

Photo-Identification Analyses in the Cape Hatteras Study Area

2025

ANNUAL PROGRESS REPORT



PREPARED BY

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Adult male goose-beaked whale (*Ziphius cavirostris*) surfacing off Cape Hatteras, North Carolina. Photographed by Will Cioffi, Duke University, taken under General Authorization Letter of Confirmation 25471 held by Duke University.

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Table of Contents

1. Cape Hatteras Photo-Identification	1
1.1 Goose-Beaked Whales	2
1.2 Short-Finned Pilot Whales	22
1.3 Testing of Computer-Assisted Photo-Identification Matching Programs	26
1.3.1 Preliminary Assessment of the Happywhale Matching Site	27
1.4 Satellite Tag Post-Deployment Monitoring	28
2. References	43

Figures

Figure 1. Photographs of ZcTag151, seen in August 2018 (top), seen in June 2025 (middle), and seen during satellite-tagging (bottom).	13
Figure 2. Photographs of ZcTag161, first seen in July 2021 (top), and seen during satellite-tagging in September 2025 (bottom).	14
Figure 3. Photographs of ZcTag164, first seen in August 2021 (top), and seen during satellite-tagging in September 2025 (bottom).	15
Figure 4. Photograph of the first photographed calf of Zca_067, first seen in August 2018 (top), and photograph of her second calf seen in June 2025 (bottom).	16
Figure 5. Photographs of Zca_102, seen in October 2020 when it was in association with its mother (top), and next seen in June 2025 (bottom) when it was without its mother.	17
Figure 6. Photographs of ZcTag134, seen in August 2022 without erupted tusks (top), and next seen in June 2025 (bottom) with tusks beginning to erupt from the lower jaw.	18
Figure 7. Percent of diatom coverage for each Region of Interest.	19
Figure 8. Tracings of diatom coverage on Zca_026r in August 2021 (top) and 1 month later in September 2021 (bottom).	20
Figure 9. An example of using patterns of diatom coverage to match the right (top) and left (bottom) sides of an animal within the same sighting.	21
Figure 10. Photographs of Gma_1-115, seen in May 2012 (top) and July 2021 (bottom).	25
Figure 11. Screenshot of the graphical user interface on Happywhale for matching dorsal fin images.	27
Figure 12. Photographs of ZcTag074, seen during satellite-tagging in August 2021 (top) and re-sight in July 2025 (bottom).	35
Figure 13. Photographs of ZcTag079, seen during satellite-tagging in August 2018 (top) and re-sight in September 2025 (bottom).	36
Figure 14. Photographs of ZcTag097, seen during satellite-tagging in August 2019 (top) and re-sight in September 2025 (bottom).	37

Figure 15. Photographs of ZcTag120, seen during satellite-tagging in July 2021 (top) and re-sight in July 2025 (bottom).	38
Figure 16. Photographs of ZcTag127, seen during satellite-tagging in September 2021 (top) and re-sight in June 2025 (bottom).....	39
Figure 17. Photographs of ZcTag133, seen during satellite-tagging in August 2022 (top) and re-sight in July 2025 (bottom).	40
Figure 18. Photographs of ZcTag134, seen during satellite-tagging in August 2022 (top) and re-sight in June 2025 (bottom).....	41
Figure 19. Photographs of ZcTag146, seen during satellite-tagging in August 2023 (top) and re-sight in July 2025 (bottom).	42

Tables

Table 1. Cetacean sightings with the numbers of photo-identification images collected for each species within the Cape Hatteras study area during 2025.	1
Table 2. Summary of images collected by species during fieldwork within the Cape Hatteras study area during 2025, with numbers of new identifications, photo-ID catalog sizes, numbers of new re-sights, and total re-sights to date.	2
Table 3. Sighting histories of goose-beaked whales re-sighted over multiple years within the Cape Hatteras study area, 2003–2025.	6
Table 4. Frequency distribution of the number of sightings of photo-identified goose-beaked whales within the Cape Hatteras study area.	11
Table 5. Frequency distribution of the number of years between first and last sightings of re-sighted goose-beaked whales within the Cape Hatteras study area.	11
Table 6. Location and contributor of goose-beaked whale catalogs created; includes number of individuals in each catalog and years when the images were collected.	12
Table 7. Frequency distribution of the number of sightings of photo-identified short-finned pilot whales within the Cape Hatteras study area.....	23
Table 8. Frequency distribution of the number of years between first and last sightings of re-sighted short-finned pilot whales within the Cape Hatteras study area.	23
Table 9. Number of new identifications, re-sights within the Norfolk Canyon catalog, and matches to the Cape Hatteras catalog of short-finned pilot whales made during each field season by HDR Inc. researchers.....	24
Table 10. Location and contributor of short-finned pilot whale catalogs created for other research groups; includes number of individuals in each catalog and years when the images were collected.....	24
Table 11. Photo-ID sighting histories of cetaceans satellite-tagged and re-sighted within the Cape Hatteras study area.....	30



Acronyms and Abbreviations

AFTT	Atlantic Fleet Training and Testing
BRS	Behavioral Response Study
DUML	Duke University Marine Lab
CMARI	Clearwater Marine Aquarium Research Institute
Gg	<i>Grampus griseus</i> (Risso's dolphin)
GIMP	GNU Image Manipulation Program
Gm	<i>Globicephala macrorhynchus</i> (short-finned pilot whale)
GOM	Gulf of Mexico
GUI	graphical user interface
HAT	Cape Hatteras study area
ID	identification/Identifier
JAX	Jacksonville
NEAQ	New England Aquarium
NOAA	National Oceanic and Atmospheric Administration
NOR	Norfolk Canyon
OSB	Onslow Bay
photo-ID	photo-identification
R/V	Research Vessel
ROI	Regions of Interest
SBU	Stony Brook University
SP	Sutherland/Patteson
Tt	<i>Tursiops truncatus</i> (bottlenose dolphin)
UNCW	University of North Carolina Wilmington
U.S.	United States
Zc/Zca	<i>Ziphius cavirostris</i> (goose-beaked whale)



1. Cape Hatteras Photo-Identification

During 2025 fieldwork supporting the Atlantic Behavioral Response Study (BRS [Southall et al. 2026](#)) and other related research, the study team collected more than 12,900 digital images within the Cape Hatteras study area. The team used these images to confirm species, identify individual animals, compile sighting histories, and conduct follow-up monitoring of satellite-tagged animals. The field team took digital photographs 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 6016 × 4016 pixels and saved in .jpg format. The team obtained photographs of six species, but most were from goose-beaked whales (*Ziphius cavirostris*), the focal species of the Atlantic BRS (**Table 1**).

Table 1. Cetacean sightings with the numbers of photo-identification images collected for each species within the Cape Hatteras study area during 2025.

Species	Common Name	Number of Sightings	Number of Photo-ID Images
<i>Globicephala macrorhynchus</i>	Short-finned pilot whale	33	2,012
<i>Grampus griseus</i>	Risso's dolphin	2	105
<i>Physeter macrocephalus</i>	Sperm whale	1	146
<i>Stenella frontalis</i>	Atlantic spotted dolphin	3	657
<i>Stenella</i> species	Spotted dolphin species	1	0
<i>Tursiops truncatus</i>	Common bottlenose dolphin	32	1,372
Unidentified delphinid	Unidentified delphinid	1	0
<i>Ziphius cavirostris</i>	Goose-beaked whale	59	8,705
Total	—	132	12,997

Key: photo-ID = photo-identification

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

During the 2025 reporting period, the team added images of 38 newly identified animals to photo-ID catalogs of short-finned pilot whales (*Globicephala macrorhynchus*), Risso's dolphins (*Grampus griseus*), sperm whales (*Physeter macrocephalus*), Atlantic spotted dolphins (*Stenella frontalis*), and goose-beaked whales (**Table 2**). Twenty-one new photo-ID re-sights were made within the short-finned pilot whale and goose-beaked whale catalogs.

Table 2. Summary of images collected by species during fieldwork within the Cape Hatteras study area during 2025, with numbers of new identifications, photo-ID catalog sizes, numbers of new re-sights, and total re-sights to date.

Species	New Images Collected	New IDs	Catalog Size	New Re-sights	Re-sights to Date
<i>Balaenoptera brydei</i>	0	0	0	0	0
<i>Balaenoptera physalus</i>	0	0	2	0	0
<i>Delphinus delphis</i>	0	0	46	0	1
<i>Globicephala macrorhynchus</i>	2,012	17	1,393	8	488
<i>Grampus griseus</i>	105	3	57	0	6
<i>Kogia</i> species	0	0	1	0	0
<i>Megaptera novaeangliae</i>	0	0	4	0	0
<i>Mesoplodon</i> species	0	0	10	0	2
<i>Physeter macrocephalus</i>	146	1	33	0	3
<i>Stenella clymene</i>	0	0	3	0	0
<i>Stenella frontalis</i>	657	4	46	0	0
<i>Tursiops truncatus</i>	1,372	0	376	0	20
<i>Ziphius cavirostris</i>	8,705	11	360	13	161
Total	12,997	38	2,331	21	681

Note: ID = Identification

To date, the team has created photo-ID catalogs for 13 taxa within the Cape Hatteras study area, across multiple United States (U.S.) Navy Atlantic Fleet Training and Testing (AFTT) monitoring projects. These catalogs include more than 2,330 distinct individuals, with 681 individuals re-sighted across all species (**Table 2**).

Ms. Waples also compared the DUML photo-ID catalogs to images of stranded cetaceans along the North Carolina coast. During 2025, she searched for potential matches of two humpback whales (*Megaptera novaeangliae*), which stranded on the North Carolina coast and were submitted by Marina Doshkov, the Marine Mammal Stranding Coordinator at Jennette’s Pier Aquarium, Nags Head, North Carolina. She also compared images of an Atlantic spotted dolphin submitted by Dr. Vicky Thayer, the North Carolina Marine Mammal Stranding Coordinator. No matches were made to either of these catalogs.

1.1 Goose-Beaked Whales

The study team added 11 new identifications to DUML’s goose-beaked whale photo-ID catalog during 2025. Another 13 whales were re-sighted for the first time. The current re-sighting rate for goose-beaked whales within the Cape Hatteras area is 44 percent. To date, 117 of 161 (72 percent) re-sighted goose-beaked whales have been documented in multiple years, and 72 have been re-sighted more than 3 years after their initial sighting (**Table 3**; tables and figures are provided at the end of this subsection). Kim Urian used the Happywhale program (described in detail in **Section 1.3.1**) to look for internal matches in the DUML goose-beaked whale catalog; the program identified 11 internal matches that were confirmed and resolved by Ms. Urian and Ms. Waples.

The goose-beaked whale sighted most frequently was Zca_049, which was photographed on 13 occasions from 2018 to 2023 and satellite-tagged in 2021 (ZcTag114; **Table 4**). The goose-beaked whale with the longest interval between re-sightings was Zca_002, with a re-sighting interval of 12 years (**Table 5**). Zca_002, an adult male, was first photographed in October 2013 and satellite-tagged in August 2018. This whale was seen multiple times during the 2018 and 2019 field seasons but was not re-sighted until July 2025.

