Tagging and Tracking of Endangered North Atlantic Right Whales in Florida Waters: 2016-17 Progress Report

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Prepared by:

Douglas P. Nowacek[1,2], Susan E. Parks[3], Andrew J. Read[1]

[1]Duke University, Nicholas School of the Environment and Duke University Marine Laboratory, Beaufort, NC

[2]Pratt School of Engineering, Duke University, Durham, NC

[3]Syracuse University, Biology Department, Syracuse, NY

Submitted by:

Virginia Beach, VA

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Tag attachment to North Atlantic right whale (*Eubalaena glacialis*) in southeastern U.S. waters during 2014. Photo collected under National Marine Fisheries Service Permit #14791 to Douglas P. Nowacek.

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Acronyms and Abbreviations

DTAG	digital acoustic tag
EGNO	identification number assigned to each identified individual in the North Atlantic Right Whale Catalog
EWS	Early Warning System
GPS	Global Positioning System
hr	hour(s)
NMFS	National Marine Fisheries Service
R/V	research vessel
UAS	unmanned aircraft system
USWTR	undersea warfare training range

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1. Background and Objectives

North Atlantic right whales (*Eubalaena glacialis*) migrate to coastal waters off Florida and Georgia during the winter months. The planned construction and use of an undersea warfare training range (USWTR) off the Atlantic coast of Florida may result in interactions with right whales on their winter calving ground. Aerial- and vessel-based visual surveys and passive acoustic monitoring are currently being used to detect right whales in the coastal waters of Florida and Georgia, as well as in offshore areas in and near the planned USWTR. Aerial surveys give the positions of individual whales, but only provide information about right whale locations at single points in time. Passive acoustic monitoring establishes presence and provides a general location of at least one whale; multiple acoustic sensors can provide more accurate locations, as well as estimates of numbers of whales (Zimmer 2011). Currently, few data exist on the movement patterns of individuals, including movement rates in both north-south and east-west directions, durations, and depths of dives, and rates of sound production by individuals on the calving grounds. These data are important to assess the effectiveness of current monitoring techniques and the potential for disturbance to right whales as the construction and operation of the USWTR commence.

The primary objective of this targeted tagging program is to fill in these knowledge gaps by collecting data on horizontal movements, dive profiles, and vocal behavior from individual right whales through the use of non-invasive, suction-cup-attached, digital acoustic tags (DTAGs). In 2016, our expanded objectives included: (1) continuing to increase the sample size of extended-duration tag attachments, along with Fastloc® Global Positioning System (GPS) technology and (2) adding the capability for aerial photography using unmanned aircraft systems (UAS).

Surveys and tagging field work began in 2014. In February 2014, weather conditions were suitable for tagging operations on 11 days, right whales were encountered on 9 days, and 7 DTAGs were successfully deployed (Nowacek et al. 2015). In February–March 2015, 8 days of field effort were conducted, but few right whales were present And only one whale was tagged successfully (Nowacek et al. 2016). This report covers the third field season, conducted January through February 2016, with a brief synopsis of the most recent 2017 field season.

2. Methods

The third field season for this project took place from late January through February 2016. The field team consisted of members from Duke University and Syracuse University, and operated out of Fernandina Beach, Florida, in the Jacksonville study area. The Research Vessel (R/V) *Richard T. Barber*, Duke Marine Lab's 9.1-meter aluminum rigid-hull inflatable boat (Safe Boats International, Bremerton, WA), powered by twin 300-horsepower outboard engines, was used for tag deployment and daytime follows. Tagging was accomplished using non-invasive suction-cup DTAGs (anticipated tag duration from 1 to 36 hours [hr]) that included Fastloc® GPS receivers, time-depth recorders, three-dimensional movement measurements, and acoustic recording capability. DTAGs were deployed from the bow pulpit of R/V *Barber* using a fiberglass pole (**Figure 1**), and retrieved either after the tags were dislodged by another whale or when the automatic release mechanism engaged. Tags were retrieved via the VHF beacon incorporated into the tag, and then data were downloaded via a PC. Researchers browsed audio recordings visually and aurally in RavenPro 1.5 (Cornell Bioacoustics Research Program) for evidence of

right whale vocalizations, positions were logged from the GPS tag, and behavior of the whales analyzed from the sensor suite (e.g., accelerometers, depth sensor). National Marine Fisheries Service (NMFS) permits to conduct this research this year were held by the Northeast Fisheries Science Center with Drs. Nowacek and Parks as named co-investigators. Institutional Animal Care and Use Committee approval was obtained from Duke University and Syracuse University prior to data collection.

Figure 1. Image of DTAG deployment to a right whale in the southeastern United States in February 2016. Photo credit Florida Fish and Wildlife Conservation Commission, collected under NMFS Permit #17355.

One addition to the project in the 2016 field season was the use of an unmanned aerial system (UAS) on an opportunistic basis. The UAS was a MicroKopter HexaXL, equipped with high resolution still and video cameras and a laser altimeter. It also carried a simple plastic collector plate to which was fixed petri dishes to be used for direct sampling from the blows (exhaled breath) of whales (**Figure 2**). The UAS was deployed manually launching it from the R/V *Barber*.

