A RETROSPECTIVE ASSESSMENT OF INVASIVE TAGGING OF NORTH ATLANTIC RIGHT WHALES

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Background

Invasive tagging (i.e. tags that penetrate into body tissue) of North Atlantic right whales, aimed at improving our understanding of their movements and activities, has been conducted by multiple research organizations beginning in the late 1980's. Different tag types, including radio and satellite tags with either an implanted barb that serves as an anchor for the electronics which are external to the body (Type A) and fully implantable with electronics contained within a housing that is internal in the body (Type C), have been developed and deployed in habitats all along the eastern seaboard of the U.S. and Canada. Results of many of these efforts have been presented in reports and publications. In 1999, the New England Aquarium (NEAq) hosted a meeting with veterinary experts to review the physiological effects from tags which resulted in a report by Kraus et al. (2000). At that time, although physiological effects were detected based on local and regional swellings, divots, and other types of scars, a mark-recapture assessment detected no difference in survival between tagged and non-tagged animals assessed from 1988-1996. Tagging efforts continued after 1996, but an assessment of potential impacts to reproduction and survival has not been conducted since that initial study, which focused on survival only.

In September 2023, the Marine Mammal Commission, in partnership with the Office of Naval Research, NOAA Fisheries, and Fisheries and Oceans Canada, hosted a North Atlantic Right Whale Tagging Workshop to review and summarize current knowledge of the effects of telemetry tags on the survival, reproduction, and health of North Atlantic right whales (Eubalaena glacialis) and other baleen whales, as well as to assess the capabilities of telemetry devices currently available to address knowledge gaps relevant to North Atlantic right whale behavior, distribution, and movements. The goals of the workshop were to:

1. review key knowledge gaps and data needs regarding the movements, life history, and ecology of North Atlantic right whales (NARWs);
2. review the history of satellite telemetry and evaluate progress in tag attachment technologies and follow-up studies; and
3. generate knowledge to inform planning and permitting decisions regarding potential tagging of NARWs, as well as other endangered baleen whales.

A report on the workshop was published in 2024 (Marine Mammal Commission, 2024).

During the MMC workshop, New England Aquarium scientists and others noted their concerns about invasive tagging and its potential negative impacts on the whales and suggested that an in-depth review of historical tagging efforts (pre-2010 to ensure adequate time had evolved to assess potential impacts) be carried out in a rigorous fashion to determine whether previous tagging has had negative impacts to reproduction and survival, and to also evaluate how successful past tagging efforts have been. For this part of the review, success is being evaluated by looking at the percentage of tags that transmitted data and the tag transmission duration of those tags. The NEAq,

at the request of the Marine Mammal Commission, and in collaboration with our colleagues at St. Andrews University, initiated a retrospective assessment of invasive tagging efforts which were conducted from 1988-2000 (the pre 2010 tagging era mentioned in the MMC report). This assessment does not include an evaluation of suction cup tags as they are not considered to be invasive. Invasive tagging has continued post 2010 in a limited fashion with the use primarily of Type A tags. The findings of those efforts are not reported on in this study.

The goals and activities of the effort reported herein are twofold: 1) To collate all information on records of invasive tagging events (whether successful in transmitting data or not) and provide information including whale ID #, date, and tag type to Drs. Enrico Pirotta and Len Thomas at St Andrews University for integration into their existing PCOMS model to evaluate reproduction and survival of tagged whales (see Pirotta et al. 2023) and 2) To review data on all tag deployments (including pertinent information from reports, publications, and through communications with personnel associated with the relevant tagging organizations) to determine the tag type (Type A or Type C), model type if available, tag transmission duration, and tag implantation duration. The physiological response to the tag was not included in this assessment. NEAq also summarized the sex, age, and reproductive status information of each tagged individual to provide insights into their demographics.

This report authored by NEAq scientists is focused on goal 2. Scientists at St Andrews University are focused on goal 1 and have provided a separate report on their findings which is posted here: https://www.mmc.gov/wp-content/uploads/Report_NARW_tagging_MMC.pdf

Methods

Tag types, deployments, and demographics of tagged whales
The North Atlantic Right Whale Identification database, a.k.a. the Catalog, curated by the New England Aquarium on behalf of the North Atlantic Right Whale Consortium, includes all photographed sightings of right whales including known individuals that had a satellite or radio tag implanted. Each tagged whale has a behavior of FRST SATTG or FRST RADTG at the sighting when the tag was deployed (or in two cases, the date when first observed with the tag – see below). Any subsequent sightings where the tag was still visibly present and photographed were noted as SATTG or RADTG. In some cases, when it was clear that the tag was gone and that sighting occurred soon after the tag stopped transmitting or was last seen, a behavior of SATTG GONE or RADTG GONE was noted. For this study, we also added tag type (Type A or Type C) as a behavior for the FRST SATTG or FRST RADTG sighting. In the sighting notes, we included details, if available, on tag design and tag model. The sex, age, and whether a female was with a calf when tagged was also summarized according to tag type.

The Kraus et al. (2000) report provides specific details of the tag designs noted for each tagging event conducted prior to 2000. Further information describing the tagging efforts and tag design can be found in Baumgartner and Mate (2005), Goodyear (1993), Kraus et al. 1996, 1997), Mate et al. (2002, 2007), Slay and Kraus (1997, 1998), and Winn et al. (1995).

Satellite tag transmission and implantation duration

Satellite tag transmission data, if provided by the tagging organization, are also included in the Catalog database with a single location added for the given individual per day (even if several positions were available). In a few cases, tags transmitted for some number of days but failed to transmit location information. These datapoints without locations were not included in the Catalog database but were noted in the sighting notes for the initial tagging event. These data were used to inform the implantation duration time but were not used for tallying the tag transmission duration. For all satellite tagging events, the number of days of transmission were synthesized into bins of: 0-1 day, 2-10 days, 11-25 days, 26-50 days, 51-100 days, >100 days, or unknown duration to provide insights into the range of transmission duration times.

Satellite tag implantation duration was calculated based on tag transmission duration and/or photographed sightings of the tag still implanted using whichever was the longer duration. A tag was considered still implanted if any portion of the tag or attachment device still remained imbedded. If there were no sightings of the tag still in the whale and no transmissions after the initial tagging event, these cases were noted as "unknown duration". All transmission durations with location data were graphed. Those limited number of cases that provided implantation durations that exceeded the transmission durations were listed in a table but were not included in the transmission duration graph.

Radio tags

Transmission duration for radio tags was difficult to assess, as observers on a vessel or a plane had to actively listen for the tag signals, record that a signal from the tag was heard. and then photograph the whale on that same day for it to be included as a sighting in the Catalog database. This is different than satellite tag transmissions where the electronic records with date, time, and location are included in the Catalog database. Since radio tags didn't typically remain attached to the whale for very long, or research groups weren't able conduct follow-up efforts beyond their near-term research endeavors, the radio tag data have only been evaluated by St. Andrews in their assessment of tagging effects on reproduction and survival and are not summarized in the results for tag transmission duration.

