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Aquatic Mammals

Aquatic Mammals

Special Issue of Anecdotes

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Contents

Introduction to the Special Issue of Anecdotes

In 1972, the *Aquatic Mammals* journal began publishing mostly narrative accounts related to the care, nutrition, transport, and housing of aquatic mammals, with a focus on dolphins and pinnipeds. Over the years, as our understanding and knowledge of aquatic mammals increased, contributions shifted to focus on topics and samples that could be assessed quantitatively. It is understood that scientific studies (research generally) are based on a foundation of reproducible methodologies with multiple observations and data points assessed statistically. Now, 50 years later, we are pleased to offer a special issue of *Aquatic Mammals* that acknowledges how the journal began and welcomes the insight to be gained from anecdotal or rare observations of aquatic mammals in both *in-* and *ex-situ* settings.

Most marine mammals are cryptic, difficult to observe, and often require large costs and time to compile samples that allow for a rigorous assessment. Even in the 2020s, for many species, a simple dated geographic location or single observation of behavior provides invaluable insight and direction for research. Unforeseen and unique behaviors (actions and interactions) may offer unexpected insight into the nature and society of a cryptic species. Rare behaviors (e.g., tool use, infanticide) or unusual circumstances allow the observer a more refined view of an individual, small group, or species, yet these observations are usually not available for distribution through the peer-review platform. The current scientific, peer-review literature does not typically encourage publication of "anecdotal" observations. As such, these insights, if not archived in some manner, may be lost from the collective record.

This special issue of *Aquatic Mammals* is intended to celebrate the insight that can be gained from rare or opportunistic observations in the field or in a managed care setting and is dedicated to capturing these observations for the record. Contributors set their accounts into the literature as much as possible and contextualized their anecdote(s) such that its scope, generality, and potential application are recognized. Our goal has been to offer this special issue as a collective record so these insights and observations may provide perspective to our research and the animals we study. We hope you enjoy reading them as much as we have during the review and publication process.

We would be remiss not to thank our copyedit and business teams—Brittany McIntosh, Sandy Larimer, Shanee Plate, and Gina Colley—for their effort and support. Similarly, a huge thank you from *Aquatic Mammals* journal AND all contributing authors to Zoomarine Algarve in Portugal for sponsoring the costs associated with this special issue. Happy Birthday to the journal and here's to 50 more years!

James D. Darling, Ph.D., Whale Trust, Guest Editor

Kathleen M. Dudzinski, Ph.D., Managing Editor, *Aquatic Mammals*

Thank you to the generosity of Zoomarine Algarve for their sponsorship of this Special Issue of Anecdotes that commemorates the 50th anniversary of *Aquatic Mammals*! We applaud Zoomarine Algarve for their stalwart and continued commitment to supporting, promoting, and celebrating Science, Education, and Conservation!

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Thank you to all the authors who provided photographs for the cover of this special issue!

Cover Photos

Front Cover

Top: Two young male bottlenose dolphins (*Tursiops truncatus*) socialize at The Roatan Institute for Marine Sciences, Anthony's Key Resort

Courtesy of K. M. Dudzinski, DCP

Bottom left: Pacific walrus (*Odobenus rosmarus divergens*) "Sivuqaq" with Ron Schusterman and Colleen Reichmuth

Courtesy of Colleen Reichmuth, Long Marine Laboratory, Institute of Marine Sciences, University of California Santa Cruz

Bottom right: Postmortem view of the first live sperm whale (*Physeter macrocephalus*) stranding in Alabama showing placement of sling and lines to lift the animal from the water using a crane

Photo credit: DISL/ALMMSN 2020; NMFS Marine Mammal Health and Stranding Response Permit #18786)

Back Cover

Top: Immature male leopard seal (*Hydrurga leptonyx*) observed on Bird Island, South Georgia

Photo credit: Claire Stainfield, British Antarctic Survey

2nd row left: A member of the 27s group of killer whales (*Orcinus orca*) tracking a harbour seal (*Phoca vitulina*) as it seeks refuge from predation between the headlines of mussel farm infrastructure (Dury Voe, Shetland, UK, on 6 March 2022)

Photo credit: Nick McCaffrey, Southspear Media & Surveys Ltd

2nd row center: Female Mediterranean monk seal (*Monachus monachus*) and her pup resting on an open beach in Greece

Copyright: P. Dendrinos/MOm

3rd row left: "Poli," a young adult female bottlenose dolphin (*Tursiops truncatus*), and two mother–calf pairs swim near Bailey's Key at The Roatan Institute for Marine Sciences, Anthony's Key Resort

Courtesy of K. M. Dudzinski, DCP

3rd row center: A harbour seal (*Phoca vitulina*) barrel rolling as it follows a Eurasian otter (*Lutra lutra*) during a dyadic interaction near Aith Pier, Shetland, on 2 April 2022

Photo credit: Nick McCaffrey, Southspear Media & Surveys Ltd

3rd row right: A group of long-finned pilot whales (*Globicephala melas*) including a neonate, within Yell Sound, Shetland, on 27 September 2019

Photo credit: Nick McCaffrey, Southspear Media & Surveys Ltd

Bottom: Two walruses (*Odobenus rosmarus*) resting on sea ice north of Svalbard, Norway

Photo credit: Christian Lydersen, Norwegian Polar Institute

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First Record of Sowerby's Beaked Whale (*Mesoplodon bidens*) on México's Coast and the Caribbean Sea

Raúl E. Díaz-Gamboa,[1] Carlos A. Niño-Torres,[2, 3]
and Wojtek Bachara[4]

[1] *Departamento de Biología Marina, Universidad Autónoma de Yucatán, Km. 15.5 Carretera Merida-Xmatkuil,*
Apdo Postal 4-116 Itzimna, Merida, Yucatán, 97000, México
[2] *Universidad de Quintana Roo, Boulevard Bahía s/n, Col. del Bosque, Chetumal, Quintana Roo, 77019, México*
[3] *Fundación Internacional para la Naturaleza y la Sostenibilidad (FINS),*
Calle Larún M75 L4, Andara, Chetumal, Quintana Roo, 77014, México
E-mail: carlosalni@gmail.com
[3] *Kolejowa 138, 05-120, Legionowo, Poland*

Sowerby's beaked whales (*Mesoplodon bidens*; Sowerby, 1804) are the most northerly species of the genus *Mesoplodon* in the Atlantic Ocean where they inhabit temperate to sub-Arctic waters (Jefferson et al., 2008). These whales are endemic to the North Atlantic Ocean where their distribution is primarily on shelf breaks and in oceanic waters associated with deep canyons (Waring et al., 2009). It is the most commonly stranded species among *Mesoplodon* in Europe (Bachara et al., 2014).

On 13 June 2018, an unidentified cetacean stranded alive on the Playacar Beach in Playa del Carmen, Quintana Roo, México (20° 36' 15.18" N, 87° 5' 19.48" W; Figure 1A). It was reported to the Marine Mammal Stranding Network of Quintana Roo, but the whale was helped back to the sea immediately by tourists, and there were no further reports about it.

We analyzed multimedia material (including photographs and videos) of the event, and from that we were able to identify the specimen as an adult male Sowerby's beaked whale of approximately 5.3 m in body length. Positive identification was possible by head, rostrum, and mouth anatomy, but mostly because of the shape and position of the teeth (Figure 1B).

Stranding events represent excellent opportunities to obtain valuable biological, ecological, and biogeographical information about species that are difficult to observe in the wild. Particularly for ziphiid species, basic biological information, such as confirmation of the species inhabiting the Caribbean Sea and their distribution patterns, is nonexistent (Bay & Island, 1999). Herein, we describe the first record of a Sowerby's beaked whale in Mexican waters and, by extension, in the Caribbean Sea. This observation must be considered extralimital of the species' usual North Atlantic Ocean range.

At least 442 stranded Sowerby's beaked whales have been documented in 410 stranding events between 1803 and 2021 (Bachara et al., 2014; W. Bachara, unpub. data, 2014 to present), and most of them occurred in the eastern North Atlantic Ocean. In the western North Atlantic, only a few records of this beaked whale have been documented from Canada and the United States (Bachara et al., 2014). In addition to the observation reported herein, other extralimital records of Sowerby's beaked whales are from Italy, France, Florida (Gulf of Mexico side), Dominican Republic (Atlantic Ocean side), and Brazil (Brunelli & Fasella, 1929; Bonde & O'Shea, 1989; Simões-Lopes & Ximenez, 1993; Bompar, 2000; Bachara et al., 2014; Bittau et al., 2017), suggesting a possible southward expansion into tropical waters from their historic range.

The present observation provides a better perspective on the number of species that could inhabit the waters of México and the Caribbean Sea, highlighting the need for further studies to update the distribution and abundance of marine mammals, especially along shelf breaks and other oceanic environments. This record expands our perspective on the number of confirmed marine mammal species for the Mexican Caribbean from 19 to 20 (Niño-Torres et al., 2015; García-Rivas et al., 2019).

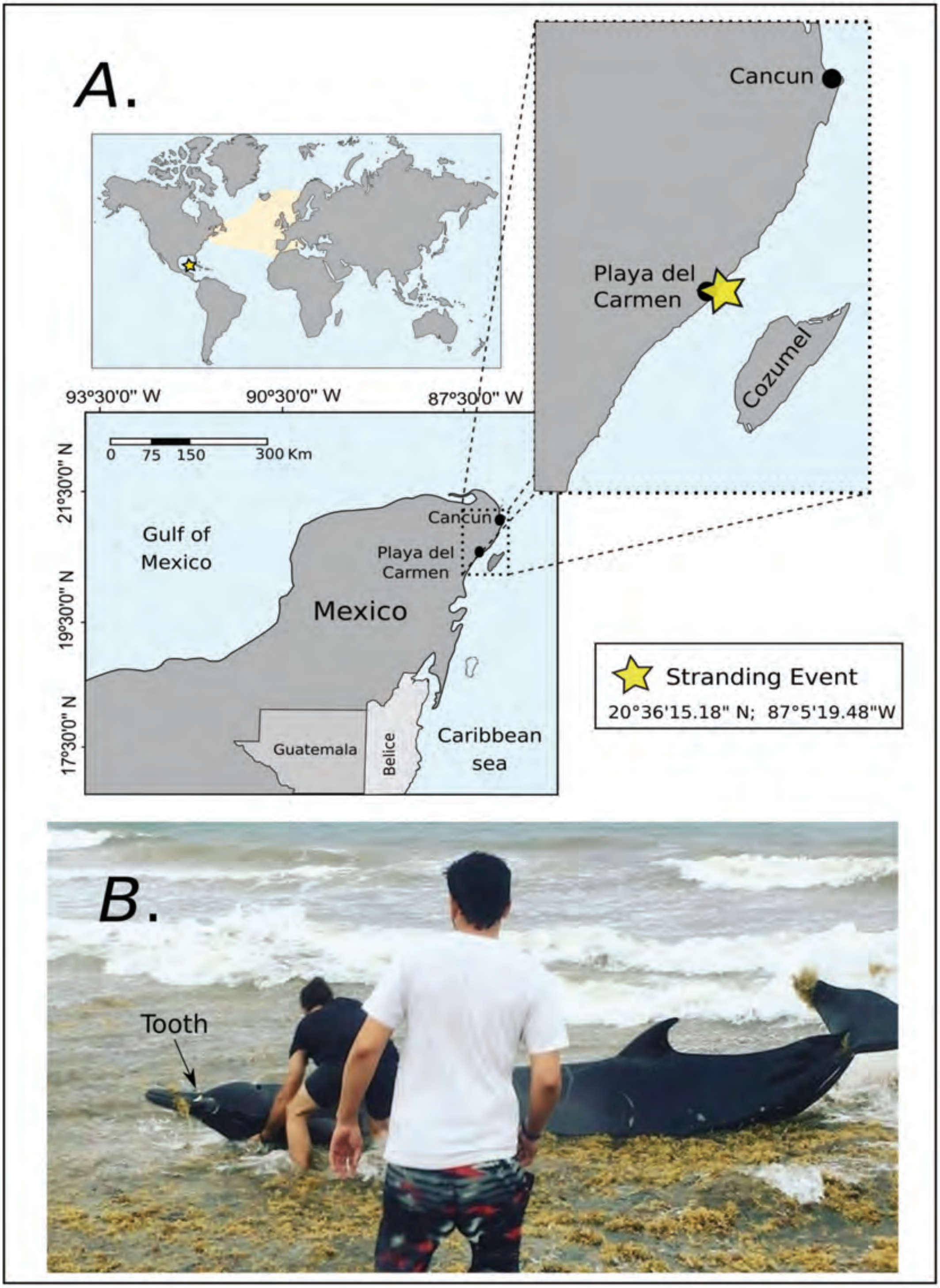

Figure 1. (A) Stranding record of Sowerby's beaked whale (*Mesoplodon bidens*) on Mexico's coast. The upper left world map also shows the typical distribution of this species in the North Atlantic (beige-shaded area; Bittau et al., 2017); and (B) the live whale being helped back to the sea by tourists.

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Northernmost Record of the Galapagos Sea Lion (*Zalophus wollebaeki*): Sightings Along the Mexican Central Pacific and the Gulf of California During La Niña Conditions

Fernando R. Elorriaga-Verplancken,[1] Jorge E. Morales-Vázquez,[2]
Christian D. Ortega-Ortiz,[3] Myriam Llamas-González,[3, 4]
Raziel Meza-Yáñez,[3] and Diego Páez-Rosas[5, 6]

[1]*Instituto Politécnico Nacional, Centro Interdisciplinario de Ciencias Marinas, La Paz, Baja California Sur, México*
[2]*Organización Biólogos Marinos ORG, Bahía de Banderas, Nayarit, México*
[3]*Universidad de Colima, Facultad de Ciencias Marinas, Manzanillo, Colima, México*
[4]*Universidad de Guadalajara, Centro Universitario de la Costa Sur, San Patricio-Melaque, Jalisco, México*
[5]*Universidad San Francisco de Quito, Galapagos Science Center, Isla San Cristóbal, Galápagos, Ecuador*
[6]*Dirección Parque Nacional Galápagos, Unidad Técnica Operativa San Cristóbal, Isla San Cristóbal, Galápagos, Ecuador*
E-mail: dpaez@usfq.edu.ec

Most organisms within the trophic web are affected by significant fluctuations in sea surface temperature (SST)—from phytoplankton (Fischer et al., 2020) to top predators such as pinnipeds (Elorriaga-Verplancken et al., 2016; Páez-Rosas et al., 2018; Gálvez et al., 2020). The global distribution of these marine carnivores depends on SST because of its effects on the input of nutrients, primary productivity, and subsequent prey availability (Guinet et al., 2001; McClatchie et al., 2016; Adame et al., 2020).

El Niño-Southern Oscillation (ENSO) has been defined as "an unstable interaction between sea surface temperature and atmospheric pressure that results in variations in oceanographic conditions in the central and eastern tropical Pacific Ocean" (Fiedler, 2002). "El Niño" is the warm phase of ENSO, which is characterized by an unusual increase in SST, weak trade winds, a reduction in nutrient advection, and a deeper mixed layer. Furthermore, this type of event has been linked to negative impacts on different pinniped populations (Trillmich et al., 1991), mainly due to low prey availability (Iriarte & González, 2004; McClatchie et al., 2016).

These positive thermal anomalies in the marine environment may cause abnormal dispersion of solitary individuals due to the extension of their regular foraging ranges. The temporal and spatial knowledge of how organisms respond to abnormal oceanographic shifts provides insights into the trophic ecology of the species (Weise et al., 2006). This has been the case for several otariids such as the Guadalupe fur seal (*Arctocephalus townsendi*; Páez-Rosas et al., 2020a), the South American fur seal (*Arctocephalus australis*; Villegas-Zurita et al., 2016), the Galapagos fur seal (*Arctocephalus galapagoensis*; Páez-Rosas et al., 2017), and the only previous record in Mexico for the Galapagos sea lion (*Zalophus wollebaeki*; Ceballos et al., 2010) in Chiapas, along the southern coast of the Mexican Pacific. This non-migrant otariid from the Galapagos Archipelago has been strongly affected by El Niño events in the past. During 2018, its overall abundance was estimated at 18,000 to 24,000 individuals; however, there was a population decline of 23.8% after the 2015-2016 El Niño (Páez-Rosas et al., 2021). Studies regarding its ecology regain relevance for this reason, as well as because of its "endangered" classification according to the International Union for Conservation of Nature (IUCN) (Trillmich, 2015).

Moreover, there are negative anomalies related to the cold phase of ENSO events, known as "La Niña." This event is characterized by an unusual decrease in SST, stronger-than-usual trade winds, nutrient-rich waters close to the ocean surface, and a decreased depth of the mixed layer (Philander, 1990). Since these cold conditions expand typical foraging areas, there can be positive outcomes, such as increased body mass of neonates (e.g., in the Guadalupe fur seal; Gálvez et al., 2020). Abnormal dispersal events, however, can also occur in some pinnipeds as a consequence of these extended foraging areas. These vagrant records have so far included the arrival of southern elephant seals (*Mirounga leonina*) to the Gulf of Panama and to Ecuador at the end of 2016 and 2017 (Páez-Rosas et al., 2018; Redwood & Félix, 2018) and a Steller sea lion (*Eumetopias jubatus* [described as a South American sea lion (*Otaria flavescens*) by Gallo-Reynoso et al., 2020]), which arrived at Colima in the Mexican Central Pacific during 2008 (Ceballos et al., 2010).

In the present paper, we provide evidence of several sightings of a single male adult Galapagos sea lion, referred to as "*Zw*-LN21," from 25 January 2021 to 4 June 2021, from the Mexican Central Pacific to the entrance of the Gulf of California (Figure 1). There were eight confirmed sightings along a path of ~720 km during this period. The southernmost location was Maruata Beach in the state of Michoacán, and the northernmost location was Mazatlán in the state of Sinaloa, separated by ~700 km (Table 1; Figure 2).

The identification of *Zw*-LN21 was based on characteristic morphological traits for its age and sex class. Adult male Galapagos sea lions are smaller or more compact relative to adult male California sea lions (*Zalophus californianus*; CSLs). The former measure up to 2 m and weigh approximately 200 kg (Eibl-Eibesfeldt, 1984). Adult male Galapagos sea lions generally have a blackish-gray pelage and a sagittal crest that is fully developed, which is a significant trait relative to subadult male CSLs; however, their neck is thinner compared to an adult male CSL (Trillmich, 1979).

These records are the northernmost for this species to date, with distances to the Galapagos Archipelago of ~2,460 km from Maruata Beach; ~2,600 to 2,700 km from Manzanillo and Melaque; ~2,800 km from Bahía de Banderas; and ~3,200 km from Mazatlán. The latter is considered to be within the entrance of the Gulf of California. Several photographs and characteristics of *Zw*-LN21 allowed us to correctly identify it as the same *Zalophus wollebaeki* individual (Figure 3).

Our observations took place during the 2021 La Niña cold conditions for the 3.4 region in the Eastern Pacific (El Niño Index or NOI = -1.2 [January], -1.0 [February], -0.9 [March], -0.8 [April], -0.7 [May], and -0.5 [June]; National Oceanic and Atmospheric Administration [NOAA], 2021). Overall, these abnormally cold conditions prevailed from September 2020 to June 2021. As briefly mentioned before, the low SST can cause an unusual dispersal of different taxa that feed over

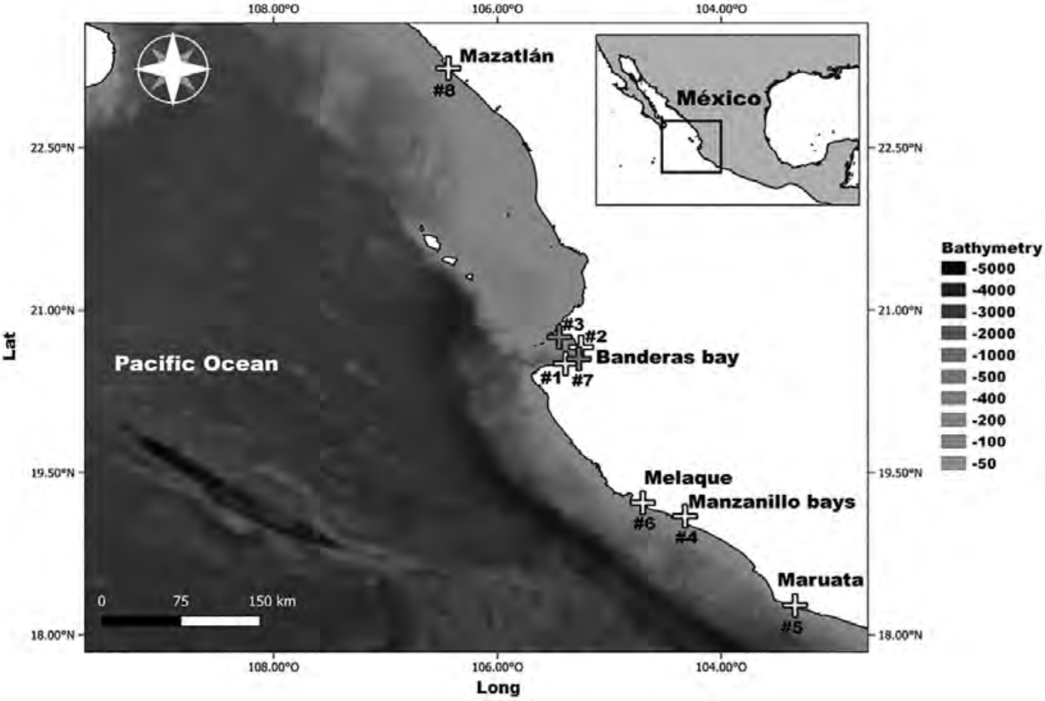

Figure 1. Geographical position of *Zw*-LN21, a Galapagos sea lion (*Zalophus wollebaeki*). Sightings from January to June 2021: (#1) Majahuitas Beach, Jalisco; (#2) Mayan Vidanta Beach, Puerto Vallarta, Jalisco; (#3) Punta Burro, Nayarit; (#4) Azul Beach, Manzanillo, Colima; (#5) Maruata Beach, Michoacán; (#6) Melaque Beach, Jalisco; (#7) Las Gemelas Beach, Puerto Vallarta, Jalisco; and (#8) in front of Universidad Autónoma de Occidente, Mazatlán, Sinaloa.

Table 1. Chronology of the sightings of the recorded Galapagos sea lion (*Zalophus wollebaeki*) from January to June 2021 along the Mexican Central Pacific

Date	Time	Site	Observations
25 January	1000 h	Majahuitas Beach, Jalisco	First report of the individual resting on southernmost beach of Banderas Bay. It entered the sea at sunset.
26 January	1230 to 1730 h	Mayan Vidanta Beach, Puerto Vallarta, Jalisco	Displacement of ~21.5 km to the northeast of the bay. Photographs corroborated that it was the same individual. Municipal civil protection cordoned the area. It entered the sea in the afternoon.
28 January-6 February	1238 to 0836 h	Punta Burro, Nayarit	Displacement of ~20.9 km to the north of the bay. Municipal civil protection arrived and cordoned the area. It entered the sea a couple of times during the afternoon of the first day. It swam near a school of fish. It rested on the beach during the second day. One of its eyes was observed closed. During the following days, it was observed swimming near a fishing net. It was observed swimming in the same area on the last day.
2 March	1700 to 2000 h	Azul Beach, Manzanillo, Colima	Displacement of ~282 km out of the Banderas Bay and to the south. It was resting on the beach. The area was cordoned to avoid an incident with people. It reacted to sounds around it. Both eyes were closed and had a yellowish secretion (Figure 2). It entered the sea after sunset. It was not observed again.
5 March	0830 h	Maruata Beach, Michoacán	Displacement of ~152 km out of the Manzanillo Bay and to the south. It was identified as the same individual based on photographs published on social media. It was noticeable that both eyes were closed (Figure 2). There was no further news.
20 April	1400 h	Melaque Beach, Jalisco	Displacement of ~193 km to the north of Maruata. It was resting on the beach. Both eyes were closed (Figure 2). It was no longer observed in the afternoon.
2-15 May	0900 to 0720 h	Las Gemelas Beach, Puerto Vallarta, Jalisco	Displacement of ~252 km to the north of Melaque. It was resting on the beach, and it entered the sea sometimes. It was confirmed that it was the same individual based on photographs. A very considerable weight gain was noticed in relation to its sightings in January and February. The left eye was open, as well as, slightly, the right one. It still showed a yellowish secretion. Some people tried to feed it, and others disturbed it.
4 June	0800 to 1800 h	Mazatlán, Sinaloa, in front of Universidad Autónoma de Occidente	Displacement of ~347 km to the north of Las Gemelas Beach. First, it was observed resting on the Norte Beach. It was moving around this site when it was captured by personnel from an aquarium, municipal civil protection, and an aquatic squadron to assess its condition. The left eye was observed open in photographs taken inside the aquarium. This was the northernmost record.

larger nutrient-rich areas related to cold conditions. Therefore, their coverage increases and reaches atypical northern latitudes. A valuable aspect of this record is that, even though it was only one individual, several sustained reports from January to June allowed us to determine its presence for almost half a year at different Mexican locations. Sightings were separated by up to 720 km between Maruata and Mazatlán.

The other extant record of this nature of a Galapagos sea lion took place during the warm conditions of the 1997-1998 El Niño in the La Encrucijada Biosphere Reserve (15º 41' 15" N, 92º 01' 23" W), 25 km south of Acapetahua, Chiapas, located 1,800 km northeast of the Galapagos Archipelago, Ecuador. This record included two dead males and an emaciated female that eventually died (Ceballos et al., 2010). Despite the well-known negative effects of El Niño on Galapagos sea lions (Páez-Rosas et al., 2021), this species has exhibited trophic flexibility during these abnormal conditions. Páez-Rosas et al. (2020b) evidenced a response to anomalous warm conditions that included reduction of the foraging niche and a higher consumption of prey found in deeper waters. Although this flexibility was described during abnormally warm conditions, it suggests that some individuals, such as *Zw*-LN21, could also display foraging variations under cold scenarios.

Figure 2. Photographic catalog of *Zw*-LN21, observed from January to June 2021 on beaches in the Mexican Central Pacific and the entrance to the Gulf of California, from which it was possible to distinguish morphological characteristics for its identification and follow-up: (#1) Majahuitas Beach, Jalisco; (#2) Mayan Vidanta Beach, Puerto Vallarta, Jalisco; (#3) Punta Burro, Nayarit; (#4) Azul Beach, Manzanillo, Colima; (#5) Maruata Beach, Michoacán; (#6) Melaque Beach, Jalisco; (#7) Las Gemelas Beach, Puerto Vallarta, Jalisco; and (#8) in front of Universidad Autónoma de Occidente, Mazatlán, Sinaloa. (*Photo credits:* JEM-V [#1 & 3]; Protección Civil Puerto Vallarta [#2]; ML-G [#4]; social net [#5]; Estela Carretero, Universidad de Guadalajara [#6]; Frank McCann [#7]; and https://www.noroeste.com.mx/mazatlan/encalla-lobo-marino-en-playa-de-mazatlan-XD1027743 [#8])

Figure 3. Image comparison between the recorded adult male Galapagos sea lion (*Zw*-LN21) sighted in the Mexican Central Pacific (top left) and another adult male of the same species (*Zw*A) photographed on the Galapagos Islands (top right), an adult male California sea lion (*Zalophus californianus*; *Zc*A) (bottom left), and a subadult male CSL (*Zc*SA) (bottom right). The protrusion of the subadult CSL's neck is thinner compared to that of the adult male *Zc*A. (*Photo credits:* DP-R [Galapagos sea lions from the Galapagos Islands] and FRE-V [two California sea lions])

Zw-LN21 exhibited an apparent disease related to at least one of its eyes. During most of its sightings, the individual had his eyes consistently closed. This individual could have been blind; however, there is no certainty about its exact health condition. Completely blind CSLs have stranded and eventually seemed to survive—most likely their feeding was aided by their highly sensitive vibrissae (Elorriaga-Verplancken et al., 2018), which have been demonstrated to facilitate a high detection capability in absence of light (Dehnhardt, 1994). Blind sea lions may be able to survive in the wild by switching their regular diet to benthic prey, using their vibrissae to detect food close to the sea floor (Thomas & Kastelein, 1990). If *Zw*-LN21 was partially blind, it could have taken advantage of shallow waters along the geographic regions where it was recorded. Additionally, the individual apparently gained weight from January to May (Table 1; Figure 2).

On 4 June 2021, *Zw*-LN21 appeared stranded, and organizations/institutions from Mazatlán (an aquarium, municipal authorities, civil protection, and the aquatic squadron) captured it with the aim of treating its apparently wounded eye and its general condition. It died 3 days later due to several probable factors, including age or health conditions that were not possible to identify. The necropsy report drafted by the collecting organizations was shared on social media (https://tvpacifico.mx/noticias/264506-fallecio-lobo-marino-rescatado-en-playas-de-mazatlan), which described several internal traumas, including fractured ribs and other lesions. Given the lack of official information on this necropsy, the cause of death of *Zw*-LN21 must be taken with caution. Further inferences cannot be made in relation to the magnitude of these injuries or their origin.

It is not possible to determine how abnormal environmental conditions and the health condition of *Zw*-LN21 were related to its extralimital record and death. Based on previous references that involve both warm and cold abnormal conditions and their connection to unusual dispersal events in pinnipeds, the effect of oceanographic factors is underlined as one of the most probable triggers of its long trip from Galapagos. On 17 March 2021 (within our analyzed period), a live Galapagos fur seal (*Arctocephalus galapagoensis*) was sighted in Marquelia (state of Guerrero, Mexico), 2,000 km north of the Galapagos Archipelago (https://guerrero.quadratin.com.mx/arriba-lobo-marino-a-playa-las-penitas-de-marquelia). However, this record has not been formally analyzed.

Extreme events involving Galapagos sea lions, and other aquatic species, should be monitored closely. These types of records will likely continue to occur due to more frequent and intense oceanographic anomalies as seen in recent decades related to ongoing climate change (Freund et al., 2019). These constant individual records and their environmental context constitute valuable information for a better ecological understanding of species, especially those that are endangered and declining, such as the Galapagos sea lion (Trillmich, 2015). Furthermore, they provide scenarios for enhanced long-term research, as well as more rigorous conservation plans.

Acknowledgments

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From Monitoring to Final Disposition: Collaborative Response to the First Live Sperm Whale (*Physeter macrocephalus*) Stranding in Alabama, USA

Jennifer C. G. Bloodgood,[1,2] Mackenzie L. Russell,[1] Cristina Díaz Clark,[1]
Elizabeth E. Hieb,[1] Debra P. Moore,[3] Theresa R. Madrigal,[4]
Scott Carmichael,[1] and Ruth H. Carmichael[1,2]

[1]*Dauphin Island Sea Lab, Dauphin Island, AL, USA*
[2]*School of Marine and Environmental Sciences, University of South Alabama, Mobile, AL, USA*
E-mail: bloodgood.jennifer@gmail.com
[3]*Mississippi State University, College of Veterinary Medicine, Mississippi State, MS, USA*
[4]*Institute for Marine Mammal Studies, Gulfport, MS, USA*

Large whale stranding responses present unique logistical challenges, particularly when the whale strands alive. Few case reports exist that share successful approaches to the many phases of response. For live large whale strandings, response efforts need to consider animal welfare, human safety, and the ability to collect, archive, and share meaningful diagnostic information. Rapidly collected biological samples from these strandings are vital to understand causes of death, build knowledge of basic biology and ecology, and support conservation and management for these protected species. Published, peer-reviewed case reports of large whale strandings primarily focus on euthanasia (e.g., Daoust & Ortenburger, 2001; Kolesnikovas et al., 2012; Harms et al., 2014), providing few details on live-animal monitoring, postmortem transport, necropsy, or disposal (e.g., Heyning & Heyning, 2001; Neto et al., 2008). According to Boys et al. (2021), however, even publications describing marine mammal euthanasia rarely include details on methods (provided in 3.1% of publications) and time to death (provided in 0.5% of publications). Additionally, most case examples focus on Mysticetes, and only one report of a response to a live sperm whale (*Physeter macrocephalus*) is available (Peterson & Hoggard, 1996; for review, see Boys et al., 2021). Because large whale strandings are rare in most regions, published reports are extremely valuable to inform the efficiency and success of future response efforts.

Sperm whales are the largest Odontocete species and are globally distributed in deep marine waters (Rice, 1989; Whitehead, 2002). They are listed as "Vulnerable" by the International Union for Conservation of Nature's (IUCN) *Red List* (Taylor et al., 2019), and in the United States, they are protected under the Marine Mammal Protection Act of 1972 and the Endangered Species Act of 1973. In the Gulf of Mexico (GOM), sperm whales are widely distributed along the continental slope and in oceanic waters. The most recent stock assessments estimate that there are ~1,180 individuals in this region, and these represent a genetically distinct population (Engelhaupt et al., 2009; Garrison et al., 2020). While information on GOM sperm whales is increasingly available, the population remains logistically difficult to study, and there have only been 16 sperm whale strandings on the GOM coast of the U.S. since 1 January 2011 according to the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) National Marine Mammal Health and Stranding Response Program (MMHSRP) database (*https://mmhsrp.nmfs.noaa.gov/mmhsrp*). Hence, sperm whale strandings, especially live-animal strandings, provide unique opportunities to collect valuable data on this population in the GOM.

Local marine mammal stranding networks in the U.S. are authorized by NOAA NMFS to respond to live- and dead-stranded marine mammals. The Alabama Marine Mammal Stranding Network (ALMMSN) at the Dauphin Island Sea Lab (DISL) is the only entity authorized to respond to stranded marine mammals in the state. This paper details the ALMMSN response, from initial report to final disposition, for the first documented live sperm whale stranding in Alabama. The animal stranded out of habitat inside Mobile Bay, which is >100 km from the nearest known sperm whale habitat (Garrison et al., 2020). We highlight the challenges and successful aspects of the response, including multi-day live-animal monitoring, in-water sedation and euthanasia, transport, field necropsy, personnel safety, and the importance of interagency collaboration throughout the process. For the sedation and euthanasia phase of response, we provide detailed doses and times of drug delivery, animal response, and time to death. Our findings will benefit other stranding networks by informing best practices for coordinating large whale stranding response, particularly in areas where these strandings are rare and resources may be limited.

Initial Report and Monitoring

Day 1—The live-stranded, out of habitat sperm whale was reported by a member of the public to ALMMSN at 1455 h on 19 November 2020. Personnel from the Alabama Department of Conservation and Natural Resources (ADCNR) were first on scene at 1613 h and provided on-water support throughout the response. The whale was stranded in 1 to 2 m of water near Weeks Bay on the eastern shore of Mobile Bay (Figure 1, Location A). The animal's respiratory rate was ~3.4 breaths per 5 min, and it was occasionally exhaling underwater. The animal was also moving unpredictably, including moving its flukes and pectoral fins, arching and turning its body, and listing to its left side (Table 1). Due to safety concerns (e.g., animal behavior, water depth, waning daylight), a response crew was designated to monitor the animal by boat from ~30 m away to maintain visual contact but avoid stress to the animal and potential human safety hazards. The crew lost sight of the whale after dark on a rising tide, and efforts to find it with spotlights were unsuccessful.

Day 2—On 20 November 2020, ADCNR and ALMMSN staff searched for the whale by boat, starting at the animal's last known location. At ~0900 h, the whale was reported by the public to ALMMSN as restranded in 1 to 2 m of water in Navy Cove, ~19 km southwest from the original stranding location (Figure 1, Location B). The on-water search crew was able to rapidly deploy to the restranding location and begin monitoring by 0915 h. Representatives from ALMMSN, ADCNR, and stranding network partners from Mississippi (the Institute for Marine Mammal Studies [IMMS] and Mississippi State University, College of Veterinary Medicine [MSU-CVM]) monitored the animal from boats throughout the day.

Two responders, one a veterinarian, approached the whale on foot in the water to perform a basic veterinary assessment. The animal was in poor body condition, the skin cranial to the dorsal fin was moderately blistered and peeling from sun exposure, and the animal's respiratory rate was 2 breaths per 5 min (Table 1). Responders covered the exposed skin with wet sheets to prevent further sun damage. The whale was alert and responsive to movement in the water. Vocalizations (clicks) from the animal were heard and felt by responders in the water and heard from the response boat ~10 m away.

Due to the animal's poor condition and prognosis, euthanasia was considered the most humane option. Estimated weight and length measurements were necessary to allow veterinarians on-site to determine doses needed for sedation and euthanasia drugs. Using a tape measure, in-water responders estimated the straight length of the whale as 1,097 cm, and this length was applied to estimate weight at 13,507 kg using the *WhaleScale* app (Harms, 2019). Due to the unusual nature of a large whale stranding in the area, sufficient drug doses were not on hand. Coordinated efforts with southeastern and west coast partners, including IMMS, MSU-CVM, NOAA, and The Marine Mammal Center in California, ensured adequate doses of sedation drugs were available the following day.

Day 3—The whale moved out of sight of boat-based monitoring crews overnight, and search efforts to relocate the whale resumed early on 21 November 2020. Due to the potential for active movement by the animal and distance between previous stranding locations, ALMMSN requested aerial support to increase search capacity. On-water and aerial search efforts, aided by ADCNR and the U.S. Coast Guard (USCG), were unsuccessful in locating the whale.

Figure 1. Map of the stranding locations (referenced in the text and in Table 1) of the sperm whale (*Physeter macrocephalus*) in Mobile Bay, Alabama

Day 4—The whale was resighted at ~1100 h on 22 November 2020 near Daphne, Alabama, a residential area ~37 km north of the previous stranding location on the eastern shore of Mobile Bay (Figure 1, Location C). ALMMSN staff arrived on scene at 1211 h. The whale was in 1 to 2 m of water adjacent to a publicly accessible waterfront park. The high visibility and accessibility of the area enabled members of the public to approach the whale by kayak, on foot, and with a recreational drone. Local media also arrived on scene and were broadcasting live. NOAA Office of Law Enforcement and Alabama Law Enforcement Agency representatives provided critical crowd control, and ADCNR provided additional boat resources and support personnel from the Marine Resources and Wildlife and Freshwater Fisheries Divisions. The whale's respiratory rate was ~9.2 breaths per 5 min, and it was occasionally exhaling underwater and rocking from sternal to lateral recumbency (Table 1). For safety, the stranding team monitored the animal from boats ~40 m away. After dark, monitoring became more difficult, and the whale, which became more mobile with the rising tide, struck the monitoring boat unexpectedly. Due to human safety concerns, vessel monitoring efforts were halted for the night.

Days 5 & 6—On-water and aerial search efforts by ADCNR and USCG personnel were unsuccessful on 23 November 2020. During these efforts, ALMMSN maintained communication with the public, community collaborators, and stranding network partners. The whale was resighted by a member of the public at 1054 h on 24 November 2020 ~25 km southwest of the Day 4 stranding location on the western shore of Mobile Bay near Fowl River (Figure 1, Location D). ALMMSN staff arrived on scene at 1154 h. High winds and rolling waves made the water functionally deeper than previous beachings (~1.5 to 2 m). The whale was rocking from sternal to lateral recumbency with the surf and lifting its flukes, making approach for sedation and euthanasia impossible. Its respiratory rate had decreased to ~1.8 breaths per 5 min (Table 1). Personnel from ALMMSN, IMMS, and MSU-CVM monitored the animal with support from the Mobile Police Department and ADCNR until sunset.

Day 7—At 0609 h on 25 November 2020, an on-site ADCNR officer confirmed that the whale was in the same location as the previous day. The water depth was ~1.5 m, and the animal remained in sternal recumbency and was less mobile than on previous days. The animal was alert, and some vocalizations (clicks) were occasionally audible. Its respiratory rate was ~4 breaths per 5 min, and the breaths were weak (Table 1). A crew of two veterinarians and two biologists from ALMMSN, IMMS, and MSU-CVM was deployed on a floating mat to assess the whale's condition and prepare for possible euthanasia. The mat was connected by a line to the response boat for safety with a designated support staff person monitoring the line (Figure 2a). The animal was not responsive to stimuli (gentle prodding with a paddle). It was deemed safe and appropriate to proceed with sedation and euthanasia under approval of the NOAA NMFS MMHSRP Southeast Regional Coordinator.

Sedation and Euthanasia

Sedation and euthanasia protocols for this specific stranding were drafted with input from colleagues at NOAA, North Carolina State University Center for Marine Sciences and Technology (NCSU CMAST), University of North Carolina Wilmington (UNCW), and Woods Hole Oceanographic Institution (WHOI). Successful sedation and intracardiac (IC) euthanasia were performed by ALMMSN, IMMS, and MSU-CVM using combined resources and established methods that were modified for deeper water (Harms et al., 2014).

Support staff on the boat recorded the animal's behavior and respirations, as well as estimated dosage and timing of administered sedation and euthanasia drugs. Sedation was accomplished starting at 1012 h, with a combination of intramuscular (IM) midazolam (675 mg; 0.05 mg/kg), acepromazine (2,701 mg; 0.2 mg/kg), and xylazine (47,275 mg; 3.5 mg/kg) administered in the epaxial muscle, allowing 10 to 15 min between drugs (1012 h, 1026 h, and 1039 h, respectively; Figure 2b). The whale's respiratory rate continued to be ~4 breaths per 5 min during this time. Respirations continued to be weak, and the animal was occasionally exhaling underwater (Table 1).

Additional IM midazolam (150 mg; 0.01 mg/kg) was administered at 1055 h to determine if deep sedation would lead to euthanasia. The whale lifted its flukes out of the water at 1059 and 1106 h. The animal did not expire after deep sedation; however, it listed slightly to its right side with the water current at 1125 h and remained in that position. Only two breaths were taken from 1101 to 1132 h, after which the blowhole remained open. With consultation of NOAA, UNCW, and WHOI partners, the decision was made to proceed with IC potassium chloride (KCl) for euthanasia.

At 1152 h, an ~7 cm incision was made through the blubber ~22 cm dorsal to the caudal aspect of the left pectoral fin insertion. A lidocaine block was not performed due to water depth and the improbability of relocating the block site after administration. A custom-made, 1-m long needle designed for large whale euthanasia (Harms et al., 2014) was inserted through the incision into the

Table 1. Daily monitoring log for the sperm whale (*Physeter macrocephalus*) stranded in Mobile Bay, Alabama, including stranding location, water depth, average respiratory rate, animal behavior, and hazards to personnel

Day	Location (depth, m)	Respiratory rate/5 min	Animal behavior	Hazards
1	A (1.0-2.0)	3.4	• Exhaling underwater • Flukes and pectoral fins moving, arching, turning whole body, listing to left side	• Deep water • Large and unpredictable movements of whale • Waning daylight
2	B (1.0-2.0)	2.0	• Skin blistering and peeling from sun exposure • Clicking and moving head in response to people in water	• Deep water • Response personnel near whale for veterinary assessment
4	C (1.0-2.0)	9.2	• Exhaling underwater • Rocking from sternal to lateral recumbency	• Deep water • Public approaching animal by foot, kayak, and drone • Waning daylight • Animal struck boat after dark
6	D (1.5-2.0)	1.8	• Rocking from sternal to lateral recumbency • Lifting flukes	• Deep water • High wind with rolling waves • Waning daylight
7	D (1.5)	4.0 (pre- and during sedation)	• Clicking • Weak breaths • Exhaling underwater post-sedation • Lifting flukes post-sedation	• Deep water • Response personnel near whale for sedation and euthanasia

heart (entry into the left atrium confirmed during necropsy), and 4.8 L of saturated KCl solution (~300 mg/ml) was administered at 1156 h (Figure 2c). The animal lifted its flukes once at 1157 h and rolled into right lateral recumbency, after which no further movement was noted. No heartbeat, palpebral or corneal reflexes, or respirations were detectable at 1206 h. Total time to death from initial sedation was 1 h 54 min. Blood for diagnostics was drawn from the ventral fluke vein at 1219 h (Nollens et al., 2018).

Postmortem Transport and Necropsy

Postmortem transport and necropsy were complicated by the animal's large size. Professional partners trained in rigging, towing, and heavy equipment operation were instrumental in successful recovery of the euthanized animal for necropsy. Because of proactive planning among ALMMSN, NOAA NMFS MMHSRP, the U.S. Army Corps of Engineers, and a local tow boat company, transport commenced within 1.5 h of euthanasia. Two orange ring buoys were attached to the animal to aid visibility on the water prior to towing (Figure 2d). The animal was towed by boat (8.5 m in length with twin 150 hp engines) from the euthanasia location to a shipping dock (~14 km at 3.4 kts; total time ~2.5 h) using an ~11-m long, 1.6-cm diameter blue synthetic tow line attached to a 6-m long yellow endless synthetic sling (~3,800 kg capacity) girth-hitched around the peduncle. Although the animal was negatively buoyant, it was kept at the water surface when underway by forward movement of the tow boat and was identifiable by a round yellow buoy attached to the tow line. An ADCNR enforcement boat escorted the towing vessel as an additional safety measure.

Once at the dock, crews from a local construction company helped attach the synthetic sling to the whipline of a crane (Liebherr LR 1280; overall capacity 300 tons; Liebherr, Bulle, Switzerland), suspending the whale vertically in the water with flukes at the surface. The round yellow buoy was attached to the peduncle to identify the whale in case it sank. A second line (14-m long blue endless synthetic sling with ~9,000 kg capacity) was basket-hitched around the peduncle cranial to the first line, and a 10-kg steel bow shackle was used to sink the line along the animal's body. The second line was attached to the forks of a Caterpillar TH407C Telehandler (~3,700 kg capacity; Caterpillar, Deerfield, IL, USA) that was maneuvered to position the line around the axilla, elevating the animal sternal in the water. A third line, identical to the second line, was weighted and basket-hitched around the maxilla. The whale's weight was distributed as evenly as possible among the lines, and all three lines were secured to the crane. The animal was lifted from the water and lowered to ~1 m above ground level for photographs (Figure 2e)

Figure 2. Assessment, euthanasia, and transport of the sperm whale stranded in Alabama: (a) Initial assessment from a floating mat connected by a line to a response boat on day of euthanasia; (b) intramuscular sedation; (c) placement of large whale euthanasia needle, shown immediately post-euthanasia; (d) preparation for postmortem transport showing the sling (yellow) and line (blue) used for towing; two orange ring buoys demarcate the whale, and the fluke is visible above the water; and (e) postmortem view of the whale showing placement of sling and lines to lift the animal from the water using a crane.

before being lifted into a semi-end dump trailer for transport (~0.25 km) to a privately owned location for necropsy.

During transportation of the whale, ALMMSN personnel began preparation for a large-scale, field-based necropsy. Preparation included packing and transporting necessary supplies and equipment, recruiting personnel and assigning roles, preparing sample collection checklists and protocols in coordination with NOAA NMFS MMHSRP (including requests from researchers across the U.S.), and coordinating logistical operations with property owners at the necropsy location. The necropsy was performed during the following 2 d, which included the U.S. holiday of Thanksgiving Day. ALMMSN was assisted by personnel from regional stranding network partners (DISL, IMMS, MSU-CVM, Gulf World Marine Institute, and Emerald Coast Wildlife Refuge) and a local small animal emergency hospital, which facilitated some time-sensitive sample analyses.

The necropsy field site was set up with eight stations (Figure 3), with personnel assigned to each station to efficiently perform tasks. Each day started with a safety briefing and clear assignment of roles and responsibilities, and there was always a trained Emergency Medical Technician on scene for human safety. Prior to entering the site, personnel were required to outfit themselves at the Personal Protective Equipment (PPE) station (1) as appropriate for their assigned task. To avoid carrying sharp or contaminated tools throughout the site, a Tools station (2) that included a cleaning and sharpening area was situated adjacent to the Necropsy trailer (3) where the whale was located. A notetaker was stationed at the Necropsy trailer. Tissues removed from the carcass were examined and transferred to Subsampling (4) and Collection (5) stations for initial processing and storage for diagnostic analyses, respectively. Supplies were transported and stored in an enclosed trailer with a generator (6; Honda EU3000iS 3,000 watt, 120V inverter generator; Honda, Hamamatsu, Shizuoka, Japan) for powering equipment. Photographers (two) moved among stations as needed.

Clean areas were accessible by crossing through a Decontamination station (7), clearly designated with foam mats, where personnel discarded or cleaned and removed PPE and washed exposed skin before crossing the biosecurity line. The First Aid/Rest station (8) included an area for photography equipment and datasheets and an area with first aid supplies, seating, food, and drinks available. A facility with running water, restrooms, and showers was accessible within walking distance of the necropsy field site.

The necropsy was completed with the whale in right lateral recumbency inside the dump trailer, allowing for easy carcass disposal but limiting the necropsy examination and sampling to the animal's left side. Additionally, the number of personnel inside the truck was limited to four to five people at a time due to safety concerns and space constraints. Additional safety measures were implemented and clearly communicated with all necropsy team members to ensure safe movement of personnel and equipment, via manually stabilized ladders, in and out of the Necropsy trailer. During necropsy, the actual straight length of the animal was measured as 1,020 cm. Successful placement of the euthanasia needle in the left atrium of the heart was confirmed. After necropsy, the carcass was transported inside the dump trailer to a remote property for burial. The truck was weighed at a weigh station before and after carcass removal to obtain an estimated carcass weight of 15,585 kg.

Photos of the whale's flukes taken during necropsy were matched to a sperm whale photographed by NOAA NMFS with approximately seven other sperm whales on 1 August 2012 along the Florida Escarpment (25.722°, -84.670°; ~800 m water depth), ~600 km from the entrance to Mobile Bay (L. Aichinger Dias, UM-CIMAS/ NMFS SEFSC, pers. comm., 26 January 2021).

Challenges and Successes

This unprecedented case underscores the importance of interagency collaboration to facilitate success at all levels of stranding response, including monitoring, sedation and euthanasia, postmortem transport, necropsy and sample handling, and carcass disposal. In total, more than 20 agencies from multiple states provided on-water, aerial, and logistical support. A Unified Command approach under the Incident Command System (ICS), modified for the number of available personnel and complexity of this event, was instituted to organize and coordinate this multiagency response effort (Geraci & Lounsbury, 2005). The ICS, a component of the National Incident Management System in the U.S., is designed to provide a hierarchy of command and organization to an incident response (e.g., Wilkin et al., 2017). Use of the ICS in large whale stranding response is recommended to help define clear roles and responsibilities (Geraci & Lounsbury, 2005). Multiple ALMMSN staff members had up-to-date ICS training, including advanced trainings at the 300 and 400 levels. Basic ICS trainings are provided online and free of charge through the Federal Emergency Management Agency (FEMA) at *https://training.fema.gov/nims*.

Planning—Proactive and collaborative planning was essential to smoothly and efficiently accomplish all parts of the response. The rapidly changing status of the animal's location and condition required adaptability and flexibility in response efforts. ALMMSN, NOAA, and other partners remained in constant communication to plan for multiple possible stranding scenarios and response options. For example, early in the response when euthanasia was determined as the most humane outcome for the stranded animal, planning commenced on logistics for towing, necropsy, and carcass disposal. Though euthanasia was not undertaken for several more days, proactive planning allowed for development of primary and alternative plans that could be quickly implemented when needed. This approach also helped to identify resources, such as local professionals and heavy equipment, that would prove invaluable

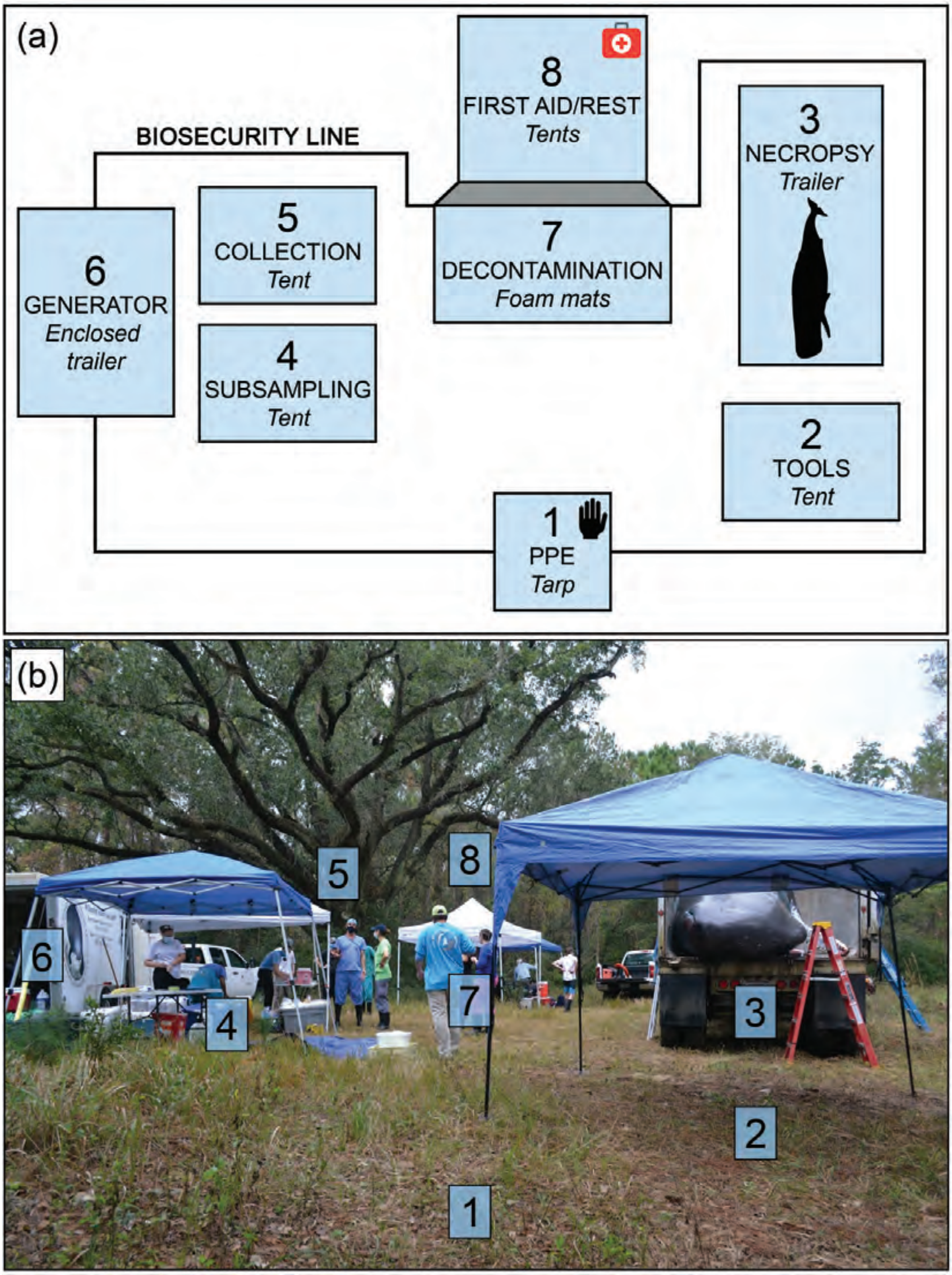

Figure 3. Necropsy field site: (a) Schematic of workstation layout. The biosecurity line demarcates the "contaminated" zone (inside the line where personal protective equipment [PPE; glove icon] was required) and the "clean" zone (outside the line). The dark gray shaded area represents the transition area from the contaminated to the First Aid/Rest station (first aid kit icon); and (b) photo of field site setup prior to beginning the necropsy. Numbers correspond to the stations in (a), which are described in the text. The PPE (1) and Tools (2) stations were not yet set up at the time this photograph was taken.

at later stages of the response. Of note, these efforts specifically facilitated timely collection and processing of some samples over a holiday when most analytical facilities were not accepting shipments or running diagnostics. Collaborative planning among various groups allowed use of collective resources and expertise and ultimately improved the success of the response efforts and the quality of data collected.

Safety—Safety was of paramount concern throughout the response effort. Concerns included the inherent risks of working with a large whale, adverse weather and water conditions, responder fatigue caused by long hours working outside, and biohazard safety and decontamination, among others. A Safety Officer was appointed early in the response to oversee safety protocols. Participant roles were discussed daily, and a debrief was held nightly, with assignments changing as needed. An effort was made to limit monitoring crews to two observers for no more than 8 h to limit personnel fatigue. Experienced captains, trained in marine mammal approach and with familiarity to local waters, supported all on-water activities, and ADCNR provided a boat captain for most overnight shifts. First aid and trauma kits and USCG-required safety equipment were always present on vessels, in vehicles, and at the field site, and all staff, including partners outside ALMMSN, were informed of the locations of these resources. ALMMSN staff are trained in cardiopulmonary resuscitation (CPR), automated external defibrillator (AED) use, and bleeding control response, and ALMMSN has an Emergency Action Plan for worst-case scenarios. Core ALMMSN staff also have 24-Hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training (developed by the Occupational Safety and Health Administration [OSHA], U.S. Department of Labor), which informed layout of the necropsy field site, particularly organization and use of the PPE, Decontamination, and First Aid stations. ALMMSN's previously developed safety protocols, training, and availability of the necessary safety equipment provided a solid basis for additional safety measures that proved important during this unique response.

Communications—Communication was a critical component of this high-profile response. A Public Information Officer from ALMMSN was designated to speak with the media so that veterinarians and stranding staff could focus on response efforts. A member of the on-water stranding team was assigned as a Communications Officer to share timely updates with the Public Information Officer. Regular media updates, including facts about sperm whales, status of search efforts, and contact information for the ALMMSN stranding hotline, were used to increase public awareness and likelihood of reporting resightings, which were vital to rapid response. Ultimately, the story was shared broadly on social media and picked up by local, regional, national, and international media outlets. Information shared with the public was vetted through the DISL and NOAA Communications offices. We found daily updates were efficient and effective, with initial posts made through social media and then added to a cumulative news story on the DISL website so that anyone following the story could see all daily updates in one location. We additionally included a Frequently Asked Questions section on the website. This approach allowed us to refer stakeholders quickly and easily to key information and to maintain consistency in public messaging throughout the response without duplicating efforts.

Communication with and participation by community partners such as law enforcement officers was critical to animal welfare as well as public and responder safety. The whale stranded in four locations across Mobile Bay, moving nearly the full length of the bay and stranding on both shorelines adjacent to residential areas over the course of 7 d (Figure 1). This wide area and extended time period garnered a great deal of public attention, making crowd control and public relations vital to ensure safe conditions throughout the response. To aid these efforts, ALMMSN communicated with ADCNR personnel as part of daily briefings and notified the USCG daily of the whale's last known location to inform safety alerts (also known as a "BOLO") for vessels in the area. Law enforcement officers were also instrumental in preventing public access to the animal in shallow waters and grounding a drone that was flying low and creating noise near the animal. Keeping community partners updated on public relations also helped to maintain consistent messaging so that these agencies and their public relations specialists could refer questions back to vetted information. Our established relationships and communications with community partners (e.g., ongoing outreach and education activities and regular training for first responders, law enforcement, municipal authorities, and other officials), which are part of regular stranding network operations, facilitated these interactions and vastly improved the response to this unprecedented event.

Conclusion

This case report contributes to the sparse literature on large whale stranding response by providing novel details on all phases of response—from monitoring and euthanasia to carcass transport, necropsy, and disposal of the first documented live-stranded sperm whale in Alabama. Stranding response and euthanasia of large whales is logistically challenging, requiring large doses of drugs, specialized equipment, and heightened safety and communications considerations due to the animal's large size. This unprecedented case highlights the need for stranding networks to have ready access to a large whale euthanasia kit and large volumes of sedation and euthanasia drugs, either on hand or via agency partnerships, even in locations where large whale strandings are uncommon. It also underscores the importance of training opportunities, such as advanced life support, bleeding control, ICS, and HAZWOPER, for stranding network members and funding to invest in these opportunities. Proactive planning, education and outreach, and protocol development that is part of regular stranding network operations can prove invaluable as a framework for unique and challenging stranding events such as the case presented herein. During ALMMSN's response to the first live large whale stranding in Alabama waters, preparedness, collaboration, and communication among local, state, federal, and private agencies were key to success.

Acknowledgments

We would like to thank all organizations involved in the response effort; ALMMSN staff and volunteers; B. Mase and the NOAA NMFS MMHSRP for help coordinating this response; and C. Harms at NCSU CMAST, W. McLellan at UNCW, and M. Moore at WHOI for their input on the sedation and euthanasia protocol. We thank the following participating agencies (in alphabetical order) for sharing personnel and resources to support the response: ADCNR, Alabama Law Enforcement Agency, Emerald Coast Wildlife Refuge (B. Dolan and D. Siesriez), Esfeller Construction, Gulf World Marine Institute (L. Albrittain), IMMS, MedVet Mobile, Mobile Police Department, MSU-CVM (S. Hughes, K. McNulty, and T. Morgan), NOAA Office of Law Enforcement (Officer G. Kornegay), NOAA Communications, The Marine Mammal Center, TowBoatUS Mobile/Blue Diving & Salvage, LLC, U.S. Army Corps of Engineers, and U.S. Coast Guard Air Station New Orleans, Aviation Training Center – Mobile, Sector Mobile, and Station Dauphin Island. Stranding response was conducted under the Stranding Agreement between DISL and NOAA/NMFS and NMFS MMHSRP Permit #18786. Response was funded by NOAA NMFS and *Deepwater Horizon* natural resource damage settlement funds provided by the Alabama Trustee Implementation Group with funding support and participation of ADCNR.

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Yawn-Like Behavior in a Beluga Whale (*Delphinapterus leucas*)

Audra E. Ames

Fundación Oceanogràfic de la Comunitat Valenciana,
Calle Eduardo Primo Yúfera (Científic) No. 1B, Valencia 46013, Spain
E-mail: aames@oceanografic.org

The yawn is a ubiquitous behavior marked by involuntary mouth opening with elongated inspiration, a peak in mouth gape, followed by a slow expiration with simultaneous mouth closure (Baenninger, 1997; Walusinski & Deputte, 2004; Guggisberg et al., 2010; Palagi et al., 2020). This basic yawning pattern is phylogenetically widespread as it has been reported for primate species (e.g., chimpanzees [*Pan troglodytes*]: Vick & Paukner, 2010; geladas [*Theropithecus gelada*]: Palagi et al., 2009; Tonkean macaques [*Macaca tonkeana*]: Zannella et al., 2017; and humans [*Homo sapiens*]: Provine & Hamernik, 1986; Provine, 2012) and other mammals (e.g., rats: Anias et al., 1984; African lions [*Panthera leo*]: Baenninger, 1987; African elephants [*Loxodonta africana*]: Rossman et al., 2020; wolves [*Canis lupus lupus*]: Romero et al., 2014; and domestic dogs [*Canis lupus familiaris*]: Silva et al., 2012; Romero et al., 2013), amphibians (Bakkegard, 2017; Hartzell et al., 2017), reptiles (Luttenberger, 1975), and some species of birds (Sauer & Sauer, 1967) and fish (Baenninger, 1987). Open mouth behavior similar to this sequence has also been noted for humans (Van Woerden et al., 1988; Sherer et al., 1990; Sepulveda & Mangiamarchi, 1995; Petrikovsky et al., 1999) and rats (Smotherman & Robinson, 1987) *in utero* but has been classified as "yawning without breathing" (Enokizu et al., 2021, p. 2; Enokizu et al., 2022, p. 106) given that fetuses do not breathe through the adult respiratory mechanism. As a result of removing breath from defining the typical yawn sequence, yawn-like behavior may also be classified in aquatic species. Fully aquatic mammals, for example, are voluntary breathers with an anatomically separate trachea and esophagus and, thus, do not breath through the mouth (e.g., Enokizu et al., 2021, 2022). However, some open mouth behaviors observed in the common bottlenose dolphin (*Tursiops truncatus*; Enokizu et al., 2021) and dugong (*Dugong dugon*; Enokizu et al., 2022) have been described as "yawn-like" as mouth opening and closing behavior during these open mouth events resembles that of humans and other terrestrial mammals.

In humans, the function of yawning is unclear. Hypotheses regarding yawn behavior range from sleepiness, respiration and/or circulatory needs, boredom and arousal, empathy, and thermoregulation among others (for a review, see Guggisberg et al., 2010). In animals, yawning or yawn-like behavior may occur as a reaction to encountering a conspecific (Siamese fighting fish [*Betta splendens*]: Baenninger, 1987), as an indicator of stress (bugerigars [*Melopsittacus undulatus*]: Miller et al., 2010), related to feeding (Herman's tortoises [*Testudo hermanni*] and European pond turtles [*Emys orbicularis*]: Luttenberger, 1975; lions and mandrills [*Papio sphinx*]: Baenninger, 1987; Red Hills salamanders [*Phaeognathus hubrichti*]: Bakkegard, 2017; and eastern hellbender salamanders [*Cryptobranchus alleganiensis alleganiensis*]: Hartzell et al., 2017), or during rest (e.g., ostrich [*Struthio camelus australis*]: Sauer & Sauer, 1967; and elephants: Rossman et al., 2020). In aquatic mammals (South American sea lions [*Otaria favescens*]: Palagi et al., 2019; dolphins: Enokizu et al., 2021; and dugongs: Enokizu et al., 2022), yawning or yawn-like behavior may be associated with drowsiness and arousal as it occurs during resting states.

Some aspects of yawn behavior may be socially modulated. Yawn contagion, for example, is a physiological response found in several species of social animals, including humans, that occurs when individuals yawn after perceiving a yawn in another individual (for a review, see Palagi et al., 2020). Contagious yawning has been found in all hominine species (chimpanzees: Anderson et al., 2004; Campbell & de Waal, 2011, 2014; Campbell & Cox, 2019; bonobos [*Pan paniscus*]: Demuru & Palagi, 2012; Tan et al., 2017; and humans: Provine & Hamernik, 1986; Provine, 1989), as well as in orangutans (*Pongo pygmaeus*: van Berlo et al., 2020), cercopithecid monkeys (geladas: Palagi et al., 2009; Gallo et al., 2021;

and Tonkean macaques: Palagi & Norscia, 2019), elephants (Rossman et al., 2020), lions (Casetta et al., 2021), wolves (Romero et al., 2014), dogs (Joly-Mascheroni et al., 2008; Silva et al., 2012; Romero et al., 2013), and rats (Moyaho et al., 2015). Yawn contagion also occurs interspecifically between humans and other mammal taxa. For example, chimpanzees show higher yawn contagion to humans (both unfamiliar and familiar) than to unfamiliar chimpanzees (Campbell & de Waal, 2014). Similarly, elephants (Rossman et al., 2020) and dogs (Joly-Mascheroni et al., 2008; Silva et al., 2012; Romero et al., 2013) yawn in response to yawning from familiar human caretakers. Herein is provided what is, to the author's knowledge, the first documentation of possible yawn-like behavior in a beluga whale (*Delphinapterus leucas*) while exploring yawn contagion as a possible explanation for this behavior.

During a behavioral observation session for a larger study on beluga vocal development (Ames & Vergara, 2020), a ~20-year-old female beluga ("Yulka"; Oceanogràfic, Valencia, Spain) displayed what appeared to be a yawn-like open mouth behavior (see supplementary video; the supplementary video for this paper is available in the "Supplemental Material" section of the *Aquatic Mammals* website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147) in response to a yawn by her human observer (the author, AEA). AEA observed and recorded (using a Canon Vixia HF R700; Canon, Tokyo, Japan) Yulka's behavior twice daily for 1 h each observation session during the pre-partum period of the larger study (see Ames & Vergara, 2020, for detailed methodology). During a morning observation session, Yulka was drifting at the top of the water column in Oceanogràfic's beluga habitat, oriented towards AEA, when the author spontaneously yawned. During the final phase of the author's yawn (expiration and mouth closure), Yulka tilted her head down and displayed an open mouth behavior for a similar duration to that of the author's yawn (~2 s). There was an obvious climax to Yulka's open mouth behavior, and Yulka was quicker to close than to open her mouth, similar to a typical yawn sequence (e.g., Palagi et al., 2020). Curiously, Yulka emitted a bubble stream immediately following the closure of her mouth, almost as if some exhalation was present at the end of the behavior.

As previously mentioned, it is difficult to classify typical yawning in aquatic mammals given that yawning in the aquatic environment would occur separately from breathing, and open mouth behaviors can also be indicative of alternative behavioral states. Belugas, for example, typically display open mouth behaviors in agonistic and socio-sexual interactions with conspecifics (e.g., Hill et al., 2015), so it is possible that Yulka's open mouth behavior was due to some environmental input related to these contexts. However, Yulka's only other social group member during this period within the larger study ("Kairo," a male beluga estimated to be in his mid-50s) was in a different

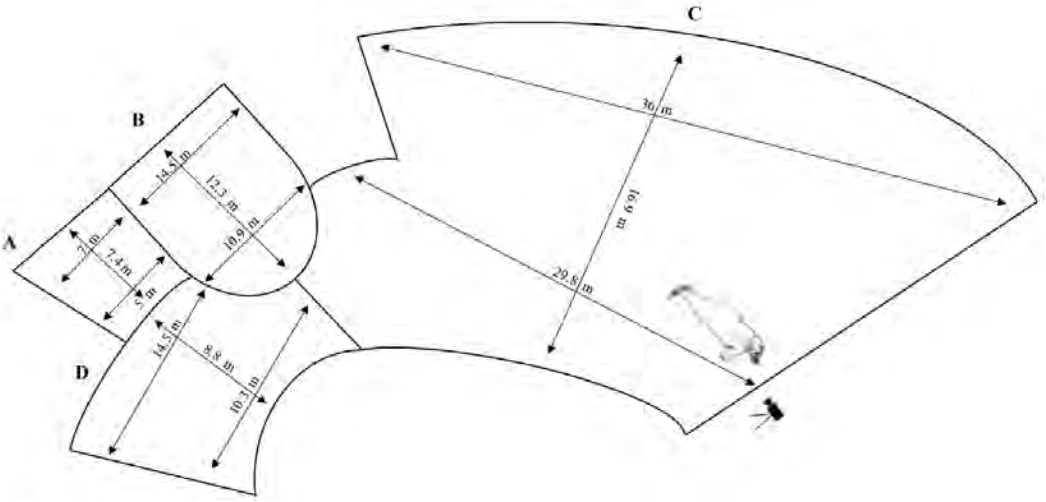

Figure 1. The pool layout of Oceanogràfic's beluga (*Delphinapterus leucas*) habitat adapted from Ames & Vergara (2020, Figure 1): (A) medical pool, (B) reproduction pool, (C) main public viewing pool, and (D) smaller public viewing pool. The "beluga" (sketch adapted from Hill et al., 2015, with permission from the original artist, Roni Dietrich) marks Yulka's location, and the "camera" marks AEA's location. Kairo was not visible on camera in pool C, which suggested he was in pool B or D at the time of the event.

habitat pool at the time of the event (Figure 1). It is possible that Yulka was directing agonistic or other behavior towards AEA, but Yulka's open mouth behavior was not accompanied by additional agonistic (e.g., bites, head jerks, melon thrusts, jaw claps; Hill et al., 2015; Lilley et al., 2020) or socio-sexual (e.g., S-postures, lateral swims, body/genital rubbing, pelvic thrusts; Hill et al., 2015) behavioral indicators. During the open mouth event, Yulka was slowly drifting at the surface of her habitat, reminiscent of the resting states for which yawning has been described to occur in dolphins and dugongs (Enokizu et al., 2021, 2022). Moreover, agonistic open mouth events are generally < 1 s in duration (Hill et al., 2015), while Yulka's open mouth behavior was ~2 s in duration, similar to the duration of yawn-like behavior in dolphins (Enokizu et al., 2021). Finally, the time elapsed from the beginning of Yulka's open mouth behavior to her maximum mouth gape was ~1 s in duration, with mouth closure occurring in < 1 s. An open-close duration ratio (i.e., the duration of mouth closure divided by the duration of mouth opening to maximum gape) of ≤ 1 is a characteristic of yawning in humans (Barbizet, 1958) and of reported yawn-like behavior in dolphins (Enokizu et al., 2021) and dugongs (Enokizu et al., 2022). Consequently, Yulka's open mouth behavior could be classified as yawn-like, though this raises additional questions as to whether this event was in response to AEA's initiating yawn and whether this exchange was due to yawn contagion.