Figure 2. The Duke UAS platform flying over a right whale to collect imagery and blow samples. The whale's blow can clearly been seen to the right of the UAS at water level. Image courtesy of Duke University, collected under NMFS Permit #17355.

3. Results

3.1 Field Effort

Field effort in 2016 took place in late January through February. Weather conditions were suitable for tagging operations (i.e., sea state forecast of Beaufort 3 or less) on 11 days during this time (**Table 1**)**.** The research team was on the water for 5 days in January (**Figure 3**) and 6 days in February (**Figure 4**).

Table 1. Summary of 2016 field effort.

Date	BSS	Survey Time (hh:mm)	At Sea Time (hh:mm)	Platform
25-Jan-16*	2-3	7:58	9:07	R/V *R.T. Barber*
26-Jan-16	1	4:45	5:49	R/V *R.T. Barber*
27-Jan-16	1-3	5:35	6:40	R/V *R.T. Barber*
30-Jan-16*	0-2	8:39	9:19	R/V *R.T. Barber*
31-Jan-16*	0-1	7:37	9:14	R/V *R.T. Barber*
01-Feb-16*	0-3	7:38	8:53	R/V *R.T. Barber*
17-Feb-16*	2-3	7:53	8:42	R/V *R.T. Barber*
20-Feb-16	2	9:23	10:40	R/V *R.T. Barber*
21-Feb-16^	1-3	8:41	9:47	R/V *R.T. Barber*
22-Feb-16*^	2	9:41	10:13	R/V *R.T. Barber*
23-Feb-16^	0-4	5:49	7:29	R/V *R.T. Barber*

* cruise with successful tag deployment and/or tracking. ^ cruise with successful unmanned aerial system flight data.
Key: BSS = Beaufort sea state; R/V = Research Vessel

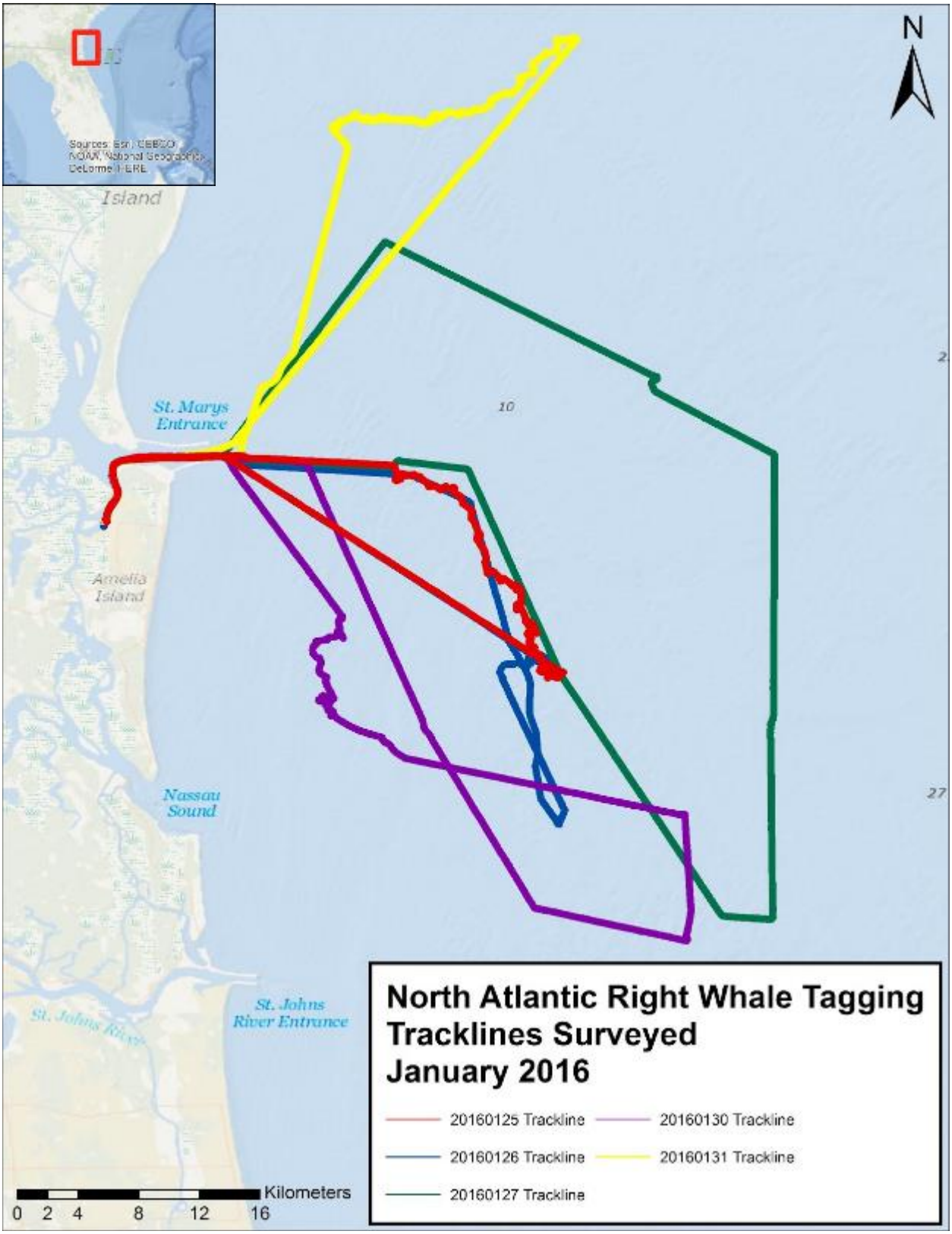

Figure 3. Map of search effort by the tagging vessel for each survey day in January 2016.