Additional information

Any further details about a given tagging event that could be gleaned from papers, reports, or data provided by a tagging organization were used to further inform the story of each tagging event. For example, the reports sometimes described issues with tag deployment or whether there was tag breakage and these were included in the sighting notes for the given tagging event (see References Cited for a list of reports that were reviewed for this effort).

Finally, we provide information on plotted locations of tagged whales as presented in published papers and data plotted from New England Aquarium tagging efforts. More detailed mapping of these tag location datapoints is being undertaken by the Office of Naval Research and will be included in their Animal Telemetry Network when submitted by the various research organizations involved in tagging.

Results

Tag types, deployments, and demographics of tagged whales

A total of 75 satellite and radio tags were deployed from 1988 to 2000 (Figure 1; Appendix 1). Note that the two events noted in 2001 are cases where the actual tag deployment date occurred in 2000 but photographic evidence was not collected at that time. No active tagging occurred in 2001, but these whales are included in the database at the date first seen with an implanted tag. The tag implantation duration is linked back to the presumed 2000 tagging date in the sighting notes (Appendix 1).

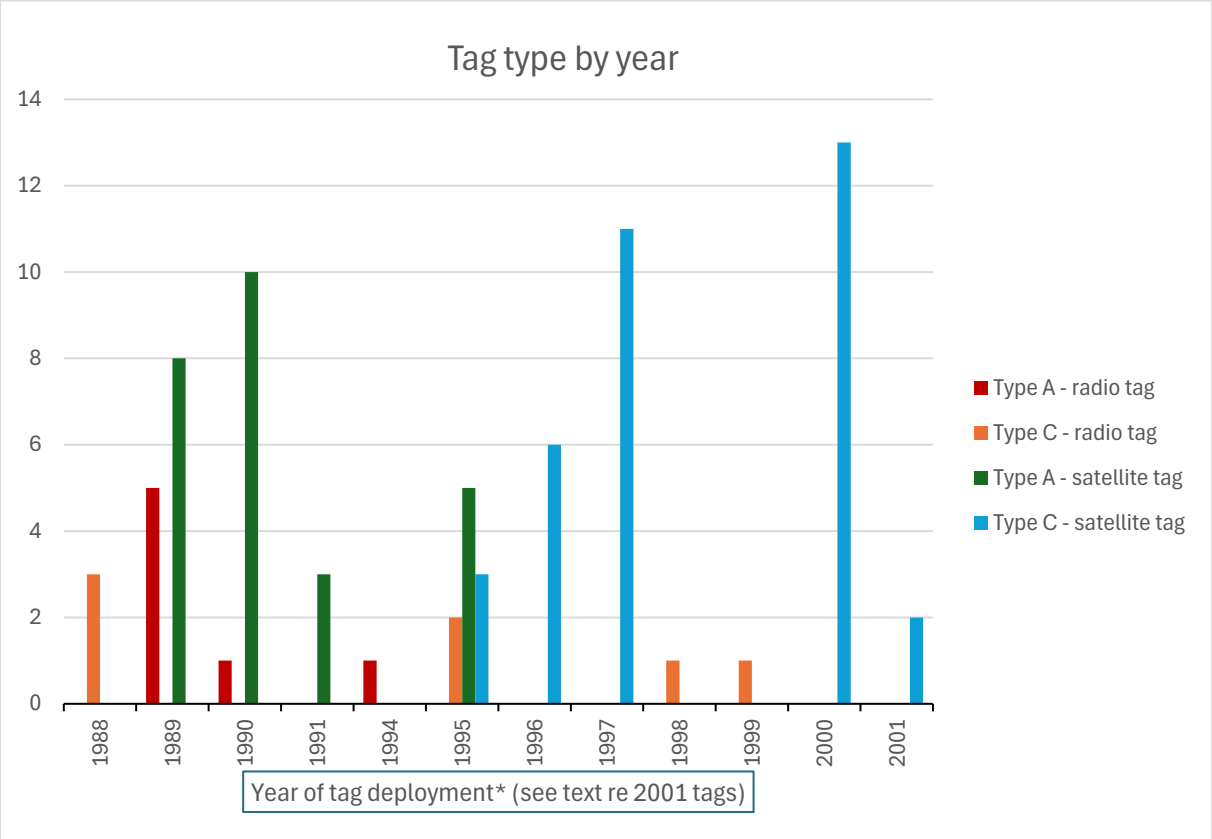

Figure 1. 75 tag deployments according to tag type and year: no tagging occurred in 1992,1993, and 2001. The two tag events noted in 2001 were tagged in 2000 but had no photographs of the tagging event.

Five organizations were involved in invasive tagging over this time period. The organizations, years of their tagging efforts, and the documented number of tag deployments according to tag type are listed in Table 1.

Table 1. Number of tag deployments according to organization, years of tag deployments, and tag type (n = 75)

	Radio tag Type A	Radio tag Type C	Satellite tag Type A	Satellite tag Type C
Center for Coastal Studies/CCS (1998)		1		
Jeff Goodyear/JG (1989,1990,1995)	2		6	1
New England Aquarium/NEA (1994, 1995, 1996, 1997, 1999)	2	3		19
Oregon State University/OSU (1989, 1990, 1991, 2000)			20	15
University of Rhode Island/URI (1988, 1989)	3	3		

The 75 tagged whales represented 70 unique individuals (four whales were tagged two times and one whale was tagged three times). The demographic breakdown of the tagged whales is provided in Figure 2. Three of the whales with type A tags and 11 with type C tags were females with calves, and 63% of all the tagged whales were females of different age classes. Also, two male calves were tagged with type A tags.

