Photo-Identification Analyses in the Cape Hatteras Study Area: 2019 Annual Progress Report

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Cover Photo Credit:

Cuvier's beaked whale (*Ziphius cavirostris*). Photographed by Danielle Waples, Duke University, taken under General Authorization Letter of Confirmation 19903 held by Duke University.

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Table of Contents

Figures

Tables

Acronyms and Abbreviations

BRS	Behavioral Response Study
Photo-ID	Photo-identification

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1. Cape Hatteras Photo-identification

Over 12,400 digital images were collected in the Cape Hatteras study area to confirm species, identify individual animals, and conduct follow-up monitoring of satellite-tagged animals during fieldwork supporting the Atlantic Behavioral Response Study (BRS) in 2019 (Southall et al. 2020). Digital photographs were taken with Canon or Nikon digital SLR cameras (equipped with 100 to 400-millimeter zoom lenses) in 24-bit color at a resolution of 6016 × 4016 pixels and saved in .jpg format. Photographs were obtained from five species, with most taken of Cuvier's beaked whales (*Ziphius cavirostris*), the primary focal species of BRS field efforts during 2019 (**Table 1**).

All digital images were individually graded for photographic quality and animal distinctiveness. All images of sufficient quality and distinctiveness were then sorted by individual within a sighting and assigned temporary identifications. The best image for each individual in that sighting was then selected and these images were compiled into a folder for each sighting for later photo-identification (photo-ID) and all images were cropped. Sighting data and photo-ID information were stored in an Access database that is managed by Kim Urian (Duke University Marine Lab).

Table 1. Cetacean sightings with the number of photo-id images collected for each species in the Hatteras study area in 2019.

Species	Common Name	Number of Sightings	Number of Photo-ID Images
Globicephala macrorhynchus	Short-finned pilot whale	14	725
Grampus griseus	Risso's dolphin	1	1
Physeter macrocephalus	Sperm whale	2	53
Tursiops truncatus	Bottlenose dolphin	7	151
Ziphius cavirostris	Cuvier's beaked whale	73	11,498
Total		**97**	**12,428**

Images of 174 newly identified animals were added to three existing photo-ID catalogs of bottlenose dolphins (*Tursiops truncatus*), short-finned pilot whales (*Globicephala macrorhynchus*), and Cuvier's beaked whales, and 103 new photo-ID matches were made within these three catalogs. To date, photo-ID catalogs for 11 species have been assembled in the Cape Hatteras study area, across multiple AFTT marine species monitoring projects, with 516 individuals re-sighted across all species (**Table 2**). In addition, all newly identified short-finned pilot whales were compared to the short-finned pilot whale photo-id catalogs from Onslow Bay, North Carolina and Jacksonville, Florida.

Table 1. Summary of images collected during fieldwork in the Cape Hatteras study area in 2019, with number of new identifications (IDs), photo-ID catalog sizes, number of new matches, and total matches to date.

Species	New Images Collected	New IDs	Catalog Size	New Matches	Matches To Date
Balaenoptera physalus	0	0	1	0	0
Delphinus delphis	0	0	46	0	1
Globicephala macrorhynchus	725	104	1,260	78	436
Grampus griseus	1	0	46	0	6
Kogia sp.	0	0	1	0	0
Megaptera novaeangliae	0	0	2	0	0
Physeter macrocephalus	53	0	20	0	1
Stenella clymene	0	0	3	0	0
Stenella frontalis	0	0	24	0	0
Tursiops truncatus	151	20	349	2	19
Ziphius cavirostris	11,498	50	177	23	53