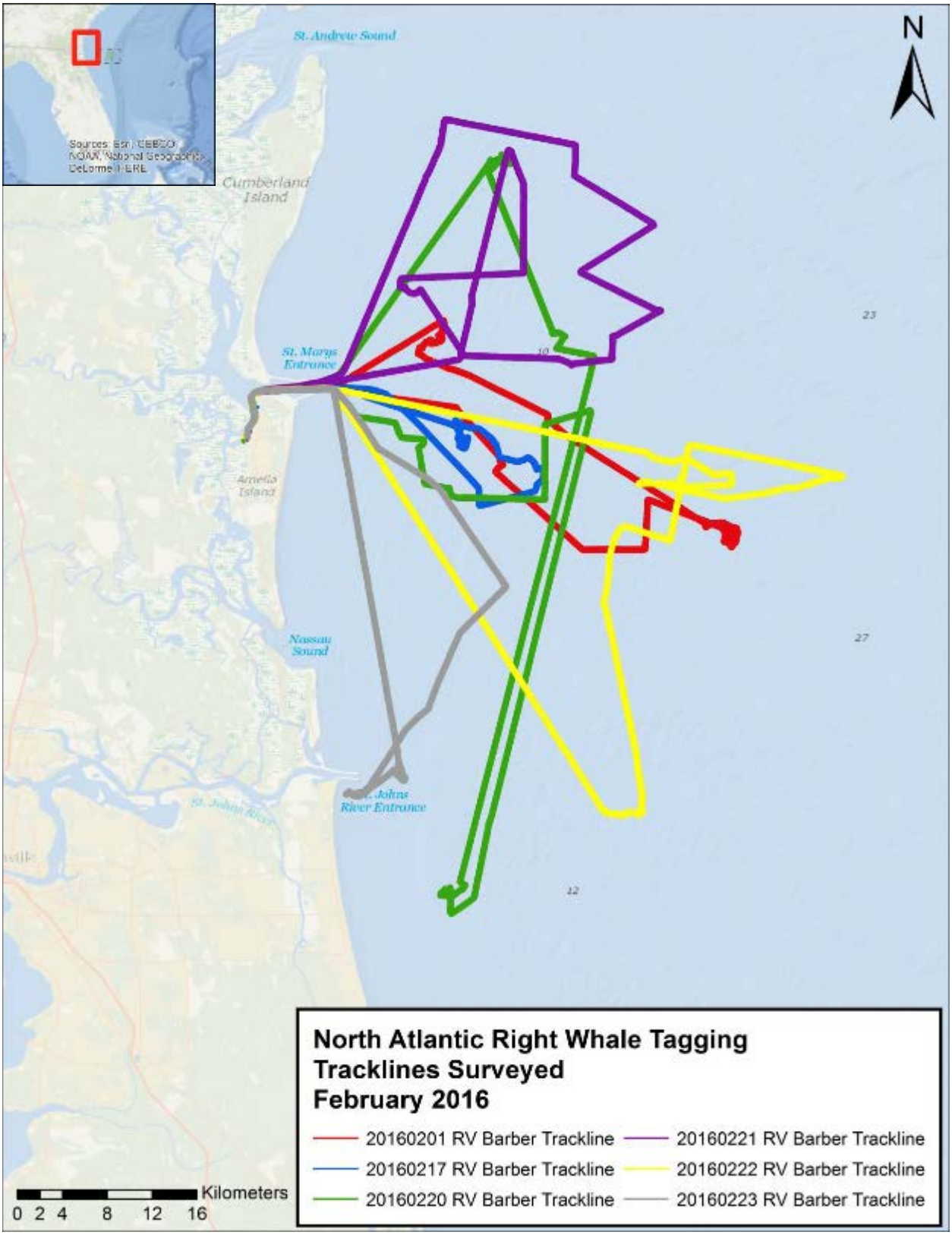

Figure 4. Map of search effort by the tagging vessel for each survey day in February 2016.

3.2 Right Whale Sightings and Tagging

We recorded 16 separate sightings of right whales in January and February 2016, including 14 of mother-calf pairs and 2 of solitary individuals (**Table 2, Figures 5 and 6**). There were several resightings; the total numbers of identified individuals included 9 calving females, their 9 calves, and a solitary animal. The 9 calving females represent 69 percent of the 13 reported from the calving ground for the entire 2015/2016 season (NARWC 2016). One identified whale—EGNO 3101—was seen on 25 January 2016 alone and resighted on 17 February 2016 with her calf. Three other mother/calf pairs were seen more than once—3405 and 3860 twice and 1281 four times. The 9 calving females represent 69 percent of the 13 reported from the calving ground for the entire 2015/2016 season (NARWC 2016). The only non-calving animal sighted was EGNO 1968—a 27-year-old female who has never been sighted with a calf (NEAQ 2017). Right whale sightings on their wintering grounds were significantly lower in 2016 than historic levels (NEAq, S Kraus, pers comm), although on par with 2014 (Nowacek et al. 2015).