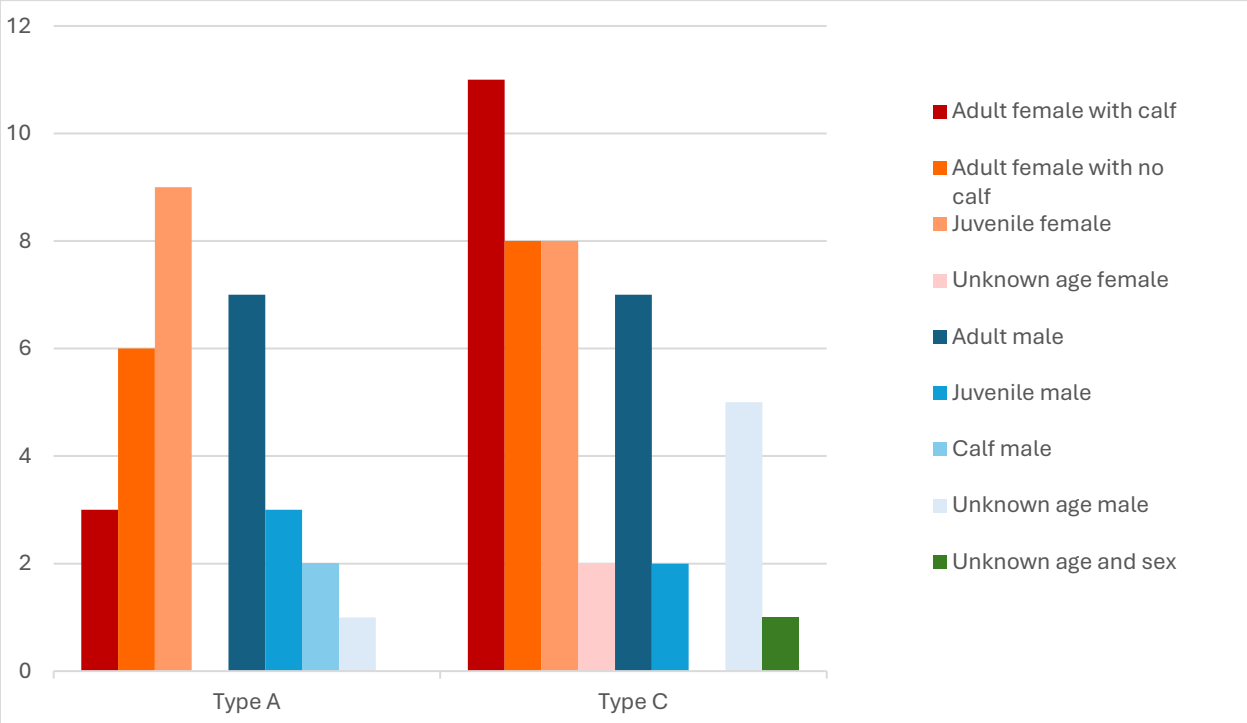

Figure 2. Demographic breakdown of tagged whales according to tag type.

Satellite tag transmission and implantation duration

Satellite tag transmission duration is found in Figure 3. We did not include information about the 14 radio tagged whales in this assessment since transmission information was sparse. A total of 58% of the 26 Type A satellite tags had either 0 transmissions (n = 14) or unknown transmissions (n = 2) and a total of 49% of the Type C satellite tags had 0 transmissions (n = 12), 1 day transmissions (n = 3) or unknown transmissions (n = 2). For the 24 tags that did transmit for more than 1 day, Type A tags ranged from 6 to 42 days and Type C tags ranged from 6 to 157 days.

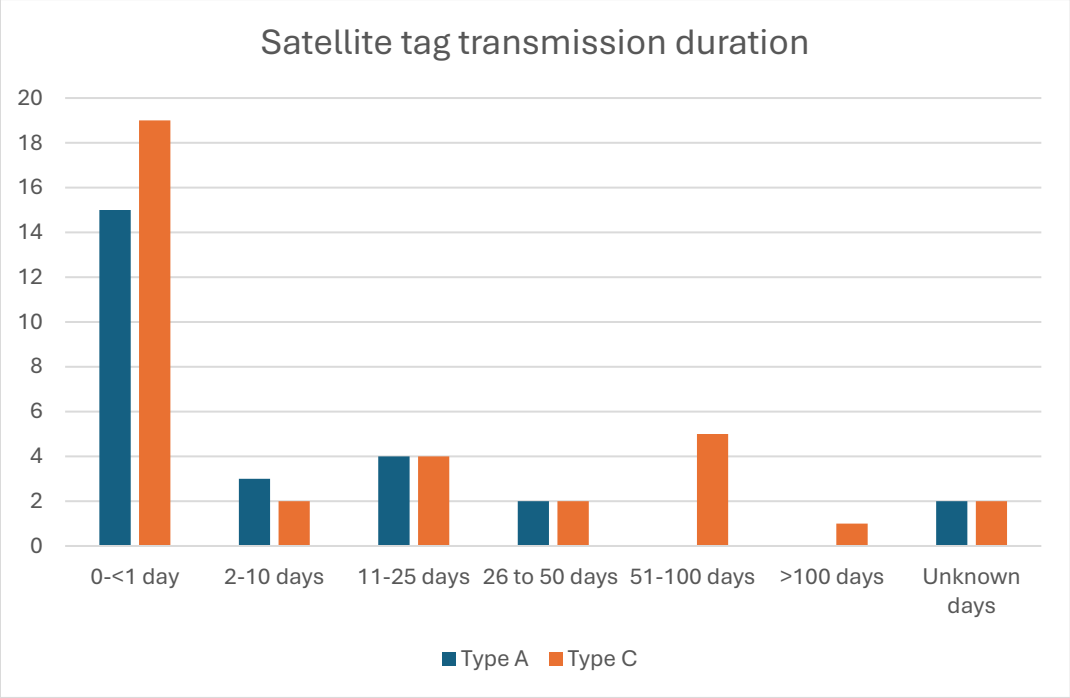

Figure 3. Satellite tag transmission duration according to tag type A or C. Note: tags that transmitted data with no locations are included as either 0 days if no locations were documented or for the partial number of days those transmissions included locations; 5 tags transmitted with either no locations or only a portion of the transmission dates with locations

Satellite tag implantation duration that exceeded tag transmission duration was documented in only 11 of the 35 cases. These implantation durations ranged from at least 6 days to 767 days whereas the transmission duration of these tags ranged from 0 to 53 days. The details of these cases are provided in Table 2 with further details in Appendix 1.

Additional information

Plots of tagged whale locations are found in Baumgartner and Mate (2005) and Mate et al. (2007) with figures from their papers included here (Figures 4, 5) and locations of right whales tagged by NEAq have also been plotted for this report (Figure 6). The location of the tagging events with subsequent transmission data shown below occurred in the Bay of Fundy and the southeast US.

Table 2. Satellite tag deployments where implantation duration was known to have exceeded transmission duration noted in order of # implantation duration days. Information about tag itself included if noted. Note: most implantation durations were unknown. The + noted for implantation durations indicates this was a minimum duration.

Whale #, age/sex	Year of tagging	Tagging org	Tag type/ model	Transmission duration (days)	Implantation duration (days)	Tag notes
1941, 1 yo female	1990	OSU	Type A/ 1990 ST-6	0 (transmitted 2 days with no locations)	6+	"Seen 6 days after tagging with one endcap pulled from housing and tag still attached by other tyne. Swelling noted." Mate et al. 1992 report
1248, Adult female	1990	OSU	Type A/ 1990 ST-6	0	8+	Had tyne in tissue 8 days after tagging but no tag. Swelling noted.
1613, 14 yo male	2000	OSU	Type C/ 1998 ST-15 D	<1	7	
1027, Adult female	2000	OSU	Type C/ 1998 ST-15D	6	15	
2310, Unk age male	2000	OSU	Type C/ 1998 ST-15 D	23	46+	
2240, Adult female	2000	OSU	Type C/ 1998 ST-15 D	<1	341	
2601, 4 yo female	2000	OSU	Type C/ 1998 ST-15 D	0	372	
2645, 4 yo female	2000	OSU	Type C/ 1998 ST-15 D	53	384	
2617, 4 yo female	2000	OSU	Type C/ 1998 ST-15 D	20	401+	
2110, 10 yo male	2000	OSU	Type C/ 1998 ST-15 D	Unknown	438	Tag was observed in whale in Aug 2001 but no active tagging that year. Likely tagged in 2000 on July 9.
2614, 4 yo female	2000	OSU	Type C/ 1998 ST-15 D	Unknown	767	Tag was first observed in whale in Aug 2001 (and through Sep 2002) but no active tagging in 2001. Likely tagged in 2000 on Aug 11.