Fourteen goose-beaked whales were satellite-tagged during the 2025 field season; three of these whales were previously sighted. ZcTag151 was first seen in June 2017 and sighted multiple times during the 2018 field season. It was not seen again until 7 years later, when it was satellite-tagged in June 2025 (**Figure 1**). At the time of tagging in 2025, ZcTag151 was accompanied by a calf; it had not been seen with a calf in previous years. ZcTag161 was first photographed in June 2021, when it was identified as an adult male. It was satellite-tagged 4 years later in September 2025 (**Figure 2**). ZcTag164 was first seen in August 2021 and also tagged 4 years later in September 2025 (**Figure 3**). Note the scars on the whale's back anterior to the dorsal fin; these are likely not caused by conspecifics but may be evidence of a shark predation attempt.

The photographic histories of individual whales continue to be used to support studies of the demographics of *Ziphius* within the Cape Hatteras study area. There is particular interest in estimating calving intervals of individual females and the survival of calves in the post-dependency period; a sufficient number of images of distinctive calves is beginning to make this analysis feasible. Photographs from the 2025 field season have provided interesting insights into the demography of this population. Zca_067 was first photographed in August 2018; at that time, she was accompanied by a calf with a distinctive dorsal fin (Zca_068; **Figure 4**). She was re-sighted in June 2022; at that time, she did not have a calf with her. She was seen a third time in June 2025 with a new calf that was also distinctive (**Figure 4**). These re-sights provide first insights into the birth interval of goose-beaked whales off Cape Hatteras.

Zca_102 was first seen as a calf with its mother in August and October 2020. It is a very distinctive whale, perhaps from a past predation attempt by a shark (**Figure 5**). It was photographed in a sighting without its mother in June 2025 (**Figure 5**). This is the first time the study team documented a calf successfully weaning from its mother and remaining in the population.

ZcTag134 was satellite-tagged in August 2022; photographs of the head taken at that time confirm that it had no erupted tusks (**Figure 6**). It was next re-sighted in June 2025. Photographs of the head show a pair of tusks erupting from the lower jaw (**Figure 6**). This is the first time the study team observed a goose-beaked whale maturing from a sub-adult into an adult.

Ms. Waples is continuing to compare images of goose-beaked whales off Cape Hatteras to five other catalogs created from images contributed by: (1) the University of North Carolina Wilmington (UNCW) aerial survey team; (2) pelagic seabird trips conducted by Kate Sutherland and Brian Patteson aboard the *Stormy Petrel* off Cape Hatteras; (3) HDR Inc. researchers near Norfolk Canyon; (4) aerial surveys by the New England Aquarium at the Northeast Canyons and Seamounts Marine National Monument in 2017 and 2023; and (5) Lesley Thorne and Joshua

Meza-Fidalgo at Stony Brook University (SBU) in 2019 during boat-based surveys along the shelf break off New York (**Table 6**). Ms. Waples continues to maintain these goose-beaked whale catalogs for the Northwest Atlantic. During this reporting period Ms. Sutherland contributed additional images taken during seabirding trips off Oregon Inlet, North Carolina in 2023. Ms. Waples curated these images and added five new *Ziphius* identifications to the Sutherland/Patteson catalog. Additionally, she made one photo-ID match between the Sutherland/Patteson and DUML catalogs. Zca_118 was photographed by Duke researchers in July 2021 and was re-sighted by Ms. Sutherland and Mr. Patteson in August 2023. To date, 10 inter-catalog matches have been made among the goose-beaked whale catalogs.

During 2025, Ms. Waples developed a sixth external goose-beaked whale catalog from aerial images collected by research staff at the Clearwater Marine Aquarium Research Institute (CMARI), who conducted aerial surveys during the North Atlantic right whale (*Eubalaena glacialis*) season. The North Carolina aerial survey team, supporting the U.S. Army Corp of Engineers, flew from the Virginia-North Carolina border to the North Carolina-South Carolina border, up to 40 nautical miles offshore, between mid-November and mid-April. These are valuable images because the CMARI team works during winter months, when the DUML team has little or no offshore effort, and the CMARI surveys cover an extensive geographic area.

Melanie White at CMARI provided 425 images of beaked whales photographed during aerial surveys conducted from 2022 through 2025. Ms. Waples graded all images for photographic quality and animal distinctiveness and created a CMARI catalog for goose-beaked whales and a separate catalog for Gervais's beaked whales (*Mesoplodon europaeus*). The CMARI goose-beaked whale catalog contains six individuals, and the Gervais's beaked whale catalog has two individuals. Ms. Waples compared the CMARI goose-beaked catalog to the DUML catalog and made two potential matches between these two catalogs. An independent researcher at DUML (Dr. Will Cioffi) confirmed the matches, but we are awaiting final confirmation of the matches by Melanie White.

During summer 2025, Madison Eastburn, an undergraduate student at the University of North Carolina at Chapel Hill, examined the potential to use diatom coverage on individual goose-beaked whales as a tool for photo-ID. Specifically, she wanted to determine whether patterns of diatom coverage on an individual whale remain constant over seasons and/or years. If this is the case, then diatom coverage could be used to identify re-sightings of otherwise non-distinct whales, such as sub-adults and females, which possess few rake marks.

Ms. Eastburn used the DUML goose-beaked whale photo-ID catalog and selected individual whales with seasonal and inter-annual re-sights. She used methods developed by Coomber et al. (2016) to divide the body of each photographed whale into equal Regions of Interest (ROIs) based on the length of the dorsal fin. She then used GIMP Photo Editor software to trace all areas of each ROI with diatom coverage and calculated the percent of diatom cover within each ROI.

Ms. Eastburn found that the highest percentage of diatom coverage occurred posterior to the dorsal and along the peduncle, with an average coverage of 62 percent. The dorsal fins had the least amount of diatom coverage, with an average coverage of 3 percent (**Figure 7**). She also found that there were no seasonal patterns in diatom coverage, and diatom coverage for an

individual whale is extremely variable over time (**Figure 8**). Therefore, patterns of diatom coverage are useful to identify individual whales only over very short periods, such as 1 or 2 weeks. Diatom coverage will still be useful to confirm photo-ID matches that are primarily based on other features such as dorsal fin notches and rake marks. Patterns of diatom coverage are also helpful when matching the right and left sides of a whale within a sighting; this is particularly useful when trying to match animals that are otherwise indistinct (**Figure 9**).

Table 3. Sighting histories of goose-beaked whales re-sighted over multiple years within the Cape Hatteras study area, 2003–2025.

ID ^a	Year ^b															
	2003–2004	2010	2011	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Zca_001r	—	—	—	X	—	X	—	—	—	—	—	—	—	—	—	—
Zca_002 (ZcTag074)	—	—	—	X	—	—	—	—	X ^m	X ^m	—	—	—	—	—	X
Zc_003 (ZcTag124)	—	—	—	—	X	—	—	—	X	—	—	X ^y	—	—	—	—
Zca_003r (ZcTag029)	—	—	—	—	X ^m	—	—	—	X	—	—	—	—	—	—	—
Zca_005	—	—	—	—	X	X	—	X	—	—	—	X	—	—	—	—
Zca_006 (ZcTag040)	—	—	—	—	X	X	—	X	X	—	X	—	—	—	—	—
Zca_008r (ZcTag047)	—	—	—	—	X ^y	—	X ^m	X ^y	X ^y	—	—	—	—	—	—	—
Zca_011r (ZcTag070)	—	—	X	—	—	—	—	—	X ^m	—	—	—	—	—	—	—
Zca_015 (ZcTag039, ZcTag077)	—	—	—	—	—	X	—	—	X	—	—	—	—	—	—	—
Zca_016 (UNCW M-003)	—	—	—	—	X	X	—	—	—	X	X	—	X	X	—	—
Zca_017	—	—	—	—	—	X	—	—	—	—	—	—	X	—	—	—
Zca_019 (ZcTag043)	—	—	—	—	X	X	—	—	—	—	—	—	—	—	—	—
Zca_020	—	—	—	—	—	X	—	—	—	X	—	X	—	—	—	X
Zca_022	—	—	—	—	—	X	—	—	—	—	X	X	—	—	—	—
Zca_023r	—	—	—	—	—	X	—	—	—	X ^y	—	—	—	—	—	—
Zca_024 (ZcTag046, ZcTag103)	—	—	—	—	—	—	X	X	—	—	X ^m	—	—	—	X	—
Zca_026	—	—	—	—	—	—	X	—	—	—	—	X ^y	—	—	—	—
Zca_027r (ZcTag129)	—	—	—	—	—	X	—	—	X	—	X	X	X	—	—	—
Zca_028 (ZcTag051)	—	—	—	—	—	—	X	—	—	—	—	X ^m	—	—	—	—
Zca_030 (ZcTag055)	—	—	—	—	—	—	—	X ^y	—	X ^m	X	—	—	—	—	—
Zca_031 (ZcTag056)	—	—	—	—	—	—	—	X	—	X	X ^y	X ^y	—	X ^m	—	—
Zca_032	—	—	—	—	—	—	—	X	X ^m	—	—	—	—	—	—	—
Zca_033	—	—	—	—	—	—	—	X	—	—	X	—	—	X	—	—

ID ^a	Year ^b															
	2003–2004	2010	2011	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Zca_033r (ZcTag049, ZcTag099)	—	—	—	—	—	—	X	X ^y	—	X	X ^y	—	—	—	—	—
Zca_034 (ZcTag126)	—	—	—	—	—	—	—	X	—	—	—	X ^m	—	—	—	—
Zca_035 (ZcTag076)	—	—	—	—	—	—	—	X	X ^y	—	X	X	—	—	—	—
Zca_035r (ZcTag048)	—	—	—	—	—	—	X	—	X	—	—	—	—	—	—	—
Zca_036	—	—	—	—	—	—	—	X	—	—	—	X ^y	—	—	—	—
Zca_037 (ZcTag068)	—	—	—	—	—	—	—	X ^y	—	—	X	—	—	—	—	—
Zca_038	—	—	—	—	—	—	—	X	X	—	—	X	—	—	—	X
Zca_039	—	—	—	—	—	X	—	X	X	—	—	—	X ^y	—	—	—
Zca_040	—	—	—	—	—	—	—	X ^y	—	X	—	—	—	—	—	—
Zca_043	—	—	—	—	—	—	—	X	—	—	X	—	—	—	—	—
Zca_044r	—	—	—	—	—	—	X	—	X ^m	—	X	—	—	—	—	—
Zca_046r	—	—	—	—	—	—	X	—	—	—	X	—	—	—	—	—
Zca_048	—	—	—	—	—	—	—	X	—	X ^m	—	—	—	—	—	—
Zca_049 (ZcTag114)	—	—	—	—	—	—	—	—	X	—	—	X ^y	X	X ^y	—	—
Zca_050 (ZcTag078)	—	—	—	—	—	—	—	—	X ^y	—	—	X	—	—	—	—
Zca_050r (ZcTag057)	—	—	—	—	—	—	—	X	X	—	—	—	—	—	—	—
Zca_051r (ZcTag058)	—	—	—	—	—	—	—	X ^y	X ^m	—	—	—	—	—	—	—
Zca_052 (ZcTag084)	—	—	—	—	—	—	—	—	X	X ^m	X ^m	—	—	X	X	—
Zca_052r	—	—	—	—	—	—	—	X	—	—	—	X	—	—	—	—
Zca_054 (ZcTag080)	—	—	—	—	—	—	—	—	X ^m	—	—	X	—	—	—	—
Zca_055 (ZcTag071)	—	—	—	—	—	—	—	—	X	—	X ^m	—	—	—	—	—
Zca_056 (ZcTag072)	—	—	—	—	—	—	—	—	X	—	X ^m	X	—	X	X	—
Zca_056r	—	—	—	—	—	—	—	—	X ^m	—	—	X ^y	—	—	—	—
Zca_057 (ZcTag079)	—	—	—	—	—	—	—	—	X	—	—	—	X	—	—	X
Zca_058	—	—	—	—	—	—	—	—	X	X	—	—	—	—	—	—
Zca_059	—	—	—	—	—	—	—	—	X ^y	—	—	X	—	X	—	—