Table 2. Summary of right whale sightings and DTAG deployments from January and February 2016.

Date	Latitude (°N)	Longitude (°W)	Group Size	Whale ID	Tag ID
25-Jan-16	30.69675	81.29469	1	3101	Eg16_025a
26-Jan-16	30.58681	81.22008	2	3115+calf	
30-Jan-16	30.54024	81.30135	2	3405+calf	Eg16_030a
31-Jan-16	30.90281	81.33092	2	1281+calf	Eg16_031a
01-Feb-16	30.6521	81.26485	2	3405+calf	
01-Feb-16	30.61079	81.11848	2	3860+calf	
01-Feb-16	30.73374	81.32282	2	1810+calf	Eg16_32a
17-Feb-16	30.64065	81.22863	2	3101+calf	Eg16_048a
17-Feb-16	30.65128	81.24881	2	1281+calf	Eg16_048b
20-Feb-16	30.30893	81.30338	2	3860+calf	
20-Feb-16	30.74928	81.21365	2	1281+calf	
20-Feb-16	30.88811	81.26799	2	3180+calf	
21-Feb-16	30.7986	81.32979	2	1281+calf	
22-Feb-16	30.65765	81.14512	2	1812+calf	
22-Feb-16	30.37812	81.14986	2	3317+calf	Eg16_053a
23-Feb-16	30.40043	81.35293	1	1968	

Seven DTAGs were successfully deployed on five different calving female right whales (**Table 2, Figures 5 and 6)**. EGNO 3101 was pregnant when first tagged on 25 January; she was tagged a second time on 17 February when she was resighted with a calf. EGNO 1281 was tagged twice, on 31 January and 17 February, and seen twice more after that; she was accompanied by a calf at all four sightings. Three other females with calves were tagged once each.

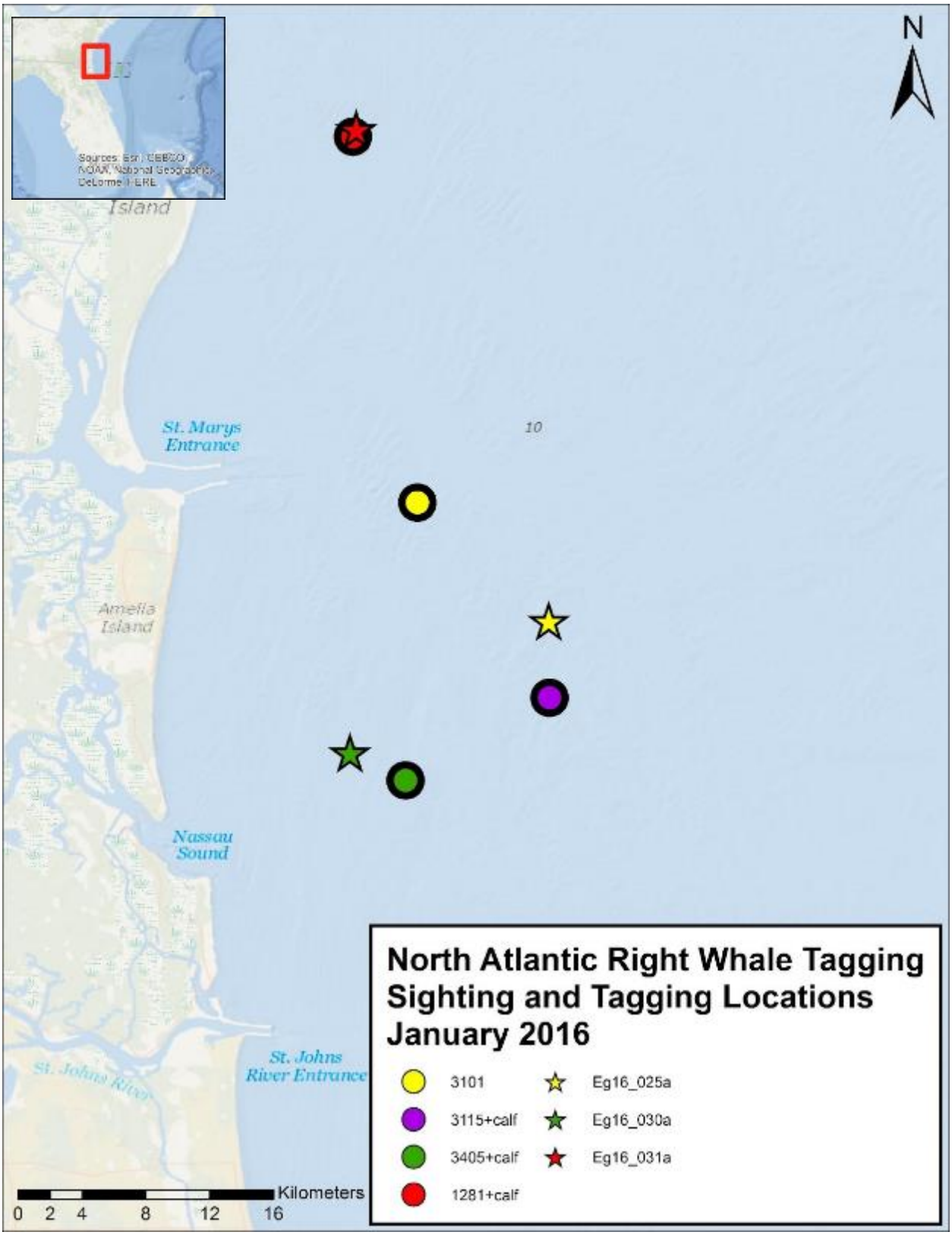

Figure 5. North Atlantic right whale sighting (circle) and tagging locations (star) during tagging operations in January 2016.