Fig. 2. Argos-acquired locations for all tagged right whales (*Eubalaena glacialis*). Because of the large number of locations in the lower Bay of Fundy, locations there are indicated as solid circles. All locations for an individual animal outside the Bay of Fundy are denoted by the same letter. Summary data for each animal are included in Table 1. The 91-m (50 fathom) isobath and the features from Fig. 1 are shown.

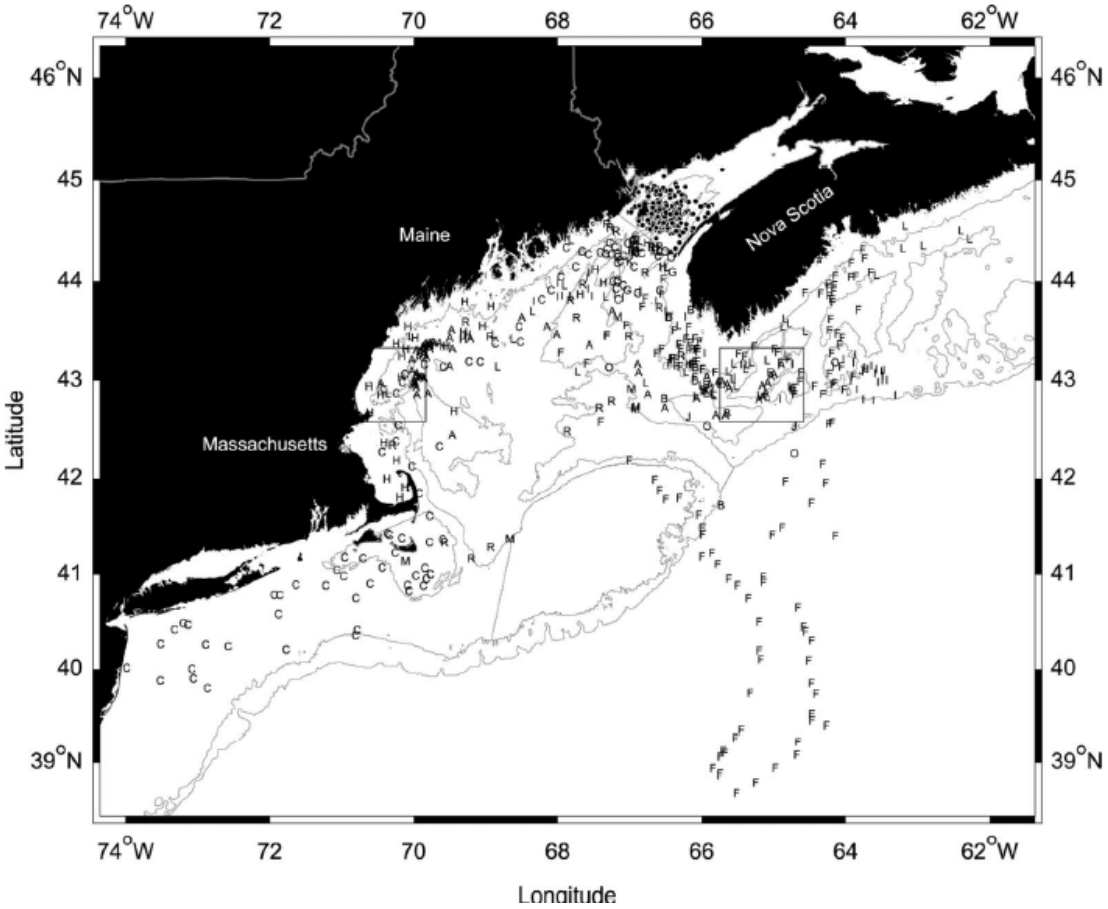

Figure 4. Tagged whale locations documented in Figure 2 in Baumgartner and Mate (2005). All tags were deployed in the Bay of Fundy. Each letter corresponds to a unique individual.

Fig. 12. Summer and fall track of a North Atlantic right whale tagged in the Bay of Fundy, Canada in 2000.

Figure 5. Detailed track of one right whale (#2320) tagged in August 2000 in the Bay of Fundy (Figure 12 in Mate et al. 2007)