ID ^a	Year ^b															
	2003–2004	2010	2011	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Zca_059r	—	—	—	—	—	—	—	X	X ^y	—	—	—	—	—	—	X ^y
Zca_061	—	—	—	—	—	—	—	—	X	X	—	X	—	—	—	—
Zca_063 (ZcTag098)	—	—	—	—	—	—	—	—	X ^m	—	X ^y	—	—	—	—	—
Zca_065	—	—	—	—	—	—	—	—	X	X	—	X	X	—	—	—
Zca_066	—	—	—	—	—	—	—	—	X ^m	—	—	X ^m	—	—	—	—
Zca_067	—	—	—	—	—	—	—	—	X	—	—	—	X	—	—	X
Zca_067r (ZcTag060)	—	—	—	—	—	—	—	X	—	—	X	X	—	—	—	—
Zca_068r	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—
Zca_071	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—
Zca_071r (ZcTag081)	—	—	—	—	—	—	—	X	X ^m	—	—	—	—	X	—	—
Zca_072	—	—	—	—	—	—	—	—	—	X	—	X	—	X	—	X
Zca_074r	—	—	—	—	—	—	—	X	X	—	—	X ^y	—	X	—	—
Zca_075	—	—	—	—	—	—	—	—	—	X	X ^m	—	—	—	—	—
Zca_076	—	—	—	—	—	—	—	—	—	X ^y	X ^y	—	—	—	—	—
Zca_077	—	—	—	—	—	—	—	—	—	X	—	X ^m	—	—	—	—
Zca_077r (ZcTag085)	—	—	—	—	—	—	—	—	X	X	—	—	—	—	—	—
Zca_078 (ZcTag089, ZcTag109)	—	—	—	—	—	—	—	—	—	X	X	—	—	—	—	—
Zca_079	—	—	—	—	—	—	—	—	—	X	—	—	—	X	—	—
Zca_080	—	—	—	—	—	—	—	—	—	X	—	X	—	—	—	—
Zca_080r	—	—	—	—	—	—	—	—	X	—	—	—	—	X ^y	—	—
Zca_082r	—	—	—	—	—	—	—	—	X ^y	X	—	X	—	—	—	—
Zca_083	—	—	—	—	—	—	—	—	—	X	X	—	X	—	—	—
Zca_086 (ZcTag091)	—	—	—	—	—	—	—	X	—	X ^m	—	X ^y	—	—	—	—
Zca_090	—	—	—	—	—	—	—	—	—	X	—	X	—	—	—	—
Zca_091 (ZcTag095)	—	—	—	—	—	—	—	—	—	X ^m	X	—	—	—	—	—

ID ^a	Year ^b															
	2003–2004	2010	2011	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Zca_092 (ZcTag096, ZcTag112)	—	—	—	—	—	—	—	—	—	X ^m	—	X	—	X	—	—
Zca_096r	—	—	—	—	—	—	—	—	X ^m	—	—	X	—	—	—	—
Zca_097r	—	—	—	—	—	—	—	X	X ^m	—	X ^y	—	—	—	—	X
Zca_099	—	—	—	—	—	—	—	—	—	—	X	X ^m	—	—	X	—
Zca_099r (ZcTag083)	—	—	—	—	—	—	—	—	X ^m	X	—	—	—	—	—	—
Zca_102	—	—	—	—	—	—	—	—	—	—	X ^y	—	—	—	—	X
Zca_106	—	—	—	—	—	—	—	—	—	—	X	—	—	X	—	X ^y
Zca_106r (ZcTag111)	—	—	—	—	—	—	—	—	X	—	X ^m	X	—	—	—	—
Zca_108r (ZcTag106)	—	—	—	—	—	—	—	—	X	—	X ^y	X	X	—	—	—
Zca_112r	—	—	—	—	—	—	—	—	X	—	X ^y	X	X	—	—	—
Zca_113	—	—	—	—	—	—	—	—	—	—	X	X	—	—	—	—
Zca_120	—	—	—	—	—	—	—	—	—	—	—	X	X	—	—	—
Zca_124	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	X
Zca_125r	—	—	—	—	—	—	—	—	—	X	—	X	—	—	—	—
Zca_128 (ZcTag122)	—	—	—	—	—	—	—	—	—	—	—	X ^y	X	—	—	—
Zca_134	—	—	—	—	—	—	—	—	—	—	—	X	X ^m	—	—	—
Zca_134r	—	—	—	—	—	—	—	—	—	X	—	X ^y	—	—	—	—
Zca_136	—	—	—	—	—	—	—	—	—	—	—	X	—	X	—	—
Zca_139	—	—	—	—	—	—	—	—	—	—	—	X	—	X	—	—
Zca_140r	—	—	—	—	—	—	—	—	—	X	—	X	—	—	—	—
Zca_142r	—	—	—	—	—	—	—	—	—	X	—	X	—	—	—	—
Zca_144	—	—	—	—	—	—	—	—	X	—	—	X	—	—	—	—
Zca_145	—	—	—	—	—	—	—	—	—	—	—	X	X	—	—	—
Zca_145r	—	—	—	—	—	—	—	—	—	X	—	X	—	—	—	—
Zca_146r (ZcTag101)	—	—	—	—	—	—	—	—	—	X	X ^m	X	—	—	—	—

ID ^a	Year ^b															
	2003–2004	2010	2011	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Zca_155r (ZcTag097)	—	—	—	—	—	—	—	—	—	X ^m	—	—	—	—	—	X
Zca_157r	—	—	—	—	—	—	—	—	—	X	X	X ^y	—	—	—	—
Zca_162r (ZcTag104)	—	—	—	—	—	—	—	—	—	—	X ^m	X	—	—	—	—
Zca_166r (ZcTag110)	—	—	—	—	—	—	—	—	—	—	X ^m	X	—	—	—	—
Zca_167r	—	—	—	—	—	—	—	—	—	—	X	X ^m	—	—	—	—
Zca_173r	—	—	—	—	—	—	—	—	—	—	X	X	—	—	—	—
Zca_182r	—	—	—	—	—	—	—	—	—	—	X ^y	X	—	—	—	—
Zca_185r (ZcTag116)	—	—	—	—	—	—	—	—	—	—	X	X ^y	—	—	—	—
Zca_198r	—	—	—	—	—	—	—	—	—	—	—	X ^y	X	—	X	—
Zca_200r	—	—	—	—	—	—	—	—	—	—	—	X ^y	—	—	—	X
Zca_225r (ZcTag164)	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	X ^m
ZcTag133	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	X
ZcTag134	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	X
UNCW M-004	—	—	—	X	—	—	—	X	—	—	—	—	—	—	—	—
SP M-001 Zca_098 (ZcTag102, ZcTag 143)	—	—	—	—	—	—	—	—	X	—	X ^m	X ^m	—	X	—	—
SP M-002 (ZcTag127)	—	—	—	—	—	—	—	—	X	—	—	X	—	—	—	—
SP M-003 (ZcTag090)	X	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—
SP M-004 (ZcTag108)	—	X	—	—	—	—	—	—	—	—	X ^m	—	—	—	—	—
SP M-005	—	—	—	—	—	—	—	—	—	X	—	X	—	X	—	—
SP M-006 (ZcTag054)	X	—	—	—	—	—	—	X ^y	X	—	—	X ^y	—	X ^m	—	—
SP M-007	—	—	—	—	—	—	—	—	—	—	—	X	—	X	—	—
HDR M-001	—	—	—	—	—	—	—	—	—	—	X	—	X	—	—	—

^a ID = Identification; Zca = *Ziphius cavirostris*; UNCW M = aerial-vessel matches to UNCW catalog; SP M = matches made to the Sutherland/Patteson catalog from seabirding trips south of Cape Point; HDR M = matches made to HDR Inc. catalog from vessel research trips offshore Norfolk, Virginia; r = goose-beaked whales that are identified by scarring patterns (rake marks).

^b X = sighted; X^m = re-sighted within same month; X^y = re-sighted within same year

Table 4. Frequency distribution of the number of sightings of photo-identified goose-beaked whales within the Cape Hatteras study area.

Number of Sightings	Number of Individuals
1	200
2	58
3	35
4	24
5	14
6	14
7	7
8	2
9	2
10	2
11	0
12	1
13	1
Total	360

Table 5. Frequency distribution of the number of years between first and last sightings of re-sighted goose-beaked whales within the Cape Hatteras study area.

Number of Years Between First and Last Sighting	Number of Individuals
Less than 1	44
1 to 2	24
2 to 3	21
3 to 4	18
4 to 5	18
5 to 6	12
6 to 7	11
7 to 8	6
8 to 9	4
More than 10	3
Total	161

Table 6. Location and contributor of goose-beaked whale catalogs; includes number of individuals in each catalog and years when the images were collected.

Catalog Descriptor^a	Research Location	Contributor(s)	Years Images Collected	Number of Individuals
SP catalog	South of Cape Point, North Carolina	Kate Sutherland/ Brian Patteson	2003–2023	21
DUML catalog	Cape Hatteras, North Carolina	Andy Read	2007–2025	360
UNCW catalog	Cape Hatteras, North Carolina Aerial Surveys	Bill McLellan	2012–2017	51
NEAQ catalog	Northeast Canyons and Seamounts Marine National Monument Aerial Surveys	Orla O'Brien	2017–2023	7
HDR catalog	Norfolk, Virginia	Jessica Aschettino	2019–2022	3
SBU catalog	New York Shelf Break, New York	Lesley Thorne/ Josh Meza-Fidalgo	2019	4
CMARI catalog	North Carolina aerial surveys	Melanie White	2022–2025	6

^a SP catalog = Sutherland/Patteson catalog from seabird trips south of Cape Point; DUML catalog = DUML catalog from research trips off Cape Hatteras; UNCW catalog = UNCW catalog made from aerial surveys; NEAQ catalog = New England Aquarium Northeast Canyons and Seamounts Marine National Monument catalog from aerial surveys; HDR catalog = HDR Inc. catalog from research trips offshore Norfolk, Virginia; SBU catalog = SBU catalog from research trips off the New York shelf break. CMARI = CMARI catalog from North Carolina aerial surveys



Photo credits: E. Heywood and W. Cioffi.