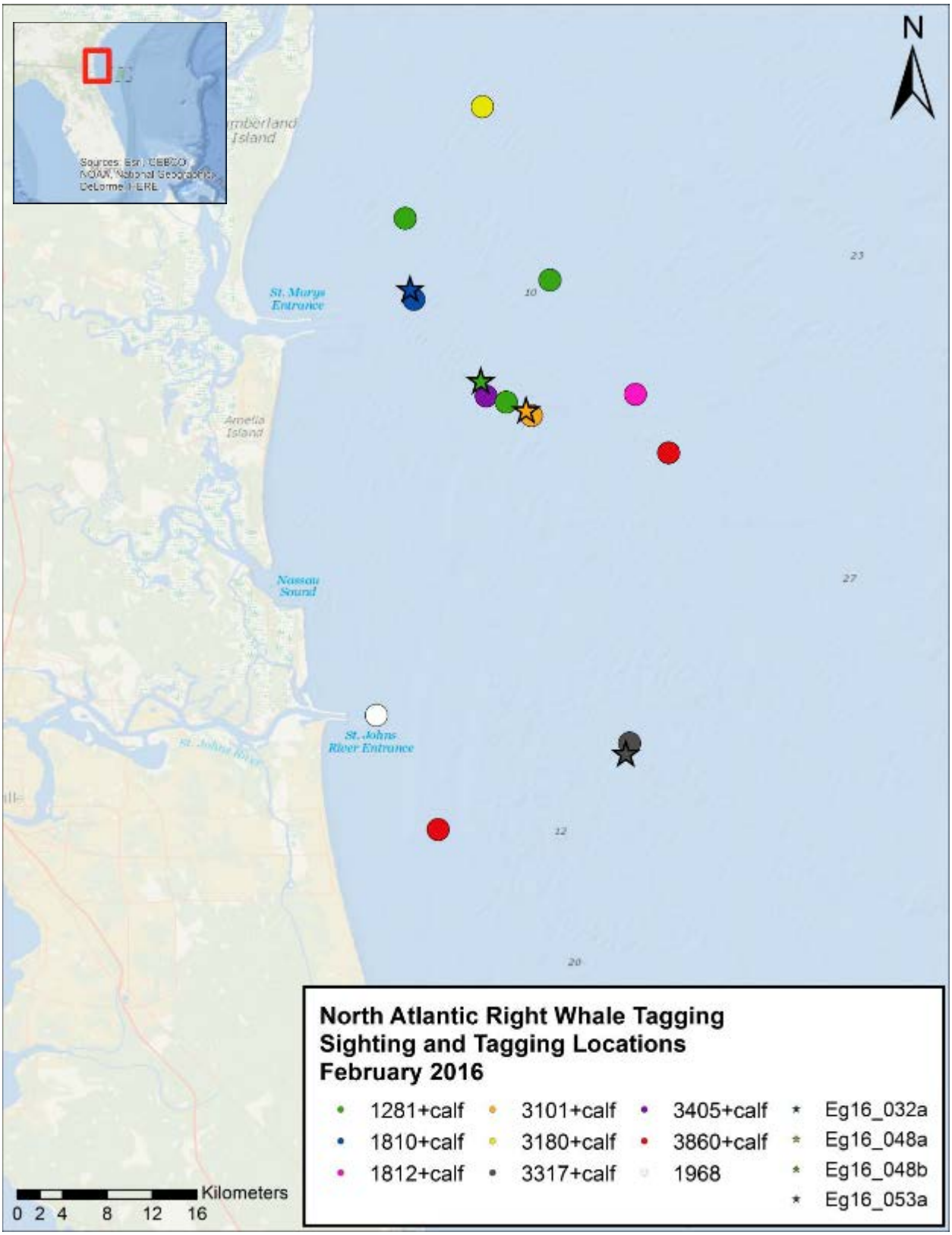

Figure 6. North Atlantic right whale sighting (circle) and tagging locations (star) during tagging operations in February 2016.

3.3 DTAG Data Analyses

Analyses of the GPS, acoustic, and dive data from the DTAGS were completed for the 2016 data, and further analyses of these data are being conducted under the supervision of Drs. Nowacek and Parks with students and technicians in their laboratories.

3.3.1 Distribution and Movements

Right whale sightings during the 2016 tagging cruises were distributed throughout most of the calving ground within vessel range of Fernandina Beach without any obvious pattern or distinct differences between January and February (**Figures 5 and 6**). The tagged animals moved both in north-south and east-west directions (**Figures 7 and 8**). There may be some differences between months in movements, although the sample sizes are small. Tagged animals sometimes moved as much as 2 kilometers in 1 hr.