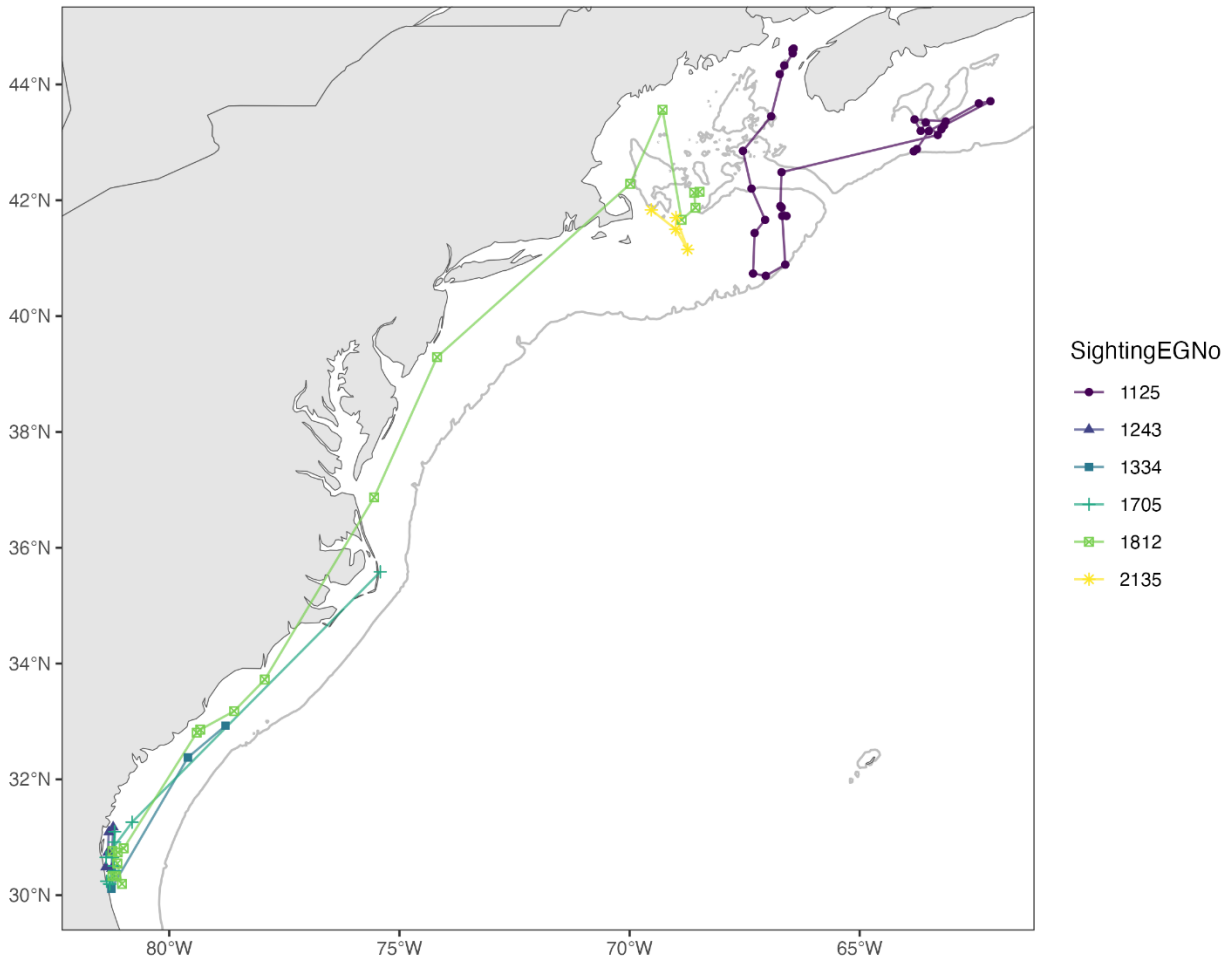

Figure 6. Tagged whale locations for New England Aquarium deployed tags. Note: EGNo 1125 was tagged in the Bay of Fundy in August 1997 (Slay and Kraus 1998), EGNo 2135 was tagged east of Cape Cod in April 1997 (NEAq unpublished data). The remaining whales, EGNo 1243, 1334, 1705, and 1812 were all tagged off the coast of Florida in the winters of 1996 and 1997 (Slay and Kraus 1997 report; see Appendix 1 for tagging dates).

Discussion

The findings of this assessment provide information on the frequency and successful transmission of location data of right whale tagging efforts during the first decades of this technology. Radio tagging success was difficult to assess, as to capture further information required actively tracking the individual whales and this information was not usually collected or reported beyond a few days. Further, it represents a technology that has been largely replaced with suction cup tags and so the need to assess past radio tagging to inform future tagging is not needed. Beyond providing information to St. Andrews University for their evaluation of impacts of all invasive tagging events, we have not conducted any further review of radio tagging.

Satellite tagging was limited in its success primarily due to a failure to transmit data. A total of 58% of Type A tags and 49% of Type C tags had either no transmissions or unknown transmission durations. This failure to transmit data was sometimes due to tags not staying attached to the whale, physical tag breakage during or shortly after deployment, or a failure of the electronics despite a successful deployment. Right whales often engage in surface active groups which involve a lot of energy and constant touching (Parks et al. 2007; Kraus and Hatch 2001) and right whales are also known to interact with the seafloor as evidenced by the presence of mud on their heads and bodies (Hamilton and Kraus 2019). These interactions as well as interactions between mother/calf pairs (14 mothers with calves were tagged during these efforts) likely play a role in the level of tag loss and breakage experienced by right whales. For the tags that did transmit data, the maximum transmission duration for Type A tags was in the 26-to-50-day range (two cases, one at 42.1 days and one at 41.5 days). For Type C tags, one tag achieved 125.8 days, a second tag transmitted for 102 days although locations were only documented for 96 days. A third tag transmitted for 157 days but no locations were documented. Five tags reached the 51-to-100 day window: 96 days (mentioned above), 68 days, 53.3 days, 52.1 days, and 52 days respectively. In addition, satellite tagging ***implantation*** duration exceeded 300 days for six of the OSU Type C tags but ***transmission*** duration was substantially shorter. Four of these six tags did not transmit data beyond two days and the remaining two transmitted for 20 days and 53 days respectively.

Tag location data showed broad and sporadic movements in the Gulf of Maine and southeastern Scotian Shelf as whales searched for foraging grounds with movements along the mid Atlantic and southeast US more linear as whales migrated to and from the calving grounds.

Implications for Future Tagging

Any future tagging proposals should clearly define how the data collected will increase the effectiveness of management, define the scientific and conservation goals that will be achieved, and quantitatively assess the sample size requirements necessary to achieve those goals. Also, an evaluation of whether other monitoring approaches might achieve those same goals is critical. These recommendations are comparable to Andrews et al (2019) who "emphasize the importance of ensuring that tagging is ethically and scientifically justified for a particular project and that tagging only be used to address bona fide research or conservation questions that are best addressed with tagging, as supported by an exploration of alternative methods." Andrews et al. (2019) also note "The health of the population should be considered so that potential stressors from tagging (disturbance, tag effects) do not further compromise the health of individuals in the population." It is well known that the health of the NARW population is poor (Pirotta et al. 2023) and thus this seems like a major concern to be considered. And lastly, Mate et al. (2007) state in their discussion, "Tagging animals is an invasive procedure and should be weighed as a benefit/cost (risk) ratio, especially for endangered species."

With these insights in mind, we propose that permit applications require answers to questions that will allow evaluation of the benefit/cost ratio, such as:

1) How many whales would need to be tagged to establish predictable movement patterns (that are not currently known, nor available from existing/future sightings, photo-ID, and acoustic data/efforts) with confidence?
2) What number of tracks in an area would be needed to inform/change management efforts in those areas?
3) How would those tagged whales inform the movement patterns of demographic groups that may be excluded from tagging effort, such as cows, calves, animals in poor health, and, in particular, those whales that do not frequent those areas where right whales aggregate (non-GSL, offshore, and non-migrating whales)?
4) Does the utilization of past tagging data suggest that this tagging effort can contribute to achieving management goals?

We would also suggest that external reviews of tagging permit applications be conducted to ensure the permit office has all relevant and scientifically vetted information to inform their decision on such applications. We recognize that these decisions are not taken lightly by the permit office and we hope this review and these suggested questions and external input can assist in that process.

The data that have been collected on NARWs are extensive and offer an understanding of their distribution, the impacts of human activities, and the need for stronger management measures throughout their range. These two retrospective studies (Pirotta and Thomas 2024 and the study presented here), our understanding of the stressors this species is presently facing, and the fact that the population has been declining since 2010 (Linden 2023), suggest that invasive tagging of this critically endangered species presents a high risk. Consequently, any tagging project must demonstrate the benefits the tagging can provide to achieving scientific and management goals.