Analysis of the images taken in the Cape Hatteras study area is ongoing. To date, 19 bottlenose dolphins have been re-sighted, with multiple years between re-sights for 14 of the 19 individuals (**Table 3**). The longest period between re-sights spans more than five years, with Ttr_7-024 first photographed in May 2007 and then re-sighted in June 2012. An additional photo-id re-sight was made last year with more than five years between sightings: Ttr_7-045 was first seen in May 2013 and was photographed again in June 2018. Another individual, Ttr_9-016, was photographed on three occasions during a five-year period, with sightings in May 2011, June 2014, and August 2016. We have also photographed bottlenose dolphins associating in the same groups over multiple years. Ttr_6-018 and Ttr_9-013 were photographed together in March 2012 and May 2013. Ttr_6-102 and Ttr_8-024 were seen in the same group in September 2013 and then observed together almost three years later in May 2016. Ttr_7-076 and Ttr_8-032 were photographed together three times over a two-year period, with sightings in May 2014 and in March and August 2016. Ttr_6-099 also was present in the groups in May 2014 and August 2016.

A single match of a common dolphin (*Delphinus delphis*) has been made; Dde 7-002 was first photographed on 27 May 2007 and then re-sighted nearly five years later on 15 March 2012. A single sperm whale (*Physeter macrocephalus*) match has been made; Pma_004 was observed on 27 and 29 May in 2013. Six Risso's dolphins (*Grampus griseus*; including GgTag017) were sighted together on two consecutive days in August 2016.

Table 2. Photo-ID matches by year of individual odontocete cetaceans, 2007–2018, in the Cape Hatteras study area, excluding Cuvier's beaked whales and short-finned pilot whales.

ID[1]	Year											
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Ttr_1-001			X		X[y]							
Ttr_6-018^						X	X					
Ttr_6-020					X		X					
Ttr_6-038							X			X		
Ttr_6-099^								X		X		
Ttr_6-102^							X			X		
Ttr_7-024	X					X						
Ttr_7-031					X[y]							
Ttr_7-045							X					X
Ttr_7-038					X[y]							
Ttr_7-058							X[y]					
Ttr_7-076^								X		X[y]		
Ttr_7-101										X[y]		
Ttr_8-024^							X			X		
Ttr_8-032^								X		X[y]		
Ttr_9-013^						X	X					
Ttr_9-016					X			X		X		
Ttr_9-027 (TtTag015)								X[m]				
Ttr_9-036									X		X	
Dde_7-002	X					X						
Pma_004							X[m]					
Ggr_6-002										X[m]		
Ggr_6-004										X[m]		
Ggr_6-005										X[m]		
Ggr_6-006 (GgTag017)										X[m]		
Ggr_7-004										X[m]		
Ggr_9-002										X[m]		

[1] Dde=*Delphinus delphis* (common dolphin); Ggr= *Grampus griseus* (Risso's dolphin) Pma=*Physeter macrocephalus* (sperm whale);Ttr=*Tursiops truncatus* (bottlenose dolphin)

m – re-sighted within same month

y – re-sighted within same year

^Observed together in multiple sightings

1.1 Cuvier's Beaked Whales

Fifty new identifications were added to the Cuvier's beaked whale photo-ID catalog during 2019 and 23 new re-sights were made with re-sights occurring both within and between years. This represents a substantial increase in Cuvier's beaked whale photo-ID effort compared to 2018 when only 15 new identifications and 10 re-sights were added to the catalog. The current re-sight rate for Cuvier's beaked whales in the Hatteras area is 30 percent, compared to a re-sight rate of 24 percent in 2018. To date, 30 of the 53 matched Cuvier's beaked whales have been seen across multiple years, and eight of those have been re-sighted more than three years apart (**Table 4**). Zca_002 was first seen in October of 2013; it was re-sighted almost five years later in August 2018 and was satellite- tagged (ZcTag074) and was re-sighted a year later in June 2019. Based on photographs of its erupted teeth this animal is an adult male and is the Cuvier's beaked whale with the longest time interval between re-sights. Zca_008r was first observed in May 2014, and was seen again in October 2014 with a small calf, confirming her as an adult female. She was photographed in May 2016 without her calf and was satellite-tagged (ZcTag047) and seen two days after tagging. During 2017, we photographed her on two occasions, in June and August, and in 2018, she was photographed on four occasions in May and August. This female represents the Cuvier's beaked whale with the most re-sights in the Cape Hatteras area, with 10 sightings made over four years.