3.3.2 Acoustic Analyses

All 7 of the DTAGS deployed on North Atlantic right whales in January–February 2016 produced useable acoustic recordings, ranging from 1 hr, 44 minutes to 11 hr, 47 minutes in duration (**Table 3**). Analysis of the acoustic recordings showed a very clear pattern. Among the six tags deployed on five different nursing mothers, only 1 right whale up-call was detected from 32 hr of tag data. On the other hand, the tag deployed on 25 January 2016 on EGNO 3101, before the birth of her calf, recorded 46 up-calls, for an average of 9.2 calls/hr and a peak rate of more than 10 calls/hr. When EGNO 3101 was tagged a second time on 17 February 2016, accompanied by a nursing calf, she was completely silent for the nearly 5 hr of recording. The DTAGs were confirmed to be functioning properly, since they successfully recorded a variety of other sounds, such as noise from nearby ships, distant construction sounds, and vocalizations from fish and other cetacean species.

Table 3. Summary of acoustic data from 7 DTAGs deployed on 5 calving female right whales in 2016.

Date	Tag ID	Whale ID (EGNO)	Acoustic record duration (hh:mm)	Status	Up-calls detected (including calls from other whales)	Calls per hour of tag recording
25-Jan-16	Eg16_025a	3101	4:59	Pregnant	46	9.23
30-Jan-16	Eg16_030a	3405	4:44	Nursing	1	0.21
31-Jan-16	Eg16_031a	1281	6:26	Nursing	0	0
01-Feb-16	Eg16_032a	1810	1:44	Nursing	0	0
17-Feb-16	Eg16_048a	3101	4:56	Nursing	0	0
17-Feb-16	Eg16_048b	1281	2:49	Nursing	0	0
22-Feb-16	Eg16_053a	3317	11:47	Nursing	0	0