Yulka was facing AEA at the time of the event, and the author was the only human in the observation area. As stated, it was unlikely Yulka was responding to another social group member, so if Yulka's behavior was a response, it was likely elicited via observation of her human observer. The slight overlap between the end of AEA's yawn and Yulka's open mouth behavior was inconsistent with what has been observed for the timing of yawn contagion in other species, however. Responses to contagious yawns commonly occur several minutes after the initiating yawn (Palagi et al., 2020). In elephants (Rossman et al., 2020) and dogs (Joly-Mascheroni et al., 2008), for example, yawn contagion occurred at least 1 min after repeated yawning by familiar handlers.

In elephants, it is unknown whether familiarity between allospecifics is influential to contagious yawning (Rossman et al., 2020), but familiarity seems to be key in dictating yawn contagion between humans and dogs, and may be related to bond maintenance (Joly-Mascheroni et al., 2008; Silva et al., 2012; Romero et al., 2013). Yulka has been a subject of AEA's ongoing research regarding beluga whales since the beginning of the larger study (Ames & Vergara, 2020) in September 2016. However, the current case occurred early within data collection for the larger study, so it was unlikely that Yulka was familiar with AEA at the time of the event (or possibly ever throughout the course of the study), although yawn contagion can occur between humans and animals with no degree of familiarity between allospecifics (Campbell & de Waal, 2014).

Alternatively, Yulka's open mouth behavior may have been an imitation of AEA's yawn. Imitation occurs when an individual learns about a behavior by observing another perform it (e.g., Whiten & Ham, 1992; Heyes, 1993). Like yawn contagion, imitation is driven socially (e.g., as a form of social learning; Whiten & Ham, 1992; Heyes, 1993; Kuczaj & Yeater, 2006), but imitation and yawn contagion appear to be mutually exclusive explanations for this open mouth behavior in non-human animals. Imitation, for example, was ruled out as a likely source of open mouth behavior in yawn contagion studies of dogs (Romero et al., 2013) and elephants (Rossman et al., 2020) as responses of animals in mouth movement control trials (i.e., trials in which humans performed mouth-opening or gaping movements without other yawning indicators) were significantly lower than responses during trials in which a familiar human yawned. Yawning may be contagious, then, due to perceived bonds between individuals that are not necessary for successful imitation to occur.

Belugas are known imitators. Individuals have been shown to replicate play behaviors (Jones & Kuczaj, 2014), trained behaviors (Abramson et al., 2017), and vocalizations of conspecifics (e.g., Vergara & Barrett-Lennard, 2008; Murayama et al., 2014) and allospecifics (e.g., Panova & Agafonov, 2017). Some anecdotal (Eaton, 1979; Ridgway et al., 2012) and empirical (Murayama et al., 2014) evidence indicates that belugas imitate human speech. One whale appeared to repeat his own name (Eaton, 1979), while another spontaneously emitted human speech-like sounds (Ridgway et al., 2012). However, there are no reports to the author's knowledge of instances during which belugas matched the motor movements of humans like what has been described herein. Known as kinesthetic imitation (Kuczaj & Yeater, 2006), matching motor movements with other individuals is common in mammals. Examples of kinesthetic imitation in humans include the imitation of facial behaviors (Meltzoff & Moore, 1977; Meltzoff & Prinz, 2002); and in marine mammals, kinesthetic imitation is exemplified in the synchronous behavior of bottlenose dolphins (e.g., Connor et al., 2000; Bauer & Harley, 2001; Herman, 2002; Kuczaj et al., 2012). Bottlenose dolphins have been shown to kinesthetically imitate human behaviors as well. For example, a dolphin that watched a human push a kickboard with his head on the surface of the water then pushed the kickboard with its rostrum (Kuczaj & Yeater, 2006), and dolphins use echolocation to aid in imitating human-modeled behavior underwater (Jaakkola et al., 2013). Given the beluga's propensity for imitation and social learning, belugas may also have the ability to imitate human motor movements.

In summary, Yulka's open mouth behavior was yawn-like as characteristics of the behavior were similar to what has been described for yawning in other mammal taxa, including a fellow delphinoid species. Further, behavioral indicators corresponding with other beluga open mouth behaviors were not present. More rigorous empirical study is required to elucidate this behavior further in the beluga whale. Future directions of research regarding yawn-like behavior in fully aquatic mammals may illuminate more on yawning as a "breathless" behavior which, in turn, may have implications for the function of this behavior in humans. It was difficult to attribute Yulka's yawn-like behavior to either yawn contagion or imitation, though, as it could not be determined if Yulka's behavioral display was a response to AEA's spontaneous yawn. However, if this were the case, the timing of the event (i.e., the overlap between the spontaneous yawn and the yawn-like behavior) was inconsistent with interspecies yawn contagion in other mammals. This does not eliminate yawn contagion as an explanation for Yulka's open mouth display, but imitation seems more likely given that belugas are demonstrated social learners. Ultimately, empirical study on interspecific kinesthetic imitation in belugas and humans would be necessary to confirm this ability in the beluga. Yawning in interspecies exchanges may occur independent of an animal's familiarity with its human caretakers, and, thus, the social processes underlying these exchanges should be further explored, especially regarding relationships between animals and their human caretakers in managed care settings.

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Traveling at Night: The First Record of Humpback Whales' (*Megaptera novaeangliae*) Wake Riding During the Nighttime

Guilherme Maricato,[1,2] Ana Luiza Pires,[1,3] Rodrigo H. Tardin,[1]
Sérgio C. Moreira,[1,4] Maria Alice S. Alves,[5] and Israel S. Maciel[1,2]

[1]*Laboratório de Ecologia e Conservação Marinha (ECoMAR), Departamento de Ecologia,*
Universidade Federal do Rio de Janeiro (UFRJ), Rio de Janeiro, Brazil
E-mail: guilherme.713@gmail.com
[2]*Programa de Pós-Graduação em Ecologia e Evolução, Instituto de Biologia Roberto Alcantara Gomes (IBRAG),*
Universidade do Estado do Rio de Janeiro (UERJ), Rio de Janeiro, Brazil
[3]*Programa de Pós-Graduação em Biologia Animal, Departamento de Biologia Animal,*
Universidade Federal Rural do Rio de Janeiro (UFRRJ), Rio de Janeiro, Brazil
[4]*Instituto Resgatando o Verde (IRV), Rio de Janeiro, Brazil*
[5]*Departamento de Ecologia, IBRAG, Universidade do Estado do Rio de Janeiro (UERJ), Rio de Janeiro, Brazil*

Little is known about the nocturnal behavior of whales due to the difficulty of observing behavior in the dark without the aid of expensive night-vision technology. However, passive acoustic monitoring and multisensory tagging methods have increased the number of studies focused on the nocturnal behavior of whales (e.g., Izadi et al., 2018; Calambokidis et al., 2019; Caruso et al., 2020). Most of them have been performed to assess the risk of ship strikes (e.g., Calambokidis et al., 2019; Keen et al., 2019; Caruso et al., 2020).

Ship strikes have become a growing concern in many areas around the world (Van Waerebeek et al., 2007; Schoeman et al., 2020; Smith et al., 2020), and the progressive increase in fatal ship strikes on whales has coincided with the worldwide growth in shipping traffic observed since 1950 (Laist et al., 2001). Nowadays, large vessels have implemented some measures to avoid ship strikes such as reducing speed limits on ships passing through whales' habitats and rerouting shipping channels around these areas (Gende et al., 2011; Lagueux et al., 2011; McKenna et al., 2012, 2015). However, no similar technology is available to guarantee the systematic avoidance of nighttime collisions with marine mammals.

Humpback whales (*Megaptera novaeangliae*) migrate long distances between feeding and breeding grounds (Zerbini et al., 2006; De Weerdt et al., 2020). In the western South Atlantic, humpback whales feed near South Georgia and the Sandwich Islands and breed primarily over the Abrolhos Bank and in adjacent areas of Brazil (Zerbini et al., 2006; Andriolo et al., 2010; Baracho-Neto et al., 2012). Migration can be an energetically costly strategy, especially for lactating females and calves that need to allocate their energy to either lactation or growth, respectively, and these energetic costs may be increased as a result of human activities (Braithwaite et al., 2015). Considering that whales may present different strategies to reduce energy costs, the present paper aims to report, for the first time, the behavior of humpback whales while wake riding.

On 17 July 2020, we observed a group of three humpback whales traveling close to the stern of a vessel during the night in the Campos Basin off southeastern Brazil (-21.61511º, -39.81805º) in oceanic waters approximately 1,500 m deep (Figure 1). This group consisted of two adults and one calf (less than 1/3 of the adult's body size). We were aboard a 36-m supply vessel equipped with two 1,200-hp central engines and powerful stern lights, cruising at between 5 and 6 kts, when the whales were sighted following the vessel. The whales were at a distance of 10 m from the vessel. We began systematic monitoring at 0315 h using focal-group sampling (Mann, 1999). The observation continued for 1 h, during which the whales always traveled close to the vessel stern for 10 km. On a number of occasions, a blow was observed at a distance of less than 5 m from the stern (Figure 2). The vessel was heading to the north (0º), the same direction as the migration of the humpback whales during the austral winter. Humpback whales are sighted frequently off southeastern Brazil, which is part of the migratory corridor used by these whales in their transition between feeding and breeding grounds (e.g., Zerbini et al., 2006; Lodi et al., 2020).

As far as we know, this is the first record of whales following a vessel for such a prolonged

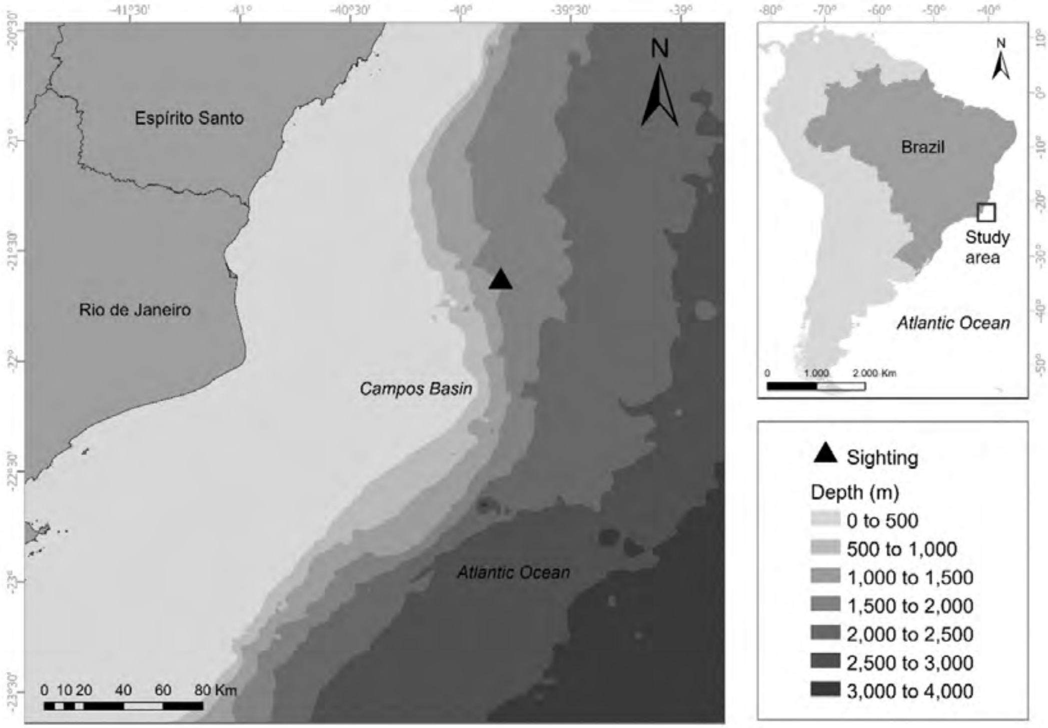

Figure 1. Sighting of the three humpback whales (*Megaptera novaeangliae*) during the nighttime in southeastern Brazil on 17 July 2020

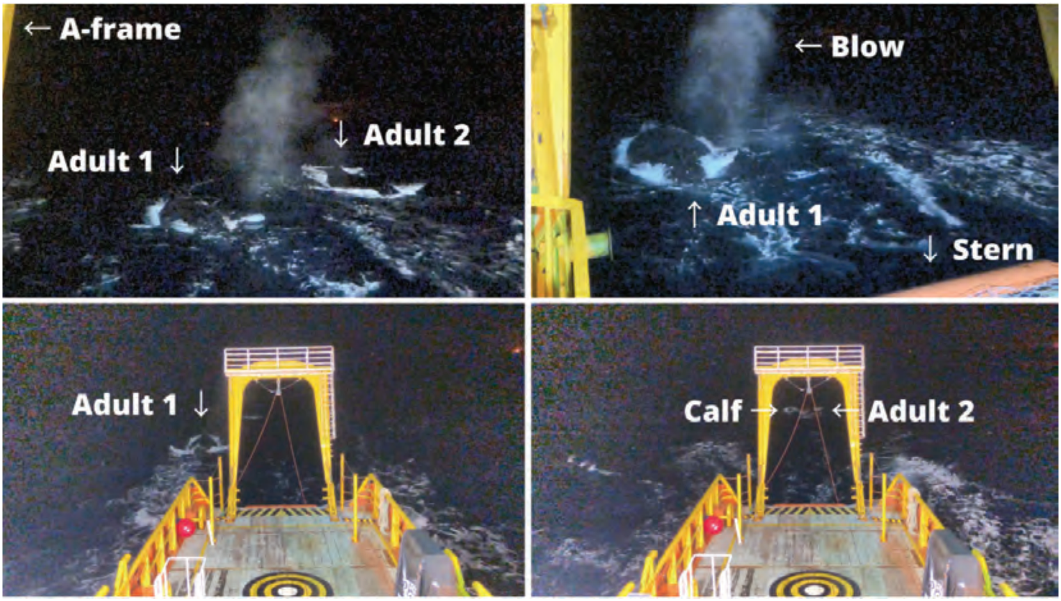

Figure 2. Photo sequence of humpback whales sighted during the nighttime in southeastern Brazil. Photos were taken from a video recorded around 0330 h on 17 July 2020.

time. Because there are no records of this type of behavior in baleen whales, we discuss herein the possible reasons. We hypothesize that these humpback whales exploited the water flow created by the vessel to save energy during the migration to their breeding grounds off eastern Brazil. As calves are likely less mobile than adults, they may "hitchhike" favorable currents and, thus, minimize energy expenditure during the seasonal migration.

Nursing the calf implies that lactating humpback whales require more energy and are, thus, more susceptible to habitat pressures (Jönsson, 1997). Lactating whales need to find alternatives to compensate their own and calves' increased energetic needs to ensure a successful migration. One of the well-known strategies is escorting. The mother–calf pair is escorted by an adult, usually a male, who provides benefits such as defense and protection from predators and other adult males (Chittleborough, 1953; Félix & Botero-Acosta, 2011; Pitman et al., 2015). Although no studies have been done for mysticetes, it has been reported for odontocetes that calves that synchronize their swimming near to their mother's body improve their average swimming speed while also reducing effort and saving energy (Noren et al., 2008; Noren & Edwards, 2011). In Australia, lactating humpback whales have been observed resting often to minimize the energy expenditure (Bejder et al., 2019). However, as whales rest near the surface, this behavior increases the risk of ship strikes (Bejder et al., 2019). In this context, wake riding may not only be an alternative strategy to save energy, but also to spend less time resting.

Our results support the need to better understand the nocturnal behavior of humpback whales to develop effective measures to mitigate the risk of ship strikes, especially during their annual migration, a critical period of the whales' life cycle.

Note: A supplemental video for this paper is available in the "Supplemental Material" section of the Aquatic Mammals website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147.

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The Survival of a Flukeless Juvenile Dolphin (*Tursiops aduncus*) in the Wild

Mi Yeon Kim,[1, 2, 3] Jae Chun Choe,[4] Dong-Guk Paeng,[5]
Shiro Kohshima,[1] and Soojin Jang[2, 4*]

[1]*Wildlife Research Center, Kyoto University, Japan*
[2]*Marine Animal Research and Conservation, Republic of Korea*
**E-mail: kesha00@gmail.com*
[3]*Jeju National University, Jeju Island, Republic of Korea*
[4]*EcoScience, Ewha Woman University, Republic of Korea*
[5]*Department of Ocean System Engineering, Jeju National University, Jeju Island, Republic of Korea*

Marine mammals are subject to external injuries from natural and anthropogenic sources. Among the leading causes of severe external injuries are vessel collision and fishing gear entanglement (Byard et al., 2012; Dwyer et al., 2014). Some individuals show remarkable recovery from these severe external injuries through rapid healing and behavioral adjustment (Elwen & Leeney, 2010; Maze-Foley & Garrison, 2020). External injuries caused by fishing gear (e.g., ghost nets and lines) can be critical as they may cause whole body entanglement or amputation of important body parts such as the dorsal fin, pectoral fins, and fluke (Nery et al., 2008). Partial mutilation of body parts or total amputation of the dorsal fin is rarely fatal for wild individuals (Wells et al., 2008). In contrast, complete amputation of the fluke is considered life-threatening and would require intervention for survival. Herein, we report on the survival of a wild, young Indo-Pacific bottlenose dolphin (*Tursiops aduncus*) with a complete fluke amputation and discuss the implications for long-term injury adjustment as well as conservation concerns.

Surrounding Jeju Island, Republic of Korea, there is a small but relatively stable population of Indo-Pacific bottlenose dolphins, with ~100 individuals observed in the island's coastal area (< 2 km), their home range (Choi et al., 2009; Kim et al., 2015). On 19 June 2019, tourists on a dolphin-watching yacht in the Kimnyeong District, northeast of Jeju Island (Figure 1), witnessed a young dolphin without a tail. A passenger recorded a 3-s video showing the dolphin bow-riding a yacht, but identity was not confirmed via the dorsal fin or other natural marks (Jang & Kim, 2019). Eyewitnesses saw the flukeless dolphin once but saw no other individual or group of dolphins in visible proximity to this dolphin throughout the day. We searched for this flukeless dolphin from land in the Kimnyeong District for two consecutive days (20 & 21 June 2019) without success.

Other studies have highlighted the importance of the carangiform locomotion in allowing dolphins to swim with a semi-lunate tail (Fish & Hui, 1991; Li et al., 2018). Two cases of dolphins without tails at aquariums have reported decreased swim speed and efficiency as the individuals adjusted their movement from an up-down to a side-to-side motion (Ueda et al., 2013; Clearwater Marine Aquarium, 2021). Therefore, survival of this young dolphin observed near Jeju Island was not ascertainable on first sighting. However, the same flukeless dolphin was observed again about 4 months later on 8 October 2019 near the Daejeong District. It would seem that this individual traveled at least 80 km along the shoreline from where it was first observed (Figure 1).

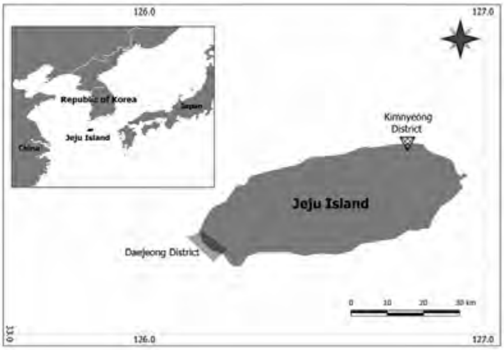

Figure 1. Map of Jeju Island showing the Kimnyeong District where the flukeless individual was first discovered (marked with a grey triangle) and the Daejeong District, which was the main study area (marked with a grey rectangle)

This individual's overall health was monitored from 8 to 11 October from a small boat (6 m, 115 hp rubber boat) and from land. Land monitoring with the naked eye or binoculars consisted of photographic surveys (Nikon D850, with Nikkor 200-500 mm), unmanned aerial vehicle surveys (Mavic Pro; DJI), and video surveys (Canon EOS-1DX Mark II). A boat survey consists of a photographic survey, an underwater video survey (GoPro4), and acoustic recording (TASCAM HD-P2, Hydrophone AQH-200, Aquafeller IV [AQA-004], Aqua-Sound). Although there are no boat regulations for dolphin watching or research in the Republic of Korea, the boat maintained a slow speed (< 5 kts) and remained at least 50 m away from the dolphin. The flukeless dolphin's close activity was recorded while the boat remained idle. The underwater video provided crucial data about how this dolphin swam and allowed for a detailed examination of the individual's injury, sex, and approximate age class. The cut shape suggests that the amputation was most likely caused gradually by entanglement in fishing lines or nets, which rules out sharp objects like blades or boat screws as a potential cause (Figure 2A & B). The amputation may have occurred by infection or natural causes; however, there was no preceding observation of severe infection in the skin layer of dolphins in this population that could cause amputation. Therefore, the injury was most likely caused by fishing gear, though a definitive cause is not possible to determine.

This flukeless individual was categorized as a juvenile male based on the lack of speckles on the belly (Figure 2; Krzyszczyk & Mann, 2012; Yagi et al., 2021). We analyzed the whistles recorded when the individual was alone to obtain its dominant whistle (Figure 2C). The dorsal fin was also photographed for future reidentification, The individual was cataloged as JTA137 in the *2019 MARC Fin Book*, which was created by the Marine Animal Research and Conservation organization (Figure 2D). During the four continuous days of close monitoring, this dolphin did not seem emaciated, with the collective evidence supporting this individual's ability to survive in the wild. Thus, it was believed that he was not in urgent need of rescue.

We analyzed this dolphin's swim sequences from underwater videos. Similar to previously reported swimming patterns of fluke-amputated dolphins in an aquarium (Ueda et al., 2013; Clearwater Marine Aquarium, 2021), he moved his peduncle left and right while moving dorsoventrally. When observed from the posterior, the peduncle's tip moved as if it was tracing an infinity symbol by twisting the peduncle upward while moving it to the other side (Figure 3; Supplemental Video: 00:20 to 00:24; the supplementary materials for this paper are available in the "Supplemental Material" section of the *Aquatic Mammals* website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147). Respirations were identified from drone footage: the dolphin surfaced in the horizontal plane then twisted his body to the right using his pectoral fins to dive back into the water. This caused a splash near the peduncle every time he took a breath—behavior which could be seen with the naked eye from land (Supplemental Video: 00:00 to 00:19).

The well-developed shoreline roads allow land monitoring of continuously moving dolphin groups around the island. Since 2014, we have conducted observations of surface behavior and movements via visual survey with the naked eye and with binoculars while constantly conducting focal group follows of dolphins from an automobile. The 2019 field research period consisted of monitoring 9.36 km of shoreline (< 2 km out from land) in the Daejeong District, which is the core habitat of this population (Kim et al., 2015; Jang et al., 2019). There are 18 inland aquacultures along this shoreline with direct pipelines to the sea that regularly discard waste, including unmarketable fish. We monitored this area over 10 days between 11 October and 26 November 2019 and observed the flukeless dolphin nine times (Table S1). This dolphin was mainly traveling but was once seen feeding on a farmed halibut in an aquaculture area (33° 15' 09.3" N, 126° 11' 36.8" E). This specific area is commonly used by the other dolphins to scavenge on discarded prey items from aquacultures, and it may have provided the flukeless dolphin with more accessible prey items. Such prey availability might have been a crucial element of survival for this flukeless individual.

Our 2020 field season started on 5 May with no observations conducted during the winter (December 2019 to April 2020). Still, the flukeless dolphin was observed in the area within a group on 13 May. Throughout the field season (through 10 November), this dolphin was not frequently observed in the Daejeong District as compared with the previous year (6 out of 16 d in 2020). However, when he was observed in the district, this dolphin was swimming more skillfully; the splash made by the peduncle during respirations had decreased when returning to the water (Supplemental Video: 00:25 to 00:32). In 2020, this individual was always within a group that exhibited foraging, traveling, and socializing behaviors while matching the group's speed, indicating that he had adjusted to life without a tail. During the summer months of 2020, two strong typhoons (Bavi at 155 km/h [950 hPa] and Maysak at 175 km/h [935 hPa]) passed over Jeju Island, which caused concern that the individual would not survive due to his

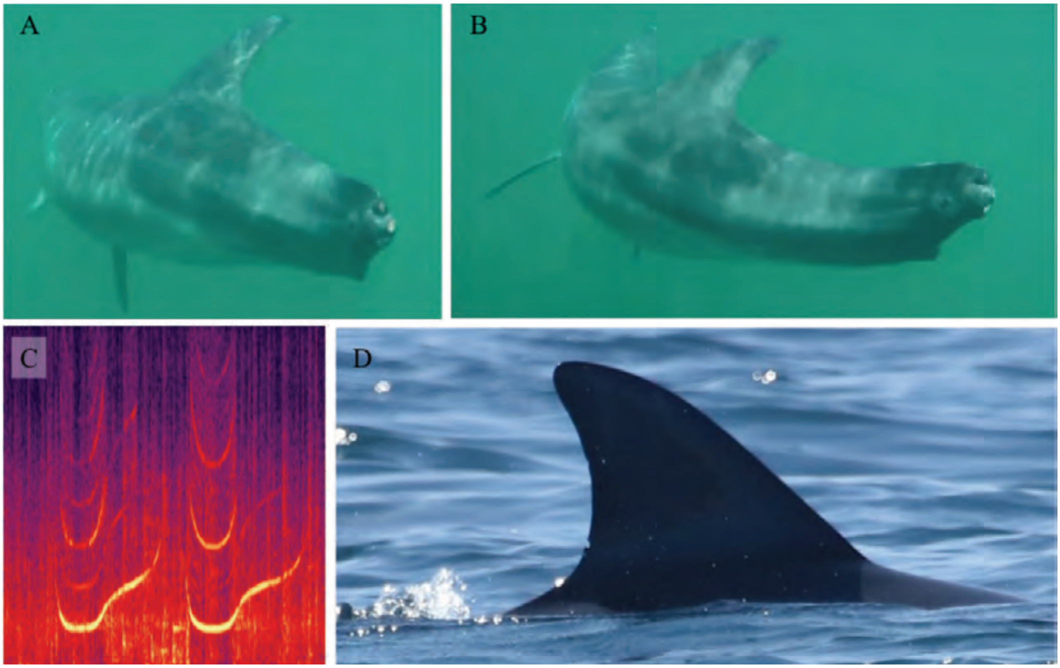

Figure 2. Images of the flukeless individual and his individual identification markers: (A) cut section, (B) left side view of the cut, (C) dominant whistle, and (D) dorsal fin (right side)

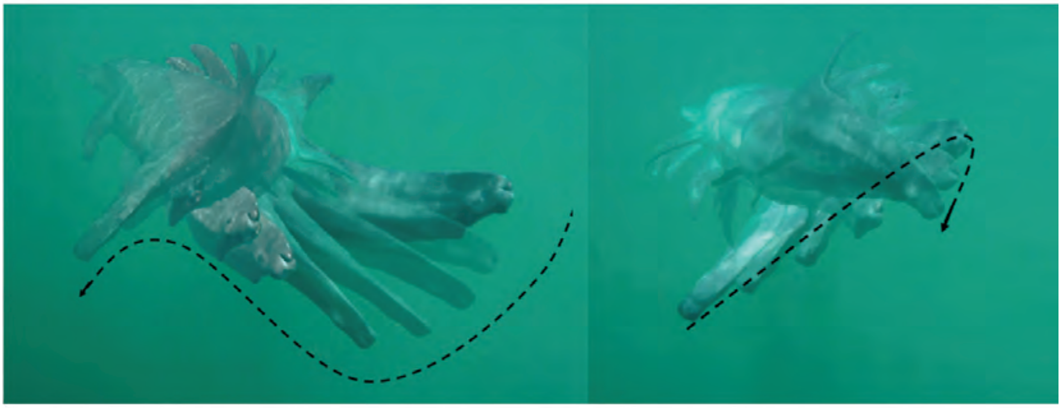

Figure 3. The sequence of peduncle movement of the flukeless individual while swimming underwater (right to left)

disability. However, he was recorded on surveys conducted after each typhoon.

When we observed his general body condition from all of the drone observations in 2019, the morphological measures, including body length, did not seem to have noticeably changed. There was no extra muscle growth or abnormality in the peduncle area. He conceivably invested most of his energy in surviving rather than growing or maturing. The assumption is that the individual consumed a similar amount of prey items to others of similar age in the group. He used most of his energy to sustain vitality while using an inefficient swimming style. If this situation continues, the lack of nutrition needed to grow during early life could decrease this dolphin's overall health.

This report reflects the importance of long-term monitoring for an accurate understanding of severe injury and the extent that unassisted recovery is possible. Since the first observation, this flukeless dolphin has been observed for 34 months in the wild. He survived, steadily regaining swimming ability and interacting with other individuals. In the encounter by a documentary team in 2022, this dolphin participated in a four-individual group social-sexual behavior, swam among a group matching their speed, and leaped out of the water (Supplemental Video: 00:45 to 01:18). In addition, the individual foraged on a small group of sardines and, on a separate occasion, fed on a broken-up fish (Supplemental Video: 01:18 to 01:34), demonstrating remarkable rehabilitation success. This is the first report on the survival of a dolphin with a complete tail amputation in the wild. Furthermore, the remarkable unassisted survival of this flukeless dolphin in the wild has implications for conscientious decisions concerning potential anthropogenic interventions towards severely injured Indo-Pacific bottlenose dolphins.

Acknowledgments

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Observations of Giant Petrels (*Macronectes* sp.) Attacking and Killing Antarctic Fur Seal (*Arctocephalus gazella*) Pups

Rebecca Nagel,[1] Jamie Coleman,[2] Claire Stainfield,[2]
Jaume Forcada,[2*] and Joseph I. Hoffman[1, 2*]

[1]*Department of Animal Behaviour, Bielefeld University, 33501 Bielefeld, Germany*
E-mail: rebecca.nagel@uni-bielefeld.de
[2]*British Antarctic Survey, Cambridge CB3 OET, UK*
**Joint senior authors*

Antarctic fur seals (*Arctocephalus gazella*) spend a majority of their lives out at sea where they are known to be preyed on by leopard seals (*Hydrurga leptonyx*) and presumably also by killer whales (*Orcinus orca*) and sharks (Boveng et al., 1998; Walker et al., 1998; Reisinger et al., 2016). Anecdotal accounts over the past three decades also suggest that during the breeding season, when large numbers of individuals aggregate ashore, Antarctic fur seals experience land predation by northern and southern giant petrels (*Macronectes halli* and *M. giganteus*). To the best of our knowledge, however, no substantiated account has yet been published. This gap in the literature is problematic given that predation can influence population dynamics, especially terrestrial predation that mainly affects juvenile survival.

Long-term monitoring studies of Antarctic fur seal populations at South Georgia and the South Shetlands have documented ongoing declines attributed respectively to climate change-driven reductions in food availability (Forcada & Hoffman, 2014) and increased aquatic predation by leopard seals (Krause & Hinke, 2021; Krause et al., 2022). Less attention has been given to changes in terrestrial predator–prey dynamics resulting from declines in the densities of animals ashore. For example, smaller aggregations of fur seals may be less vigilant (the Many Eyes hypothesis; Olson et al., 2015) or predators may be able to harvest a larger proportion of prey at low density (the Predator Satiation hypothesis; Kramer et al., 2009). Furthermore, predators may shift facultatively between scavenging and predation, respectively, as the availability of carcasses increases or decreases (Wilson & Wolkovich, 2011). For example, scavengers may take advantage of temporarily vulnerable segments of prey populations, such as newborn young, when densities are low and carrion is scarce (Mattisson et al., 2016).

To facilitate further research addressing the drivers of Antarctic fur seal population dynamics, we provide photographic and video evidence of Antarctic fur seal pups being attacked and killed ashore and in the shallows. Since the 1980s, when the British Antarctic Survey began its long-term monitoring program of Antarctic fur seals on South Georgia, anecdotal observations of terrestrial predation of pups by otherwise scavenging birds, such as giant petrels, brown skuas (*Stercorarius antarcticus*), and snowy sheathbills (*Chionis albus*), have been made. However, aside from one account of sheathbills pecking at open wounds on seals (Doidge et al., 1984), to the best of our knowledge, no direct evidence of similar behaviors by other avian species has yet been published. To substantiate these anecdotal reports of terrestrial predation on Antarctic fur seal pups, we provide detailed verbal accounts and video evidence of two techniques frequently employed by the northern and southern giant petrel species when attacking and killing Antarctic fur seal pups: (1) pecking and (2) drowning. Interactions between giant petrels and Antarctic fur seal pups were recorded opportunistically during the 2021 breeding season at Bird Island and on the mainland of South Georgia, which together with the other islands in the South Georgia island group account for around 95% of the global pup production of Antarctic fur seals (Forcada & Staniland, 2018).

Northern and southern giant petrels are large, scavenging seabirds that breed sympatrically on South Georgia (Poncet et al., 2020). Hatching dates of both petrel species overlap with the Antarctic fur seal, gentoo penguin (*Pygoscelis papua*), and macaroni penguin (*Eudyptes chrysolophus*) breeding seasons, which range roughly from late November until February (Hunter, 1984; Duck, 1990; Barlow & Croxall, 2002). During this time, fur seal placentae and carcasses as well as penguin carcasses make up the vast majority of the petrel's diet (Hunter, 1983). Thus, so far, giant petrel feeding ecology has been described in the scientific literature as "clearing beaches of decaying matter" (Doidge et al., 1984, p. 459), although we did find an anecdotal account of giant petrels attacking macaroni penguin chicks (Horswill et al., 2016).

In the observations in this study, giant petrels mainly attacked small, unattended Antarctic fur seal pups in beach areas with a low density of adult animals. Either individually or in groups, giant petrels most frequently approached the pups from the ground and pecked under the shoulder joint, where the fore-flipper connects to the body, or at the anus. While healthy pups or pups in close proximity to their mothers could successfully fend off such attacks, weaker or unattended pups were often dragged to less dense beach areas or towards the water (Figure 1). Pecking usually created a hole in the body cavity from which the petrels tore off pieces of flesh or pulled out the pup's entrails. Pups would invariably cry out during the attack but were often too weak to crawl away (see supplementary video file, timestamp for video 1; the supplementary video file for this paper is available in the "Supplemental Material" section of the *Aquatic Mammals* website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147). Occasionally, two or more petrels were observed attacking a single pup, which was subsequently pulled apart by the two individuals.

The natal coat of Antarctic fur seal pups lacks the water-repellent properties of adults (Irving et al., 1962). Thus, while pups do venture into the water prior to molting at around 60 days of age, they do not yet demonstrate efficient swimming and diving behavior. In the shallow waters adjacent to the breeding beaches, we observed giant petrels exploiting this opportunity by blocking swimming pups from returning to the shore until they became exhausted and drowned. During this time, the giant petrels invariably pecked under the shoulder of the pup to pull off pieces of flesh (see supplementary video file, timestamps for videos 2, 3 & 4). We observed petrels sitting on the water surface between a pup and the shore and pecking or snapping at the pup if it approached the shoreline, thereby blocking its return to the beach (see supplementary video file, timestamp for video 5). Finally, petrels were also observed actively pulling a pup towards the water or holding a pup underwater to drown it (see supplementary video file, timestamps for videos 6 & 7).

These observations (Table 1) raise a number of questions and possible directions for future work. First, northern and southern giant petrel populations on South Georgia and Bird Island have increased by 27 and 74%, respectively, from the 1980s until 2007 (Poncet et al., 2020). Over the same period, the number of Antarctic fur seals breeding on Bird Island has declined by 24%, and the average birth weight of female pups has declined by 7.8% (Forcada & Hoffman, 2014). Consequently, there are not only more giant petrels now than several decades ago, but shrinking seal

Figure 1. Giant petrel (*Macronectes* sp.) attacking an Antarctic fur seal (*Arctocephalus gazella*) pup near the water's edge

Table 1. Details of the videos accompanying our verbal descriptions of giant petrel (*Macronectes* sp.) predatory behaviors. A short textual description of each video is provided. The files have been collated, and the timestamps denote when each observation begins in the supplementary video file. Except for video 5 (date: 24 January 2022; location: Grytviken, South Georgia), all observations were filmed on 25 December 2021 at King Edward Point Beach, South Georgia. Please note the graphic context of some of the videos.

Video file	Timestamp	Textual description of video
Video 1	6 s	Giant petrel pecking under the flipper of a live pup on land, tearing off large bits of flesh and entrails.
Video 2	34 s	Giant petrel pecking under the flipper of a live pup in the water, tearing off large bits of flesh and entrails.
Video 3	52 s	Two giant petrels initially fighting over access to a pup in the water; one petrel then chases the pup and begins to peck it under the flipper.
Video 4	1 min 15 s	Giant petrel pecking under the flipper of a live pup in the water.
Video 5	1 min 27 s	Giant petrel initially preventing a pup from returning to the shore by holding its head underwater and pecking it under the flipper and anus; the attack is interrupted by a second giant petrel, at which point the pup successfully swims to shore.
Video 6	2 min 21 s	Giant petrel pecking under the flipper of a live pup, tearing off large bits of flesh and entrails; the pup was initially on land, but the petrel grabbed it by the head and attempted to drag it into the water.
Video 7	2 min 56 s	Giant petrel pecking under the flipper of a live pup in very shallow water—possibly by the force of the pecking, the pup is dragged into deeper water.

populations and lighter pups may provide the birds easier opportunistic access to weak, undefended pups. A declining fur seal population also likely corresponds with a decrease in the amount of carrion available for the giant petrels to scavenge. As this preferred food source becomes scarce, giant petrels may increasingly revert to facultative predation. A recent study conducted during two breeding seasons did find that pup mortality due to predation was higher at a low density compared to a high density breeding colony, and that predation contributed to a majority of pup deaths (Nagel et al., 2021a). Still, long-term observations are necessary to substantiate any possible relationship between fur seal population density and terrestrial pup predation by giant petrels.

Second, it is yet unclear how increased predation by giant petrels might affect fur seal population dynamics. It is possible, for instance, that by targeting small, weak pups that might otherwise have died of starvation, the overall impact of predation on population growth may not be strong. Furthermore, pups born at low density and thus under higher predation pressure may adjust their phenotype to match their environment (i.e., niche conformance; Trappes et al., 2022). This was recently suggested by Nagel et al. (2021b) who found that pups born at low density were more active and spent a greater amount of time in sheltered habitats compared with pups born at high density, which may be an adaptive behavioral response to increased predation risk.

In conclusion, declining Antarctic fur seal densities may be linked to an increase in pup mortality attributable to facultatively predatory giant petrels. Although terrestrial predation has been anecdotally observed by the long-term monitoring program carried out by the British Antarctic Survey at South Georgia, we provide the first detailed account of such behavior by giant petrels. More thorough investigations of this system through a combination of detailed, long-term field observations and demographic modeling could provide valuable information on top-down effects and ecosystem performance in the face of ongoing environmental change.

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A Walrus (*Odobenus rosmarus*) at the North Pole

Christian Lydersen,[1] Åsa Lindgren,[2] Karin Alfredsson,[2] and Kit M. Kovacs[1]

[1]*Norwegian Polar Institute, NO-9296, Tromsø, Norway*
E-mail: Lydersen@npolar.no
[2]*Swedish Polar Research Secretariat, c/o Luleå Technical University, SE- 97187 Luleå, Sweden*

Walruses (*Odobenus rosmarus*) have a patchy circumpolar Arctic range. In the North Atlantic, they are distributed in shallow, coastal areas throughout much of the Canadian Eastern Archipelago, the west and northeast coasts of Greenland, the Svalbard and Franz Josef Land Archipelagos, and in the southern Barents Region, particularly in the Pechora and Kara Seas. The Pacific walrus (*O. r. divergens*) ranges from the Bering and Chukchi Seas to the Laptev Sea in the west and the Beaufort Sea in the east (Lydersen, 2018).

There are many records of walruses outside their normal range. In general, these extralimital records involve animals that have wandered south of their normal distributional area. Vagrants have been recorded in Japan in the Pacific (Nishiwaki & Nagasaki, 1960) and along the coasts of Canada and the United States in the west Atlantic (Allen, 1930; Wright, 1951; Manville & Favour, 1960), and as far south as Spain in the East Atlantic (Nores & Perez, 1988). Walruses are reported annually from the coasts of northeastern Europe, especially along the Norwegian coastline (Lund, 1954; Born, 1988; van Bree, 1997; Ree & Syvertsen, 1998). One vagrant was instrumented with a satellite transmitter at the Faroes Islands; it was tracked to the west coast of Svalbard, which was presumably its point of origin (Born et al., 2014). There are also reports of extralimital occurrences of walruses in the central Canadian Arctic where Pacific and Atlantic (*O. r. rosmarus*) walruses likely mix (Harington, 1966). Currently, in some areas, they are thought to be expanding their range northwards as a result of climate change-induced reduction in the extent of Arctic sea ice (Yurkowski et al., 2019).

During August and September 2018, the Swedish icebreaker I/B *Oden* was the base for a scientific expedition in the Arctic Ocean. This expedition was a cooperative effort between the Swedish Polar Research Secretariat and the U.S. National Science Foundation whose main mission was to sample metrological and atmospheric data from a drift station. Following a short sampling period at the North Pole, a drift ice station was established on an ice floe at 89° 00' N, 39° 11.51' E on 14 August. On 27 August, a walrus was sighted in the waters behind the vessel (which was then located at 89° 38.2' N, 24° 4' E). A few days later, the walrus was again observed about 2 km from the vessel, "inspecting" the scientific equipment that was deployed from the ice edge (Figure 1). In total, this walrus was observed five times during the course of a week.

South of their normal distributional area, walruses tend to move into populated areas; thus, when they haul out on land, they are easily observed and often reported in local media. But published observations of walruses north of their normal coastal-shelf distributional areas are few. Extensive sea ice over the Arctic Ocean has limited the number of ships entering this area in the past. Some scientific, tourist, and military ice-breaking vessels have gone into the northern areas on an annual basis, but we have not come across any observational records of walruses as far north as the I/B *Oden* observation. Marine mammal tracking studies have demonstrated that some species do enter the Arctic Ocean, but generally they remain over coastal shelves or in the marginal ice zone (Hamilton et al., 2021, 2022). A few exceptions to this do exist. A hooded seal (*Cystophora cristata*) instrumented off the east coast of Greenland (at 73° N) travelled almost to the North Pole before the tag moulted off the seal at 88.5° N; thereafter, the tag drifted slowly with the sea ice in a southeasterly direction (Vacquie-Garcia et al., 2017). In addition, a polar bear (*Ursus maritimus*) instrumented in Alaska was tracked close to the North Pole (Durner & Amstrup, 1995). A polar bear was also observed in the same area at the same time as the walrus reported herein during I/B *Oden's* ice drift station. However, when it comes to walruses, of the more than 90 individuals that have been instrumented from the Svalbard/Franz Josef Land population, the northernmost position recorded has been 82° N (Wiig et al., 1996; Kovacs & Lydersen, unpub. data, 2002-2022; Freitas et al., 2009; Hamilton et al., 2015; Lowther et al., 2015). Similarly, the northernmost record in a walrus tracking study from East Greenland by Born & Knutsen (1992) was also 82° N. Additionally, in records from the Norwegian

Figure 1. An adult male walrus (*Odobenus rosmarus*) inspecting various scientific equipment close to the North Pole (*Photo credit for both photos:* K. Alfredsson)

Polar Institute's mammal sighting database in which research vessels, Coast Guard ships, tourist vessels, and other visitors to Svalbard report sightings, the northernmost location of some 2,800 walrus observations (including more than 75,000 individuals) was just north of 82° N (Bengtsson et al., 2021).

The walrus observed on the I/B *Oden* expedition could of course have come from any Arctic area, but it is a much shorter distance from terrestrial haul-out sites to the North Pole for Atlantic walruses than for Pacific walruses. The ice edge in areas north of Svalbard and Franz Josef Land has generally been 80 to 82° N in summer throughout the last decade, providing a resting platform for ice-dependent pinnipeds. Walruses are known to occupy areas with dense ice cover, and they can travel many hundreds of kilometers inside the ice edge during the winter breeding period in the areas between Svalbard and Franz Josef Land (Freitas et al., 2009), so ice extent at the North Pole currently should not represent a barrier to walruses. However, the water depth at the North Pole is greater than 4,000 m, and walruses usually feed on benthic bivalves and other bottom-dwelling organisms. There is sympagic (ice-associated) production on the underside of sea ice, especially under multi-year sea ice. Recently, it has also been demonstrated that there is a mesopelagic layer between 300 to 600 m in the Central Arctic Ocean, which is thought to consist of fish and zooplankton (Snoeijs-Leijonmalm et al., 2021). However, neither of these sources are likely to provide food for a walrus. This fact, in combination with the relatively modest diving records for walruses (for Svalbard walruses, 140,000 dives were analysed; only 1.2% of these were deeper than 100 m, and max. record was 461 m; see Lowther et al., 2015), likely rules out the North Pole area as a potential feeding area for this species. The male walrus reported herein was in good condition, so it is likely that he was a transient visitor to this latitude.

Thus, this walrus at the North Pole should be considered a vagrant visitor to this area, and its presence should not be interpreted as a climate change-induced range expansion. It is likely that his trip to this extreme latitude was exploratory. Walruses can fast for significant periods of time, fuelled by their extensive blubber layer. They can also cover linear distances of 670 km in 10 days (Freitas et al., 2009), so this individual would likely have little trouble finding his way in a short period of time to shallower southern waters where appropriate prey is available.

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Unusual Left-Handed Surface Feeding with Bubble Production in Fin Whales (*Balaenoptera physalus*)

Conor Ryan[1] and Andrew Malcolm[2]

[1]*Shore Street Close, 50 Main Street, Tobermory, PA75 6NT, Scotland*
E-mail: miolmor@gmail.com
[2]*Carrignagour, Lismore, Co. Waterford, Ireland*

The use of exhaled bubbles by foraging cetaceans to corral, encircle, or startle prey may constitute tool use (Mann & Patterson, 2013). Humpback whales (*Megaptera novaeangliae*) are well known to form closed rings of bubbles to encircle and concentrate prey for more efficient feeding—both alone and in cooperative groups (Jurasz & Jurasz, 1970; Hain et al., 1982; Friedlaender et al., 2011). Similar behaviour has been documented in Bryde's whales (*Balaenoptera brydei*; Kot et al., 2014), but the extent to which bubbles are used for prey manipulation is less understood for other rorqual species, including blue (*Balaenoptera musculus*), fin (*Balaenoptera physalus*), and minke (*Balaenoptera acutorostrata*) whales (Kot et al., 2014).

Bubbles have been associated with feeding in fin whales (Kot et al., 2014). Citing Brodie's 1993 study, Kot et al. (2014) considered that fin whales may produce bubbles incidentally either from jaw cavitation or actively from the nares. The latter is more likely because Brodie's (1993) study reported a synovial joint-crack or "pseudocavitation" (p. 2547), which produces bubbles within tissues that are not emitted into the environment. When feeding, fin whales are understood to be strongly "right-handed," favouring right-lateral lunges (RLLs; Katona et al., 1983; Kot et al., 2014). RLL is defined as "forward trajectory feeding where the whale rotates at a shallow angle from the sea surface, with its right side directed towards the sea-bed" (Kot et al., 2014, p. 1351).

Herein, left-lateral lunge-feeding (LLF) coupled with the emission of long bubble-streams is described. This behaviour occurred approximately 20 times by solitary and paired whales ($n = 3$) and was photographed over a 3-h period (1200 to 1615 h) on 11 December, and again on 14 December 2010, during winter fin whale surveys in Clonea Bay, County Waterford, Ireland (N 52.0913°, W -7.4849° and N 52.0998°, W -7.4513°, respectively). Navigation charts indicate a gravel benthos with mean depths of 20 and 60 m, respectively, at these locations.

Fin whales are typically considered a pelagic species, although they sporadically occur in shallow coastal waters of the Celtic Sea during autumn and winter to feed on shoals of spawning herring and sprat (Whooley et al., 2011; Harma et al., 2012; Ryan et al., 2014). The prey type could not be verified during observations in this study, but previous research suggests that sprat and herring are the most likely prey (Ryan et al., 2014). Photo-identification and biopsy sampling were the priority research activities, so only two examples of this behavior were photographed (Figure 1). This includes the presence of continuous bubble-streams over 20 to 100 m, followed by surface LLF feeding (Figures 1 & 2). The actual emission of bubbles was occurring out of sight underwater. LLFs generally marked the terminus of about 200-m diameter, clockwise-arced manoeuvres (Figure 2). Surface signatures of these straight or curved streams of exhaled air were observed as continuous rows of audible, marble-sized bubbles. Complete circles were not observed. Both photo-identification and molecular sexing results confirmed that the whales photographed in Figure 1 were different individuals of both sexes (Ryan, 2012).

The observed bubble-streams were much longer than those described for fin whales by Kot et al. (2014) and may have been used to manipulate prey (e.g., Sharpe & Dill, 1997) from below and behind to facilitate capture. Manoeuvrability in rorquals is scaled to body size (Segre et al., 2022), which may account for the different strategies among rorquals (Friedlaender et al., 2011). Humpback whales typically return to the bubble net to engulf prey (Hain et al., 1982; Friedlaender et al., 2011). Fin whales, however, were always observed lunge-feeding ahead of (and heading away from) bubble-streams with a rapid approach and longer streams of bubbles. Clupeids can be corralled by a closed net of bubbles but will rapidly flee from open walls of bubbles (Sharpe & Dill, 1997). Therefore, herring and sprat may be concentrated ahead and above a fin whale when

Figure 1. (A) Fin whales (*Balaenoptera physalus*) on 11 and 14 December 2010 in shallow coastal waters of County Waterford, Ireland; images show long, right-curved bubble-streams preceding a left-lateral surface lunge-feeding; and (B) fin whale doing a more typical right-lateral lunge in the absence of bubble-streams. (*Photographer:* Conor Ryan)

rapidly pursued from below and behind using a bubble-stream (Figure 1).

While not quantitatively analysed herein, the qualitative evidence of regular and perhaps exclusive LLF in combination with bubbles contrasts with findings of previous studies that showed a strong preference for RLL feeding in fin whales: 81.1% (*N* = 212, Atlantic), 97.4% (*N* = 304, Gulf of California), and 100% (*N* = 185, Gulf of St. Lawrence) (Tershy & Wiley, 1992; Kot et al., 2014). These observations lend support to the hypothesis that asymmetrical pigmentation in fin whales may have evolved for prey-herding (Katona et al., 1983) rather than preserving countershading during RLL feeding (Mitchell, 1972). The combination of bubble-streams and exposing white pigment would increase visibility to prey and enhance the prey flight response (Sharpe & Dill, 1997; Nøttestad et al., 2002), which has been documented in killer whales (*Orcinus orca*) (Similä & Ugarte, 1993; Nøttestad et al., 2002).

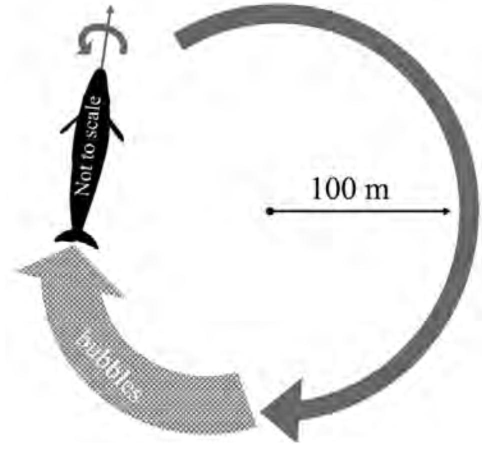

Figure 2. Orientation of fin whales showing clockwise swim direction (thick grey lines) and counter-clockwise roll direction (thin grey line) during feeding events associated with bubble-streams (patterned line)

Forage fish endurance—for example, the ability to escape predators—is dependent on body size (He & Wardle, 1998). Consequently, the more rapid pursuit of prey by fin whales compared with humpback whales, as an example, may result in fine-scale prey size selection. As such, the diversity of lunge-feeding strategies in rorquals raises interesting questions about the maintenance of niche partitioning. In conclusion, these observations suggest that fin whales are not strictly right-handed and may use white jaw pigment in combination with bubbles to herd prey. Quantitative research is warranted to better understand this behaviour in fin whales, as well as the response of their prey, as a potential mechanism for niche partitioning.

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First Record of a Blainville's Beaked Whale (*Mesoplodon densirostris*) in Cuba

Jorge Alberto Martínez-Fernández,[1] Aurora Paniagua-Mendoza,[2]
Fernando R. Elorriaga-Verplancken,[3] Hiram Rosales-Nanduca,[4]
Anidia Blanco-Jarvio,[4] Roberto Robles-Hernández,[5]
Claudia Ballínez,[2] and Wojtek Bachara[6]

[1]*Centro de Investigaciones de Medio Ambiente de Camagüey, Camagüey, Cuba*
[2]*Megafauna Marina, Atención, Rescate, Ecología y Sociedad (MMARES, AC), La Paz, BCS, México*
E-mail: aurorapaniagua@mmaresac.org
[3]*Instituto Politécnico Nacional, Centro Interdisciplinario de Ciencias Marinas (CICIMAR-IPN), La Paz, BCS, México*
[4]*Universidad Autónoma de Baja California Sur (UABCS), Departamento Académico*
de Ingeniería en Pesquerías, La Paz, BCS, México
[5]*Procuraduría Federal de Protección al Ambiente (PROFEPA), La Paz, BCS, México*
[6]*PO Box 555, 05-120 Legionowo, Poland*

The Ziphiidae family (beaked whales) is poorly known in comparison to other cetaceans (MacLeod et al., 2006). Since sea surface observations of these odontocetes are generally brief and in poorly accessible locations, a large amount of their biological information is obtained from strandings (e.g., MacLeod et al., 2003; Whitt et al., 2011; Bachara et al., 2020). The Blainville's beaked whale (*Mesoplodon densirostris*; BBW) is no exception with several stranding records throughout the world, including South Africa (Pringle, 1963), Tasmania (Guiler, 1966), Brazil (Castello & Pinedo, 1980), the Cayman Islands (Rosario-Delestre et al., 1999), Canada (McAlpine & Rae, 1999), New Caledonia (Borsa & Robineau, 2005), Fiji (Leslie et al., 2005), The Netherlands (Camphuysen et al., 2008), Ecuador (Félix et al., 2011), Kenya (Valle, 2012), Southeast Asia (Bachara et al., 2015), the Philippines (Bachara & Blatchley, 2018), El Salvador (Bachara et al., 2020), and the Mexican Central Pacific (Ortega-Ortiz et al., 2021), among others.

The BBW is thought to be the most abundant species with the largest worldwide range among all members of the genus *Mesoplodon* (Reeves et al., 2003; MacLeod et al., 2006). Its distribution comprises tropical and warm temperate waters of all oceans, from low to mid-latitudes of both hemispheres, including higher latitudes, probably due to warm water currents such as the Gulf Stream and the Agulhas Current (Mead, 1989; MacLeod et al., 2006; International Union for Conservation of Nature [IUCN], 2020).

Limited movements and a strong site fidelity have been evidenced for the BBW off Hawaii and the Bahamas Archipelago, suggesting a population structure (IUCN, 2020; Joyce et al., 2020). In the Bahamas Archipelago, this fidelity is probably related to foraging as BBWs have shown inter-individual spatial association with the benthos (Joyce et al., 2017), possibly reflecting a switch from prey from the mid-water/lower mesopelagic zone to prey from the benthic boundary layer as evidenced by Arranz et al. (2011) off the Canary Islands. In this regard, like other members of the Ziphiidae family, the BBW is a deep diver that inhabits mainly oceanic waters. Its mean diving depth is 1,156 m (range from 880 to 1,455 m; Schorr et al., 2009). However, they can be found close to shore, around islands and continental shelf edges (MacLeod & Zuur, 2005) such as the Bahamas Archipelago close to Cuba, Hawaii, and the Canary Islands, where long-term surveys have been conducted (Johnson et al., 2007; Baird et al., 2011; Joyce et al., 2017; IUCN, 2020).

Herein, we provide the first stranding report of a BBW in Cuba. The species was identified based on its characteristics by two of the authors (JA-MF and WB). The 4.75-m-long adult female stranded on Playa Santa Lucía (21.570438° N, 77.047246° W), located ~20 km from Nuevitas and ~110 km from Camagüey in central Cuba, on 11 January 2022 (Figure 1). This species is characterized by a spindle-shaped body with a small head, a small dorsal fin located about two thirds of the way back from the snout tip, small and narrow flippers, and tapered flukes with no median notch. There is also a single pair of shallow throat grooves, and the blowhole is a crescent

Figure 1. Location of Playa Santa Lucía, close to Nuevitas in the east coast of Cuba, where the Blainville's beaked whale (*Mesoplodon densirostris*) stranded

with the ends pointing forward; therefore, the "hinge" is at the front. The beak is moderately long in adults but much shorter and stubbier in younger animals (Figure 2). The posterior half of the lower jaw of this species is highly arched (Mead, 1989). Because of local authorities' protocols related to public health and response to marine mammal strandings, the body was quickly transported to a dune area and buried on the same date as the reported stranding. Because of this, even though its condition code was between 2 and 3 (between freshly dead and moderately decomposed), it was not possible to perform a necropsy or take samples to make a genetic identification. The cause of death was not identified; however, the individual did not show anthropogenic marks of any kind (e.g., from fishing nets or boat strikes) nor was it found to be in poor body condition. A brief evaluation found sand in its blowhole, up to 10 cm inside, suggesting that the individual was alive when it stranded. Additionally, some lacerations and hematomas were observed, which may have resulted from its struggle in the intertidal zone prior to its death.

Research on marine mammals around Cuba is scarce. Most of the knowledge from this region comes from gray literature, strandings, or from local fishermen. A solid compilation by Whitt et al. (2011) confirmed the presence of 17 cetacean species in the Cuban Exclusive Economic Zone (EEZ—around 200 nmi around the territory). These confirmed species included three baleen whales (two of them were identified from stranding records) and 14 odontocetes (13 of them were identified from stranding records). The Cuvier's beaked whale (*Ziphius cavirostris*) is among these species that were stranded on the northern (Varona, 1980) and southern (Blanco-Domínguez, 2011) coasts of Cuba. The Gervais' beaked whale (*Mesoplodon europaeus*) is the other confirmed beaked whale reported in the Cuba EEZ, including strandings in different areas, such as the northern coast east of La Habana (Varona, 1985; Whitt et al., 2011). The Sowerby's beaked whale (*Mesoplodon bidens*) has not been confirmed in this region; however, this species is classified as possible (Whitt et al., 2011) because of its occurrence in the northern Gulf of Mexico (MacLeod & Mitchell, 2006).

Although not confirmed by sightings or strandings, Whitt et al. (2011) classified the BBW as a "possible" species in the Cuban EEZ because of its wide distribution throughout tropical, subtropical, and warm-temperate waters of the world (Reeves et al., 2003; MacLeod et al., 2006) and the confirmed BBW stranding recorded nearby at the Cayman Islands (Rosario-Delestre et al., 1999). Moreover, there are sightings of this species in waters around The Bahamas Archipelago, ~390 km east of Cuba (MacLeod et al., 2004), off Puerto Rico (Rosario-Delestre et al., 1999), and near Guadeloupe Island in the Caribbean Sea (Rinaldi et al., 2006). Additionally, there are reports of several unidentified beaked whales offshore of La Habana, just outside the EEZ (e.g., Aguayo, 1954; Whitt et al., 2011).

Our BBW stranding record in central Cuba and the relatively short period that elapsed since its death (1 or 2 d), when added to sightings in waters off other regions nearby (mentioned above), reinforces the possibility of this species inhabiting the Cuba EEZ. This is an important contribution to the still incipient knowledge on the marine mammal fauna in Cuban waters, especially regarding (potential) cetacean diversity around this country, providing an even higher resolution of knowledge of the BBW that, although classified as "Least Concern" by the International Union for Conservation of Nature's (2020) *Red List*, is still part of the lesser-known family of cetaceans (Johnson et al., 2004; MacLeod et al., 2006), enhancing the relevance of this type of report. Moreover, based on this event and future similar ones (regardless

Figure 2. The Blainville's beaked whale that stranded on Playa Santa Lucía, Cuba, on 11 January 2022: (1) small head, (2) single pair of shallow throat grooves, (3) small dorsal fin about two thirds of the way back from the snout tip, (4) small and narrow flippers, and (5) moderately long beak in this stage (adulthood).

of location), a continuous improvement of measures regarding marine mammal stranding response programs is encouraged. This is in relation to carcass handling (e.g., a more thorough analysis prior to burial), its analysis, and the significance of taking samples for a better stranding assessment.

Stranding data can be a useful tool to better understand marine mammal distribution patterns around a region (e.g., Elorriaga-Verplancken et al., 2020). However, these events must also be considered carefully. These are not necessarily indicative of an actual distribution because they can involve sick or injured individuals that could have moved beyond their normal range, or carcasses may have been transported and deposited by currents (MacLeod et al., 2006; Whitt et al., 2011). More systematic surveys in the Cuba EEZ are recommended to formally conclude that this species inhabits this region. Still, BBW records in other regions nearby mentioned in this report suggest that its natural presence in the Cuba EEZ should be expected.

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Beaked Whales Stranding Records from the Mexican Caribbean and Gulf of Mexico

Raúl E. Díaz-Gamboa,[1] Carlos A. Niño-Torres,[2, 3] and Wojtek Bachara[4]

[1]*Departamento de Biología Marina, Universidad Autónoma de Yucatán, Km. 15.5 Carretera Merida-Xmatkuil,*
Apdo Postal 4-116 Itzimna, Merida, Yucatán, 97000, México
[2]*División en Desarrollo Sustentable, Universidad Atónoma del Estado de Quintana Roo,*
Boulevard Bahía s/n, Col. del Bosque, Chetumal, Quintana Roo, 77019, México
[3]*Fundación Internacional para la Naturaleza y la Sostenibilidad (FINS),*
Calle Larún M75 L4, Andara, Chetumal, Quintana Roo, 77014, México
E-mail: carlosalni@gmail.com
[4]*Kolejowa 138, 05-120, Legionowo, Poland*

Beaked whales are a group of odontocetes characterized by reduced dentition, and the diet of most species is dominated by mesopelagic or bathypelagic squid and fish (Folkens et al., 2002). The Family Ziphiidae includes 22 species, which are grouped into six genera that are recognized worldwide (Mead, 2009; Carroll et al., 2021). Their pelagic habits, long dives, and little time at the surface make it difficult to find and study them. In addition, these whales do not form large groups, and interaction with humans is scarce. Therefore, beaked whales are identified as rare; for many species, few details are available about their presence, distribution, biology, and ecology.

Herein, we present all historical records of beaked whales in the Mexican Caribbean and Gulf of Mexico. The study area included six Mexican states: (1) Tamaulipas, (2) Veracruz, (3) Tabasco, (4) Campeche, (5) the Yucatán in the Gulf of Mexico, and (6) Quintana Roo in the Caribbean Sea. We conducted an exhaustive search of beaked whale sightings and stranding records in peer-reviewed journals; databases; books; theses; news reports; technical reports from universities, the government, and scientific collections; as well as databases from one of the authors (W. Bachara), the Yucatan Marine Mammal Research and Conservation Program (PICMMY-UADY in Spanish), and the Mexican Caribbean Marine Mammal Stranding Network (RVMMCM in Spanish).

A total of 22 confirmed records (from 1974 to 2022) were obtained for 23 stranded beaked whales (Figure 1; Table 1). The highest number of records was for the Gulf of Mexico ($n = 14$) followed by Quintana Roo ($n = 8$). Records included four beaked whale species: (1) Cuvier's beaked whale (*Ziphius cavirostris*), (2) Blainville's beaked whale (*Mesoplodon densirostris*), (3) Gervais' beaked whale (*Mesoplodon europaeus*), and (4) Sowerby's beaked whale (*Mesoplodon bidens*). The species most represented was the Gervais' beaked whale ($n = 12$ individuals).

Cuvier's beaked whale (Cuvier, 1823)—This species was reported in the Gulf of Mexico and Caribbean Sea with seven records in three different Mexican states (Veracruz, Yucatán, and Quintana Roo) (Figure 2a). These records date between 1974 to 2021. The first for the species in the Mexican Caribbean was in 1974, and the first for the Mexican Gulf of Mexico was in 2004. Würsig et al.

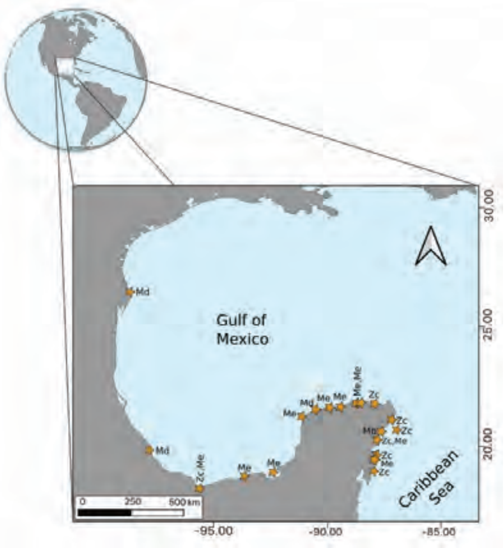

Figure 1. Stranding records of beaked whales in the Mexican Gulf of Mexico and Caribbean Sea. Stars shows the stranding location for each individual. Zc = *Ziphius cavirostris*, Me = *Mesoplodon europaeus*, and Md = *Mesoplodon densirostris*.

Table 1. Beaked whale stranding records in the Mexican Gulf of Mexico and Caribbean Sea. *Sources:* a = Aguayo et al., 1988; b = Niño-Torres et al., 2015; c = Gallo-Reynoso & Pimienta, 1989; d = Solís-Ramírez, 1995; and e = Díaz-Gamboa et al., 2022.

Species	Number of individuals	Sex	Length (cm)	Date (d/m/y)	Locality	Region	First record
Ziphius cavirostris	1	--	--	21/6/1974	Tulum, Quintana Roo	Caribbean	Mexican Caribbean
	1	--	--	15/12/1986 a	Puerto Morelos, Quintana Roo	Caribbean	
	1	--	--	14/6/2004	El Cuyo, Yucatán	Gulf of Mexico	Mexican Gulf of Mexico
	1	M	--	21/3/2011 b	Mahahual, Quintana Roo	Caribbean	
	1	--	600	5/4/2013	Cozumel, Quintana Roo	Caribbean	
	1	--	--	1/10/2014	Coatzacoalcos, Veracruz	Gulf of Mexico	
	1	M	520	24/4/2021	Sian Ka'an, Quintana Roo	Caribbean	
Mesoplodon densirostris	1	M	400	21/3/1999	Sisal, Yucatán	Gulf of Mexico	México & Mexican Gulf of Mexico
	1	F	400	18/8/2010	Matamoros, Tamaulipas	Gulf of Mexico	
	1	--	300	27/10/2020	Playa de Juan Angel, Veracruz	Gulf of Mexico	
Mesoplodon europaeus	1	--	--	12/5/1986 c	Isla Aguada, Campeche	Gulf of Mexico	México & Mexican Gulf of Mexico
	1	--	318	26/1/1995 d	Chelem, Yucatán	Gulf of Mexico	
	1	M	260	6/7/1999	Celestún, Yucatán	Gulf of Mexico	
	1	M	421	29/7/2009	Telchac Puerto, Yucatán	Gulf of Mexico	
	2	M/F	--	4/5/2010 b	Bahía Ascencion, Quintana Roo	Caribbean	Mexican Caribbean Sea
	1	M	425	5/7/2010 b	Paraiso, Tabasco	Gulf of Mexico	
	1	--	440	7/7/2011	Rio Lagartos, Yucatán	Gulf of Mexico	
	1	M	392	11/3/2013 b	Tulum, Quintana Roo	Caribbean	
	1	F	460	26/7/2015	Las Coloradas, Yucatán	Gulf of Mexico	
	1	--	--	5/12/2019	Coatzacoalcos, Veracruz	Gulf of Mexico	
	1	F	470	5/8/2022	Coatzacoalcos, Veracruz	Gulf of Mexico	
Mesoplodon bidens	1	M	530	13/6/2018 e	Playa del Carmen, Quintana Roo	Caribbean	México & Mexican Caribbean Sea

(2000) reported 18 strandings and 14 sightings of this species in the U.S. Gulf of Mexico.

Blainville's beaked whale (Blainville, 1817)—This species was observed only in the Gulf of Mexico, with three records in three different Mexican states (Tamaulipas, Veracruz, and Yucatán) (Figure 2b) dating from 1999 to 2010. The 1999 record was the first for the species in México. Würsig et al. (2000) reported four strandings and two sightings of this species in the U.S. Gulf of Mexico.

Gervais' beaked whale (Gervais, 1855)—This species was documented in the Gulf of Mexico and Caribbean Sea with 11 records (12 individuals)

Figure 2. (a) Cuvier's beaked whale (*Ziphius cavirostris*) in Mahahual, Quintana Roo, México, in 2011; (b) Blainville's beaked whale (*Mesoplodon densirostris*) in Sisal, Yucatán, México, in 1999; and (c) Gervais' beaked whale (*Mesoplodon europaeus*) in Las Coloradas, Yucatán, México, in 2015. (*Photo credits:* All pictures were taken by REDG team from the Departamento de Biología Marina, Universidad Autónoma de Yucatán)

in five different Mexican states (Veracruz, Tabasco, Campeche, Yucatán, and Quintana Roo) (Figure 2c). These records date from 1986 to 2022, with 1986 the first for the species in México and the Mexican Gulf of Mexico and 2010 for the Mexican Caribbean Sea. Würsig et al. (2000) reported 11 strandings of this species in the U.S. Gulf of Mexico and four in northwestern Cuba.

Sowerby's beaked whale (Sowerby, 1804)—This species was observed only once in 2018 near Quintana Roo, which is considered extralimital of its usual North Atlantic Ocean range (Díaz-Gamboa et al., 2022). There is only one stranding record reported of this species in the U.S. Gulf of Mexico (Bonde & O'Shea, 1989).

This summary of beaked whale records offers a quick view about the number of beaked whale species observed in the Gulf of Mexico and Caribbean Sea near Mexican shores. It also highlights the need to develop future studies of these species to update information about their distribution and abundance, especially in this zone marked by an extensive petroleum industry.

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Aggressive Behavior of Short-Finned Pilot Whales Towards Sperm Whales in the Gulf of California: Insight into Food Competition

Raúl E. Díaz-Gamboa,[1] Diane Gendron,[2] and Fabiola Guerrero-de la Rosa[3]

[1]Departamento de Biología Marina, Universidad Autónoma de Yucatán, Km. 15.5 Carretera Merida-Xmatkuil,
Apdo Postal 4-116 Itzimna, Merida, Yucatán, 97000, México
[2]Centro Interdisciplinario de Ciencias Marinas, Instituto Politécnico Nacional, La Paz, BCS, México
[3]Unidad de Microbiología Básica y Aplicada, Facultad de Ciencia Naturales,
Universidad Autónoma de Querétaro, Santiago de Querétaro, México
E-mail: f.guerrero.de.la.rosa@gmail.com

Short-finned pilot whales (*Globicephala macrorhynchus*) inhabit tropical, subtropical, and warm temperate waters of the world, generally offshore, where they feed mainly on squid (Jefferson et al., 2008; Olson, 2009). Along with five other delphinids, the pygmy killer whale (*Feresa attenuata*), the melon-headed whale (*Peponocephala electra*), the false killer whale (*Pseudorca crassidens*), the killer whale (*Orcinus orca*), and the long-finned pilot whale (*Globicephala melas*), they form a group colloquially called "blackfish," which preys on other cetaceans, either commonly or occasionally (Carwardine, 2002; Weller, 2009). Sperm whales (*Physeter macrocephalus*), the largest odontocete, are characterized as deep, long divers and teutophagous in offshore waters (Whitehead, 2003). Herein, we describe an observation of short-finned pilot whale aggressive behavior towards sperm whales during a cetacean survey in the southern Gulf of California.