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Appendix 1. Invasive tag deployments of all tag types according to right whale catalog # (EGNo) and in order of date of deployment. Information on tag types can be found in the Kraus et al. 2000 report or in publications from the organizations involved in tagging. Non-tagging behavior abbreviations include: SAG- surface active group, MUD-mud anywhere on whale, W/CALF – female with calf of the year, SKM FD – skimfeeding at surface, RXN – reaction to tagging, DART – biopsy darting, SK – skin collected during darting, ENTGL – whale with attached gear at sighting

EGNo	Gender	Age	Age Class	Year	Month	Day	Area	Observer	Behaviors	Last Year Sighted	Sighting Note
1026	M	15	A	1995	10	8	BOF	NEA/N	FRST SATTG, SAG, TYPE C	2009	Tag_type_name: NEA-SAT-A Tag transmission duration: 0 days Tag implantation duration: unknown Note: When tag deployed, 5 cm of tag was protruding, line broke and arrow stayed stuck on tag
1027	F	A	A	2000	8	12	BOF	OSU	FRST SATTG, TYPE C	2007	TagID 824 Tag_type_name: 1998 ST-15 D Tag transmission duration: 6.89 days (OSU meta data) and 6.3 days (Baumgartner and Mate 2005 paper); Tag implantation duration: minimum 15 days (8/12 to 8/27);
1027	F	A	A	1989	10	12	BOF	NEA/N	FRST SATTG, TYPE A	2007	TagID 4172 Tag design BM-SAT-A Tag_type_name: 1989 ST-3 Tag transmission duration: 0 days Tag implantation duration: <3 days (10/12 to 10/15 - tag gone)
1048	M	A	A	1997	9	26	BOF	NEA/N	FRST SATTG, TYPE C	2022	Tag_type_name: NEA-SAT-D Tag transmission duration: 0 days Tag implantation duration: Unknown Note: Poor implantation, deployment arrow stuck on

EGNo	Gender	Age	Age Class	Year	Month	Day	Area	Observer	Behaviors	Last Year Sighted	Sighting Note
1114	F	A	A	2000	8	12	BOF	OSU	FRST SATTG, TYPE C	2000	TagID 23040 Tag_type_name: 1998 ST-15 D Tag transmission duration: 20.90 days (OSU meta data) and 18.9 days (Baumgartner and Mate 2005 paper) Tag implantation duration: unknown
1121	M	A	A	1989	10	15	BOF	NEA/N	FRST RADTG, SAG, TYPE A	2022	Tag_type_name: JG-RAD Tag transmission duration: Unknown Tag implantation duration: Unknown
1122	M	A	A	1997	9	11	BOF	NEA/N	FRST SATTG, TYPE C	2022	Tag_type_name: NEA-SAT-D Tag transmission duration: 0 days Tag implantation duration: Unknown Note: deployment arrow stayed on
1125	F	A	A	1997	8	25	BOF	NEA/N	FRST SATTG, MUD, TYPE C	2005	Tag_type_name: NEA-SAT-D Tag transmission duration: 52 days Tag implantation duration: Unknown
1127	F	A	A	1990	8	25	BOF	NEA/N	FRST SATTG, TYPE A	1994	TagID 835 Tag design BM-SAT-C Tag_type_name: 1990 ST-6 Tag transmission duration: 0 days Tag implantation duration: unknown (likely less than 2 days)

EGNo	Gender	Age	Age Class	Year	Month	Day	Area	Observer	Behaviors	Last Year Sighted	Sighting Note
1135	F	A	A	1990	8	24	BOF	NEA/N	FRST SATTG, TYPE A	1996	TagID 840 Tag design BM-SAT-C Tag_type_name: 1990 ST-6 Tag transmission duration: 6.9 days Tag implantation duration: Unknown
1136	M	A	A	1997	8	27	BOF	NEA/N	FRST SATTG, MUD, SAG, TYPE C	1999	Tag_type_name: NEA-SAT-D Tag transmission duration: 0 days Tag implantation duration: Unknown
1138	M	8	J	1989	9	21	BOF	NEA/C4	FRST SATTG, TYPE A	1993	TagID 4173 Tag design BM-SAT-B Tag_type_name: 1989 ST-3 Tag transmission duration: 0 days Tag implantation duration: Unknown (maybe <4 days)
1140	F	A	A	1990	8	24	BOF	NEA/N	FRST SATTG, TYPE A	2014	TagID 839 Tag design BM-SAT-C Tag_type_name: 1990 ST-6 Tag transmission duration: 41.5 days Tag implantation duration: <58 days (tag gone on 10/21/1990)
1146	M	A	A	1989	10	15	BOF	NEA/N	FRST SATTG, SAG, TYPE A	2015	Tag ID 843 Tag design BM-SAT-A Tag_type_name: 1989 ST-3 Tag transmission duration: 21.2 days Tag implantation duration: Unknown

EGNo	Gender	Age	Age Class	Year	Month	Day	Area	Observer	Behaviors	Last Year Sighted	Sighting Note
1152	M	A	A	1990	8	24	BOF	NEA/N	FRST SATTG, TYPE A	2016	TagID: 831 Tag design BM-SAT-C Tag_type_name: 1990 ST-6 Tag transmission duration: 0 days Tag implantation duration: At least 15 days (transmissions with no locations)
1153	F	17	A	1997	8	18	BOF	NEA/N	FRST SATTG, TYPE C, W/CALF	1998	Tag_type_name: NEA-SAT-D Tag transmission duration: 0 days Tag implantation duration: Unknown Note: arrow stuck
1163	F	8	A	1989	6	3	GSC	URI/V	ENTGL, FRST RADTG, SKM FD, TYPE A	1992	Tag_type_name: JG-RAD Tag transmission duration: <1 day Tag implantation duration: Unknown (tag designed for barb to remain in whale)
1202	X	U	U	1988	5	29	GSC	URI/V	FRST RADTG, SAG, TYPE C	1988	Tag_type_name: JG-RAD Tag transmission duration: Unknown Tag implantation duration: Unknown This whale used to be #1432
1243	F	15	A	1997	1	22	GA	NEA/V	FRST SATTG, TYPE C, W/CALF	2022	Tag_type_name: NEA-SAT-C Tag transmission duration: 6 days Tag implantation duration: 9 days

EGNo	Gender	Age	Age Class	Year	Month	Day	Area	Observer	Behaviors	Last Year Sighted	Sighting Note
1243	F	9	A	1991	9	27	BOF	NEA/N	FRST SATTG, TYPE A, W/CALF	2022	TagID 1385 Tag design BM-SAT-C Tag_type_name: 1990 ST-6 Tag transmission duration: 7.9 days Tag implantation duration: Unknown
1245	F	8	J	1990	9	22	BOF	NEA/N	FRST SATTG, RXN, SAG, TYPE A	2022	Tag_type_name: JG-SAT Tag transmission duration: 0 days Tag implantation duration: Unknown
1248	F	A	A	1990	8	24	BOF	NEA/N	FRST SATTG, TYPE A	2006	TagID 834 Tag design BM-SAT-C Tag_type_name: 1990 ST-6 Tag transmission duration: 0 days Tag implantation duration: 8 days (tyne in tissue 8 days after tagging but no tag)
1254	F	A	A	1995	2	27	FL	NEA/A	FRST RADTG, TYPE C, W/CALF	1995	Tag_type_name: NEA-RAD Tag transmission duration: 8 days Tag implantation duration: Unknown
1268	F	A	A	1995	2	1	FL	USCG/V	FRST RADTG, TYPE C, W/CALF	2002	Tag_type_name: NEA-RAD Tag transmission duration: 23 days Tag implantation duration: Unknown
1281	F	A	A	1995	9	16	BOF	NEA/N	FRST SATTG, SATTG GONE, TYPE A	2019	Tag_type_name: JG-SAT Tag transmission duration: 0 days Tag implantation duration: 0 days Note: tag broke and fell out on same day