Sixteen Cuvier's beaked whales were tagged in 2019 and two of those individuals were matched to the photo-ID catalog. Zca_099r was photographed on three occasions in August 2018 and was tagged in May 2019 (ZcTag083). Zca_052 was first seen in June 2018 and was tagged in May 2019 (ZcTag084).

We are also beginning to document individual Cuvier's beaked whales associating with each other over extended periods of time. Zca_024 and Zc_008r were satellite tagged in the same group in May 2016 (ZcTag046 and ZcTag047, respectively) and were seen together again in June 2017. We have confirmed that Zca_008r is an adult female and that Zca_024 is an adult male.

In November of 2019, Danielle Waples met with Kate Sutherland, a scientist who works aboard the charter vessel *Stormy Petrel*, captained by Brian Patterson, out of Hatteras Inlet. This vessel is used for pelagic birding trips, duting which beaked whales are encountered frequently. Kate contributed approximately 65 images of Cuvier's beaked whales that she and Brian have taken during their pelagic seabird cruises from 2003 to 2018. These images will be graded for photo quality and animal distinctiveness and a new catalog created for these trips to be compared to the existing Duke University catalog. This comparison will allow us to determine how frequently the Cuvier's beaked whales we observe during the BRS move south of Cape Hatteras over several years.

Table 3. Photo-ID matches by year of Cuvier's beaked whales in the Cape Hatteras study area, 2013–2019.

ID[1]	Year						
	2013	2014	2015	2016	2017	2018	2019
Zca_001r	X		X				
Zca_002 (ZcTag074)	X					X	X^m
Zc_003		X				X	
Zca_003r (ZcTag029)		X^m				X	
Zca_005		X	X		X		
Zca_006 (ZcTag040)		X	X		X	X	
Zca_008r (ZcTag047) ^		X^y		X^m	X^y	X^y	
Zca_015 (ZcTag039, ZcTag077)			X			X	
Zca_019 (ZcTag043)		X	X				
Zca_024 (ZcTag046) ^				X	X		
Zca_027r			X			X	
Zca_029 (ZcTag054)					X^y		
Zca_030 (ZcTag055)					X^y		X
Zca_032					X	X^m	
Zca_035 (ZcTag076)					X	X^y	
Zca_035r (ZcTag048)				X		X	
Zca_037 (ZcTag068)					X^y		
Zca_038					X	X	
Zca_040					X^y		X
Zca_042 (ZcTag062)					X^y		
Zca_044r				X		X^m	
Zca_048					X		X
Zca_050 (ZcTag078)						X^y	
Zca_050r (ZcTag057)					X	X	
Zca_051 (ZcTag069)						X^y	
Zca_051r (ZcTag058)					X^y	X	
Zca_052 (ZcTag084)						X	X^m
Zca_053 (ZcTag075)						X^m	
Zca_053r					X^m		
Zca_054 (ZcTag080)						X^m	
Zca_054r					X^y		X
Zca_056r					X^m		
Zca_059					X^m		
Zca_059r					X	X^y	
Zca_063						X^m	
Zca_066						X^m	

ID[1]	Year						
	2013	2014	2015	2016	2017	2018	2019
Zca_071r (ZcTag081)					X	X[m]	
Zca_074r					X	X	
Zca_076r						X[m]	
Zca_079r (ZcTag073)						X[y]	
Zca_085r						X[m]	
Zca_092r						X[m]	
Zca_094r						X[m]	
Zca_095r						X[m]	
Zca_096r						X[m]	
Zca_097r						X[m]	
Zca_099r (ZcTag083)						X[m]	X
Zca_117r						X[y]	
Zca_121r (ZcTag082)							X[y]
M-001 (ZcTag030)		X[y]					
M-002		X	X				
M-003		X	X				
M-004	X				X		