On the morning of 28 January 2005, sperm whales and bottlenose dolphins (*Tursiops truncatus*) were detected using an omnidirectional hydrophone, approximately a mile from our boat. At 0930 h (at 25° 02.32' N, 110° 45.30' W during the survey), a group of 13 female and juvenile sperm whales associated with offshore bottlenose dolphins was travelling north; our research vessel was focal following the sperm whales to photograph individual flukes and to sample sloughed skin or collect biopsies. Until 1252 h (at 25° 14.69' N, 110° 54.22' W), the sperm whales continued travelling north as a group with unsynchronized dives of ~35 min, spending 8 min at surface intervals (Figure 1). At 1308 h (at 25° 14.90' N, 110° 54.33' W), the sperm whales changed their vocalizations from usual clicks to codas and creaks, and began making shallow dives of ~24 min until all individuals gathered at the surface. At 1346 h (at 25° 17.054' N, 110° 53.20' W), a group of ~30 short-finned pilot whales, composed mainly of females, with some males, juveniles, and calves, was sighted heading towards the sperm whales. At 1403 h, the pilot whales arrived at the sperm whale group and began chasing sperm whales and displaying excited behavior (e.g., fast swimming, porpoising, breaching; Figure 2). At that time, the sperm whales remained closely together, performing very shallow dives of ~5 min and spending little time at the surface. The interaction became aggressive when a pilot whale made physical contact with the caudal fin of a sperm whale, which caused the sperm whale to immediately hit the water surface with its fluke, defecate, and then submerge. Although we could not see what caused the sperm whale to react, we believe the pilot whale might have bit the sperm whale fluke. After this, the sperm whales displayed lobtailing, sidefluking, fast swimming, porpoising, and defecating behaviors until, at 1413 h, they synchronized deep dives while showing their flukes. At 1418 h (at 25° 17.85' N, 110° 52.66' W), the pilot whales continued displaying fast swimming and breaching with no sperm whales observed at the surface. At that time, we collected some skin/blubber biopsies from the pilot whales until they all submerged, after which we lost sight of them. At 1534 h (at 25° 30.07' N, 110° 55.52' W), the sperm whales were resighted about 6.5 km away from the boat heading northeast, while the pilot whales were observed approximately 3.2 km behind them, following the same course.

Before the interaction, biopsy and sloughed skin samples had been collected from two different sperm whale individuals. Biopsies were taken from the pilot whales after the interaction. In addition, phytoplankton samples were collected using a 64 µ mesh size net for 5 min at 1 kt speed. These samples were analyzed to determine the carbon and nitrogen stable isotope ratios to estimate the trophic level and

Figure 1. Female and immature sperm whale (*Physeter macrocephalus*) group in the Gulf of California before the interaction with short-finned pilot whales (*Globicephala macrorhynchus*) (*Photo credit:* Raúl E. Díaz-Gamboa, CICIMAR)

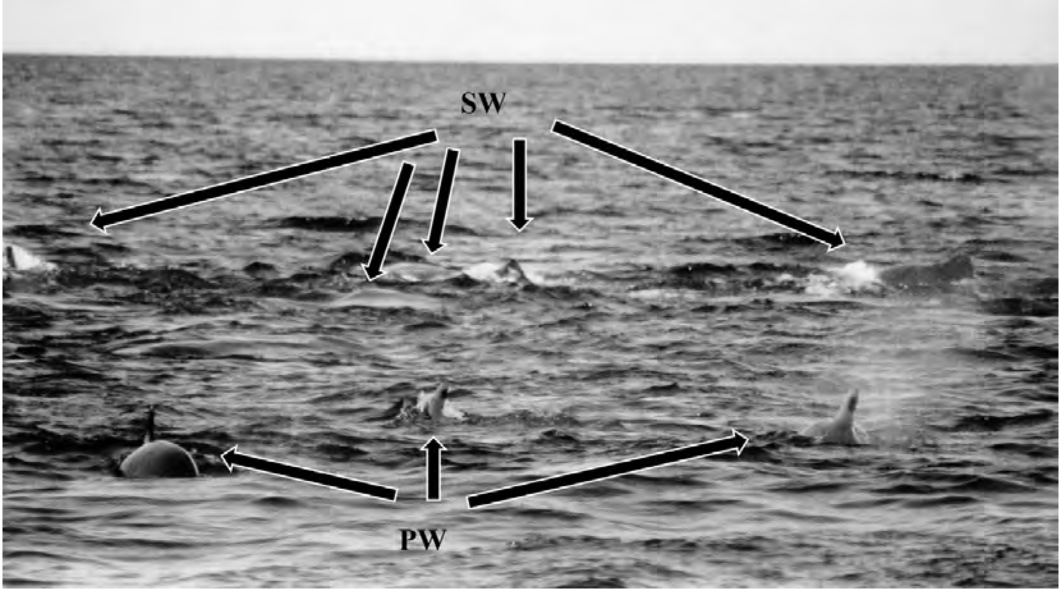

Figure 2. Pilot whales (PW) chasing the sperm whales (SW) (*Photo credit:* Raúl E. Díaz-Gamboa, CICIMAR)

the average diet of both species in the area (Díaz-Gamboa et al., 2018). Trophic level was estimated using the following (Hobson & Welch, 1992):

$$TL = 1 + (D_m - D_n) / 2.82‰$$

where *TL* is the trophic level of the cetacean; *1* the trophic level of phytoplankton; D_m the $\delta^{15}N$ of the cetacean; D_n the $\delta^{15}N$ of the phytoplankton; and *2.82‰* is the estimated value of $\delta^{15}N$ enrichment between cetacean skin and the prey consumed (Borrell et al., 2012; Gimenez et al., 2016).

Pilot whales and sperm whales had similar carbon and nitrogen stable isotope ratios, indicating that both fed in the same isotopic region and at a similar trophic level; therefore, it is possible they

Table 1. Stable isotope ratios of phytoplankton, pilot whales, sperm whales, and potential prey in the Gulf of California (mean ± SD in ‰) and trophic level

Species	*n*	$\delta^{13}C$	$\delta^{15}N$	Trophic level
Phytoplankton	20	-21.20 ± 1.00	11.70 ± 1.20	1.00
Pilot whales (*Globicephala macrorhynchus*)	4	-15.17 ± 0.20	19.44 ± 0.18	3.70
Sperm whales (*Physeter macrocephalus*)	2	-15.09 ± 0.03	20.23 ± 0.51	4.03
Jumbo squid* (*Dosidicus gigas*)	15	-17.05 ± 0.81	16.74 ± 0.89	2.79

*Values from Díaz-Gamboa et al. (2018)

focused on the same prey (Table 1). The jumbo squid (*Dosidicus gigas*) has been reported as the main prey of female and immature sperm whales in the Gulf of California (Ruiz-Cooley et al., 2004; Díaz-Gamboa et al., 2018). Both our results and those of Díaz-Gamboa et al. (2018) agree that the potential primary prey of sperm whales and pilot whales was the jumbo squid (Table 1). Although the number of sperm whale samples is low, the isotopic values agree with those reported by Díaz-Gamboa et al. (2018).

Pilot whales have been observed behaving aggressively towards other cetaceans such as humpback whales (*Megaptera novaeangliae*), common dolphins (*Delphinus delphis*), and *Stenella* sp. dolphins (Ciano & Jørgensen, 2000; Olson, 2009). In addition, agonistic interactions between short-finned pilot whales and sperm whales have been reported in the Gulf of Mexico and South Pacific and were serious enough to provoke the sperm whales into a marguerite formation response (Weller et al., 1996). In this instance, the defensive response of the marguerite formation was not observed possibly due to the absence of calves.

Besides killer whales, there are few records of other blackfish attacking cetaceans in the wild; only records of false killer whale, pygmy killer whale, and pilot whale attacks have been described (Weller, 2009). That said, the killer whale and false killer whale are the only species reported to predate on sperm whales (Palacios & Mate, 1996). Some sperm whale behaviors (e.g., lobtailing, sidefluking, fast swimming, porpoising, defecating) displayed in this observation have been reported during aggressive interactions with these cetaceans (Herman & Travolga, 1980; Palacios & Mate, 1996; Weller et al., 1996). Therefore, the response behavior of these sperm whales may have been due to previous interactions with other blackfish, and it is not unreasonable that they felt threatened by the pilot whales.

Even considering there was visible physical contact between one pilot whale and one sperm whale, it is unlikely that this interaction was for predation purposes. Although social play by the pilot whales cannot be discounted, the trophic results suggest that both species fed on jumbo squid and, therefore, compete for the same resource in the Gulf of California. Our hypothesis to describe this interaction is that this aggressive interaction by pilot whales was harassment to a possible competitor, either by competitive exclusion or by food robbery.

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Longman's Beaked Whale (*Indopacetus pacificus*) in Fiji

Sam R. Fisher,[1] Steve Anstey,[2] Isikeli Nasaunivalu,[3] and Robert N. Fisher[4]

[1]*Department of Biology, La Sierra University, Riverside, CA, USA*
[2]*Ahura Resorts Conservation Foundation, Nadi, Fiji*
[3]*Likuliku Lagoon Resort, Malolo Levu, Fiji*
[4]*Western Ecological Research Center, U.S. Geological Survey, San Diego, CA, USA*
E-mail: rfisher@usgs.gov

Beaked whales (Ziphiidae) are the second largest family of cetaceans with 24 currently recognized species, and the Longman's beaked whale (*Indopacetus pacificus*) is one of the least known globally (Reeves et al., 2003; Yamada et al., 2019). Longman's beaked whales occur in tropical waters from the western Indian Ocean to the eastern Pacific (Jefferson et al., 2015), with strandings in the Pacific reported from Hawaii, the Philippines, Taiwan, Japan, and New Caledonia (West et al., 2013; Garrigue et al., 2016; Acebes et al., 2019; Kobayashi et al., 2021; see Figure 1). Herein, we report the first record of this species in Fiji.

A dead whale was found stranded on 8 April 2020 on the island of Malolo Levu at Likuliku Resort, Ahura Resorts, on the lagoon beach (17.7392 S, 177.1512 E; Figure 1). It was photographed by resort staff before being disposed of

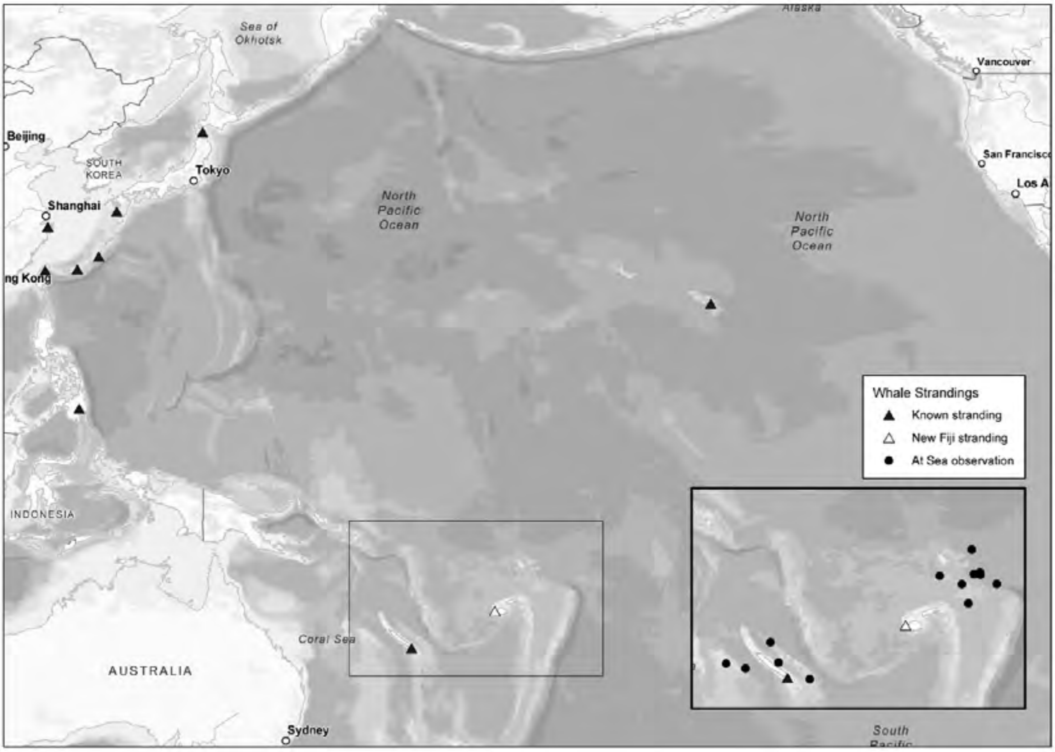

Figure 1. Published Longman's beaked whale (*Indopacetus pacificus*) stranding events (black triangles) within the Pacific Ocean with the newest stranding from Fiji shown as a white triangle. At-sea observations (black circles) are only shown for the Fiji region (see cutout area in the lower right corner of the figure).

offshore (Figure 2). The beak and tail showed large amounts of damage, mostly abrasions, perhaps caused from Cyclone Harold on 7 April 2020, that might have caused the whale to wash across the reef. Aside from this damage, there was no obvious trauma to the carcass, and the whale appeared to be in good condition based on direct observation. The whale's age could not be determined, but because of its apparently large size (Figure 2b) and numerous, healed cookiecutter shark (e.g., *Isistius* spp.) bite wounds (Figure 2a), it appeared to be an adult. The whale was possibly a female because there were no visible teeth protruding from the tip of the lower jaw (Figure 2).

We identified the whale as *Indopacetus pacificus* based on several diagnostic features present in the photos (Figure 2). These features include black marking around and behind the eye, which extends as a band to the insertion of the flipper; pale flanks behind the flipper band; another dark band, which extends up from the eye to just behind the blowhole that forms a posterior boundary to the pale melon; a large and conspicuous crease at the base of the well-developed melon; separation of the pale sides of the melon by a dark, longitudinal, dorsal band; a small, pale "ear spot" behind the eye; and a lower jaw that extends beyond the upper jaw (Pitman et al., 1999; Jefferson et al., 2015).

Figure 2. (a) *Indopacetus pacificus* that stranded on 8 April 2020 on the island of Malolo Levu, Fiji: (a) the distinct crease between melon and beak (black arrow) is somewhat distorted by ripples on water; several healed cookiecutter shark bite scars are evident on the body; and (b) man is shown for scale; the whale was not measured.

At-sea sightings of *Indopacetus pacificus* have been recorded at least 200 km northeast of Fiji, toward Wallis and Futuna (15.84° S, 177.37° W; found using the OBIS Seamap, accessed on 10 January 2022. Search term: *Indopacetus pacificus*; Halpin et al., 2009; Van Canneyt, 2022). Although Fiji is usually included within the suspected at-sea range of this species (e.g., Jefferson et al., 2015; Carwardine, 2020), to date there has been no direct evidence that it occurs there (Miller et al., 2016; Vertnet (vertnet.org) database checked April 2020). Blainville's beaked whale (*Mesoplodon densirostris*) was the only other beaked whale species previously recorded from Fiji (Leslie et al., 2005). This is the second stranding of a previously unrecorded cetacean species—and the fourth marine mammal—reported from Fiji within recent years (Hill-Lewenilovo et al., 2019; Chute, 2021; Dehm et al., 2021). Social media has helped to increase the number of stranding events recorded globally, but outreach and education can ensure important specimens are not lost to science so that they can be properly documented and preserved, if necessary (Dehm et al., 2021).

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Allomaternal Care and Allonursing Behaviors by a Primiparous Bottlenose Dolphin

Kathleen M. Dudzinski,[1] Manon Themelin,[1]
Heather M. Manitzas Hill,[2] and Teresa T. Bolton[3]

[1]*Dolphin Communication Project, PO Box 7485, Port Saint Lucie, FL 34985, USA*
E-mail: kathleen@dcpmail.org
[2]*Psychology Department, St. Mary's University, 1 Camino Santa Maria, San Antonio, TX 78228, USA*
[3]*The Roatan Institute for Marine Sciences, Anthony's Key Resort, Sandy Bay, Roatan, Honduras*

Allocare—alloparenting or allomaternal care—has been documented for both sexes in terrestrial, aquatic, and avian species (for a review, see Riedman, 1982), and may be linked to the evolution of an increased brain size in some social mammals (Isler & van Schaik, 2012). The benefits afforded through an allocare strategy enable mothers to travel and forage unencumbered, minimize energy expenditure, and increase energy intake, thereby allowing these species to invest more heavily or efficiently in offspring than mothers who exclusively care for their offspring (Burkart et al., 2009; Isler & van Schaik, 2012). Allocare occurs when supportive care is provided for conspecific young by individuals other than the genetic parents (i.e., siblings, aunts, uncles, or unrelated individuals identified as "helpers"). These helper individuals behave in a way that benefits a young animal (Wilson, 1975; Riedman, 1982; Whitehead, 1996; Gero et al., 2009; Schubert et al., 2009; Stanton & Mann, 2012), but their action(s) may also have advantages to the alloparent (Whitehead, 1996; Lewis & Pusey, 1997; Mann & Smuts, 1998; Roulin, 2002; Gero et al., 2009; Isler & van Schaik, 2012).

Numerous non-mutually exclusive functions have been proposed for allocare and include added protection for the offspring, opportunities to rest or forage for the mother, a chance to secure favor from an adult female for future mating opportunities, experiences for naïve females to practice or learn to care for young animals (e.g., Mann & Smuts, 1998; Simard & Gowans, 2004; Hill & Campbell, 2014; Augusto et al., 2016), among others. Allonursing has also been confirmed for several species of social mammal (see Roulin, 2002, for a review of the alternative hypotheses for why lactating females nurse non-offspring young). Spontaneous lactation by females (multiparous and primiparous) has also been reported for some mammals (e.g., bottlenose dolphins [*Tursiops truncatus*]: Kastelein et al., 1990; Ridgway et al., 1995; belugas [*Delphinapterus leucas*]: Leung et al., 2010).

In this paper, we describe the behavior and potential reproductive development of a primiparous common bottlenose dolphin ("Poli") as related to allomaternal care, including allonursing positioning, that suggests she was practicing maternal actions as well as receiving potential mentoring by an unrelated, multiparous adult female.

In 2022, Poli was an adult female common bottlenose dolphin resident to The Roatan Institute for Marine Sciences (RIMS) at Bailey's Key, Roatan, Honduras. In June 2011, Poli was the second calf (and first female) born to "Mika," an adult female also born at The RIMS. Mika died when Poli was ~4.5 y old; loss of her mother at this young age might have impacted the onset of Poli's reproductive maturity. Three other female dolphins born at The RIMS in summer 2011 and 2012 each had their first pregnancies in 2019 (The RIMS, unpub. data, 2011-2019); Poli did not exhibit follicular development until December 2021 (confirmation via voluntary ultrasound). In late 2020/early 2021, Poli was observed in Dolphin Communication Project (DCP) video data appearing to show interest in the newest calf ("Sandy"); this calf was from one of the other three females who were the same age as Poli. Poli often swam in infant position to Sandy when Sandy was in infant position to "Tilly." ("Infant position," often referred to as "P3," is defined as when the calf swims below the mother near the genital slit and mammary openings.) Poli also initiated pectoral fin contacts and body rubs with Sandy whether or not Tilly was present. These exchanges between Poli and Sandy were documented when Sandy was more than 6 mo old (DCP, unpub. data, 2020-2021). Still, Poli appeared to be readily distracted from Sandy by other dolphins, swimmers, fish, and objects. Poli was also observed sharing allomaternal actions toward Sandy with two other young adult female dolphins when Tilly was not within visual range.

In October/November 2021, three calves were born to The RIMS group: two calves (to "Gracie" and "Elli") were born in late October, and the third calf (to "Calli") was born in mid-November. All three neonates were present during DCP's underwater video data collection in late 2021 and early 2022, with observations discussed herein from the video data collected from 28 November to 3 December 2021 and from 2 to 21 January 2022. Underwater observations were collected in 30- to 45-min videotaped sessions between 0630 and 0800 h daily (see Dudzinski et al., 2010, for details of the video collection process at The RIMS, and Dudzinski et al., 1995, for details of the underwater recording system). Specifically, three 30-min sessions yielded several observations of Poli interacting with Gracie's calf (born in October 2021) while Gracie was nearby—either within visual range or out of view of the camera and Poli and the calf (Table 1). In the December video data, Poli is more visible than Gracie and her calf (Table 1), suggesting Poli was spending less time with this mother–calf pair or that she might have been readily distracted by other dolphins, the researcher, or other objects in or near the lagoon. In January 2022, Poli was in view for almost the same amount of time as Gracie and her calf, suggesting Poli might have been spending more time with Gracie and her calf (Table 1).

In December, when her calf was about 1 mo old, Gracie's placement (within 3 to 5 adult dolphin body lengths) and vigilance (inferred from attention and gaze oriented toward her calf and Poli) indicated that she was attentive to, if not overseeing, Poli's interactions with her calf (Table 2). During one session in December, these three dolphins were observed in a triad swim formation (150.81 s; Table 2) more than in either possible dyad with the calf (Poli–calf: 57.78 s; Gracie–calf: 39.11 s; Table 2). This trend shifted between December 2021 and January 2022, with the triad swim formation per session ranging from 61.47 to 83.07 s (Table 2). Similarly, the amount of time Poli spent with Gracie's calf in both infant and echelon positions increased between December and January (Table 2). It is possible that once the mother–calf bond was stable, then Gracie might have been more relaxed in her calf vigilance when Poli was with her calf. Additionally, Gracie's vigilance with Poli might also have been a form of mentoring given that Poli was primiparous and did not have an available kin maternal model (Riedman, 1982; Komdeur, 2006; Schubert et al., 2009; Briga et al., 2012).

Table 1. Total time Gracie, her calf, and Poli are observed during three sessions recorded on video

	Total time observed on screen (s)		
Session ID	Gracie's calf	Gracie	Poli
December A42146	285.69	281.45	337.61
January A42209	213.41	200.80	228.66
January A42210	162.47	164.80	169.64
Total (s)	661.57	647.04	735.92
Total (min)	11.00	10.80	12.30

Note: Please see Supplemental Video.

Our hypothesis that Gracie could be mentoring Poli is supported anecdotally by Gracie's retrieval of her calf when Poli was distracted by the camera, other dolphins, or other objects when the calf was 1 mo old (i.e., in December). On several occasions (3 in November/December 2021; 2 in January 2022), when Poli had Gracie's calf in echelon or infant position, Poli's attention to the calf waned—for example, she investigated the researcher/camera by shifting her attention toward the camera lens and echolocating on the camera. In each instance, Gracie swam forward, "scooped" her calf into echelon position with her body, and slowly moved out of visual range (~12 m away). Poli responded by circle swimming the camera/researcher once and then made a fast swim in the direction that Gracie and her calf went (see Supplemental Video; the Supplemental Video for this paper is available in the "Supplemental Material" section of the *Aquatic Mammals* website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147). Additionally, in our December observations, Gracie swam in close proximity to her calf with the calf often in echelon position to Gracie (Table 2); however, in January, there was more distance between Gracie and her calf, and other positions (e.g., parallel or staggered parallel positioning to Poli and the calf or to the calf; Table 2) were used.

In addition to infant or echelon swim positions, Gracie's calf was observed attempting to nurse from Poli's mammary slits (Figure 1; Supplemental Video). While Gracie's calf was observed (and recorded) nursing from her mother, six apparent nursing events were also documented by Gracie's calf toward Poli's genital area/mammary slits (Table 2). The only time Poli used the "mom" position for infant swims was when Gracie's calf was in the nursing position and made contact to Poli's mammary slits (Table 2). Poli's mammary glands were not developed nor was milk evident from her, though Gracie's calf placed her rostrum at Poli's mammary slits (Figure 1). Gracie's calf was observed twice nursing from Gracie for an average

Table 2. Observations of Poli and Gracie's calf; Gracie and her calf; and Poli, Gracie, and the calf together during three 30-min sessions in December 2021 and January 2022. P3 is the acronym for infant position. Time spent in the mom and calf positions by Poli when she was in P3 or echelon with the calf were documented. The triad included all three females in a "stacked P3" swim formation.

			Time Poli swims in each position w/calf (s)				Time of Gracie's position during triad (s)		Calf "nursing" Poli	
Date (session)	Total time swimming in dyad or triad (s)		P3 mom	P3 calf	Echelon mom	Echelon calf	Echelon w/calf	Parallel w/Poli	Events	Mean duration (s)
1 Dec 2021 (A42146)	Poli–calf	57.78	0.00	43.60	14.18	0.00	--	--	0	0.00
	Gracie–calf	39.11	0.00	0.00	39.11	0.00	--	--		
	Triad*	150.81	0.00	109.10	33.21	0.00	69.05	74.05		
10 Jan 2022 (A42209)	Poli–calf	135.69	17.81	105.03	12.85	0.00	--	--	2	1.50
	Gracie–calf	0.00	0.00	0.00	0.00	0.00	--	--		
	Triad*	61.47	0.00	40.07	11.08	0.00	12.87	33.95		
11 Jan 2022 (A42210)	Poli–calf	57.95	63.23	25.71	19.31	0.00	--	--	4	2.85
	Gracie–calf	5.28	0.00	0.00	5.28	0.00	--	--		
	Triad*	83.07	29.29	0.00	50.30	0.00	22.63	56.60		

*When in the triad formation, Gracie is either Echelon mom to calf or following Poli/calf in parallel staggered (swimming in the same horizontal plane but slightly before or behind) or parallel (swimming perfectly in line) to Poli.

Table 3. Nursing positions by calf to Poli and Gracie with descriptions of each event documented on video in January 2022

Session ID	Mom position	Duration (s)	Comments
A42209	Poli	1.25	Calf angles toward genital area but cannot confirm contact; not really nursing. Poli responds by slowing down, directing her genitals to calf, and then doing it again a bit later before the next bout.
	Poli	1.75	Far and blurry but does look like nursing position.
	Gracie	1.99	Might be nursing position but very far and blurry.
A42210	Poli	1.00	Calf angles toward genital area but cannot confirm contact; kind of "checking the area."
	Poli	2.50	Could be nursing position, but very far and blurry. Poli is on left side pushing genital area to calf.
	Poli	6.15	Calf clearly at mammary slits. Poli is stationary, on her right side, and head is vertically down. Gracie is near KD and looks at Poli/calf when it starts and gets closer, starting a triad swim/parallel staggered on left of Poli.
	Poli	1.72	Quite sure nursing position happens again in background. Poli is turning on her right side. Gracie is still parallel staggered on left of Poli.

of ~2 s (Table 3). The nursing position bouts by Gracie's calf to Poli ranged from 1.00 to 6.16 s ($\bar{x}$ = 2.38 s), which seemed to be similar in length to the observed time spent by the calf nursing from her mother (Table 3). Poli's posture to the calf during nursing attempts included mostly horizontal, mostly on her right side, and occasionally on her left side. The calf initiated the attempted nursing bouts and placed her rostrum against Poli's genital area/mammary slits. Poli reacted by remaining stationary or shifting her position slightly (Table 3; Figure 1; also see Supplemental Video).

In 2022, Poli was a primiparous, adult (~11 y) female bottlenose dolphin who had only showed interest in calves that might be considered allomaternal care in the last 1 to 2 y. As a subadult female, Poli shared physical contact (e.g., pectoral fin and body contact) and engaged in play

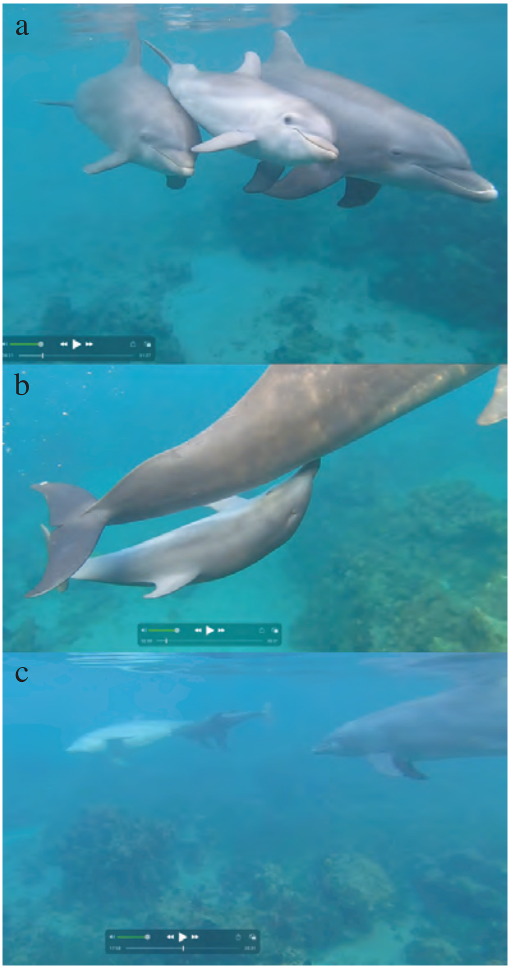

Figure 1. (a) Poli, Gracie's calf, and Gracie swimming in a staggered parallel formation; (b) Gracie's calf with her rostrum against Poli's genital area; and (c) Poli on her right side, stationary, while Gracie's calf presses her rostrum to Poli's mammary area with Gracie watching from about 3 m distance. All images taken from DCP video recorded in January 2022. See Supplemental Video for sequences.

behaviors (e.g., chases, circle swims, object play) with older (6 mo to 1 to 2 y old) calves. Her recent, more focused attention to other adult females with neonate calves, and to the calves specifically, suggests that Poli might have been maturing both socially and developmentally as would be required for her future potential maternal role (Levengood & Dudzinski, 2015; Harvey et al., 2017). This increase in allomaternal behavior exhibited by Poli coincided with her follicle development and observed mating activity with an adult male (all co-authors, pers. obs., 2022). Poli also seemed to practice a holding position for Gracie's calf to attempt nursing, even though Poli was not lactating and did not produce milk during our observations. Gracie is an experienced mother with several successful offspring. It is possible that Gracie displayed this nursing posture to Poli out of our camera's view, and Poli was simply imitating Gracie's behavior. It is also possible that Poli's position at the bottom of the triad with Gracie and her calf afforded her the opportunity to observe how Gracie and her calf interacted. That is, Gracie and her calf could be a model for Poli as she learns skills required to parent and that allomaternal care might offer (e.g., Whitehead, 1996; Mann & Smuts, 1998). With this logic, the increased allomaternal behavior by Poli could represent her practice of behaviors she will likely need in the future with her own offspring. Future observations of Poli with her own calves may offer insight into the benefits of her actions as an alloparent.

Epilogue

In October 2022, Dudzinski visited the RIMS and AKR to continue long-term data collection of the dolphins. Poli was confirmed to be pregnant, due in early 2023.

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Observations of Mating Practice by Non-Sexually Mature Male Belugas (*Delphinapterus leucas*)

Heather M. Manitzas Hill,[1] Jackson R. Ham,[2] and Malin K. Lilley[3]

[1]*Department of Psychology, St Mary's University, San Antonio, TX 78228, USA*
E-mail: hhill1@stmarytx.edu
[2]*Department of Neuroscience, University of Lethbridge, Lethbridge, Alberta, Canada T1K 3M4*
[3]*Department of Life Sciences, Texas A&M University, San Antonio, TX 78224, USA*

Mating is critical to the propagation of cetaceans, and while much of this system is biologically hardwired or uses innate behavioral systems (see Hogan, 2001, for details on the development of behavior systems), there is evidence that learned behaviors contribute significantly to a species' success. However, the mechanisms by which cetaceans select their mates or develop the critical behaviors needed for mating success remain unknown. Whether females select male humpback whales (*Megaptera novaeangliae*) based on an intriguing song (see Herman, 2017), or female harbor porpoises (*Phocoena phocoena*) choose males that show the best aerial maneuvers (Keener et al., 2018), or female river dolphins (e.g., *Inia geoffrensis*) choose the male that presents the best stick (Martin et al., 2008; Araújo & Wang, 2012), or male bottlenose dolphins (*Tursiops truncatus*) choose previously successful breeders (Schaeff, 2007), we do not fully understand the roles of innate behaviors or learned behaviors within cetacean mating systems (reviewed by Orbach, 2019; Schaeff, 2007).

Belugas, or white whales (*Delphinapterus leucas*), are odontocetes that inhabit Arctic and subarctic waters, and live in a fission-fusion social system (Michaud, 2014; O'Corry-Crowe et al., 2020; Mayette et al., 2022), with seasonal migrations between winter hunting areas and summer socializing areas (Frost & Lowry, 1990; Lydersen et al., 2001; O'Corry-Crowe et al., 2018). There are 22 recognized beluga stocks, two of which are critically endangered: (1) the Cook Inlet stock and (2) the St. Lawrence River stock (Pippard, 1985; Lowry et al., 2012). One of the most important questions that remains is why these two stocks continue to decline in number. While many explanations include anthropogenic effects, such as noise, toxins, boat traffic, and strikes (Krasnova et al., 2015; Lesage, 2021; Vergara et al., 2021), there may also be an issue with mate selection. As a sexually dimorphic species with males about 1.5 times larger than females (Heide-Jørgensen & Teilmann, 1994; Stewart, 1994), some scientists have suggested that females may choose their mating partners. Unfortunately, this suggestion remains speculative as a systematic study on mate selection has yet to be conducted, and the possible mechanisms have not been elucidated.

Socially, belugas are considered gregarious as they can be found in large social groupings, especially during the summer when hundreds or thousands of belugas converge on socialization areas (e.g., Cunningham Inlet; Sergeant & Brodie, 1975). While migrating to hunting grounds, some stocks of belugas are thought to split off into smaller, sex- and age-based social groups that appear to be related (O'Corry-Crowe et al., 2020). That is, adult males may be found in small social groups that travel separately from larger social groups that include females and their sexually immature offspring (O'Corry-Crowe et al., 2020). Curiously, despite the tendency to be found in large social groups that travel together, there appear to be limited social interactions indicative of bonded animals. Work with belugas in managed care has shown that adult and juvenile males appear to have partner preferences when provided opportunities for same age and sex companions (Hill et al., 2015a, 2015b, 2018; Mazikowski et al., 2018; Lilley et al., 2020), and this same-sex preference emerges early in development (Mazikowski et al., 2018; Ham et al., 2022). Adult females appear to be much more independent and bond primarily with their unweaned offspring (Krasnova et al., 2006, 2009, 2014). The frequent socio-sexual behavior observed in males and young females is very rarely observed in adult females (Hill et al., 2015b). As calves, females do appear to have partner preferences at times but are much more variable in their interactions with others (Ham et al., 2022).

Behaviorally, observations from both the natural habitat and managed care corroborate that belugas are extremely vocal and display oriented—whether the beluga stock inhabits the muddy waters of the Cook Inlet or the clear waters of Cunningham Inlet (Horback et al., 2010; Hill et al., 2015b; Lomac-MacNair et al., 2016). One area of research that our laboratory has pursued is the development of socio-sexual behaviors and their relationship to non-conceptive behaviors and courtship-oriented mating behaviors. Since 2007, one beluga population in human care has been studied systematically using the same data collection protocols, creating a large behavioral dataset (Hill & Nollens, 2019). This longitudinal study has provided opportunities to follow the development of beluga behavior, with some animals followed since their birth and through their juvenile and subadult phases. In total, 20 different belugas (12 females and 8 males, ranging between birth and 35+ y) have been observed. Over the years, social composition has varied with respect to the adult males and sexually maturing subadult males present in this population and, occasionally, the number of sexually mature females. Animal care staff typically determine the daily social compositions but often group the belugas in compositions that are typical of wild populations (i.e., mothers and calves, mixed age and sex weaned immatures, and adult male and females without offspring).

Because breeding season occurs annually (usually February to May for this population, which is similar to wild populations; Heide-Jørgensen & Teilmann, 1994), social compositions are managed to simulate the breeding environments in the wild. After a number of years of study, it became clear that behavioral milestones existed and depended on social composition, especially with regard to the socio-sexual repertoire, which overlaps with and precedes the courtship/mating repertoire (see Ham, 2021; Ham et al., 2022). Ham et al. (2022) found these beluga calves (male and female) performed some elements of adult male courtship behavioral repertoire, but those behaviors were not well-formed and developed in a piecemeal fashion instead of emerging simultaneously. By the time the same male calves reached juvenile and subadult status (i.e., approximately 4 to 6 y and 7 to 10 y, respectively; sexual maturity is achieved by most males after 10 y; Robeck et al., 2005), many aspects of the courtship and mating repertoire were more fully developed (i.e., adult-like in topography) (Lilley et al., 2020). Together, these studies suggested that mating behavior, especially behaviors involved in courtship, by male belugas may have a learned, behavioral component that subsequently could affect their future success as a progenitor. These behavioral emergence trends were moderated by the presence or absence of adult male or immature male belugas. Ham et al. (2022) found that calves with older, mature males present during their pre-weaning years produced socio-sexual behaviors at an earlier age than those who had not had older, mature males present, whereas weaned, immature males were more likely to display socio-sexual, courtship behaviors if young calves were present (Lilley et al., 2020). It is unclear if the presence of an adult male provides a model for adult male courtship behavior or enables immature animals to practice with the older males, while the presence of younger calves provides more opportunities to practice. It is likely a combination of both explanations given that immature animals occasionally displayed socio-sexual or future courtship behaviors toward inanimate or inappropriate stimuli such as environmental enrichment objects or humans (Ham et al., 2022). These trends suggest that emergence and mastery of some innate behaviors that are later exhibited in the adult male courtship/mating repertoire are influenced by the social composition and presence of older males, which could have long-term consequences on reproductive success. That is, if one male beluga is more socially adept due to previous exposure and practice (i.e., courtship behaviors) compared to another, future interactions with females may be affected, especially if female mate choice occurs.

In belugas, copulation is rarely observed. Glabicky et al. (2010) described the seasonal increase in pelvic thrusting for males that is correlated with the mating season, and Ham et al. (2021b) found that sexual play and other social behaviors fluctuate on a seasonal basis, peaking when mating and calving occurs in concert with hormones (Robeck et al., 2005; Richard et al., 2017). Despite many 24-h observations, few reproductive copulations were ever recorded for a breeding population of belugas with two adult males and seven adult females, but copulation had occurred as indicated indirectly by pregnancies. The adult male courtship sequence typically begins with directed gazes, follows at a distance, closer proximity lateral presentations, horizontal S-postures with the genital region thrust forward, and bubble trails with some open mouth displays (Lilley et al., 2022). In addition to visual displays, the adult male also produces a deep foghorn vocalization more frequently during the breeding season and may become more vocal (observations that need to be studied systematically). If a female is interested, she will swim with the male. In our experience, these sequences do correspond with follicular activity and can last up to a week (H. Manitzas Hill, pers. obs.).

Based on multiple observations across years and multiple facilities, it appears that adult males may vary in their mating success. Whether this mating success is related to body condition, vocalizations, behavior, or some other unidentified element, the mechanism remains unknown.

In this paper, we describe a series of observations that were categorized as courtship displays by two different immature males toward two different older, unrelated adult females. Both anecdotes have not been described before nor have they been included in previous work on understanding the emergence of behaviors represented initially in socio-sexual repertoires as immature males and later represented in courtship/mating repertoires.

Anecdote One

One observation occurred in May of 2012 in which an almost 5-y-old sexually immature male beluga initiated a sequence of social interactions that were perceived as courtship attempts toward a mature female. As shown in Supplemental Video A, the male initially presented to the mature female and swam alongside her (the Supplemental Videos for this paper are available in the "Supplemental Material" section of the *Aquatic Mammals* website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147). In most other circumstances, the adult female would have ignored him and swam away or responded with agonistic behavior (e.g., Horback et al., 2010; Ham et al., 2021a). However, on this occasion, she continued to reciprocate the interaction with similar responses. The resulting interactions between the two belugas included bubble streams typically produced by the male, circle swimming around the adult female by the immature male, open mouths by both, mouthing along the female's body by the male, and mouth-to-mouth interactions with each other (see Hill et al., 2019, for a description of mouth-to-mouth interactions between juveniles). The intriguing piece to this observation was that the social interaction was atypical for both animals. While tolerant to calves, the mature female either ignored or vocalized with a threat bark and head jerk when this male had previously swam too closely. Likewise, this immature male rarely attempted to swim with adult females as he spent more of his time interacting with younger animals or with the adult male (Hill & Ramirez, 2014; Lilley et al., 2020; Ham et al., 2022). Throughout this unusual social interaction, the male displayed many elements of the socio-sexual and courtship repertoires but did not do so in a typical adult behavioral sequence or form, and some behaviors such as an erection and thrust were missing (Glabicky et al., 2010; Hill et al., 2015b; Lilley et al., 2022). This social interaction lasted for approximately 3 min and was one of the first attempted courtship interactions observed for this immature male with an adult female.

Anecdote Two

A second set of observations occurred with a different 7- to 8-y-old male beluga and a different adult female between March and April 2020 (four observations), again in July 2020 (one observation), and then again between May and June 2021 (three observations). Like the other male beluga, this immature beluga also directed lateral presentations and pair swims toward the adult female. Unlike "Anecdote One," in which the female engaged with the male and reciprocated some of the behaviors, in this set of observations, the adult female played a more active role. That is, this female actively solicited attention from the male by also displaying lateral presentations and bubble streams in addition to maintaining the social interaction through spatial proximity. Generally, the male displayed lateral presentations to the female, swam alongside her, exhibited sexual S-postures, bubble streamed, produced several open mouths, and had small erections several times (despite being capable of full erections and previously observed with penile erections). However, contact was minimal, no mouth-to-mouth interactions occurred, and only occasional pelvic thrusting was observed. Like the younger male in "Anecdote One," these sequences were incomplete in comparison to previously recorded adult male courtship displays. On one occasion, the male opened his mouth at the surface and then, after submerging and beginning the presentation behavior, produced simultaneous bubbles from both his blowhole and his mouth. Following this behavior, the adult female also produced bubbles from the blowhole while reciprocating an S-posture toward the male (see Supplemental Video B).

Knowledge of the courtship and mating process in belugas would benefit beluga populations in their natural habitat as well as beluga populations in managed care (see Manitzas Hill et al., 2021). While some behaviors of the courtship repertoire emerge as part of the developmental process of calves, other behavioral aspects of the repertoire may benefit from socially appropriate models, like the presence of older male subadults and adults to observe and potential adult females with whom to practice. This idea is supported by research with bottlenose dolphin juvenile males that have been observed to practice socio-sexual behavior with adult females, age-matched conspecifics, and adult males (Mann, 2006; Harvey et al., 2017). Based on the timing of the seasonal breeding in wild populations and gestation length, it seems plausible that the summer gatherings of belugas, where animals of both sexes and all ages are present (O'Corry-Crowe et al., 2018, 2020), is a time that immature calves may be able to observe how subadult and adult males court the adult females and potentially even participate in a more playful manner (Lilley et al., 2020; Ham et al., 2022). If male competition is present in belugas (see Kelley et al., 2015), most likely in subtle forms, and female choice occurs, then observation of successful males (i.e., able to copulate with a receptive female) could influence future reproductive success for the immature males.

The two sets of observations described herein provide additional insight to the development of courtship in belugas. Based on our longitudinal work, socio-sexual behavior, which is often playful, emerges early (in the first month of life) and is directed first toward the calf's mother and similar-aged calves for both male and female calves (Ham et al., 2022). These behaviors subsequently become more refined and complex over time with practice, especially when exposed to older immature males and adult males (Hill et al., 2015b; Lilley et al., 2020; Ham et al., 2022). Same-sex, socio-sexual behaviors become more frequent for males as they mature, whereas these behaviors drop off for females (Lilley et al., 2020). Although immature females may be the recipient of attempted pelvic thrusts and courtship maneuvers by immature and mature males, the females do not practice the same behaviors as frequently as they mature. Clearly, more observations are needed to better understand the mating system of belugas. However, it seems reasonable that practice with specific courtship behaviors and its adult sequence is needed to develop the repertoire fully, and this process can be facilitated by the presence of appropriate male models and potential adult female partners as males near sexual maturity. For example, with different observations that could be categorized as mating practice for immature male belugas, the adult male that was present in the social composition was observed to intervene between the interacting immature male and adult female at times while making no response other times; no pattern was observed depending on current group composition (H. Manitzas Hill & M. Lilley, pers. obs.). Future studies should attempt to correlate frequency and/or refinement of socio-sexual behavior and mating success (i.e., number of successful pregnancies, number of calves sired). This knowledge can inform animal management processes for both captive and wild populations, especially beluga stocks that are critically endangered, and should continue to be studied systematically in both settings.

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Observations of Courtship in Belugas (*Delphinapterus leucas*)

Malin K. Lilley,[1] Jackson R. Ham,[2] and Heather M. Manitzas Hill[3]

[1]*Department of Life Sciences, Texas A&M University–San Antonio, San Antonio, TX 78224, USA*
E-mail: malin.lilley@tamusa.edu
[2]*Department of Neuroscience, University of Lethbridge, Lethbridge, Alberta, Canada T1K 3M4*
[3]*Department of Psychology, St Mary's University, San Antonio, TX 78228, USA*

Successful copulation is necessary for the continuation of many species, but the courtship behavior (i.e., vocal and behavioral displays) leading to a successful copulation can vary greatly, even among cetaceans. The variation in pre-copulation behavior seems related to the mating system of a particular species. For example, the songs of humpback whales (*Megaptera novaeangliae*) are thought to attract females (see Herman, 2017), and males are often seen escorting females, sometimes while physically competing with each other, in a system of male dominance polygyny (Mobley & Herman, 1985; Clapham, 1996; Pack et al., 2002; Cerchio et al., 2005). North Atlantic right whales (*Eubalaena glacialis*) likely engage in a mating system that includes sperm competition based on genetic analyses and observations of an adult female simultaneously copulating with several adult males (Mate et al., 2005; Frasier et al., 2007). Mate et al. (2005) noted that a female North Atlantic right whale did not attempt to evade the males and remained passively at the surface. Although harbor porpoises (*Phocoena phocoena*) also experience sperm competition, reproductive behavior includes males pursuing and copulating with females at high speeds while the females surface to breathe (Keener et al., 2018; Orbach et al., 2020). Bottlenose dolphins (*Tursiops* spp.) have also been observed in mating contexts where males pursue females prior to copulation (Connor et al., 1992). For some bottlenose dolphin populations, members of male alliances coordinate to herd a female who is ovulating, which increases opportunities for successful copulation (Wiszniewski et al., 2012; Connor & Krützen, 2015). Cues that a female bottlenose dolphin is receptive to copulation may include chemical signals and behavioral changes such as immobilization (described by Muraco & Kuczaj, 2015).

Cetacean courtship can involve visual or acoustic displays as a means of encouraging other individuals to participate in actual copulation (or intromission), which is necessary for fertilization. In some cases, courtship does not lead to copulation if the intended audience is not receptive to the display. Copulation and courtship are distinct from socio-sexual behavior, which is not reproductive in nature. Socio-sexual behavior in belugas (*Delphinapterus leucas*) is observed throughout the year, although there is some seasonal variation (Glabicky et al., 2010; Ham et al., 2021b). Sexually immature females and males of all ages engage in socio-sexual behavior, but adult (i.e., 11+ y) females rarely participate (Hill et al., 2015). The socio-sexual repertoire begins to develop in calves during the first 3 y of life (Ham et al., 2022) but is not complete until belugas are closer to sexual maturity (i.e., approximately 6 y for females and 8 y for males; Lilley et al., 2020). The presence of adult males appears to influence the development of socio-sexual behavior (Ham et al., 2022), but it remains to be seen if these opportunities for observation and practice translate into successful reproduction.

In some cetacean species, females may be selective in their mate choice either through physiological or behavioral resistance (see Orbach, 2019). One example of this is the observations of dusky dolphin (*Lagenorhynchus obscurus*) females avoiding copulation attempts with direction changes and accelerated swims (Orbach et al., 2019). Less well-documented is how female cetaceans might be selective in mating by seeking out and actively engaging in copulation with specific males. Both Muraco & Kuczaj (2015) and Orbach et al. (2019) reported female bottlenose dolphins displaying passive behaviors described as listless, floating, and immobile to indicate receptiveness to copulation. However, information regarding specific courtship and copulation behavior for most cetacean species has not been well-described. Belugas, or white whales, live in Arctic and subarctic waters and are categorized into numerous stocks (i.e., populations). Although recent research has described their social structure to vary seasonally, with large summer congregations nearshore and smaller groups dispersed the remainder of the year (O'Corry-Crowe et al., 2018), their courtship and copulation behavior has not been well-documented in the published literature (Kelley et al., 2015).

An early account of beluga mating describes males pursuing females with such aggression that the females died (reviewed by Kleinenberg et al., 1964). Although this early description was anecdotal, a recent report from a managed care setting (Richard et al., 2021) contradicts these observations of such violent behavior and suggests that female belugas may even choose with whom to mate. Richard et al. (2021) systematically observed one female beluga housed with two male belugas and described the female as choosing to engage with one male preferentially over the other by either rolling her ventral region toward or away from each male as they presented their genital region toward her. As erections were only present during a small number of interactions observed, Richard et al. suggest that the courtship behavior of male belugas is mostly displays and that attempted copulation is less frequent.

Purpose and Method

Despite births of beluga calves in managed care occurring in the absence of artificial insemination, few instances of courtship and copulation have ever been reported for belugas. The purpose of this paper is to describe a small number of observations where adult females were observed engaging in courtship interactions with an adult male (see Table 1 for subject demographics). These anecdotal observations are a result of a longitudinal study which has documented a group of 20 individual belugas (12 females and 8 males, ages ranging between birth and 35+ y), multiple times a week, since 2007. The group composition has varied across the study, but, at any given time, has typically included several mature females, one mature male, and several immature belugas born at the facility. Since 2007, on average, 10 belugas were present at any given time. Because they are housed in seven interconnected pools, there are times when all of the belugas are in the same social group; at other times, the belugas are separated into smaller groups of two or more individuals. The number and size of the social groups are often changed several times within a single day. The overall social behavior of this beluga group reflects the behavior observed in wild beluga populations (see Manitzas Hill et al., 2021).

Observation One: Male Display and Female Participation

In April 2021, an adult female beluga (F1) was observed actively swimming down the water column to join the adult male beluga (M1) on the bottom of the habitat after he presented his ventral side to her (Hill et al., 2015). They swam together for several minutes, but direct copulation was not observed. On a different day in April, F1 and M1 engaged in several interactions over the course of a 30-min observation period. M1 presented his ventrum (i.e., chest, belly, ventral peduncle) to F1 in an S-posture (i.e., body in an S-shape with genitals positioned toward the conspecific as described by Hill et al., 2015) as he swam along the bottom of the environment, and the female swam to join him and positioned herself ventral side up next to his side. As they turned slightly, she turned her ventral side to him. He thrusted his genital region to contact her side, but no penile erection was observed. They separated and swam independently for a few minutes before joining again at the bottom of the habitat, where the female once again positioned herself alongside the male, at which point he thrusted again. Following his second thrust, F1 stopped swimming until M1 was close in proximity and aligned her body to be parallel to M1. M1 thrusted, contacting the female's side (i.e., lateral part of anterior and posterior peduncle as described in Ham et al., 2021a) in numerous locations with his genital region. This sequence was repeated. On the fourth thrust, the female lifted her flukes and peduncle slightly as the male thrusted, which gave him access to her genitals, but still no erection was observed (see Supplemental Video A for an excerpt of this sequence; the Supplemental Videos for this paper are available in the "Supplemental Material" section of the *Aquatic Mammals* website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147). Following this, the two separated and

Table 1. Belugas (*Delphinapterus leucas*) who are the focal subjects for the reported observations

Subject	Sex	Age at observations	Previously produced offspring?
M1	Male	Est. 27-29 y	Yes
F1	Female	11 y	Yes
F2	Female	11 y	Yes
F3	Female	Est. 31 y	Yes

swam independently. After several minutes, M1 began swimming back and forth at the bottom of the habitat with his ventrum presented, exhibiting an S-posture toward F1 who was near the surface and unresponsive to him. The male continued these presentations for about 5 min, at which point the female suddenly swam to the bottom and lined up again with her ventrum up and her side along his ventrum (similar to the copulatory position of wild belugas described by Kleinenberg et al., 1964). M1 thrusted his genital region again and released a small stream of bubbles, then a bubble burst (Hill et al., 2011), and immediately formed another S-posture with an erection visible before thrusting once more (see Supplemental Video B for an excerpt of this sequence). The female actively remained near the male's side, and they slowly swam forward through the water. After this sequence, both belugas surfaced to breathe simultaneously, with the male returning to swim underwater while the adult female remained at the surface, which resulted in termination of the male–female interaction for that observation. Although several other individual belugas were present in the social group at the time, only one other female beluga (F2, described below) briefly followed the pair and observed their behavior. In May 2021, F1 was observed engaging with an environmental enrichment device (EED), which she left to join the adult male. M1 thrusted his genital region toward her shortly after she joined him. The adult female reciprocated this thrust by slightly turning her body so her ventrum was closer to the male's ventrum. This sequence was the only interaction during the observation period.

Observation Two: Multiple Female Solicitation and Object Use

In May 2021, a different adult female (F2) was observed engaging in courtship behavior with the adult male (M1). M1 presented his ventrum to F2 a few times before the female swam over to the male and turned her ventrum slightly toward him. Later in the observation, M1 presented his ventrum toward the female in "Observation One," F1, but that female swam away, and F2 swam over and positioned herself alongside M1 (see Supplemental Video C for an excerpt of this sequence). Although no instances of copulation occurred, the courtship display of the male resulted in the female actively choosing to engage in a sexual interaction with the male by altering her swim direction and speed, similar to "Observation One."

During another observation day in May 2021, M1 was seen carrying an EED on his head and dorsal ridge before displaying courtship behavior with both F1 and F2 (see Supplemental Video D for an excerpt of this sequence). Both F1 and F2 had been interacting with the same object earlier that day. Although all other belugas in this managed care population interact with EEDs, M1 had not been observed interacting with an EED spontaneously before this observation.

Observation Three: Synchronized Swimming During Courtship

A third adult female (F3) was observed swimming with M1 on two separate days in April 2019. They swam together for several minutes, both synchronized in their swim direction and swim speed, while M1 presented his genital region toward F3's side. M1 was not observed to have an erection, but F3 maintained her proximity to him and was observed lining up alongside his ventrum. In some instances, F3 rolled so that her ventrum was close to M1's ventrum; and in other instances, she rolled her ventrum away from M1's ventrum. Additionally, the adult female appeared to lift her flukes and peduncle upwards as the male thrusted his genital region toward her and made contact in some instances (see Supplemental Video E for an excerpt of this sequence). This interaction took place near the bottom of the habitat and not at the surface, although after several minutes of interacting at the bottom, the pair came to the surface a few times to breathe, after which they floated motionlessly apart from one another. After floating at the surface for a few minutes, both dove back down to the bottom, in synchrony, and resumed swimming together. Although several other belugas were part of this social group, two juvenile males are visible in the video engaging in socio-sexual behavior with each other while potentially observing the above interaction.

While the observations described above are anecdotal, they appear to elucidate the roles of male and female belugas in courtship and mate choice. From these observations, several patterns emerged and appear to partially reflect the limited reports from wild belugas (Kleinenberg et al., 1964; Lomac-MacNair et al., 2016). Unlike some cetacean species, such as harbor porpoises and finless porpoises, where the males pursue the females at high speeds (Keener et al., 2018; Serres et al., 2021), the behavior of the male beluga in these observations was display-based, similar to those reported in wild belugas (Lomac-MacNair et al., 2016) and the findings of Richard et al. (2021). In the present study, the male did have several females he could court at any given time, but, for the most part, he directed his displays at just one female for a given observation period. For each observation period, the female at whom the displays were directed was almost always the female who later interacted with the male. Because the male was typically some distance away and usually at the bottom of the habitat when he displayed his body in an S-posture presentation with his genital region presented to the female, the three adult females described in this paper were active participants in the interaction. The females changed their swim trajectory to swim over to the male and actively adjusted their body positions to be aligned with the male. In some instances, the females rolled so that their ventrums were closer to the male's ventrum, like descriptions of bottlenose dolphin copulation (Tavolga & Essapian, 1957); and in a few cases, the females were observed to lift their flukes and peduncle up, which seemed to allow the male to gain better access to the female's genitals. Two of the females also displayed a behavior that resembled the immobility described for female bottlenose dolphins and harbor porpoises (Muraco & Kuczaj, 2015; Orbach et al., 2019). Similar to Richard et al. (2021), both the females and male involved in these observations allowed conspecifics in the same habitat to swim close by. As the observing belugas were mostly calves and juveniles, their intent observation of the copulation may provide an opportunity for social learning (Ham et al., 2022).

The use of objects in courtship behavior has been suggested for other cetacean species, including river dolphins (*Inia geoffrensis*; Martin et al., 2008) and Australian humpback dolphins (*Sousa sahulensis*; Allen et al., 2017) for which the males of both species have been observed carrying and displaying objects (e.g., sticks, sponges, etc.) in what are hypothesized to be attempts at attracting females. Although this is the first description of a courtship display potentially involving object carrying for belugas, belugas have been previously observed interacting with objects while engaging in both socio-sexual behavior and non-social sexual behavior (Hill et al., 2015; Lilley et al., 2020; Ham, 2021; Ham et al., 2022), and male killer whales (*Orcinus orca*) have been observed carrying objects while courting females in human care (M. Lilley, pers. comm. with animal care staff at SeaWorld of Texas). Wild belugas have also been observed carrying objects, although the context of these instances (e.g., play, socio-sexual, courtship) is unknown (Krasnova et al., 2014).

Unlike socio-sexual interactions that happen above and below the surface, these courtship interactions took place underwater and most frequently at the bottom of the habitat. In addition to the poor visibility that often occurs in wild settings, the depth of courtship behaviors might be why this is not well-documented in wild populations and emphasizes the value of studying belugas in managed care settings. Similar to Richard et al. (2021), most of the courtship behavior reported herein did not involve the male having an erection. In the few instances where an erection was present, complete intromission was not observed. Based on the observations of beluga behavior thus far, actual copulation is likely a rare event compared to the time spent in courtship displays. It is possible that the belugas engaged in actual copulation outside these observations. Although all three females and the adult male have produced offspring prior to these observations, the events recorded herein did not result in detectable pregnancies.

This paper provides additional information about the active role female belugas play in courtship and copulation behavior and will hopefully spark future research on this topic so that the mating system of belugas can be better understood. Female choice and the quality of the male's display may be important for breeding success and, therefore, a population's survival. Whether males are selected for their behavioral displays, vocal displays, or body condition is not known. Social groups with multiple mature males and multiple mature females are necessary to better understand the complexity of male and female mate choice for belugas. Historically, for many species, there has been a paucity of information on the females' role in courtship and copulation (e.g., female birdsong and ornamentation research; Haines et al., 2020), but the female's role in courtship and mate choice must be remembered when describing mating behaviors. The observations reported herein help to close that gap for belugas, and hopefully future research will continue to do so.

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Account of a Solitary Humpback Whale (*Megaptera novaeangliae*) Bubble-Net Feeding in the Moray Firth, Northeast Scotland

Eleanor M. Marwood,[1] Ciarán J. Dolan,[1, 2]
Tom J. Dolan,[1] and Kevin P. Robinson[1, 2]

[1]*Cetacean Research & Rescue Unit (CRRU), PO Box 11307, Banff AB45 3WB, Scotland, UK*
E-mail: ellamarwood@live.com
[2]*Centre for Ecology and Conservation, University of Exeter, Penryn, Cornwall TR10 9FE, England, UK*

Humpback whales (*Megaptera novaeangliae*), like other rorquals, possess ventral pleats that allow them to engulf large volumes of water, dense with prey, through an efficient lunging action (Pyenson et al., 2012). This feeding method is implemented by humpback whales in various ways by different populations that show behavioural plasticity between geographical locations. In Alaska, for example, humpbacks may dive down hundreds of metres to feed upon aggregated krill (Burrows et al., 2016), while in the west Antarctic Peninsula, the whales feed both closer to the surface and at depth (Ware et al., 2010). To maximise the energetic efficiency of lunge feeding, some humpback populations employ a unique behaviour known as bubble-net feeding, involving the simultaneous expulsion of air underwater while swimming to form a vertical, cylindrical ring of bubbles (Wiley et al., 2011; McMillan et al., 2018). Targeted baitfish are subsequently confused and confined at the water's surface into a tightly packed ball by the rising bubbles (Sharpe & Dill, 1997; Leighton et al., 2007; Wiley et al., 2011; Bryngelson & Colonius, 2019). The whales then lunge through this bait ball with their mouths agape, engulfing as many netted prey as possible.

The earliest eyewitness report of bubble-net feeding was recorded in 1905 off the coast of Norway by Ingebrigtsen (1929). Since then, the behaviour has been well-documented in other regions of the world, from the Atlantic Ocean, including North America's eastern seaboard around the Stellwagen Bank National Marine Sanctuary and other regions of the Gulf of Maine (Askin et al., 2017; Mastick et al., 2022), in the northeastern Pacific in Alaska and Canada (Jurasz & Jurasz, 1979; Hain et al., 1982), in the Baja Californian breeding grounds off the coast of Mexico in the eastern Pacific (Gendron & Urban, 1993), in the southeastern Pacific in the Magellan Strait (Acevedo et al., 2011) to the Southern Ocean around the South Shetland Islands (Herr et al., 2016), off the east coast of Australia in the southwestern Pacific (Pirotta et al., 2021), and in the Arabian Sea in the northern Indian Ocean (Baldwin et al., 2011). To date, however, this behaviour has only briefly been reported once within UK waters in the Firth of Clyde on the west coast of Scotland (Zonfrillo, 1996), although only a vague account of observed surface bubbles was provided in this case, with no description of the pathway or mechanics of the feeding whale.

On 8 October 2021, during a dedicated boat survey for minke whales (*Balaenoptera acutorostrata*) in the Moray Firth, northeast Scotland, a solitary adult humpback whale was encountered performing bubble-net feeding manoeuvres. The whale was encountered approximately ~11 km offshore (57° 46.948' N, 2° 14.061' W) in an area with a bottom depth of 143 m as measured with a dual frequency echosounder (Raymarine plc, Fareham, UK). Minke whales were also observed in the immediate area, along with multiple bird species forming active feeding rafts comprising northern gannets (*Morus bassanus*), European herring gulls (*Larus argentatus*), black-legged kittiwakes (*Rissa tridactyla*), guillemots (*Uria aalge*), and razorbills (*Alca torda*). The bubble-netting behaviour was recorded from a DJI Mavic Pro2 Unmanned Aerial Vehicle (UAV) (Da-Jiang Innovations, Shenzhen, China) post-encounter, flown 30 m above the humpback; from this vantage point, the size, body mechanics, and swim path of the whale were fully observed.

The captured video showed the humpback whale releasing bubbles in a corkscrew, "Fibonacci-shaped" spiral as it circled upwards in a clockwise direction (Figure 1), increasing its turn rate towards the end of the spiral (see Supplemental Video File 1; the supplemental video for this paper is available in the "Supplemental Material" section of the *Aquatic Mammals* website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147). Two separate spiral

Figure 1. Still images of one of the bubble-net feeding sequences as captured from the UAV drone. During each sequence, the humpback whale (*Megaptera novaeangliae*) circled in a clockwise upwards spiral (with an increasing body turn rate) while blowing bubbles in a continuous stream through 1.5 revolutions. Video footage of this sequence is available as Supplemental Video File 1. (*Video footage credit:* Ciarán Dolan)

events were recorded from the UAV, with the duration of bubble release (time from the first to last exhaled bubbles breaking the water's surface) lasting 12 and 14 s, respectively, as bubbles were released as a continuous stream through 1.5 revolutions as tracked from above. The diameter of the bubble net spanned ~13.5 m, proximate to the whale's estimated length at 12.8 m, as calibrated from the footage with respect to the 8-m survey vessel *in situ*. Each of the upward spirals concluded with the whale lunging dorsally through the centre of the surfacing bubble net, the mouth of the whale agape with ventral pleats fully distended (Figure 2). Dense aggregations of prey could be identified on the depth-finder but were too deep to sample. However, during subsequent boat surveys over the following days, minke whales were recorded surface feeding on juvenile sprat (*Sprattus sprattus*) in the very same encounter area.

The configuration of the recorded bubble net, described above, was comparable to existing descriptions of this complex feeding behaviour from other accounts. For example, Wiley et al. (2011) described individual humpbacks from the Stellwagen Bank National Marine Sanctuary, Gulf of Maine, northwestern Atlantic, performing similar upwards spiral manoeuvres (in both clockwise and anti-clockwise directions) as well as more complex double-loop strategies and coordinated methods involving multiple animals. In our present observations, the whale released a continuous stream of surfacing bubbles, creating a discrete annular bubble curtain as opposed to the multiple bubble bursts also described for the species (e.g., Jurasz & Jurasz, 1979; Hain et al., 1982). Wiley et al. (2011) proposed a 20-m depth limit for bubble-net feeding whales due to the physics of bubble dispersal to which humpback whales have behaviourally adapted. In the present Moray Firth encounter, the turbidity of the water restricted visibility from the UAV as the whale circled below the surface; however, the duration of the rising bubble trail was consistent with a dive depth within this projected 20 m interval.

While records of humpback whales remain low in northeast Scotland (Reid et al., 2003; Robinson et al., 2007), an increasing trend in the number of sightings of the species is evident in recent years (Ryan et al., 2016; O'Neil et al., 2019). Since 2001, 17 individuals have been documented in the Moray Firth by the CRRU research team between

Figure 2. The humpback whale surfacing vertically through the centre of the bubble trap in a dorsal lunge, with mouth fully agape and ventral pleats distended (*Still from phone video footage:* Tom Dolan)

July and October (K. P. Robinson, unpub. data), for which all identifying fluke photographs were submitted to the *North Atlantic Humpback Whale Catalogue* (NAHWC), which contains over 10,500 individuals collated over four decades. Humpbacks are a migratory species, undertaking long journeys from their low latitude breeding grounds to higher latitude areas to feed (Rizzo & Schulte, 2009), and previous studies have managed to map these routes from the mark-recapture of individually recognisable animals (e.g., Stevick et al., 2003; Robbins et al., 2011). Accordingly, one of the Moray Firth individuals captured by the CRRU in August 2013 (NA06642) was subsequently observed in 2015 off Cape Verde in the east Atlantic by Strava Tours, and then more recently in April 2018 in the Azores in the northeast Atlantic by Whale Watch Azores. Lindsey Jones, who maintains the NAHWC and discovered these matches, confirmed this is the first humpback from Scotland that has been recaptured in both the migratory stopover area of the Azores *and* the Cape Verde Islands breeding ground, and the second known resighting between Cape Verde and Scotland (Lindsay Jones, pers. comm., April 2020).

It has been proposed that humpbacks in the Southern Hemisphere supplement their energy stores on Antarctic migrations by feeding off of the east coast of Tasmania (Andrews-Goff et al., 2018). The Moray Firth may subsequently provide a short-term replenishing area for these whales on their passage to known destinations further north in Iceland and the Barents Sea (Stevick et al., 2006) or when making the return journey southwards (e.g., O'Neil et al., 2019). The regional and temporal availability and predictability of prey quintessentially influence the foraging responses of baleen whales (Robinson et al., in press), and the highly productive waters of the Moray Firth may provide important food reserves for these migrating whales (Robinson et al., 2009; Paxton et al., 2014).

A better knowledge of the movements and behaviour of humpback whales in inshore Scottish waters is also valuable from a conservation perspective. Entanglement in static fishing gear (e.g., pots, creels), for example, has been identified as the largest anthropogenic threat to baleen whales in these waters (Northridge et al., 2010), with estimates of at least six humpbacks being entangled in Scotland each year (Leaper et al., in press). The species is highly susceptible to entanglement due to its elongated pectoral fins that are easily caught up in ground lines (Ryan et al., 2016). Despite the low densities of humpback whales recorded in Scottish waters, entanglements of the species nevertheless show an increasing trend (Leaper et al., in press). Encouragingly, Scottish creel fishermen have shown willingness to engage in entanglement mitigation (MacLennan et al., 2019) and have suggested measures such as the introduction of sinking lines, which should be pursued with some urgency.

The use of UAVs in cetacean research provides a non-invasive, cost-effective, and highly versatile tool for collecting data from free-ranging marine mammal populations (e.g., Christiansen et al., 2016; Aniceto et al., 2018; Raoult et al., 2020). Indeed, the present report underscores the value of UAVs for documenting anecdotal behaviours that might otherwise have been missed using traditional boat-based monitoring methods alone. Based on the former recapture of individual NA06642 between Scotland and the Cape Verde Islands, the migratory route of the bubble-netting humpback whale reported herein could conceivably be the same. The most recent study of the Cape Verde breeding population reported just 267 individuals (Wenzel et al., 2020), and genetic analyses have established clear population separation between this east Atlantic population and the larger, western Atlantic breeding population in the Dominican Republic (e.g., Palsbøll et al., 1997; Constantine et al., 2012). Thus, future studies focusing on the collection of skin samples from Scottish humpbacks for microsatellite genotyping would provide a more thorough understanding of the large-scale movements and migratory origin of these intermittent seasonal visitors.

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A Juan Fernández Fur Seal (*Arctocephalus philippii*, Peters, 1866) in the Galápagos Islands: Insights from the First Anecdotal Observation in the Last Century

Juan José Alava,[1, 2] Godfrey Merlen,[3] Patricia Rosero,[4]
Isabel C. Avila,[5, 6] and Sandie Salazar[7]

[1]*Institute for the Oceans and Fisheries, University of British Columbia, Vancouver, BC, Canada*
E-mail: j.alava@oceans.ubc.ca
[2]*Fundación Ecuatoriana para el Estudio de Mamíferos Marinos (FEMM), Guayaquil, Ecuador*
[3]*Sea Shepherd, Puerto Ayora, Santa Cruz Island, Galápagos, Ecuador*
[4]*Universidad de Las Américas, Quito, Ecuador*
[5]*Grupo de Ecología Animal, Universidad del Valle, Cali, Colombia*
[6]*Institute for Terrestrial and Aquatic Wildlife Research, University of Veterinary Medicine Hannover, Foundation, Germany*
[7]*Universidad San Francisco de Quito, Galapagos Science Center, Campus Cumbaya, Quito, Ecuador*

The Juan Fernández fur seal (*Arctocephalus philippii*) is a pinniped species endemic to Chile, inhabiting the Juan Fernández Archipelago (i.e., Robinson Crusoe, Santa Clara, and Alejandro Selkirk Islands) and Desventuradas Islands (i.e., San Félix and San Ambrosio Islands) (Aurioles-Gamboa, 2015; Osman & Moreno, 2017; Aurioles-Gamboa & Trillmich, 2018). This species recently has been observed and recorded in marine and coastal regions outside its normal distribution range along the southeastern tropical Pacific (Table 1). The vagrant behaviour and occasional presence of this fur seal species have been observed along the Pacific coast of South America and oceanic islands, including Colombia, Galápagos Islands, Ecuador, Perú, and on Chile's mainland coast, as reported elsewhere (Majluf & Reyes, 1989; Merlen, 1995; Reeves et al., 2002; Alava & Salazar, 2006; Avila et al., 2014; Aurioles-Gamboa, 2015; Jefferson et al., 2015; Alava & Aurioles-Gamboa, 2017; Aurioles-Gamboa & Trillmich, 2018; Páez-Rosas et al., 2020; Alava et al., 2021).

The sighting of this species in Punta San Juan (Perú) (Majluf & Reyes, 1989), for instance, was considered as the northern limit of its occurrence (Aurioles-Gamboa, 2015). El Niño–Southern

Table 1. Documented observations of the Juan Fernández fur seal (*Arctocephalus philippii*) in the southeastern tropical Pacific, including the Galápagos Archipelago, Colombia, and Perú, from 1973 to 2019

Records in chronological order	Date	Location	Geographical coordinates	Age/sex category (number of fur seals [*n*])	Body condition	Source/ reference
1	1973 to 1984	Punta San Juan, Perú	15° 21' 59" S, 75° 11' 31" W	Adult or juvenile males (n = 10-15)	N/A	Majluf & Reyes, 1989
2	1986	San Cristóbal Island southwestern coast, Galápagos Islands, Ecuador	0° 54' S, 89° 36' W	Presumably an adult male (n = 1)	Apparent good body condition	Merlen, 1995; this study
3	4 July 2007	San Francisco (local beach), Puerto Buenaventura, Colombia	3° 53' N, 77° 4' W	Adult male (n = 1)	Poor body condition (emaciated)	Avila et al., 2014
4	24 June 2019	Playa de Oro, Puerto Baquerizo Moreno, San Cristóbal Island, Galápagos Islands, Ecuador	0° 54' S, 89° 36' W	Subadult male (n = 1)	Good body condition	Páez-Rosas et al., 2020

Oscillation (ENSO) events and ocean warming are considered to be the environmental, density-independent factors influencing the long dispersion and extralimital records of vagrant Juan Fernández fur seals (Avila et al., 2014; Aurioles-Gamboa, 2015; Páez-Rosas et al., 2020; Table 1). Observations of tropical and subtropical pinniped species outside their normal home ranges are becoming the norm in the southeastern tropical Pacific (Alava & Aurioles-Gamboa, 2017).

