R team conducted species-verification trials in March, October, and December 2023 in collaboration with Duke University and HDR, Inc. During these trials, Naval Undersea Warfare Center (NUWC) personnel used the M3R PAM displays to look for species of interest and direct the on-water team to the locations of the animals via satellite phone texts. Upon locating the animals, the field team verified the species; collected behavioral and environmental data; took photographs for their photo-ID catalogs; took biopsy samples; and potentially deployed satellite tags. The focal species for these efforts were:

1. Short-finned pilot whales (*Globicephala macrorhynchus)*
2. Bottlenose dolphins (*Tursiops truncatus*)
3. Atlantic spotted dolphins (*Stenella frontalis*)
4. Risso's dolphins (*Grampus griseus*)
5. Rough-toothed dolphins (*Steno bredanensis*)

During the three field sessions conducted in 2023, all five focal species were acoustically identified by M3R and three were visually verified by the on-water team: bottlenose dolphins, Atlantic spotted dolphins, and rough-toothed dolphins (**Table 14**).

Table 14. M3R acoustic detections and visual verifications at JSWTR in 2023.

Species		Number of Acoustic Detections Logged	Number of Acoustic Detections Directed	Number of Acoustic Detections Visually Verified
Common Name	Scientific Name			
Bottlenose dolphin	*Tursiops truncatus*	24	12	16
Atlantic spotted dolphin	*Stenella frontalis*	10	10	10
Risso's dolphin	*Grampus griseus*	6	2	0
Rough-toothed dolphin	*Steno bredanensis*	1	1	1
False killer whale	*Pseudorca crassidens*	2	1	1
Minke whale	*Balaenoptera acutorostrata*	2	1	1
Short-finned pilot whale	*Globicephala macrorhynchus*	18	2	0
Unidentified dolphin	Delphinidae sp.	210	14	0

A total of 273 acoustic detections were logged, including 24 for bottlenose dolphins, 18 for short-finned pilot whales, 10 for Atlantic spotted dolphins, 6 for Risso's dolphins, 2 for false killer whales, 2 for minke whales, and 1 for rough-toothed dolphins. A total of 210 acoustic detections were unable to be identified to the species level and remained classified as unidentified delphinid species. Snapping shrimp were persistently present during all trials, but not explicitly monitored. Each acoustic detection may represent either a single animal or a group of animals; however, note that each detection is not necessarily a new individual or a new group, as the same animal or group could be detected more than once over the course of the day. In addition, individuals could potentially move between groups.

Of these acoustic detections, there were 43 cases in which M3R directed the on-water team to animals of interest. Here 'directed' sightings are considered those in which a location was sent, and the field team decided to go to the location. The on-water team visually verified 16 groups of bottlenose dolphins, 10 groups of Atlantic spotted dolphins, and single groups of rough-toothed dolphins and false-killer whales, as well as a single minke whale. Numerous photos, underwater footage, and behavioral data were collected from all verified species. Two biopsies were collected from the group of 14 false-killer whales, along with a single biopsy from a bottlenose dolphin during the March trial. No animals were successfully tagged, due to a combination of weather restrictions and staffing limitations. Visualizations for all field effort sightings can be seen in Figures 15 - 17.