[1] Zca=*Ziphius cavirostris* (Cuvier's beaked whale); M=aerial-vessel match to UNCW catalog

r – Cuvier's beaked whales that are identified by scarring patterns (rake marks)

m – re-sighted within same month

y – re-sighted within same year

^Observed together in multiple sightings

In addition to taking photographs of the dorsal fin and body scarring, used for photo-ID, we also attempt to obtain high-quality images of the head of each animal. We are using these photographs to identify adult male Cuvier's beaked whales (with erupted teeth) so that we can begin to understand the demographics of this population. We classify animals as adult males if they have erupted teeth at the tip of their lower rostrum or extensive linear scarring, believed to be caused from interactions with other adult males (McSweeney et al. 2007, Falcone et al. 2009; **Table 5, Figure 1**). Currently we classify animals as adult females only if we photograph them with a dependent calf (an individual <50 percent of the body length of the other individual surfacing in close proximity; McSweeney et al. 2007; **Table 5, Figure 2**). Researchers in Hawai'i (McSweeney et al. 2007, Baird 2016) use the accumulation of cookie cutter shark (*Isistius brasiliensis*) scars to differentiate adult females from subadult animals, but we rarely see these scars on Cuvier's beaked whales off Hatteras. Researchers in the Mediterranean (Coomber et al. 2016) use pigmentation patterns to differentiate males and females, but these patterns may vary between regions. We classify whales as subadult males if we have photographs of teeth just beginning to erupt from the lower jaw (**Table 5, Figure 3**). Currently we have no method based on our photographs to classify whales as subadult females. Most animals in our catalog have not yet been identified to age or sex class (**Table 5**). These include animals where we have a photo of the head as well as the body but the whales have no erupted teeth and minimal scarring (**Figure 4**). These also include animals with moderate amounts of scarring but no photograph

of their heads to confirm whether or not they are adult males. Many of these non-classified whales are likely adult females or subadult males or subadult females.

Danielle Waples presented the results of the age and sex classifications of Cuvier's beaked whales from Cape Hatteras at a workshop on Age and Sex Classification of Cuvier's Beaked Whales from Photographs during the World Marine Mammal Conference in Barcelona, in December 2019. The purpose of this workshop was to bring together scientists who collect individual identification photographs of Cuvier's beaked whales from study sites around the world to share photo-identification methodologies and work towards standardized protocols for assigning age and sex class to known individuals. At the conclusion of this workshop, we agreed to work together with researchers from Hawaii, Southern California, and the Mediterranean to score age and sex in a consistent manner, so that we can draw comparisons regarding the demography of these populations. We biopsied 10 Cuvier's beaked whales from 2013 to 2018 and all samples have been genetically analyzed to confirm sex. We hope that, with more whales assigned a sex through genetics, we can determine pigmentation patterns or other characteristics to use for gender and age classification.

Table 4. Age class and gender classifications of Cuvier's beaked whales based on photographs.

Age Class	Gender	Defining Characteristics	Number
Adult	Male	Erupted teeth, extensive linear scarring	65
Adult	Female	Presence of a dependent calf	8
Subadult	Male	Teeth beginning to erupt	4
Subadult	Female	None at present time	0
Unknown	Unknown	No photograph of head Photograph of head but no erupted teeth & minimal scarring	100

Figure 1. Photograph of an adult male Cuvier's beaked whale showing erupted teeth and extensive linear scarring.

Figure 2. Photograph of an adult female Cuvier's beaked whale with her calf.

Figure 3. Photograph of a subadult male Cuvier's beaked whale with teeth erupting from the lower jaw.

a)

b)

c)

Figure 4. Examples of Cuvier's beaked whales that cannot be assigned a gender or age class based on photographs. These include: a) animals with a head photo but no erupted teeth, b) animals with minimal or no scarring, or c) animals with moderate scarring but no photograph of the head.