Figure 1. Photographs of ZcTag151, seen in August 2018 (top), in June 2025 (middle), and during satellite-tagging in June 2025 (bottom).



Photo credits: A. Read and N. Kayne

Figure 2. Photographs of ZcTag161, first seen in July 2021 (top), and seen during satellite-tagging in September 2025 (bottom).

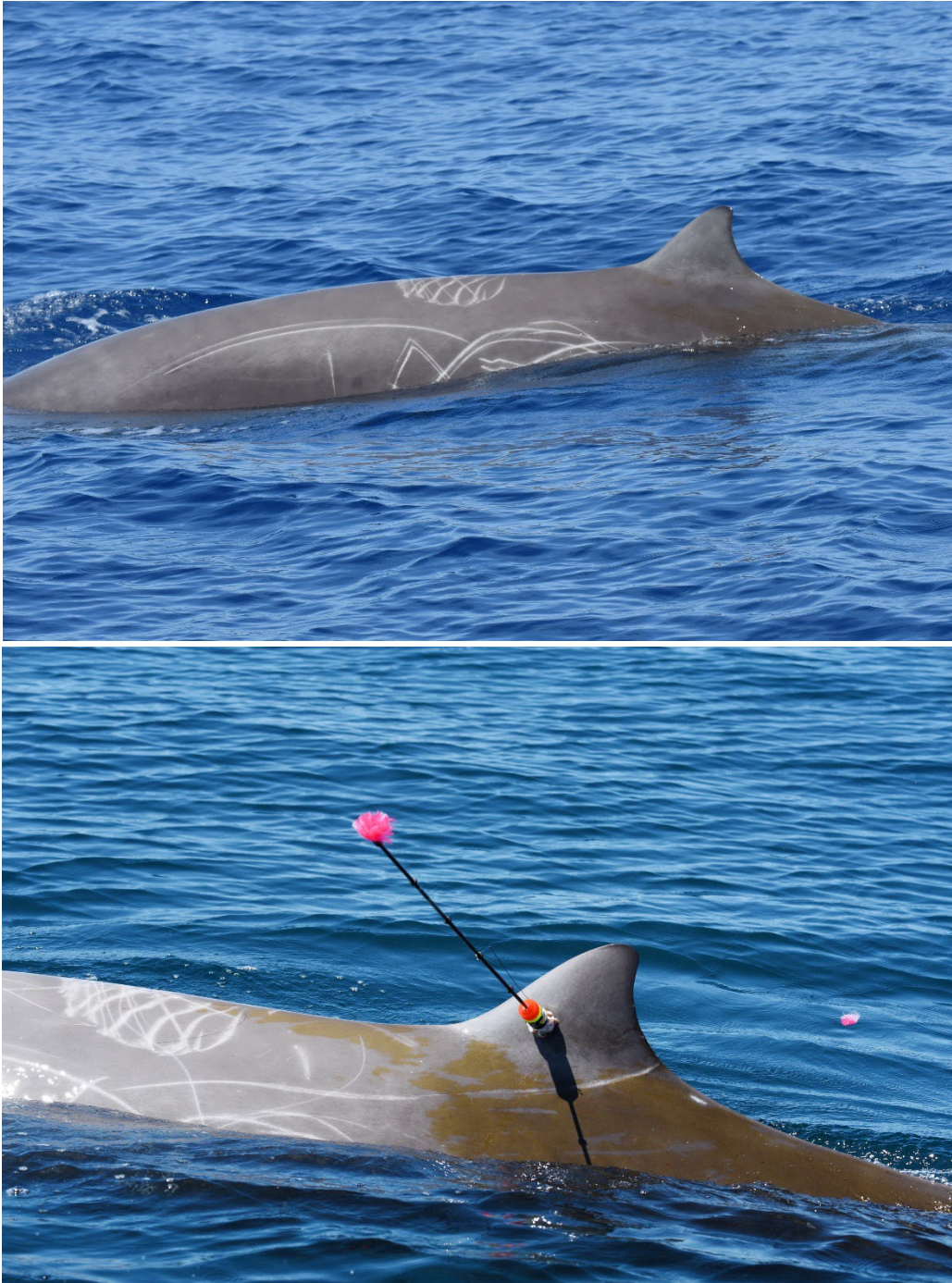


Photo credits: H. Foley and V. Panigada.

Figure 3. Photographs of ZcTag164, first seen in August 2021 (top), and seen during satellite-tagging in September 2025 (bottom).



Photo credits: D. Waples and W. Cioffi.

Figure 4. Photograph of the first photographed calf of Zca_067, first seen in August 2018 (top), and photograph of her second calf seen in June 2025 (bottom).



Photo credits: W. Cioffi.

Figure 5. Photographs of Zca_102, seen in October 2020 when it was in association with its mother (top), and next seen in June 2025 (bottom) when it was without its mother.



Photo credits: D. Webster and W. Cioffi.

Figure 6. Photographs of ZcTag134, seen in August 2022 without erupted tusks (top), and next seen in June 2025 (bottom) with tusks beginning to erupt from the lower jaw.

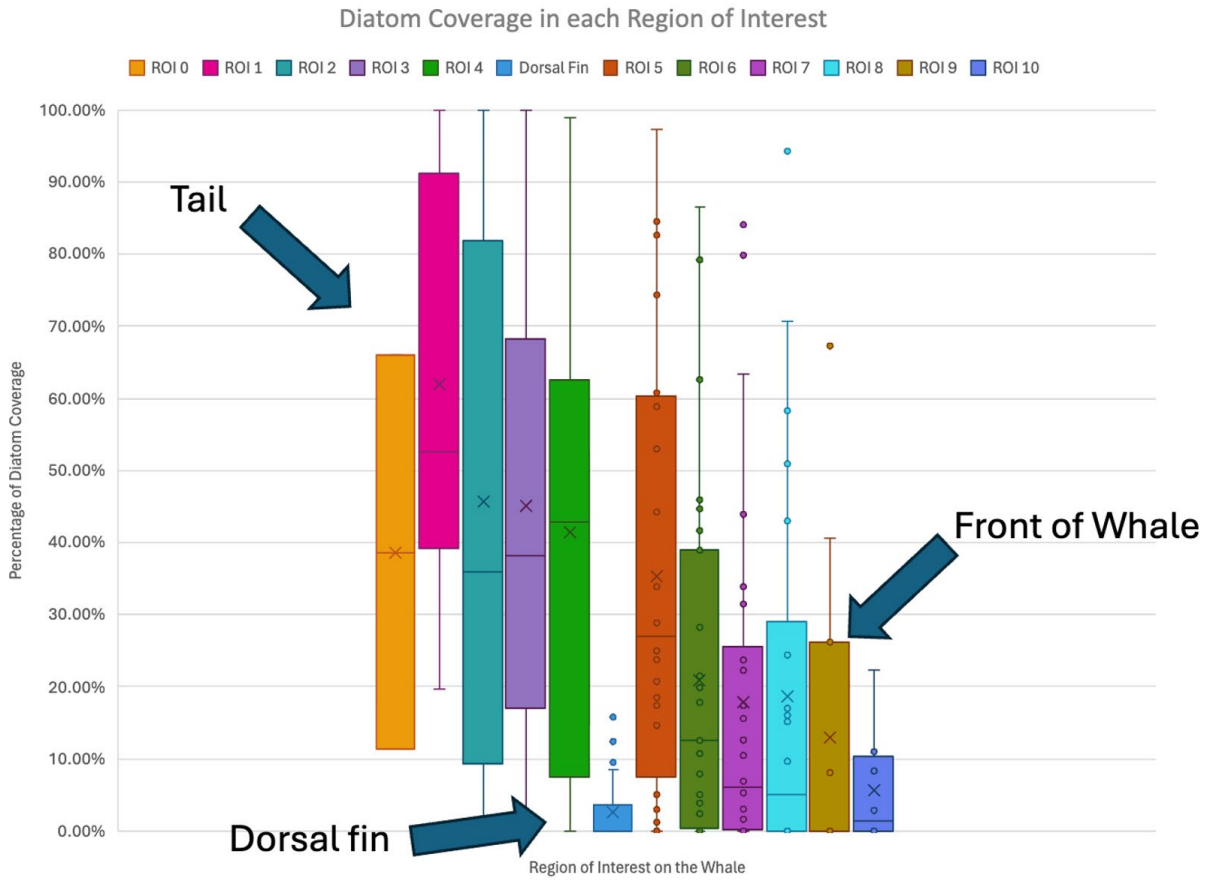


Figure courtesy of Madison Eastburn.

Figure 7. Percent of diatom coverage for each Region of Interest.