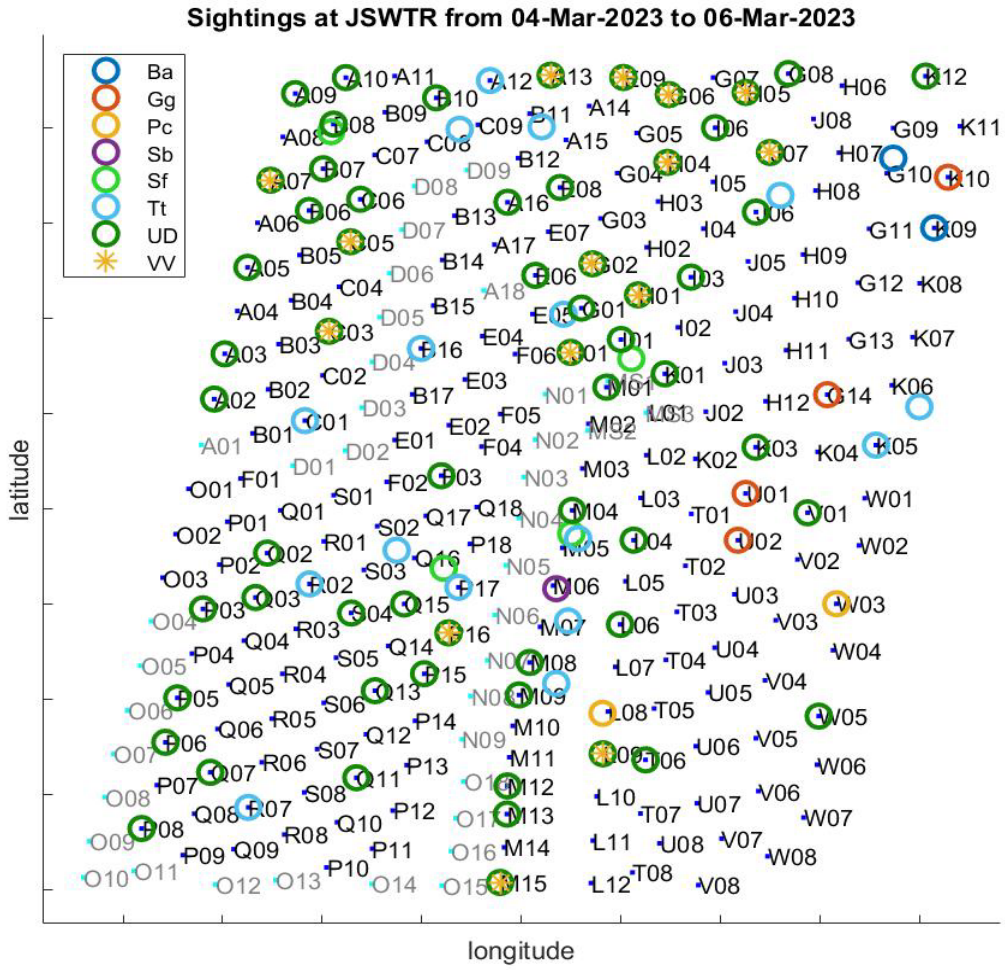

Figure 15. Acoustic detections (sightings) at JSWTR from March 4 – 6 2023. Species included minke whale (Ba), Risso's dolphins (Gg), false killer whales (Pc), rough-toothed dolphins (Sb), Atlantic spotted dolphins (Sf), bottlenose dolphins (Tt), and unidentified delphinid species (UD). Detections that were visually verified (VV) by Duke University are overlaid with an asterisk.