Páez-Rosas et al. (2020) recently reported an observation of Juan Fernández and Guadalupe (*Arctocephalus philippii townsendi*) fur seals in the Galápagos Islands as unprecedented records attributed to the incidence of cold marine currents (e.g., Humboldt Current) or anomalous oceanographic events (e.g., ENSO events). Notwithstanding, the Juan Fernández fur seal as a single identified species was observed previously in the Galápagos Islands in the last century by Merlen (1995). Thus, this species is not a new visitor to the islands.

Herein, we provide further insights on this first opportunistic observation based on a rigorous examination of the original photo of this species from the late 1900s, deposited in the Charles Darwin Research Station Library by the second author (GM) in the 1980s, to complement the recent sightings of an individual of this species genetically identified by Páez-Rosas et al. (2020). Doing so, we also contribute with more details on the extralimital records, movement, and behavioral ecology of this fur seal species subjected to the influence of changing oceans and regional climate change in the southeastern tropical Pacific Ocean.

In 1986, an unidentified fur seal was observed on the rocky lava shore of the southwestern coast of San Cristóbal Island close to Puerto Baquerizo Moreno (0° 54' S, 89° 36' W; Figure 1), one of the main populated islands of the Galápagos Archipelago. According to the external description and examination of the archived photo (see black and white illustration shown in Figure 2),

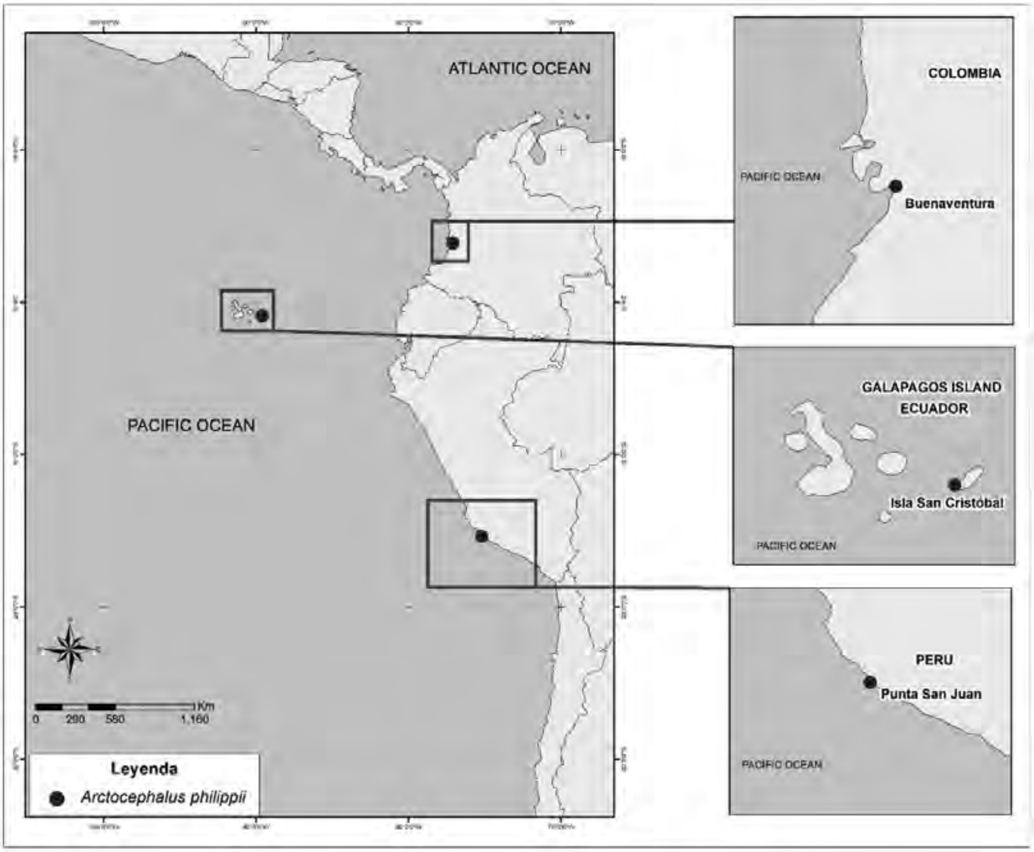

Figure 1. Map of the Galápagos Archipelago showing the location of the anecdotic observation of the Juan Fernández fur seal (*Arctocephalus philippii*) on the southwestern coast of San Cristóbal Island in 1986, and other recent sightings of this species in Perú (Punta San Juan) and Colombia (Buenaventura), as reported in Table 1

Figure 2. Illustration of a Juan Fernández fur seal observed on the southwestern coast of San Cristobal Island, based on the original black and white photograph taken by the second author (GM) and archived in the Charles Darwin Station Library (Puerto Ayora, Santa Cruz Island, Galápagos Islands). Artwork courtesy of N. Alava Calle.

the otariid was identified as a Juan Fernández fur seal and exhibited a dark brown coloration with a mane from the top of the head to the top of the shoulders; however, it was not possible to visualize the golden yellow to tan-tipped guard hairs in this photo. Of particular attention was the long, slender, and pointed snout or muzzle with a distinctive bulbous rhinarium, and the head shape (Figure 2), which is a characteristic trait for this species that has the longest snout among southern fur seal species (Reeves et al., 2002; Jefferson et al., 2015; Aurioles-Gamboa & Trillmich, 2018). Based on this unique trait, the animal in question did not exhibit morphological features matching those of the two well-known endemic otariids, the Galápagos sea lions (*Zalophus wollebaekii*) and the Galápagos fur seal (*Arctocephalus galapagoensis*), which indeed lack the long, slender, and pointed snout observed in *A. philippii*.

Still, the animal resembles and is comparable to its closest and more similar relative, the Guadalupe fur seal, mainly found in the Northern Hemisphere. While the snout of *A. townsendi* is also pointed, it shows a tapering muzzle that appears slightly upturned, with the nostrils pointing downward at an angle, a feature not observed on the snout of *A. philippii*. Moreover, *A. philippii* possess a short hind flipper compared to the moderately long hind flippers of *A. townsendi*.

Despite the complexity to discriminate morphologically the Juan Fernández fur seal from the Guadalupe fur seal, the former can be distinguished from other fur seals by the shape of the head, snout length and shape, and fur coloration differences (Reeves et al., 2002; Jefferson et al., 2015; Aurioles-Gamboa & Trillmich, 2018).

Based on exhaustive inspection of the original photo in comparison with Figure 2 in Páez-Rosas et al. (2020), we assert that our observation was the first northernmost record prior to the sighting of an emaciated individual in Colombia by Avila et al. (2014), and well before the second record for the Galápagos Islands (Páez-Rosas et al., 2020). Some other unconfirmed sightings and anecdotal records have been informed for Ecuador's continental coast (J. J. Alava, pers. obs., March 2021; Alava et al., 2021).

Ongoing changing ocean conditions driven by regional climate changes could be prompting the expansion and behavioral movement of non-native pinniped species to remote, oceanic islands of the southeastern Pacific Ocean (Alava et al., 2022). Density-dependent factors, such as increasing population growth rate, and density-independent factors, such as the influence of the Humboldt Current during cold conditions, ENSO events, and ocean warming due to global climate change triggering these long dispersals (Alava & Carvajal, 2005; Elorriaga-Verplancken et al., 2016; Páez-Rosas et al., 2017, 2018, 2020; Avila et al., 2021; Rosero & Alava, 2021; Alava et al., 2022), should be considered to explain the unusual occurrence of this species in regions far from its home ranges.

As it stands, the individual recorded in 1986 by Merlen (1995) occurred during cold and warm periods that exhibited negative and low to moderate positive sea surface temperature (SST) anomalies (i.e., mean Oceanic Niño Index [ONI]-SST anomaly: 0.242 ± 0.61 [SD], ranging from -0.5 to 1.2; Figure 3) 4 y after one of the strongest El Niño episodes in 1982, which dramatically affected the endemic pinniped species of the Galápagos Islands (Merlen, 1995; Alava & Salazar, 2006; Alava & Aurioles-Gamboa, 2017). Similarly, the recent sightings of June 2019 were associated with the influence of the cold Humboldt Current (Páez-Rosas et al., 2020), with low positive SST anomalies (i.e., mean ONI-SST anomaly: 0.475 ± 0.21 [SD], ranging from 0.1 to 0.7), following 4 y after the third, strong 2015 ENSO event (Figure 3).

These observations underscore the propagated post-impact force of intense and recurrent ENSO events alternated with negative (i.e., La Niña events) or low-moderate positive SST anomalies, likely influencing the extralimital distribution of this pinniped species and the availability of its main preys in the southeastern tropical Pacific Ocean in the face of a changing ocean (Alava et al., 2022). However, our understanding is limited regarding the mobile or vagrant behavior of *A. philippii* in tandem with its sensitivity and vulnerability to the accumulative impacts of climate change, affecting marine mammals (Albouy et al., 2020), and the increasing frequency of El Niño in recent decades (e.g., Freund et al., 2019), ultimately affecting changes in food supply or prey distribution and nutritional status.

The Juan Fernández fur seal was intensively hunted in the past with such a high magnitude that this species was very close to extinction (Aurioles-Gamboa, 2015; Osman & Moreno, 2017). It was estimated that at least 3,870,170 individuals were captured during commercial exploitation from 1687 to 1898, leading some to believe this species extinct by 1900 (King, 1964; Maxwell et al., 1967; Hubbs & Norris, 1971; Torres, 1987a, 1987b) as a consequence of the vast hunting exploitation (Osman & Moreno, 2017). In 1965, Bahamonde (1966) reported the presence of small colonies on Alejandro Selkirk and Robinson Crusoe Islands, announcing that the species was not extinguished and had been rediscovered. Its capture and

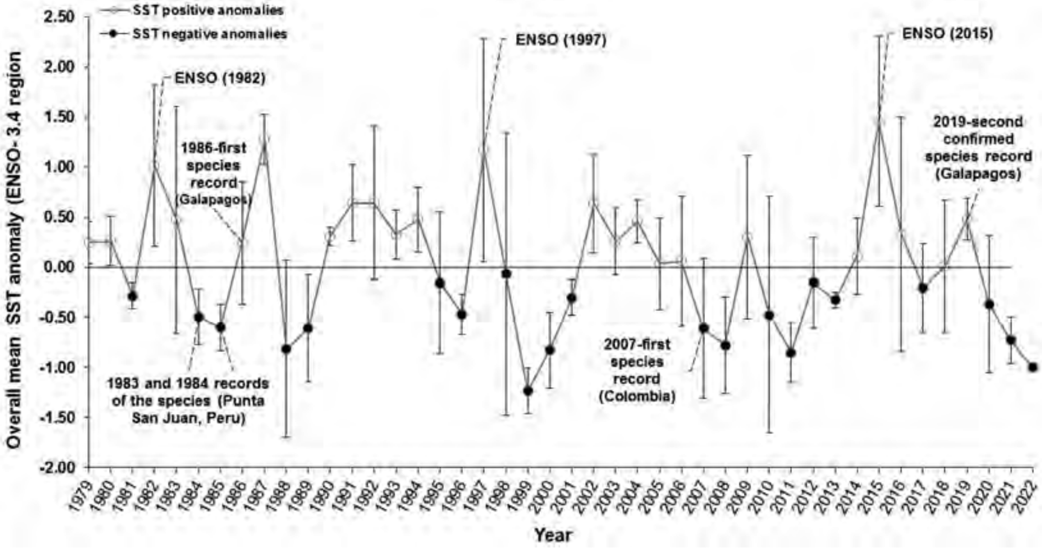

Figure 3. Records of the Juan Fernández fur seal plotted in combination with the overall annual average of SST anomalies (i.e., the Oceanic Niño Index [ONI]) in the El Niño 3.4 Region (i.e., 3-mo running mean of *ERSST*, Version 5, SST anomalies in the El Niño 3.4 Region; Huang et al., 2017; https://origin.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ONI_v5.php), based on centered 30-y base periods in the Eastern Tropical Pacific from January 1979 until May 2022. Warm (e.g., El Niño events) and cold (e.g., La Niña episodes) periods are represented by white and black circles, respectively. The error bars are standard deviations (SD) to show the variability of the ONI-SST anomaly data.

exploitation has been prohibited in Chile since 1965 (Aguayo, 1979), and full protection status was extended to all *Arctocephalus* species in 1978 (Torres, 1987b).

The Juan Fernández fur seal was "Near Threatened" according to the criteria of the International Union for Conservation of Nature's *Red List of Threatened Species* until 2008 (Aurioles & Trillmich, 2008) when a population ranging from 12,000 to 18,000 individuals was reported (Aurioles & Trillmich, 2008; Aurioles-Gamboa, 2015; Jefferson et al., 2015). As the population is reaching stability and gradually increasing with a population size of 32,278 individuals, not including females performing foraging trips and juveniles (Osman & Moreno, 2017), the species is currently listed as of "Least Concern," according to the last IUCN assessment (Aurioles-Gamboa & Trillmich, 2018).

While there are scarce field data to suggest that an increase of this species' population would be a contributing factor to the dispersion of vagrant individuals, questions linger about the environmental stressors and climatic events affecting this species and its habitat (Avila et al., 2014; Aurioles-Gamboa, 2015; Aurioles-Gamboa & Trillmich, 2018; Páez-Rosas et al., 2020). Searching previous pinniped anecdotic records and historical data is essential to obtain reliable knowledge of past and current intrinsic and extrinsic factors affecting their population dynamics. As highlighted by Rosero & Alava (2021), local unreported records and knowledge in combination with systematic field and scientific observations can serve to propose and recommend management strategies for the conservation and protection of threatened, non-native roaming pinniped species that temporarily arrive or visit Ecuadorian waters, including the Galápagos Islands.

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An Unexpected Benefit from Drone-Assisted Fecal Sample Collection: Picking Up Subsurface Poop After It Floats to the Surface

Robin W. Baird, Jordan K. Lerma, Colin J. Cornforth, and Kimberly A. Wood

Cascadia Research Collective, 218½ W. 4th Avenue, Olympia, WA 98501, USA
E-mail: rwbaird@cascadiaresearch.org

Discovering how established methodologies can be applied in a new way can be quite exciting. We experienced this on 5 November 2021 while testing the use of an unoccupied aerial system (UAS, aka drone) as part of an effort to collect fecal samples from odontocetes in Hawai'i.

In the past, fecal samples from cetaceans have been collected (1) using scat-detecting dogs (e.g., Rolland et al., 2006; Ayres et al., 2012), (2) by simply following behind animals and watching for fecal plumes (i.e., the reddish-brown diffuse and spreading cloud of feces as the animal defecates) or looking for fecal material in the fluke prints (e.g., Hanson et al., 2010; Ford et al., 2016), or (3) opportunistically when defecations were observed while working with cetaceans for other reasons. While trying to collect both fecal and prey samples from fish-eating killer whales (*Orcinus orca*) in the murky waters of the Salish Sea, Washington, one of us (RWB) followed directly behind the whales while the sampler, positioned on a bow pulpit, would scan the fluke prints in case samples were welling up to the surface (see Hanson et al., 2010). Since the whales were typically traveling at speeds of 5 to 7 km/h, this required slowing the vessel down prior to reaching a fluke print in case a sample was available, and then increasing speed again if nothing was visible. While this approach was quite successful in the Salish Sea, with much better water clarity in Hawai'i and after having experienced the benefits of using a drone to observe and track a difficult-to-follow species (Baird et al., 2021), we thought that using a drone to visually monitor for the presence of fecal plumes from surfacing or near-surface whales would help increase fecal sample collection rates (e.g., Lemos et al., 2020). This would allow the research vessel to remain farther behind the animals, minimizing the potential for disturbance, as well as potentially increasing the number of individuals that could be simultaneously monitored for defecations, and, thus, sample collections. In November 2021, we undertook a 13-d field effort off the island of Hawai'i as part of a long-term study of Hawaiian odontocetes (Baird, 2016). One project goal was to test the approach of using a drone to aid in fecal sample collection with one or more of the odontocetes that we typically encounter (Baird et al., 2013).

Field operations were undertaken with a 7.3-m rigid-hulled Zodiac with a custom-made bow pulpit, providing an elevated platform for the sampler. Fecal samples were collected with a swimming pool leaf net on a ~4 m pole. On 5 November 2021, from 1152 to 1242 h (Hawai'i Standard Time), we worked with a group of approximately 25 short-finned pilot whales (*Globicephala macrorhynchus*) in approximately 950 m water depth off the west side of Hawai'i Island (19.557° N, 156.021° W). The group was dispersed over an estimated area of 750 × 450 m in small subgroups of one to five individuals. Individuals were generally traveling slowly to the south, interspersed with periods of surface logging and occasional milling. These behaviors are typical for pilot whales during midday in Hawaiian waters (Baird, 2016). We maneuvered the research vessel to generally remain 20 to 60 m behind a subgroup of whales. We launched and retrieved a DJI Mavic 2 Pro twice, with the drone in the air for a total of 39 min. A live video feed (1,080 p) from the drone was monitored using a DJI CrystalSky high brightness display. This display is brighter than other tablets, allowing for better monitoring of the darker areas in the image and tracking animals while subsurface in full sun. If whales visible to the drone pilot dove out of sight, the drone was maneuvered to find a new subgroup to observe, and the research vessel moved to the new subgroup. The drone was flying above or to the side of animals at altitudes ranging from 15 to 50 m and was positioned to minimize glare and to maximize the likelihood of detecting a fecal plume (which in slowly moving pilot whales can be up to 2 m long and half a meter wide) or floating fecal material. While the drone pilot was monitoring the video feed for fecal plumes or fecal material, we were set up for sample collection and were monitoring the water in front of and beside the boat for fecal material for ~30 min (Figure 1; see supplemental video; the supplemental video for this paper is available in the "Supplemental Material" section of the *Aquatic Mammals* website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147). During that time, we collected three fecal samples (at 1211 h, 1213 h, and 1231 h), at distances of ~30 m, ~20 m, and ~7 m, respectively, from the closest whale that we were following. Based on the relative positioning of whales and the boat, we believe all three fecal samples likely came from different individuals, although we were not able to identify which individuals the samples came from given the defecations were subsurface. After collection, samples were stored in a cooler with ice packs and were archived for later analysis at the Health and Stranding Lab at the University of Hawai'i.

No fecal plumes were observed, and none of the fecal samples we collected were noted by the

Figure 1. (A) Collection of a floating fecal sample from short-finned pilot whales (*Globicephala macrorhynchus*) on 5 November 2021—although not visible from the drone, the sample is next to the boat in this image; and (B) collecting floating reddish-brown fecal material from a short-finned pilot whale.

drone pilot at the surface prior to their detection from the boat. While this may have been due in part to the altitude of the drone, it appeared that all three samples we collected originated from whales defecating far enough below the surface that fecal plumes were not visible to the drone pilot, and the fecal material took some time to float to the surface. During all three sample collections, fecal material was observed coming up to the surface next to and in front of the boat as sample collection was underway. These observations were insightful. Despite the fact that the drone pilot did not spot the fecal plumes, the mere use of the drone to visually monitor for fecal plumes led us to remain farther back from the animals than we would have otherwise, thus revealing an unexpected benefit of drone-assisted fecal sample collection.

Obviously, not all pilot whale (or other cetacean) fecal material will float, but collection of fecal material that sinks would require positioning the boat very close to a defecating whale or require sampling by a snorkeler in the water (e.g., Parsons et al., 2003). This approach of drone-assisted fecal sample collection has the benefit of allowing the research vessel to generally remain farther away from the whales, minimizing the potential for disturbance to the animals. The ideal distance for following for collecting samples is likely to depend on many factors, including species, travel speed, sea conditions, and group size, among other factors. There are downsides, however. When multiple whales are present in a subgroup, or if individuals are regularly changing their positions relative to one another, collecting samples farther away from the animals reduces the likelihood of being able to match the sample to the individual whale that defecated. Importantly, as well as allowing for simultaneous monitoring of multiple individuals for defecations, positioning the vessel farther behind the animals provides more time for subsurface poop to float to the surface, allowing for collection of samples that would otherwise be missed if following closer to the individuals.

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Leopard Seal (*Hydrurga leptonyx*) Immature Male Play Behaviour

Claire Stainfield and Jaume Forcada

British Antarctic Survey/Natural Environment Research Council,
High Cross, Madingley Road, Cambridge CB3 0ET, UK
E-mail: Claire-375@hotmail.co.uk

Leopard seals (*Hydrurga leptonyx*) are known to migrate from their breeding grounds in the Antarctic to subantarctic waters for the austral winter (Rounsevell & Eberhard, 1980; Walker et al., 1998; Jessopp et al., 2004; Staniland et al., 2018). They are frequently considered solitary; however, observations are difficult to obtain throughout the majority of their range (Southwell et al., 2008; Rogers et al., 2013). At South Georgia, leopard seals are most frequently sighted after the breeding season (Hamilton, 1939), and they are sighted at Bird Island (54º 00' S, 38º 03' W) between April and November. Sighting numbers fluctuate from year to year, being driven by environmental factors and prey availability (Jessopp et al., 2004). The prey available to leopard seals at Bird Island is abundant and varied throughout these winter months, including but not limited to, Antarctic fur seals (*Arctocephalus gazella*), gentoo (*Pygoscelis papua*) and macaroni (*Eudyptes chrysolophus*) penguins, fish, and Antarctic krill (*Euphausia superba*) (Walker et al., 1998; Forcada et al., 2009). Studies of the winter leopard seal population at Bird Island have shown a combination of adult seals with high site fidelity, but most are transient young animals, gathering together to exploit the island's resources (Jessopp et al., 2004; Forcada & Robinson, 2006).

The abundance of prey, and its reliance on Bird Island's coastline, has provided the opportunity for the winter population of visiting leopard seals to be systematically monitored using identification tags (Walker et al., 1998) since 1993, and photo-identification through individual pelage patterns since 2005 (Forcada & Robinson, 2006). The intensive monitoring of individuals within and between winter seasons at Bird Island provides a unique opportunity to record behavioural observations, with a focus on individuals with assigned age based on measurements, as well as confirmed sex and site-fidelity details. An individual's age can be estimated by total straight-line length measurements, while sex can be determined by visually inspecting a seal's ventral area (Laws, 1957).

Herein, we present observations recorded in the 2019 season to describe social interactions of this "solitary" species. While observations of leopard seals in areas of high prey abundance have recorded kleptoparasitism (Krause et al., 2015) and prey-sharing (Hiruki et al., 1999; Robbins et al., 2019), this paper reports the social interactions, observed from the shoreline, between multiple immature male leopard seals without a prey item present. The behaviour observed, which could be interpreted as play and as part of the process of learning adult behaviour, has not been reported before in this species.

In the austral winter, daily systematic surveys of a 2 km section of the Bird Island, South Georgia, coastline are completed as part of a long-term monitoring programme by the British Antarctic Survey (see Jessopp et al., 2004). The 2019 observation season started on 24 April and concluded on 29 October. All observations of leopard seals were recorded, and individuals were catalogued. During observations, multiple digital photographs were collected of all sides of each animal, and they were identified following photo-identification methods in Forcada & Robinson (2006). Individual seals were recognised through their unique pelage patterns and then monitored during opportunistic observations. Each seal's presence and behaviour were recorded on land and in the water from observer vantage points on the shoreline.

Where possible, if a seal was hauled out, its sex was noted if the ventrum was observed, total body length was measured, and the individual would receive an identification tag. These identification tags are coloured cattle tags placed into the inter-digit webbing of the rear flippers with a unique four-digit number printed on both sides, with possible matching tags placed in both flippers. Seals were classified into an age category depending on standard length (nose to tail length): pups (up to 200 cm), immature (from 200 to 285 cm for females and to 275 cm for males), or adults (longer than 285 cm for females and 275 cm for males) following Laws (1957).

Images and videos were collected to illustrate behaviours displayed and to construct a timeline during observations (see Supplemental Video; supplemental material for this paper is available in the "Supplemental Material" section of the *Aquatic Mammals* website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147). Relevant interactions and predations were noted daily with the corresponding individual seal or seals observed and identified where possible.

Combining the age and sex information obtained from such resources as the long-term dataset at Bird Island with these opportunistic observations of group behaviour such as this example could be invaluable to understanding the development, learning, and potential sociality of leopard seals.

A range of behaviours and interactions between individuals were observed during the surveys throughout the season. A descriptive account of interactions that took place during a 5-d period (8 to 12 August 2019) is presented herein. The social interactions observed involved up to five different photo-identified individuals, which were classified as immature with length measurements obtained in the season and whose sex was visually confirmed, with one individual seal recorded in a previous season visiting the island as a pup (Table 1). The four male individuals without previous season sightings can be estimated as immature, approximated as 3 y old; according to the curve in McLaren (1993), all were shorter than 275 cm and therefore immature (McLaren, 1993; Rodgers, 2009). Individual 2014007 was first recorded in 2014, which meant he was at least 5 y old at these observations.

Over the 5-d period, the leopard seals were seen swimming in proximity close enough to each other to be touching; they would follow each other in the water and then twist at the surface, swimming over each other, occasionally lightly biting each other's backs and holding each other using their front flippers (Figure 1A-G & Supplemental Appendix). This type of behaviour was observed multiple times during the observation days, with the groups of individual seals interacting for at least 1 to 2 h within the observable range of the shallow bays and kelp. Observations were limited to when the seals were in an area of water which could be observed. They ceased when the animals left the bay and visual contact was lost, and they continued when spotted in the observable area again. On several occasions, the observations started as the group of seals were seen following in close proximity, swimming at the surface along the shoreline before entering the shallow inlet. On all occasions when leaving the observable area, it was noted that all the seals in the group were travelling in the same direction along the coast, following in close proximity again while swimming at the surface. There did not seem to be an obvious cue for the group to stop the interactions and leave the bay.

The behaviour described above was first observed on 8 August at 1215 h involving two immature males: 2019002 and 2019010. Both were recorded daily for the five consecutive days close interactions were observed: on 8 August at 1215 h and again at 1700 h, on 9 August at 1400 and 1700 h, on 10 August at 1445 h, and on 12 August at 1320 and 1700 h. On 12 August, individual 2019010 had an erect penis (Figure 1H). Individuals 2019002 and 2019010 were also recorded hauled out in close proximity (< 5 m) on the beach on 11 August at 1130 h with a third immature female 2019024. Individual 2019010 left the beach at 1210 h after an attempt to apply an identification tag, while individual 2019002

Table 1. Details of the six individuals involved in the observations. J = immature, M = male, and F = female. In the column listing identification tag numbers, tag placements in the left or right webbing of the seals' rear flippers are shown by the slash (/). The number before the slash indicates a tag placed in the left flipper, and the number after the slash indicates a tag placed in the right flipper. "B" indicates that the tag was blue in colour.

Identification code (ID)	First sighting in 2019	Last sighting in 2019	Length (cm)	Age class	Sex	Identification tag number	Additional season sightings
2014007	8 Aug.	4 Sept.	246	J	M	B4967/	Yes: 2014, 2017, 2021
2019002	19 May	12 Aug.	267	J	M	B4964/B4964	No
2019008	28 June	7 Sept.	272	J	M	/B4957	No
2019010	22 June	30 Aug.	270	J	M	None	Yes: 2020, 2021
2019023	5 Aug.	21 Aug.	250	J	M	B4968/B4968	No
2019024	11 Aug.	31 Aug.	277	J	F	B4966/B4966	No

Figure 1. Images illustrating the following observed behaviours: (A) following behaviour, (B) close contact swimming, (C) twisting, (D) holding with front flippers, (E) biting, (F) group interactions, (G) group interactions, and (H) erect penis (*Photo credit:* Claire Stainfield)

remained on the beach until 1500 h, and individual 2019024 remained on the beach until 1600 h.

On 10 August at 1220 h, the behaviour was observed involving a group of five leopard seals: 2014007, 2019008, 2019023, 2019002, and 2019010. All these seals were confirmed as immature males. From the shoreline vantage, the group appeared as a mass of twisting bodies, all touching and swimming over each other at the surface of the water. Seals could be seen fore-flipper holding within the group, and individual 2019010 presented an erect penis during the interaction. Visual contact was lost at 1330 h as the group of five seals left the shallow cove swimming in close proximity to each other in the same direction. This was the only occasion during the 5-d period that this activity involved more than just two animals. As mentioned above, individuals 2019002 and 2019010 returned to the area later that day at 1445 h and continued to interact with each other without the rest of the group present.

There were individual seals sighted during the observation that were not interacting with the playing animals. A total of three individuals were photo identified on 8 August, two on 9 August, six on 10 August, 11 on 11 August, and four on 12 August.

Play has been recognised as a functional behaviour for building strength in muscles, improving coordination, and bonding in social species. It is often associated with developmental milestones in some species (Renouf & Lawson, 1986; Harcourt, 1991). In birds and mammals, play is associated with juveniles, with relatively few records of adult animals exhibiting the behaviour (Bekoff & Byers, 1981). Burghardt (2005) proposed a set of criteria to classify behaviour as play, suggesting that it should be performed by healthy individuals, should be repeated and rewarding, and should appear non-functioning in the short term or be modified from its original function. To understand these criteria in context, we can first explore the common example of play in pinniped species: the locomotive play of porpoising (Harcourt, 1991). The function of this behaviour is to be able to travel fast and change direction rapidly, which is useful for predator avoidance (Harcourt, 1991; Williams, 2001). This behaviour is often demonstrated by healthy pups as they learn to swim, with the reward of building up coordination, muscle development, and physical fitness (Renouf & Lawson, 1986; Harcourt, 1991). In the short term, the behaviour is not necessary for pups as they are dependent on their mother's milk to survive (Nagel et al., 2021), and it should be modified from its original function as it can be performed in shallow waters in the absence of predators (Harcourt, 1991).

The immature male leopard seal behaviour described in this paper meets the same play behaviour criteria. All individuals appeared healthy, and the behaviour was repeated not only in the same observation period but multiple times over the duration of a single day and over the five consecutive days. The behaviour described has similarities to "play copulation" and "play fighting" such as holding with fore flippers and light biting at the base of the neck as documented in harbour seals (*Phoca vitulina*; Renouf & Lawson, 1986) and South American fur seals (*Arctocephalus australis*; Harcourt, 1991). The adult consequence of this behaviour displayed in terms of function would most likely be with the goal of a successful mate/territory being determined and a resulting copulation. The group displaying the behaviour was comprised of only immature males that were approaching sexual maturity. The behaviour would be considered non-functioning in the short term and was modified from its original function as the interaction involved all males and therefore no mating copulation would have taken place. The play fighting also did not result in injury or escalate to a territory being held or defended.

One theory of the reward of performing this "play" behaviour is that it aids in individual development by allowing the individual to practice motor skills requisite for adulthood. Another theory is that the "play" behaviour was bonding behaviour strengthening a male group alliance. Male alliances have been documented in other mammal species (Olson & Blumstein, 2009), including bottlenose dolphins (*Tursiops truncatus*; Wiszniewski et al., 2012), and has been shown to increase foraging success in river otters (*Lontra canadensis*; Blundell et al., 2004). Leopard seals have a large, diverse foraging range (Staniland et al., 2018), and it is unknown how much of this range the species travels alone. It would be an understandable incentive for younger animals to maximize socializing opportunities during high density congregations. Evidence of leopard seals' group prey processing, while suggested as rare, has been documented in South Georgia waters (Robbins et al., 2019), supporting social interactions in this species.

The play behaviour displayed by the immature male leopard seals has not been documented in literature for this species. Whether these interactions were typical and potentially influenced by seal individuality or a result of a higher than usual congregation of leopard seals in 2019, potentially in response to particular environmental influences at Bird Island, remains unknown. We hypothesize that the winter population of leopard seals at Bird Island and the longer residency times of some individuals facilitate social interaction. Whether sociality in leopard seals might be related to sex and age differences as well as to tolerance to conspecifics, spatial distancing, and sharing resources requires further exploration.

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Rare Sighting of a North Atlantic Minke Whale (*Balaenoptera acutorostrata*) Mother–Calf Pair in Massachusetts Bay

Bruna L. Silva,[1, 3] Sulmaan W. Khan,[2] and Laura J. Howes[1, 3]

[1]Boston Harbor City Cruises, 1 Long Wharf, Boston, MA 02210, USA
[2]Independent Researcher, 50 Bridge Street, Lexington, MA 02421, USA
[3]University of Massachusetts Boston, Department of Biology,
100 William T. Morrissey Boulevard, Boston, MA 02125, USA
E-mail: sulmaan.khan@gmail.com

The North Atlantic minke whale (*Balaenoptera acutorostrata*) is a common, but enigmatic, mysticete in New England waters. Sightings are usually brief—a glimpse of a dorsal fin and dark back before submergence. Minke whales along the U.S. East Coast are considered part of the Canadian East Coast population, but key questions about stock structure and population trends remain uncertain (Hayes et al., 2021). Details about calving grounds and migratory patterns are limited despite passive acoustic monitoring studies (Risch et al., 2013, 2014b). Immature animals are generally believed to linger in lower latitude areas during summer months (National Oceanic and Atmospheric Administration [NOAA] Fisheries, 2021), and calves are rarely recorded in Massachusetts waters.

Our sighting of an adult minke whale and calf in Massachusetts Bay on 27 August 2021 is therefore noteworthy. This observation was opportunistic and occurred while returning from a whale watch. At 1348 h, we spotted two minke whales ahead of us in close proximity to each other. The whales coordinated dive times and appeared to be traveling north. They were first seen at latitude 42.20.04 and longitude -70.29.44. Winds were variable at a Beaufort scale of 1, and there was no swell or surface glare. The whales dove but reappeared almost immediately to our starboard. Two experienced observers witnessed this sighting from the second-level cabin of a 37 m catamaran, but obtaining satisfactory photographs proved difficult due to the small space inside. However, species identification was straightforward: we had excellent views of the sickle-shaped dorsal fin and the diagnostic white bands on the flippers ("minke mittens") of both whales. The adult surfaced next to the bow and was estimated to be about 8 m in length; the accompanying calf was approximately half the size of the adult, or around 4 m. (We estimate length and distances in the field by using our 37 m catamaran as a benchmark for comparison, a process in which we are experienced.) Minke whale aging in the field is a complicated subject (Christensen, 1981; Olsen & Sunde, 2002; Hayes et al., 2021), but given the existing literature, we would estimate the calf to be an unweaned individual of ~5 to 6 mo of age, based on its length. The two minke whales were traveling when first sighted, but the smaller whale changed behavior and made several close approaches to the vessel while we drifted. Minkes are often elusive in this area, surfacing only once or twice during sightings (pers. obs.); however, the presumed calf surfaced ~7 times during our observations, often within 2 m of our vessel. In total, the sighting lasted 9 min, during which time the adult minke never strayed more than 3 m from the smaller individual. Given that other mysticete mothers seek to maintain proximity with calves (Taber & Thomas, 1982; Szabo & Duffus, 2008), the close distance maintained between individuals supports our assumption that this was a mother–calf pair.

Murphy (1996) wrote one of the few accounts of minke whales in the area; she reported only three calves sighted in more than 10,000 cruises between 1979 and 1992. In 5,261 whale watches operated by Boston Harbor City Cruises and the New England Aquarium between 2013 and 2021, this is the only confirmed sighting of a likely minke mother and calf (Boston Harbor City Cruises, unpub. data, 2013-2021).

A single sighting cannot answer questions definitively, but it can stimulate them. The best estimate of the Canadian East Coast population of minke whales (in a survey area stretching from Newfoundland to Florida) is 21,968, with a minimum estimate of 17,022 (Hayes et al., 2021). Still, there are several uncertainties surrounding this population estimate. The assessment acknowledged the need for "more information on the spatio-temporal variability of the species' dive profile" (Hayes et al., 2021, p. 47). Minke whales are generally assumed to travel to low latitude breeding grounds to calve, but identifying breeding areas has proven difficult (Risch et al., 2013). Breeding has been described as "diffusely seasonal" (Perrin et al., 2018, p. 611). Neonates range between 2.4 and 3.5 m; calves are believed to be weaned when they reach the ages of 4 to 6 mo, at lengths ranging from 4.4 to 5.5 m (Kavanagh et al., 2018; NOAA Fisheries, 2021). It has been hypothesized that in the Northeast Atlantic, some minkes might calve in more northerly water (Anderwald et al., 2007; Kavanagh et al., 2018). It is possible that northerly calving occurs in the Northwest Atlantic too, where there is less published research.

This observed mother–calf pair could be explained by two hypotheses. The first is that the mother did not travel south, and the calf was born in a higher latitude, probably between October 2020 and February 2021. Kavanagh et al. (2018) suggested that warmer water might affect birth locations in the Atlantic. This assumes that migration is driven in part by a need for warmer water for parturition—a theory that is still debated (Corkeron & Connor, 1999). For smaller animals, migration is physically more costly than it is for a humpback (*Megaptera novaeangliae*) or North Atlantic right (*Eubalaena glacialis*) whale (Corkeron & Connor, 1999); calving in more northerly latitudes would reduce that physical cost for minkes. The second hypothesis is that the calf traveled with its mother from a more southerly locale. While breeding grounds remain hard to confirm, observations and passive acoustic monitoring suggest that the southeastern U.S. and Caribbean are likely breeding and calving areas (Murphy, 1996; Risch et al., 2014b). Passive acoustic monitoring has suggested that the waters of Massachusetts Bay are more of a migration corridor than feeding ground for North Atlantic

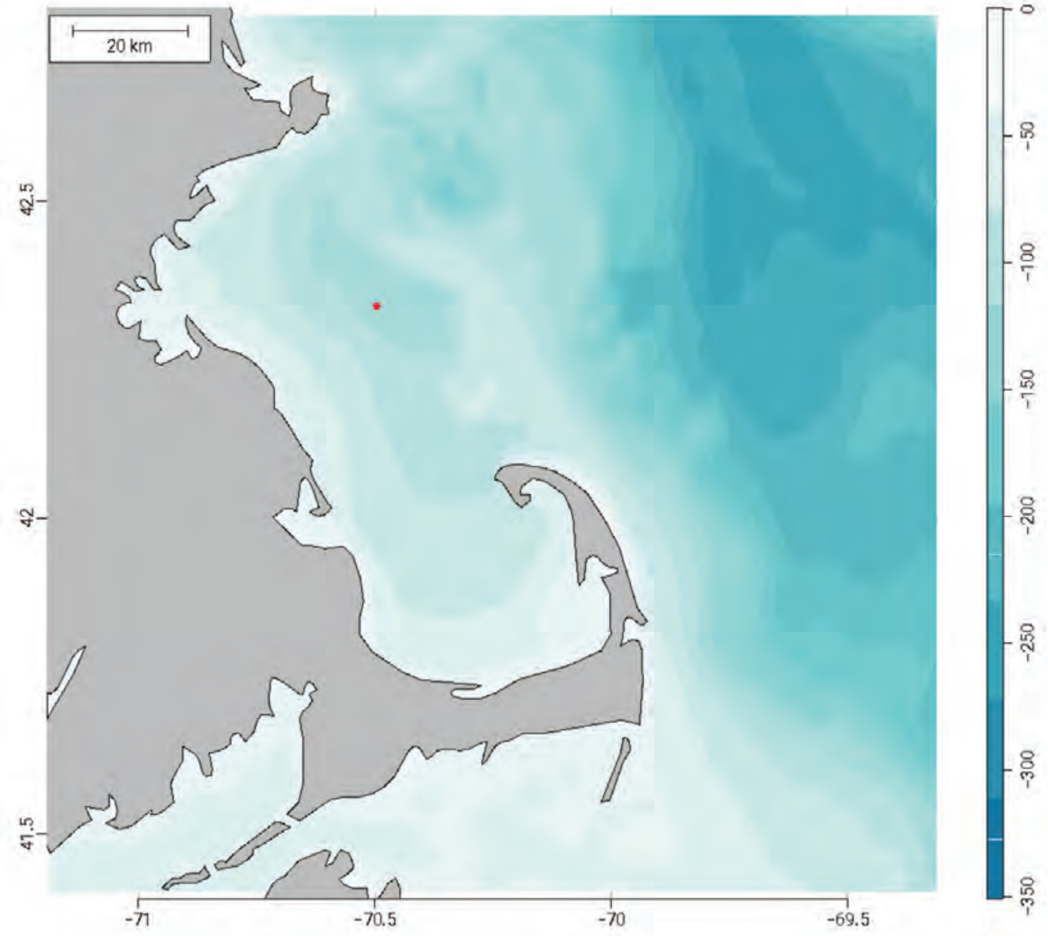

Figure 1. Location of minke whale (*Balaenoptera acutorostrata*) mother–calf sighting within Massachusetts Bay on 27 August 2021 shown as a red dot. Land is colored in grey, while blue shading corresponds to water depth ranging from 0 to 350 m.

minke whales (Risch et al., 2013, 2014a); in this scenario, the whales would pass through Massachusetts Bay on their way to Canadian waters. The calf's size does suggest that while it was still with its mother, it was nearing the age where it would soon be fully weaned. It is therefore conceivable that this particular calf accompanied its mother up north from its place of birth to Massachusetts Bay. We do see minkes feeding in Massachusetts Bay quite frequently on whale watches, though it is often difficult to follow them for long. At this particular location (Figure 1), the seabed is undulating, and the changes in depth allow for upwelling and abundant food.

The population structure of the North Atlantic minke whale remains poorly understood (Risch et al., 2013; Hayes et al., 2022); and in other places (i.e., Iceland and Norway), minkes continue to be harvested commercially. If mother–calf pairs use or increase their use of Massachusetts Bay and the Gulf of Maine regularly, conservation measures will need to reflect that use. We do know that whales in our region are threatened by entanglement in fishing gear and by vessel strikes (Moore, 2021). Furthermore, climate change has caused a shift in the movements of North Atlantic right whales (Meyer-Gutbrod et al., 2021) and has changed distributions of humpbacks, blue whales (*Balaenoptera musculus*), fin whales (*Balaenoptera physalus*), and sei whales (*Balaenoptera borealis*) (Davis et al., 2020). Just what impact a changing climate will have on minke whales' migratory movements remains to be seen.

A single opportunistic sighting like ours cannot address all these issues definitively. But in showing us something that we were not expecting to see, a sighting like this should inspire further research, whether through passive acoustic monitoring or aerial and vessel-based surveys. Long term scientific research, citizen science, and careful observation can all deepen our understanding of the whales that call Massachusetts Bay home and better inform regional conservation policies.

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Killer Whale (*Orcinus orca*) Male Carrying a Dead Calf

Anna Bisther[1] and Dag Vongraven[2]

[1]*Reportagebörsen, Kronhusgatan 2F, S-411 13 Gothenburg, Sweden*
E-mail: anna.bisther@reportageborsen.se
[2]*Norwegian Polar Institute, Fram Center, N-9296 Tromsø, Norway*

Killer whales (*Orcinus orca*) in the coastal waters off Norway are known to follow the seasonal movements of herring (*Clupea harengus*), a major prey item for the whales (Christensen, 1988). Photo-identification studies of killer whales in Norwegian waters were initiated in the 1980s in areas where herring concentrated on wintering grounds and during spawning in the spring (Jourdain et al., 2021). Stable associations between adult males and females, and within both sexes, were revealed already during the first years of fieldwork (Lyrholm, 1988; Bisther & Vongraven, 1995; Similä, 1997).

In 1987, the Tysfjord area in Lofoten (68° N) became a new wintering ground for the herring, which was followed by several hundred killer whales. The scenario lasted until 2002 when parts of the herring stock started wintering offshore (Kuningas, 2014). The killer whales in the Tysfjord area occurred in groups of ~15 to 20 whales. Observed groups contained females with young and adult males, or temporary (in terms of hours) constellations of two or three adult males (Bisther & Vongraven, 1995). Actual group sizes and social organisation of Norwegian killer whales have been studied in recent years (Jourdain et al., 2021) and are still under investigation. Due to the high concentration of killer whales in the fjord area, it was common to have several groups of killer whales within close range of others, sometimes splitting into smaller units or aggregating into larger ones. One way to study the social behaviour of the whales in such crowded scenarios was to use a focal sampling approach in which specific individuals were continously observed to reveal, for instance, companion preferences (Vongraven & Bisther, 1993). This approach was used when an adult killer whale male, readily identified as fully grown due to its larger size and characteristic dorsal fin, surfaced with a dead calf on 15 November 1993.

The male and the dead calf, which seemed to be newborn due to the reddish coloration and relatively tiny size (approximately 2 m), occurred together with one juvenile and three female-sized whales. These three whales were smaller than the male and could either be adult females or subadult males. The group moved in a slow, tight formation, and the male pushed and carried the calf forward with his rostrum. Several of the whales spy-hopped frequently, lifting their heads vertically out of the water, and, after 45 min, the male also spy-hopped, holding the calf in his mouth. A female-sized whale, and possibly the mother of the calf, swam close (within a whale length) and synchronously next to the male and kept her proximity to him during the entire encounter that lasted 2 h 12 min. This whale did not touch the calf when she surfaced. The observation of the male carrying the calf ended when five other female-sized whales, one young male, and two calves approached the group. Both groups made a 3-min-long dive. The male and the female-sized whale then surfaced and moved away, leaving the dead calf with the new group. The calf was last seen in the center of the new group, with whales milling around it. The male and the escorting female-sized whale were later identified as NV-6 and NV-5, and both had also been identified together the previous year (T. Similä, pers. comm., 14 April 1996).

This kind of behaviour is rarely observed among whales, and such information is therefore often found to be anecdotal. The few records of killer whales carrying dead calves include an adult female observed in 2010 in the coastal waters of Washington State carrying a dead neonate while escorted by her young son (Reggente et al., 2016) and an adult female in the same area that became known through media worldwide when carrying a dead calf for over 17 d (Cuthbert & Main, 2018).

Bearzi et al. (2018) analysed 78 records of behavioural responses to dead conspecifics among cetaceans. The observations were made between 1970 and 2016, and included only two records where adult males were observed carrying dead calves. One included a short-finned pilot whale (*Globicephala macrorhynchus*) described in Baird (2016), and the other is a short blog post about the adult killer whale male described in this paper (van Ginneken, 1994).

The carrying of a dead calf can be described as a subcategory of epimeletic behaviour and is considered a consequence of the cooperative and protective nature of long-lived social mammals, often displaying alloparental care, and can be explained by kin selection (Reggente et al., 2018). Killer whales and pilot whales have been shown to have similar social systems, which are based on matrilinear kinship groups and with little or no dispersal by males from their natal group (Alves et al., 2013). This might partly explain why the few records so far of adult males displaying epimeletic behaviour towards dead calves are found in these two species. However, an alternative and opposite explanation is also plausible for males carrying dead newborns due to the observation of infanticidal teamwork conducted by an adult killer whale male and his post-reproductive mother in the West Coast Transient population in the North Pacific Ocean (Towers et al., 2018). Together, the two whales killed and carried around a newborn calf of an unrelated female from the same population, a behaviour suggested to provide mating opportunities for the infanticidal male and inclusive fitness benefits for his mother.

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The First Two Detected Cases of Polythelia with Possible Polymastia in the Mediterranean Monk Seal (*Monachus monachus*)

Miguel Ángel Cedenilla,[1] Rosa Pires,[2] Fernando Aparicio,[1]
Moulaye Haye,[1] and Abba M'Bareck[1]

[1]*Fundación CBD-Habitat, c/Ángel Hernández, 13, 28002 Madrid, Spain*
E-mail: michcedeni@cbd-habitat.com
[2]*Instituto das Florestas e Conservação da Natureza (IFCN), Jardim Botânico – Eng.º*
Rui Vieira Caminho do Meio, Bom Sucesso 9064-512, Funchal, Madeira, Portugal

The Mediterranean monk seal (*Monachus monachus*) populations in the eastern Atlantic consisted of thousands of individuals until the arrival of Europeans in the 14th and 15th centuries (González, 2015). Currently, this seal is one of the rarest mammal species worldwide (Karamanlidis & Dendrinos, 2015), with only two Atlantic populations remaining. One is located at Madeira Archipelago (Portugal), with an estimated population of only 20 individuals (Pires et al., 2019), but in the late 1980s was estimated at only six to eight individuals (Pires & Neves, 2001). The other population, at the Cabo Blanco peninsula (Western Sahara/Mauritania) with 350 individuals estimated (CBD-Habitat, unpub. data, 2021), recovered from a mass die-off that reduced its size to 100 individuals in 1997 (Forcada et al., 1999). Both populations have suffered recent "bottlenecks" (Marchessaux, 1989; Forcada et al., 1999; Pires & Neves, 2001) that have minimized their genetic variability, which was already very low (Pastor et al., 2004). In Cabo Blanco, the species' genetic variability declined further after this mortality. In Madeira, the four individuals analyzed were homozygous with an allelic distribution that suggested a genetically impoverished subpopulation of Cabo Blanco (Dayon et al., 2020). According to the latest genetic studies, individuals from both populations share the same haplotype MM05 (Karamanlidis et al., 2016). With this background, we show the first two cases of polythelia with possible polymastia recorded in two breeding females of this species and hypothesize about its potential consequences.

The Mediterranean monk seal is a Phocidae, but it differs from the other members of this family because these females have four nipples instead of two, with two on each side of the belly with the navel in the center. This trait is shared with Hawaiian monk seals (*Neomonachus schauinslandi*) and bearded seals (*Erignathus barbatus*), which, though an exception among phocids, is common in otariids and odobenids (Riedman, 1990).

Mediterranean monk seals exhibit a maternal-care system that lies between the phocid and otariid patterns, perhaps being closer to the latter (Pastor et al., 2011). Lactation length is much longer (4 mo) than usual among phocids, including the Baikal seal (*Pusa sibirica*), whose pups are weaned in 2 to 3 mo. And, indeed, this species lies at the lower end of the duration range for otariid nursing as the northern fur seal (*Callorhinus ursinus*) and Antarctic fur seal (*Arctocephalus gazella*) have pups weaned at 4 mo old (King, 1983; Riedman, 1990; Boyd, 1991; Pastor et al., 2011; Jefferson et al., 2015). For this reason, monk seals are considered the most primitive members of the Phocidae family and probably still present ancestral mothering and lactation patterns from which the other phocids evolved (Repenning & Ray, 1997).

Having glands that secrete milk to nourish neonatal offspring characterizes all mammals. The number of mammary glands and nipples depends on the number of offspring that females of a certain species must nurse (Koyama et al., 2013). During embryogenesis, nipples arise from a pair of mammary ridges extending along the ventral body wall from mid-axilla to the inguinal area. Extra mammary glands (polymastia) may also arise from these ridges, leading to supernumerary nipples (polythelia). Supernumerary nipples may be unilateral or bilateral (McLaughlin et al., 2008).

Polythelia is a congenital anomaly of the mammary glands wherein there are accessory nipples along the milk line apart from the normal nipples. It is a benign condition with chances of malignancy in the accessory nipples (Arunagiri & Anbalagan, 2016). The term *polythelia* covers a range of eight types, from morphologically and functionally normal additional sinuses (Type 1) to "polythelia pilosa," a patch of hair only, but with the characteristic that they are all associated with histologically identifiable glandular tissue (see Hsu et al., 2000).

For the first time, two cases of polythelia (supernumerary nipples) with possibility of polymastia (supernumerary mammary glands) has been detected for this species. In November 2016, in the Madeira monk seal population (Portugal), an identified lactating female, "Maminhas," was nursing her pup; she presented three nipples along the right embryonic lactiferous line and two along the left line (Figure 1A). Each nipple was observed with milk suggesting that this female had five functioning mammary glands.

The second case was observed at the Cabo Blanco monk seal colony (Western Sahara/Mauritania) through photo-identification pictures taken of breeding female 2363, "Oca," in March 2020. Although monitored since 2011, and having had at least three pups in 2012, 2014, and 2020, no lactation of this female had been recorded, and it was not possible to know if the 5th nipple was active in milk production (Figure 1B).

There is no proof of polymastia in either of the two cases described, only for polythelia. Without any evidence of the existence of additional glandular tissue by anatomical and physiological analysis, it is impossible to confirm these nipples offered milk—even in the case of the female from Madeira, through whose numerary nipples milk flowed, though those nipples appeared functional. But this does not mean that the phenomenon is accompanied by polymastia as it may happen that the supernumerary nipple is connected to the mammary gland of another nipple, that it has a separate supernumerary gland, that it has no gland, or that it has an abortive one (Martin et al., 2016).

Despite intense monitoring of both populations for more than 20 years and through sophisticated means of obtaining digital images and direct observation, no cases of polythelia, with possible polymastia, had ever been detected in females in either monk seal population. In these, the arrangement of the nipples on the ventral area is easily observable and already visible from 2 mo of age when they shed their neonatal lanugo for a short-haired gray fur.

This phenotypic phenomenon with genomic base and potential heritability could be transmitted with relative probability in such a small population. Considering that the data for each population is $n = 1$, which is not valid for statistical

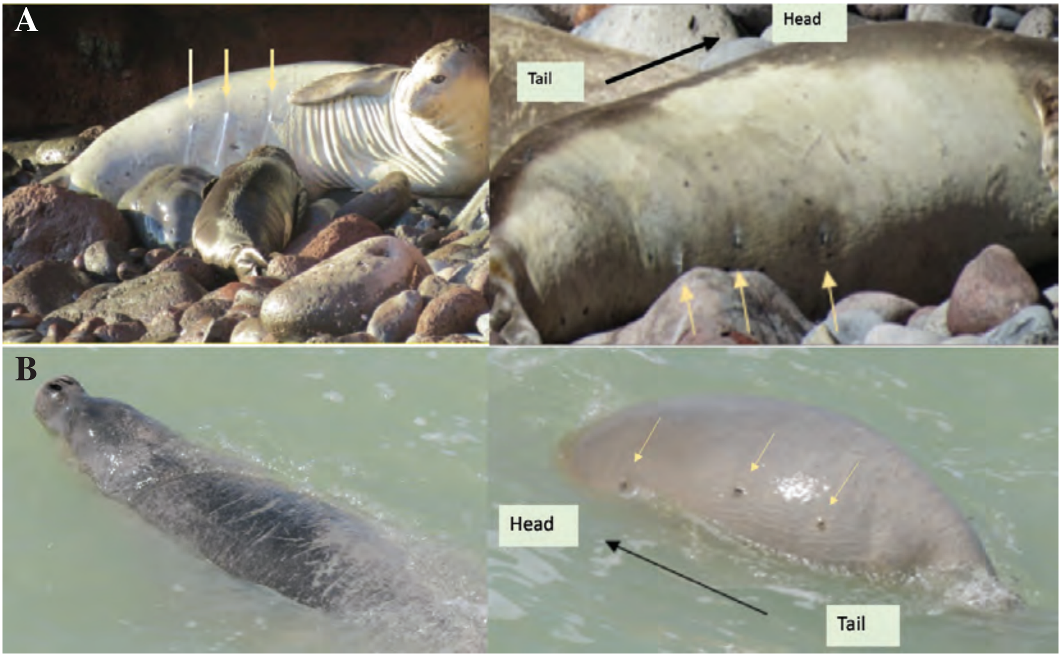

Figure 1. The two females in which polythelia has been detected with possible polymastia: (A) female "Maminhas" on the island of Deserta Grande, Madeira, in 2016, nursing her calf. You can see how a stream of milk comes out of each nipple, which would indicate possible polymastia (yellow arrows). (*Photo credit:* Sergio Pereira and Miguel A. Cedenilla/LIFE MADEIRA MONK SEAL); and (B) female 2363, "Oca," at the Cabo Blanco colony. The three nipples can be clearly seen (yellow arrows). (*Photo credit:* Moulaye Haye/CBD-Habitat)

purposes, and that this phenomenon has only been detected in reproductive females, we dare to infer an incidence rate taking into account the proportion of known breeding females for both populations. The population of Madeira has 13 breeding females, identified in 2019 (*Project Life Madeira Monk Seal Layman's Report*, 2019), which represents a 7.69% incidence of this anomaly. In the Cabo Blanco colony, there are 116 breeding females (CBD-Habitat, unpub. data, 2021), which represents a 0.86% incidence.

We do not know if this condition also affects males—juvenile or adult. In males, the presence of nipples on their external anatomy is undetectable by direct observation and, if present, is likely vestigial. However, from now on, it will be necessary to analyze the phenomenon in male carcasses.

In general, for most mammalian species, polythelia is less conspicuous in males. In addition, the prominence of supernumerary nipples/areolas is hormone dependent and may not appear before puberty, so, in many species, screening is done only in adults (Hsu et al., 2000). Therefore, we are aware of this bias in the sex difference and the possible higher incidence of polythelia in the two monk seal populations.

Supernumerary teats are common in many mammalian species. The association with malignancy is controversial and very rare in the human and animal literature. The frequency of polythelia varies considerably between species and even between breeds. Species used for livestock usually have a high incidence due to genetic management, and the condition might affect animals in terms of causing diseases and mammary infections (Martin et al., 2016). Therefore, given this seal's low genetic variability, its health status must be monitored to evaluate possible anomalies and to take measures, if necessary.

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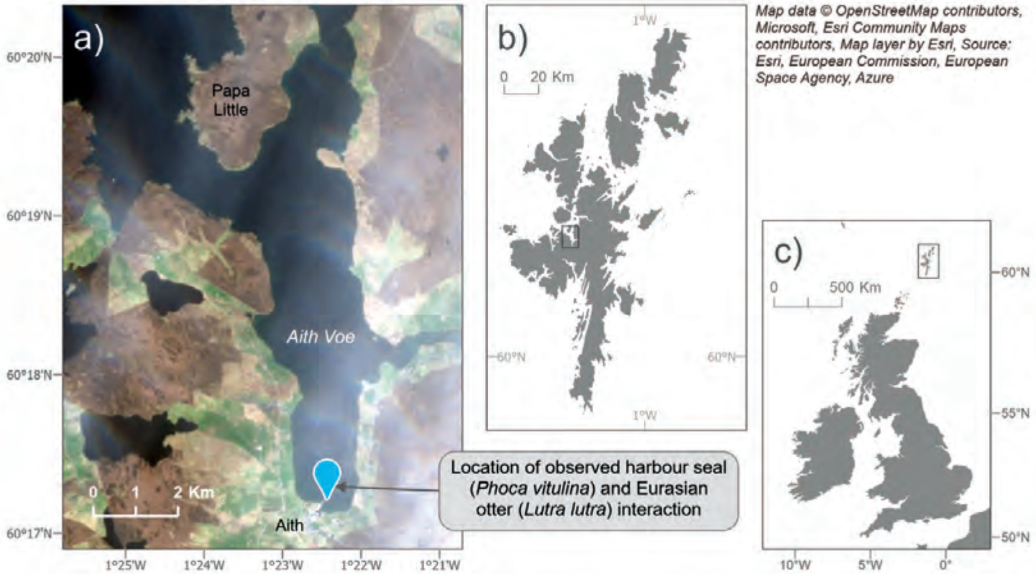
Dyadic Interspecific Interaction Between a Harbour Seal (*Phoca vitulina*) and a Eurasian Otter (*Lutra lutra*)

Emily L. Hague[1] and Nick McCaffrey[2]

[1]*Centre for Marine Biodiversity & Biotechnology, Institute of Life and Earth Sciences,*
Heriot-Watt University, Edinburgh EH14 4AS, UK
E-mail: elh2001@hw.ac.uk
[2]*Southspear Media and Surveys Ltd, Aith, Shetland, UK*

This paper documents an opportunistic observation of a dyadic interaction between a harbour seal (*Phoca vitulina*) and a Eurasian otter (*Lutra lutra*) within the southern remit of Aith Voe, Shetland, Scotland, United Kingdom, on 2 April 2022. The interaction occurred both on and within ~10 m of Aith Pier, a man-made public pier consisting mainly of rock armour (i.e., human-placed rock to protect shoreline structures), which juts northeast into the sheltered waters of Aith Voe (Figure 1). During the described encounter, the tide was rising (Low: 0615 h, 0.38 m; High: 1234 h, 2.18 m), and there was light southwesterly wind (4.5 km/h; Beaufort State 1). The interaction was recorded by an unmanned aerial system (UAS) (Mavic3, DJI Fly, *Firmware*, Version 1.5.10), which was launched at 0746 h from Aith Pier (60.286496, -1.3751324). The UAS collected 3 min 18 s of aerial video footage (the Supplementary Video for this paper is available in the "Supplemental Material" section of the *Aquatic Mammals* website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147).

The harbour seal is first visible in the UAS video footage swimming ~1 m from the most northeasterly perimeter of the pier (60.287061, -1.3738901; Figure 1). The seal momentarily stopped and adopted a bottling position, with head up and out of the water, looking in the direction



Location of observed harbour seal (*Phoca vitulina*) and Eurasian otter (*Lutra lutra*) interaction

Map data © OpenStreetMap contributors, Microsoft, Esri Community Maps contributors, Map layer by Esri, Source: Esri, European Commission, European Space Agency, Azure

Figure 1. (a) Location of the observed harbour seal (*Phoca vitulina*) and Eurasian otter (*Lutra lutra*) interaction off Aith Pier, Shetland; (b) location of Aith Voe in relation to Shetland; dark box indicates observation location; and (c) location of Shetland Isles in the United Kingdom.

of the pier, before submerging and diving out of view of the UAS (to depth > ~8 m). As the seal dove, the otter became visible to the UAS as it emerged from the above-water rock armour infrastructure of the pier, climbed down the rocks, entered the water, and swam around the base of the pier towards the location the seal was last visible. Shortly after the otter entered the water (9 s), the seal ascended, and then logged, head up, facing directly towards the otter, which was ~3 m away. The otter then climbed out of the water and up the rock armour while the seal appeared to watch. As the otter climbed nearer the top of the rock armour, the seal swam around the base of the pier in the same direction as the otter, periodically stopping and appearing to look, head up, towards the direction of the otter.

The following video clip began 1 min later as both the harbour seal and otter swam parallel to the rocks, with the harbour seal about five (otter) body lengths behind the otter. After 10 s, the otter exited the water and disappeared into a gap within the rock armour. As the otter exited, the seal stopped swimming and was stationary, head up, facing the otter's path. Approximately 12 s after exiting the water, the otter peered head out from the rock armour at a higher position (~1 m) than its entry point and looked in the direction of the seal. As the otter retreated within the cavity of the rock armour, the seal slowly continued on its original path and left the UAS field of view. The otter briefly peered out of the rock armour again and then emerged, re-entered the water, and swam in the same direction in which the seal was last seen. As the UAS panned southwest, the seal re-entered the field of view and barrel-rolled (full rotations along its longitudinal axis) as it swam directly towards the otter (see Supplementary Video; https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147). The otter continued along its trajectory, and the seal turned 180° to follow, and again spun horizontally, so at times it swam ventral side up (Figure 2a). As the seal caught up with the otter (to ~1 seal body length away), the otter stopped swimming and stood on a partially submerged piece of rock armour, at which point the seal immediately stopped swimming and oriented itself towards the otter. The seal turned away after 8 s and began to spiral through the water again, whereas the otter re-entered the water and began to swim parallel along the rock armour in the opposite direction to its previous trajectory. The seal immediately gave a few apparent hard rear flipper propulsions and pursued the otter, positioning itself to swim ~0.5 m behind the otter (half the seal body length) (Figure 2b). The otter then exited the water into the same area of rock armour it had exited and re-emerged previously. The seal slowed and placed its head into the rock armour in the area where the otter was last seen, and then appeared to turn away as the observation terminated.

Total body length measurements of both individuals were not available, though qualitative assessment suggests they are of comparative length and are both estimated at ~100 cm long (nose to end of tail). This is shorter than the asymptotic length of harbour seals at sexual maturity (> 140 cm) (Hall et al., 2019), and, thus, this seal is likely a juvenile. A lone otter of this length is likely an adult male (Kruuk, 2006).

Despite anecdotal reports of "otters in Shetland being in frequent contact" with harbour seals (Kruuk et al., 1989, p. 241), and anecdotal evidence of similar interspecific dyadic interactions in other coastal areas of Shetland (N. McCaffrey, unpub. data; R. Shucksmith, unpub. data), there are no direct observations reported within the published literature. As such, this observation provides insight into two charismatic coastal species, both of which have been subject to regional

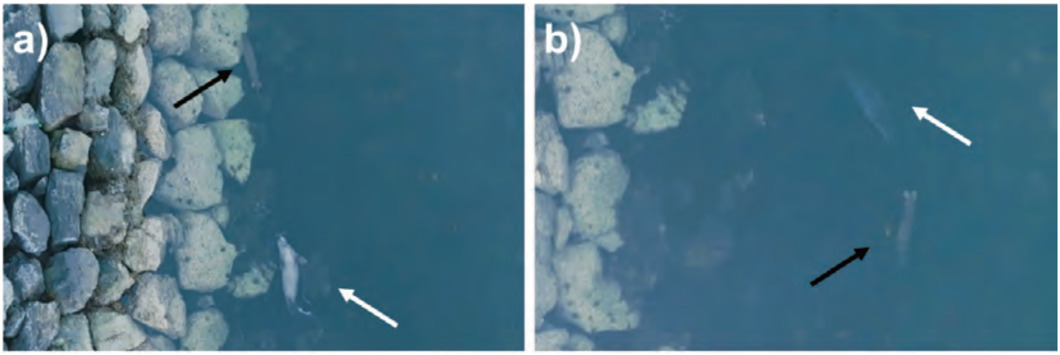


Figure 2. (a & b) Examples of an interspecific interaction between a harbour seal (white arrow) and a Eurasian otter (black arrow) observed alongside Aith Pier, Shetland

population declines in previous decades (Conroy & Chanin, 2000; Thompson et al., 2019). Two recorded phocine distemper virus (PDV) outbreaks in 1988 and 2002 severely affected UK harbour seal populations (Hall et al., 2006), with the effects on otters unknown. Indeed, the closed population of Shetland otters may be vulnerable to epizootic diseases carried by harbour seals, such as PDV, with close contact through direct interspecific interactions, as described here, potentially increasing the likelihood of disease transmission (Kruuk et al., 1989; García-Díaz, 2021). Other otter species, such as the northern sea otter (*Enhydra lutris kenyoni*), are known to be susceptible to and capable of transmitting PDV, which contributed to some sea otter mortalities in Kachemak Bay, Alaska (Goldstein et al., 2009).

Aside from potential disease transmission, the motivations, causes, and consequences of the described interaction are unknown. For example, potential drivers may be oriented towards sexual behaviour (e.g., Harris et al., 2010; Rohner et al., 2020), interspecific social play (e.g., Wilson, 1974; Sullivan, 1981; Renouf & Lawson, 1986, 1987; Harcourt, 1991a, 1991b; Burghardt, 2005; Quaglietta et al., 2014), inquisitive behaviour (e.g., Renouf & Lawson, 1987; Osinga et al., 2012; García-Díaz, 2021), intraguild predation (e.g., Elton & Miller, 1954; Levine, 1976; Brownlow et al., 2016), or interference competition (e.g., Erlinge, 1972; Kruuk & Moorhouse, 1990; Wilson & Hammond, 2019; Carter et al., 2020). Further collation of interspecific behavioural observations for both species are recommended to build an understanding of the motivation, causes, and potential consequences of the behaviour described in this paper.

Acknowledgments

All UAS flights were conducted by a United Kingdom Civil Aviation Authority (CAA) accredited pilot with a General Authorisation certificate (CAA Operator Reference: 5282). No animal ethics or scientific licences were obtained prior to the observation as the footage was collected opportunistically and not part of any predetermined scientific study. Post-hoc analysis of the footage was conducted under the Heriot-Watt University Ethics Permit 2022-3327-6614. ELH is a PhD student with a stipend provided by the James Watt Scholarship from Heriot-Watt University. The authors thank the reviewer and editorial team of *Aquatic Mammals* for their time and the careful and considered editing of the paper, and also thank Zoomarine-Portugal for supporting the open access publication of the special issue to which this paper contributes.

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Evidence that Humpback Whales (*Megaptera novaeangliae*), Including Calves, Use Isolated Johnston Atoll in the Tropical Central North Pacific

Robert L. Pitman[1] and James D. Darling[2]

[1]*Marine Mammal Institute, Hatfield Marine Center, Oregon State University, Newport, OR 97365, USA*
E-mail: robert.pitman@oregonstate.edu
[2]*Whale Trust, PO Box 243, Makawao, HI 96768, USA*

We report two observations, one firsthand (RLP), of humpback whales (*Megaptera novaeangliae*), including calves, at Johnston Atoll, 1,330 km southwest of Hawaii (Honolulu). Stories of humpback whales at Johnston Atoll have been circulating for decades, but they have been difficult to verify (Johnston et al., 2007; Darling et al., 2020). A preliminary scientific survey conducted there in 2007 reported no whale sightings (Johnston et al., 2007). The observations herein provide credibility to the lay accounts, and, occurring 9 years apart, suggest that this habitat is, at least sporadically, a breeding location for North Pacific humpback whales.

Little is known about the presence of humpback whales in the North Pacific between Hawaii and the western Pacific winter breeding assemblies (Figure 1). There have been few surveys and sightings in this vast area. A Japanese visual cetacean survey reported a single humpback whale on 5 February 1993 at 19.38° N, 168.65° W, approximately 1,400 km west of Hawaii (Ohizumi et al., 2002). In 2019, during the Hawaii–Asia segment of the acoustic Humpback Pacific Survey (HUMPACS), humpback whale songs were detected in the deep ocean on 1 January 2019 at 19.89° N, 159.72° W, 363 km west of Hawaii, and from 24 to 29 January 2019 between 20.16° N, 172.38° W and 19.86° N, 174.93° W, about 1,900 km west of Hawaii (Darling et al., 2020). Humpback whales were also reported as "continually present" from December 2014 to January 2015 during an acoustic survey of the seamounts to the southwest of Hawaii; the most distant is the Cross Seamount at 18.75° N, 158.25° W, 260 km southwest of the Big Island of Hawaii (Klinck et al., 2015, p. ES-1). While this area of detection is relatively close to the known breeding concentrations in the Hawaiian Islands, it is of interest due to its location to the southwest and the presence of humpback whales at the seamounts (Figure 1).

Johnston Atoll (16.73° N, 169. 53° W; Figure 1, inset) encompasses approximately 130 km^2, including four islands (two natural and two artificial) with a total exposed land mass of 2.8 km^2. The largest is Johnston Island, which accommodates an airport and a former U.S. military facility. Johnston Island has been uninhabited since 2004 and is currently a National Wildlife Refuge administered by the U.S. Fish and Wildlife Service. Instead of having a continuous fringing reef, the atoll has a 12-km reef crest on the northwestern edge that creates a shallow lagoon 3 to 10 m deep. Seawater temperature is approximately 27°C in winter ("Johnston Atoll," n.d.; *Johnston Atoll National Wildlife Refuge*, n.d.; Parrott-Sheffer, n.d.).

Our firsthand sighting occurred in 1992 while RLP was conducting seabird research at the atoll. RLP heard from local fishermen that they had seen some whales in the lagoon the previous day. The next day (5 April), he joined another fishing party in the lagoon for 5 h, hoping to see the whales. Observation conditions were good (Beaufort 3), and a minimum of four humpbacks were observed, including two single adults and a likely cow–calf pair (calf less than half the size of the attendant whale). The presumed calf breached four to five times ~0.5 km from the vessel. The boat operators said they had also seen four humpback whales on the previous day, which they assumed was the same group. They further reported that the earlier whales were fluking and showing the white undersides of their tails.

The first report of humpback whales at Johnston Atoll that we are aware of comes from a 1983 Draft Environmental Impact Statement prepared by the U.S. Army Corps of Engineers for construction of the Johnston Atoll Chemical Agent Disposal System. The report states that there had been no previously confirmed sightings of humpback whales at Johnston Atoll until the fishing vessel F/V *Magic Dragon* reported "a number of humpback whales including at least three adults and a calf at JA [Johnston Atoll] during a fishing trip there in March of 1983." The report also stated, "We do not know if this is a recent phenomenon or has been occurring for some time without recorded sightings" (U.S. Army Corps of Engineers, 1983, p. 85).