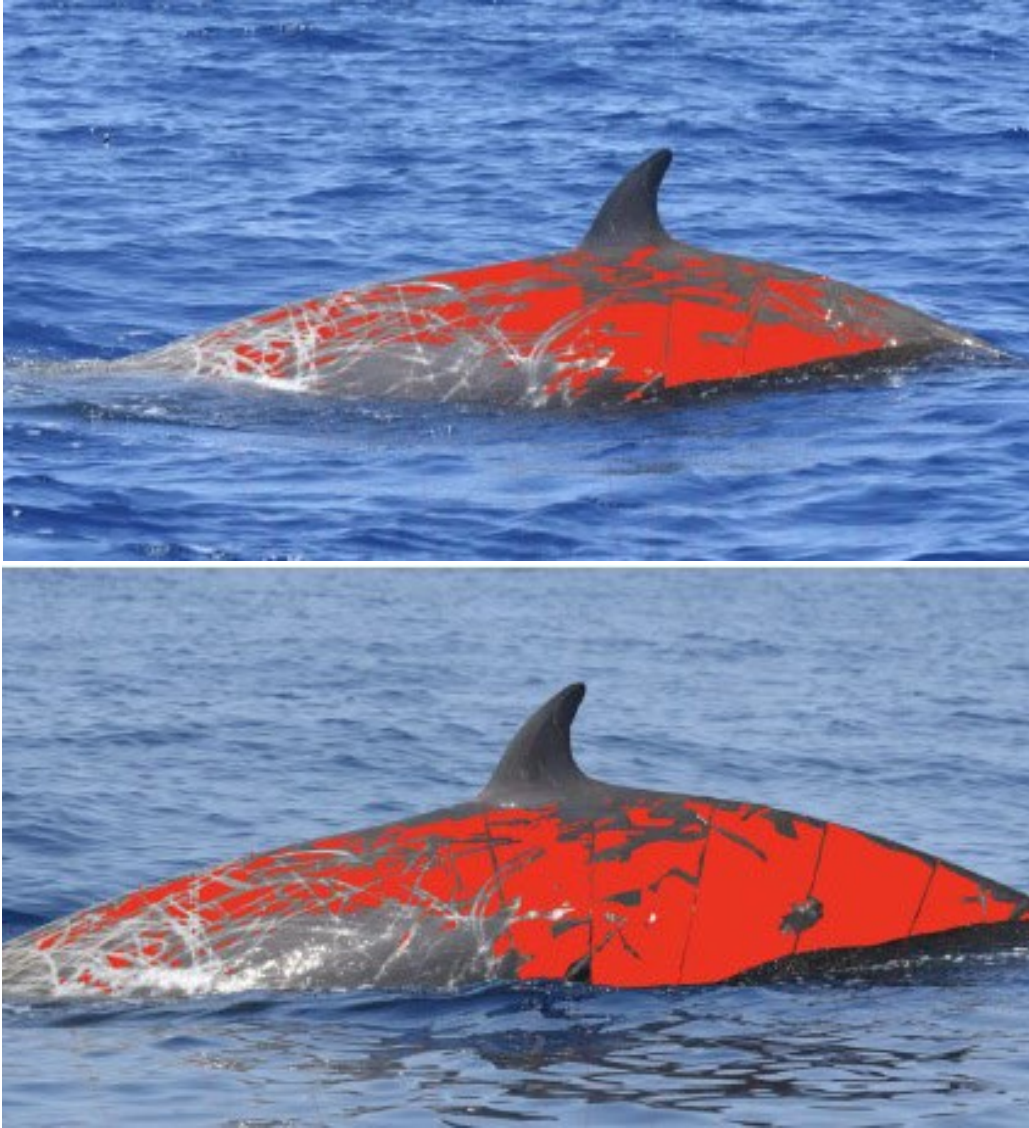


Photo Credits: A. Harshbarger. Figures courtesy of Madison Eastburn.

Figure 8. Tracings of diatom coverage on Zca_026r in August 2021 (top) and 1 month later in September 2021 (bottom).



Photo credits: D. Waples.

Figure 9. An example of using patterns of diatom coverage to match the right (top) and left (bottom) sides of an animal within the same sighting.

1.2 Short-Finned Pilot Whales

The study team added 17 new identifications to the short-finned pilot whale catalog during 2025 and re-sighted 8 individuals for the first time since their initial sightings. The current re-sighting rate of this species is 35 percent, unchanged from 2024. More than 200 short-finned pilot whales have been photographed on 3 or more occasions, and 24 animals have been re-sighted more than 6 times (**Table 7**; tables and figures are provided at the end of this subsection).

Short-finned pilot whales return to the Cape Hatteras study area over extended periods. More than 130 pilot whales have spans of at least 5 years between their first and last sightings, and 30 pilot whales have records that span a decade or more (**Table 8**). These long-term photo-ID records demonstrate that short-finned pilot whales exhibit strong, but intermittent, site fidelity to the Cape Hatteras area.

Ms. Waples will complete a systematic comparison of the 17 newly identified short-finned pilot whales added to the Cape Hatteras photo-ID catalog in 2025 to catalogs for this species from Onslow Bay, North Carolina, and Jacksonville, Florida. Ms. Waples has previously matched four pilot whales between the Cape Hatteras and Onslow Bay study areas. These four photo-ID matches are the only short-finned pilot whale matches documented between the Cape Hatteras and Onslow Bay catalogs. To date, no matches have been made between the Cape Hatteras and Jacksonville catalogs.

Jessica Aschettino provided images of short-finned pilot whales collected by HDR Inc. researchers during their 2025 field work within the Norfolk Canyon area. Approximately 3,000 images were graded for photographic quality and animal distinctiveness, and all images of sufficient quality and distinctiveness were then sorted by individual within each sighting. The best image for each individual was then compared to the existing Norfolk photo-ID catalog. A total of 20 new individuals were added to the Norfolk short-finned pilot whale catalog; this catalog currently contains 344 individuals (**Table 9**). No new re-sightings of pilot whales within the Norfolk catalog occurred.

Ms. Urian compared the 20 new individuals in the Norfolk short-finned pilot whale catalog to the Cape Hatteras short-finned pilot whale catalog, which contains 1,393 individuals. Ms. Urian used Happywhale to make these comparisons (see **Section 1.3.1**). No new matches were made between the catalogs; currently 47 matches exist between the Norfolk and Cape Hatteras catalogs. Ms. Waples plans to compare the new Norfolk pilot whale IDs to the short-finned pilot whale catalogs from Onslow Bay, North Carolina; Jacksonville, Florida; and SBU, New York, during the coming months.

As with the goose-beaked whale catalog, Ms. Urian used the Happywhale program to look for internal matches within the DUML short-finned pilot whale catalog; the program identified 12 internal matches that were confirmed and resolved by Ms. Urian and Ms. Waples. Interestingly, Happywhale identified potential internal matches between several short-finned pilot whales whose dorsal fin had changed over the intervening years between re-sights. Gma_1-115 was first photographed in May 2012 and re-sighted 9 years later in July 2021 missing a top portion of its dorsal fin (**Figure 10**).

Currently, Ms. Waples has created short-finned pilot whale catalogs for six research locations (**Table 10**). She will continue to maintain and update these catalogs, as images are provided, and make inter-catalog comparisons for short-finned pilot whales. To date, 57 photo-ID matches have been made between these inter-catalog comparisons. DUML researchers look forward to receiving additional photographs from the contributors to increase understanding of the movements of short-finned pilot whales along the U.S. East Coast, Gulf of Mexico, and Caribbean.

Table 7. Frequency distribution of the number of sightings of photo-identified short-finned pilot whales within the Cape Hatteras study area.

Number of Sightings	Number of Individuals
1	905
2	281
3	98
4	59
5	26
6	10
7	8
8	4
9	1
10 or more	1
Total	1,393

Table 8. Frequency distribution of the number of years between first and last sightings of re-sighted short-finned pilot whales within the Cape Hatteras study area.

Number of Years Between First and Last Sighting	Number of Individuals
Less than 1	134
1 to 2	48
2 to 3	44
3 to 4	61
4 to 5	68
5 to 6	17
6 to 7	22
7 to 8	46
8 to 9	15
9 to 10	3
10 to 11	14
11 to 12	9
More than 12	7
Total	488

Table 9. Number of new identifications, re-sights within the Norfolk Canyon catalog, and matches to the Cape Hatteras catalog of short-finned pilot whales made during each field season by HDR Inc. researchers.

Field Season	New IDs	Catalog Size	Resights within NOR Catalog	Matches between NOR and HAT Catalogs
2015	84	84	0	11
2016	47	131	3	13
2017	48	179	3	13
2018	19	198	0	0
2019	32	230	1	3
2020	26	256	2	2
2021	26	282	1	1
2022	13	295	0	1
2023	25	320	1	3
2024	4	324	0	0
2025	20	344	0	0
Total	344	—	11	47

Key: HAT = Cape Hatteras study area; ID = Identifications; NOR = Norfolk Canyon study area

Table 10. Location and contributor of short-finned pilot whale catalogs created for other research groups; includes number of individuals in each catalog and years when the images were collected.

Descriptor ^a	Research Location	Contributor(s)	Years Images Collected	Number of Individuals
GOM catalog	Gulf of Mexico	Keith Mullin	2003–2007	180
HAT catalog	Cape Hatteras, North Carolina	Andy Read	2006–2025	1,393
OSB catalog	Onslow Bay, North Carolina	Andy Read	2007–2013	24
JAX catalog	Jacksonville, Florida	Andy Read	2009–2018	52
HDR catalog	Norfolk Canyon, Virginia	Jessica Aschettino	2015–2025	344
SBU catalog	New York Shelf Break, New York	Lesley Thorne/ Josh Meza-Fidalgo	2018–2019	14

^a GOM catalog = Catalog from National Oceanic and Atmospheric Administration research cruises in the Gulf of Mexico; HAT catalog = DUML catalog from research trips off Cape Hatteras; OSB catalog = DUML catalog from research trips off Onslow Bay; JAX catalog = DUML catalog from research trips off Jacksonville; HDR catalog= HDR Inc. catalog from research trips offshore Norfolk; SBU catalog= SBU catalog from research trips off the New York shelf break



Photo credits: R. Tyson and W. Cioffi.

Figure 10. Photographs of Gma_1-115, seen in May 2012 (top) and July 2021 (bottom).

1.3 Testing of Computer-Assisted Photo-Identification Matching Programs

The DUMML team has used photo-ID methods to identify, monitor, and track cetaceans in AFTT study sites since 2007 (Onslow Bay and Hatteras, North Carolina, and Jacksonville, Florida). To date, the study team has generated photo-ID catalogs for 14 species, ranging from rarely photographed species, (e.g., a single Bryde's whale [*Balaenoptera brydei*] off Cape Hatteras) to DUMML's very large catalog of short-finned pilot whales, which includes 1,393 individuals photographed off Hatteras since 2006. As some of DUMML's catalogs (short-finned pilot whales, goose-beaked whales, bottlenose dolphins [*Tursiops truncatus*], spotted dolphins) have grown over the last two decades, the study team has tested various approaches to make the labor-intensive photo-ID workflow more efficient. However, none of the computer-assisted matching programs the team has tested have eliminated the bottleneck of having a human analyst conducting manual matching.

This year, the study team tested the [Happywhale](#) matching system, which was trained on 24 different species and has delivered nearly automated results for species such as humpback whales, pilot whales, and bottlenose dolphins ([Patton et al. 2023](#)). The team's goal was to test this system, following successful reports from colleagues at the April 2025 Marine Species Monitoring Meeting who had been using the Happywhale matching system for humpback and pilot whale photo-ID with great success. The algorithm excels with species identifiable by features on their dorsal fins, such as pilot whales, but is less effective for those identified by pigmentation patterns, such as goose-beaked whales ([Patton et al. 2023](#)). The team collaborated with Dr. Ted Cheeseman, the developer of Happywhale, to use the platform to improve the matching efficiency for DUMML's short-finned pilot whale and goose-beaked whale photo-ID catalogs.

In June 2025, Dr. Cheeseman demonstrated the Happywhale user interface for matching humpback whales; unfortunately, a graphical user interface (GUI) was not available for use with other species. Additionally, the algorithm was only able to run one-to-one comparisons (i.e., comparing a catalog or collection of images to itself). The study team submitted DUMML's short-finned pilot whale and goose-beaked whale catalogs to Dr. Cheeseman to identify potential internal matches in these catalogs and see how the results were returned from the matching system. The model performed well for pilot whales, with a high probability of correct matches in the top 5 percent of the catalog, resulting in 13 internal matches out of nearly 1,400 individuals; 3 were pilot whales that had acquired new features to their dorsal fins. For the goose-beaked whale catalog ($n=360$), the process was more laborious, requiring manual review of all potential matches. The study team identified 11 internal matches, but it is unclear what features the algorithm used to identify potential matches, including dorsal fin shape, scars, or other features.