EGNo	Gender	Age	Age Class	Year	Month	Day	Area	Observer	Behaviors	Last Year Sighted	Sighting Note
1303	F	A	A	1997	10	4	BOF	NEA/N	FRST SATTG, MUD, SAG, TYPE C	2011	Tag_type_name: NEA-SAT-D Tag transmission duration: 0 days Tag implantation duration: Unknown
1308	F	13	A	1996	9	6	BOF	NEA/N	FRST SATTG, TYPE C	2011	Tag_type_name: NEA-SAT-B Tag transmission duration: 0 days Tag implantation duration: Unknown
1327	M	A	A	1997	8	29	BOF	NEA/N	FRST SATTG, SAG, TYPE C	2016	Tag_type_name: NEA-SAT-D Tag transmission duration: 0 days Tag implantation duration: Unknown
1334	F	A	A	1996	2	7	FL	NEA/V	FRST SATTG, TYPE C, W/CALF	2019	Tag_type_name: NEA-SAT-B Tag transmission duration: 18 days Tag implantation duration: Unknown
1405	F	13	A	1997	1	28	GA	NEA/V	FRST SATTG, TYPE C, W/CALF	1999	Tag_type_name: NEA-SAT-C Tag transmission duration: 0 days Tag implantation duration: Unknown
1405	F	4	J	1988	5	29	GSC	URI/V	FRST RADTG, SAG, TYPE C	1999	Tag_type_name: JG-RAD Tag transmission duration: Unknown Tag implantation duration: Unknown

EGNo	Gender	Age	Age Class	Year	Month	Day	Area	Observer	Behaviors	Last Year Sighted	Sighting Note
1406	F	7	J	1991	10	5	BOF	NEA/N	DRT, FRST SATTG, RXN, TYPE A	2000	TagID 1387 Tag design BM-SAT-C Tag_type_name: 1990 ST-6 Tag transmission duration: 21.4 days Tag implantation duration: Unknown
1408	F	12	A	1996	9	16	BOF	NEA/N	FRST SATTG, TYPE C, W/CALF	2016	Tag_type_name: NEA-SAT-B Tag transmission duration: 0 days Tag implantation duration: 0 days Note: tag implantation poor
1421	M	A	A	1990	9	12	BOF	NEA/N	FRST SATTG, MUD, TYPE A	1990	TagID: 823 Tag design BM-SAT-C Tag_type_name: 1990 ST-6 Tag transmission duration: 42.1 days Tag implantation duration: Unknown
1422	M	A	A	1989	9	13	RB	NEA/C4	FRST SATTG, SAG, TYPE A	1989	Tag_type_name: 1989 ST-3? Tag transmission duration: Unknown Tag implantation duration: Unknown Note: details about this tagging event were not available from OSU
1428	M	A	A	1989	10	15	BOF	NEA/N	FRST SATTG, TYPE A	2009	TagID: 844 Tag design BM-SAT-B Tag_type_name: 1989 ST-3 Tag transmission duration: 0 days Tag implantation duration: Unknown

EGNo	Gender	Age	Age Class	Year	Month	Day	Area	Observer	Behaviors	Last Year Sighted	Sighting Note
1503	F	10	A	1995	9	16	BOF	NEA/N	FRST SATTG, TYPE A, W/CALF	2010	Tag_type_name: JG-SAT Tag transmission duration: 0 days Tag implantation duration: <4 days
1509	F	A	A	1997	1	20	FL	NEA/V	FRST SATTG, TYPE C, W/CALF	2005	Tag_type_name: NEA-SAT-C Tag transmission duration: 0 days Tag implantation duration: Unknown
1602	F	3	J	1989	9	21	BOF	NEA/C4	FRST SATTG, TYPE A	2002	TagID: 838 Tag design BM-SAT-B Tag_type_name: 1989 ST-3 Tag transmission duration: 0 days Tag implantation duration: Unknown
1608	F	5	J	1991	9	28	BOF	NEA/N	FRST SATTG, TYPE A	2018	TagID: 1386 Tag design BM-SAT-C Tag_type_name: 1990 ST-6 Tag transmission duration: 23.7 days Tag implantation duration: Unknown
1609	M	9	A	1995	9	10	BOF	NEA/N	FRST SATTG, TYPE A	2016	Tag_type_name: JG-SAT Tag transmission duration: 0 days Tag implantation duration: <20 days
1611	F	3	J	1989	9	13	RB	NEA/C4	FRST SATTG, SAG, TYPE A	2022	Tag_type_name: 1989 ST-3? Tag transmission duration: Unknown Tag implantation duration: Unknown Note: details about this tagging event were not available from OSU

EGNo	Gender	Age	Age Class	Year	Month	Day	Area	Observer	Behaviors	Last Year Sighted	Sighting Note
1613	M	14	A	2000	8	11	BOF	OSU	FRST SATTG, TYPE C	2018	TagID 833 Tag_type_name: 1998 ST-15 D Tag transmission duration: 0.42 days Tag implantation duration: At least 7 days
1624	M	U	U	1989	5	29	GSC	URI/V	FRST RADTG, SAG, SKM FD, TYPE A	2005	Tag_type_name: JG-RAD Tag transmission duration:<1 day Tag implantation duration: Unknown (tag designed for barb to remain in whale)
1629	F	U	A	1990	8	26	BOF	NEA/N	FRST SATTG, RXN, TYPE A, W/CALF	2002	TagID: 825 Tag design BM-SAT-C Tag_type_name: 1990 ST-6 Tag transmission duration: 9.9 days Tag implantation duration: Unknown
1702	M	3	J	1990	8	31	BOF	JG*	FRST RADTG, TYPE A	1990	Tag_type_name: JG-RAD Tag transmission duration: Unknown Tag implantation duration: Unknown
1703	F	2	J	1989	10	12	BOF	NEA/N	FRST SATTG, SAG, TYPE A	2022	TagID 4174 Tag design BM-SAT A Tag_type_name: 1989 ST-3 Tag transmission duration: 0 days Tag implantation duration: Unknown
1705	F	9	A	1996	2	8	FL	NEA/V	FRST SATTG, TYPE C, W/CALF	2013	Tag_type_name: NEA-SAT-B Tag transmission duration: 39 days Tag implantation duration: Unknown

EGNo	Gender	Age	Age Class	Year	Month	Day	Area	Observer	Behaviors	Last Year Sighted	Sighting Note
1705	F	2	J	1989	6	1	GSC	URI/V	FRST RADTG, SKM FD, TYPE A	2013	Tag_type_name: JG-RAD Tag transmission duration: 2 days Tag implantation duration: Unknown (tag designed for barb to remain in whale)
1705	F	1	J	1988	5	28	GSC	URI/V	FRST RADTG, SAG, TYPE C	2013	Tag_type_name: JG-RAD Tag transmission duration: At least 2 days Tag implantation duration: Unknown
1802	F	7	J	1995	9	11	BOF	NEA/N	FRST SATTG, TYPE A	2022	Tag_type_name: JG-SAT Tag transmission duration: 0 days Tag implantation duration: <8 days
1812	F	A	A	1996	2	21	FL	NEA/V	FRST SATTG, TYPE C, W/CALF	2022	Tag_type_name: NEA-SAT-B Tag transmission duration: 96 days Tag implantation duration: Unknown
1813	M	U	U	1995	10	8	BOF	NEA/N	FRST SATTG, SAG, TYPE C	2018	Tag_type_name: NEA-SAT-A Tag transmission duration: 1 day Tag implantation duration: Unknown
1903	M	0	C	1989	9	9	BOF	JG*	FRST RADTG, TYPE A	1994	Tag_type_name: JG-RAD Tag transmission duration: Unknown Tag implantation duration: < 4 days (tag seen on 9/11 and gone on 9/13)