There are three main humpback whale breeding assemblages in the North Pacific: (1) the eastern Pacific off Mexico and Central America; (2) the central Pacific around the Hawaiian Islands, including the northwestern chain; and (3) the western Pacific off several island chains, including the Mariana Islands, the Babuyan Islands in the northern Philippines, and the Japanese islands of Okinawa and Ogasawara (e.g., Wolman & Jurasz, 1977; Rice, 1978; Urbán & Aguayo, 1987; Darling & Mori, 1993; Acebes et al., 2007; Johnston et al., 2007; Lammers et al., 2011; Kobayashi et al., 2017; Hill et al., 2020). These areas all share two

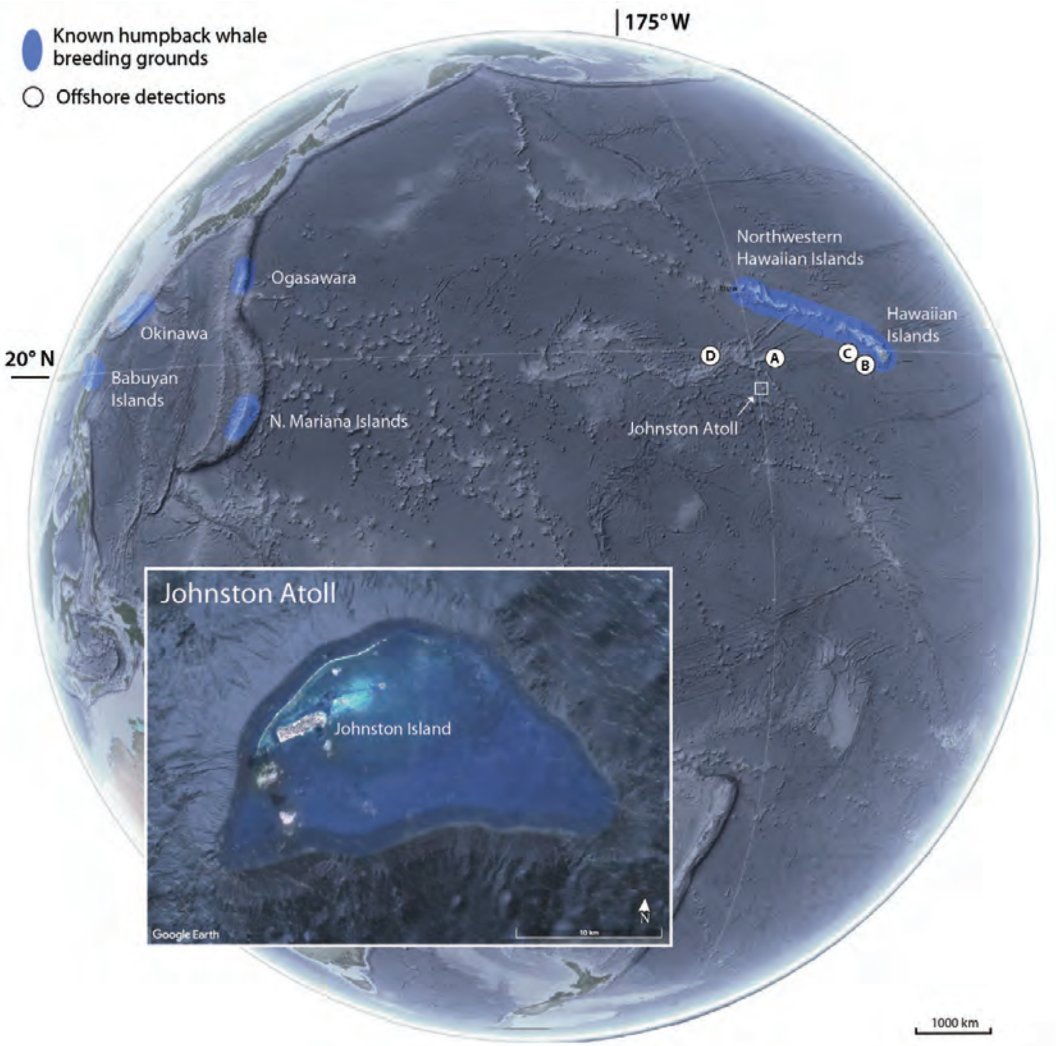

Figure 1. The central-western North Pacific with known humpback whale (*Megaptera novaeangliae*) breeding grounds and Johnston Atoll. The circled letters indicate the locations of offshore humpback whale detections west of Hawaii. *Sources:* (A) 1993 Japanese cetacean visual sighting survey of Northwest Pacific (Ohizumi et al., 2002); (B) 2014-2015 U.S. Naval autonomous glider acoustic survey of seamounts southwest of Hawaii (Klinck et al., 2015); and (C & D) 2019 Humpback Pacific Survey (HUMPACS), which recorded acoustic signals with a wave glider west of Hawaii (Darling et al., 2020). See the citations above for the survey courses.

habitat characteristics apparently necessary for breeding/calving humpbacks: (1) shallow waters (< 200 m) and (2) warm sea temperatures (21 to 28°C) (Johnston et al., 2007; Rasmussen et al., 2007). Within waters of this temperature range in the eastern Pacific, there is only deep ocean between the westernmost breeding grounds off Mexico (i.e., Islas Revillagigedo) and Hawaii. Between the known breeding areas in Hawaii and the western Pacific, however, there are numerous potential breeding sites, including seamounts, atolls, and islands (Figure 1).

The single sighting during the 1993 Japanese survey and the 2019 HUMPACS song detections described above were all in waters > 1,000 m deep (Figure 1). One possible explanation for these unexpected occurrences was that whales were travelling to or from, known or unknown, shallow-water breeding grounds. The Japanese survey sighting was approximately 315 km north of Johnston Atoll; the closest 2019 HUMPACS song detection was ~478 km northwest of the atoll (Ohizumi et al., 2002; Darling et al., 2020). For perspective, the distance from the southernmost to northernmost main Hawaiian Islands (Kona, on the island of Hawaii, to Kauai) is ~425 km.

These observations confirm that Johnston Atoll is visited by humpback whales, including calves, during at least some years; determining how many and how often will require further study. The occurrence of humpbacks at Johnston Atoll also provides a potential explanation for the deep-water detections < 500 km to the north and northwest of the atoll. Perhaps most importantly, these observations raise the possibility of alternate or additional breeding grounds beyond the well-known locations in Mexico, Hawaii, and the western Pacific—locations scattered among the numerous islands, atolls, and seamounts in the tropical central-western North Pacific.

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The Northernmost and Westernmost Records of the Guadalupe Fur Seal (*Arctocephalus philippii townsendi*)

Courtney N. Pace,[1] Marc A. Webber,[2, 3] Deborah D. Boege Tobin,[4]
Susan Pemberton,[3] Jane Belovarac,[1] and Caroline E. C. Goertz[1]

[1]*The Alaska SeaLife Center, 301 Railway Avenue, PO Box 1329, Seward, AK 99664, USA*
E-mail: courtneyp@alaskasealife.org
[2]*The Marine Mammal Center, 2000 Bunker Road, Sausalito, CA 94965, USA*
[3]*California Academy of Sciences, Department of Ornithology and Mammalogy, 55 Music Concourse Drive, Golden Gate Park, San Francisco, CA 94118, USA*
[4]*University of Alaska Anchorage–Kenai Peninsula College–Kachemak Bay Campus, 533 E. Pioneer Avenue, Homer, AK 99603, USA*

The Guadalupe fur seal (*Arctocephalus philippii townsendi*; GFS) population was decimated in harvests for fur by commercial sealers in the late 18th and early 19th centuries to the point of presumed extinction by the late 1920s (Townsend, 1916; Weber et al., 2004; García-Aguilar et al., 2018). Presently, these animals are protected as an "Endangered" species under Mexican law (NOM-059-SEMARNAT-2010) and as a "Threatened" species under the U.S. Endangered Species Act (National Oceanic and Atmospheric Administration [NOAA], 1985); however, the International Union for Conservation of Nature considers it of "Least Concern" (Aurioles-Gamboa, 2015). The pre-exploitation population size was estimated to be approximately 200,000 individuals (Hubbs, 1979). Following this intensive hunting period, the species was considered extinct until a single adult male was sighted on San Nicholas Island in 1949 (Bartholomew, 1950), and, subsequently, a small breeding colony was observed on Guadalupe Island, Baja California, in 1954 (Hubbs, 1956). The population size was estimated at 500 individuals in 1967 and about 7,400 individuals in 1993 (Peterson et al., 1968; Gallo-Reynoso, 1994; García-Aguilar et al., 2018). As of 2013, the GFS population was estimated between 34,000 and 44,000 individuals and has an annual growth rate of 5.9% (García-Aguilar et al., 2018). This current abundance represents around one-fifth of the estimated historical population (García-Aguilar et al., 2018). Their recovery has been challenged by anomalously warm water in the GFS range since 2013 that has resulted in shifts in distribution, abundance, body mass, and mortality related to food availability (McCue et al., 2021).

The GFS historical range included the islands of Baja California, Mexico, to the Channel Islands in southern California in the United States (Peterson et al., 1968; García-Aguilar et al., 2018). However, archaeological data indicate its range may have included areas from California to Washington (Etnier, 2006) and south toward Socorro Island, Mexico (Revillagigedo Archipelago; Hamilton, 1951). A figure is provided by McCue et al. (2021) indicating current suspected core and geographic ranges for the species. Both ranges appear to be derived from analysis of tag returns from satellite-tracked animals, strandings, and consideration of the location of suspected optimal feeding habitat. The McCue et al. (2021) report presents core range as the best estimates of the area of highest abundance and geographic range as the area of widest distribution (see Figure 1). The majority of the GFS population centers around Guadalupe Island, the only recognized breeding colony for this species. However, recolonization has occurred at a secondary site with mostly sexually immature animals at the San Benito Islands (Gallo-Reynoso, 1994; Hambrecht et al., 2016; García-Aguilar et al., 2018). At this time, Guadalupe Island, the San Benito Islands, and Farallón de San Ignacio Island in the southern Gulf of California are the only locations where this species hauls out year-round (Aurioles-Gamboa et al., 2010; García-Aguilar et al., 2018; Gutiérrez-Osuna et al., 2022).

Extralimital sightings of GFSs have occurred mostly northward of Guadalupe Island (Aurioles-Gamboa et al., 1999). Numerous reports have occurred along the California coast, as well as along the Oregon and Washington coasts, and at least one individual was reported at Vancouver Island, British Columbia, Canada (Table 1). Many of these sightings have coincided with abnormal oceanic conditions. The increased sightings in Oregon and Washington have been attributed to a reemergence of the species in their northern

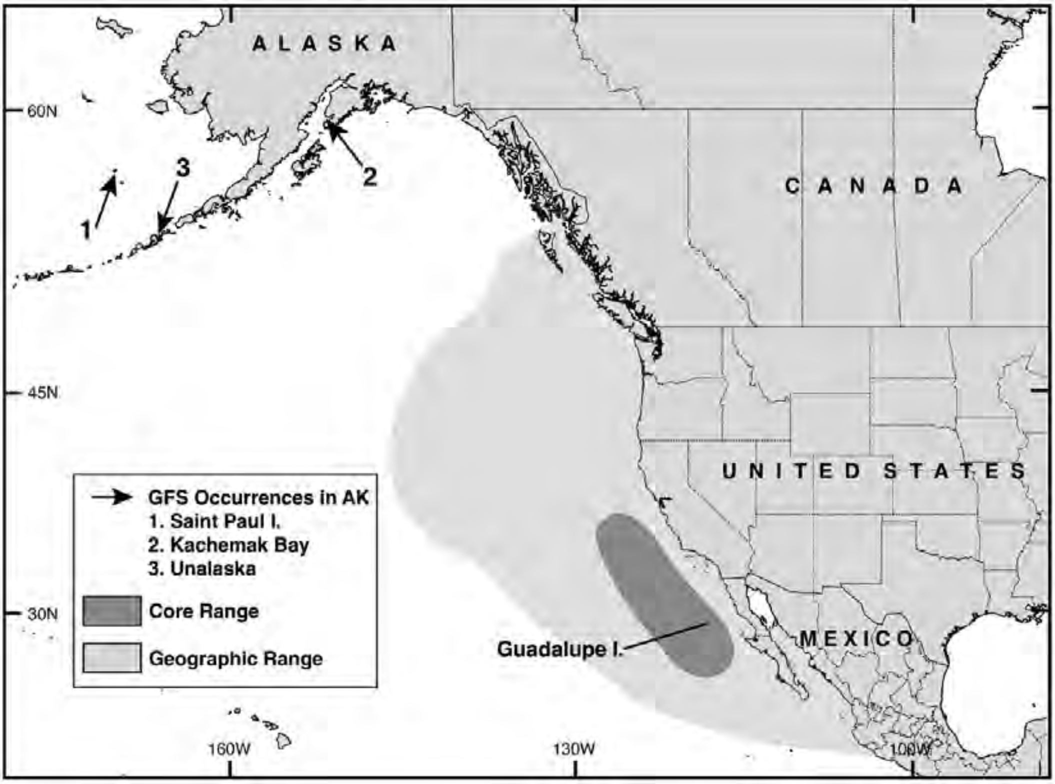

Figure 1. Core and geographic range of Guadalupe fur seals (*Arctocephalus philippii townsendi*) and the stranding locations for Records #1 through 3 (adapted from McCue et al., 2021)

historic range (D'Agnese et al., 2020). Relative to the northern sightings, less frequent observations have occurred south of Guadalupe Island, and the southernmost record for the species comes from an extreme extralimital sighting in the Galápagos Archipelago (Páez-Rosas et al., 2020). The following records add the GFS as a second fur seal species in Alaska, alongside the northern fur seal (*Callorhinus ursinus*).

Record #1

Between 1 to 5 July 1998, a GFS in apparent good condition came ashore at a northern fur seal rookery on Saint Paul Island in the Bering Sea (Figures 1 & 2). Scott Buckel, a visiting birder, posted his photograph to the iNaturalist citizen scientist online application (https://www.inaturalist.org) in 2018, at which point it was reviewed and identified as a GFS by one of the authors (SP). When contacted, Buckel did not recall the exact day the photographs were taken, but the dates provided cover the span of his visit to Saint Paul. The sighting location was near the Reef Rookery Public Viewing Platform near Saint Paul Village (57.111231 N, 170.285654 W). To the best of our knowledge, the animal was not resighted or reported by other sources around this time. Its sex and length are unknown, but it appeared to be a 4- to 6-y-old young male (R. L. DeLong, pers. comm., 21 May 2019).

Record #2

On 28 July 2007, a juvenile male GFS was found (by DDBT) in distress in Kachemak Bay, Alaska (59.32733 N, 151.51220 W; Figure 1). On initial presentation, it was thought to be a northern fur seal due to the location. The individual was observed to bump up against a stationary vessel with little to no reaction and appeared lethargic, emaciated, and obtunded (Figure 3C). The animal was then transported to the Alaska SeaLife Center (ASLC) in Seward, Alaska, for rehabilitation. Upon initial assessment, the yearling animal weighed 12.4 kg and was dehydrated and in poor body condition. It was positively identified as a GFS based on its long and pointed snout, abundant dark gray color, characteristic vocalizations, presence of fur on the dorsum of the foreflippers beyond the metatarsals,

Table 1. Guadalupe fur seal (*Arctocephalus philippii townsendi*) extralimital sightings north of Mexico. The criteria for defining sightings as extralimital has changed since the mid-20th century as the population has reoccupied parts of its former range north of Guadalupe Island.

Location	Km from Guadalupe Island	Year	Records	Animal condition	Oceanic condition	References
Southern CA Bight, USA	330-590	1949-1986	62 on islands; 3 at sea	Normal	El Niño (multiple) La Niña (multiple)	Stewart et al., 1987
San Miguel Island, CA, USA	590	1992-1993 1997	1 on island 2 (mother–pup)	Normal Normal	El Niño El Niño	Melin & DeLong, 1999
Princeton, CA, USA Monterey, CA, USA	943-1,020	1984 1997	1 stranded 1 stranded	Poor	El Niño and La Niña	Webber & Roletto, 1987
Central/Northern CA, USA (including SE Farallon Island)	700-1,125	1988-1995	9 stranded; 4 on island; 1 at sea	Poor; normal; poor	El Niño (multiple); La Niña (1 y)	Hanni et al., 1997
Saint Paul Island, AK, USA	5,090	1998	1 on island	Normal	El Niño	This study (Record #1)
WA & OR, USA	1,550-2,250	2005-2016	169 stranded	Mostly poor	El Niño (multiple), La Niña (multiple), MHW/"The Blob"	D'Agnese et al., 2020
Kachemak Bay, AK, USA	4,230	2007	1 rescued at sea	Poor	El Niño	This study (Record #2)
Dutch Harbor, AK, USA	4,718	2014	1 stranded	Poor	MHW/"The Blob"	This study (Record #3)
CA, OR & WA, USA	400-2,250	2015-2021	715 stranded	Mostly poor	MHW/"The Blob," El Niño, La Niña	NOAA, 2022
Vancouver Island, BC, Canada	2,382	2016	1 stranded	Poor	El Niño	CBC News, 2016

and the shorter hind flippers relative to the northern fur seal (Webber & Roletto, 1987; Jefferson et al., 2015; Elorriaga-Verplancken et al., 2021; Figure 3A & B). The animal's health was assessed, and appropriate treatment was administered, consisting of anti-parasitic medication and assisted feeding. Hematology and biochemistry data collected during rehabilitation were compared to published values for northern fur seals, and results were within normal range. Thoracic and abdominal radiographs were unremarkable, and fecal culture was negative for *Salmonella*, *Shigella*, and *Campylobacter* spp. Serology was negative for *Leptospira serovars*, phocine distemper virus, and phocine herpesvirus. Genetic testing at the NOAA Southwest Fisheries Science Center was a match to *A. townsendi*. In October 2007, the animal (named "Mica") was declared healthy for release and was transported to The Marine Mammal Center in Sausalito, California. To monitor this individual, the animal was equipped with a satellite tag (SPOT tags, Model 293; Wildlife Computers, Redmond, WA, USA) glued to the dorsum using epoxy. The fur seal was released on 26 October 2007 in San Simeon, California (Figure 4). Following release, the satellite tag returns indicated that this animal followed movement patterns and frequented areas typical of other fur seals in the area (Figure 5). The tag transmitted for 82 d, with the last received transmission on 26 January 2008. The subsequent fate of the animal is unknown.

Record #3

The third Alaska record was discovered when one of the authors (MAW) saw a photograph of a GFS in the *Unalaska Port of Dutch Harbor Official 2015 Visitors Guide* while traveling to Unalaska on an Alaska Marine Highway ferry. The photographer, Bret Richardson of Unalaska, was contacted, and he shared his images. This animal came ashore at Second Priest Rock in Summer Bay near the entrance to Dutch Harbor (53.902798 N, 166.466262 W) and was photographed over a

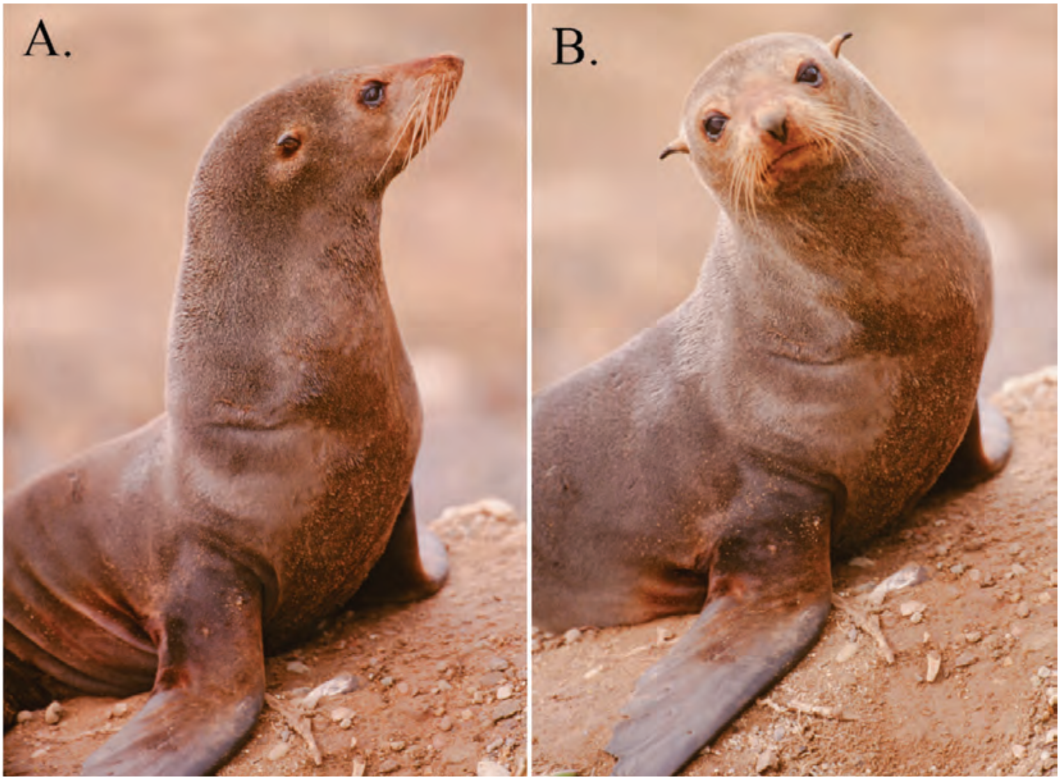

Figure 2. Guadalupe fur seal (Record #1) from Saint Paul Island, Alaska, 1998: (A) side view showing the long muzzle, which is longer than in northern fur seals; and (B) view showing the fur on the dorsum of the foreflipper extending beyond the bend in the flipper characteristic of the GFS. (*Photo credit:* Scott Buckel)

brief period in the middle of the day on 25 March 2014 before it left the area (Figures 1 & 6). This GFS looked moderately emaciated and appeared to have been the size of an adult or a large subadult female; sex and length are unknown.

All three animals in this report were found well out of the current core and geographic ranges of this species (McCue et al., 2021; Figure 1). They were also far from the primary rookery at Guadalupe Island. Minimum distances to Guadalupe Island are presented in Table 1. Record #1 from Saint Paul Island represents the longest reported distance from Guadalupe Island for this species. At 5,090 km, it exceeds the southernmost sighting of a GFS in the Galápagos reported by Páez-Rosas et al. (2020) of approximately 4,500 km from Guadalupe Island by almost 600 km. All these records taken together underscore the extreme wandering and movement capable by this species and the wide habitat tolerances of Guadalupe fur seals from the subarctic to tropical waters.

It is unknown if these extralimital sightings were due to climate change, disorientation caused by emaciation, range and population expansion, or other reasons. Effects of climate change on marine mammals can potentially include effects of reduced sea ice and rising sea levels on animal haul-out sites or species tracking a specific range of water temperatures in which they can physically survive (Learmonth et al., 2006). Other more indirect effects include changes in prey availability affecting distribution, abundance and migration patterns, community structure, exposure to predators, increased risk of human interaction, and susceptibility to disease and contaminants (Learmonth et al., 2006; NOAA, 2013). A species' distribution is often affected by several factors; however, prey availability plays a significant role and, in turn, decreases in prey can lead to nutritional stress and immune suppression (Forcada, 2002; NOAA, 2013). Ultimately, climate change can potentially influence growth, reproduction, and the overall success of a marine mammal population (Learmonth et al., 2006; McCue et al., 2021).

Strandings of GFSs have increased in recent years with most occurring in California, Oregon, and Washington (NOAA Fisheries Marine Mammal Health and Stranding Response Program

Figure 3. Guadalupe fur seal (Record #2) "Mica" after admission to the Alaska SeaLife Center: (A) image displaying the characteristic gradual transition of haired to hairless areas down the dorsum of the foreflipper, and the relatively short hind flipper seen in this species as compared to the northern fur seal; (B) view showing the characteristic long, pointed muzzle; and (C) image showing Mica malnourished. (*Photos:* Alaska SeaLife Center; activities permitted under NOAA/NMFS MMHSRP Permit #932-1489)

[MMHSRP] National Database, unpub. data, 1984-2019; Lambourn et al., 2012; D'Agnese et al., 2020; McCue et al., 2021). A high frequency of strandings between 2005 and 2007 prompted the NOAA Working Group to declare an Unusual Mortality Event (UME); however, no specific environmental factors were found to have caused the increased number of GFS strandings or their movement north (Lambourn et al., 2012). In contrast, adverse effects of unusual warming events on GFSs were documented a few years later. A large scale (~2,000 km wide and ~200 m deep) surface warming anomaly (1 to 4°C above normal), termed the Pacific Marine Heatwave or "The

Figure 4. Guadalupe fur seal (Record #2) Mica (left), released in 2007 after rehabilitation, with another GFS that stranded in California. A white satellite tag is attached to the back of Mica's neck. (*Photo credit:* The Marine Mammal Center)

Blob," was present in the northeastern Pacific Ocean. This anomaly was first observed off the southern coast of Alaska in December 2013, and it expanded into the west region of Baja California by mid-2014, thus creating a barrier to nutrients that would normally flow from the subarctic to the central Pacific, leading to secondary biological impacts (Bond et al., 2015; Kintisch, 2015; Elorriaga-Verplancken et al., 2016b).

These abnormal environmental conditions were thought to play a role in the unusual distribution of these GFSs. This anomaly of warmer conditions led to the increased stranding of 715 mostly emaciated, recently weaned GFS pups along the coasts of California, Oregon, and Washington from 2015 to 2021 (McCue et al., 2021; Table 1). Additionally, a few emaciated GFSs were recorded in the southwest Gulf of California in 2015-2016 (Elorriaga-Verplancken et al., 2016a). This phenomenon, declared a UME, was attributed to malnutrition secondary to suboptimal prey conditions (McCue et al., 2021). The Pacific Marine Heatwave "reduced the upwelling influence on the upper water column in the southern California Current Large Marine Ecosystem (CCLME) diminishing the primary productivity and consequently altering the abundance and distribution of important prey species for several oceanic predators" (Gálvez et al., 2020, p. 7), including the Guadalupe fur seal (Barth et al., 2007; Cavole et al., 2016; Zaba & Rudnick, 2016; Gálvez et al., 2020). In addition, the positive sea surface temperature (SST) anomalies were determined to have a negative effect on GFS neonatal body weight gain (Gálvez et al., 2020). Neonates had the lowest weights at birth and the slowest weight gain in 2014, as well as low weights and the lowest survival rate in 2015, all of which were likely due to persistently warm environmental conditions (Gálvez et al., 2020). The warm SST conditions may have led to a reduction or dispersion of prey species typically found in nursing GFS females' foraging range. This effect on food availability may have led to lower forage quality followed by dietary changes for nursing females, which may have resulted in limited nutrition for their pups (Gálvez et al., 2020). Additionally, changes in feeding trip duration and maternal attendance may have occurred (Gálvez et al., 2020). Overall, this documents a sensitivity of GFSs to regional warming conditions and potential vulnerability to continued climate change that may ultimately impact their recovery (Gálvez et al., 2020). Both the 1998 and 2007 records from Alaska were associated with or nearly with El Niño events, while the 2014 record took place during the 2013-2015 marine heat wave event in the northeastern Pacific.

While the presence of these GFSs in Alaska is most likely associated with the occurrence of warmer waters, it may indicate potential new foraging grounds and/or increases in population size or range. Less knowledge is available on the GFS

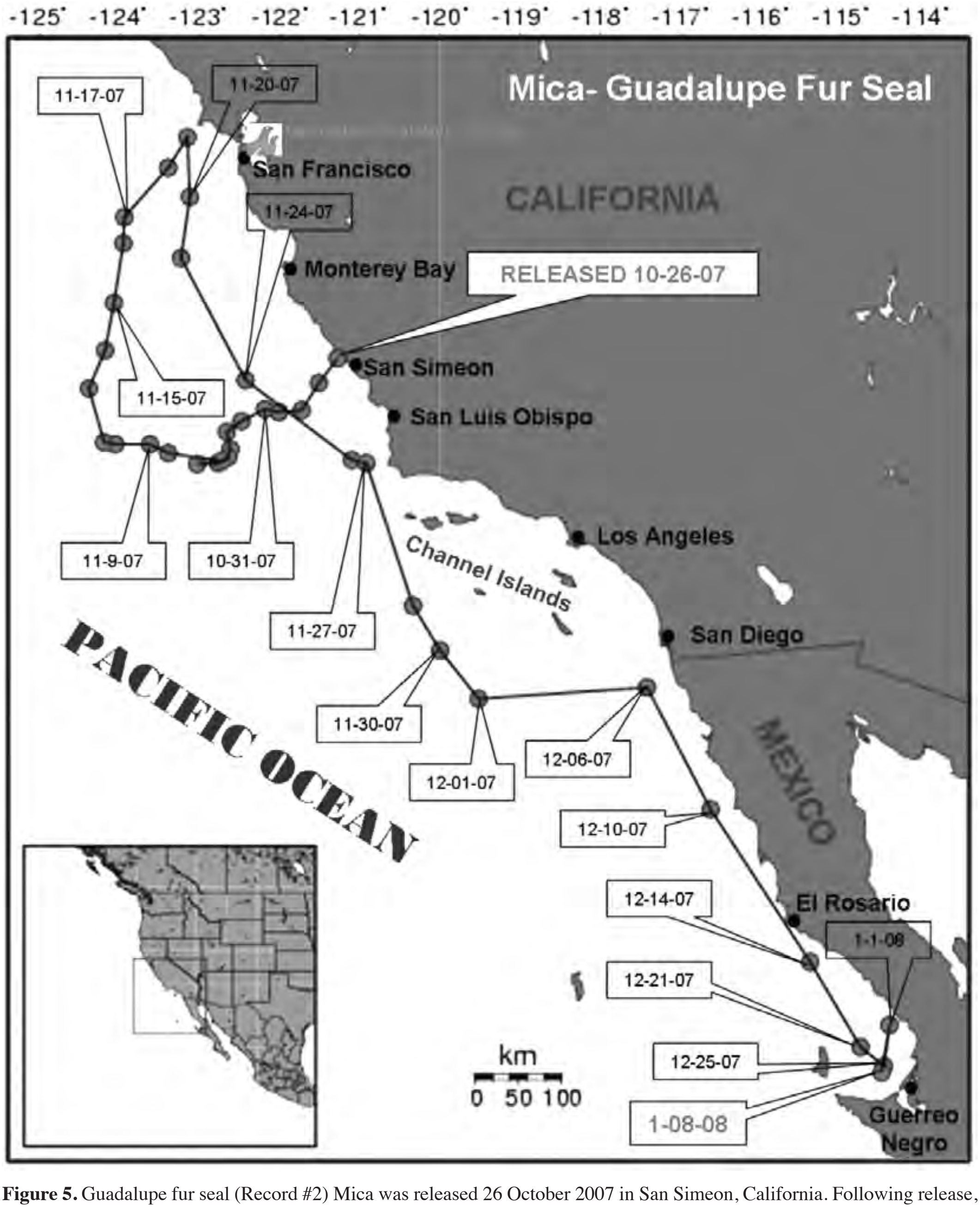

Figure 5. Guadalupe fur seal (Record #2) Mica was released 26 October 2007 in San Simeon, California. Following release, the satellite tag returns indicated that this animal followed movement patterns and frequented locations typical of other GFSs in the area. Graphic created through the Maptool program, a product of SEATURTLE.ORG; dates in MM-DD-YY format.

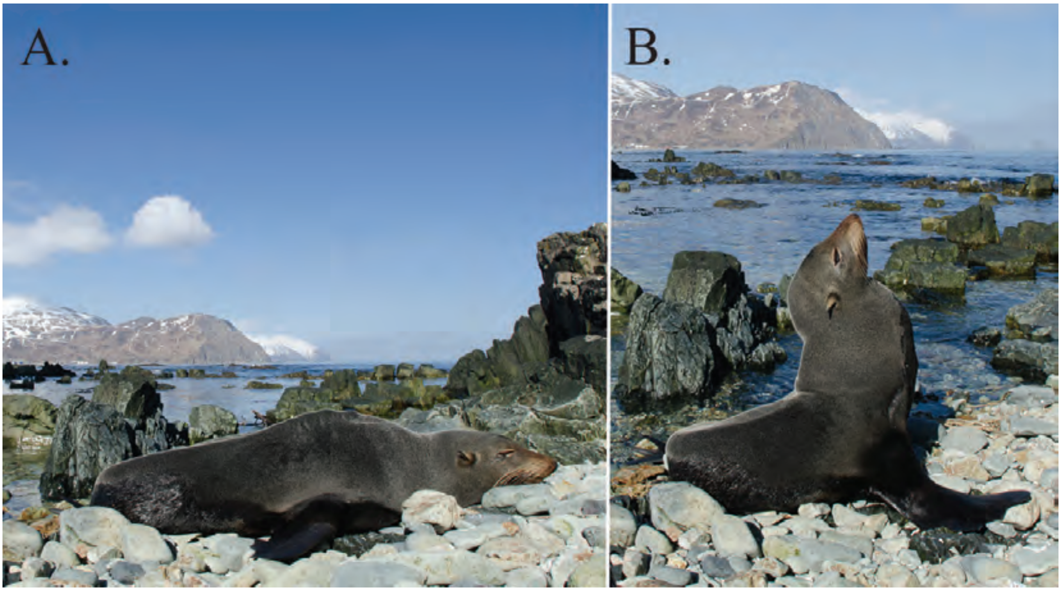

Figure 6. Guadalupe fur seal (Record #3) on Unalaska Island in 2014: (A) moderate emaciation can be seen along the top of the back and side of the chest; and (B) side view showing the long muzzle and evidence of emaciation. (*Photos:* Brett Richardson)

compared to other pinnipeds (Lander et al., 2000), and these extralimital sightings may indicate that GFSs occur in Alaskan waters more commonly than previously believed (Aurioles-Gamboa et al., 1999). In addition, this report contributes to the few studies documenting post-release movement patterns of this species, which, in turn, may aid in the management and release criteria for rehabilitated GFSs (Lander et al., 2000).

The GFS population continues to increase and rebound; therefore, it is likely this species will extend its breeding range and foraging grounds. Continued monitoring of these animals is essential to obtain a better understanding of population dynamics and to identify potential local and regional threats (García-Aguilar et al., 2018). Although GFSs continue to recover, prolonged warming conditions or oceanographic abnormalities pose a threat to this species with potentially additional UMEs (Gálvez et al., 2020). GFSs have one main breeding colony, have a narrower feeding strategy, and dive mostly to shallow depths for cold-blooded species (mainly squid) that are sensitive to changes in ocean temperatures; thus, the effects of climate change may negatively impact this population undergoing recovery (McCue et al., 2021). In addition, the decreased genetic diversity secondary to the genetic bottleneck may have left the population more vulnerable to infectious disease or environmental stressors (Weber et al., 2004; D'Agnese et al., 2020). Furthermore, it is imperative to report strandings (such as Record #2) and analyze trends in relation to oceanic conditions and population growth; and because two species of fur seals can be found in Alaska, care must be taken to identify them at sea and on land (Villegas-Zurita et al., 2015; D'Agnese et al., 2020).

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Anecdotal Observations of Open Beach Use by Female Mediterranean Monk Seals (*Monachus monachus*) and Their Pups in Greece: Implications for Conservation

Panagiotis Dendrinos, Styliani Adamantopoulou, Kimon Koemtzopoulos,
Panagiotis Mpatzios, Odysseas Paxinos, Eleni Tounta,
Dimitris Tsiakalos, and Alexandros A. Karamanlidis

MOm/Hellenic Society for the Study and Protection of the Monk Seal, Solomou Street 18, 10682 Athens, Greece
E-mail: akaramanlidis@gmail.com

With global biodiversity in decline (Butchart et al., 2010), calls have been made for the use of the best scientific data in conserving threatened or endangered species and the ecosystems upon which they depend (Smallwood et al., 1999). Given the inherent difficulties relating to the study of rare and/or elusive species, anecdotal data (e.g., unforeseen and unique behaviors) have occasionally been used to better understand a species' life history (Frey et al., 2013; Surf et al., 2019) and to aid in defining management and conservation priorities (Bennett, 2016; Zapelini et al., 2020). Considering that use of anecdotal data in species conservation may occasionally lead to a false interpretation of the actual situation in nature (McKelvey et al., 2008), and therefore negatively impact subsequent conservation efforts, the acceptance of anecdotal data as empirical data should always be treated with caution.

The Mediterranean monk seal (*Monachus monachus*) is one of the rarest seals on Earth (Karamanlidis et al., 2016); the species has been listed as "Endangered" by the International Union for the Conservation of Nature (IUCN), and the global population has been estimated to number fewer than 800 individuals (Karamanlidis & Dendrinos, 2015; Karamanlidis et al., 2019). Three main subpopulations survive: one in the Archipelago of Madeira, one at Cabo Blanco in the Atlantic Ocean, and one in the eastern Mediterranean Sea, mainly around the islands and coasts of Greece, Turkey, and Cyprus (Karamanlidis et al., 2019). Improving our knowledge of the Mediterranean monk seals' life history, including habitat use, is essential to understanding the ecological needs of the species (Dendrinos et al., 2007c) and for designing and implementing effective conservation measures. In Greece, where the species' subpopulation is considered one of the most important worldwide (Karamanlidis et al., 2019), understanding habitat use and protecting critical habitat have been identified as conservation priorities (Dendrinos et al., 2020).

Mediterranean monk seals are coastal marine mammals. When at sea, the species in Greece roams widely within the 200 m isobath (Dendrinos et al., 2007a; Adamantopoulou et al., 2011) where it feeds (Karamanlidis et al., 2014) and rests (Karamanlidis et al., 2017). On land, these monk seals exclusively use marine caves to give birth and raise their pups throughout their range (Karamanlidis et al., 2016); however, this has not always been the case. Mounting evidence suggests that, like many other seal species, this monk seal used to frequent open beaches for some of its basic biological needs (Johnson & Lavigne, 1999; Johnson, 2004; González, 2015). This paper describes six examples of female Mediterranean monk seals and their pups using open beaches in Greece and discusses the implications of these anecdotal observations for the conservation of the species.

The observations were made between 1992 and 2022 throughout coastal and insular Greece (Figure 1) during field research conducted by MOm/Hellenic Society for the Study and Protection of the Monk Seal. When encountering monk seals on open beaches, we non-invasively photographed and/or videotaped them from a distance (i.e., most observations were less than 10 to 20 min; the supplemental video for this paper is available in the "Supplemental Material" section of the *Aquatic Mammals* website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147). Observations were also collected through the Rescue and Information Network (RINT), a nationwide citizen-science project in Greece (Adamantopoulou et al., 1999), but only after thoroughly reviewing the information provided to conclude it was reliable.

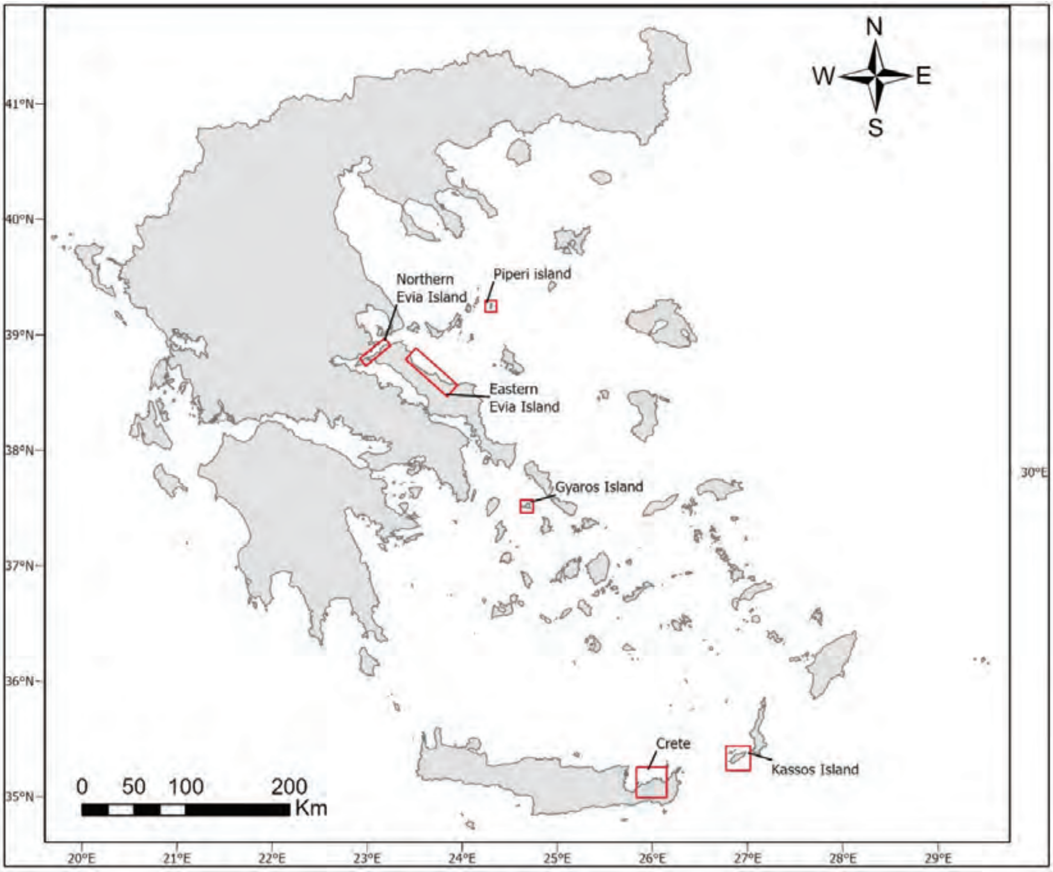

Figure 1. Map of Greece indicating the location of six areas where anecdotal observations of female Mediterranean monk seals (*Monachus monachus*) and their pups using open beaches were recorded

Case 1 – Kassos Island

A female Mediterranean monk seal and her pup were recorded on an open beach in Greece by the RINT on 1 September 1993 at the island of Kassos, part of the Dodecanese Islands (Figure 1). The observer reported a newborn pup suckling from its mother on an open beach at the southern part of the island with a placenta lying next to it. No photographs or videos of the observation were provided, but the description was so detailed as to be considered reliable.

Case 2 – Eastern Evia Island

In 2003 (15 October) and 2005 (29 October), the RINT received reports from observers that a female Mediterranean monk seal and her newborn pup were seen on the eastern part of Evia Island (Figure 1). In the first case in 2003, the newborn pup was suckling from its mother on an open beach, while in the second case in 2005, the newborn pup was observed on an open beach with its umbilical cord still attached. In both cases, no photographs or videos were provided, but the descriptions were considered reliable.

Case 3 – Gyaros Island

On 22 October 2004, the RINT received information from a remote (i.e., inaccessible to humans and therefore with low human activity) location at the uninhabited Gyaros Island (Figure 1) regarding an adult female and three pups resting on an open beach and/or swimming in the nearshore water. Photographs were provided (Figure 2A). On 7 November 2004, during an on-site inspection, we recorded three adult females and 11 newborn pups resting on an open, cliff-bound beach (~70 m wide, 15 m deep, covered with pebbles) and/or swimming in the nearshore water. On 5 December 2005, at the same location, we recorded four

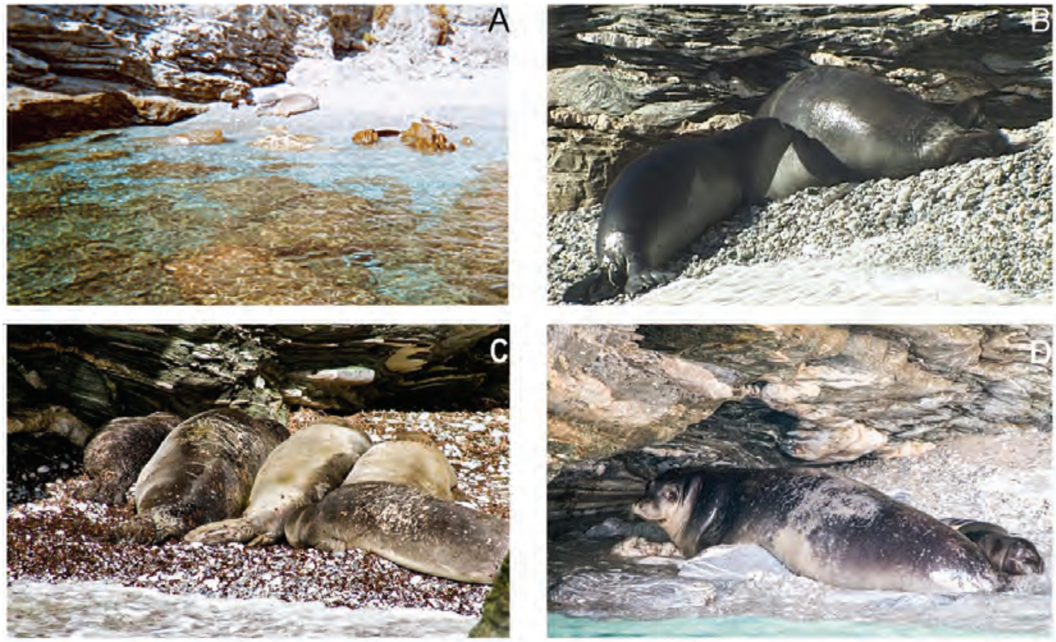

Figure 2. Anecdotal observations of female Mediterranean monk seals and their pups using open beaches at Gyaros Island: (A) a female monk seal and three newborn pups using an open beach on 22 October 2004 (©Dounavis); (B) a female monk seal and her pup using an open beach on 5 December 2005 (©Karamanlidis/MOm); (C) four female monk seals and a pup using an open beach on 20 November 2010 (©Karamanlidis/MOm); and (D) a female monk seal and her newborn pup using an open beach on 8 October 2015 (©Dendrinos/MOm).

adult females, one subadult, and three newborn pups on the beach and/or swimming in the nearshore water. One of the adult females was recorded suckling her pup (Figure 2B). Female monk seals and their pups were recorded again on 20 November 2010 (4 adult females and 1 pup; Figure 2C), 4 November 2011 (1 adult female suckling her newborn pup), and 8 October 2015 (1 adult female and her newborn pup; Figure 2D). All these seals were recorded on two open, cliff-bound beaches covered with pebbles, located 200 and 500 m to the east and west of the original observations in 2004.

Case 4 – Crete

On 5 September 2019, the RINT received information of a female monk seal and her pup on an open, cliff-bound beach at a remote location at the northeastern part of Crete (Figure 1). The observer reported blood and parts of placenta lying on the beach. Considering the information on habitat suitability for the species in the area (i.e., no suitable pupping cave nearby), we concluded that the pup was born on the open beach. On 17 October 2019, we recorded a female monk seal resting with her newborn female pup on the open, cliff-bound beach site (~15 m wide, 15 m deep, covered with sand, pebbles, and rocks; Figure 3A & B). Observers reported to the RINT that the mother–pup pair remained in the general area for at least another 2 mo. The same individual was reported again at the same location in 2020 (4 & 14 September; Figure 3B & C) and in 2021 (10 October), both times accompanied by female newborn pups. In 2020 and 2021, this pair was observed on an open rock formation.

Case 5 – Piperi Island

On 19 October 2021, an adult female monk seal and her newborn pup were observed using an open, cliff-bound beach (~150 m wide, 30 m deep, covered with fine sand and pebbles) at a remote location at Piperi Island, the core area of the National Marine Park of Alonissos, Northern Sporades (Figure 1). The mother–pup pair were observed resting at the least-exposed, left part of the beach (Figure 4A). The pair were observed again on 20 February 2022 at the right part of the same beach; the pup had undergone its first molt (Figure 4B) and was being weaned.

Figure 3. Anecdotal observations of a female Mediterranean monk seal and her pups using an open beach/rock formation along the coast of Crete: (A) a female monk seal and her newborn pup using an open beach on 17 October 2019 (©Dendrinos/MOm); (B) image from a drone showing an overview of the open beach habitat used by a female monk seal and her pup in October 2019 (©MOm); (C) a newborn pup and its placenta on an open rock formation on 4 September 2020 (©Marakis); and (D) image from a trap camera of a female monk seal and her pup using an open rock formation on 14 September 2020 (©MOm).

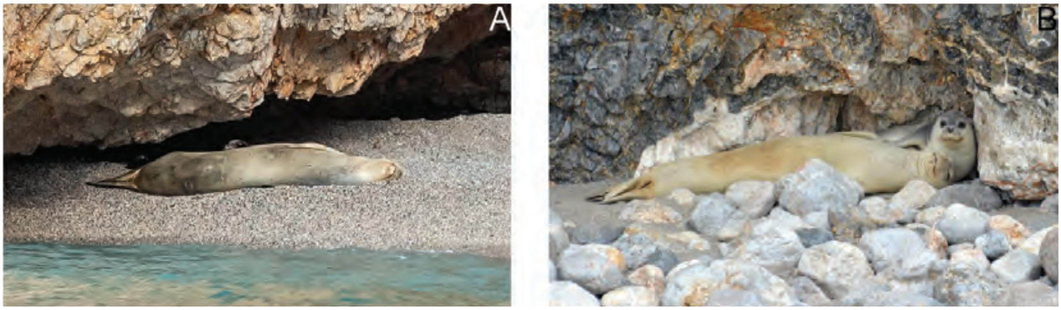

Figure 4. Anecdotal observations of a female Mediterranean monk seal and her pup using an open beach at Piperi Island: (A) a female monk seal and her newborn pup using an open beach on 19 October 2021 (©Dendrinos/MOm); and (B) a female monk seal and her molted pup using an open beach on 20 February 2022 (©Miskedaki/MOm).

Case 6 – Northern Evia Island

On five separate occasions in October and November 2021, we observed four adult female monk seals and their newborn pups using an open, cliff-bound beach (~30 m wide, 15 m deep, covered with sand, pebbles, and rocks) at the northern part of Evia Island (Figure 1). The seals were observed interacting with each other by vocalizing—both on land and underwater as determined by the use of a hydrophone (Charrier/MOm, unpub. data)—and suckling (Figure 5). In contrast to all previous observations, this open beach was close to an aquaculture installation, and human activity was at times intense, with boats frequently passing by, although no noticeable disturbance to the animals was documented.

Unlike most other marine mammals, pinnipeds are amphibious and return to land (or ice) to give birth and molt (Berta, 2018), thus rendering the

Figure 5. Image from a drone showing two female Mediterranean monk seals and three newborn pups using an open beach on 22 October 2021 at northern Evia Island (©MOm)

availability and spatial arrangement of suitable terrestrial habitat (i.e., "critical habitat"; *sensu* Ray, 1976) of utmost importance for their survival (Harwood, 2001). When looking for places to come ashore, pinnipeds seem to select places such as open beaches that are isolated (e.g., remote islands), likely to reduce exposure (i.e., they are cliff-bound) to terrestrial carnivores, as in the case of the Pacific harbor seal (*Phoca vitulina richardii*; Nordstrom, 2002), and/or humans, as in the case of the grey seal (*Halichoerus grypus*; Harwood, 2001), to reduce the overall threat to survival (Kovacs et al., 2012). Increased human/predator pressure has often displaced pinnipeds from their preferred open beach habitats (e.g., northern elephant seal [*Mirounga angustirostris*]; Rick et al., 2011), occasionally to the point of using unsuitable marine caves as critical pupping habitat (Stringell et al., 2014). Upon reduction of this pressure, however, monk seals may return to their preferred habitat (Culloch et al., 2012).

The aforementioned pattern of displacement from critical habitat due to increased human/predator pressure resulting in use of marginal habitat and return to use of preferred habitat once pressures have ceased to exist appears to be relevant also to the Mediterranean monk seal and its current conservation status. Once an open beach dweller (Johnson & Lavigne, 1999), this monk seal population experienced heavy hunting pressure throughout time (González, 2015; Morales-Pérez et al., 2017), gradually leading it to seek remote, difficult-to-access marine caves that offered protection against humans (Karamanlidis et al., 2016) but also other predators (De Waele et al., 2009). Marine caves currently used by monk seals for pupping in Greece share a set of common geomorphological features that are believed to protect them mainly from human activity (Dendrinos et al., 2007c). The combination of continued anthropogenic pressure and use of marginal pupping habitat, which, in turn, has resulted in reduced pup survival rates (Gazo et al., 2000; de Larrinoa et al., 2021), played an important role in the decrease of this species and its resulting precarious conservation status (Karamanlidis & Dendrinos, 2015; Karamanlidis et al., 2019). Considering the monk seals' conservation status, it has been suggested that the marginal cave habitat currently used by this seal might not be suitable for the survival of the species and that recovery of the Mediterranean monk seal will require a partial return to open beaches (Sergeant et al., 1978; Karamanlidis et al., 2016).

More recently, conservation efforts appear to have had a positive effect on habitat use patterns of the Mediterranean monk seal. In (protected) areas where human activity is controlled and therefore low, such as the marine protected area at the Desertas Islands in Madeira, reproductive females and their pups have been observed using open beaches, thus reacquiring their natural, original habitats and behavior (Pires & Neves, 2000). Our examples provide clear evidence that this is occasionally also the case in Greece. Whether use of open beaches is a recent phenomenon or has persisted throughout time and been undetected by our monitoring efforts is difficult to evaluate. Given the limited availability of suitable pupping caves and the ongoing population recovery of the Mediterranean monk seal in Greece (Dendrinos et al., 2020; Adamantopoulou et al., 2022), we believe that open beach use is a recent phenomenon being driven by breeding females in their attempt to reduce intraspecific competition for space in pupping caves (Dendrinos et al., 2007b; Karamanlidis et al., 2021) by increasing the available pupping habitat. A (partial) return of the Mediterranean monk seal to open beaches could have the same beneficial effects to population demographics as in other seal species (e.g., the northern elephant seal; Lowry et al., 2014).

Regardless of the reasons Mediterranean monk seals in Greece are or have started using open beaches to cover basic biological tasks, this fact has important implications for the species' conservation in the country and across the species' range. The small (i.e., 10 to 100 m wide, 10 to 20 m deep), open, cliff-bound beaches may be considered potential critical habitat for the species. This type of habitat is very similar to the open beaches used by monk seals at Madeira (Pires & Neves, 2000) and should be included in planning of future research and management actions for the Mediterranean monk seal in Greece. Considering that use of open beaches will inevitably lead to an increase of human–seal interactions, we identify the following management actions that are consistent with conservation priorities identified in the new Action Plan for the Mediterranean monk seal in the country (Dendrinos et al., 2020):

1. Expand monitoring efforts of critical habitat throughout the country to include open, cliff-bound beaches.

2. Establish (local) Monk Seal Vigilance Teams tasked with mitigating (negative) human–seal interactions.

3. Inform and educate relevant conservation authorities (e.g., management bodies of protected areas, Port Police authorities) in Greece to the return of the Mediterranean monk seal to open beaches.

4. Include the return of the Mediterranean monk seal to open beaches as an issue in environmental education and public awareness activities. Within the framework of this activity, the *Mediterranean Monk Seal Watching Guidelines* (MOm, 2022) should be promoted.

Apart from the implications for the conservation of the Mediterranean monk seal in Greece, the results of our observations should be considered on a wider scale. In Cabo Blanco, where the subpopulation clings to perilously little habitat (i.e., 3 caves along ~1 km of shoreline; de Larrinoa et al., 2021), it has been recommended to test the viability of reintroducing monk seals to some portion of their previous range to increase total abundance and enhance population viability in the Atlantic (González, 2015). The results of our observations indicate that cave dwelling is not necessarily an innate characteristic of the species and that monk seals do use open beaches under specific circumstances. Creating these circumstances could improve conservation prospects for the species in the region.

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Previously Undocumented Long-Finned Pilot Whale (*Globicephala melas*) Placental Expulsion in Coastal Waters of Shetland, United Kingdom

Emily L. Hague,[1] Nick McCaffrey,[2] Karen A. Stockin,[3] and Dara N. Orbach[4]

[1]*Centre for Marine Biodiversity & Biotechnology, Institute of Life and Earth Sciences,*
Heriot-Watt University, Edinburgh EH14 4AS, UK
E-mail: elh2001@hw.ac.uk
[2]*Southspear Media and Surveys Ltd, Aith, Shetland, UK*
[3]*Cetacean Ecology Research Group, School of Natural Sciences,*
Massey University, Albany, Auckland 0745, New Zealand
[4]*Department of Life Sciences, Texas A&M University–Corpus Christi, Corpus Christi, TX 78412, USA*

This paper describes the first documented observation of placental expulsion by a long-finned pilot whale (*Globicephala melas*), which was captured on video by an unmanned aerial system (UAS) in coastal waters of the Shetland Isles, Scotland, United Kingdom. The advent and development of UAS technology provides novel opportunities to observe and document biologically significant events that are challenging, if not impossible, to observe via boat or from land (Ransome et al., 2022).

Around Scotland, long-finned pilot whales show a strong association for deep water off the continental shelf edge (Weir et al., 2001; Hammond et al., 2017; Rogan et al., 2017) and thus are relatively infrequently sighted in coastal Scottish waters. Due to the logistical challenges of studying pelagic species, the understanding of some attributes of long-finned pilot whales remains limited, with courtship, mating, and parturition poorly described and rarely (if ever) observed. Therefore, the identification of Shetland's coastal waters as a site of placental expulsion provides new insights for the North Atlantic population of long-finned pilot whales.

Observation

On 27 September 2019 at 1351 h (BST), an unmanned aerial system (DJI Mavic 2 Pro and then a DJI Inspire) was launched following land-based sightings of a group of long-finned pilot whales in the Shetland Isles (Figure 1). During the 1.5 h encounter, 19 min 39 s of aerial video captured a series of events associated with the apparent placental expulsion from one of the presumed (based on body length) adult long-finned pilot whales. (Cropped video of the encounter is available in the "Supplemental Material" section of the *Aquatic Mammals* website: https://www.aquaticmammals-journal.org/index.php?option=com_content&view=article&id=10&Itemid=147).

The group, comprising a minimum estimate of 40 individuals, was first observed at 1354 h within Yell Sound, located 1.5 km northwest of the Isle of Lamba, Shetland (60.521261, -1.306385; water depth at location: 40 to 60 m; Figure 1). The group swam directionally north at ~7 km/h. At 1423 h, the group was located 2 km due north of the Isle of Lamba (60.5340771, -1.2900745), still tracking directionally north in a tight-knit formation and travelling at pace (~11 km/h). Leading the fast-paced group were two presumed adults travelling in parallel and flanking a young calf that swam in echelon between the two adults. The calf had a flaccid dorsal fin and pale gray colouration (Figure 2), a characteristic prevalent in newborn long-finned pilot whales (Auger-Méthé & Whitehead, 2007; Verborgh et al., 2021). The calf was in close proximity with the adult that expelled the "placenta," so it is plausible that the calf may have been a neonate. The video resolution was insufficient to determine whether diagnostic fetal folds were present on the calf; these have been used previously to identify pilot whale neonates (Verborgh et al., 2021).

At 1423 h, one of the two leading adults provided a hard kick with its fluke and then expelled a globular white and red tissue, assumed to be from its genitals (60.5353853, -1.2899942; water depth at location: 60 to 80 m; Figure 3a; Supplemental Video). The tissue immediately surfaced upon expulsion. Morphologically, the tissue was similar in gross appearance to other cetacean placental tissue documented within the literature, with a crescent-shaped bicornuate structure evident and visible umbilical cord (Benirschke &

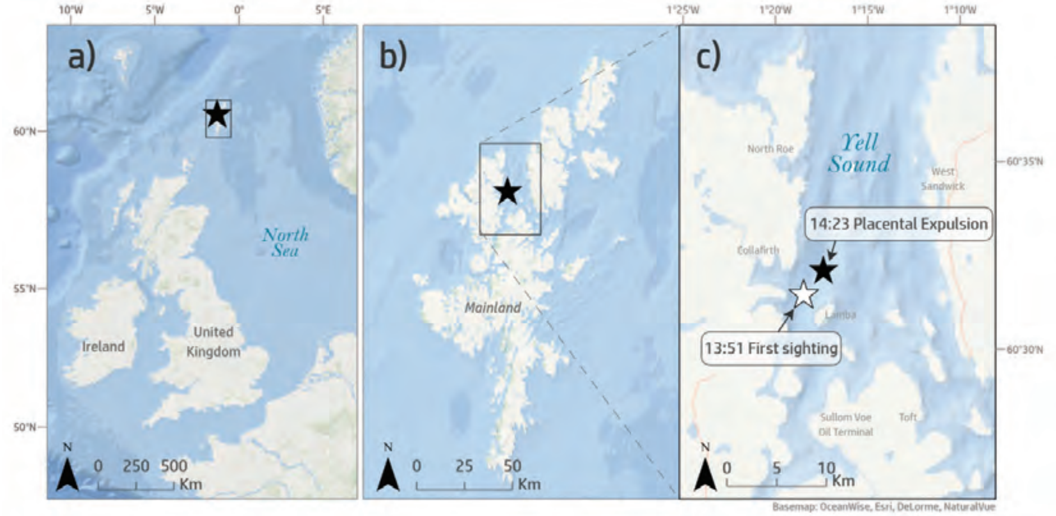

Figure 1. (a) Location of the Shetland Isles in relation to the rest of the United Kingdom and the North Sea; (b) location of the placental expulsion observation (black star) near the Shetland Isles; and (c) detailed location where the long-finned pilot whales (*Globicephala melas*) were first sighted (white star), with site of placental expulsion (black star) within Yell Sound.

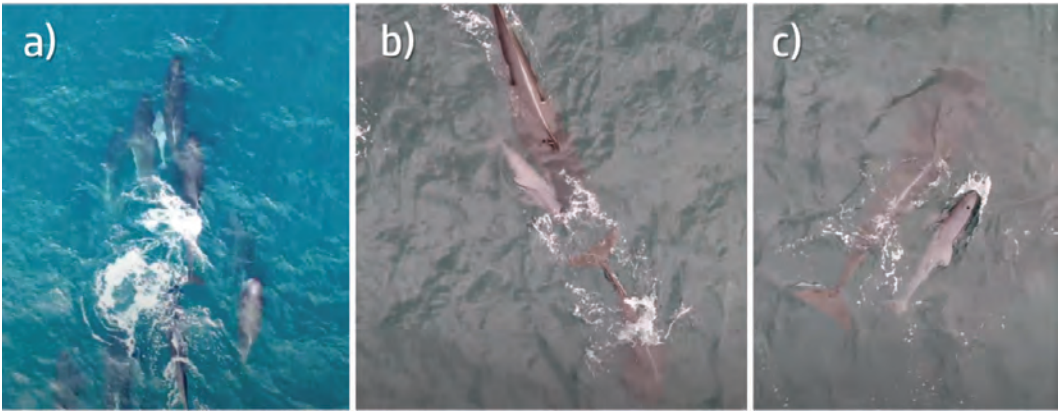

Figure 2. (a) The observed fast-paced group of long-finned pilot whales, led by the (assumed) adult that expelled the placental-like tissue, who also had a calf swimming in the echelon position; (b) example of the calf's flaccid dorsal fin; and (c) calf in echelon position to adult that expelled placental-like material. (*Drone footage credit:* Nick McCaffrey)

Cornell, 1987; Silvers et al., 1997; Jones et al., 2022; Figure 3b). The pilot whales immediately orientated themselves at least 270° towards the putative placenta before momentarily leaving the UAS's field of view. The group then encircled the biological material, milling in direct proximity to the tissue (Figure 3c). One presumed adult surfaced closely alongside the material, while another smaller individual swam directly under it and touched the tissue via its tail fluke. A third presumed adult surfaced alongside the putative placenta and orientated its body to kick the material with its flukes. At 1424 h, the group then resurfaced approximately three adult body lengths away from the tissue and reorientated parallel line abreast to one another (Neumann & Orams, 2003). The UAS abandoned the putative placenta to follow the group. When the tissue was next in the field of view (1425 h), at least 12 pilot whales surfaced and milled in close proximity, with one individual spy-hopping alongside it (Figure 3d). The spy-hopping behavioural event could have been in response to the presence of the UAS (Fettermann et al., 2019).

The UAS was returned to land at 1427 h and exchanged for a second UAS (DJI Inspire). At

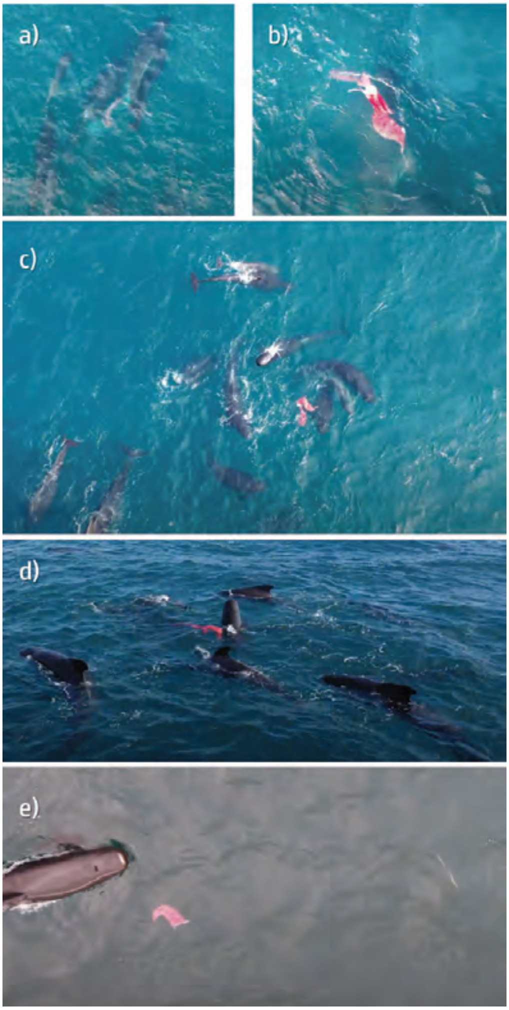

Figure 3. (a) Placental-like expulsion from the presumed adult long-finned pilot whale; (b) first observation of placental-like material; (c) milling and circling around first observed placental-like material; (d) spy-hop next to initial placental-like material; and (e) second observed placental-like material (potential second horn). (*Drone footage credit:* Nick McCaffrey)

1439 h, the group was relocated and observed for 5 min 1 s swimming slowly and logging at the surface. The next video clip begins at 1515 h, showing the group still swimming slowly and logging at the surface, with one individual tail slapping twice in quick succession. At 1519 h, a second piece of apparent biological matter, again resembling placental material, was further observed proximate to the group (Figure 3e; Supplemental Video). Three individuals swam alongside the floating tissue. As long-finned pilot whales have a bicornuate uterus, with each horn of the placenta typically expelled in succession (Blanchet et al., 2009), it is plausible that the second observation of assumed placental tissue represented the second horn. The second observed biological material appeared to be different from the first observed tissue, comparatively smaller in size and paler in colour, with apparent differences in texture and shape also noted (Figure 3e).

At 1525 h, ~40 pilot whales were visible within the UAS field of view, which provides a minimum estimate of group size during this encounter. This observation suggests that the expulsion of putative placental tissue (and potentially parturition itself) represents a social rather than solitary activity. Further, there were multiple presumed mother–calf pairs observed in this group, supporting close kinship for this species, where some groups consist of closely related adult females and their offspring (Amos et al., 1991). The group forms part of the Northeast Atlantic population of long-finned pilot whales, with recent abundance estimates predicting 172,195 (CV = 0.35) individuals in this oceanic and shelf region (Rogan et al., 2017).

Due to the inherent difficulties in studying mobile marine megafauna, knowledge of reproductive parameters for pilot whales has arisen through analyses of individuals harvested during drive-fisheries (e.g., Martin & Rothery, 1993) and via analyses of individuals stranded during mass stranding events (MSEs) of which pilot whales are particularly prone (Martin et al., 1987; Gales et al., 2012; Brownlow et al., 2015; Anabella et al., 2017; Betty, 2019; Betty et al., 2019, 2020, 2022). An analysis of almost 2,000 females captured during the Faroese drive hunts between 1986 and 1988 estimated the average age at sexual maturity (8 y), inter-birth interval (average 5.1 y), a 12-mo gestation period, and a peak in conceptions and births in boreal summer and autumn (Martin & Rothery, 1993). In contrast, data from pilot whales captured on the east coast of the Atlantic suggest a longer gestation (15.5 to 16 mo) and births to be most prevalent in mid-August (Newfoundland, Canada; Sergeant, 1962). Similar reproductive insights into the North Atlantic population have been obtained through MSEs in British waters, which has enabled estimation of female age and length at sexual maturity (7 y; 300 to 400 cm), inter-birth interval (3.5 y), and reproductive rate (11%). No apparent seasonality in parturition was noted (Martin et al., 1987). The present observation of putative placental expulsion, likely indicative of recent birth, occurred late in September, which is in line with drive-fisheries-derived estimates of birth seasonality.

Parturition and associated placental expulsion have been documented for some cetaceans in captivity (e.g., Essapian, 1963), with time between parturition and placental expulsion varying somewhat between species (bottlenose dolphin [*Tursiops truncatus*]: *n* = 13, range = 220 to 570 min [Biancani et al., 2021], and *n* = 1, 10 h [McBride & Kritzler, 1951]; killer whale [*Orcinus orca*]: *n* = 1, 10 h [Asper et al., 1988]; beluga whale [*Delphinapterus leucas*]: *n* = 18, average = 7.6 h [Robeck et al., 2005]; finless porpoise [*Neophocaena asiaeorientalis asiaeorientalis* and *N. a. sunameri*]: *n* = 11, average = 7 h 21 min [Deng et al., 2019]; pantropical spotted dolphin [*Stenella attenuata*]: *n* = 1, 4.5 h [Ikeshima et al., 2021]). As parturition was not directly observed during the observation described herein, it is not possible to report time between parturition and placental expulsion. However, given evidence of the time elapsed between parturition and placental expulsion for captive cetaceans, it is likely that the observation of this expulsion is an indication of a birth within the previous 12 h. Furthermore, we observed two expelled pieces of apparent placental material. Expulsion of > 1 piece of placental material has only previously been recorded for a captive harbour porpoise (*Phocoena phocoena*), with the suspected left- and right-horn expelled 5 h and 7 h after birth, respectively (Blanchet et al., 2009).

In contrast to captivity, cetacean parturition is seldom observed in the wild. Observations from a vessel of ante- and postpartum behaviour have been recorded opportunistically for killer whales (Stacey & Baird, 1997), false killer whales (*Pseudorca crassidens*; Notarbartolo di Sciara et al., 1997), beluga whales (Béland et al., 1990), bottlenose dolphins (Perrtree et al., 2016), sperm whales (*Physeter macrocephalus*; Weilgart & Whitehead, 1986), southern right whales (*Eubalaena australis*; Sironi et al., 2019), and humpback whales (*Megaptera novaeangliae*; Silvers et al., 1997; Faria et al., 2013; Ransome et al., 2022). However, vessel platforms typically limit direct observations of parturition itself, which usually occurs underwater; thus, expulsion of the calf and/or placental tissue may be missed. For some vessel-based observations, blood and tissue were observed floating on the surface instantaneously or up to 15 min post first observation of a neonate (e.g., false killer whale: Notarbartolo di Sciara et al., 1997; humpback whale: Silvers et al., 1997; Ransome et al., 2022), or retrieved the following day (Sironi et al., 2019). In contrast to a typical subsurface birth for cetaceans, Mills & Mills (1979) directly observed the birth of a gray whale (*Eschrichtius robustus*) because the mother maintained her back arched and head underwater in an apparent attempt to keep the head of the emerging neonate above the water. No placental tissue was witnessed nor located despite a dedicated search (Mills & Mills, 1979). Observations of ante- and postpartum behaviour have also been recorded opportunistically during two independent aerial surveys of a North Atlantic right whale (*Eubalaena glacialis*); large clouds of bloody discharge were visible in the water, with “a solid mass at the surface nearby,” which potentially may have represented placental tissue (Zani et al., 2008, p. 23; also see Foley et al., 2011).

Along with the inherent challenges of observing placental expulsion in free-ranging cetaceans (e.g., subsurface, rarity), ocean turbidity, sea state, and/or low water visibility may further limit observations (Ransome et al., 2022). Observations may also be rare because placental tissue may sink (Silvers et al., 1997) or may attract and then be consumed by scavengers such as sharks or seabirds (Taylor et al., 2013; Ransome et al., 2022). While there are currently no recorded observations of placentophagia (consumption of the placenta) by marine mammals, the energy-rich placenta is known to be consumed by many terrestrial eutherian mammalian species (Mota-Rojas et al., 2020). Placentophagia may be absent for cetaceans as birth is aquatic, and mothers often focus on aiding their offspring to breathe at the surface immediately following parturition (Kristal et al., 2012). Placental material is estimated to contain 5% of the total energy of gestation (southern right whales; Christiansen et al., 2022) and may weigh approximately 10 to 17% of calf birth weight (killer whales; Benirschke & Cornell, 1987). During the observation described herein, there was no apparent evidence of placentophagia, though some pilot whales did interact with and kick the biological material with their flukes, which may plausibly represent an attempt to break it apart or facilitate sinking to reduce predator attraction.