In September 2025, the Happywhale development team implemented the ability to compare batches of images (query images) to a reference set or catalog of images and created a GUI so researchers could run catalog comparisons independently within their own account. The study team still has to submit catalog images to Happywhale for upload; ideally, the team would be able to complete this step as well, something that the developers are working toward in future

iterations of the program. The user can select a threshold for the similarity rankings, select “Yes/No/Maybe” for potential matches, and download a CSV export of the results to review offline if necessary (Figure 11).

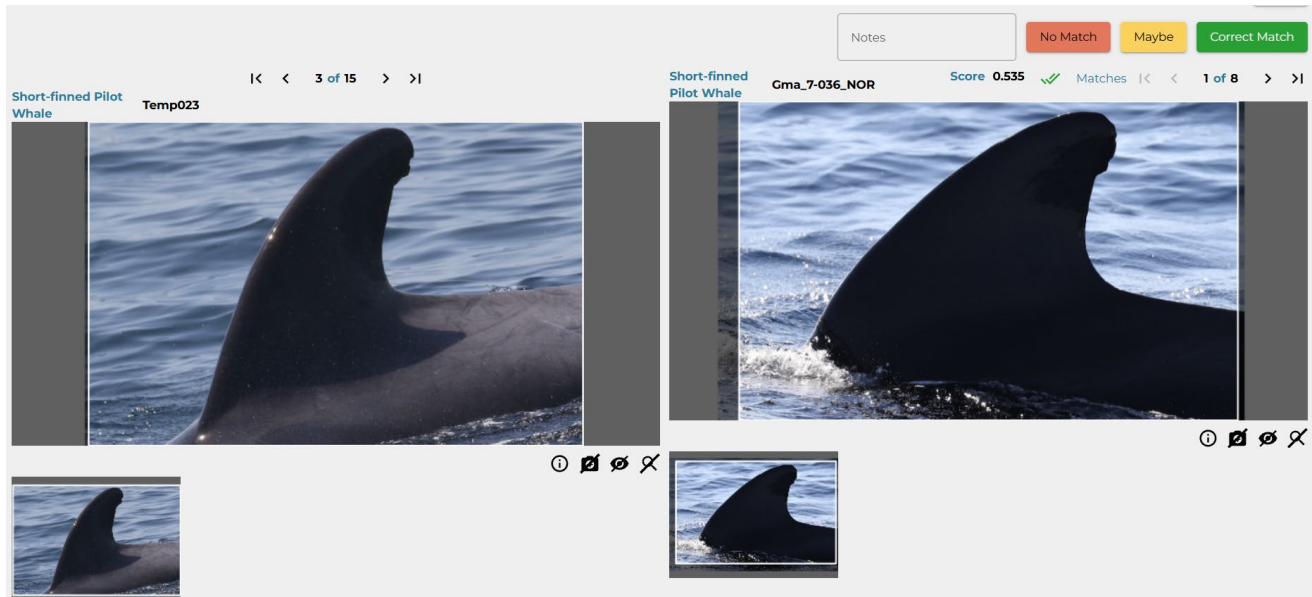


Figure 11. Screenshot of the graphical user interface on Happywhale for dorsal fins.

The study team tested the new interface by comparing pilot whale images collected during the BRS field effort in Cape Hatteras during 2023 to the existing DUML short-finned pilot whale catalog. The team matched 2 pilot whales photographed in 2023 (of 17 unique identifications) to the catalog, so the team added the remaining 15 newly identified whales to the DUML pilot whale catalog.

In early December 2025, the study team received permission from HDR Inc. to compare its preliminary short-finned pilot whale images from the 2025 field season to the existing HDR Norfolk pilot whale catalog using the Happywhale platform. The study team first used Happywhale to identify internal matches within the HDR pilot whale catalog; it found none. The team then compared the 2025 whales ($n=20$) to the HDR catalog and found no matches, so the team added 20 new individuals to the HDR Norfolk Catalog.

1.3.1 Preliminary Assessment of the Happywhale Matching Site

The Happywhale GUI remains under development, and the study team has provided feedback to Dr. Cheeseman for potential improvements, such as integrated photograph editing tools (e.g., the ability to zoom, flip, rotate images), which will allow improved comparisons of images. Currently, users can upload a limited number of images for comparison but cannot add these to existing catalogs. The ability for a user to upload and manage large reference catalogs would significantly enhance workflow efficiency for managing catalogs. Additionally, enabling catalog sharing among colleagues and species-specific filtering across research areas would greatly facilitate collaboration. The algorithm's performance for goose-beaked whales remains suboptimal; the study team hopes that by contributing its image collection, the team can help improve the training dataset for *Ziphius* and other beaked whales.

1.4 Satellite Tag Post-Deployment Monitoring

Follow-up monitoring of the health of satellite-tagged animals continues to be an important focus for the study team's photo-ID efforts. The field team has deployed 123 satellite tags on 117 individual goose-beaked whales between 2014 and 2025 and has re-sighted 84 of these animals (71 percent). The satellite-tagged whales have a much higher re-sight rate than the general population of *Ziphius* off Cape Hatteras (71 percent versus 44 percent) because every effort was made to relocate these animals following tagging, monitor their well-being, and document the shedding of the tag. This effort was greatly helped by using an ARGOS Goniometer that receives signals from the satellite tags and provides the field team information on the general direction and distance to the tagged whales in real time.

Many re-sightings occurred within the same field season, but 52 of the re-sighted whales (62 percent) were photographed at least 1 year after tagging (**Table 11**; tables and figures are included at the end of this subsection). Ten whales that were tagged from 2018 through 2023 were re-sighted during 2025. Eight of these whales had not been sighted since the field season in which they were tagged, giving us important information about the long-term effects of satellite tagging on goose-beaked whales.

ZcTag074 was satellite-tagged in August 2021; the tag shattered on contact, leaving one pin with a small piece of plastic attached to it in the dorsal fin. The whale was photographed several times during the 2019 season and still had the pin with the piece of plastic in its dorsal fin. It was not re-sighted again until July 2025, at which time the hardware and plastic had been shed, leaving a healed scar in the dorsal fin (**Figure 12**).

ZcTag079 was also satellite-tagged in August 2021. It was re-sighted from the Research Vessel (R/V) *Shearwater* in August 2022; however, few photographs were taken, and the quality of the photographs was not sufficient to tell if the tag was still attached to the whale. It was sighted again from the R/V *Shearwater* in September 2025, and the photographs showed that both tag and hardware were gone and only two depressions remained, near the dorsal fin leading edge (**Figure 13**).

ZcTag097 was tagged in August 2019 and seen several additional times during that month, but it was not sighted again until September 2025, more than 6 years from when it was tagged. The tag was no longer present, but a piece of hardware remained in the dorsal fin (**Figure 14**).

ZcTag120 was instrumented with a satellite tag in July 2021; it was sighted several times that season but not seen again until July 2025. The tag and the hardware had been shed, leaving one healed notch in the trailing edge of the dorsal fin and one healed hole going through the dorsal fin (**Figure 15**).

ZcTag127 was satellite-tagged in September 2021 and was not re-sighted until 4 years later in June 2025. No tag or hardware remained, and two healed scars could be seen (**Figure 16**).

ZcTag133 was tagged in August 2022; this whale was not re-sighted until July 2025. Photographs show that the tag and hardware were gone, leaving two healed scars (**Figure 17**).

ZcTag134 was instrumented with a satellite tag in August 2022. It was not re-sighted until 3 years later in June 2025. The whale had multiple scars at the base of its dorsal fin, possibly caused by one pin being shed before the other, allowing the tag to rotate and cause additional scars (**Figure 18**).

ZcTag146 was satellite-tagged in August 2023 and not re-sighted until September 2025; at that time, it had no remaining tag or hardware and two healed scars (**Figure 19**).

The DUMML research team is continuing to work on a manuscript documenting the effects of satellite tags on goose-beaked whales and short-finned pilot whales, with Dr. Andrew Read as the lead author. The team is planning to submit this manuscript during 2026.

To date, the field team has deployed 80 satellite tags on 79 short-finned pilot whales off Cape Hatteras and resighted 31 of these animals (39 percent). Most of these re-sightings occurred within the same field season, but 12 of the re-sighted whales (39 percent) occurred across multiple years (**Table 11**). There were no re-sights of satellite-tagged short-finned pilot whales during the 2025 field season. This reflects, in part, the focus on goose-beaked whales during the 2025 field season.

Table 11. Photo-ID sighting histories of cetaceans satellite-tagged and re-sighted within the Cape Hatteras study area.

ID ^a	Year ^b												
	2006– 2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
GgTag017	—	—	—	ST ^m	—	—	—	—	—	—	—	—	—
GmTag087	—	ST ^y	—	—	—	—	—	—	—	—	—	—	—
GmTag089	—	ST	X	—	—	—	—	—	—	—	—	—	—
GmTag091	X	ST	X	—	—	—	—	—	—	—	—	—	—
GmTag096	X ^y	ST	—	—	X	X ^y	—	—	—	—	—	—	—
GmTag097	X ^y	ST	X	—	—	—	—	—	—	—	—	—	—
GmTag122	X	—	ST ^m	—	—	—	—	—	—	—	—	—	—
GmTag127	—	—	ST ^m	—	—	—	—	—	—	—	—	—	—
GmTag134	—	—	ST	—	—	X	—	—	—	X	—	—	—
GmTag135	—	—	ST ^y	—	—	X	X	—	—	X	—	—	—
GmTag136	X	—	ST ^y	—	—	X ^m	—	—	—	—	—	—	—
GmTag140	—	—	ST	—	X	—	—	—	—	—	—	—	—
GmTag157	—	—	—	ST	X	—	—	—	—	—	—	—	—
GmTag172	—	—	—	—	ST ^m	—	—	—	—	—	—	—	—
GmTag175	X	—	—	—	ST ^m	—	—	—	—	—	—	—	—
GmTag176	X	—	—	—	ST	—	—	X	—	—	—	—	—
GmTag179	—	—	—	—	ST	X	—	—	—	—	—	—	—
GmTag182	—	—	—	—	ST ^m	—	—	—	—	—	—	—	—
GmTag197	X	X	X	—	X	ST ^y	—	—	—	—	—	—	—
GmTag198 (GmTag227)	X	—	—	—	—	ST ^y	ST ^y	—	—	—	—	—	—
GmTag199	—	—	—	—	—	ST ^m	—	—	—	—	—	—	—
GmTag201	—	—	—	—	—	ST ^y	—	—	—	X	—	—	—
GmTag203	—	—	—	—	—	ST ^y	—	—	—	—	—	—	—
GmTag204	—	—	X ^y	—	—	ST ^y	—	—	—	—	—	—	—