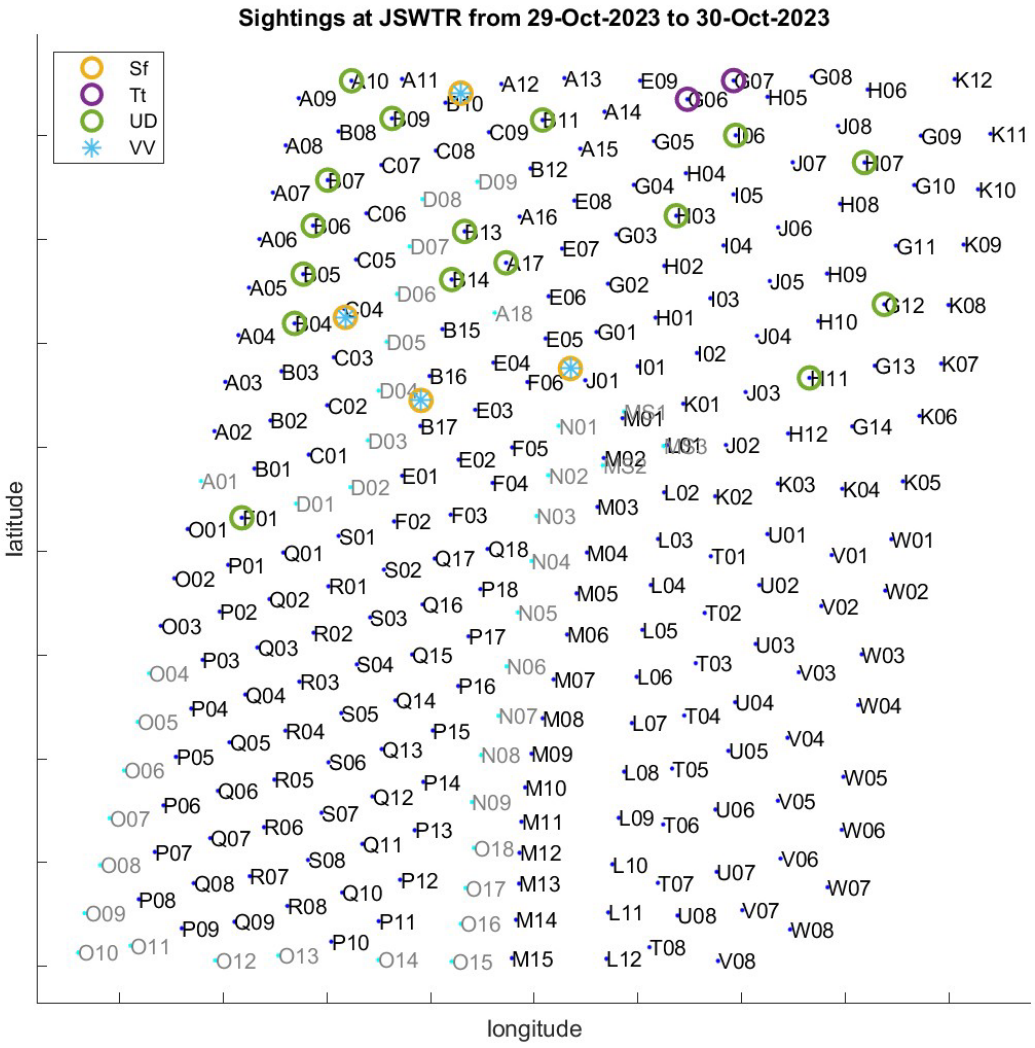

Figure 16. Acoustic detections (sightings) at JSWTR from October 29 – 30 2023. Species included Atlantic spotted dolphins (Sf), bottlenose dolphins (Tt), and unidentified delphinid species (UD). Detections that were visually verified (VV) by Duke University are overlaid with an asterisk.

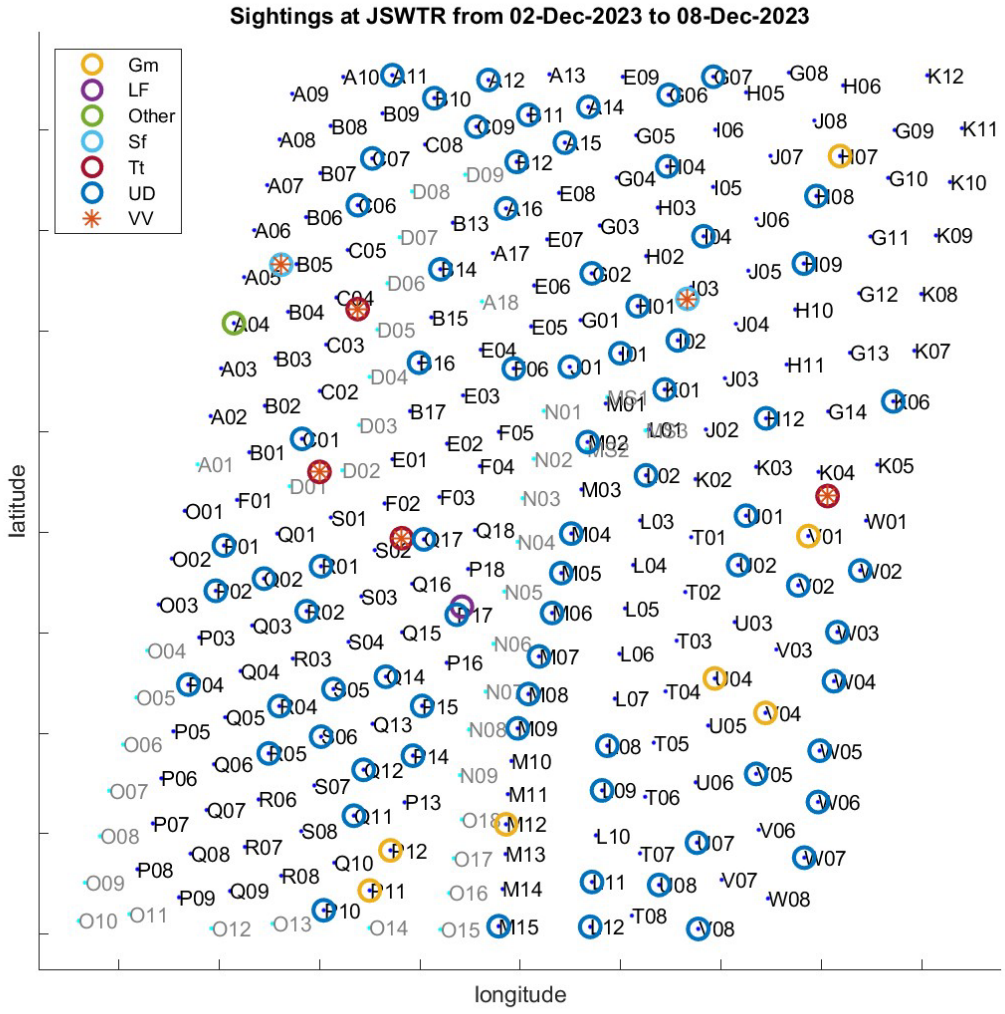

Figure 17. Acoustic detections (sightings) at JSWTR from October 2 – 8 2023. Species included Short-finned pilot whales (Gm), unknown low-frequency biological source (LF), snapping shrimp (Other), Atlantic spotted dolphins (Sf), bottlenose dolphins (Tt), and unidentified delphinid species (UD). Detections that were visually verified (VV) by Duke University are overlaid with an asterisk.

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