Building a knowledge base of observations of biologically significant events, along with identification of areas that are important to marine mammal life history and survival (e.g., important foraging, resting, calving, and breeding areas), is essential to inform and improve current conservation measures. Using the unique perspective of a UAS, this paper describes placental expulsion by a long-finned pilot whale in the waters around the Shetland Isles. As UAS use increases, it is likely that similar observations of previously undocumented biologically significant events will also increase. Through documentation of such observations, these new insights and perspectives may serve to highlight important regions for conservation.

Acknowledgments

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Female Humpback Whale (*Megaptera novaeangliae*) Positions Genital-Mammary Area to Intercept Bubbles Emitted by Males on the Hawaiian Breeding Grounds

Meagan E. Jones,[1,2] Charles P. Nicklin,[1] and James D. Darling[1]

[1]*Whale Trust, PO Box 243, Makawao, HI 96768, USA*
E-mail: mjones@whaletrust.org
[2]*University of Hawaii Maui College, 310 W. Kaahumanu Avenue, Kahului, HI 96732, USA*

The production and use of bubble streams, nets, bursts, dribbles, and rings by cetaceans are widely documented (see review by Moreno & Macgregor, 2019). Bubbles are produced by the controlled exhalation of air through the blowhole(s) or from bursts of air released from the mouth. Observations indicate that bubble releases are produced in several different contexts, including agonistic, stressful, social, foraging, and sexual. Bubbles play important roles in cetacean social interactions; however, in most circumstances, their specific function has yet to be determined.

Humpback whales (*Megaptera novaeangliae*) are well known for their use of bubbles, especially in a feeding context where lone whales or cooperative groups use a variety of bubble-based tactics to net, trap, herd, and concentrate different prey species (e.g., Jurasz & Jurasz, 1979; Hain et al., 1982; D'Vincent et al.,1985; Sharpe & Dill, 1997; Wiley et al., 2011). Vigorous use of bubbles is also a feature of humpback whale behavior on breeding grounds. The most obvious are the long bubble streams emitted by males, primarily from "principal" escorts during challenges from other males (e.g., Tyack & Whitehead, 1983).

In this paper, we describe a different context for bubble use by humpback whales on the Hawaiian breeding grounds. In contrast to the bubbles produced by competing male humpbacks, we report an anecdotal observation of male production of bubbles directed at the female's genital-mammary region. In this situation, the female tolerates and possibly aids in the reception of the bubbles by situating her body in the bubble stream (Figure 1; see supplemental video; the supplemental video for this paper is available in the "Supplemental Material" section of the *Aquatic Mammals* website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147). While we have observed this behavior on multiple occasions, usually the observation is not of the length or completeness needed to definitively state that bubbles are directed at the female (vs at other males in the group) or, if bubbles do reach the female, whether it is intentional or not.

This observation occurred ~20 y ago and was videotaped. Field notes of the encounter have not been located; however, the 14-min video recording clearly illustrates a different context for bubble use and strongly suggests that bubbles play a role in male–female interactions during the breeding season.

The encounter occurred in February or March between 2000 and 2003 in the Au'au Channel off West Maui, Hawaii (approx. 20.85° N, 156.73° W). On this day, our research team encountered a multiple male–single female adult group milling at the surface. The female in this group was motionless or moving very slowly, with three males circling around her. We immediately noticed bubble streams and clouds rising to the surface and that there was no apparent agonistic behavior between the males. As such, CPN entered the water to provide further behavioral context for the surface observations.

Video Observations

The entire 14-min video and the "Supplementary Video Descriptions" file are included in the supplemental materials (also see Figure 1A-D). The main observations are summarized below.

Group Composition

The group was comprised of one adult female and three adult males. The female's sex was confirmed by the presence of the hemispherical lobe (Figure 1C). Male sex was presumed by behavior, including that multiple female groups are not seen together on breeding grounds (Jones, 2010), and multiple male groups typically form around a female (Tyack & Whitehead, 1983). Three of the four individuals seen on the video are clearly identifiable by individual natural markings (see

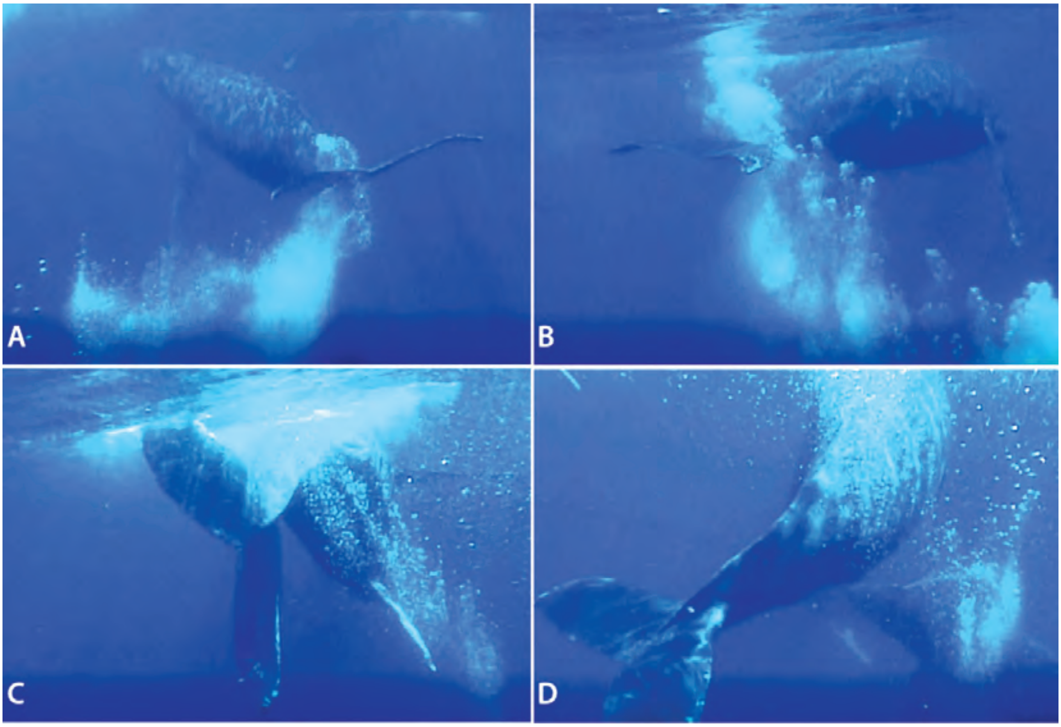

Figure 1. Examples of humpback whale (*Megaptera novaeangliae*) male production and female reception of bubbles (see supplemental video): (A) & (B) show the stationary female slightly lifting her flukes (A) and sliding her tail stock over the bubble releases (B). (C) shows the female rolling toward the bubbles, revealing the hemispherical lobe and swollen genital area. In (D), the female slides her flukes and rear body from left to right over the bubble stream below. Another male with white pectoral fins can be seen deeper and toward the front of the female. (*Photo/video credit:* Charles P. Nicklin, NOAA Permit #753-1599)

"Supplementary Video Descriptions" in the supplemental materials).

Female Condition and Behavior

The female was noticeably large in girth and appeared to have a swollen genital area (Figure 1C). She was generally stationary both at depth (~15 to 20 m) and just beneath the sea surface. When not stationary, she was nearly so, only moving forward slowly. Importantly, there was no obvious indication of the female avoiding the males as is often seen on breeding grounds (Glockner-Ferrari & Ferrari, 1985; Jones, 2010). Indeed, on five separate occasions, the female appeared to position the ventral posterior portion of her body in the direction and/or vicinity of the bubbles.

Male Behavior

Three adult males (referred to as M1, M2, and M3) are repeatedly seen throughout the supplemental video. The one male (M1) that was consistently nearest to the female did most, if not all, of the bubble production. A second male with white pectoral fins (M2; see supplemental materials) was usually distant in the video frame and/or at the front periphery of the female. The third male (M3) can be seen four times in the video and may have been responsible for one of the bubble emissions. On two occasions, the female can be seen in the center of two males. There was no obvious coercion of the female or male–male agonistic displays typical of male interactions around a female on the breeding ground (Darling et al., 2006).

Bubble Use and Production

In the supplemental video, 12 discrete instances of underwater bubble streams and/or bubble clouds are produced by a male while moving toward and underneath the posterior one-third of the female's body. These bubbles rise upward, breaking on her underside in the genital-mammary region (see Figure 1). In addition to the underwater expulsion of bubbles from the blowholes toward the female, M1 also releases large bubble clouds from its mouth upon each surfacing.

Female Orientation to the Bubbles

The supplemental video shows that the female does not attempt to evade or avoid the males or the bubbles. On five separate occasions, she can be seen rolling toward, arching, or slightly lifting and/or moving her tail above the bubble releases. On at least two occasions, the female rolls and appears to orient her body toward the bubble releases such that they strike her in the genital-mammary region. In these cases, the bubbles rise toward the surface on either side of her tail stock (Figure 1D).

While this male production, and apparent female acceptance, of bubbles is intriguing and appears to reveal a new dimension to male–female interactions on breeding grounds, any interpretation of the behavior is clearly speculative. Unlike bubble-netting or agonistic behavioral displays, the function of these bubbles directed at the female is neither obvious nor intuitive based on current understanding of reproductive behaviors. While speculative, there are two primary contexts within which to consider this behavior (i.e., adult female humpbacks migrating to breeding grounds with different reproductive objectives): (1) to maximize mating opportunities (mature females without calves) and (2) to ensure successful birth and calf development (Gabriele, 1992; Jones, 2010).

Scenario 1: Mating/Estrus Female—A female present to mate and in estrus could explain (1) the female's receptiveness of the males (compared to fleeing from or leading competitive males in some form of female choice) and (2) male attention toward the female. The supplemental video shows a male producing and directing bubble exhalations toward the female's genital-mammary area and the female responding by orienting her underside toward the bubbles. In this scenario, it seems reasonable to speculate that this interaction may serve a sexual purpose, including some form of pre-copulatory stimulation or assisting in the release of chemical cues as to the female's reproductive status or readiness to mate. Conceivably, it may even play a role in inducing estrus, which has been shown to occur in anestrous ewes in the presence of multiple males (Miquel-Cruz et al., 2019).

Scenario 2: Late Pregnant Female—Another possibility is that the female is late pregnant and about to give birth. This could explain her extended/notable girth, swollen genitals (as described in Patton & Lawless, 2021), and even the presence of multiple males around a birthing female (see review in Ransome et al., 2021). If this is pre-birth behavior, we speculate that the bubbles could stimulate the release of hormones such as oxytocin known to be vital in the birthing process (Fuchs et al., 2001). Oxytocin is released with activation of somatosensory nerves, "induced by touch, stroking, warmth and light pressure on the skin" (Uvnäs-Moberg et al., 2015, p. 6). In this case, mammary glands—especially sensitive—are located on either side of the genital slit where the bubbles appear to be directed and received. It seems possible then that the clouds of bubbles from male humpbacks may also serve this purpose. But the pressing question is, if this is the case, why are males involved? What is in it for them?

In their review on bubble use and production in cetaceans, Moreno & Macgregor (2019) indicate that humpback whales and some species of odontocetes produce bubbles in a sexual context. However, details are limited, and what is described seems to be different than the behaviors described here. Their reference to humpback whales (Baker & Herman, 1984), for example, refers to the use of bubbles in male–male competitive behavior around females. The interpretations of odontocetes using bubbles in sexual contexts is also complicated by associated aggressive behaviors and unsuccessful mating attempts by immature males (e.g., Herzing, 1996), and similar bubble use in social contexts outside of sexual behavior (Moreno, 2017). While interesting, it is not readily apparent that these reports of cetacean bubble use in a sexual context provide any additional insights or contexts for the interpretation of the male–female interactions described here.

Bubble use in humpback whales, as with other cetaceans, is complex; and as this observation indicates, it can occur in a variety of different situations on both feeding and breeding grounds. The male production and female reception of bubbles strongly suggest that they may also play a role in courtship, mating, and/or in the birthing process. Whatever function the bubbles serve, this is a different context for their use than the bubble streams typically associated with male–male agonistic displays on humpback whale breeding grounds. Future research aimed at understanding the hormonal state of male and female humpbacks within different social groups and situations on breeding grounds should provide the insight needed to determine the correct context for the behavior patterns described.

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Harassing Behavior by Short-Finned Pilot Whales (*Globicephala macrorhynchus*) Towards a Mother and Calf Sperm Whale (*Physeter macrocephalus*) Pair

Manuel Fernández,[1] Eduardo Morteo,[2] Christian A. Delfín-Alfonso,[2, 3]
and Isabel Hernández-Candelario[2]

[1]*Pelagic Life, AC, General Juan Cano 13, San Miguel Chapultepec,*
Delegación Miguel Hidalgo, CP 11850, Ciudad de Mexico, México
[2]*Laboratorio de Mamíferos Marinos (LabMMar), Instituto de Investigaciones Biológicas, Universidad Veracruzana,*
Dr. Castelazo Ayala S/N, Industrial Ánimas, CP 91190, Xalapa, Veracruz, México
[3]*Laboratorio de Zoología, Instituto de Investigaciones Biológicas, Universidad Veracruzana,*
Dr. Castelazo Ayala S/N, Industrial Ánimas, CP 91190, Xalapa, Veracruz, México
E-mail: isabelhdezc@gmail.com

The following paper describes an interaction between two cetacean species: the sperm whale (*Physeter macrocephalus*) and the short-finned pilot whale (*Globicephala macrorhynchus*). The event occurred on 6 June 2021 during a research survey. The crew of Pelagic Life, AC, and the Marine Mammal Laboratory at Universidad Veracruzana was surveying the Continental Slope off the Veracruz coast in the southwestern Gulf of Mexico (GoM) when a mother–calf sperm whale pair was observed. The animals were resting at the surface when a group of at least eight short-finned pilot whales approached and started an unusual behavior against the sperm whales. Herein, we describe what seemed to be an agonistic interaction between these animals.

The GoM is considered a semi-enclosed basin with communication to the Caribbean Sea through the Yucatán Channel (Monreal-Gómez et al., 2004). The southern portion, particularly the littoral of Veracruz state, presents a gentle slope towards the east (Vázquez de la Cerda, 2004; Pérez-Brunius et al., 2013). Its high productivity is due to oceanographic characteristics that host high biodiversity (Elliot, 1982; Etter, 1983; Fernández et al., 1993; Toledo-Ocampo, 2005; Zavala-Hidalgo et al., 2006; Linacre et al., 2015). While sperm whales have been documented in this region (Ortega-Ortiz et al., 1998; Ortega-Ortiz, 2002; Würsig, 2017; García-Aguilar, 2021), studies on this species have occurred primarily in the northern GoM (Fritts et al., 1983; Mullin et al., 1994; Davis et al., 2000); here, the highest abundance of sperm whales has been observed primarily over the continental shelf along Texas (Würsig et al., 2000). Short-finned pilot whales have also been documented in the GoM (Davis & Fargion, 1996; Davis et al., 2002). In the southern GoM, they typically occur in groups of at least nine individuals (Caldwell, 1955; Padilla et al., 1985; Ramírez-León et al., 2018; García-Aguilar, 2021; García-Aguilar et al., 2021). Still, in the southern GoM, information about sperm whales and short-finned pilot whales is incipient.

Interspecific interactions with sperm whales have been documented elsewhere (Weller et al., 1996; Kasamatsu et al., 2000; Jaquet & Gendron, 2002; Curé et al., 2013); for instance, male sperm whales present anti-predator strategies by interfering with killer whales' (*Orcinus orca*) acoustic signals, remaining silent in their presence (Arnborn et al., 1987; Curé et al., 2013). Observations in the north-central GoM have documented sperm whales exhibiting a defense reaction in the presence of pilot whales, which has been described as agonistic; this was supported by variable movements against the mother–calf pair causing them stress, resulting in the typical "marguerite-rosette formation" (Nishiwaki, 1962; Weller et al., 1996; Pitman et al., 2001). This defensive behavior has also been documented in the presence of false killer whales (*Pseudorca crassidens*) in the Galápagos Islands (Palacios & Mate, 1996), and in the presence of killer whales, during which time sperm whales appeared agitated and abruptly changed their direction (Whitt et al., 2015). Nevertheless, to the best of our knowledge, this is the first documented interaction between these sperm and pilot whales in the southwestern GoM. It is noteworthy that sperm whales are listed as vulnerable (Taylor et al., 2019; International Union for Conservation of Nature [IUCN], 2022), though information in this GoM region is scarce (Galindo et al., 2009). This area is highly susceptible to anthropic disturbances from major vessel transit (at least 27 commercial cargo lines) related to the export/import of products (38 cargo types), most with weekly arrivals—a total of 2,012 major vessels in 2021 (Administración Portuaria Integral de Veracruz S. A. de C. V. [APIVER], 2022).

The observations presented in this paper occurred during routine surveys of deep-water cetaceans off the coast of Veracruz at the end of the dry season (which lasts from March to June). Weekly boat-based surveys were conducted under good sea conditions (wind speed < 15 km/h) in a 10-m IMEMSA m/v *Bonanza*, powered by two outboard (140 hp) motors. Three observers positioned at the front, left, and right sides of the boat searched for cetaceans with the unaided eye. An unmanned aerial vehicle (UAV; drone) DJI Phantom 4 was often used to record sightings (video and photos) to document group structure and behavior. The research boat maintained a safe distance (~50 to 100 m) to avoid disturbing any animals. Drone photographs were taken *in situ*, and footage was reviewed to assess the behavior of cetacean species from which still frames were selected to exemplify specific behaviors.

On 6 June 2021, at 1600 h, ~55 km off Veracruz and in waters ~900 m deep (19° 24.666 N, 95° 42.125 W), the crew observed a mother–calf sperm whale pair resting on the surface. The drone approached within 100 to 200 m from our boat and ~50 to 100 m of altitude to document the pair (see Supplementary Material Video, which is available in the "Supplemental Material" section of the *Aquatic Mammals* website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147). Within a few minutes, a group of ~15 to 20 short-finned pilot whales were sighted, and eight approached the sperm whales (1610 h at the same location). The pilot whales remained close to the mother–calf pair and were visible from the boat. The group dispersed into at least three subgroups around a 1.6 km radius and surrounded the mother–calf pair, appearing calm as evidenced by spy-hopping and slow movements in front of the sperm whale's head; the calf remained close to the right-side lateral peduncle (at 1615 h; Figure 1; Supplementary Material Video Sequence 1). The pilot whales seemed to escort the sperm whales (while the calf remained close to the mother), with no evidence of sudden behaviors between the two species (Figure 1).

The aggregation shape started to change as the pilot whales got closer (~2 m) to the sperm whales. At 1620 h, one pilot whale crossed below the sperm whales (~5 m under, using the estimated body length of pilot whales as reference), while three other individuals passed in front of the mother, one more to the mother's right and another two approaching from the same side. The calf stayed on the surface, swimming at the left side near the mother's head, and the pilot whales remained near each other at the adult sperm whale's flank (Supplementary Material Video Sequence 2). The mother's behavior changed to what might have been distress, suggested by her open mouth (which also was observed briefly at the start of the encounter) and spinning movements and posturing, with the calf near her mouth as the pilot whales periodically moved away from the

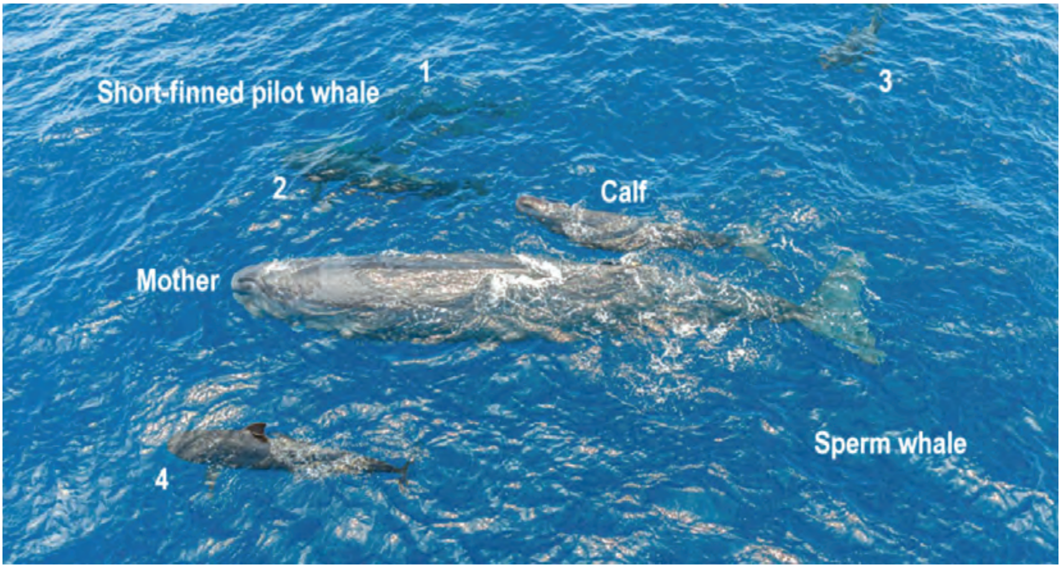

Figure 1. Drone photograph of a group of short-finned pilot whales (*Globicephala macrorhynchus*; ~4 individuals) surrounding a mother–calf pair of sperm whales (*Physeter macrocephalus*) in the southwestern Gulf of Mexico (*Drone footage credit:* Manuel Fernández)

mother and then regained proximity to one another (Supplementary Material Video Sequence 3). The sperm whales submerged while the pilot whales passed above them, remaining close to each other as they continued to be escorted by the pilot whales. During this event, we witnessed alternating periods of surfacing and diving (~5 m below the surface), with very slow continuous forward movements by both species. The adult sperm whale lifted the head and adopted an inverted underwater posture directly below the calf (6:50 to 7:58 min; Supplementary Material Video Sequence 3). One pilot whale was observed swimming fast below the mother, who splashed with her fluke and apparently tried to bite the pilot whale (10:24 min; Supplementary Material Video Sequence 3). Simultaneously, the other pilot whales were seen within a few hundred meters of our vessel approaching slowly (within 3 m) as the interaction between the short-finned pilot whales and sperm whales kept its course.

After being pursued by pilot whales, the sperm whales increased their speed (~30 km/h), with the pilot whales following at ~4 m, sometimes spreading out and changing positions. The sperm whales' course did not change direction but continued westward where another sperm whale was spotted breaching. Periodically, the mother decreased speed and stopped on her right side, exposing her lower jaw, which was followed by a forceful displacement of water (see Supplementary Material Video Sequence 3). Corresponding with pilot whales' high energetic behavior (moving around the mother–calf pair), the adult sperm whale was witnessed arching and moving her peduncle side-to-side to displace water in response to two pilot whales approaching the calf.

During this last observation (1624 h), eight pilot whales escorted the sperm whales (10:50 min; Supplementary Material Video Sequence 4), six along the right flank and two on her left side (11:28 min; Supplementary Material Video Sequence 4). Suddenly, the interaction became more intense when six additional pilot whales joined the group. All 14 pilot whales used their tails in a violent fashion towards the mother, seemingly to separate her from the calf (14:55 min; Supplementary Material Video Sequence 4).

By the end of the encounter (1628 h), the adult sperm whale stopped being inverted and postured herself vertically while opening her mouth and facing the pilot whales (16:03 to 17:22 min; Supplementary Material Video Sequence 4). This position seemed to be advantageous in reducing harassment as the pilot whales dispersed (to 5 m away); however, shortly afterward, they resumed the same escorting position. Finally, the sperm whales increased their speed, and only two pilot whales kept up with their pace. Our observations ended at 1633 h. Since the westward course of the whales did not change, we assumed the mother–calf pair joined the other sperm whale that had been breaching to the west.

The observed interaction between sperm whales and pilot whales off the Veracruz coast may have served as an attempt to harass the sperm whale pair in order to isolate the calf, which would then be easier to hunt. Pilot whales have been documented to occasionally feed on small cetaceans (Perryman & Foster, 1980) and behave aggressively towards sperm whales in the north GoM (Weller et al., 1996). Our observations are similar to those in the Strait of Gibraltar where a group of pilot whales presented agonistic behavior against sperm whales as represented by abrupt head movements in and out of the water and the use of the marguerite-rosette formation (Foundation for Information and Research on Marine Mammals [FIRMM], 2021). This documented behavior was hard to explain, though it is possible that the pilot whales displayed threatening behavior against the sperm whales as the former are known to behave aggressively towards other cetaceans (Brown et al., 1966; Perryman & Foster, 1980; Shane et al., 1993; Perrin et al., 2002).

As far as we are aware, observations of pilot whales harassing or hunting sperm whales have not been documented in the area. Even when pilot whales are known for hunting other cetaceans (Ciano & Jøorgensen, 2006), our observations are not considered valid proof of hunting behavior on sperm whales. Since no injuries were observed, pilot whales might have been practicing hunting tactics, which could be supported by their agonist behavior towards this mother–calf pair (e.g., Norris, 1977; Shane, 1995a, 1995b; Palacios & Mate, 1996). Our observations highlight the need for research in this region to enhance our understanding of both species for which limited data exist.

Acknowledgments

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Recovery of a Mid-Gestational Gray Whale (*Eschrichtius robustus*) Fetus Near Tofino, British Columbia

Paul Cottrell,[1] Brendan Cottrell,[2] Tanya Dowdall,[3] Alys Hoyland,[4]
Ashley Hoyland,[4] and Stephen A. Raverty[5]

[1]*Department of Fisheries and Oceans, 401 Burrard Street, Vancouver, BC V6C 3S4, Canada*
[2]*Applied Remote Sensing Lab, Department of Geography, McGill University,*
805 Sherbrooke Street W, Montreal, QC H3A 0B9, Canada
[3]*Parks Canada, 2040 Pacific Rim Highway, Ucluelet, BC V0R 3A0, Canada*
[4]*PO Box 760, 998 Jensen's Bay Road, Tofino, BC V0R 2Z0, Canada*
[5]*Animal Health Center, 1767 Angus Campbell Road, Abbotsford, BC V3G 2M3, Canada*
E-mail: stephen.raverty@gov.bc.ca

Gray whales (*Eschrichtius robustus*) are the only extant species of Eschrichtiidae. In the North Pacific, they comprise a western population of ~250 animals and an eastern group with up to 16,650 individuals as of 2021/2022 (this reflects a 38% decline in population; Eguchi et al., 2022; Torres et al., 2022). These animals have the longest migration route of any marine mammals, which extends from summer feeding grounds in the Bering, Chukchi, and Beaufort Seas to calving, breeding, and assemblage areas off Baja California and Mexico. Gray whales transit neritic or coastal zones with cow–calf pairs avoiding open waters, presumably due to threats associated with transient killer whale predation (Swartz, 2018). These whales occasionally have incursions into shallow mud flats to forage for infaunal and benthic crustaceans and other prey species. In Canada, gray whales were subdivided in 2014 into two distinct populations, consisting of the Northern Migratory and Pacific Coast Feeding Groups; and in 2017, both groups were designated Schedule 1, Special Concern (Committee on the Status of Endangered Wildlife in Canada [COSEWIC], 2017).

Over the last three decades, the population status of gray whales has had considerable fluctuation with declines reported in 1998-1999; and more recently, the population has diminished from an estimate of 28,000 in 2016 to 21,000 in 2021 (Torres et al., 2022) with most losses incurred in calf and adult age cohorts and a prominent reduction in annual calf crops (Stewart & Weller, 2021). In recognition of the precipitous decline in gray whale numbers, an Unusual Mortality Event (UME) was declared by the National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA) in 2019 (Torres et al., 2022). Animals have stranded throughout the migratory corridor with evidence of suboptimal body condition or emaciation (Christiansen et al., 2021; Torres et al., 2022), but vessel strike and killer whale (*Orcinus orca*) predation have been associated regionally with significant mortality (Raverty et al., 2019). Prey availability and changes in ocean biophysics have been linked to dynamics in gray whale distribution and nutritional condition (Moore et al., 2022), possibly contributing to reduced fecundity, early embryonic loss, and fetal resorption, culminating in diminished calf recruitment. Rapid and ongoing transformations in the Pacific Arctic ecosystem (Huntington et al., 2020) have been implicated in not only suboptimal nutritional condition but also reproductive failures (Moore et al., 2022).

In a review of NOAA and Department of Fisheries and Oceans (DFO) level A data collected with stranding incidents, all age classes of gray whales have been observed stranded between 2016 and 2021, with most fetal and neonatal strandings recorded in Mexico calving lagoons (Raverty et al., 2019). To the best of our knowledge, no fetuses have previously been identified in gray whale strandings recorded in British Columbia (DFO, unpub. incident data, 2007-2022). This paper reports the recovery of a gray whale carcass in 2021, with morphometrics consistent with a mid-gestational fetus off the east coast of Vancouver Island, British Columbia.

On 30 October 2021, a small male gray whale carcass was reported dead and floating nearshore in Tofino Harbor, British Columbia (latitude: 49.15003040; longitude: -125.9229541; Figure 1). DFO officers were dispatched to the site, and the carcass was secured, towed ashore, and a necropsy performed on 31 October 2021.

Figure 1. Gray whale (*Eschrichtius robustus*) fetus observed dead and floating near Tofino Harbor, British Columbia (Photo courtesy of Dr. J. Darling)

The animal presented in moderate body condition and fair (code: 3.5 to 4.0) postmortem condition (Geraci & Lounsbury, 2005). There were reduced subcutaneous and visceral (e.g., perirenal, epicardial, mesenteric) adipose stores. Little fat oozed on incision of the blubber, and the animal was moderately muscled. Throughout the torso and on the leading edges of the flippers and flukes, there was multifocally extensive sloughing and loss of skin with partial maceration (with imbibed water) of the exposed dermis and blubber. Three transverse fetal folds were noted along the left flank, and the right torso could not be readily assessed due to epidermal loss. Throughout the rostrum, there were three widely distributed vibrissae. The umbilical stock was moist, pale tan yellow, and measured 80 cm (vein), 105 cm (vein), and 111 cm (artery); the vasculature was patent, the distal limits were abruptly truncated, and the entire length was splayed. There was partial retraction of the skin around the margin of the umbilicus with eversion of the underlying blubber. The vasculature within the internal aspect of the umbilicus was partially patent. Along the right lateral aspect of the thoracic and abdominal walls, there was moderate multifocal subcutaneous congestion (possible hypostasis), and the chest cavity contained ~10 ml of clear serosanguinous fluid that did not clot on exposure to air. The lungs were partially inflated; representative portions of lung tissue floated or were neutrally buoyed on immersion in formalin. There was mild multifocal subpleural congestion and atelectasis. The thymus was well developed and within the cranial mediastinum, and the foramen ovale and ductus arteriosus were patent. The stomach contained a few strands of seaweed and 5 ml of ingested placental fluid. Extending from the distal third level of the small intestine and entire length of colon, the lumen was distended by abundant meconium; and within the midlevel of the jejunum, there were prominent transverse constriction bands with segmental serosal congestion and injected vasculature. The urinary bladder was empty and collapsed. The morphometrics for this carcass were compiled (see Table 1). Premature live birth and subsequent death of this animal were attributed to the stage of fetal development, possibly exacerbated by the lack of colostral consumption and associated metabolic derangements of hypoglycemia and presumptive hypogammaglobulinemia.

Stranding records between 2008 and 2021 were reviewed, and 44 gray whale strandings were recorded. Based on morphometrics, these consisted of nine adults, seven subadults, five juveniles, two calves, and one fetus (DFO, unpub. incident data, 2007-2022). There were 20 incidents with no age identified. The stranding incident number, date,

Table 1. Carcass morphometrics; lengths and blubber thickness are provided in cm.

Straight lengths	Measurement (cm)		
Total length	307		
Snout to eye	47		
Snout of anterior flipper	79		
Snout to umbilicus	156		
Snout to anus	207		
Axillary girth	155		
Anus girth	88		
Flipper anterior length	51* and 37**		
Flipper maximum width	21		
Tail fluke width	83		
Blubber thickness	Axillary	Mid-thoracic	Anus
Mid-dorsal	1.5	2.0	2.4
Mid-lateral	2.4	2.4	2.3
Mid-ventral	2.6	1.9	1.9

*Cranial insertion
**Caudal insertion

Table 2. Summary of gray whale stranding identification number, date, location, and, when identified, age class. Twenty-four animals were identified by age. A = adult, SA = subadult, J = juvenile, C = calf, and F = fetus.

DFO ID (AHC ID)	Date (d/mo/y)	Stranding location	Age class
4904	4 June 2009	Hesquiat	
5596	24 March 2010	Hesquiat	
5631	4 April 2010	Sooke	
5672	6 May 2010	Quatsino	
5963	2 November 2010	Ucluelet	
6614	11 May 2011	Graham Island	
6624	28 May 2011	Sooke	
6665	10 June 2011	Port Hardy	
6922	1 August 2011	Graham Island	
12-0060	22 April 2012	Nitnat	
12-0124	4 June 2012	Masset	C
12-0134	15 June 2012	Nitnat	
13-0070	24 April 2013	Port Hardy	
13-0194	18 July 2013	Graham Island	
14-0346	20 September 2014	Prince Rupert	
15-112 (15-2923)	20 April 2015	Tofino	J
15-470	6 October 2015	Port Hardy	J
16-091	29 March 2016	Tofino	SA
17-104	2 April 2017	Tofino	
17-171	30 April 2017	Port Hardy	J
18-038	6 February 2018	Victoria	C
18-105	22 March 2018	Hesquiat	J
18-246	6 June 2018	Masset	SA
19-0107 (19-0280)	4 April 2019	Duncan	A
19-0681	9 May 2019	Graham Island	J
19-0180	15 May 2019	Graham Island	
19-0206 (19-3119)	26 May 2019	Queen Charlotte	A
19-0237 (19-3671)	5 June 2019	White Rock	A
19-0248	10 June 2019	Port Hardy	
19-0249	9 June 2019	Port Hardy	
19-0255	18 April 2019	Tofino	SA
19-0271	16 June 2019	Graham Island	
19-0340 (19-4585)	6 July 2019	Graham Island	SA
19-0677 (20-2109)	6 November 2019	Tofino	SA
20-0119 (20-3994)	14 April 2020	Tofino	A
20-0177 (20-3010)	14 May 2020	Barkley Sound	SA
20-0240	11 June 2020	Graham Island	SA
20-0278 (20-6381)	4 July 2020	Port Hardy	A
20-0307 (20-6383)	9 July 2020	Tofino	A
21-0140 (21-2739)	16 April 2021	White Rock	A
21-0195	3 May 2021	Quatsino	A
21-0566	14 August 2021	Nootka	
21-0787	30 October 2021	Tofino	F
21-0792	5 November 2021	Kyuquot	A

geographic location, and age class are presented in Table 2. Most strandings occurred along the outer coast of Vancouver Island with a preponderance of reports along the inner coast of Haida Gwaii (Figure 2); these likely reflect the regional migratory routes. Annual gray whale sightings off the British Columbia coast tend to occur between November and January, with a peak in the latter half of December. Southward migrations tend to be segregated demographically with pregnant and near-term females in the initial phase, followed by estrous females, adult males, and then immature whales of both sexes, with a similar migration pattern apparent on the northward journey (Ford, 2014).

Female gray whales attain sexual maturity at a mean of 8 y (range = 6 to 12 y; Swartz, 2018). There is a strong phenology of seasonal and synchronized mating that typically occurs within 3 wks between late November and early December *en route* or near the southern extent of the migration, in or near the calving grounds and nearshore assemblages. Late conceptions may occur in January in the southern extent of the migration route. Breeding appears promiscuous with a single estrous every 2 y (Rice & Wolman, 1971; Swartz, 2018). In some cases, however, delayed pregnancies have been inferred with possible early embryonic loss and subsequent return to estrous resulting in a secondary ovulation.

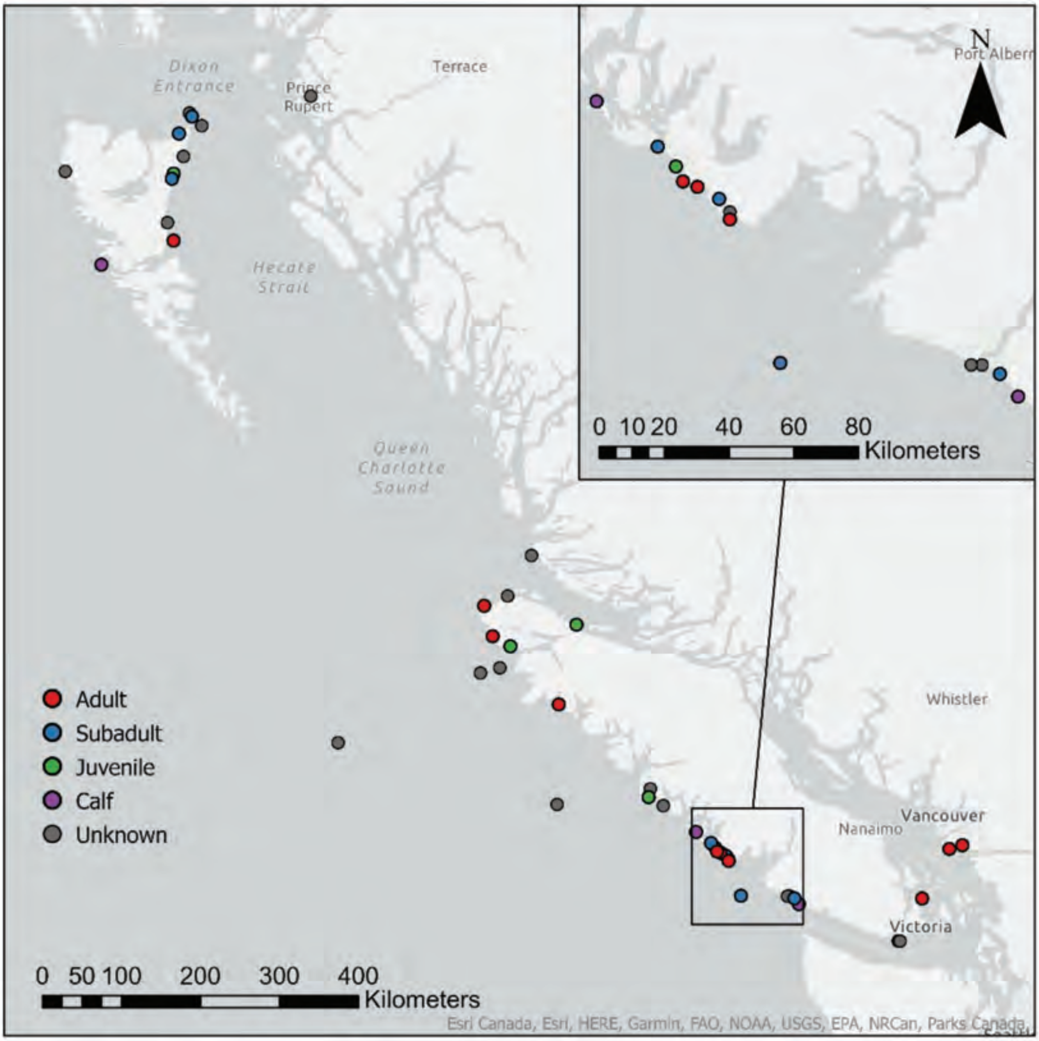

Figure 2. Map of reported gray whale strandings along the British Columbia coastline. Note the cluster of animals around Nootka Sound. The fetus stranded along the northwestern portion of Vancouver Island.

The mean gestation is 418 d but may range from 11 to 13 mo. Calving typically occurs between 26 December and 1 March (Swartz & Jones, 1983), with a peak reported in mid-January. Some variation in the calving intervals may be attributed to genetics, nutritional condition, environmental factors, intercurrent disease, and other factors.

Gestation length and fetal growth curves for gray whales have largely been derived from historic whale fisheries along the coast (Rice, 1983), live captures, and evaluation of presumed abortions, perinates, or neonates in calving lagoons (Sanchez Pacheco, 1998). When ovaries were available, the morphometric data were compared to presence and size of a *corpus luteum* (Rice, 1983), particularly when an embryo was not readily apparent on examination of the uterine contents. Copulation has been reported throughout the year; however, based on analysis of body lengths grouped by months, a mean conception date of 5 December has been cited (Rice & Wolman, 1971), which coincides with near completion of the southward migration. Early embryonic growth is completed by early March with a mean length of 10.1 cm, followed by a more accelerated, near exponential mid-gestational growth phase from June to October. In October, the mean body length of three examined fetuses was 340 cm (range: 301 to 374 cm; Zimushko & Ivashin, 1980). Some variation in growth at this stage of development was attributed to more prolonged breeding and conception intervals, possible primiparous females, intercurrent disease, suboptimal nutritional condition, females of small stature, and variation in individual development rates (Sumich et al., 2013). More gradual fetal growth has been reported between December and January with a proposed 4-wk prenatal diapause, characterized by a late gestational cessation in linear growth but increase in body mass (Rice, 1983). However, evaluation of additional mid-gestational and near-term fetuses and neonates did not substantiate this phenomenon (Sumich et al., 2013), and growth appears sustained throughout gestation. Average gray whale neonate length varies between publications and extends from 457 cm (range: 376 to 516 cm) in January, 437 cm (range: 360 to 510 cm) in February, and 444 cm (range: 354 to 540 cm) in data combined for January and February (Swartz & Jones, 1980a, 1980b; Rice, 1983; Sanchez Pacheco, 1998; Sumich et al., 2013). Past average birth lengths ranged between 4.6 and 4.7 m (Sumich et al., 2013); and in a more recent study modelling postpartum growth and development of North Pacific gray whales, mean birth length of females was 4.66 m with a SD of 0.379, and in males, it was 4.60 m with a SD of 0.305 (Agbayani et al., 2020).

Based on the stranding location, date, and morphometrics, the examined fetus was most consistent with a mid-gestational stage of development. Unfortunately, there are too few examined fetuses with a known conception time, so some variability in *in utero* growth is acknowledged. However, the total length of the examined animal was 307 cm, well below near-term or postpartum fetal lengths. The observation of vibrissae, fetal folds, patent ductus arteriosus and foreman ovale, and enterocolonic meconium were consistent with fetal development. The eyes were scavenged, and the apposition of the palpebral margins could not be assessed. However, partial aeration of the lungs and closure of the umbilical vasculature suggest that the animal had been born alive, inhaled, and succumbed shortly thereafter. The immature stage of fetal development presumably resulted in the loss of this animal.

Several threats to gray whales have been recognized and include coastal development, entanglements, entrapment, vessel or propeller strike, increased ambient noise, ocean acidification, disruption of feeding habitats, climate change, prey shifts, killer whale predation, exposure to harmful algal blooms (biotoxins), ingestion of plastic and marine litter, potential toxic or oil spills, and possible resumption of First Nations harvest (Gavrilchuk & Doniol-Valcroze, 2021). Few infectious agents have been detected in examined gray whales and include calicivirus, enterovirus, equine encephalitis (arbovirus), parapoxvirus, paramyxovirus, *Toxoplasma gondii*, *Sarcocystis* spp., multiple opportunistic and recognized pathogenic bacteria, secondary fungal involvement, numerous helminths, and ectoparasitic lice and barnacles (Stimmelmayr & Gulland, 2020). Ongoing efforts to report, recover, and conduct postmortem examinations not only provide insights into the natural history of these animals, but invaluable information on potential infectious and non-infectious disease processes that may impact individual and population health.

The migratory and reproductive strategies of gray whales are closely linked with active foraging in highly productive regions in Alaska during the summer and prolonged migration to southern breeding and calving grounds (Rice, 1983). The recovery of this fetus along the west coast of Vancouver Island coincided with the early stages of the southward migration from summering feeding grounds in Alaska to the calving lagoons along the coasts of California and Mexico. With the recent decline in annual calf recruitment through the gray whale UME, recovery and thorough examination of fetuses and perinates may provide valuable insights into potential infectious and non-infectious processes that may contribute to the overall decline of the eastern gray whale population.

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Aversive Response of Grey (*Halichoerus grypus*) and Harbour (*Phoca vitulina*) Seals Exposed to Camphor: A New Approach to Keep Seals Away from Sensitive Areas?

Sylvia Campagna,[1, 2] Kirstin Anderson Hansen,[3, 4]
Magnus Wahlberg,[3, 4] and Aurélie Célérier[1]

[1]*CEFE, Université Montpellier, CNRS, EPHE, IRD, Université Paul Valéry Montpellier 3, Montpellier, France*
E-mail: sylvia.campagna@cefe.cnrs.fr
[2]*University of Nîmes, Rue du Dr G. Salan, 30021, Nîmes Cedex 1, France*
[3]*Department of Biology, University of Southern Denmark, Campusvej 55, 5230 Odense M, Denmark*
[4]*Fjord&Bælt, Margrethes Plads 1, 5300 Kerteminde, Denmark*

Pinnipeds are semi-aquatic mammals that face a constantly changing environment as they move from land to water. Such an amphibious lifestyle has required specific physiological adaptations—for example, in their sensory systems: visual, acoustic, tactile, and chemical (olfactory and gustatory) modes. Their gustatory system has not been studied in detail, so little is known about their chemoreception abilities. Still, some information is available; in comparison to terrestrial mammals, pinnipeds have a reduced number of taste buds, suggesting a limited sense of taste (Kastelein et al., 1997; Yoshimura & Kobayashi, 1997). The ability to detect acidic and salty solutions has been demonstrated in Steller sea lions (*Eumetopias jubatus*; Kuznetsov, 1982) and California sea lions (*Zalophus californianus*; Friedl et al., 1990), and both species did not respond to sweet tastes. Indeed, the TAS1R2 and TAS1R3 genes encoding the sweet taste receptors are not functional, at least in several species of pinnipeds (Jiang et al., 2012; Wolsan & Sato, 2020), including nine species of phocids and six species of otariids (Wolsan & Sato, 2020). The umami taste receptors were also found to be pseudogenized (Jiang et al., 2012; Wolsan & Sato, 2020). Although the gustatory abilities of pinnipeds appear limited, a high sensitivity to slight differences of salt concentration has been demonstrated in harbour seals (*Phoca vitulina*). As salinity levels represent a potential source of information for orientation in marine environments, sensitivity to salt could be involved in fine-scale underwater movements (Sticken & Dehnhardt, 2000).

Pinnipeds also have a generally reduced olfactory apparatus in comparison with their terrestrial relatives (Harrison & Kooyman, 1968; Van Valkenburgh et al., 2011; Bird et al., 2020). Both peripheral (Kuzin & Sobolevsky, 1976) and central (Harrison & Kooyman, 1968) olfactory structures are present, and much more prominently so in Otariidae compared to the Phocidae and Odobenidae (Harrison & Kooyman, 1968; Reynolds & Rommel, 1999). Pinnipeds employ odours in different social interactions (Lowell & Flanigan, 1980; Insley et al., 2003), especially in mother–pup recognition (Pitcher et al., 2011) as part of a multimodal process that includes vocalizations and visual cues. However, mother Australian sea lions (*Neophoca palatina*) are able to recognize their pups based solely on scent (Pitcher et al., 2011). Several studies in captivity have shown that South African fur seals (*Arctocephalus pusillus*) can differentiate artificial odours (Laska et al., 2008, 2010). Captive California sea lions were also able to discriminate between different odours (social and non-social odours), both in the air and underwater (Brochon et al., 2021). In phocids, behavioural experiments conducted on harbour seals demonstrated that they were able to respond to familiar and unfamiliar odour (fish and eucalyptus, respectively) and were highly sensitive to dimethyl sulphide, a chemical compound released in productive marine areas (Kowalewsky et al., 2006). Furthermore, genetic evidence indicated that pinnipeds still retain large numbers of functional olfactory receptor genes, although the number is lower than in their related terrestrial mammals (Liu et al., 2019).

Despite the scant available literature on chemoreception in pinnipeds, it appears that all studies so far have focused on few species (mainly otariids) among the 34 extant species. This is probably explained by the availability of the studied species in human care and/or their better accessibility in the wild. In phocids, data on chemosensory perception are only available for harbour seals (Sticken & Dehnhardt, 2000; Kowalewsky et al., 2006).

A preliminary study on phocid abilities to perceive and behaviourally react to chemicals was started, focusing on species with very little data available such as grey seals (*Halichoerus grypus*). Similar trials were conducted in similar environments and at the same time with harbour seals. Comparing these two sympatric species that share similar diets (Brown et al., 2012) but display different patterns of social interactions should provide clues about whether their chemical sensory perception(s) are the same or not.

During the development phase of this project, several chemical compounds were tested as well as different methods of presentation. Observations were made on one adult male grey seal at the University of Southern Denmark's Marine Biological Research Center and one adult female harbour seal at Fjord&Bælt (Kerteminde, Denmark). All seals were born in human care. All individuals had a long history in training for various research projects but had never before experienced olfactory trials. In one trial, one drop of organic, pure camphor essential oil (Thibène, France) was directly deposited onto a sterile cotton gauze (Mercurochrome, Paris, France) and presented to the male grey seal (see Supplemental Video 1; the supplemental video for this paper is available in the "Supplemental Material" section of the *Aquatic Mammals* website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147) and the female harbour seal (data not shown). Similar experiments were carried out, but the cotton gauze with camphor was inserted into an iron tea ball infuser or in a plastic box with holes to avoid any direct contact with the odour source. All trials were conducted during daily training sessions in which the individuals were asked to touch their nose to a target stick.

Camphor is a naturally occurring compound extracted from the wood of a camphor laurel tree (*Cinnamomum camphora*). It is widely used in human health as a nasal decongestant and cough suppressant (Burrow et al., 1983), and also as a topical analgesic (Burkhart & Burkhart, 2003).

When camphor was presented directly on a cotton gauze, the grey seal started to behaviourally react as soon as the bottle of camphor essential oil was opened by shaking his head with an open mouth while the experimenter was standing a few meters away. Head shaking could be regarded as a response to aversive or disturbing stimuli as observed in birds after being exposed to deterrent food (Skelhorn & Rowe, 2009) or noxious odours (Burne & Rogers, 1996). An even stronger aversive behaviour was monitored when the seal was closer to the chemical source (Supplemental Video 1). The animal moved back, chewed, and refused the primary reinforcement (i.e., fish). The vacuum "chewing" behaviour (i.e., chewing with nothing in the mouth) has been described in horses as a possible displacement activity performed in stressful situations (Scopa et al., 2018). The trial was then immediately ended to avoid stressing the animal further. The same experiment was carried out with a female harbour seal (data not shown). When the camphor was presented for the first time, her spontaneous behaviour was slightly different compared with the male grey seal: the harbour seal chewed several times but did not move away or shake her head.

After these initial responses, new testing was done two days later, with the cotton pad soaked with camphor inserted into an iron tea ball diffuser to avoid seal whiskers or the nose from touching the compound directly. In this set-up, the male grey seal still displayed aversive behaviour when exposed to the camphor stimulus, but it was less intense and only repeated mouth openings were recorded (data not shown). However, a new behaviour was documented as the male started to vocalize just after the removal of the diffuser. Camphor was also presented to the harbour seal, and her chewing behaviour was again observed; however, after seven close approaches to the camphor, this seal moved back and spontaneously dove into the pool. Trials using camphor were then stopped in agreement with the trainers to not stress these seals nor impact their usual training, which is based on positive reinforcement. Interestingly, no aversive behaviour was observed when grey and harbour seals were exposed to another unfamiliar chemical (lavender essential oil) suggesting that the observed responses to camphor were probably not a neophobic reaction. Camphor appears then to be a possible repellent compound for these two phocids, or at least for these two individual animals. In a recent study on odour discrimination in captive California sea lions, camphor was included in the different chemical stimuli following our suggestion (Brochon et al., 2021). In this otariid, camphor was not a powerful repellent by itself, but it had a negative effect when paired with an attractive food odour. Indeed, the animals displayed a reduced response to a fish odour when a camphor odour was added (Brochon et al., 2021).

To our knowledge, camphor has been shown to act as a repellent in at least two species of mammal: (1) snowshoe hares (*Lepus americanus*; Sinclair et al., 1988) and (2) common voles (*Microtus arvalis*; Schlötelburg et al., 2019). Camphor is also a known repellent in many insects such as anopheles (Asadollahi et al., 2019). Although the scent of camphor is mediated by odorant receptors (Sicard, 1985), camphor also has other, less understood, sensory properties; for example, camphor was able to potentiate the perceived intensity of both hot and cold stimuli when applied on hairy skin (Green, 1990). Interestingly, camphor has been shown to interact with several transient receptor potential (TRP) ion channels in mammals (Moqrich et al., 2005) such as TRPV3. Mammalian TRP genes are involved in trigeminal nociception and in an animal's ability to detect their environment through thermosensation, mechanosensation, and gustation (Clapham, 2003; Montell, 2005). Several members of the TRPV subfamily (V1 to V4), as well as TRPM8 and ankyrin-repeat TRP 1 (TRPA1), are important in temperature detection (thermoTRPs) (Patapoutian et al., 2003). All thermos-TRP channels are apparently also chemosensitive, potentially enabling these channels to detect multiple sensory modalities. For example, TRPV1 is stimulated by capsaicin, TRPM8 is sensitive to menthol, and TRPA1 can be activated by mustard and cinnamon oil (Patapoutian et al., 2003). The slight "burning" sensation of camphor application to the skin (Green, 1990) is, therefore, consistent with its activation of TRPV3 (Moqrich et al., 2005).

The observed strong aversive behaviour by these two seals in a direct presentation of camphor could be related to a repellent feature of the compound itself or via activation of some TRP channels, possibly through contact with the whiskers and nose skin. Indeed, several TRP channels have been shown to be present in the whisker pad skin of the rodent TRPV1 channel in trigeminal ganglions (Shinoda et al., 2011; Ando et al., 2020). Since pinnipeds have 10 times more nerve endings around their vibrissal follicles than terrestrial mammals (Marshall et al., 2006; Hyvärinen et al., 2009), it cannot be excluded that contact with pure camphor essential oil could have triggered a strong and noxious trigeminal excitation. When the camphor was presented to seals using a plastic box with holes or an iron tea ball diffuser, the grey seal behaviour was more moderate; this could be explained by the container diffusing the odour, by potential habituation to the camphor, or by a less effective stimulation of trigeminal neurons.

Overall, the female harbour seal's reaction to camphor appeared less pronounced compared to the grey seal, but it cannot be ruled out, given a sample size of two animals, whether sensitivity to camphor might have been related to sex. Also, a species effect is not possible to rule out. Unfortunately, it was not possible to further investigate the reaction to camphor by replicating the trials and involving more individuals due to potential stress on the seals.

Considering the previous findings, the use of camphor as a natural chemical deterrent of seals in sensitive areas seems both achievable and reasonably adaptable given the easy production of camphor. Moreover, camphor is highly volatile and has been detected up to 800 m from its source (Müller et al., 2004). Ballard Locks in Salmon Bay (Seattle, USA) is, for example, a sensitive area as the locks create a migration bottleneck for salmon returning to their spawning grounds, enhancing predation by seals in this area. Acoustic deterrent devices have been widely used to prevent pinniped predation (reviewed in Götz & Janik, 2013), but several concerns have been raised, including lack of long-term efficiency and possible hearing damage to animals (Findlay et al., 2021). The combined use of acoustic and chemical stimuli may offer a solution by decreasing sound exposure and potentially limiting the habituation of seals.

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Observations of Adult–Calf Nonreproductive Copulatory Behavior in North Atlantic Right Whales (*Eubalaena glacialis*)

Gina L. Lonati,[1] Natasha J. Hynes,[1,2] Kelsey R. Howe,[3]
Delphine Durette-Morin,[2,4] Moira W. Brown,[2] and Kimberley T. A. Davies[1]

[1]*University of New Brunswick Saint John, Department of Biological Sciences,*
100 Tucker Park Road, Saint John, NB E2K 5E2, Canada
E-mail: gina.lonati@unb.ca
[2]*Canadian Whale Institute, 16 Herring Cove Road, Welshpool, NB E5E 1B6, Canada*
[3]*Anderson Cabot Center for Ocean Life, New England Aquarium, 1 Central Wharf, Boston, MA 02110, USA*
[4]*Dalhousie University, Department of Oceanography, 1355 Oxford Street, Halifax, NS B3H 4R2, Canada*

Nonreproductive copulatory behavior (NCB; also called nonreproductive, nonprocreative, nonconceptive, or socio-sexual behavior) refers to animals engaging in sexual behavior without the possibility of reproduction. This type of behavior includes interactions among same-sex, adult–immature, immature–immature, or interspecies individuals, as well as sexual activity that occurs outside of the conceptive season (reviewed in Bagemihl, 1999; Furuichi et al., 2014). NCBs, such as penile erection in the presence of conspecifics, genital-to-genital contact, or genital manipulation using various body parts, have been reported for several taxonomic groups, particularly primates (Bagemihl, 1999; Brown & Dixson, 2000; Sommer & Vasey, 2006; Li et al., 2007; Bailey & Zuk, 2009; Furuichi et al., 2014; Grueter & Stoinski, 2016). These behaviors may establish and strengthen social bonds or express dominance and could therefore be associated with complex social structures and intelligence (Sommer & Vasey, 2006; Bailey & Zuk, 2009; Furuichi et al., 2014). Alternatively, NCB may be a form of self-satisfaction, play, or practice for future procreation (Bailey & Zuk, 2009; Balcombe, 2009; Furuichi et al., 2014), or it may be maladaptive (Bailey & Zuk, 2009). These theories are not all mutually exclusive, and some or all may explain why these behaviors occur during a particular encounter within a particular species.

In Odontoceti, cases of same-sex, adult–calf, and interspecies copulatory behaviors have been reported for several small species that are capable of being observed in captivity or are relatively accessible in the wild (Spotte, 1967; Bagemihl, 1999; Mann, 2006; Xian et al., 2010; Hill et al., 2015; Harvey et al., 2017; Lilley et al., 2020; Serres et al., 2021). In Mysticeti, however, fewer cases of NCB have been documented. Specifically, four mysticete species—bowhead whales (*Balaena mysticetus*), gray whales (*Eschrichtius robustus*), humpback whales (*Megaptera novaeangliae*), and southern right whales (*Eubalaena australis*)—are known to engage in same-sex and adult–immature sexual behaviors (Rice, 1983; Würsig et al., 1993; Bagemihl, 1999; Pack et al., 2002; Sironi, 2004; D'Agostino et al., 2017). The first case of NCB between a mysticete adult and calf was documented in 2015 when researchers in Golfo San José off Península Valdes, Argentina, observed an adult male southern right whale pursuing a mother–calf pair (D'Agostino et al., 2017). During the pursuit, the calf became separated from its mother, at which point the male assumed a ventrum-up posture underneath the calf, positioning the calf between his flippers. Underwater video from a GoPro™ captured the male inserting his penis into the calf's genital slit (D'Agostino et al., 2017).

Similar to southern right whales, critically endangered North Atlantic right whales (*Eubalaena glacialis*, NARWs) engage in a promiscuous mating system in which individuals can have multiple mates (Brownell & Ralls, 1986; Kraus & Hatch, 2001; Kraus et al., 2007). Currently, the NARW species' sex ratio may be slightly male biased at approximately 3:2 (Hamilton et al., 2021), and while estimates of age at sexual maturity range between 5 to 21 y (average 9 y) for females and 10 to 15 y for males, it is likely females and males reach sexual maturity at similar ages (Frasier et al., 2007; Kraus et al., 2007). Observable mating behaviors take place in surface active groups (SAGs), defined as two or more whales at the surface less than one body length apart, with frequent physical contact (Kraus & Hatch, 2001; Kraus et al., 2007; Parks et al., 2007). A focal female will often roll, invert (i.e., flip ventrum-up), or swim horizontally during a SAG, presumably to select the strongest, fittest, most agile mate. Meanwhile, males will jockey for what is called the "alpha" position closest to the female for a chance at copulation when she rolls upright. They will often place one or both flippers on her to maintain their position and possibly detect or predict her movements (Kraus & Hatch, 2001).

Advancements in aerial imagery via remotely piloted aircraft systems (RPAS; commonly called drones) have allowed for more photo-documentation of free-swimming large whales *in situ* (Torres et al., 2018; Fiori et al., 2020; Orbach et al., 2020). Herein, we present two cases of adult–calf NCB in NARWs, both recorded using RPAS in the Shediac Valley in the southwestern Gulf of St. Lawrence (GSL), Canada. Observation #1 was made by colleagues (N. Hawkins & A. Tapia, Nick Hawkins Photography) on 26 July 2020 from the R/V *Calanus* and included an adult male, a female calf, and the calf's mother. Observation #2 was made on 18 July 2021 during a NARW research expedition on the F/V *Jean-Denis Martin* and included an adult male and a presumed female calf. Both observations were opportunistic—that is, not the focus of the RPAS flights. After reviewing these videos, we consulted the literature and NARW behavioral experts (P. Hamilton & A. Knowlton, New England Aquarium; M. Moore, Woods Hole Oceanographic Institution; S. Parks, Syracuse University) to help characterize both observations.

Observation #1 – 26 July 2020

At ~1300 h ADT, three NARWs were observed exhibiting SAG-like behavior at 47.7308° N, -64.0519° W. An Inspire 2 RPAS (DJI, Shenzhen, China) carrying a DJI Zenmuse X7 visible-spectrum camera (4K video at 4,096 × 2,160 pixel resolution) with a circular polarizing filter was launched. The RPAS provided live-stream, first-person-view video to the pilot. At first, the RPAS flew directly over two NARWs that were later photo-identified as NARW Catalog #1429 (a 38-y-old adult male) and the 2020 female calf of NARW Catalog #2642 (a 24-y-old adult female).

Between 1305 and 1314 h, RPAS video was recorded (Supplemental Video 1, timestamps 00:05 to 07:10; the supplemental video for this paper is available in the "Supplemental Material" section of the *Aquatic Mammals* website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147). Initially, #1429 was observed ventrum-up and aligned head-to-head and ventrum-to-ventrum with the calf, with his flippers positioned on either side of the calf. This posture resembled that of the male southern right whale reported in D'Agostino et al. (2017) and was similar to a behavior sometimes observed between mothers and their calves called "cradling" (Zani & Hamilton, 2017). Since subsurface water visibility was poor and the dark coloration of #1429's ventrum provided poor contrast, we were unable to observe the adult male's genitalia and thoroughly assess his subsurface behaviors and positions. Occasionally, #1429 rolled upright and separated from the calf to breathe; at this point the calf inverted or rolled with its dorsum toward #1429 (e.g., timestamps 01:18 to 01:34 and 02:54 to 04:02). The calf also performed two tail slashes (i.e., lateral movements of the tail) near #1429 when both whales were upright (i.e., dorsum-up) at the surface (timestamps 01:03 to 01:21).

At 1309 h, #2642 ascended from beneath #1429 and began swimming around her calf at the surface (timestamp 04:20). When #1429 resumed a ventrum-up, cradling-like position beneath the calf, #2642 turned and swam toward the calf's right midsection (timestamp 05:06). Then, #2642 appeared to push her calf off #1429 with her rostrum and chin (timestamp 05:18). The calf remained mostly upright during this time. At 1311 h, #2642 and her calf swam away from #1429 together.

At 1313 h, during a separate video from the same RPAS flight, #1429 was observed ventrum-up underneath the upright calf once more (timestamp 05:51). The mother pushed her calf off #1429 again, causing the calf to roll ventrum-up (timestamps 06:00 to 06:38; Figure 1). The calf remained in this position for ~30 s while #1429 surfaced upright and the mother performed a ~15 s dive. The pilot terminated the video shortly thereafter and flew the RPAS back to the vessel due to low battery.

In total, 7 min of RPAS video at an altitude of ~20 m was recorded of these three whales. Post-flight behavioral observations were not conducted. #1429 was observed on three other occasions between 20 June and 31 July 2020, and in each sighting, he was alone. In this same time period, the mother–calf pair was observed seven times. Specifically, on 23 July 2020, #2642 and her calf were observed in a SAG with another adult female and adult male. Later that day, the Aerial Survey Team from Fisheries and Oceans Canada (DFO) sighted the calf of #2642 with a 6-y-old juvenile male (NARW Catalog #4446). The male was photographed in a ventrum-up, cradling-like position beneath the calf, and #2642 was also observed interacting with the two whales. NCB could not be confirmed as the male's genital area was not visible from the plane. The other five sightings were of #2642 and her calf by themselves.

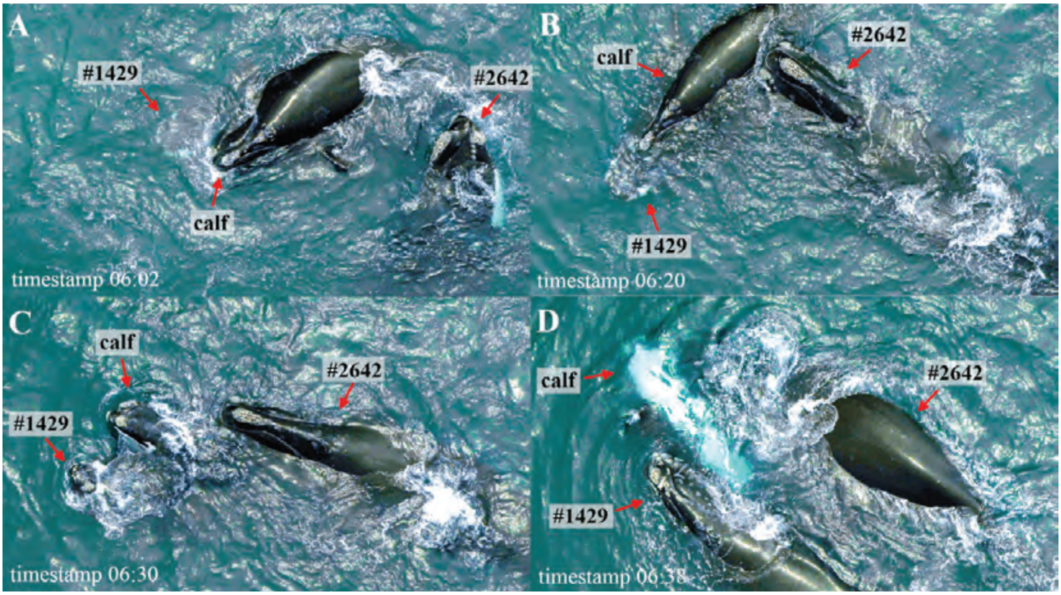

Figure 1. A series of video still images (Supplemental Video 1, timestamps 06:02 to 06:38) taken with a remotely piloted aircraft system (RPAS)-mounted camera at 1313 h on 26 July 2020 in the Gulf of St. Lawrence, Canada, of three North Atlantic right whales (*Eubalaena glacialis*, NARWs)—an adult female (#2642), her 2020 calf, and an adult male (#1429): (A) #1429 was submerged in a ventrum-up, cradling-like position underneath the calf and #2642 was turning toward her calf; (B) #2642 contacted the left mid-section of her calf with her rostrum as she swam forward and over #1429; (C) the calf rolled sideways off #1429 as #2642 continued to push the calf with her chin; and (D) the calf (white belly) inverted as #1429 surfaced and #2642 began to dive. (Photos provided by Nick Hawkins Photography)

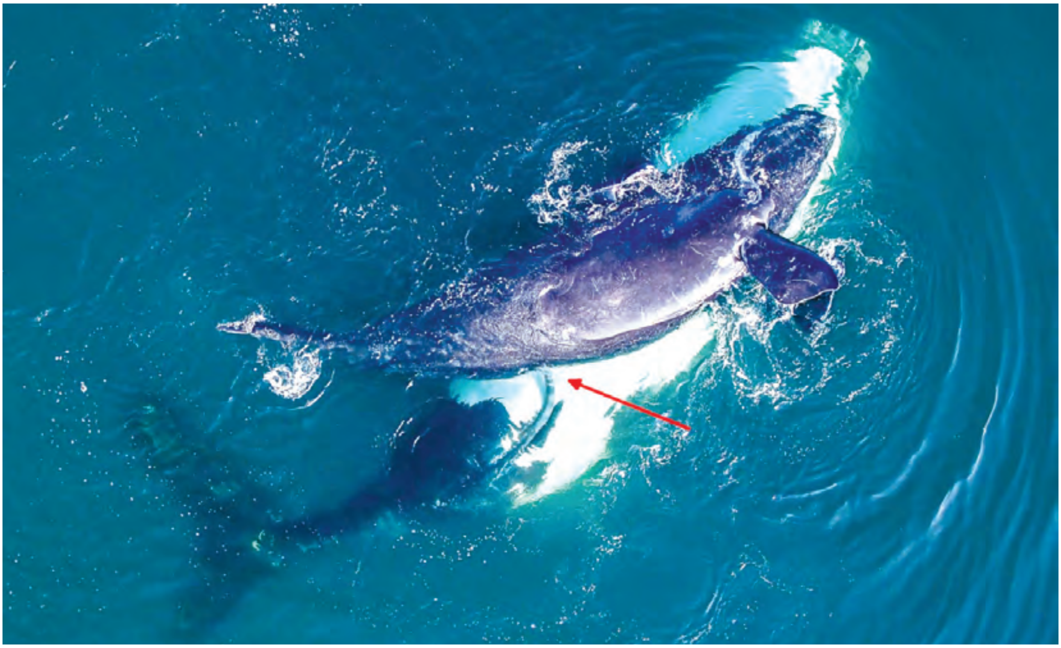

Figure 2. Photograph captured by an RPAS-mounted camera at 0836 h on 18 July 2021 in the Gulf of St. Lawrence, Canada, showing likely intromission (red arrow) between an adult male NARW (#3442, ventrum-up, white belly) and the 2021 presumed female calf (rolled right side up) of #3720 (*Photo credit:* Gina Lonati, University of New Brunswick Saint John)

Observation #2 – 18 July 2021

At 0736 h ADT, a NARW mother–calf pair was sighted at 47.9054° N, -63.9348° W and identified in real time as NARW Catalog #3720 (a 14-y-old adult female) and her 2021 calf, her first known offspring. Based on genital morphology that was partially observed that day, the calf was presumed female, with confirmation pending from molecular sexing analyses (Frasier et al., 2006).

The vessel approached the pair to facilitate photo-identification and visual health assessment. At 0833 h, a DJI Matrice 210 V2 RPAS was launched. The RPAS carried a DJI Zenmuse XT2 for collecting simultaneous long-wave thermal infrared video and visible-spectrum video (12 megapixels, 4K Ultra HD), a PEN E-PM2 camera (Olympus, Tokyo, Japan) for collecting visible-spectrum photographs (16.1 megapixels), and a laser altimeter (modified from Dawson et al., 2017). The RPAS provided live-stream, first-person-view video to the pilot. For the purposes of this paper, we only reviewed visible-spectrum imagery.

Between 0834 and 0847 h, continuous video (Supplemental Video 1, timestamps 07:11 to 20:06) and sequential still images (at 1 Hz) were collected with the RPAS. At first, the calf was observed rolling laterally at the surface with its right side up; the white ventrum of a larger NARW was present underneath it. Initially, we thought the larger whale was #3720 cradling her calf; however, once the RPAS was directly overhead, the male genitalia of the larger whale could be seen. Visibility was facilitated by very light winds (1 to 3 kts), low wave heights (< 0.2 m), and contrast between the whale's gray penis and white ventrum. The larger whale was later identified as NARW Catalog #3442, a 17-y-old male.

For ~10 min, #3442 and #3720's calf interacted at the surface. Specifically, #3442 was aligned head-to-head and ventrum-to-ventrum with the calf and had his flippers positioned vertically on either side of the calf, resembling #1429 from Observation #1. He also appeared to probe the calf's genital region with his extended penis underwater. Meanwhile, the calf rolled, thrashed side to side, and arched often at the surface. Occasionally, #3442 surfaced to breathe, but then returned to a ventrum-up, cradling-like position beneath the calf. Intromission could not be confirmed, although we suspect it occurred for a maximum of 1 min, 15 s between 0835 and 0836 h (timestamps 07:55 to 09:10; Figure 2). Near the end of this suspected intromission, the calf defecated (timestamp 09:05) and then rolled away from the adult.