1.2 Short-finned Pilot Whales

Totals of 104 new identifications and 78 new re-sights were added to the short-finned pilot whale catalog in 2019. Much of this increase represents images collected in 2018 and processed in 2019.

The current re-sight rate of short-finned pilot whales is 34 percent compared to 31 percent in 2018. More than 190 short-finned pilot whales have been seen on three or more occasions and three animals have been re-sighted more than seven times (**Table 6**). Gma_6-055 (GmTag097) was sighted eight times between May 2008 and June 2018, Gma_6-078 (GmTag218) was photographed 10 times between May 2007 and August 2018 and Gma_7-127 (GmTag096) was seen eight times between May 2008 and August 2018. The three pilot whales that have been sighted the most frequently have all been satellite-tagged.

We also are documenting individual short-finned pilot whales returning to the Cape Hatteras study area over extended periods. More than 100 pilot whales have spans of at least five years between their first and last sightings and 14 pilot whales have periods of 10 or more years between sightings (**Table 7**). Gma_1-062, Gma_6-024 and Gma_9-025 were first seen in the same large group in May 2007, when Gma_6-024 and Gma_9-025 were biopsied; Gma_6-024 is a male and Gma _9-025 is a female. Gma_6-024 was sighted in 2014 and again in June 2018, over 11 years after its first sighting. Gma_1-062 and Gma_9-025 were sighted in the same group again in August 2018, 11 years after their first sighting together. These long-term re-sights demonstrate that both male and female short-finned pilot whales exhibit strong site fidelity to the Cape Hatteras area.

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

Five short-finned pilot whales were satellite-tagged during 2019 and two of those animals were matched to the photo-ID catalog. Gma_7-208 was originally seen in June 2015 in a group of 20 pilot whales that included GmTag135. They were both re-sighted in the same group in July 2019, along with two other individuals from the 2015 sighting, and Gma_7-208 was satellite-tagged (GmTag224). Gma_7-318 was first photographed off Hatteras, North Carolina, in May and August 2007. It was re-sighted by HDR scientists during surveys off Norfolk, Virginia, in November 2016 and was sighted again off Hatteras and satellite-tagged in May 2019 (GmTag223; **Figure 5**). With 12 years between its initial and most recent sighting, this satellite-tagged pilot whale has the longest sighting history in the Cape Hatteras study area.

The 104 newly identified short-finned pilot whales added to the Hatteras photo-id catalog were systematically compared to the short-finned pilot whale catalogs for Onslow Bay, North Carolina and Jacksonville, Florida. We had previously matched three pilot whales between the the Hatteras and Onslow Bay study areas. Gma_8-165 was seen in Onslow Bay, North Carolina, in a group of 40 short-

finned pilot whales in August of 2007 and re-sighted and satellite tagged (GmTag209) in the Cape Hatteras area 11 years later in August of 2018. Two other short-finned pilot whales were also photographed with Gma_8-165 in both of these two sightings. We have added a fourth pilot whale seen in both Hatteras and Onslow Bay; Gma_8-179 was also present in the Onlsow Bay sighting in August 2007 and the Hatteras sighting in August 2018 (**Figure 6**). These four photo-ID matches are the only short-finned pilot whale matches documented between the Cape Hatteras and Onslow Bay catalogs. To date we have not made any matches between the Hatteras and Jacksonville pilot whale photo-id catalogs.