EGNo	Gender	Age	Age Class	Year	Month	Day	Area	Observer	Behaviors	Last Year Sighted	Sighting Note
1941	F	1	J	1990	8	26	BOF	NEA/N	AVD, FRST SATTG, TYPE A	1990	TagID: 827 Tag design BM-SAT-C Tag_type_name: 1990 ST-6 Tag transmission duration: 2 days (transmissions on 8/26 and 8/28 with no locations Tag implantation duration: At least 6 days (whale not seen again) Note: on 9/1 - tag on; endcap off
1981	M	1	J	1990	8	25	BOF	NEA/N	FRST SATTG, TYPE A	2014	TagID: 833 Tag design BM-SAT-C Tag_type_name: 1990 ST-6 Tag transmission duration: 11.6 days (according to OSU metadata table) Tag implantation duration: Unknown
2110	M	10	A	2001	8	14	BOF	NEA/N	FRST SATTG, SAG, TYPE C	2008	Tag_type_name: 1998 ST-15 D Tag transmission duration: Unknown Tag implantation duration: 438 days - 7/9/2000-9/20/2001 (note: this is based on an unconfirmed tagging event in 2000)
2135	M	6	J	1997	4	23	GSC	CCS	FRST SATTG, TYPE C	2021	Tag_type_name: NEA-SAT-C Tag transmission duration: 15 days Tag implantation duration: Unknown
2220	M	U	U	1995	10	3	BOF	NEA/N	DRT, FRST SATTG, SATTG GONE, SK, TYPE A	1996	Tag_type_name: JG-SAT Tag transmission duration: 0 days Tag implantation duration: Unknown Note: Tag broke and tag stayed in whale. Necropsy report on 3/1996 suggests the barb may have migrated through the body

EGNo	Gender	Age	Age Class	Year	Month	Day	Area	Observer	Behaviors	Last Year Sighted	Sighting Note
2223	F	6	J	1998	3	25	CCB	CCS/SW	FRST RADTG, SKM FD, TYPE C	2022	Tag_type_name: CCS RADTG Tag transmission duration: Unknown Tag implantation duration: At least 8 days
2240	F	A	A	2000	8	12	BOF	OSU	FRST SATTG, TYPE C	2005	TagID 825 Tag_type_name: 1998 ST-15 D Tag transmission duration: 0.40 days Tag implantation duration: At least 341 days (8/12/2000-7/19/2001; tag gone on 8/1/2001)
2250	M	U	U	1995	10	8	BOF	NEA/N	FRST SATTG, TYPE C, W/UNPH EG	1995	Tag_type_name: NEA-SAT-A Tag transmission duration: 0 days Tag implantation duration: <11 days Note: Found dead on 10/19/1995 from vessel strike but no tag noted
2310	M	U	U	2000	8	12	BOF	OSU	FRST SATTG, TYPE C	2019	TagID 823 Tag_type_name: 1998 ST-15 D Tag transmission duration: 27.2 Tag implantation duration: At least 46 days (8/12/2000-9/27/2000)
2320	F	U	U	2000	8	11	BOF	OSU	FRST SATTG, TYPE C	2015	TagID 23039 Tag_type_name: 1998 ST-15 D Tag transmission duration: 125.8 days Tag implantation duration: Unknown

EGNo	Gender	Age	Age Class	Year	Month	Day	Area	Observer	Behaviors	Last Year Sighted	Sighting Note
2430	F	U	U	2000	7	9	BOF	OSU	FRST SATTG, TYPE C	2022	TagID: 846 Tag_type_name: 1998 ST-15 D Tag transmission duration: 0 days Tag implantation duration: Unknown
2440	M	0	J	1994	12	9	DBAY	NEA	FRST RADTG, TYPE A	2022	Tag_type_name: NEA-RAD Tag transmission duration: Unknown Tag implantation duration: Unknown
2601	F	4	J	2000	8	12	BOF	OSU	FRST SATTG, TYPE C	2010	TagID 10839 Tag_type_name: 1998 ST-15 D Tag transmission duration: 0 days Tag implantation duration: at least 372 days (8/12/2000-8/19/2001)
2610	F	U	A	1996	10	1	BOF	NEA/N	FRST SATTG, TYPE C, W/CALF	1996	Tag_type_name: NEA-SAT-B Tag transmission duration: 0 Tag implantation duration: At least 157 days (transmitted 10/30/96-3/6/97 - no locations)
2614	F	5	J	2001	8	1	BOF	NEA/N	FRST SATTG, SAG, TYPE C	2022	Tag_type_name: 1998 ST-15 D Tag transmission duration: Unknown Tag implantation duration: 767 days - 8/11/2000-9/17/2002 (note: this is based on an unconfirmed tagging event in 2000)

EGNo	Gender	Age	Age Class	Year	Month	Day	Area	Observer	Behaviors	Last Year Sighted	Sighting Note
2617	F	4	J	2000	8	12	BOF	OSU	FRST SATTG, TYPE C	2005	TagID 1387 Tag_type_name: 1998 ST-15 D Tag transmission duration: 19.82 days Tag implantation duration: At least 401 days (8/12/2000-9/17/2001)
2645	F	4	J	2000	7	13	BOF	TAG/OSU	FRST SATTG, TYPE C	2015	TagID 4174 Tag_type_name: 1998 ST-15 D Tag transmission duration: 53.33 days Tag implantation duration: At least 384 days (7/13/2000-8/1/2001)
2710	F	2	J	1999	9	1	BOF	NEA/N	ENTGL, FRST RADTG, TYPE C	2014	Tag_type_name: NEA-RADTG Tag transmission duration: 2 days Tag implantation duration: Unknown
2743	M	3	J	2000	8	11	BOF	OSU	FRST SATTG, TYPE C	2022	TagID 10822 Tag_type_name: 1998 ST-15 D Tag transmission duration: 0 days Tag implantation duration: Unknown
2795	M	U	U	2000	8	11	BOF	OSU	FRST SATTG, TYPE C	2022	TagID 10829 Tag_type_name: 1998 ST-15 D Tag transmission duration: 67.96 Tag implantation duration: Unknown

EGNo	Gender	Age	Age Class	Year	Month	Day	Area	Observer	Behaviors	Last Year Sighted	Sighting Note
3030	M	U	U	2000	8	12	BOF	OSU	FRST SATTG, TYPE C	2002	TagID 828 Tag_type_name: 1998 ST-15 D Tag transmission duration: 52.08 days Tag implantation duration: Unknown