Starting at 0844 h (timestamp 16:25), #3442 rolled upright to breathe, and the calf rolled laterally and swam in a clockwise circle. As the calf's head neared the peduncle of #3442, the adult male performed a horizontal tail slash that nearly contacted the calf's head (timestamp 16:55). The adult male performed another tail slash ~8 s later as he turned and swam away from the calf. We continued to record RPAS video of #3442 for 3 min as he swam subsurface. At 0847 h, the pilot terminated the video and flew the RPAS back to the vessel due to low battery.

In total, the flight lasted 16.5 min, during which ~13 min of video and 427 still images were collected. Altitude above the two whales ranged from 13 to 36 m. The calf's mother was not observed from the RPAS, and observations of post-flight behaviors were not conducted. This mother–calf pair was not sighted for the remainder of the summer. However, #3442 was observed the following day (19 July 2021) in a SAG, which included one adult female, three adult males, one juvenile female, and one juvenile male. #3442 was also observed on 16 August 2021 engaging in a SAG with one other adult male. In RPAS videos of both of these SAGs, #3442's extended penis was often visible.

Interpretations and Discussion

Observations of copulatory behavior in wild cetaceans are rare because mating activity usually occurs underwater. However, NARWs regularly engage in copulatory behaviors near the surface, which offers a unique opportunity to study the sexual behaviors of this species. Our observations represent the first documented cases of adult–calf NCB in NARWs, and, to the best of our knowledge, they are the first RPAS-based observations of these behaviors in any cetacean (but see Orbach et al., 2020, for the use of RPAS to study mating patterns in free-ranging dolphins). The RPAS provided a useful, minimally invasive vantage point to collect minutes-long, high-resolution video of these near-surface behaviors, specifically allowing us to observe the genitalia of one of the males underwater, which would not have been possible from a vessel.

There are many theories, both adaptive and maladaptive, to explain the prevalence of NCBs in nature (summarized in Bailey & Zuk, 2009); therefore, we can only speculate about this behavior in NARWs and other mysticetes. For example, it could be important for immature individuals to learn successful mating behaviors (Sironi, 2004; Mann, 2006; Furuichi et al., 2014). Both calves in the cases presented here exhibited a lot of rolling, and the calf of #2642 maintained a ventrum-up posture for up to 30 s at a time, possibly trying to invert as adult females do in SAGs to incite male competition for access to their genital area (Kraus & Hatch, 2001). Right whale calves are also known to engage in "play" behaviors (e.g., rolling, turning, touching) with their mothers, which may help calves develop motor skills and coordination for future socializing, mating, and feeding (Thomas & Taber, 1984). Therefore, adult–calf NCB may also be a form of play that facilitates calf development. In addition, these interactions may establish or strengthen social bonds as Mann (2006) hypothesized for bottlenose dolphins (*Tursiops truncatus*). This could be especially important for species that live in vast aquatic environments where establishing and maintaining connections between conspecifics is difficult. Furthermore, NCB could be a means of self-satisfaction, although we could not confirm whether ejaculation took place in either case presented here, and we have no way of knowing any of the whales' physiological responses (e.g., sexual arousal) to these interactions.

Alternatively, it is possible that NCBs do not serve to benefit the population or are aberrant. It may simply be a case of mistaken identity or an indicator of the species' small population size. With only 336 NARWs estimated to remain in 2020 and only ~20% of those being adult females (Pettis et al., 2022), there is some support for the "mate deprivation hypothesis," which states that males with limited access to females may exhibit more forced or deviant copulatory behavior (Thornhill & Thornhill, 1983, 1992; Lalumière et al., 1996; Haddad et al., 2015). Ultimately, NARW reproductive rates have declined in the last decade due to increased anthropogenic stressors and a declining and shifting food source (Meyer-Gutbrod et al., 2015, 2021; Pettis et al., 2017; van der Hoop et al., 2017; Moore et al., 2021; Stewart et al., 2021), and the connection between NCBs and successful or unsuccessful reproduction—if any—remains poorly understood.

While reviewing these videos, we questioned whether the calves were being harassed by the adult males, and, in the case of #2642, if the mother was trying to protect her calf by separating it from #1429. Such speculations, however, would be largely based on an assumption that the males' sexual advances were unwanted, unsolicited, or harmful to the calves. Currently, we do not have sufficient insight into the behavioural biology of this species to know whether NCB is beneficial or detrimental to calves.

In summary, these two observations represent the first documented cases of adult–calf NCB in NARWs. While we do not know the frequency or purpose(s) of these interactions among right whales, further observations of whales with RPAS will provide more insight. Without the ability to observe postures and genitalia underwater, researchers on vessels and land could easily overlook or misidentify these behaviors, especially given the resemblance to mother–calf cradling (Zani & Hamilton, 2017). RPAS technology offers a unique opportunity to study and interpret the behavioral ecology and reproductive strategies of these large, cryptic animals (Torres et al., 2018; Fiori et al., 2020; Orbach et al., 2020).

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Epimeletic Behavior in Bottlenose Dolphins (*Tursiops truncatus*) in the South of Portugal: Underwater and Aerial Perspectives

Joana Castro,[1, 2] Joana M. Oliveira,[1] Guilherme Estrela,[1]
André Cid,[1] and Alicia Quirin[1]

[1]*AIMM – Associação para a Investigação do Meio Marinho,*
Rua Maestro Fred. Freitas N15-1, 1500-399 Lisboa, Portugal
E-mail: jmadeiracastro@gmail.com
[2]*MARE – Marine and Environmental Sciences Centre, Faculdade de Ciências*
da Universidade de Lisboa, Campo Grande, 1749-016 Lisboa, Portugal

Numerous species of cetaceans are known to engage in epimeletic (caregiving) behavior towards injured or distressed conspecifics (Harzen & dos Santos, 1992; Howells et al., 2009; Bearzi et al., 2018). This behavior refers to the help given by one or more healthy individuals towards a sick, injured, or dead individual (Caldwell & Caldwell, 1966; Bearzi et al., 2017) and can be directed towards adults, designated as "succorant," or towards infants, designated as "nurturant" (Caldwell & Caldwell, 1966). Caldwell & Caldwell (1966) divided succorant behavior into three broad categories: (1) *standing by* (where despite not directly aiding the distressed animal, healthy individuals stay with it, even if it entails remaining in a dangerous area), (2) *excitement* (where companions of the afflicted individual appear extremely disturbed as well and may attempt to protect it from a perceived source of danger), and (3) *supporting* (where the struggling mammal is directly assisted by the succorants, who support it at the surface to breathe). Reports of succorant behavior are uncommon, albeit existent for both wild and captive cetaceans (Kuczaj et al., 2015). On the other hand, nurturant behavior, typically provided by adult females, appears to be more commonly observed in cetaceans (Cockcroft & Sauer, 1990).

Epimeletic care is usually provided to live, struggling conspecifics and is considered adaptive because it may determine the animal's survival (Harzen & dos Santos, 1992; Dudzinski et al., 2003). However, it is sometimes extended to perished animals and, therefore, appears maladaptive (Bearzi et al., 2017). Several reports document adult females carrying deceased, sometimes even decomposing, calves (Fertl & Schiro, 1994). The persistence of this behavior for long periods of time can result in high energetic expenditure, which can lead them to linger behind the rest of the pod and spend less time foraging and socializing, as reported in killer whales (*Orcinus orca*) by Shedd et al. (2021). Additionally, disease transmission from the cadaver poses a risk for the carrier's health (Bearzi et al., 2017).

Common bottlenose dolphins (*Tursiops truncatus*) display one of the highest rates of reported epimeletic behavior among cetacean species (Reggente et al., 2018; Pedrazzi et al., 2022), and the genus *Tursiops* is second only to the genus *Sousa* in the frequency of recorded behavior directed towards dead conspecifics (Bearzi et al., 2018). The amount of observations is likely influenced by the sporadic nature of these events combined with the higher accessibility to study more abundant and widely distributed species, such as bottlenose dolphins, relative to others (Bearzi et al., 2017). Epimeletic behavior also appears to be correlated with their comparatively higher encephalization quotient (Bearzi et al., 2018). Indeed, epimeletic care reflects a high degree of sociality (Pilleri, 1971, as cited in Bearzi et al., 2018), which has been associated with intelligence in cetaceans (Fox et al., 2017).

In this paper, we describe an opportunistic observation of both types of epimeletic behavior in wild common bottlenose dolphins off the Algarve, Portugal. Nurturant behavior by an adult female towards a dead calf, presumably its offspring, and apparent succorant behavior from other adult dolphins towards the distressed female were recorded through direct observation and documented with photographs as well as underwater and aerial footage. We aim to contribute new evidence towards epimeletic behavior in *Tursiops truncatus*.

On 11 November 2021, a field survey was conducted by the Associação para a Investigação do Meio Marinho (AIMM) research team off the south coast of mainland Portugal. The survey was conducted on board the research vessel *Ketos*, a 6.7-m-long rigid hull inflatable boat powered by a single 135 hp outboard engine, from 1018 to 1527 h, lasting 5 h 9 min. At around 1215 h, a group of bottlenose dolphins (*Tursiops truncatus*) was sighted 12.6 km from the coast of Albufeira in an area with a depth of 295 m (Figure 1). This group was composed of 50 to 60 individuals and contained adults, juveniles, and calves. The sighting lasted 1 h 12 min.

During the sighting, an adult dolphin was observed carrying a deceased calf (Figure 2A-C), and several other adults were present during the event. Digital single-lens reflex (DSLR) cameras paired with telephoto lenses were used to obtain photographs, including dorsal fin photographs for individual identification. A waterproof VIZU Extreme X6S camera was used to record underwater footage from the boat. A Mavic 2 Pro Unmanned Aerial Vehicle (UAV) equipped with a Hasselblad digital camera (1" CMOS sensor, 4K: 3,840 × 2,160 24/25/30p) and paired with a tablet was used to collect aerial video footage (video footage for this paper is available in the "Supplemental Material" section of the *Aquatic Mammals* website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147). Underwater and aerial footage were analyzed *post hoc* using *VLC media player*. We used a still image taken from the UAV footage to measure the calf's body length in relation to the length of the female displaying nurturant behavior. This female was assumed to be 2.5 m long as compared with female bottlenose dolphins in the northern Atlantic (Mead & Potter, 1990).

According to definitions in Bearzi et al. (2018), the carrier dolphin is hereby referred to as "postmortem attender" (PA), and the individuals that remained in the same area as the PA are referred to as "bystanders." The PA was manipulating the carcass, constantly maneuvering around it, lagging behind the main group. However, at least seven other adult dolphins were observed in close proximity (mostly ≤ 10 m) to the PA.

A total of 1,056 photographs, 17:12 min of aerial video footage, and 03:53 min of underwater footage were collected. We selected the relevant footage, excluding the segments during which the PA was not visible, and thus analyzed 06:40 min of aerial footage (38.8% of the total) and 02:21 min of underwater footage (60.5% of the total). The individuals involved in the event were identified through photo-identification using photographs taken from the boat. Although analysis of the aerial and underwater videos did not allow us to track the individuals associated with the PA throughout the footage, we were able to determine the sex of four dolphins involved through photographs of their genital area. The PA was identified as a female with a distended abdominal area (Figure 3A & B). The dead calf was identified as male (Figure 4A) with a body length estimated at 117.5 cm. The carcass was not visibly decomposed and exhibited moderate scarring in the form of tooth rake marks laterally and ventrally around its pectoral fins (Figure 4A & B). It displayed fetal folds (Figure 4C), had no erupted teeth, and the rostral whiskers were no longer visible (Figure 4D). Finally, two of the seven bystanders were identified as adult males.

The behavior of the group was continuously monitored during the sighting. The majority of the group was traveling and socializing (based on Castro et al., 2021). On the other hand, the PA spent most of the time directly interacting with the calf's body, carrying it with the rostrum and/or head both at the surface and during dives (Figure 2B & C). When surfacing

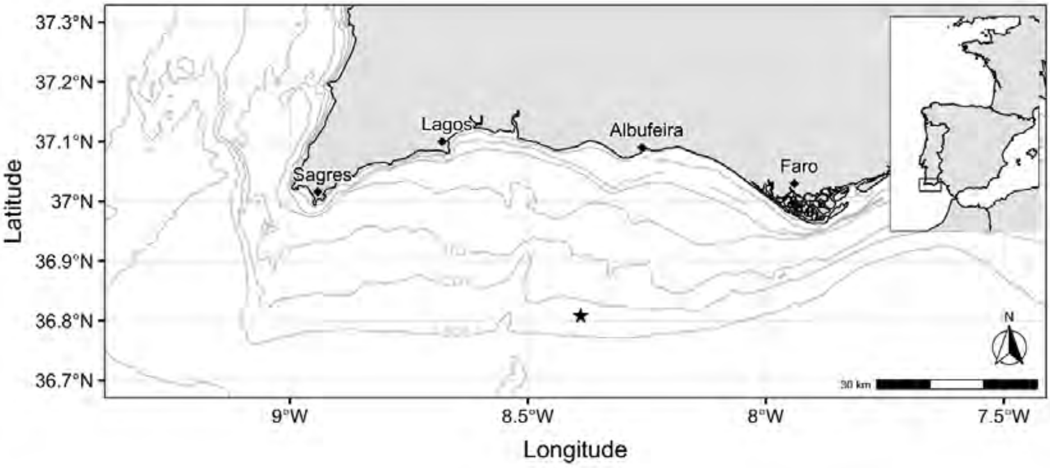

Figure 1. Map of the study area in southern Portugal with bathymetric lines in meters. The black star symbol represents the common bottlenose dolphin (*Tursiops truncatus*) sighting.

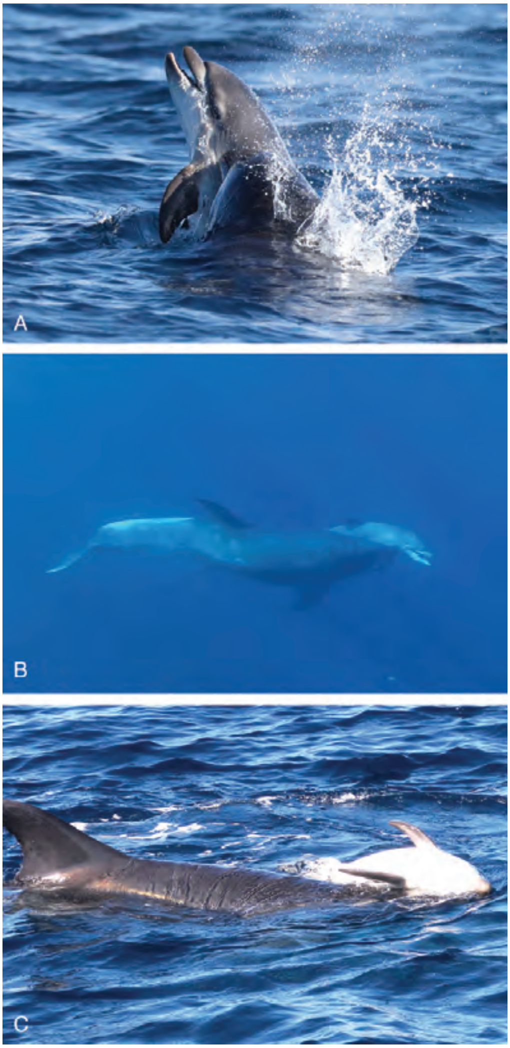

Figure 2. Physical contact of the postmortem attender (PA) with the calf's body: (A) "launching" the body out of the water, (B) underwater carrying, and (C) carrying at the surface. (Photos courtesy of AIMM – Associação para a Investigação do Meio Marinho)

Figure 3. Ventral area of the PA: (A) genital slit and sex (female) visible, and (B) distended abdominal region. (Photos courtesy of AIMM – Associação para a Investigação do Meio Marinho)

or near the surface, the PA was observed repeatedly nudging the calf's body upwards, even "launching" it out of the water on two occasions (Figure 2A). While diving, the PA used the rostrum to push the body deeper and manipulated it, performing twisting and rolling motions before returning to the surface. The PA displayed this carrying behavior throughout our observation, including when our team left the area, possibly continuing beyond that point. The bystanders displayed a calm behavior, mainly swimming after, alongside, and ahead of the PA at varying distances. PA–bystander interactions were observed in three instances and appeared to be instigated by the PA. Shortly after releasing the calf's body (which subsequently sank), the PA swam towards one or more nearby bystanders, prompting at least one to change direction and swim towards the calf's body with her. Additionally, there was a fourth similar instance when the PA was out of view for 15 s, and the moment of contact with the bystanders was not recorded. The bystanders were never observed providing physical support to the PA or physically interacting with the calf's body. Further, no interactions among the bystanders were observed, with the exception of one brief socio-sexual display where a bystander exposed its ventral area to another.

We estimated the dead calf's age at around 3 wks by comparison with the physical development (e.g., absence of rostral whiskers and teeth, presence of fetal folds) of a captive bottlenose dolphin calf described by Cockcroft & Ross (1990), as well as infant length measurements by Biancani et al. (2021) and Noren et al. (2006). The absence of visible teeth also indicates that it was less than 3 mo old (Cockcroft & Ross, 1990). Simultaneously, the distended abdominal region observed in the female may indicate a recent pregnancy due to the prolonged period

Figure 4. Detailed images of the calf's body: (A) ventral area displaying tooth rake marks and the genital slit (male), (B) tooth rake marks on the flank, (C) visible fetal folds, and (D) visible lower jaw with no erupted teeth and without rostral whiskers. (Photos courtesy of AIMM – Associação para a Investigação do Meio Marinho)

during which the genital tract remains extended after delivery (Sheldon, 2004; Noakes, 2009). Considering this, along with the estimated age of the dead calf, the observed female was likely its mother. Motherhood in cetaceans is characterized by an intense dedication towards the dependent offspring (Mann, 2018; Rendell et al., 2019), particularly so for bottlenose dolphins in which the connection between mother and infant can persist for up to 11 y (Triossi et al., 1998). The loss of offspring is therefore expected to induce physical and emotional responses in these animals.

One explanation for the observed nurturant behavior is that it may represent grief. Grief, initially expressed as distress, anxiety, and depression (Parkes, 1998), is a set of reactions to loss such as a sudden interruption in a very intense tie to another individual (Bearzi et al., 2017). Although animal emotions are difficult to assess and are an overall controversial topic, they have been particularly associated with intelligent animals such as cetaceans (Simmonds, 2006). The general behavior exhibited by the female, consisting of swimming around the body, compulsively pushing and carrying it, is consistent with the characteristic reactions considered as mourning in humans and other mammals (Bearzi et al., 2017).

Our observations of the PA launching the calf's body out of the water could demonstrate an effort to stimulate it, with the purpose of resuscitation. In terrestrial mammals, this type of vigorous handling of an inanimate body may lead to its revival; however, it is unknown if similar manipulation has the same effect on cetaceans (Bearzi et al., 2017). Apparent resuscitation attempts among cetaceans have been suggested by Harzen & dos Santos (1992) to result from a difficulty in understanding that the inanimate animal has already passed away. Since the calf's body observed during this encounter was fresh (corresponding to decomposition stage 1 [Early & Goff, 1986] and decomposition condition code 1 [IJessldijk & Brownlow, 2016]), the female PA may have misinterpreted it as being alive. However, reports of cetacean mothers carrying decomposing bodies of their offspring—or even objects when the body was unavailable (see Kilborn, 1994)—suggest that this behavior is not limited to a lack of understanding of death since, in both situations, the carrier is unlikely to misinterpret the circumstances.

The PA appeared to display stereotypic behavior (Bearzi et al., 2018), fixating on the body, carrying it for the entire duration of our observation, and thus potentially also inflicting the observed scars. The PA only left the calf's body for short periods of time for a brief interaction with the bystanders and immediately returned to it. The hypothesis that this behavior represents a way for the PA to elicit assistance from the nearby dolphins should not be ruled out. Kuczaj et al. (2015) reported a case in which a struggling bottlenose dolphin obtained help from other members of the group in response to its emitted signals of distress (i.e., distress calls and bubble streams). During our observation, the bystanders did react to the female's approach and swam along with her towards the carcass; however, we did not observe them interacting with the carcass. This behavior as well as the general proximity to the PA are consistent with the *standing by* category of succorant epimeletic behavior defined by Caldwell & Caldwell (1966), and the behavior contrasts with the behavior from the rest of the group members who did not appear to be influenced by the event reported here.

If the unconfirmed-sex bystanders were females, they might have been close associates of the PA. In bottlenose dolphins, female–female affiliations are predominantly influenced by a shared reproductive state and kinship (Diaz-Aguirre et al., 2020). Mothers benefit from these bonds for communal calf rearing (Rendell et al., 2019), and other females may be strongly involved in postmortem attendance behavior when a calf dies (Quintana-Rizzo & Wells, 2016).

Alternatively, the bystanders may have been motivated by reproductive purposes as suggested by the brief belly-up event between two of these dolphins. This interaction can indicate socio-sexual behavior, and sexual interactions have been observed around dead conspecifics (e.g., Dudzinski et al., 2003; Jog et al., 2020). Since females from multiple species of mammals recur to a sexually receptive state shortly after losing their offspring (Hrdy, 1979), the bystanders may benefit from remaining in close proximity to the PA to facilitate mating access. It is further possible that the bystanders were involved in the death of the calf, which also could have caused the observed scars. Male-perpetrated infanticide can function to improve male reproductive fitness by accelerating the mother's resumption to breeding condition, subsequently allowing the males to mate with her and father their own offspring (Bearzi et al., 2017; López et al., 2018). Although these possibilities cannot be excluded, they warrant information about the sex of all bystanders, and more socio-sexual displays would be expected if their behavior had solely reproductive purposes.

In this paper, nurturant epimeletic behavior of a female bottlenose dolphin towards a deceased calf and apparent succorant epimeletic behavior of multiple adult individuals in the south of Portugal are discussed. Our observations are consistent with postmortem bereavement and thus suggest that the primary motivation of the female to carry out this behavior was grief, particularly because she was the supposed mother of the dead newborn.

Aerial and underwater footage provide a rare spatial perspective of this event. Reports and detailed observations of epimeletic behavior in wild cetaceans are scarce and limited to sporadic events. Therefore, the case described in this paper contributes towards the understanding of this type of behavior in cetaceans, particularly in *T. truncatus*, and furthers our knowledge on the social behavior of this species in mainland Portugal.

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Observations of the First Documented Indian Ocean Humpback Dolphin (*Sousa plumbea*) in the Northernmost Red Sea Gulf of Aqaba

Oz Goffman, Jeffrey Rozio, Ori Galili, Stavit Drori, Dana Reininger,
Shlomi Marko, and Dan Kerem

IMMRAC (Israel Marine Mammal Research & Assistance Center), The Recanati Institute for Maritime Studies,
School of Marine Sciences, University of Haifa, Mount Carmel, Haifa 31905, Israel
E-mail: dankerem@research.haifa.ac.il

On 3 January 2021, an apparently healthy adult female Indian Ocean humpback dolphin (*Sousa plumbea*), accompanied by her seemingly thriving nursing calf, was observed in the Eilat Marina in the Gulf of Aqaba, Israel (Figure 1a-c). The adult female was named "Ella," and on 14 January 2021, following a southern gale, Ella was sighted alone and was assumed to have lost her calf. Since then and until her last sighting on 14 June 2022, she had been sighted during daytime hours almost daily in sandy shallow coastal waters along a 2.1-km narrow strip from Eilat Marina to Eilat North Beach lagoon and to Aqaba Marina, Jordan, with most of her observations in the Eilat Lagoon (Figure 2b). She had not been documented in the vicinity of coral patches in Eilat or in Aqaba. She had also never been documented associating with local Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) or with the three free-ranging Black Sea common bottlenose dolphins (*Tursiops truncatus*

Figure 1. Images of Ella and calf throughout the study period: (a) Ella with calf swimming within the Eilat Marina, Israel; (b) calf in apparent good body condition; (c) Ella in apparent good body condition during recorded foraging behavior; and (d) Ella approaching and swimming alongside stand-up paddleboarding (SUP) surfers in the northern beaches of Eilat.

ponticus), residents of Eilat Dolphin Reef, which regularly frequented the same area. Ella was also clear of scars and tooth rakes that might have indicated unobserved interspecific contact.

Israel Marine Mammal Research & Assistance Center (IMMRAC) staff conducted sporadic surveys to search for Ella from a 5 m vessel with an outboard motor; however, to cause minimal disturbance, most observations of Ella were made at a distance with a drone (DJI Mavic Mini 2, 4K @30 fps resolution camera) or with a telephoto DSLR camera. IMMRAC staff also received and collated citizen-science anecdotal information of Ella sightings from fishermen, swimmers, SCUBA divers, sailors, lifeguards, and stand-up paddleboarding (SUP) surfers. Video clips loaded onto social media sites in Aqaba complemented sightings in Eilat. Over the 16 mo since Ella arrived, 91 sightings were documented. Citizen-science sightings were only included when accompanied by species-identifiable photographs/videos, though they were accepted with and without individual photo-ID matching because we assumed she was the only humpback dolphin in the area.

The collected data indicated that Ella spent much of her daytime hours foraging. Of the 91 sightings, 19 were classified as foraging, and 11 of these involved active hunting bouts in which fish and shrimp were documented. The rest were interpreted to be foraging *sensu* (Shane, 1990)—that is, repeated dives in varying directions in one location, often making tailstock or flukes-up dives, with mud occasionally stirred up. Active hunting included three main methods (see Supplementary Video Part 1: drone photography; the supplementary video footage for this paper is available in the "Supplemental Material" section of the *Aquatic Mammals* website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147):

1. *Mud plume feeding* – Ella formed a roughly circular mud plume with her flukes that rose

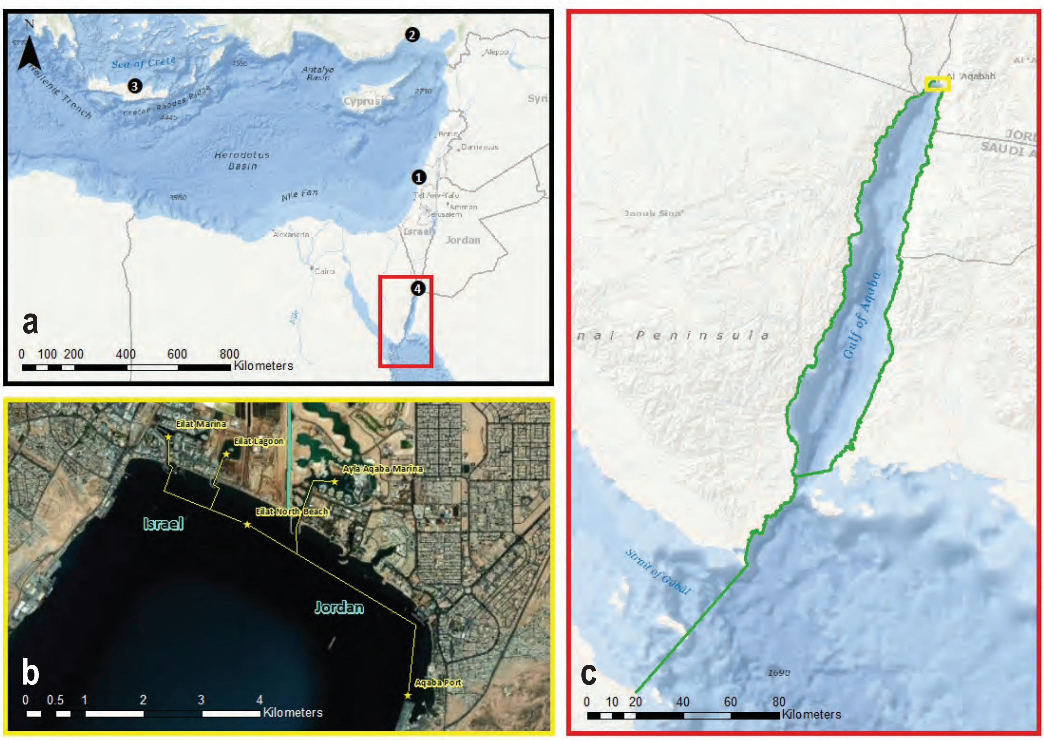

Figure 2. Geographical setting of the study: (a) map of the eastern Mediterranean and Sinai Peninsula, showing the four cases of extreme vagrancies reported for *Sousa plumbea*: (1) Israeli Mediterranean coast; (2) Mersin Bay, Turkey; (3) northern Crete, Greece; and (4) Eilat/Aqaba, Israel/Jordan; (b) enlarged map of the tip of the Gulf of Aqaba—all sightings of Ella occurred within the area between the yellow line and the coast. Yellow stars from left to right are Eilat Marina, Eilat Lagoon, Eilat North Beach, Ayla Aqaba Marina, and Aqaba Port; and (c) enlarged map of the Sinai Peninsula—depicted in green are the two potential courses Ella might have travelled to reach Eilat and Aqaba.

to the surface, and then charged up through the plume's center.

2. *Rush feeding* – Ella chased fish below the surface in a meandering course that included circles and hairpin turns, often on her side or back.

3. *Tail slapping* – Ella exhibited tail slapping just at and below the water's surface, performed amid a chasing bout.

Potential prey items identified from video clips were fringelip mullet (*Crenimugil crenilabrus*), Red Sea houndfish (*Tylosurus choram*), a species that is likely either wide-banded hardyhead silverside (*Atherinomorus lacunosus*) or Samoan silverside (*Hypoatherina temminckii*) (H. Agranati, pers. comm., 20 April 2022), and an unidentified dendrobranchiate shrimp (D. Edelist, pers. comm., 15 April 2022).

A unique above-water episode, documented inside the Eilat Marina, included "headstands" followed by tail slaps on the water's surface and in-air summersaults ending with a flat-bodied crash on the surface (Supplementary Video Part 2: telephoto camera photography). Such behavior may have been to "show off," but since disturbances on the water surface indicated intense underwater activity, a hunting mode that used noise to disorient prey seems like a viable possibility.

Ella fit the definition of a solitary yet sociable dolphin (Lockyer & Müller, 2003). She had never been observed approaching a sailboat or motor vessel, but since May 2021, she had begun to interact with SUP surfers, approaching their boards from below and swimming in formation (Figure 1d). Beginning in July 2021, she had begun to interact with swimmers and snorkelers, and often she was highly vocal in the process (Supplementary Video Part 3: underwater camera photography with sound recording). None of these interactions included physical contact.

Vagrancy

In a review of Red Sea cetaceans, Notarbartolo di Sciara et al. (2017) remarked that the Indian Ocean humpback dolphin, although not abundant, occurred along the entire African and Arabian coasts of the Red Sea, wherever suitable shallow habitat exists. They further commented that while the lack of records of this species from certain areas might be due to lack of reporting observers, the complete lack of sightings from the steep-shored Sinai coast of the Gulf of Aqaba, despite a reasonable observer effort and reporting system, likely reflects the real situation. While Indian Ocean humpback dolphins are probably not residents here, occasional vagrants may take advantage of the narrow fringing reefs, with occasional sand fans at wadi mouths, that extend along the Gulf coasts. For a nursing mother, this could be quite a feat.

The closest point in the Red Sea where residency of the species is confirmed is the Hurghada–El Gouna area, Egypt (Notarbartolo di Sciara et al., 2017). The shortest distances from Hurghada to Eilat/Aqaba up the Arabian coast and up the Sinai coast are 376 and 353 km, respectively (Figure 2b). They are somewhat above the maximum distance of 275 km covered by a female and calf as documented (by catalog matching) for the species in South Africa (Vermeulen et al., 2017). With a conservative travel rate of 12 km/d reported by Vermeulen et al. (2017), these distances would be covered in roughly 30 d.

Other members of this obligatory coastal species have proven to be quite far ranging, with two or possibly three odysseys into the eastern Mediterranean through the Suez Canal (Figure 2a). Sightings occurred in northern Israel (Kerem et al., 2001); Mersin Bay, Turkey (Ozbilgin et al., 2018); and northern Crete (Frantzis, 2018), with estimated covered distances, hugging the coast where possible, of 300, 1,000 and 2,330 km, respectively. To reach Crete, passages over deep open water totaling 75 km are required (Frantzis, 2018).

Diet and Foraging

Information on the diet of the Indian Ocean humpback dolphin is scant. In all areas studied, stomach contents and foraging observations suggest this species is a generalist piscivore feeding on reef-associated, demersal, and estuarine fish (Plön et al., 2015), with occasional cephalopods and crustaceans (Baldwin et al., 2004). Data on foraging/hunting behavior are even more scarce. Herding bonefish onto exposed sand banks, both singly and cooperatively, and deliberately beaching to seize the prey was described by Peddemors & Thompson (1994) and by Baldwin et al. (2004). The hunting modes utilized by Ella are newly described for this species, but each had been documented for bottlenose dolphins (*Tursiops* sp.): mud plume feeding (Lewis & Schroeder, 2003), circle and hairpin rush feeding (Leatherwood, 1975; Shane, 1990), and subsurface tail slaps (Shane, 1990).

Sociality

Some Indian Ocean humpback dolphins in the Hurgadha–El Gouna area of Egypt's Red Sea coast have been observed associating with Indo-Pacific bottlenose dolphins (A. Ziltener, pers. comm., 18 March 2021). As far as we know, Ella was not involved in such an interaction. The Gulf of Aqaba/Eilat has a history of hosting solitary-sociable dolphins (Goffman et al., 2022). Ella's behavior towards humans progressed somewhat beyond the "Stage 2" level of interaction expressed by solitary-sociable dolphins (Wilke et al., 2005), but any further potential evolution of her sociability was cut short by her disappearance.

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This anecdotal entry is dedicated to Ella, who suddenly appeared and as suddenly left—sharing moments of her life and thereby enriching ours.

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Drift Dives in a Bowhead Whale (*Balaena mysticetus*)

Susanna B. Blackwell,[1, 2] Outi M. Tervo,[3] Nynne E. Lemming,[3]
Lori T. Quakenbush,[4] and Mads Peter Heide-Jørgensen[3]

[1]*Greeneridge Sciences, Inc., 5142 Hollister Avenue #283, Santa Barbara, CA 93111, USA*
E-mail: susanna@greeneridge.com
[2]*Institute of Marine Sciences, University of California at Santa Cruz, Santa Cruz, CA 95064, USA*
[3]*Greenland Institute of Natural Resources, Strandgade 91, 3, Postboks 2151, 1016 Copenhagen, Denmark*
[4]*Arctic Marine Mammal Program, Alaska Department of Fish and Game, Fairbanks, AK 99701, USA*
Current address for Nynne E. Lemming: Danish Environmental Protection Agency, 5000 Odense C, Denmark

During so-called drift dives, an animal spends a proportion of the dive not moving, suspended in the water column while drifting up- or downwards, depending on its buoyancy. Roles of drift dives are believed to include resting, sleeping, or digesting food (e.g., Crocker et al., 1997; Miller et al., 2004; Andersen et al., 2014), which are important components in at least some species' activity cycles. Drift diving was first documented in both species of elephant seals, *Mirounga angustirostris* and *M. leonina* (e.g., Hindell et al., 1991; Le Boeuf et al., 1992), and later other pinnipeds such as New Zealand fur seals (*Arctocephalus forsteri*; Page et al., 2005) and hooded seals (*Cystophora cristata*; Andersen et al., 2014). Drift dives also occur in cetaceans such as sperm whales (*Physeter macrocephalus*; Miller et al., 2008) and humpback whales (*Megaptera novaeangliae*; Zoidis et al., 2014). Herein, we describe the presence of drift dives in a bowhead whale (*Balaena mysticetus*) and hypothesize about their role.

In mid-April 2013, four bowhead whales in Disko Bay, West Greenland, were instrumented with Acousonde™ sound and movement tags (www.Acousonde.com) in a tag-retention study carried out by the Greenland Institute of Natural Resources. Tags were connected to a stainless steel or Kevlar tether, 0.5 to 1 m long, and then to a 4-cm stainless steel spear, which was implanted 10 cm under the skin on the whale's dorsal side as described in Heide-Jørgensen et al. (2013). A magnesium link, connected to the tether right above the skin, corroded in the presence of saltwater and detached the tag from the insertion point. While multi-day deployments were sought, all tags detached prematurely within 8 to 25 h. Retrieval was enabled by the ARGOS transmitter (SPOT5; Wildlife Computers, Redmond, WA, USA) and VHF transmitter (ATS Telemetry, Isanti, MN, USA) that were attached to the Acousonde™.

The tags recorded various data streams on nine different channels. Those relevant to this paper are water depth (10 Hz sampling rate), the x-axis of the 3-D accelerometer (10 Hz sampling rate), and acoustic sampling (HTI-96-MIN hydrophone with nominal sensitivity of -201 dB re 1 V/µPa, preamp gain 14 dB, anti-alias filter with 3-dB reduction at 9.2 kHz and 22-dB reduction at 11.1 kHz, 25,811 Hz sampling rate).

While investigating the data, we found that one of the whales' records included dives during which the accelerometer's x-axis (accel$_x$) remained near -1 g for extended periods while the whale was at depth. The front of the Acousonde™ is heaviest as it contains the battery and the electronics, whereas the distal end is made of syntactic foam. Therefore, when free-floating, the Acousonde™ assumes a position near vertical in the water column, and the tag's accel$_x$ channel reports a value near -1 g (see illustration in Figure 1C, inset). Such a position can only be obtained by a tethered tag if a whale is motionless in water with little or no current, or if it is descending vertically on a dive, in which case the depth values would change accordingly. In the cases described here, the value of accel$_x$ remained near -1 g for periods of up to ~48 min while the whale's change in depth over the same period was small, on average a few mm/s. Basically, the Acousonde™ indicated that the whale was immobile at depth while slowly drifting and ascending.

Depth and accel$_x$ values were averaged over 3-s samples (no overlap) throughout each of the four tagged whales' records. The first 1.5 h of data, during which the whales showed behavioral effects of tagging (S. B. Blackwell, unpub. data, 2013-2015; Quakenbush et al., 2015), were excluded from all analyses. In addition, surface intervals were removed by ignoring data collected within 5 m of the surface. All 3-s samples with accel$_x$ values between -1.02 and -0.98 g and a change in depth of less than 20 cm/s were flagged—such samples will hereafter be called "drift samples." One whale (S1, a male as determined by genetics

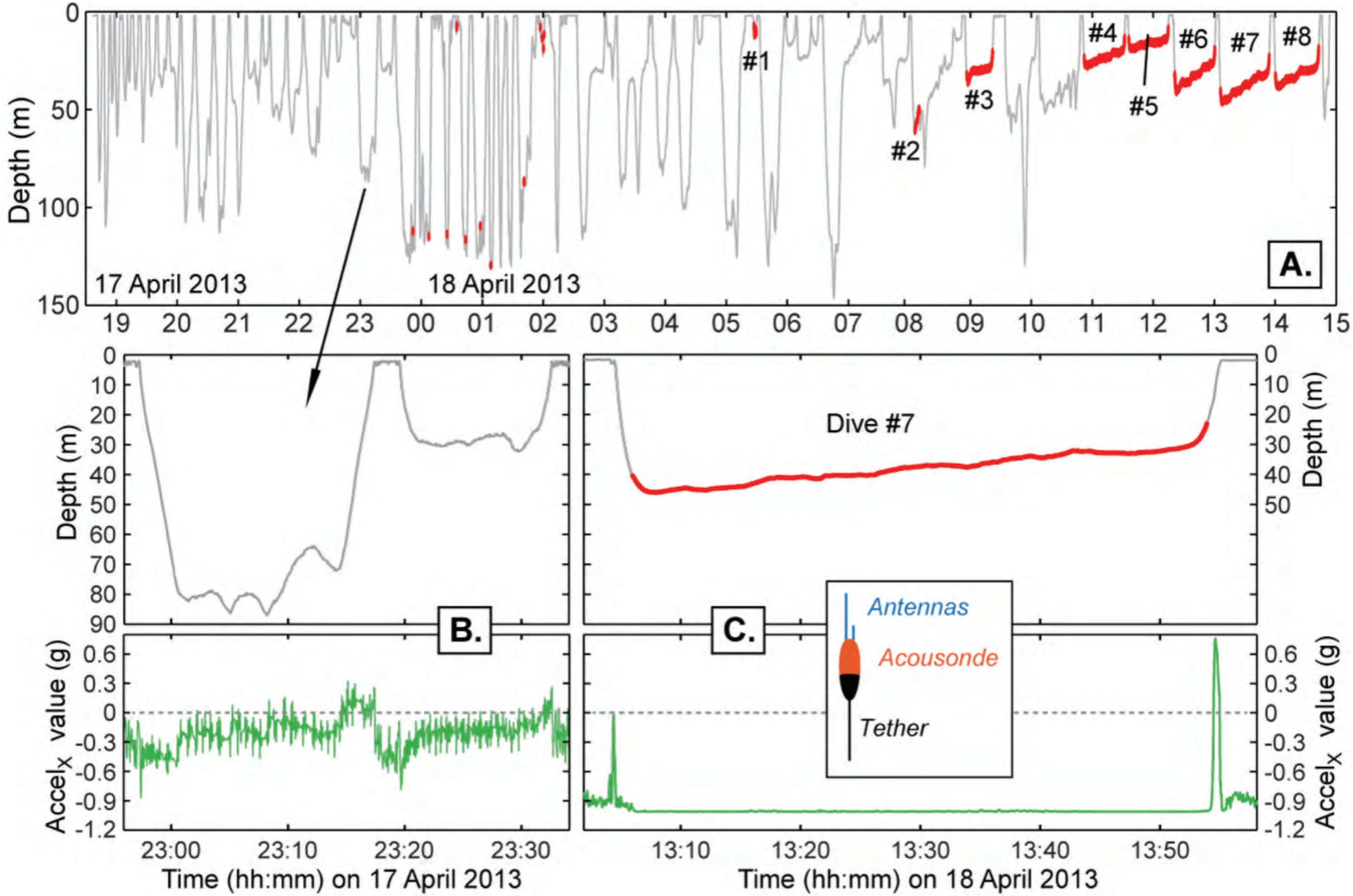

Figure 1. (A) Entire 20-h dive record of whale S1, 17-18 April 2013—red dots show all detected drift samples; (B) two example dives without drifting—with the exception of the sections highlighted in red in (A), dives showed regular stroking by the whale (lower panel), generally of the burst-and-glide type; and (C) drift dive #7 (see Table 1), showing how the accel$_x$ value quickly stabilized at ~-1 g (position of Acousonde™ shown in inset) and stayed there for the dive's entire bottom time of ~48 min.

Table 1. Characteristics of S1's drift periods, and the dives containing those periods, numbered 1 through 8 (see Figure 1). The "Start time" and "Dive duration" pertain to the entire dive. The "Duration of drift" is the time between the first and last drift sample. "% still" indicates the percentage of the drift duration made up by drift samples. "Mean depth" is calculated over the entire drifting duration, while "Mean accel_x" and "Mean depth change" are calculated using only drift samples—that is, 3-s samples that met the accel_x and depth change criteria. See text for information on the "Slope of regression on drift." Because depth is a positive value, the negative slopes represent ascent in the water column. S1 was tagged at 1841 h on 17 April 2013.

Dive (and drift) #	Start time of dive (18 April 2013)	Dive duration (mm:ss)	Duration of drift (mm:ss)	% of dive in drift	% still	Mean depth (m)	Mean ± SD accel_x value (milli-g)	Mean ± SD depth change (cm/s)	Slope of regression on drift (mm/s)
1	5:26:32	3:44	2:18	61.6	87.0	10.1	-1,003 ± 7	8.8 ± 4.6	--
2	8:01:58	49:52	4:12	8.4	88.1	55.0	-1,006 ± 5	4.3 ± 2.3	--
3	8:54:50	28:11	25:33	90.7	100.0	30.1	-1,005 ± 5	1.8 ± 2.3	-1.7
4	10:50:44	41:43	39:48	95.4	98.9	23.4	-1,008 ± 5	1.4 ± 2.1	-3.6
5	11:34:57	40:19	38:51	96.4	98.7	16.2	-1,006 ± 6	1.4 ± 2.0	-2.1
6	12:19:06	42:16	39:24	93.2	96.2	32.6	-1,005 ± 7	1.8 ± 2.8	-6.4
7	13:04:32	50:29	47:57	95.0	100.0	38.0	-1,009 ± 3	1.5 ± 2.1	-5.7
8	13:58:28	45:19	42:36	94.0	97.3	32.4	-1,007 ± 6	1.4 ± 2.2	-5.8

from a skin sample obtained during tagging), the subject of this paper, had a total of 4,742 drift samples. The other three whales (T1, T2, and T3) did not demonstrate drift periods of any substantial length: they had 2, 34, and 43 drift samples, respectively, 85% of which were grouped into durations of less than 15 s, and the longest of which lasted 21 s.

In contrast, all but 17 of S1's drift samples occurred during eight different dives (Table 1). Six of those dives (#s 3 through 8 in Table 1) included longer drift periods lasting 25.5 to 48 min, during which the whale was immobile in the water column (accel_x near -1 g) and slowly ascending. More than 96% of 3-s samples included in those periods satisfied the conditions for a drift sample ("% still" column in Table 1). Two shorter periods (#s 1 and 2 in Table 1), less than 4.2 min long, preceded these longer periods but showed similar behavior. Whale S1's 20-h dive record is shown in Figure 1A, together with a comparison of accel_x values during regular dives (Figure 1B) vs drift dives (Figure 1C). All of S1's drift dives were in the second half of his dive record, and five of the eight drift periods (#s 4 through 8) occurred in a continuous bout lasting nearly 4 h, interrupted only by active ascents to the surface to breathe (Figure 1A). Regular fluke stroking resumed during the short dive following dive #8, during which the tag detached.

The average slope of the longer drift periods (#s 3 through 8 in Table 1) was estimated by fitting a linear regression to the drift samples as a function of time while omitting the end of the descent and the start of the ascent. Regression slopes (all ascending) were in the range of 1.7 to 6.4 mm/s (Table 1). These vertical drift rates are remarkably close to neutral buoyancy, a point at which slight changes in buoyancy lead to larger changes in the rate of movement (Aleyev, 1977; Webb et al., 1998). At the generally shallow depths of S1's drift dives (< 50 m), the influence of gas (through the amount of air taken on a dive) is critical. Sperm whales have been observed releasing air to adjust their buoyancy during drift dives (Miller et al., 2004, 2008). Similarly, bubble releases were heard more than a dozen times on S1's acoustic record; such behavior may explain the "bumpiness" in the drift dives' bottom time.

Low levels of flow noise in S1's acoustic record provided further evidence for the lack of movement during drifting at depth as flow noise can be used as a proxy for swim speed (e.g., Simon et al., 2009). Sound pressure levels (SPLs) in the one-third octave band centered at 25 Hz were plotted as a function of depth for 1-s non-overlapping samples taken throughout S1's record (Figure 2). Received levels during the eight drift periods had a median value of 75.6 dB re 1 μPa compared to 117.3 dB for the non-drift samples of the record, a difference of > 40 dB (Figure 2). Note that S1's acoustic record was not otherwise quiet during drift periods, with continuous song by bowhead whales and bearded

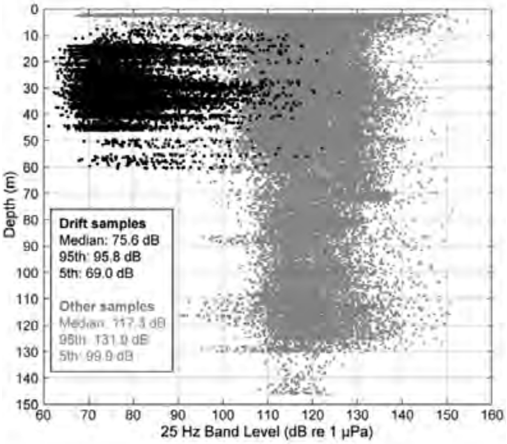

Figure 2. Received sound pressure level in the one-third octave band centered at 25 Hz as a function of depth for 1-s non-overlapping samples taken throughout the record of S1. Black dots denote sound levels taken during times of drifting while gray dots denote sound levels during all other activities. The median, 5th, and 95th percentiles are given for each cloud of points.

seals (*Erignathus barbatus*), occasional calls by beluga (*Delphinapterus leucas*), and numerous cracking icebergs. Median received broadband SPLs during drifting was 107 dB re 1 µPa (10 Hz to 9.3 kHz, n = 14,479 1-s samples, 5th to 95th percentile, 103 to 115 dB).

Mean dive durations for bowhead whales are relatively short, generally between 8 and 18 min (Krutzikowsky & Mate, 2000; Laidre et al., 2007; Heide-Jørgensen et al., 2013; Citta et al., 2021). Meanwhile, reported maximum dive durations are more variable, from less than 30 min for some individuals (Laidre et al., 2007) to more than an hour (Krutzikowsky & Mate, 2000). S1's dive durations were within these ranges: 41.4 min (± SD 7.4 min) for the six dives that included a high percentage of drifting (#s 3 through 8 in Table 1), and 16.4 min (± SD 10.5 min) for the remaining 42 dives of his record.

The function of the dives described here may be for rest or sleep as such is the function usually ascribed to drift dives (e.g., Miller et al., 2008; Meir et al., 2013). The lack of movement (Figure 1), low received levels of sound (Figure 2), and long dive durations all support this assertion. Researchers studying bowhead whales in the field have seen them rest at the surface (e.g., J. C. George, W. R. Koski, & W. J. Richardson, pers. comm., 29 April 2022) and so have fishermen (Christiansen, 1962). Carroll & Smithhisler (1980) also mention cases in which bowheads that were apparently resting were startled when approached by a vessel. Resting underwater has been described in humpback whales (Cartwright & Sullivan, 2009; Bejder et al., 2019) and sperm whales (Miller et al., 2008) but not yet, to our knowledge, in bowhead whales. This may be in part because time-depth information alone, which constitutes the majority of bowhead dive records collected to date, makes it difficult to distinguish drift dives from active foraging dives. This problem has also been reported with other diving marine mammals—for example, distinguishing benthic feeding vs benthic resting dives in elephant seals (Hassrick et al., 2007). An examination of time-depth recorder data from past studies (i.e., Heide-Jørgensen et al., 2013), including manual evaluation of candidate dives, confirmed these difficulties.

The tagging procedure is likely stressful for a bowhead whale, but we have no evidence that S1 reacted differently to tagging than the other three whales in 2013, or the nine whales tagged similarly (with retrievable Fastloc GPS tags) in 2008 through 2011 (Heide-Jørgensen et al., 2013). Effects of tagging were examined for the 2013 whales by quantifying their fluke stroke rate, flow noise, and vertical displacement during surface intervals, all of which returned to baseline 0.5 to 1.5 h after tagging (S. B. Blackwell, unpub. data, 2013-2015; Quakenbush et al., 2015). Meanwhile, S1's first long drift (#3) took place more than 14 h after tagging.

In summary, this paper has shown the presence of drift dives in a bowhead whale dive record. A larger sample size of long-duration records that include accelerometer information will be necessary to determine the importance and purpose of drift dives to bowhead whales.

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Fifty Shades of Gray: The First Leucistic Bottlenose Dolphin (*Tursiops truncatus*) Sighting off the Cedar Keys, Florida, Gulf of Mexico

Stefanie K. Gazda[1] and Mackenzie L. Russell[2]

[1]*University of Florida, Department of Biology, 876 Newell Drive, Gainesville, FL 32611, USA*
E-mail: stefanie.gazda@ufl.edu
[2]*Dauphin Island Sea Lab, 101 Bienville Boulevard, Dauphin Island, AL 36528, USA*
E-mail: mrussell@disl.org

Melanin is the group of pigments found in the skin of animals, and the quantity determines coloration patterns. Variations in the production of melanin has been linked to different disorders (for a review, see Braun-Falco et al., 2000). For example, hypopigmentation, those with reduced melanin production, include albinism (total absence of pigmentation; skin is white and eyes are shades of red) and leucism (deficiency of pigmentation; skin is abnormally pigmented often in shades of white or tan and eyes are a normal color) (Fertl & Rosel, 2018; Olson & Allen, 2019; Hauser-Davis et al., 2020; Walsh, 2020).

Leucism in marine mammals is rare as reported in the literature. Olson & Allen (2019) found 114 records of leucism in class Mammalia, 33 of which are in order Carnivora, with most reports (18) belonging to family Mustelidae, followed by 12 references to family Otariidae and two references to family Phocidae. In marine mammals, atypically white individuals have been reported in 33 marine mammal species (Fertl & Rosel, 2018), and a review of the dolphin literature found 14 reports of leucism in five dolphin species worldwide from 1929 to 2019 (Hauser-Davis et al., 2020). Anomalously colored marine mammals are often met with wide public attention when observed because of their rarity, which is also often reported in local news and media. For example, a hypopigmented bottlenose dolphin first seen in Clearwater, Florida, in 2021 ("Shark-Scarred Rare White Dolphin," 2021) garnered additional media attention when it was sighted again in 2022 ("Rare White Dolphin Spotted in Clearwater Canal," 2022). These publicly reported observations of abnormally colored marine mammals included in news articles are usually not published in peer-reviewed literature, and neither of the reviews on leucism (Olson & Allen, 2019; Hauser-Davis et al., 2020) incorporated news articles into their searches, which may be a source for additional cases of leucism.

In this paper, we report the first confirmed sighting of an anomalously colored adult female bottlenose dolphin (*Tursiops truncatus*) in the northeastern Gulf of Mexico (GOM). The light brown-to-tan dolphin was nursing a normally colored calf north of the Cedar Key islands in Florida. The area of the Cedar Keys (29.096944, -83.066111) comprises five major islands, numerous smaller islands, and wetland areas connected to the mainland off the northwest coast of Florida. The public in this area have provided multiple unconfirmed reports of a seasonal transient anomalously colored bottlenose dolphin observed only in the winter months (January and February) since 2001 when dedicated dolphin photo-identification research commenced in the Cedar Keys. The last unconfirmed sighting reported by the public of an unusually colored dolphin in the area was in January 2022. In addition, Steinhatchee, Florida, which is a town located on the GOM north-northwest from the Cedar Keys area (Figure 1), was the site of multiple live captures of dolphins in the 1960s for the purposes of selling them to the live animal entertainment industry ("Blonde Dancing Dolphin Getting Mate," 1967; "Mr. Nevin Stuart Obituary," 2014). Some of these dolphins were noted as "blonde" in color in news articles about their capture and subsequent lives spent under human care ("Blonde Dancing Dolphin Getting Mate," 1967; Walsh, 2020). These dolphins are not all mentioned in the scientific literature (they are mentioned briefly in Walsh, 2020) but could indicate a historical source of the genetic anomaly of leucism in bottlenose dolphins.

Steinhatchee, Florida, is ~65 km northwest of the Cedar Keys (Figure 1), within the travel range of an inshore bottlenose dolphin (Shane et al., 1986). The town sits on the Steinhatchee River, which discharges into the GOM and has a suspected resident population of dolphins. Mr. Nevin Stuart, a long-time Steinhatchee resident,

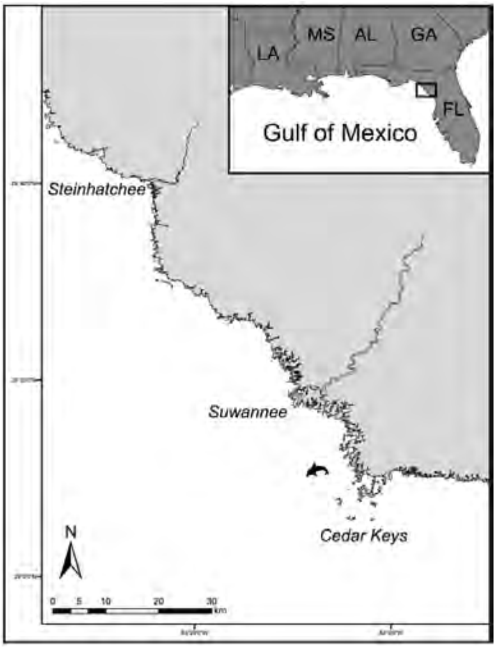

Figure 1. Map of the area with the Cedar Keys, Suwannee, and Steinhatchee areas labeled. The location of the 15 July 2017 sighting is noted by the dolphin icon.

captured at least two (likely three) dolphins identified as "albino" ("Mr. Nevin Stuart Obituary," 2014) in the waters surrounding Steinhatchee prior to the Marine Mammal Protection Act of 1972. One of these anomalously colored dolphins, named "Lilly," was a ~5-y-old female bottlenose dolphin when captured in 1964 (Walsh, 2020) and was sold to Marineland in Marineland, Florida, where she lived until her death in 2009. It is unlikely that she was a true albino but likely leucistic because her eyes were not red-hued and her skin was light tan in color, indicating the presence of some pigment-producing melanin ("Blonde Dancing Dolphin Getting Mate," 1967; Walsh, 2020). She was known as the "blonde" or "champagne" dolphin due to the light color of her eyes and was often dubbed "Lilly Champagne" ("Blonde Dancing Dolphin Getting Mate," 1967). Her coloration, according to news reports, was attributed to a recessive genetic trait, but no genetic studies were ever published for her case ("Rare 'Blonde' Dolphin at Marineland Dies at Age 47," 2009). In 1967, Mr. Stuart captured a male bottlenose dolphin of similar coloration in the same area near Steinhatchee, which was also brought to Marineland to be a companion of Lilly, though they never had offspring ("Blonde Dancing Dolphin Getting Mate," 1967; Walsh, 2020). Given that these animals had similar coloration and were captured from the same area of the GOM, it is possible that they were genetically related. In wild populations of bottlenose dolphins, adult females rarely associate with their sons while reproductively receptive, possibly to reduce inbreeding (Wallen et al., 2017). We do not have data on any association patterns of these dolphins while in the wild nor at Marineland. This male "blonde" dolphin had offspring with a normally colored dolphin while at Marineland and all were typically colored. Lilly did not have any offspring while in captivity ("Rare 'Blonde' Dolphin at Marineland Dies at Age 47," 2009), and her reproductive history while in the wild is not known.

The Cedar Key Dolphin Project (CKDP) is a 501(c)(3) nonprofit organization officially founded in 2017 (EIN: 82-1600242). Researchers from the CKDP have been conducting research on the bottlenose dolphin population in the region of the Cedar Keys (29.132, -83.057) since 2001, focusing on population dynamics, foraging ecology, and social structure. On 5 July 2017, at 1146 h (EDT), while conducting dolphin photo-identification surveys, researchers encountered a group of dolphins, including a suspected leucistic individual, slightly offshore from the Cedar Keys area (29.176, -83.121; Figure 1). Sighting data were collected using methods described in Gazda et al. (2005). Briefly, observations were made from a 4.26-m Wahoo boat with an 80-hp Yamaha outboard motor. Individual dolphins were photographed using a Nikon camera fitted with an 80-350 mm zoom lens. Once a dolphin or dolphin group was encountered, the markings on the dorsal fin were photographed for individual identification (Caldwell, 1955; Würsig & Würsig 1977) using the methods described by Defran et al. (1990). Individuals were included in the group if they were within 10 m of any other group member (Smolker et al., 1992).

The group of dolphins encountered during this sighting consisted of 17 individuals, including two calves. Due to the water clarity, we were able to sex five of the adults, which were all female. No males were positively confirmed. Two of the 17 dolphins did not have high enough quality photographs to assign a code or individual identification, to them. The abnormally colored dolphin (Figure 2a & b) was assigned an identification code of "MNOS." Of the non-calf dolphins identified in the sighting, five are considered resident; the other 10 are considered transients and were only seen during this sighting, including MNOS (Gubbins, 2000). The group was traveling in a generally straight and northerly direction, with occasional foraging and socializing

Figure 2. Images from the 15 July 2017 sighting: (a) MNOS behind the normally colored calf she was observed nursing; and (b) MNOS traveling in the foreground of the picture, next to the dolphin TEOS, a normally colored dolphin. (Photos taken by S. Gazda under NOAA Permit #14450, now #21938)

behaviors. The group was tightly associated, with most group members within one adult body length of each other while traveling. The group was observed for ~30 min, during which time we observed repeated instances of the abnormally colored adult dolphin nursing a normally colored calf (Figure 2a).

Abnormal pigmentation of the skin is most often attributed to genetics (Fertl & Rosel, 2019), though it can be caused by other factors such as pollution, systemic infection, scarring, or other etiological factors (Walsh, 2020). Coloration patterns of a species are usually thought to arise from a selective advantage such as predator avoidance or hiding from prey. Within cetaceans, there is no evidence of background matching, which is a type of camouflage with a color pattern that blends in with the environment (Caro et al., 2011). However, cetaceans utilize a camouflage called countershading that is characterized by having lighter coloration ventrally and darker coloration dorsally (Caro et al., 2011). Hypopigmentation is suspected to negatively affect the survival and reproduction of marine mammals by reducing countershading, thus making the animal more susceptible to predators, reducing mating success, and having a reduced fitness if the coloration pattern is due to inbreeding (Hauser-Davis et al., 2020). In a 2020 review of leucism in delphinid species, Hauser-Davis et al. found that cetaceans with leucism were surviving until adulthood, indicating that they may not be more susceptible to predation, although more studies are needed. This review did not find any previous reports on sightings of leucistic dolphins with offspring.

Given that our sighting included the hypopigmented dolphin nursing a normally colored calf, the abnormal coloration does not necessarily negatively affect the reproductive success of these animals, though it may affect their foraging success due to difference in countershading (Caro et al., 2011; Hauser-Davis et al., 2020). This dolphin was also clearly an adult, so our sighting also supports the ability of these suspected leucistic cetaceans to reach adulthood. Because there are reports of multiple hypopigmented dolphins in this area of the northeastern GOM (Walsh, 2020), it is possible that this trait is due to inbreeding. More research, including a genetic component (part of the long-term research goals of the CKDP), is needed to determine the relatedness of the dolphins in the Cedar Keys and Steinhatchee locations and to elucidate the possible relative fitness of these animals. Although Lilly never produced offspring at Marineland, she did live to be nearly 50 y old ("Rare 'Blonde' Dolphin at Marineland Dies at Age 47," 2009). Given that two to three dolphins in the Steinhatchee area were captured in the 1960s because of their "blonde" coloration, there is unlikely a significant selection against this coloration in this area. Unfortunately, this artificial selection for this trait by capture operations might have removed a major source of gene flow of hypopigmented dolphins into proceeding generations. The observation that MNOS, the hypopigmented adult from our sighting, was nursing a normally colored calf suggests that it is possible that the underlying recessive genetics could continue to be carried by normally colored offspring of the adult dolphins that were captured.

This is the first sighting by dedicated marine mammal researchers of a hypopigmented, suspected leucistic bottlenose dolphin in the northeastern GOM. The adult female dolphin nursing a normally colored calf makes the sighting even more unusual. The use of news articles that are over 50 years old aided in the creation of this paper and represents a potentially useful dataset of information in public records regarding rare sightings such as leucistic marine mammals in never-before-reported locations like the northeastern GOM.

Acknowledgments

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Southern Right Whale Sightings and Two Incidences of Interaction with Peale's Dolphins in Los Ríos Region, Southern Chile

Henrike Niebaum[1, 2]

[1]*Centro Ballena Azul, c/o Laboratorio de Mamíferos Marinos, Instituto de Ciencias Marinas y Limnológicas,*
Universidad Austral de Chile, Casilla 567, 5090000 Valdivia, Los Ríos Region, Chile
[2]*Universität Osnabrück, Department of Biology, Barbarastraße 11, 49076 Osnabrück, Germany*
E-mail: henrike.niebaum@mailbox.org

According to the International Union for the Conservation of Nature, the Southeastern Pacific (SEP) subpopulation of southern right whales (*Eubalaena australis*, Desmoulins, 1822; SRWs) is critically endangered with ≤ 50 mature individuals left (Cooke, 2018). Most of the ~4.5 annual sightings in Chile concentrate between 18° and 25° S, and near 33° S (Aguayo-Lobo et al., 2008; also see Thiel et al., 2007; Pavés et al., 2020). South of 40° S, the coastal waters of Isla Chiloé, Los Lagos Region (see Figure 1), seem to be important for the subpopulation, possibly including habitat for reproductive behavior (Galletti Vernazzani et al., 2014). Data from the northwardly adjacent Los Ríos Region (near 40° S; see Figure 1) are scarce (Aguayo-Lobo et al., 2008; Galletti Vernazzani et al., 2014). Anecdotal reports are therefore of scientific and conservation value. This paper comprises detailed behavioral observations meant to enhance the understanding of, and to encourage further research on, SEP SRW social and ecological functioning and needs. It also covers SRW behavior not yet reported for this subpopulation, and it represents the first documentation of interspecific interaction between SRWs and Peale's dolphins (*Lagenorhynchus australis*, Peale, 1848; PDs) in the SEP.

The sightings took place in Bahía Chaihuín (39° 56' S, 73° 35' W), Comuna de Corral, southern Los Ríos Region (see Figure 1). Bahía Chaihuín is unique compared to most of Los Ríos Region's coastline. It roughly measures 3 km^2, and it is sheltered from strong currents and winds by its northern-directed opening. The bay's northern and southern shores are steep and rocky, but along the bay's rather shallow east end is a wide beach, and sandy dunes form a barrier to the broad estuary of Río Chaihuín. The river's only narrow opening lies in the bay's northeastern corner. I lived in Chaihuín from mid-2013 to mid-2015 to study PDs. This also enabled anecdotal documentation of rarer species and events. During these opportunistic sightings, notes were taken, and photographs and/or videos were collected with a Canon PowerShot SX130 IS. When necessary, binoculars (Nikon 7×50 mm) were used. All sightings were made from land under good to excellent weather and sea conditions (BSS ≤ 3). SRWs were mainly identified through V-shaped blows, lack of a dorsal fin, form of head/mouth, and presence of callosities on the head. PDs were identified through size, shape, and coloration (e.g., Goodall et al., 1997). Distances, heights, and SRW lengths are rough estimates.

Over the 2-y-period, I witnessed a SRW in Bahía Chaihuín on three occasions: (1) 23 June 2013, (2) 26 October 2013, and (3) 22 July 2014. Sighting durations were 40, 75, and 68 min, respectively, although the SRW of sighting 2 may have stayed in the bay longer. The sightings from austral winter (sightings 1 & 3) involved interactions with PDs.

Sighting 1

On 23 June 2013 at 1503 h, I spotted from the beach a 9 to 15 m long SRW at 250 m, close to the northern shore. Also, ~20 PDs were within the bay. All but four to six PDs were surface active and headed in the direction of the SRW. An additional ~10 PDs arrived in the bay, after which ~25 PDs immediately engaged in pronounced aerial behavior—mostly vertical leaps with lateral reentries—which was perceived as noisy. During the entire sighting, all PDs remained at ≥ 100 m from the mysticete; the SRW moved steadily from north to south along the beach at 250 m. At 1515 h, ~20 PDs dispersed again along the beach, engaged in calmer activity. I last saw the SRW at 1543 h in the southwestern part of the bay. While crossing the bay, the SRW showed a regular respiration pattern: there was a sequence of three breaths within ≤ 1 min every 10 min.

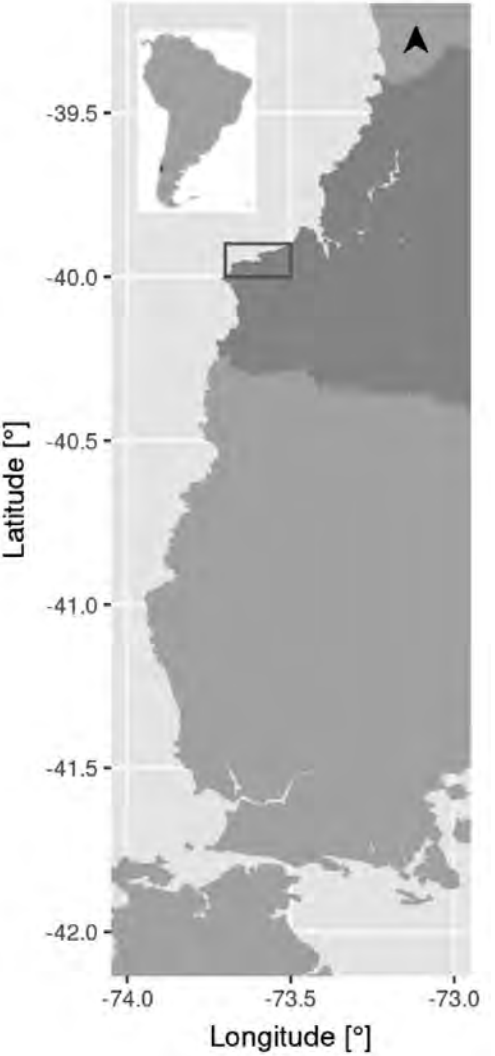

Figure 1. Section of the southern Chilean coast. Los Ríos Region (dark gray) is located north of Los Lagos Region (lighter gray in the south, including the northern portion of Isla Chiloé). The dark gray rectangle in Los Ríos Region highlights Bahía Chaihuín, with Punta Chaihuín as a distinct northwestern landmark. The map was built with *R*, using package 'chilemapas' as its basis.

Sighting 2

On 25 and 26 October 2013, several local citizens independently reported to me at least one SRW in Comuna de Corral. One SRW allegedly moved northeast into Bahía Chaihuín and remained close to the opening of Río Chaihuín. The SRW's behavior was described as "calm, sometimes rolling on the back, showing pectoral fins, thorax, and abdomen." No other cetaceans were mentioned. At 1155 h on 26 October, I started my own observations from a 14-m high location on the bay's northern shore. I saw a ~14-m-long SRW (later with reservations sexed as male) dive in intervals of ≤ 1 min in the northeastern part of the bay. The dives were performed in a horizontal body position, with occasional brief horizontal exposures of the fluke at the surface. The SRW with the fluke may have been engaged with a long, lead-colored object, but visibility precluded confirmation. Balaenids elsewhere have been documented to physically interact, or play, with objects (Würsig et al., 1989; Würsig, 2009).

At 1158 h, this SRW suddenly turned towards the bay's northwestern shore, traveling at ~10 km/h. Increasing speed (to ~15 km/h), the SRW then swam very close to the surface, above, in between, and/or through fishing nets mounted over ~250 m^2 near the northern shore, to the northwestern edge of the bay (i.e., Punta Chaihuín; Figure 1). Fishing gear imposes a potential entanglement threat (e.g., Cooke, 2018; Cooke & Zerbini, 2018). It is unclear whether the SRW crossed the nets intentionally or unintentionally, but both the SRW and the nets remained seemingly unharmed. I followed the SRW to Punta Chaihuín and continued my observations from a ~20-m-high vantage point at 1220 h. The SRW stayed mostly at 50 to 100 m from shore, slightly south of Punta Chaihuín, exhibiting a diverse spectrum of surface and aerial behaviors. Breathing was performed in ventral or vertical (entire head lifted, mouth closed) positions. After a lobtail-initiated submersion of ~5 min, the SRW started a series of breaches (up to two thirds of the body lifted above surface). Reentries were lateral, dorsal, or between the two, yielding foam and loud splashes. Breaching intervals ranged from < 5 s to 1 min, interrupted by respirations or short dives initiated by brief lobtails. The last breach was performed at > 100 m from shore at 1239 h. At 1241 h, the SRW, again between 50 and 100 m from shore, started a sequence of aerial fluke/peduncle behaviors. For ~1 min and in intervals of roughly 15 s, the SRW's posterior body was lifted several times up to 5 m above the surface (see Figure 2). The mostly ventral but also dorsal fluke reentries often produced foam and loud splashes. Note that, because of the height and back-slapping intensity of these lifts, the term "lobtail" is avoided. After this regular pattern, this fluke behavior was combined with different longitudinal body rotations right below the surface, interrupted by short sequences of respiration. As a consequence of this rolling/rotation, many fluke elevations were not vertical but more lateral, and the action was less noisy. Episodes, separated by 30 to 90 s, comprised three to five

Figure 2. Upright tail lifting (sailing) within a series of fluke/peduncle aerial behaviors by the southern right whale on 26 October 2013 (sighting 2) (*Photo credit:* Víctor Andrés Palma Aravena, used with permission)

fluke lifts separated by 6 to 12 s. Respiration was mostly audible onshore. During one sequence, also involving fluke aerial behavior, a breath was immediately followed by a very loud and deep bellowing call (~2 s); it was clearly audible, perceived by myself and a volunteer. Assuming this sound was emitted by the SRW, it may have been an up call/upsweep call (Clark, 1982; Jacobs et al., 2019). Once, two PDs traveled fast and straight southeast into the bay, at a distance of > 50 m to this SRW. No interactions between, or reactions by, the species were apparent. At 1253 h, the SRW started traveling southwest, remaining submerged for 7 min. The SRW repeated the fluke lift behavior at 200 m offshore with respiration intervals of 4 to 60 s. The SRW continued the southwest heading. I stopped observations at 1310 h.