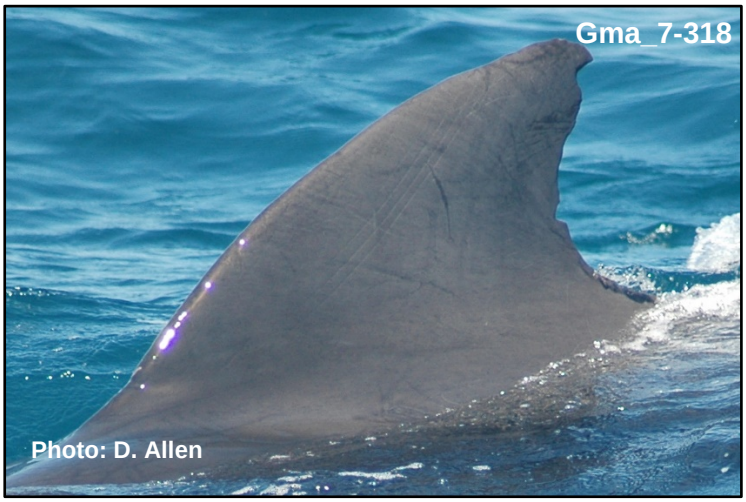
Table 5. Frequency distribution of the number of sightings of photo-identified short-finned pilot whales in the Cape Hatteras study area.

Number of Sightings	Number of Individuals
1	824
2	240
3	100
4	58
5	17
6	10
7	8
8	2
9	0
10	1
Total	**1,260**

Table 6. Frequency distribution of the number of years between first and last sightings of photo-identified short-finned pilot whales in the Cape Hatteras study area.

Number of Years Between First and Last Sighting	Number of Individuals
1	145
2	65
3	58
4	60
5	17
6	26
7	39
8	11
9	1
10	10
11	3
12	1
Total	**436**

a)



b)

c)

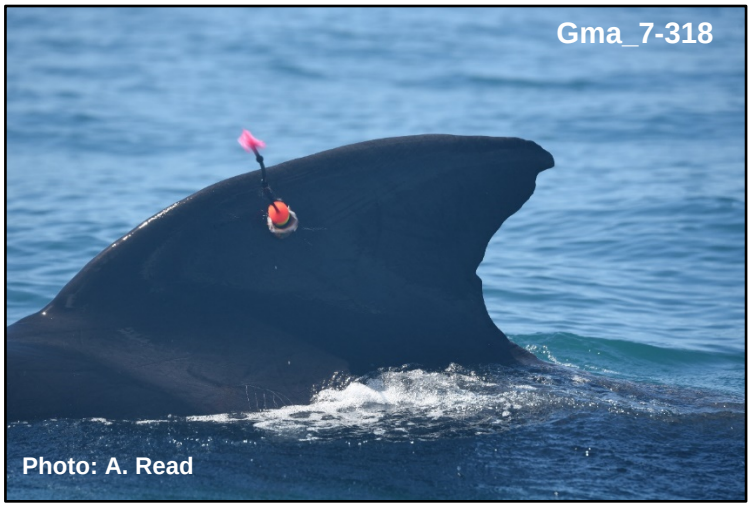


Figure 5. Photographs of Gma_7-318 a) in Hatteras in August 2007 and b) re-sighted in Virginia in November 2016, and c) re-sighted and satellite-tagged in Hatteras in May 2019 (GmTag223)

a)

b)

Figure 6. Photographs of Gma_8-179 a) in Onslow Bay in August 2007 and b) re-sighted in Hatteras in August 2018.

1.3 Satellite Tag Post-deployment Monitoring

Follow-up monitoring of the health of satellite-tagged animals continues to be an important focus of our photo-ID efforts. Although most re-sightings have been of satellite-tagged short-finned pilot whales and Cuvier's beaked whales, a single Risso's dolphin was re-sighted on the day after it was tagged in 2016 and a single bottlenose dolphin was re-sighted five days after tagging in 2014 (**Table 8**).