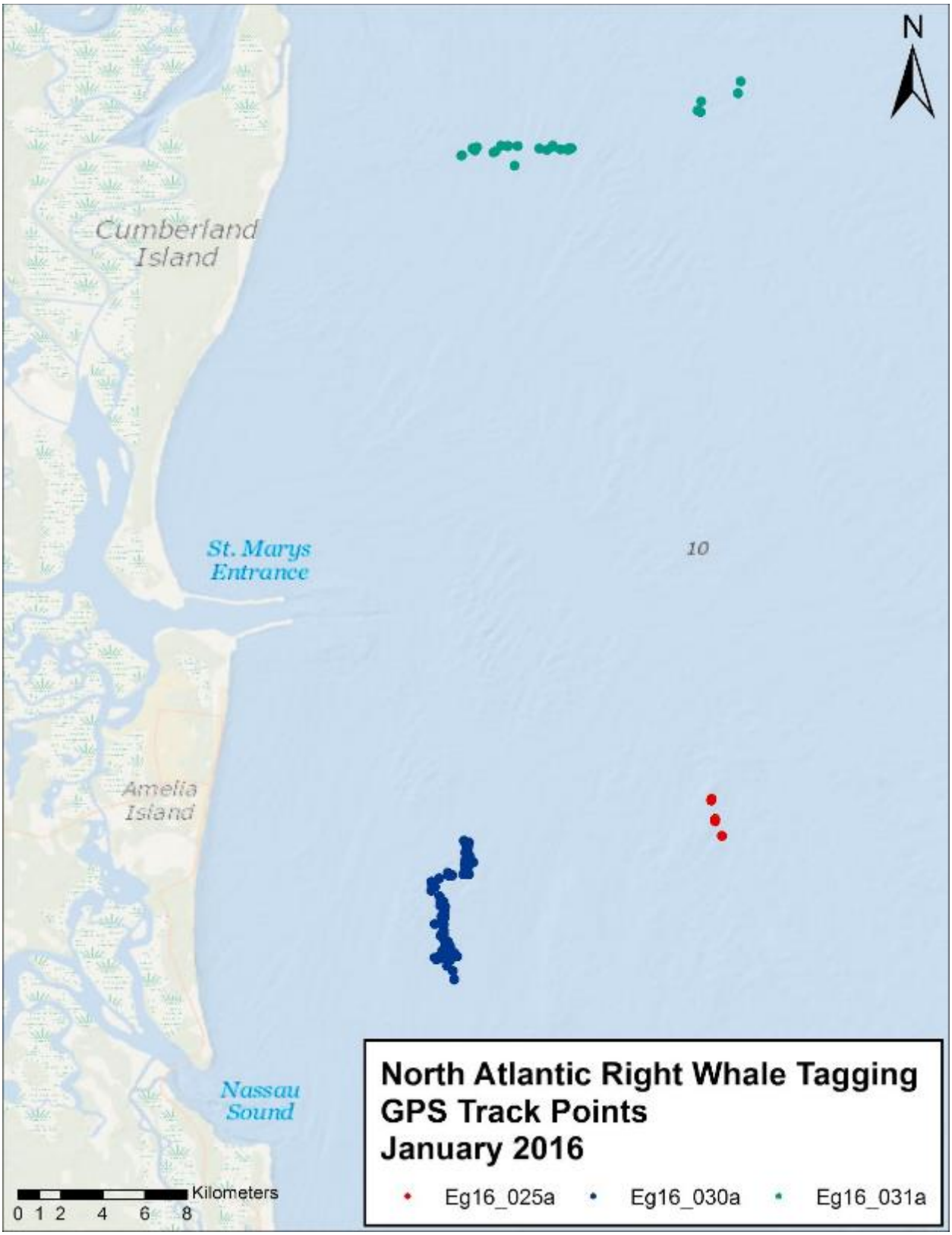

Figure 7. Fastloc® GPS positions for 3 tagged North Atlantic right whales in January 2016: EG16_025a (EGNO 1281, 25 January), EG16_030a (EGNO 3405, 30 January), and Eg16_031a (EGNO 1281, 31 January). EGNO 1281 was pregnant at this time; the other two animals were accompanied by calves.

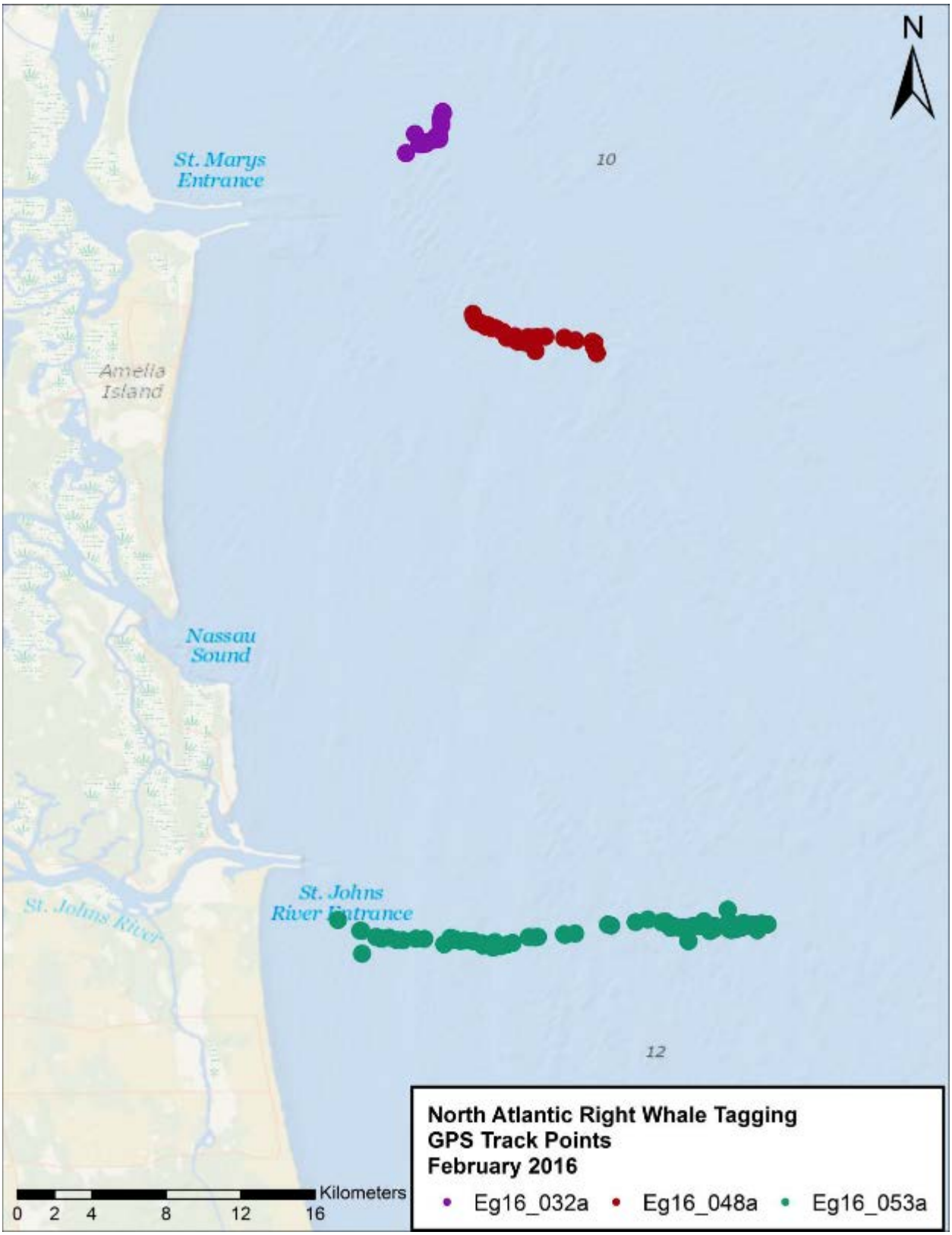

Figure 8. Fastloc® GPS positions for 3 tagged North Atlantic right whales, all females with calves in February 2016: EG16_032a (EGNO 1810, 1 February), EG16_048a (EGNO 1281, 17 February), and EG16_053a (EGNO 3317, 22 February).

The most striking result from the acoustic analyses to date is the absence of detectable right whale calls from nursing females, aside from a single upcall detected on the 30 January, 2016 tag deployment (**Table 3**). Additional sounds such as anthropogenic noise from nearby ships, distant construction sounds, and vocalizations from fish and other cetacean species also were noted.