ID ^a	Year ^b												
	2006– 2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
GmTag205	—	—	—	—	—	ST ^y	—	—	—	—	—	—	—
GmTag206	—	—	—	—	—	ST ^y	—	—	—	—	—	—	—
GmTag207	X ^y	—	X	—	—	ST ^m	—	—	—	—	—	—	—
GmTag208	—	—	—	—	—	ST ^m	—	—	—	—	—	—	—
GmTag216	—	—	—	—	—	ST ^m	—	—	—	—	—	—	—
GmTag218	X ^y	—	X ^m	—	—	ST ^m	—	—	—	—	—	X	—
GmTag223	X ^y	—	—	X	—	—	ST ^m	—	—	—	—	—	—
GmTag226	—	—	—	—	—	—	ST ^y	—	—	—	—	—	—
TtTag015	—	ST ^m	—	—	—	—	—	—	—	—	—	—	—
ZcTag029	—	ST ^m	—	—	—	X	—	—	—	—	—	—	—
ZcTag039 (ZcTag077)	—	—	ST	—	—	ST	—	—	—	—	—	—	—
ZcTag040	—	X	ST	—	X	X	—	X	—	—	—	—	—
ZcTag046 (ZcTag103)	—	—	—	ST	X	—	—	ST ^m	—	—	—	X	—
ZcTag047	—	X ^y	—	ST ^y	X ^y	X ^y	—	—	—	—	—	—	—
ZcTag048	—	—	—	ST	—	X	—	—	—	—	—	—	—
ZcTag049 (ZcTag099)	—	—	—	ST	X ^y	—	X	ST ^y	—	—	—	—	—
ZcTag051	—	—	—	ST	—	—	—	—	X ^m	—	—	—	—
ZcTag054	—	—	—	—	ST ^y	—	—	—	X ^y	—	X ^m	—	—
ZcTag055	—	—	—	—	ST ^y	—	X ^m	X	—	—	—	—	—
ZcTag056	—	—	—	—	ST	—	X	X ^y	X ^y	—	X ^m	—	—
ZcTag057	—	—	—	—	ST	X	—	—	—	—	—	—	—
ZcTag058	—	—	—	—	ST ^y	X ^m	—	—	—	—	—	—	—
ZcTag060	—	—	—	—	ST	—	—	X	X	—	—	—	—
ZcTag062	—	—	—	—	ST ^m	—	—	—	—	—	—	—	—

ID ^a	Year ^b												
	2006– 2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
ZcTag069	—	—	—	—	—	ST ^y	—	—	—	—	—	—	—
ZcTag071	—	—	—	—	—	ST	—	X ^m	—	—	—	—	—
ZcTag072	—	—	—	—	—	ST	—	X ^m	X	—	X	X	—
ZcTag073	—	—	—	—	—	ST ^y	—	—	—	—	—	—	—
ZcTag074	X	—	—	—	—	ST ^m	X ^m	—	—	—	—	—	X
ZcTag075	—	—	—	—	—	ST ^m	—	—	—	—	—	—	—
ZcTag076	—	—	—	—	X	ST ^m	—	X	X	—	—	—	—
ZcTag078	—	—	—	—	—	ST ^m	—	—	X	—	—	—	—
ZcTag079	—	—	—	—	—	ST	—	—	—	X	—	—	X
ZcTag080	—	—	—	—	—	ST ^m	—	—	—	—	—	—	—
ZcTag081	—	—	—	—	X	ST ^m	—	—	—	—	X	—	—
ZcTag082	—	—	—	—	—	—	ST ^y	—	—	—	—	—	—
ZcTag083	—	—	—	—	—	X ^y	ST	—	—	—	—	X	—
ZcTag084	—	—	—	—	—	X	ST ^m	X ^m	—	—	X	X	—
ZcTag085	—	—	—	—	—	X	ST ^y	—	—	—	—	—	—
ZcTag086	—	—	—	—	—	—	ST ^y	X ^y	—	—	—	—	—
ZcTag087	—	—	—	—	—	—	ST	—	X ^m	—	—	—	—
ZcTag088	—	—	—	—	—	—	ST ^m	—	—	—	—	—	—
ZcTag089 (ZcTag109)	—	—	—	—	—	—	ST	ST	—	—	—	—	—
ZcTag090	—	—	—	—	—	—	ST ^y	—	—	—	—	X	—
ZcTag091	—	—	—	—	X	—	ST ^m	—	X ^y	—	—	—	—
ZcTag092	—	—	—	—	—	—	ST ^y	—	—	—	—	—	—
ZcTag093	—	—	—	—	—	—	ST ^y	—	—	—	—	—	—
ZcTag094	—	—	—	—	—	—	ST	—	X	—	—	—	—
ZcTag095	—	—	—	—	—	—	ST ^m	X	—	—	—	—	—

ID ^a	Year ^b												
	2006– 2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
ZcTag096 (ZcTag112)	—	—	—	—	—	—	ST ^m	—	ST ^y	—	X	—	—
ZcTag097	—	—	—	—	—	—	ST ^m	—	—	—	—	—	X
ZcTag098	—	—	—	—	—	X ^m	—	ST ^y	—	—	—	—	—
ZcTag101	—	—	—	—	—	—	X	ST ^m	X	—	—	—	—
ZcTag102 (ZcTag143)	—	—	—	—	—	—	—	ST ^m	X ^y	—	ST	—	—
ZcTag104	—	—	—	—	—	—	—	ST ^m	X	—	—	—	—
ZcTag105	—	—	—	—	—	—	—	ST ^m	—	—	—	—	—
ZcTag106	—	—	—	—	—	X	—	ST ^y	X	X	—	—	—
ZcTag107	—	—	—	—	—	—	—	ST ^y	—	—	—	—	—
ZcTag108	—	—	—	—	—	—	—	ST ^m	—	X	X	—	—
ZcTag110	—	—	—	—	—	—	—	ST ^m	X	—	—	—	—
ZcTag111	—	—	—	—	—	X	—	ST ^m	X	—	—	—	—
ZcTag114	—	—	—	—	—	X	—	—	ST ^y	X	X	—	—
ZcTag115	—	—	—	—	—	—	—	—	ST ^y	—	—	—	—
ZcTag116	—	—	—	—	—	—	—	—	ST ^y	—	—	—	—
ZcTag117	—	—	—	—	—	—	—	—	ST ^y	—	—	—	—
ZcTag118	—	—	—	—	X	X	—	—	ST	—	—	—	X
ZcTag120	—	—	—	—	—	—	—	—	ST ^y	—	—	—	X
ZcTag121	—	—	—	—	—	—	—	—	ST ^y	X	—	—	—
ZcTag122	—	—	—	—	—	—	—	—	ST ^y	X	—	—	—
ZcTag123	—	—	—	—	—	—	—	—	ST ^y	—	—	—	—
ZcTag124	—	X	—	—	—	X	—	—	ST ^y	—	—	—	—
ZcTag125	—	—	—	—	—	—	—	—	ST ^m	—	—	—	—
ZcTag126	—	—	—	—	X	—	—	—	ST ^m	—	—	—	—
ZcTag127	—	—	—	—	—	—	—	—	ST	—	—	—	X ^y

ID ^a	Year ^b												
	2006– 2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
ZcTag129	—	—	X	—	X	X	—	X	X	ST ^y	—	—	—
ZcTag130	—	—	—	—	—	X	X	—	X	ST ^y	—	—	—
ZcTag131	—	—	—	—	—	—	—	—	—	ST ^m	—	—	—
ZcTag132	—	—	—	—	—	—	—	—	—	ST	X	—	—
ZcTag133	—	—	—	—	—	—	—	—	—	ST	—	—	X
ZcTag134	—	—	—	—	—	—	—	—	—	ST	—	—	X
ZcTag135	—	—	—	—	—	—	—	—	—	ST ^m	—	—	—
ZcTag136	—	—	—	—	—	—	—	—	—	—	ST ^m	—	—
ZcTag137	—	—	—	—	—	—	—	—	—	—	ST ^y	—	—
ZcTag139	—	—	—	—	—	—	—	—	—	—	ST	—	X
ZcTag141	—	—	—	—	—	—	—	—	—	—	ST	X	—
ZcTag144	—	—	—	—	—	—	—	—	—	—	ST ^m	—	—
ZcTag146	—	—	—	—	—	—	X	—	X	—	ST	—	X
ZcTag151	—	—	—	—	X	X ^m	—	—	—	—	—	—	ST ^y
ZcTag154	—	—	—	—	—	—	—	—	—	—	—	—	ST ^m
ZcTag155	—	—	—	—	—	—	—	—	—	—	—	—	ST ^m
ZcTag156	—	—	—	—	—	—	—	—	—	—	—	—	ST ^m
ZcTag157	—	—	—	—	—	—	—	—	—	—	—	—	ST ^y
ZcTag164	—	—	—	—	—	—	—	—	—	—	—	—	ST ^m

^a ID = identification; Gg = *Grampus griseus* (Risso's dolphin); Gm= *Globicephala macrorhynchus* (short-finned pilot whale); Tt = *Tursiops truncatus* (bottlenose dolphin); Zc = *Ziphius cavirostris* (goose-beaked whale)

^b ST= year when satellite tagging occurred for that individual; X = sighted; ^m = re-sighted within same month; ^y = re-sighted within same year



Photo credits: A. Read and M. Bradley.

Figure 12. Photographs of ZcTag074, seen during satellite-tagging in August 2021 (top) and re-sighted in July 2025 (bottom).