To date 79 short-finned pilot whales have been satellite-tagged off Cape Hatteras and 29 of these (37 percent) have been re-sighted (**Table 8**). Most of these re-sightings occurred within the same field season, but 10 (34 percent) have been re-sighted across multiple years after being tagged. GmTag096 was first photographed in May 2008, and was also seen in 2010 and 2012. It was satellite-tagged in September 2014 and re-sighted in May 2017 and again in August 2018, four years after it was satellite-tagged (**Figure 7**). GmTag135 was satellite-tagged in October 2015 and re-sighted three years later in June 2018 and again during our most recent field season in July 2019 (**Figure 8**).

Fifty-eight Cuvier's beaked whales have been satellite-tagged from 2014 through 2019, and 33 (57 percent) have been resighted (**Table 8**). As with the short-finned pilot whales most of the re-sightings occurred within the same field season, but 10 (30 percent) were re-sighted over multiple years after being tagged. The first Cuvier's beaked whale to be satellite-tagged in the Cape Hatteras area, ZcTag029, was initially sighted and tagged in May 2014. It was re-sighted five days later and then seen again four years later in May 2018 (**Figure 9**). Another Cuvier's beaked whale, ZcTag039, was first observed and tagged in June 2015. It was re-sighted over three years later in August 2018 when it was satellite-tagged for a second time (ZcTag077; **Figure 10**). Finally ZcTag055 was satellite-tagged in May 2017 and was re-sighted during the current field season in May 2019 (**Figure 11**).

Photo-ID provides a useful means to document and assess the long-term effects of tagging on individual short-finned pilot whales and Cuvier's beaked whales. In general, there are few instances of long-term damage to the dorsal fin of tagged animals and the vast majority of individuals appear to be well-healed. We intend to conduct a full assessment of the effects of satellite-linked tag deployments on short-finned pilot whales and Cuvier's beaked whales and prepare a manuscript for publication describing these follow-up efforts.

Table 7. Photo-ID sighting histories of cetaceans satellite-tagged and re-sighted in the Cape Hatteras study area. A red X denotes the year when satellite tagging occurred for that individual.

ID	Year												
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
GgTag017										X[m]			
GmTag087								X[y]					
GmTag089								X	X				
GmTag091	X							X	X				
GmTag096		X		X		X[y]		X			X	X	
GmTag097		X				X		X	X				
GmTag122						X			X[m]				
GmTag127									X[m]				
GmTag134^									X			X	
GmTag135^									X[y]			X	X
GmTag136						X			X[y]			X	
GmTag140									X		X		
GmTag157										X	X		
GmTag172											X[m]		
GmTag175						X					X[m]		
GmTag179											X	X	
GmTag182											X[m]		
GmTag197		X						X	X		X	X[y]	
GmTag201												X[y]	
GmTag203												X[y]	
GmTag204									X			X[y]	
GmTag205												X[y]	
GmTag206												X[y]	
GmTag207					X[y]	X	X		X			X[m]	
GmTag208												X[y]	
GmTag216												X[m]	
GmTag218	X[y]	X[m]							X[m]			X[m]	
GmTag223	X[y]												X[m]
GmTag226													X[y]
GmTag227													X[y]
TtTag015								X[m]					
ZcTag029								X[m]				X	
ZcTag039 (ZcTag077)									X			X	

ID	Year												
	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
ZcTag040									X		X	X	
ZcTag046										X		X	
ZcTag047								X[y]		X[y]	X[y]	X[y]	
ZcTag048										X		X	
ZcTag054											X[y]		
ZcTag055											X[y]		X[m]
ZcTag057											X	X	
ZcTag058											X[y]	X[m]	
ZcTag062											X[m]		
ZcTag069												X[y]	
ZcTag073												X[y]	
ZcTag074							X					X[m]	X
ZcTag075												X[m]	
ZcTag076												X[m]	
ZcTag078												X[y]	
ZcTag080												X[m]	
ZcTag081												X[m]	
ZcTag082													X[y]
ZcTag084													X[m]
ZcTag085													X[y]
ZcTag086													X[y]
ZcTag087													X[m]
ZcTag088													X[m]
ZcTag089													X[m]
ZcTag090													X[y]
ZcTag091													X[m]
ZcTag092													X[y]
ZcTag093													X[y]
ZcTag095													X[m]
ZcTag096													X[m]
ZcTag097													X[m]