3.4 Unmanned Aerial System Deployment

The trial deployment of the unmanned aerial system (UAS) was a success, with deployments on three days in February 2016 (**Table 1**). High-quality aerial images were collected of three different adult right whales and one calf. We also collected blow samples and photographs on 23 February from EGNO 1968, a whale that looked compromised (e.g., peeling and grayish skin, large numbers of orange cyamids) and had a piece of baleen that was clearly out of place protruding from the mouth (**Figure 9**). We contributed the images to New England Aquarium for the North Atlantic right whale catalog and the breath sample to Dr. Michael Moore at the Woods Hole Oceanographic Institution for an on-going study.

Figure 9. Image of the head of EGNO 1968 taken from the UAS. Note the poor condition of the skin and the piece of baleen protruding from of the mouth. Collected under NMFS Permit #17355 (NEFSC).

4. Summary of 2016-17 Field Effort and Results

We arrived in Fernandina Beach, Florida on 01 February ready to tag any available right whales that might be observed in the area. Unfortunately, what began as a very quiet season for North Atlantic right whales continued through the month of February. Only four adult whales were spotted in the calving grounds between 01 December 1 2016, when aerial survey teams began their annual monitoring the population and help mitigate ship-strike potential, and February. Three of the four whales that were spotted gave birth to calves, and the fourth (EGNO 3530, better known as Ruffian), was spotted in January entangled in fishing gear. He was successfully disentangled by a collaborative effort between the Georgia Department of Natural Resources and the Florida Fish and Wildlife Conservation Commission, and was last observed mid-January gear-free. Despite several days on the water (Table 4), our team was only able to tag EGNO 2614, a 21-year-old female, who was with her calf, as that pair are the only two whales seen in the area at any time in the month of February. We tagged EGNO 2614 on 07 February just south of the St. Mary's Inlet, and collected the tag approximately 24 hours later and 25 nautical miles to the northeast in inshore Georgia waters. While we do not know what time the tag was shed from the animal, EGNO 2614 and her calf were also spotted within one nm of the tag recovery location. However, that sighting was the last time any team spotted a right whale in the area. After several more days of searching, including the Georgia aerial survey team expanding their search radius with three flights reaching as far north as Cape Hatteras, North Carolina in an attempt to locate any additional animals in the southeast region, we returned home to North Carolina and New York. The data from the tag are being analyzed.

Table 4. Effort for February 2017 right whale tagging project. Note that there were more good weather days, but particularly later in the month we decided to err on the side of conserving boat-days and waited until whales were sighted.

Date	Sea State	Km Surveyed	Survey Time (hr:min)	At Sea Time (hr:min)	Platform
2-Feb-17	0-2	160.9	05:52	06:22	R/V *R.T. Barber*
3-Feb-17	1-4	107.34	05:11	06:05	R/V *R.T. Barber*
6-Feb-17	2	124.9	06:17	06:58	R/V *R.T. Barber*
7-Feb-17	3-4	22.1	03:12	04:00	R/V *R.T. Barber*
8-Feb-17	2-3	68.5	03:10	06:00	R/V *R.T. Barber*
12-Feb-17	2-4	110.0	06:39	07:30	R/V *R.T. Barber*

5. Future Directions

Plans for 2017-18 field work are currently being developed but will likely include expanding the geographic scope of the project into the mid-Atlantic to begin addressing occurrence and movements outside of the southeast calving area. Specifically, an initial effort to sample for the occurrence of right whales in the mid-Atlantic will begin with deployment of an acoustic glider, in collaboration with Dr. Mark Baumgartner, which will sample, generally, VA-NC waters. As described by Baumgartner et al (2013) we will use a Slocum glider outfitted with a PAM system that while diving the glider is capable of detecting right whale up-calls and then relaying that information back to shore upon surfacing. The glider only reports that it heard a whale on the previous dive (i.e., it does not have the ability to localize the calling whale), but that detection provides useful information as the detection radius is limited and thus giving us a relatively small area over which the whale was located. These detections themselves (or lack thereof) provide a key piece of information as we have the least information about right whale movements in the mid-Atlantic region compared to the rest of the right whale range. This information will help us work towards a better picture of their movements and habitat utilization in the VA-NC area. The glider will operate in an area along the continental shelf and shelf-break from just north of Oregon Inlet, NC to approximately the VA-MD line. Finally, a somewhat limited field effort will continue at the JAX location to increase the sample size of tagged individuals, with an emphasis on single animals (not mother-calf pairs) when feasible.

6. Publications and Presentations

The following analyses are currently either completed or in progress to support the publications and presentations from this project:

1. Dive behavior
    a. G_0
    b. Depths for availability
    c. Time spent at % of water column
2. Movement analysis
    a. Total GPS data (include Accusonde deployments with fastloc from earlier Parks et al deployments)
    b. Kernel density
    c. First passage time, if applicable
3. Vocal repertoire – mother-calf pairs
    a. The ‘burp’ from m-c pairs
    b. Call rate
    c. Gunshots
4. Mother-calf behavioral states and transition (colaborative)
5. Noise exposure – Noise in SEUS right whale habitat
    a. Ships, dolphins, pile driving
    b. JAX Harp as reference
    c. Location of whale as a function of noise

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