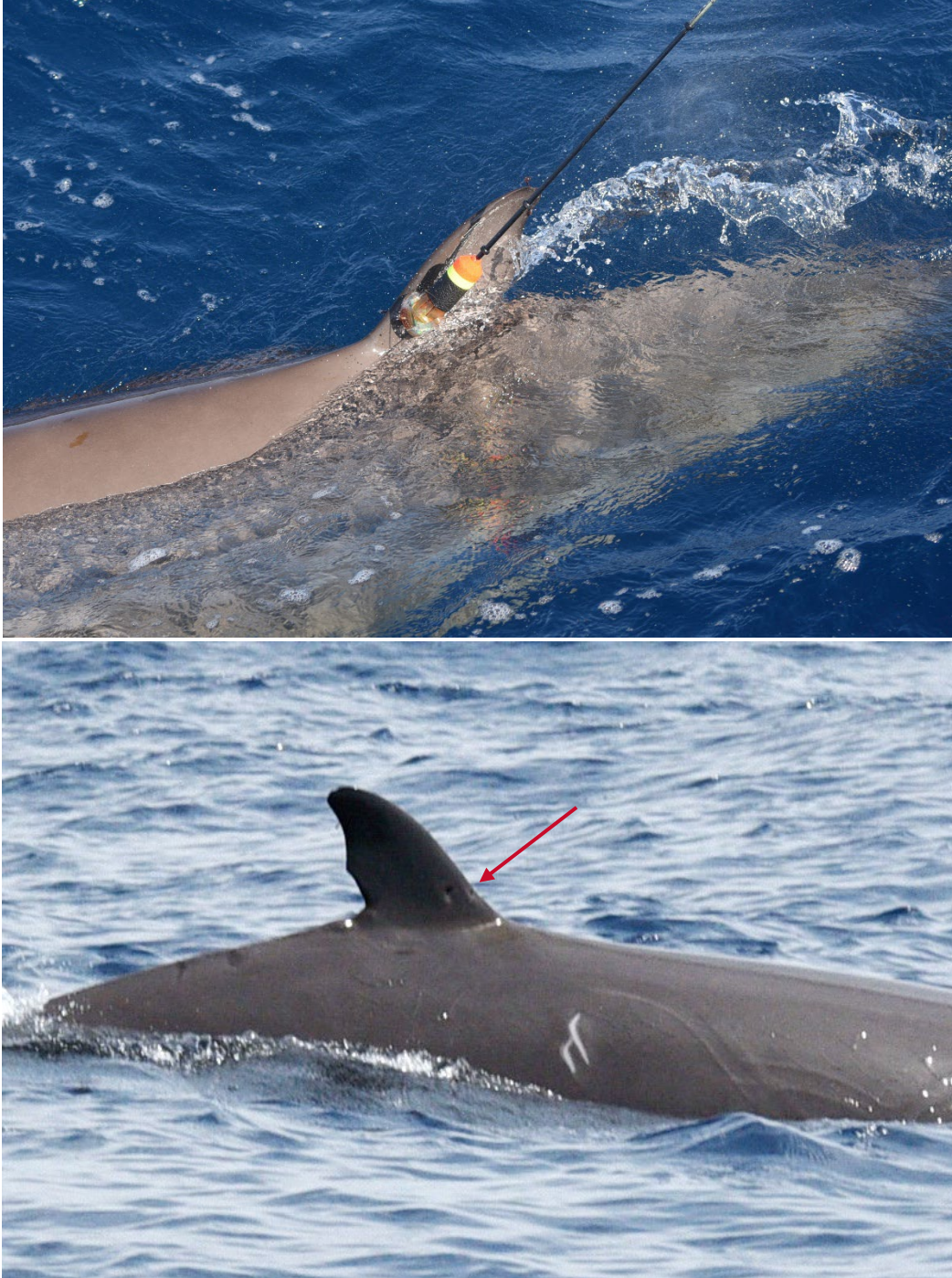


Photo credits: A. Read and V. Panigada.

Figure 13. Photographs of ZcTag079, seen during satellite-tagging in August 2018 (top) and re-sighted in September 2025 (bottom).



Photo credits: W. Cioffi and K. Sutherland.

Figure 14. Photographs of ZcTag097, seen during satellite-tagging in August 2019 (top) and re-sighted in September 2025 (bottom).



Photo credits: W. Cioffi and A. Read.

Figure 15. Photographs of ZcTag120, seen during satellite-tagging in July 2021 (top) and re-sighted in July 2025 (bottom).

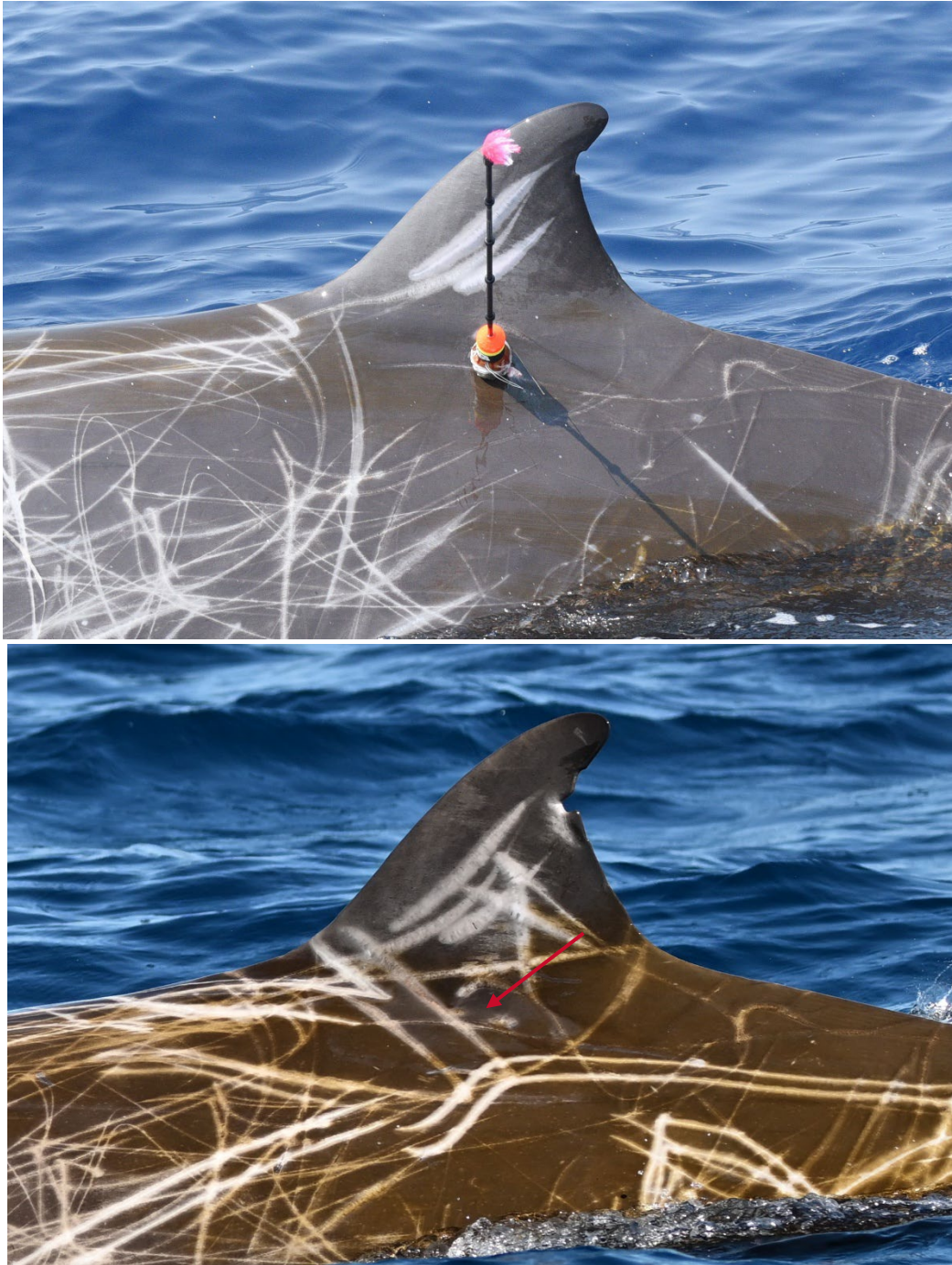


Photo credits: W. Cioffi and K. Sutherland.

Figure 16. Photographs of ZcTag127, seen during satellite-tagging in September 2021 (top) and re-sighted in June 2025 (bottom).



Photo credits: D. Webster and A. Read.

Figure 17. Photographs of ZcTag133, seen during satellite-tagging in August 2022 (top) and re-sighted in July 2025 (bottom).



Photo credits: D. Webster and W. Cioffi.

Figure 18. Photographs of ZcTag134, seen during satellite-tagging in August 2022 (top) and re-sighted in June 2025 (bottom).

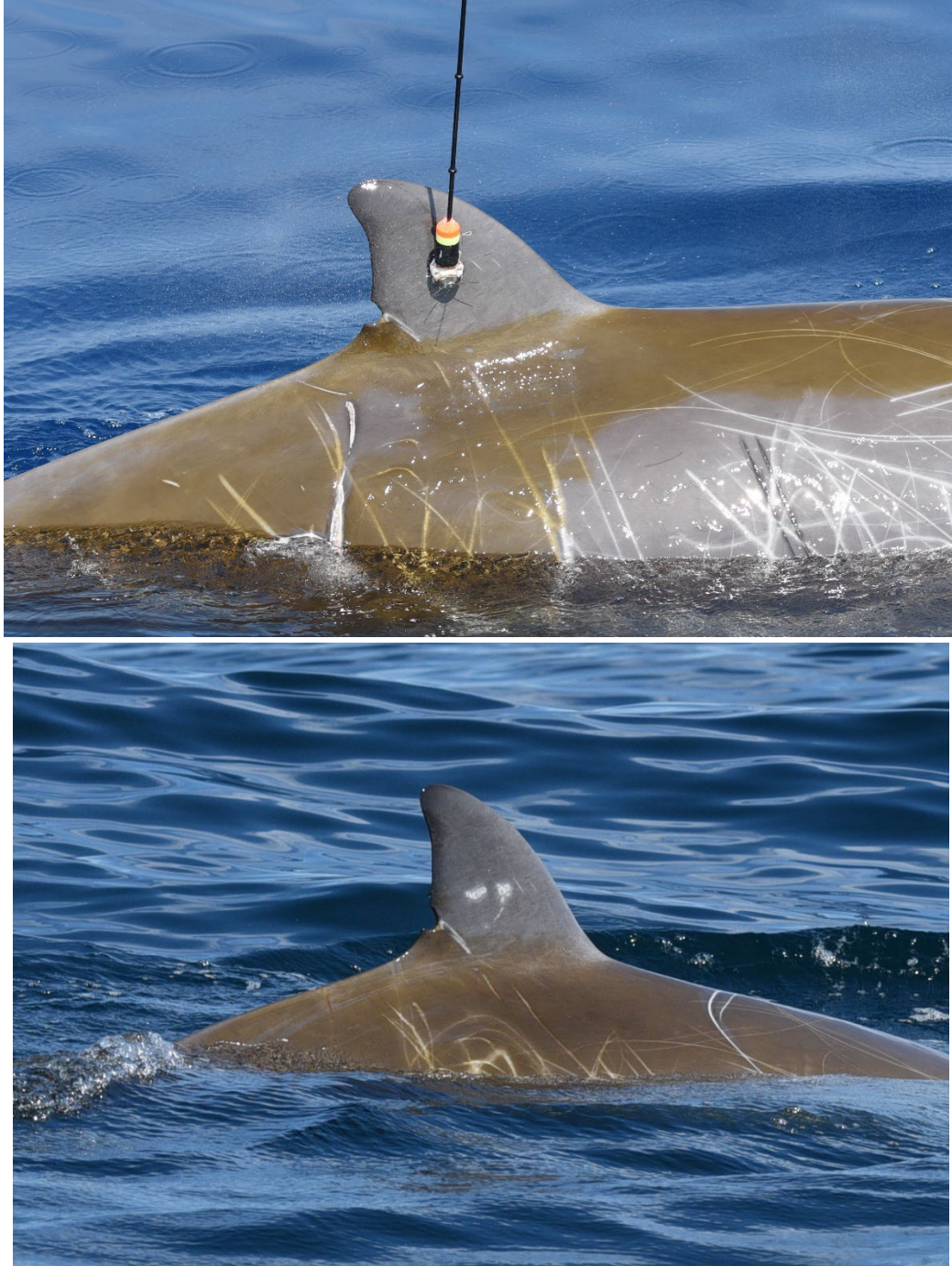


Photo credits: K. Sutherland and V. Panigada.

Figure 19. Photographs of ZcTag146, seen during satellite-tagging in August 2023 (top) and re-sighted in July 2025 (bottom).

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