[1] Ggr= *Grampus griseus* (Risso's dolphin); Gma= *Globicephala macrorhynchus* (short-finned pilot whale); Ttr=*Tursiops truncatus* (bottlenose dolphin); Zca=*Ziphius cavirostris* (Cuvier's beaked whale)

m – re-sighted within same month

y – re-sighted within same year

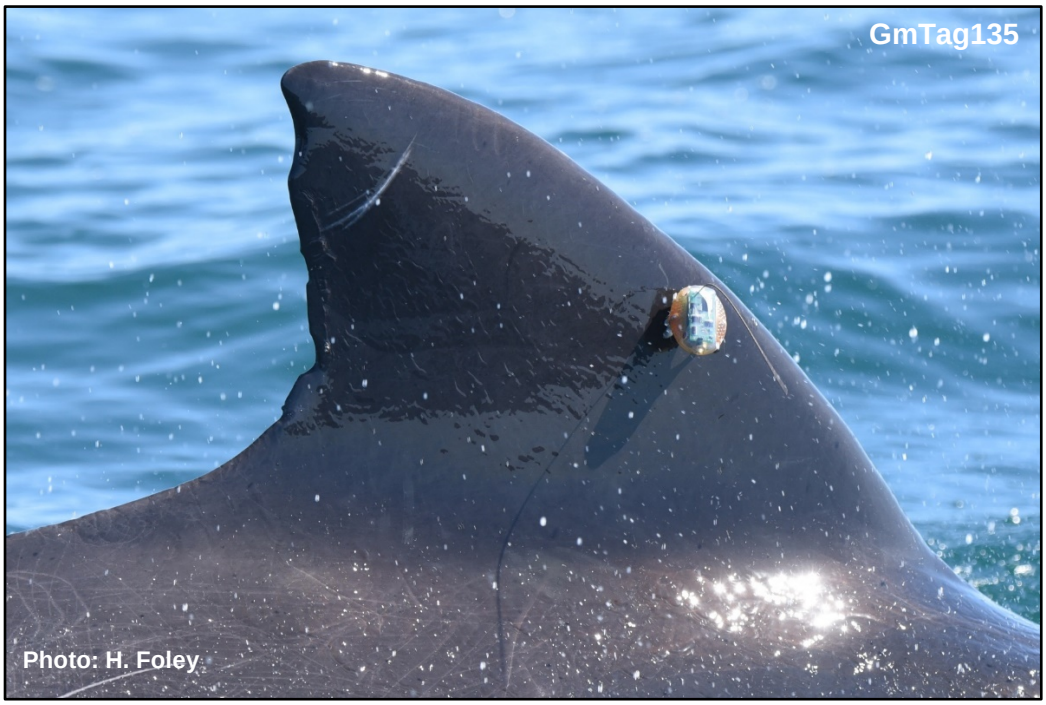
1

a)

b)

Figure 7. Photographs of GmTag096 during a) satellite-tagging in September 2014 and b) re-sight in August 2018.

a)



b)

Figure 8. Photographs of GmTag135 during a) satellite-tagging in October 2015 and b) re-sight in July 2019.

a)

b)

Figure 9. Photographs of ZcTag029 during a) satellite-tagging in May 2014 and b) re-sight in May 2018.

a)

b)

Figure 10. Photographs of ZcTag039 during a) satellite-tagging in June 2015 and b) re-sight and re-tagging in August 2018 (ZcTag077). The arrow indicates the scars from the prior tag.

a)

b)

Figure 6. Photographs of ZcTag055 during a) satellite-tagging in May 2017 and b) re-sight in May 2019.

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