Sighting 3

At 1652 h on 22 July 2014, from the bay's northern shore, I spotted a SRW only ~9 m long, possibly an immature/subadult (e.g., Tormosov et al., 1998). There were ~15 highly active PDs in the same (northeastern) section of the bay performing different leaps, among other behaviors. A direct interaction between both species lasted ~10 min. The odontocetes moved around the SRW, also at distances ≤ 1 PD's length, occasionally even over the whale. After two blows, the SRW's head remained at the surface for several seconds before breathing (Supplemental Video sequence 1; the supplementary video footage for this paper is available in the "Supplemental Material" section of the *Aquatic Mammals* website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147). Next, the SRW lifted the fluke a few centimeters above the surface, let the fluke submerge, and assumed a horizontal position, followed by bubbles visible at the surface. While the SRW was underwater, the PDs swam, humped fast, and plowed (i.e., a distinct variation of a fast ventral surface swim producing a bow wave and whitewater; Niebaum, 2022) over very short distances, mostly in tight subgroups; they changed directions quickly. This activity continued for another 3 min, although with less intensity. At 1704 h, the SRW headed slightly south, and I clearly perceived a strong, deep sound, ~1 s long and different from the one in sighting 2. Assuming this sound was from the SRW, it rather resembled a "slap" (Clark, 1982). Within seconds, all PDs hurried > 1 km away to the bay's southeast. The SRW remained in proximity to the narrow opening of Río Chaihuín, right behind the surf zone, breathing every 1 to 5 min in a ventral position. Pectoral fins above the water surface indicated lateral and dorsal body positions. About 40 min into this observation, the SRW became more active (see Supplemental Video sequence 2). This behavior continued until 1800 h. The SRW then submerged with an arched body, slightly elevated the fluke above surface once, produced bubbles, and left the bay heading northwest.

Both winter sightings, 1 and 3, involved interactions with PDs. These observations partly fit patterns reported for PDs from the Southwestern Atlantic where interactions with SRWs have been described to last up to 4 h and to consist of *Lagenorhynchus* spp. swimming around the larger cetaceans, although not near the fluke (de Haro & Iñíguez, 1997). I perceived and interpreted the behavior in sightings 1 and 3 as interspecific socialization. However, the delineation of some PD behavioral states remains blurry (Niebaum, 2022). Also, no exact conclusions can be drawn on one species' attitude towards the other—for example, whether playful behavior would have been uni- or bidirectional, or whether there was an acute competition over space and/or food resources. To me, it seemed to be the PD who decided whether, or not (sighting 2), to approach the SRW. However, the sound presumably emitted by the apparently younger SRW (sighting 3) might have been an acoustic signal directed at the dolphins. The "slap" might correspond to a "snort," hypothesized to be used by *Eubalaena* spp. to chase off *Lagenorhynchus* spp. (Würsig, 2009). It is unclear what caused the visibly excited PDs to keep their distance to the SRW in sighting 1. The larger individual in austral spring (sighting 2) was apparently either ignored by the two PDs traveling by or actively avoided.

"Sailing" or "tail-sailing"—that is, the uplifting of the peduncle and fluke for several minutes—has often been observed in SRWs and other Balaenid species, although its function remains unknown (e.g., Hamner et al., 1988; Würsig, 2009). Among other functions, a foraging function has been suggested (Hamner et al., 1988). To my knowledge, sailing has not been reported for SEP SRWs. The upright sailing observed in sighting 2 soon changed into a more varied fluke/peduncle behavior, intertwined with body rotation, but was later repeated, interrupting travel activity. Combined with the breaches and emitted call, followed by the presumed male's departure, an intraspecific communicative function of sailing, possibly related to reproductive behavior, is suggested here. Upsweep calls have been hypothesized to serve intraspecific long-distance communication (Clark, 1982), and they have been recorded more often in traveling than during resting, and (to human perception) by lone rather than grouped individuals, of all age classes and both sexes (Clark, 1983, as cited in Jacobs et al., 2019).

It is unclear if some of the observed SRW behaviors in proximity to the opening of Río Chaihuín were playful and/or related to hygiene. At least sightings 2 and 3 likely comprised episodes of skim-feeding, likely on zooplankton (e.g., Valenzuela et al., 2018). Opportunistic spring foraging has been reported for SRWs elsewhere (Hoffmeyer et al., 2010). Accounts of SEP SRWs feeding on small vertebrates have been dismissed so far (Galletti Vernazzani et al., 2014), but SRW foraging strategies may vary greatly among individuals (Valenzuela et al., 2018). Thus, it is unclear whether in Bahía Chaihuín, SRWs additionally take advantage of small anadromous fish species, locally abundant in winter and spring, as has been concluded for PDs (Niebaum, 2022; L. Osman/The Nature Conservancy, pers. comm., 2014).

The fact that there were only three SRW sightings over two years demonstrates that Bahía Chaihuín offers SRW habitat for an infrequent but recurring use during their understudied migrations. Timing of the sightings largely coincided with others from the SEP north of 47/41/40° S (Aguayo-Lobo et al., 2008; Galletti Vernazzani et al., 2014; García-Cegarra et al., 2021). They potentially confirm that the SRW subpopulation prefers coastal waters during winter and spring but do not dispel speculations about summer/fall subantarctic vs offshore migrations (Cooke, 2018; Cooke & Zerbini, 2018). Nevertheless, upsweep calls have recently been recorded at Isla Chiloé, also in summer and fall (Jacobs et al., 2019). Regarding Los Ríos Region, locals, including staff of the nature reserve Reserva Costera Valdiviana, run by The Nature Conservancy, told me about a SRW spending several days and giving birth in Bahía Chaihuín a few years prior to 2013. Though seemingly undocumented, the occurrence of such an event in the sheltered, shallow bay is not unlikely, and I strongly encourage further research as much as the maintenance of collective conservation efforts.

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Juvenile Northern Elephant Seal (*Mirounga angustirostris*) Onshore with Prey at Point Reyes National Seashore

Marjorie A. Cox,[1, 2] Sarah A. Codde,[3] and Matthew J. Lau[3]

[1]Point Reyes National Seashore Association, 1 Bear Valley Road, Point Reyes Station, CA 94956, USA
[2]California Academy of Sciences, 55 Music Concourse Drive, San Francisco, CA 94118, USA
E-mail: Mcox@calacademy.org
[3]Point Reyes National Seashore, 1 Bear Valley Road, Point Reyes Station, CA 94956, USA

In situ observations of northern elephant seal (*Mirounga angustirostris*; NES) foraging behavior are exceedingly rare as they primarily feed at depths of 400 to 600 m (Robinson et al., 2012). Previous studies of the NES diet using stomach content analysis found a large proportion of squid; however, these findings were biased toward prey species with hard parts that are retained in the stomach (i.e., squid beaks; Antonelis et al., 1994). The use of developing technologies such as satellite tags, time-depth recorders, and animal-mounted video recorders in relation to foraging depth and location have determined that the diet of adult female NESs primarily consists of myctophid fishes in addition to opportunistic feeding on mesopelagic squid species (Yoshino et al., 2020; Adachi et al., 2021). However, even with video images of prey items, it is difficult to identify to species from the images alone (Yoshino et al., 2020).

Adult female NESs tend to forage in the water column off the continental shelf, while adult males mostly forage benthically along the continental margin (Le Boeuf et al., 2000). Research on foraging behavior has focused on adults, primarily adult females, but juvenile foraging behavior has not been as widely researched. Many juveniles may not migrate as far or travel as quickly as adults; however, they exhibit the same general migration and diving pattern (Le Boeuf et al., 1996). By their fourth migration, as 2-y-olds, juvenile diving appears to be equal in depth and duration to an adult's (Le Boeuf et al., 1996). Most juvenile NESs are on land for 1 to 3 mo in the fall for the "juvenile haulout" and for several weeks in the spring to molt. During the haul-out periods, the NESs are fasting on land and rely on their blubber stores for energy (Ortiz et al., 1978). At Point Reyes National Seashore (PRNS), yearling (1 y) NESs are observed year-round, although the majority are at sea during breeding season (December through March), which suggests variability in juvenile migratory and foraging behavior.

On 25 January 2022, during a routine population survey, PRNS biologists observed a juvenile, likely 1-y-old, NES on shore with prey. Age was determined by body size, pelage condition, and seasonal timing. Sex was not determined as the ventral area was not visible. The NES was observed in the rocky intertidal, swimming into a cove with a fish dangling from the lower teeth (Figure 1). The NES was observed for about 5 min hauling out of the water and continually moving up the beach, periodically resting while the fish remained in its mouth (Figure 2). The observers moved past the NES to avoid disturbance. Approximately 20 min later, the biologists returned to the site and observed the NES resting on the beach. The area was searched, and the fish was not found, appearing to have been consumed by the NES. A small amount of blood was visible around the NES's mouth. It is unlikely that parasitic common ravens (*Corvus corax*) or gulls (*Larus* spp.) had stolen the prey since parasitic bird activity was not observed.

The prey item was identified as a spotted ratfish (*Hydrolagus colliei*) by California Academy of Sciences Ichthyology Collection Manager Dave Catania. This species is a known prey item of NESs determined through stomach contents (Antonelis et al., 1994), but recent research suggests this may not be a common prey item, at least for adult females (Yoshino et al., 2020). Spotted ratfish are found in coastal benthic habitat from southeast Alaska to the Gulf of California (Hart, 1973), from the intertidal to > 900 m depth (Jopson, 1958). The range of this fish suggests that it would be an available prey item for juvenile NESs.

Since regular monitoring of NESs began at PRNS in 1984, this behavior has not been documented. After consultation with researchers at Año Nuevo State Reserve, we ascertained that an observation with a NES on shore with prey has not been documented in the southern rookeries. The NES arriving on land with an apparently

Figure 1. Juvenile northern elephant seal (*Mirounga angustirostris*) in water with spotted ratfish (*Hydrolagus colliei*) in mouth (*Photo credit:* M. Cox/NPS)

Figure 2. Juvenile northern elephant seal exiting water with spotted ratfish in mouth (*Photo credit:* M. Cox/NPS)

fresh-caught and fully intact fish suggests it was captured in nearshore waters and possibly brought on land to avoid inter- or intraspecific in-water competition. If bringing prey on shore was a common behavior, it would likely have been documented previously as NESs are one of the most consistently studied species of marine mammal. More in-depth research on juvenile, and specifically yearling, behavior is needed to determine if this observation was an anomaly or if some yearling NESs are foraging near their haul-out sites and may opportunistically bring prey ashore. If juvenile NESs are foraging closer to shore, it may contradict the hypothesis that all age classes of NESs are continuously fasting during haul-out periods. Regardless, this is a unique sighting of a NES with a clearly identifiable prey item.

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A Stampede of Risso's Dolphins (*Grampus griseus*) Following Playbacks of the Calls of Mammal-Eating Killer Whales

Andrew J. Read,[1] Danielle M. Waples,[1] Heather J. Foley,[1]
Zachary T. Swaim,[1] John Calambokidis,[2] Alex Vanderzee,[2]
Douglas P. Nowacek,[1] and Brandon L. Southall[1, 3]

[1]*Duke University Marine Laboratory, 135 Duke Marine Lab Road, Beaufort, NC 28516, USA*
[2]*Cascadia Research Collective, 218½ W. 4th Avenue, Olympia, WA 98501, USA*
[3]*Southall Environmental Associates, 9099 Soquel Drive, Suite 8, Aptos, CA 95003, USA*

During our respective careers, we have been fortunate to witness some dramatic observations of animal behavior in the field, but it can be difficult to portray the intensity of these events with the sterile prose we typically employ in scientific manuscripts. In this brief paper, we describe one of the most dramatic behavioral responses we have witnessed in more than 200 playback trials with natural and anthropogenic sounds to dozens of marine mammal species.

In August 2013, we were conducting controlled playback experiments off Catalina Island, California, to determine how Risso's dolphins (*Grampus griseus*) responded to the sounds of mammal-eating killer whales (*Orcinus orca*). This was part of a broader study of how social structure influences the behavioral response of odontocetes to these predators.

Our field protocol was typical for such experiments—full details are available in the original paper (Bowers et al., 2018). We deployed a Digital Acoustic Tag (DTAG) on a focal dolphin from a rigid-hulled inflatable boat (RHIB) and supplemented the tag record with visual observations of the focal individual and its social group from the RHIB. To conduct the playbacks, we deployed a custom sound source from a larger vessel situated several hundred meters away from the focal animal. In each trial, we played three acoustic stimuli in random order: calls of mammal-eating killer whales, calls of humpback whales (*Megaptera novaeangliae*), and calls of other Risso's dolphins. Each stimulus consisted of seven repeated calls spaced 4 s apart, so the entire presentation of each stimulus lasted for approximately 30 s. The three stimuli were presented 30 min apart, and observers on the RHIB were blind to the playback sequence and identity of the calls used in each trial.

On 15 August, we were working just northeast of Catalina Island in excellent conditions—overcast and calm. At 1130 h (PDT), we observed a group of ~15 Risso's dolphins and tagged an adult animal of unknown sex (CRC-477) at 1238 h (Figure 1). Subsequent photo-identification of this group confirmed that at least 10 different individuals were present. Six of these individuals had been identified in previous years near Catalina, and two have been photographed in subsequent years.

We began a focal follow of the tagged whale in a group of five animals at 1244 h. At 1250 h, more dolphins approached the focal group, and the animals spread out in a scattered aggregation. We briefly lost track of the focal animal but relocated it at 1320 h in a group of 12. We presented the first stimulus (the calls of other Risso's dolphins) at 1322 h, and the focal animal and its group exhibited little or no visible response. At 1352 h, when we presented the second stimulus (calls from a mammal-eating killer whale), the focal group consisted of ~20 animals. The group became quiet (based on recordings from the DTAG), and the animals started to travel west at a moderate pace. At 1400 h, the focal group suddenly started porpoising to the southwest and, at 1410 h, they further increased their travel speed and headed to the north-northwest. By 1411 h, the animals were swimming rapidly, performing rapid direction changes and fast surfacings. The tag came off the focal animal at 1414 h and was retrieved by the small boat crew at 1420 h, who returned it to our larger research vessel.

We decided to send observers back out to relocate the focal group and obtain additional photo-identification images. At 1430 h, we resighted the group, which had raced off to the west; the RHIB had to run very hard to approach the animals. Our larger vessel, with a top speed of ~12 kts, was unable to catch up. The Risso's dolphins were swimming extremely rapidly in a tight group, with every animal porpoising as they surfaced in synchrony. The lead group consisted of ~25 animals

Figure 1. (A) Focal Risso's dolphin (*Grampus griseus*) on 15 August 2013 off Catalina Island, California; and (B) focal group of Risso's dolphins fleeing from the sound source, observed by researchers in the RHIB. (Photos taken by Danielle Waples, NOAA Permit #14534)

in a tight chevron formation, with each animal almost within touching distance of its neighbor. Two other groups of ~25 Risso's dolphins were exhibiting the same behavior, trailing behind the lead group by 75 to 100 m. By 1440 h, the lead group was still very tight and running hard at 10 kts (18.5 km/h; we used the GPS on the RHIB to estimate travel speed). By 1456 h, the animals finally dropped their speed to 5 kts, and one animal began chin slapping. The group then slowed even more and milled together in a very tight group; and at 1511 h, they moved off to the southwest. Observers aboard the RHIB reported that the animals appeared exhausted.

Several aspects of this response are noteworthy. First, this was one of the most dramatic responses we have witnessed in a playback trial with any species. The animals responded to the calls of a potential predator by increasing group cohesion and stampeding away from the source of the sounds in extremely tight groups. This response took the animals approximately 10 km away from their original position in less than an hour. Such sustained, high-speed directed travel is highly atypical for this species; we have not observed it before nor since in more than a decade of research on Risso's dolphins in various sites around the world (see Barluet de Beauchesne et al., 2022, for a rich description of the behavioral response of this species to the sounds of conspecifics). Second, the most dramatic aspect of the response occurred *after* the DTAG had been shed by the focal animal, presumably due to its kinematic response to the killer whale calls. Thus, we were unable to capture this portion of the response on the tag record, instead relying on focal observations for this later aspect of the response. Finally, and perhaps most interestingly, the most dramatic portion of the response to the killer whale calls was delayed rather than immediate. The focal animal and its group responded immediately to the calls by moving rapidly away from the source but waited for almost 30 min for the final stampede. We speculate that, during this period, the Risso's dolphins localized the source of the killer whale calls and then listened for additional calls. When they heard none, they chose to flee in a directed manner away from the perceived threat. The animals may have also used this period to coordinate their collective response with other groups in the area. It is worth emphasizing that our acoustic stimulus was very brief—only 30 s or so—and that mammal-eating killer whales are typically silent when hunting.

These observations complement recent studies that have investigated the response of marine mammals to tactical military sonars in the context of anti-predatory behavior (Harris et al., 2017; Miller et al., 2022). There is increasing evidence that marine mammals respond to certain types of sonar in a manner that is consistent with their species-specific anti-predator behavior. Further, among species that respond to the sounds of predators by fleeing, such a delayed response may not be uncommon. For example, in ongoing studies of the behavioral responses of Cuvier's beaked whales (*Ziphius cavirostris*) to tactical military sonar, we have observed similar delayed behavioral responses in which the strongest and most sustained avoidance behavior occurs minutes and even hours following acoustic exposure (Southall et al., unpub. obs.). We believe that, in such cases, once a perceived threat has been localized but is no longer audible, animals may respond by moving rapidly away from the last known location of the threat.

We hope that these observations capture some of the intensity of the response we observed on that beautiful August afternoon off Catalina Island. None of us ever had observed such behavior before that day nor have we seen anything of comparable magnitude since.

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Play Behavior by a Juvenile Humpback Whale (*Megaptera novaeangliae*) with an Inanimate Object (Driftwood) in the Gulf of Tribugá, Colombia

Ann Carole Vallejo,[1] Dalia C. Barragán-Barrera,[1] Nohelia Farías-Curtidor,[2]
Jenny Bachmann,[1] Edwin Gonzáles Murillo,[1, 3] Luis Antonio Lloreda,[1, 3]
and Yerson Gonzáles Murillo[1, 3]

[1]*R&E Ocean Community Conservation, 2580 Valleyridge Drive, Oakville, ON L6M 5H5, Canada*
E-mail: carole.vallejo@oceancommunityconservation.org
[2]*Independent researcher, Bogotá, Colombia*
[3]*Local fisherman, Jurubirá, Colombia*

Humpback whales (*Megaptera novaeangliae*) are a cosmopolitan species that often visit inshore waters close to the coast, making it easier to see and study them. Consequently, this baleen whale has been researched the most, particularly in Colombia (Flórez-González et al., 2007; Avila et al., 2013). The Colombian Pacific is visited by hundreds of humpback whales from Stock G (that feed along the western Antarctic Peninsula) from early May to late December (Acevedo et al., 2017; Avila et al., 2020). These whales use the warm and calm Colombian waters to breed and mate (Flórez-González et al., 2007; Avila et al., 2013, 2020). The Gulf of Tribugá, located on the north Pacific coast of Colombia, is known for its biodiversity and pristine ecosystems almost untouched by human development. Humpback whales are common here. Throughout the breeding season, humpbacks, including competitive groups of males, solitary males, and mother–calf pairs with or without escorts, can be observed displaying a variety of behaviors.

Assessing whale behavior offers a better understanding of the importance of these species in marine ecosystems as well as giving knowledge about their ecology and habitat use (Kiszka et al., 2015). Focal follow efforts of humpback whales have facilitated research into identifying and categorizing their behavior (Kavanagh et al., 2017), including general behaviors (diving, resting, foraging; Tyson et al., 2012; Friedlaender et al., 2016), surface actions (breach, head lunge, tail and fin slaps; Deakos, 2002; Kavanagh et al., 2017), feeding (via bubble net, lunge-feeding, snaking, surface straining; Hain et al., 1982), and interactive behaviors (spy-hopping, rolling, play with an object, evasion; Félix & Botero-Acosta, 2012), among others (Clapham, 2000; Kiszka et al., 2015; Kosma et al., 2019).

Whales and dolphins often interact in playful ways, which suggests innovation and creativity (Patterson & Mann, 2015), with playful activity prevalent among various species and exhibited by all age classes (Paulos et al., 2010). It has been suggested that play behavior may facilitate an individual's ability to acquire knowledge, adapt to changing environments, contribute to species survival, and provide young animals a venue in which they may cultivate important relationships (Mann & Smuts, 1999; Kuczaj & Makecha, 2008). Nonetheless, defining what play represents in animals is difficult and a subject of debate (Burghardt, 2005). Herein, we report the first observed humpback whale play behavior with a foreign object in the Gulf of Tribugá in Colombia.

In August 2020, ongoing cetacean monitoring was performed by a group of trained fishermen from the Gulf of Tribugá as part of a community science program implemented by the R&E Ocean Community Conservation Foundation as a contingency plan for monitoring marine mammals in the area during COVID-19 lockdown. On 28 August, during a survey, a juvenile humpback whale was encountered. The young whale, ~7 m long, was seen close to Termales (Latitude: 65° 24' 649" N; Longitude: 77° 27' 675" W; Figure 1), within the Gulf of Tribugá, at 1109 h. About 600 m away, the original behavior noted was identified as resting on its back, with the white ventral side visible at the surface. However, once the team carefully approached the individual (~5 m), they detected an object, identified as an ~1.5-m-long piece of driftwood, which this juvenile was rolling around its body. Observations and video-photographic evidence collected by the research team (fishermen) showed the following behaviors displayed by this juvenile humpback whale:

- Very shallow, almost superficial dives, submerging and coming up underneath the driftwood, positioning it on its back close to the dorsal fin, and lifting it (Figures 2A & 3A)

- Rolling observed, which is likely to change the position of the driftwood from its back to its ventral side (Figures 2B & 3B)

- Some type of manipulation or maneuvering of the driftwood with its pectoral fins (Figure 3C), as well as budging and pushing the driftwood with its rostrum (Figures 2C & 3D)

- Tail movements such as very small ventral tail slaps and swishes at surface (see Supplementary Video 1, which is available in the "Supplemental Material" section of the *Aquatic Mammals* website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147)

In general, the humpback whale seemed relaxed and to be engaged in a very playful interaction with the driftwood. The whale's behavior did not seem interrupted by the presence of the research

Figure 1. Geographic position of where a humpback whale (*Megaptera novaeangliae*) was observed playing with an inanimate (driftwood) object in the Gulf of Tribugá (northern Colombian Pacific)

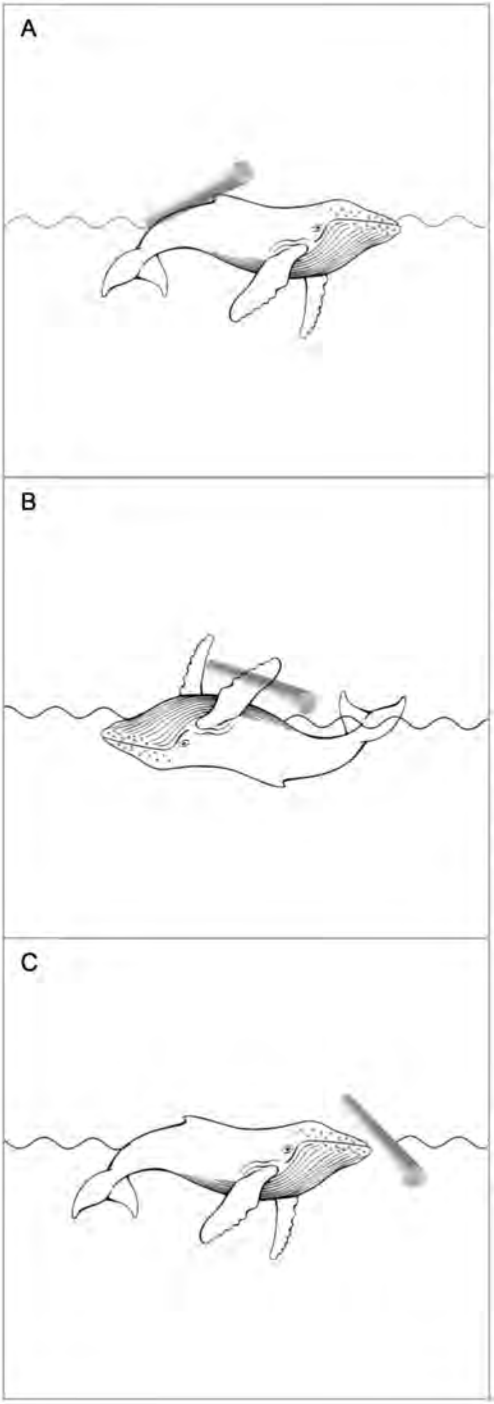

Figure 2. Graphic description of a young humpback whale playing with driftwood: (A) inanimate object on its back close to the dorsal fin; (B) object on the ventral side around the pectoral fins; and (C) whale pushing driftwood with its rostrum. (Sketches created by Ann Carole Vallejo)

boat, and no other boats were present. The behavior was observed for almost 11 min. The sighting ended at 1120 h.

This behavior meets at least three criteria for play categorization in animals suggested by Burghardt (2005): (1) it was voluntary and seemed pleasurable or self-rewarding; (2) it was different from more serious behaviors in that it was exaggerated, precocious, or incomplete; and (3) even though during the observation start the juvenile was already interacting with the driftwood, the animal did not seem stressed or hungry and appeared healthy. This kind of behavior has been observed in other cetaceans, mainly in odontocetes, such as dolphins, but a few object play observations have been reported for mysticetes (Parra, 2007; Owen et al., 2012; Shea & Gallagher, 2021).

Studies on wild and captive dolphins suggest that individuals have the capacity to carry animate and inanimate objects on their rostra, melons, fins, and tail flukes (Miles & Herzing, 2003; Kuczaj & Yeater, 2007; Parra, 2007). Object manipulation has a range of functions (Smolker et al., 1997; Parra, 2007), including socio-sexual displays (Martin et al., 2008), epimeletic behavior (Fertl & Fulling, 2007), and object play (Payne, 1972; Würsig et al., 1989; Bloom, 1991; Miles & Herzing, 2003; Greene et al., 2011). For example, functional behavior has been observed in bottlenose dolphins (*Tursiops truncatus*) carrying objects on their rostrum and on the melon, pectoral flippers, and tail flukes in Shark Bay, Western Australia, and in England, respectively (Bloom, 1991; Parra, 2007). Courtship behaviour has been observed with aquatic plants and balls of clay (Martin et al., 2008). Play behaviour was studied for captive bottlenose dolphins from the Roatan Institute for Marine Science on Roatan, Honduras, and for wild Atlantic spotted dolphins (*Stenella frontalis*) from near Bimini, The Bahamas; these object play interactions found that the captive dolphins played with biological debris, human-made objects, inanimate objects, and trash while wild dolphins interacted more with the sand (Greene et al., 2011). Atlantic spotted dolphins (Miles & Herzing, 2003) and rough-toothed dolphins (*Steno bredanensis*; Kuczaj & Yeater, 2007) have been documented carrying seagrass. In Patagonia, Argentina, killer whales (*Orcinus orca*) play with their prey, throwing prey in the air and recapturing it again, repeating this activity a couple of times for each prey item (Lopez & Lopez, 1985).

Among baleen whales, southern right whale (*Eubalaena australis*) calves in Patagonia have been observed manipulating seaweed with their heads and flippers (Payne, 1972). In Australia, juvenile and subadult humpback whales grasp seaweed in their mouths and drape it over their backs and

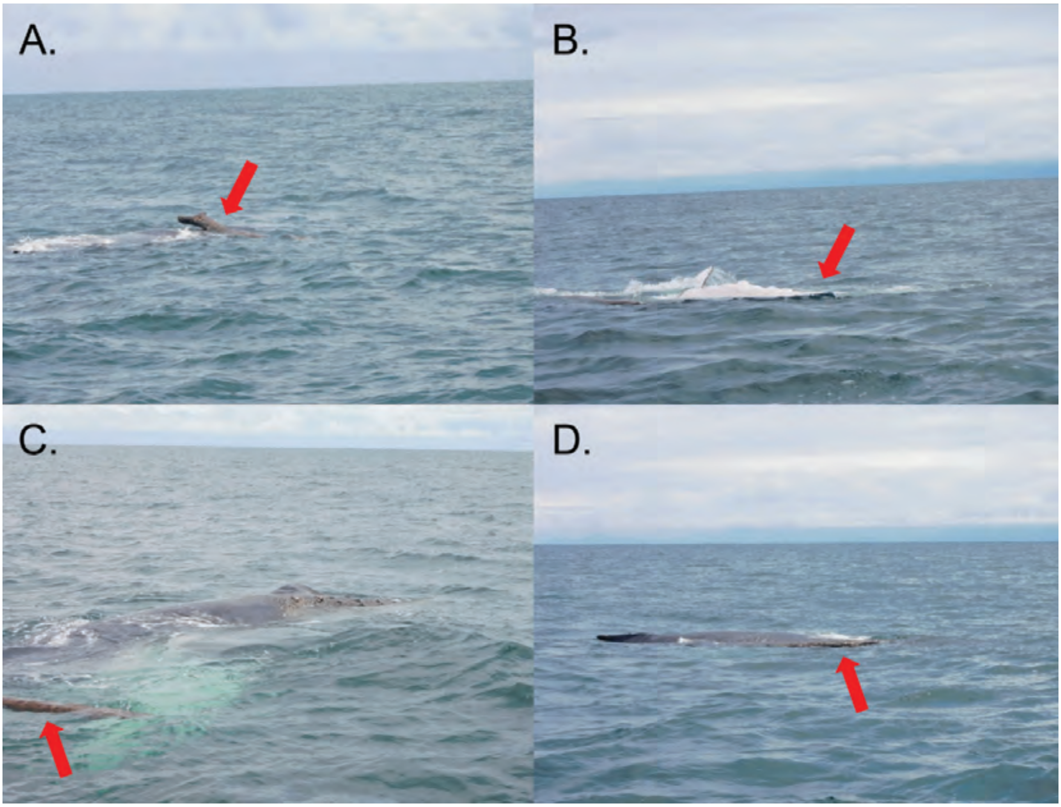

Figure 3. Photos of a young humpback whale playing with driftwood in the Gulf of Tribugá (northern Colombian Pacific): (A) the humpback carrying driftwood on its back; (B) the whale with driftwood on its ventral side and by its right pectoral fin; (C) the humpback with driftwood by its right pectoral fin; and (D) the whale nudging driftwood by with its rostrum. Red arrow in all frames shows driftwood position. (*Photo credit:* Yerson González Murillo)

pectoral fins (Owen et al., 2012). In Hawaii, a juvenile female humpback whale was observed manipulating a big piece of cargo net; over the course of an hour, it passed the net between its pectoral fin to its rostrum repeatedly (Deakos et al., 2010).

A recent study off New England recorded an encounter between a humpback whale and a large lion's mane jellyfish (*Cyanea capillata*; Shea & Gallagher, 2021). Even though manipulation of the jellyfish was similar to how the humpback manipulated the driftwood in this event, the purpose might have been different. Detailed observation of the jellyfish manipulation by the whale's fins and rostrum suggested a purpose that was potentially therapeutic, specifically for wound healing or parasite removal (Shea & Gallagher, 2021), which was not indicated with the driftwood interaction here.

Observations reported here were similar to those made by Würsig et al. (1989) of bowhead whales (*Balaena mysticetus*) in the Beaufort Sea. During 1981, 1982, and 1984, bowhead whales were observed playing with an organic item—a log, ~20 m long—from 5 s to 1.5 h. Most interactions with logs consisted of whales nudging or pushing them with their head or body, manipulating the logs with flippers while belly-up underneath the logs, or lifting the log with the back or tailstock (Würsig et al., 1989). Additionally, there was a news report in British Columbia near Comox Harbor (retrieved 22 April 2022): a ~4-y-old humpback whale was seen playing with a log, and its behavior was referred to as logging or resting. The interaction was described as the whale repetitively going back and forth, diving with a large log, lifting it onto her head, and actively playing with it (Zimmer, 2018).

In the Gulf of Tribugá, the young humpback was observed doing the same behavior as described for bowhead whales (Würsig et al., 1989), nudging or pushing, lifting, manipulating, and moving with and around the driftwood. It has been suggested that this type of behavior may provide a mechanism by which young animals perfect motor skills via practice, which can facilitate the development of flexible problem-solving skills by providing animals a safe context to explore the consequences of new behaviors (Kuczaj & Makecha, 2008). In addition, the manner in which these whales interact with logs/driftwood seems to be similar to that seen in bouts of sexual behavior (Würsig et al., 1989) and maternal discipline (Payne, 1995).

Many cetaceans have shown high cognitive capacity, behavior plasticity, and learning capabilities (Patterson & Mann, 2015); and while some behaviors may be better understood than others in humpback whales, the few examples of innovative object use in mysticetes suggest we have more to learn about their behavioral subtleties (Paulos et al., 2010; Shea & Gallagher, 2021). The study of play in cetaceans is made difficult because of their aquatic lifestyle. Observations of wild cetaceans are limited to surface behavior, although there are exceptions (e.g., Brunnick, 2000; Dudzinski et al., 2009). Therefore, inclusion of trained local communities in sampling efforts, particularly in developing countries where long-term monitoring programs have not been established, gives us the opportunity to monitor more frequently areas with gaps about cetacean occurrence and behavior. As a result of these observations of play behavior, the scope of knowledge regarding the social dynamics, developmental processes, flexibility, and cognitive abilities of cetaceans has been expanded.

Acknowledgments

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Novel Bubble-Cloud Feeding Behavior of a Humpback Whale (*Megaptera novaeangliae*) in the Gulf of California

Joelle J. Buffa,[1] Chris Biertuempfel,[2] and Maria Najera[3]

[1]*School of Natural Resources and the Environment, ENR2-Building, 1064 E. Lowell Street,*
University of Arizona, Tucson, AZ 85721, USA
E-mail: clyde_joelle@verizon.net
[2]*Oceanic Society, 30 Sir Francis Drake Boulevard, Ross, CA 94957, USA*
[3]*Vive Loreto Tours, Loreto, Baja California Sur, México*

Humpback whales (*Megaptera novaeangliae*) undergo long migrations between high latitudes where food sources are rich in the summer and low latitudes where calving and breeding occur in the winter. Although monotypic, three separate populations are generally recognized: (1) North Pacific, (2) North Atlantic, and (3) Southern Hemisphere (Shirihai & Jarrett, 2006). The North Pacific humpback whale population's summer feeding range primarily encompasses the Pacific Rim from California in the United States to Kamchatka in Russia, including offshore waters of Alaska, British Columbia, Washington, Oregon, and California (Calambokidis et al., 2000; Urbán et al., 2000; Barlow et al., 2011). México is one of three main wintering areas (others include Japan and Hawaii) used by North Pacific humpback whales. Four subregions are recognized within México: (1) Southern Baja California coast, (2) Northern Gulf of California, (3) mainland coast of México, and (4) the Revillagigedo Archipelago (Urbán & Aguayo, 1987; Calambokidis et al., 2001). Urbán et al. (2000) and Calambokidis et al. (2001) indicate that wintering Mexican Pacific humpback whales preferentially migrate to California, Oregon, and Washington, and, to a lesser extent, to British Columbia summering areas.

Humpback whales employ a variety of feeding techniques, some of which involve the coordination and cooperation of multiple individuals. Lunge-feeding is a whale rushing upward from below, breaking the water surface at a near-vertical angle with mouth agape to capture prey (Hain et al., 1982). Numerous studies have described bubbling behaviors used to confuse, corral, and capture prey—mostly schooling fish (e.g., herring [*Clupea* spp.]; Sharpe & Dill, 1997; Friedlaender et al., 2011) or krill (*Euphausia* sp.; Jurasz & Jurasz, 1979; Hain et al., 1982). During bubble feeding, the whale(s) blow(s) bubbles underwater in varying patterns that form clouds, encircling nets, or curtains as they rise to the surface (Clapham, 2000; Friedlaender et al., 2011). These bubbles manipulate prey behavior by constraining the movement of fish schools (Sharpe & Dill, 1997). An individual or multiple whales will then lunge vertically either through or to the side of the bubbles to gulp down prey that are caught in the bubble structure. Laboratory experiments simulating whale bubble nets showed that Pacific herring (*Clupea harengus pallasi*) are reluctant to swim through a bubble curtain even when frightened (Sharpe & Dill, 1997).

Two general types of bubble-feeding behaviors have been described: (1) bubble-net feeding and (2) bubble-cloud feeding (Jurasz & Jurasz, 1979; Hain et al., 1982). Bubble-net feeding involves the underwater release of multiple columns of random-sized bubbles that rise to the surface forming a net, curtain, or spiral through which the whale(s) lunge(s) to feed (Friedlaender et al., 2011). Bubble-net feeding has been well-documented in Northern Pacific humpback whales on their Southeast Alaska summer feeding ground (Jurasz & Jurasz, 1979), in the Northwestern Atlantic (Hain et al., 1982), and in the Southern Ocean (Mastick, 2016). In bubble-cloud feeding, a single underwater exhalation produces a single relatively large (4 to 7 m in diameter) circular cloud of small, uniform-sized bubbles that rise to the surface (Hain et al., 1982). Clapham (2000) reported a difference in humpback foraging techniques between oceans, with bubble clouds being the most common bubble structure used in the North Atlantic but never observed in the North Pacific.

This paper reports our observation of an individual humpback whale bubble-cloud feeding on small schooling fish in the Gulf of California offshore of Loreto, Baja California Sur, México. Our observation is rare in several respects. Except for one report in northern California (Kieckhefer, 1992), we found no documentation of bubble-cloud feeding in the North Pacific population despite it being a common technique used by North Atlantic humpback whales (Hain et al., 1982). Second, the behavior we observed occurred on the winter range. Humpback whales typically do not feed in their tropical breeding areas (Clapham, 2000); however, there are a few documented occurrences of humpbacks feeding in Mexican waters (Urbán & Aguayo, 1987; Frisch-Jordán et al., 2019). Only one (Gendron & Urbán, 1993) described a solo humpback creating a bubble net (not a cloud) to feed on krill in the southern Gulf of California, México.

The individual we are reporting is a previously identified humpback whale, cataloged CRC-18680 in the Cascadia Research Collective database and as HW-MN0502142 in the Happy Whale database. It was photographed and positively identified in the Santa Barbara Channel, California (June 2019 and September 2020), and in the Gulf of California, Baja California Sur, México (February 2020) (Figure 1).

The authors made this sighting while aboard the 7.62-m panga *Concha* during a whale-watching trip organized by the Oceanic Society (Ross, CA, USA) and Vive Loreto Tours (Loreto, Baja California Sur) on 26 March 2021. Visibility was good (~4.5 km), and sea conditions were calm (Beaufort Sea State 1). The observation, which began at 1200 h and lasted for ~1 h, occurred in nearshore waters just north of Isla Coronado, Baja California Sur, México (26° 9' 51.942" N, 111° 17' 32.898" W).

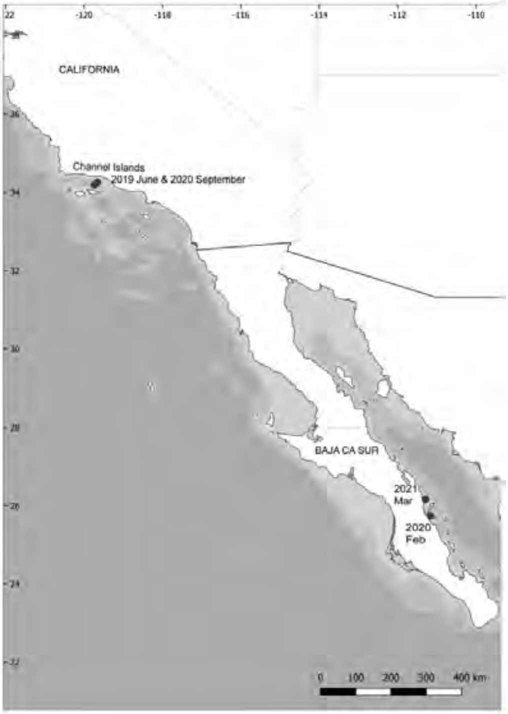

Figure 1. Sightings of humpback whale (*Megaptera novaeangliae*) CRC-18680/HW-MN0502142 in coastal waters of the Gulf of California, Baja California Sur, México, and in Santa Barbara Channel north of Channel Islands (Map courtesy of S. A. Thompson, Farallon Institute, Petaluma, California)

On the morning of 26 March, our group was snorkeling on the east side of Isla Coronado, where, among the many species of tropical fish, we noted a large bait ball of sardines. At ~1135 h, our captain received a marine radio call from another skipper reporting a large whale off the northern tip of Isla Coronado. We motored north along the Isla's eastern side and located the humpback whale. The behavior we describe below was ongoing as we approached the area where the other vessel was already present.

A solitary humpback whale was actively feeding. After swimming back and forth several times at the surface, it dove, fluke exposed, as it sounded. Photos of the ventral fluke were collected for identification and to document behavior (Figure 2). Several minutes later, a 12- to 16-m diameter circle (as estimated by its size in relation to the length of the whale) of small uniform bubbles rose to the surface (a bubble cloud). Less than 5 min following bubble-cloud formation, the whale explosively lunged vertically through the center of the bubble cloud it had created, mouth agape. As it rose one-quarter to one-third the length of its body above the water's surface, it closed its mouth and, with the throat and lateral pleats very distended, expelled water (Figure 3). Small fish could be seen jumping at the surface of the bubble cloud.

During our observation period, the humpback repeated the pattern of swimming, diving, bubble-cloud creation, and lunge-feeding on small schooling fish associated with the bubble structures in a large arc around our vantage point. Each of the four to five bubble clouds that we observed appeared on the water surface as a whitish or aqua-colored oval or circle that contrasted with the surrounding undisturbed deep blue surface (Figure 4). Most of the bubble clouds were widely spaced, at least 200 m or more apart, and 5 to 10 min elapsed between each bubble cloud's creation. However, in one instance, the whale created two bubble clouds less than a whale length apart and lunge-fed vertically up through the undisturbed water between the two bubble structures. We last saw this humpback whale swimming in a northeasterly direction, away from Isla Coronado.

The third author (MN) leads regular marine ecology boat trips in the area and had observed this humpback whale in the same general area over the previous 3 mo. It was always observed alone, but bubble-feeding behavior had not been noted in those previous encounters.

Figure 2. Tail fluke ID photo of humpback whale CRC-18680/MN0502142 taken 26 March 2021 (*Photo credit:* Chris Biertuempfel)

Figure 3. Humpback whale CRC-18680/HW-MN0502142 lunge-feeding through bubble cloud on water surface, 26 March 2021 (*Photo credit:* Chris Biertuempfel)

Figure 4. Bubble cloud rising to water surface prior to humpback whale lunge-feeding, 26 March 2021 (Photo courtesy of Clyde Morris)

Allen et al. (2013) traced the cultural spread of a novel foraging technique related to bubble feeding through a North Atlantic population of humpback whales over a 27-y period. In 1980, one whale in the Gulf of Maine was observed using an innovation, now called lobtail feeding, followed by a bubble-feeding sequence. Analyzing legacy data collected by observers on commercial whale-watching boats, the percentage of whales using this behavior accelerated through time until the end of the study (2007) when 37% of the population was sighted lobtail feeding. Other studies (Cerchio et al., 2001; Helweg et al., 2005) indicate that year-to-year changes of humpback whales' complex breeding songs in the North Pacific and Southern Hemisphere are culturally spread. This suggests that humpbacks learn by watching or listening to their neighbors.

Humpbacks have strong fidelity to specific summer feeding areas and winter breeding/calving regions (Urbán et al., 2000; Calambokidis et al., 2001). Genetic and resighting evidence suggests two groups of humpback whales in the eastern North Pacific: (1) a central stock that feeds in Alaskan waters and migrates predominantly to Hawaii and (2) a southern stock that feeds along the coast of California and winters off México (Baker et al., 1998; Urbán et al., 2000). Two consecutive winter sightings of humpback whale CRC-18680/HW-MN0502142 in México combined with two consecutive summer sightings in California indicate it belongs to the southern stock. Since bubble foraging has rarely been reported for this stock, our observation raises some intriguing questions about the origin, adoption, and spread of novel feeding behaviors.

One hypothesis is that this humpback had an encounter with a member of the central stock, which utilizes bubble-feeding behaviors more commonly on the summer range and adopted the feeding method. Although solo when we observed it, humpback CRC-18680/HW-MN0502142 was in a group of five whales when first documented on 29 June 2019. An alternative hypothesis is that this individual devised and began using bubble-cloud feeding independently. In either case, it would be valuable to track whether the bubble-feeding behavior is transmitted and spreads through the southern stock of the eastern North Pacific.

Photo-identification of individual whales is important in describing movements between wintering habitat and summer feeding areas (Calambokidis et al., 2001) and has been used to trace the origin, adoption, and spread of novel feeding behaviors (Allen et al., 2013). Cooperative or "crowd sourced" databases, such as Happy Whale, would be particularly helpful in tracking socially transmitted behaviors that take place over large distances and take longer to manifest than the time span of many research projects. An understanding of culturally transmitted feeding behaviors would be furthered by researchers and other observers logging whale encounters in photographic databases and documenting anecdotal observations.

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Blue Whale (*Balaenoptera musculus*) Mother–Calf Pair Behavioral Response to Vessel in the Southern California Bight

Mari A. Smultea,[1] Frances C. Robertson,[2] and Dagmar Fertl[1, 3]

[1]*Smultea Environmental Sciences, PO Box 256, Preston, WA 98050, USA*
E-mail: mari@smulteasciences.com
[2]*San Juan County Marine Program, PO Box 729, Friday Harbor, WA 98250, USA*
[3]*Ziphius EcoServices, 30403 N. Holly Oaks Circle, Magnolia, TX 77355, USA*

During systematic line-transect aerial surveys flown to collect data on marine mammal density and behavior in the Southern California Bight (for detailed methodology, see Jefferson et al., 2014; Lomac-MacNair & Smultea, 2016; Smultea, 2016), the opportunity arose to interrupt the survey to circle and video-document a blue whale (*Balaenoptera musculus*) mother and calf's behavioral response to an approaching recreational vessel; details are described herein.

On 24 May 2013, a solitary blue whale mother–calf (MC) pair was sighted ~12 km west of Mission Beach, California (32.7618 N, -117.3808 W), in waters with a depth of 1,064 m. The MC pair was circled with the survey aircraft for 54 min, from 0824 to 0918 h (PST). The calf was estimated to be a little more than one-half of the mother's body length (BL) (~12 m based on an average BL of ~23 m for a female North Pacific blue whale; McClain et al., 2015). A small outboard recreational vessel (~10 m long) was first seen about 1.5 km from the blue whales. The vessel directly approached the mother and calf to within ~400 m, at which time it stopped while the mother was between the calf and the vessel. The calf then approached the vessel, moving between the mother and the vessel, then returned to the mother, remaining between the mother and the vessel. The vessel remained stationary within ~250 to 400 m of the MC pair for about 5 min and then began to move, accelerating to a wake-producing speed of ~10 km/h while heading away from the mother and calf. As the vessel abruptly moved, the calf abruptly increased swim speed (as evidenced by suddenly creating whitewater splashes) and moved away from both the vessel and its mother to the largest observed MC separation distance of ~50 m. This resulted in the mother again positioning herself between the calf and the vessel. The calf remained at the surface during this time. About 9 s after the vessel departed, the calf returned to within ~2 to 3 m of its mother and remained within ~2 to 25 m until our survey aircraft left, ~9 min later. The latter incident was the fastest swim observed from the calf and the farthest separation distance of the calf from its mother. Overall, the MC pair moved at a mean speed of about 2 to 3 km/h based on distance traveled between their first and last observed locations. (Quantitative tabular summaries for this encounter are provided as supplemental information at this journal's website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147).

The calf made modest but detectable changes in its behavior in response to vessel proximity and activity, particularly when the vessel was at its closest approach. The two primary responses were to first approach then move away rapidly when the vessel began moving and quickly accelerated. The calf first approached the vessel while it was stationary. When the small vessel abruptly moved away, the calf quickly swam away from it, maximizing the calf's observed distance from its mother. In vessel presence, maximum spacing between the mother and calf increased from ~25 to ~50 m (see Table S1). In addition, the calf decreased its blow interval when the vessel was present nearby (see Table S2). In contrast, the mother did not display any notable changes in behavior in the close absence or presence of the vessel. Presumed nursing was observed four times (see Smultea et al., 2017) and only in the absence of a vessel: three times before the vessel's close approach and once after the vessel departed, which was the longest apparent nursing session observed. Presence of the vessel did not affect the position of the calf relative to the mother's side; while in view both at and below the water surface, the calf was positioned primarily (85% of 55 30-s sampling intervals; see Table S3) on the left side of its mother, regardless of whether the vessel was present or not. During vessel absence, the percentage of time that the calf was in view increased by approximately 15%; however, there was little change in the percentage of time that the mother was in view.

The observed behavioral avoidance of the vessel by the calf, which was associated with an increase in speed at the water surface, is not unlike other reports of blue whales exhibiting fleeing responses to vessel disturbance (reviewed by Perry, 1998), which incidentally also are similar to flight responses by blue whales during observed predator attacks (Ford & Reeves, 2008). MC pairs have greater energetic requirements than other age and social classes and, therefore, are likely affected by anthropogenic activity in ways that are not immediately apparent. Reproductive success (including calf mortality) greatly depends on the behavioral responses of MC pairs to human disturbances. Close approaches by vessels to a MC pair (or vice versa) may inadvertently disrupt nursing behavior and result in impacts such as displacement of the mother and calf and increases in swim speed (e.g., Scheidat et al., 2004), thereby affecting energetic expenditure of the animals. It has been occasionally reported that mysticete juveniles and calves tend to be more curious and less experienced than other age classes and, therefore, are more likely to approach a vessel to investigate it (humpback whale [*Megaptera novaeangliae*]: Watkins, 1986; Garrigue & Derville, 2022); blue whale (Small, 1971); and minke whale [*Balaenoptera acutorostrata*]: Mitchell, 1974; Stern et al., 1990). Close approaches also pose risks for injurious or fatal vessel–whale strikes (e.g., Laist et al., 2001; Lammers et al., 2003; Conn & Silber, 2013; Szesciorka et al., 2019). Vessel–whale collisions leading to injury and death are considered to be a critical threat to population health for blue whales (National Marine Fisheries Service [NMFS], 2020) and a leading cause of death for the highly endangered North Atlantic right whale (*Eubalaena glacialis*; Kraus et al., 2016). It is not known whether, and in what ways, the observed short-term responses such as those we observed translate to longer-term changes in reproduction, survival, or population size (see Moberg, 2000; Bejder et al., 2006). Results indicate that separation distance is a measurable parameter that may be indicative of a reaction to a stimulus (in this case, the calf moved away from the vessel and the mother when the vessel began moving again). Our observations contribute to the relative paucity of behavioral data for blue whales, especially MC pairs, focused on behavior near small vessels.

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Necrocoitus in Common Bottlenose Dolphins (*Tursiops truncatus*) near Sarasota, Florida

Amber Lea D. Kincaid,[1] Gretchen N. Lovewell,[1]
Jason B. Allen,[2] Kim Bassos-Hull,[1, 2] Jessica L. Blackburn,[1]
Rebeccah A. Hazelkorn,[1, 3] and Randall S. Wells[2]

[1]*Mote Marine Laboratory, 1600 Ken Thompson Parkway, Sarasota, FL 34236, USA*
E-mail: aldkincaid@gmail.com
[2]*Chicago Zoological Society's Sarasota Dolphin Research Program,*
c/o Mote Marine Laboratory, 1600 Ken Thompson Parkway, Sarasota, FL 34236, USA
[3]*NOAA, National Marine Fisheries Service, 263 13th Avenue S, St. Petersburg, FL 33701, USA*

Necrocoitus (historically referred to as Davian behavior) has been reported in a variety of vertebrate and invertebrate species (Dickerman, 1960; Moeliker, 2001; Izzo et al., 2012; Ashaharraza et al., 2020; Wang & Meyer-Rochow, 2020). Several marine mammal species have been observed engaging in necrocoitus, including the Florida manatee (*Trichechus manatus latirostris*), the southern sea otter (*Enhydra lutris nereis*), the Pacific pilot whale (*Globicephala scammonii*), and the common bottlenose dolphin (*Tursiops truncatus*), which represents the majority of cetaceans who have been observed engaging in postmortem attentive behavior (Brown, 1962; Harris et al., 2010; Bills et al., 2013; Bearzi et al., 2018; Methion & Díaz López, 2021). Most observations of postmortem attentive behavior in cetaceans involve epimeletic behavior from a live, adult female with a dead calf (Caldwell & Caldwell, 1966; Quintana-Rizzo & Wells, 2016; Bearzi et al., 2017, 2018). In addition to epimeletic behavior, accounts of bottlenose dolphins reacting to dead conspecifics include behavior consistent with mate-guarding, agonistic behavior, and arousal, but observed intromission is extremely rare and has not been photo documented (Brown, 1962; Dudzinski et al., 2003; Methion & Díaz López, 2021).

In Sarasota and Manatee Counties in west-central Florida, four separate events occurred over seven years in which two adult male bottlenose dolphins engaged in postmortem attentive behavior toward a female conspecific (Figure 1). The observed behaviors included escorting the carcass, aggressively swimming directly into or on top of the carcass, and vocalization. In at least one case, necrocoitus was observed, but postmortem examination findings indicate it likely occurred in the other three cases as well. All 12 of the dolphins involved were sexually mature; and in each respective case, the two adult males were pair-bonded (Wells et al., 1987; Owen et al., 2002).

The Stranding Investigations Program (SIP) at Mote Marine Laboratory (MML) in Sarasota, Florida, was formally established in 1985 and responds to reports of stranded (i.e., sick, injured, out-of-habitat, or dead) cetaceans in Sarasota and Manatee Counties. All confirmed strandings are documented according to protocols established by the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries). Most cetacean carcasses are necropsied and sampled for life history, pathology, toxicology, and other permitted research. SIP personnel work closely with the Chicago Zoological Society's Sarasota Dolphin Research Program (SDRP), whose staff members have been studying dolphins in and around Sarasota Bay since 1970. As the world's longest-running study of a wild dolphin population, the SDRP's efforts have identified a resident community of approximately 170 dolphins spanning as many as five concurrent generations in Sarasota Bay (Wells, 2020). The SDRP studies social structure, communication, and behavior, as well as ecology, biology, and individual and population health (Wells, 2020).

On 20 April 2016, at 1052 h, SIP personnel received a report of a dead dolphin floating belly-up in Anna Maria Sound, Florida (27.5052°, -82.7109°). Two subsequent reports were made about the same dolphin, and SIP recovered the carcass at 1320 h. The SDRP identified the female carcass as "ULYS" by her unique dorsal fin markings. ULYS had been seen 110 times and had calved at least four times during the period 28 August 1997 through 19 April 2016 (the day prior to recovery), with the most recent known calf born in 2013. Holmes Beach Police

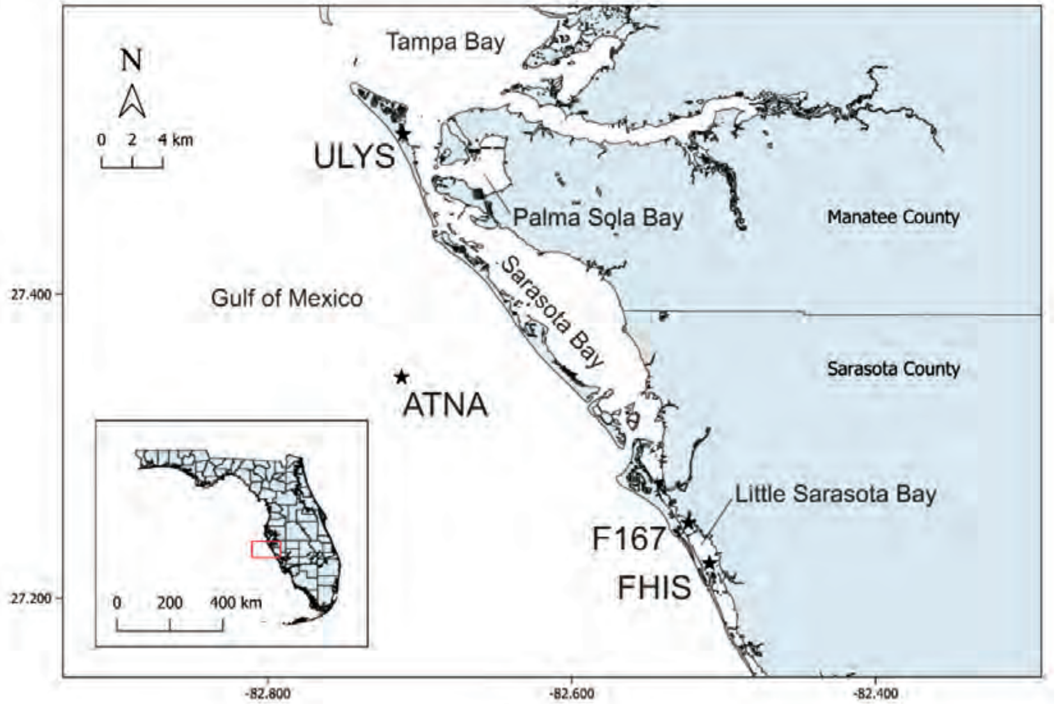

Figure 1. Locations of the four stranding events, denoted by the female bottlenose dolphins' (*Tursiops truncatus*) IDs: ULYS, ATNA, FHIS, and F167

Department (HBPD) officers secured the carcass prior to SIP's arrival by tying a line around the fluke insertion. After the dolphin was secured, the HBPD officers took photos and approximately 5 min of video over several smartphone recordings, capturing interactions between two live dolphins and the carcass (Figure 2). The live dolphins were identified by freeze brands that had been previously applied during health assessments (Scott et al., 1990) as pair-bonded males "F178" and "F188." F178 had been seen 400 times from 4 May 2006 (when the two were determined to be pair-bonded) through 21 April 2016, and F188 had been seen 404 times from 4 May 2006 through 21 April 2016. Sexes were known for both from health assessments. ULYS had never been seen with F178 or F188 prior to the recovery (see Figure S1 for a sighting history map; supplementary figures and video footage for this paper are available in the "Supplemental Material" section of the *Aquatic Mammals* website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147). The recordings show the two male dolphins aggressively ramming and swimming over ULYS's carcass and briefly emitting vocalizations at the surface. These vocalizations were determined to be burst-pulse vocalizations (L. Sayigh, pers. comm., 9 March 2022; see Video Sequence S1), which have been associated with agonistic, aggressive, and sexual interactions, as well as successful cooperative tasks, in dolphins (Herzing, 1996; Blomqvist & Amundin, 2004; Eskelinen et al., 2016).

After recovering the carcass, SIP personnel conducted a full necropsy. Notable findings included fresh to healed conspecific rake marks, excessive splaying of the urogenital area (Figure 2), frank (fresh, bright red) blood in the thoracic cavity, broken epihyoid bone with associated tissue reaction, and an approximately 5-cm perimortem rupture in the uterus with green and decomposed tissue caudal to the rupture. Histopathology analysis concluded that trauma from conspecific aggression was a possible cause of death.

On 25 November 2018, at 1208 h, SIP personnel received a report of a dead dolphin approximately 11 km offshore of Longboat Key in the Gulf of Mexico (27.3453°, -82.7120°). SIP recovered the carcass at 1305 h with the assistance of the Sarasota Police Department's (SPD) marine unit; the SDRP identified it by dorsal fin markings as "ATNA." During the recovery, two dolphins (identified by dorsal fin markings as pair-bonded males "TNBS" and "BELY") were observed in

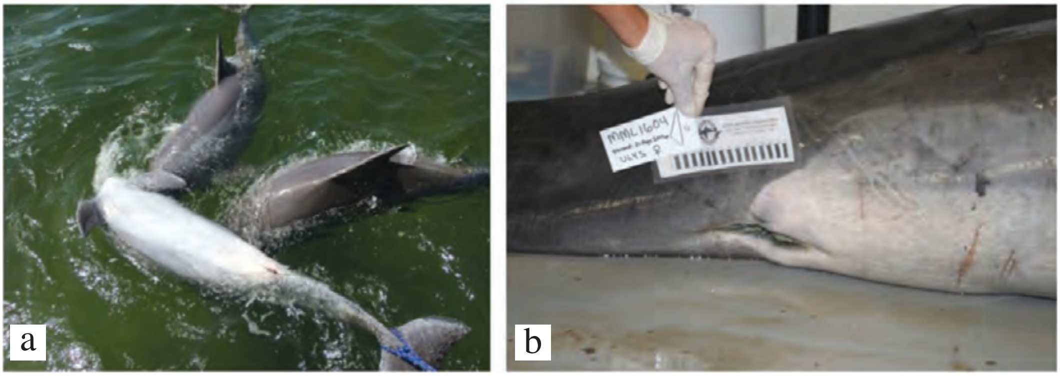

Figure 2. (a) Still from video footage showing F188 (left) and F178 (right) ramming into ULYS's carcass after it was secured with a dock line (Video footage courtesy of Holmes Beach Police Department); and (b) ULYS's urogenital slit, splayed and discolored (Photo courtesy of Mote Marine Laboratory).

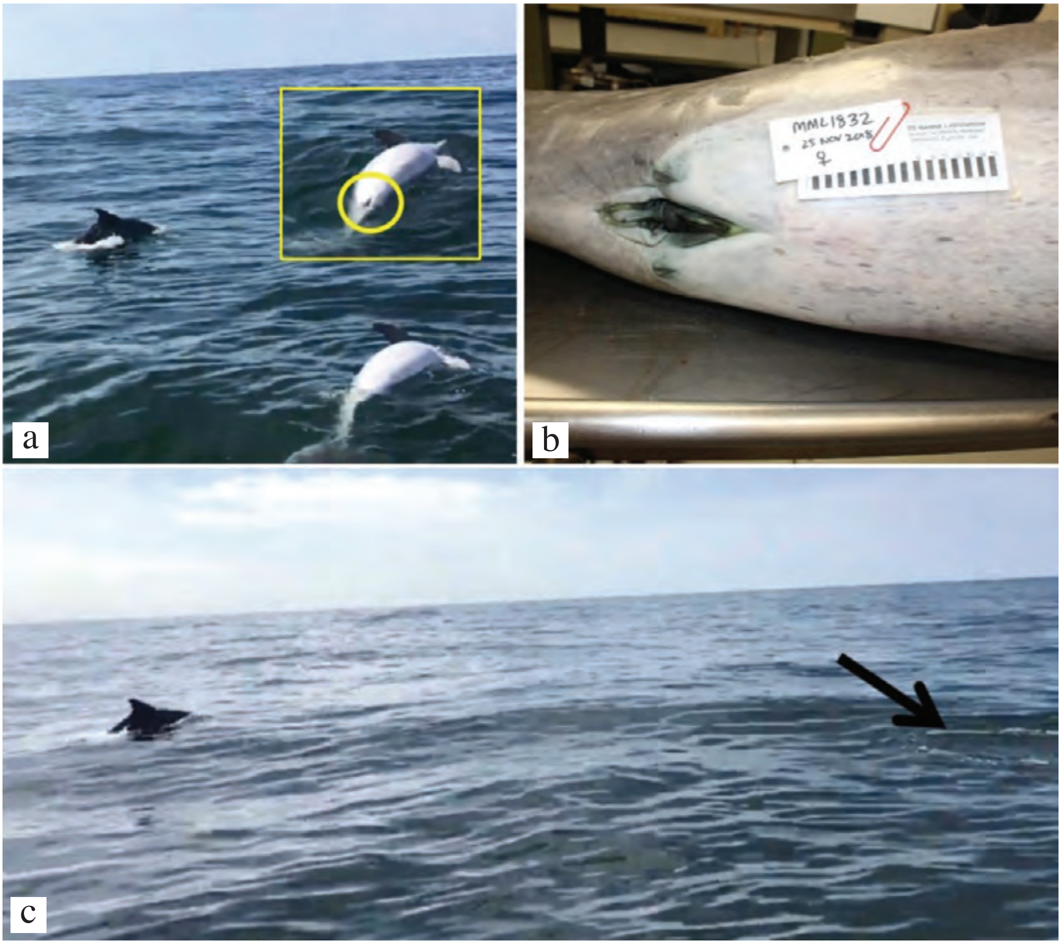

Figure 3. (a) Still from video footage of TNBS with inset showing ATNA's splayed genital slit; (b) ATNA's urogenital slit, splayed and discolored; and (c) BELY surfacing near ATNA's carcass as it is approached by SPD (arrow points to where TNBS surfaced in [a]). (Video footage and photo courtesy of Mote Marine Laboratory)

close proximity (~5 to 10 m) to the carcass, and the responding biologist recorded 19 s of video on her smartphone (Figure 3). Of note, the carcass exhibited a widely splayed genital slit (Figure 3). The SDRP had a limited sighting history of the three dolphins involved, none of whom were considered part of the year-round resident Sarasota Bay community (see Figure S2 for a sighting history map). ATNA had been seen 23 times from 12 October 1989 through 8 November 2018, TNBS 12 times during the period 12 December 1987 through 22 January 2015, and BELY eight times during the period 28 July 1998 through 22 January 2015. BELY was confirmed as male via remote biopsy, and it is presumed that TNBS is also a male given the high coefficient of association (COA) to BELY (Table 1). ATNA had never been seen with either male dolphin prior to the date of stranding. SIP personnel conducted a full necropsy, and while no cause of death was determined or inferred, there was marked distension and decomposition of the vagina as opposed to other soft tissue (Figure 3).

On the morning of 4 August 2020, SIP personnel received six reports of a dead dolphin with two live dolphins pushing the carcass near Intracoastal Waterway (ICW) channel marker 48B in Little Sarasota Bay (27.2228º, -82.5093º). SDRP personnel arrived on scene at 1024 h and observed nine live dolphins in the vicinity, including one dolphin interacting with the carcass. Behaviors during the interaction included ramming, swimming over the carcass, and intromission (Figure 4), sometimes involving the male lifting his fluke high into the air before quickly bringing it down to connect with the carcass. The dead female was identified by dorsal fin markings as "FHIS," and the two dolphins that were seen pushing her were identified as pair-bonded males "F276" and "F142" (sexed and freeze-branded during SDRP health assessments). F142 was identified as the dolphin interacting with FHIS when SDRP personnel first arrived. FHIS had been seen 41 times from 14 August 1991 through 15 July 2020, and she had calved five times during that period, with the most recent calf born in 2016 or 2017. F142 and F276 had been seen 295 times and 311 times, respectively, from 7 September 2010 through 4 August 2020. Consistent with the previous two cases, FHIS had not previously been observed with either male (see Figure S3 for a sighting history map). SIP personnel recovered the carcass at 1054 h with assistance from the Sarasota County Sheriff's Office marine unit and towed the carcass to land. F142 followed the boat for the ~4 km tow and milled in the area as the carcass was brought to land from the boat. Necropsy findings for FHIS included a widely splayed genital slit (Figure 4) with associated muscles and reproductive organs extremely friable; no cause of death could be determined.

Incidentally, F276 and F142 were found dead over the following 2 days. A cause of death was not determined for either of these dolphins, and testing on all three carcasses ruled out morbillivirus, influenza, coronavirus, and brevetoxicosis.

On the afternoon of 20 May 2022, SIP personnel received a report of a dead dolphin floating north of ICW channel marker 57 in Little Sarasota Bay (27.2492°, -82.5231°). With assistance from an SPD officer and a boat, SIP personnel recovered the carcass, identified by dorsal fin markings as "F167," at 1520 h. F167 had been seen 256 times since 11 May 2000 and had birthed six known calves, including a yearling calf that was seen in the vicinity of F167's carcass. Two adult dolphins were observed interacting with the carcass in a similar fashion as the previous incidents (Figure 5), ramming the carcass, swimming over it, and emitting burst-pulse vocalizations (L. Sayigh, pers. comm., 20 June 2022; see Video Sequence S2). These dolphins were identified as male "F182" (sexed and freeze-branded during SDRP health assessments) and "C834" (identified by dorsal fin markings), presumed to be a male based on the high COA with F182. F182 had been seen 702 times from 2 February 1989 through 18 May 2022, and C834 had been seen 617 times from 19 June 1992 through 4 May 2022. F167 had occasionally been seen with the two males in the past (see Figure S4 for a sighting history map), but

Table 1. Lifetime half-weight coefficients of association (COA) between bottlenose dolphins (*Tursiops truncatus*) involved in Davian behavior events

Dolphins	F178-F188	TNBS-BELY	F276-F142	F182-C834	C834-F142	C834-F276	F182-F276	F182-F142	F167-F182	F167-C834
Half-weight COA	0.619	0.700	0.662	0.294	0.157	0.128	0.087	0.086	0.013	0.021

Note: Dolphin pairings with COAs lower than 0.05 are not listed, with the exception of pairings including F167, the only female dolphin to have been seen alive with any of the males. Pair-bonded males (highlighted) show the highest association. COAs were calculated from the first sighting of each dolphin through 1 January 2022 (29 August 2022 for the dolphins involved in the most recent case).

Figure 4. F142 prior to (a) and during (b) intromission with FHIS's carcass—the first known photograph of intromission between a live male bottlenose dolphin and a dead female conspecific; and (c) FHIS's urogenital slit, widely splayed and discolored. ([a] & [b] Photos courtesy of Sarasota Dolphin Research Program; and [c] Photo courtesy of Mote Marine Laboratory)

the COAs between F167 and the two males were not significant (Table 1). The three live dolphins followed the carcass as it was towed to land. F167 was heavily raked, and necropsy findings included perimortem trauma to the genital region (Figure 5) and areas of edema and consolidated hemorrhage in the left mammary.

Intromission was confirmed in the case of FHIS, and the similar conditions of the four females' urogenital slits leads to the belief that intromission occurred in the other three instances. F142 exhibited aggressive behavior toward FHIS as did F178 and F188 toward ULYS and F182 and C834 toward F167; TNBS and BELY are suspected to have done so toward ATNA prior to SIP's arrival on scene. While other highly intelligent mammals with complex social systems, such as chimpanzees (*Pan troglodytes*) and rhesus macaques (*Macaca mulatta*), have been observed beating dead conspecifics, they also live in societies organized by rank in which violence may be more common than in dolphin species (Wrangham & Wilson, 2004; Bulh et al., 2012; Wells, 2013). Sarasota Bay common bottlenose dolphins typically do not exhibit the aggressive behavior that is especially associated with sexual frustration (Herzing, 1996; Methion & Díaz López, 2021) or reproductive behavior that is common for

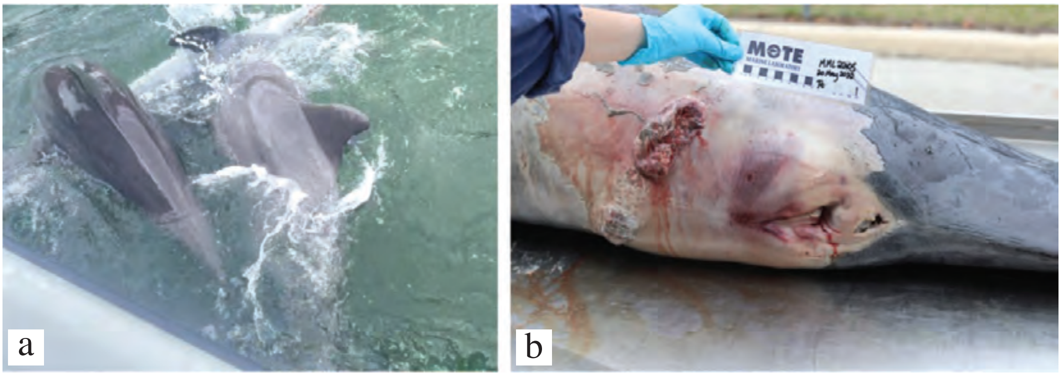

Figure 5. (a) C834 (left) and F182 (right) swimming over F167's carcass while it was being towed to shore; and (b) F167's urogenital slit, discolored and splayed. (Video footage and photo courtesy of Mote Marine Laboratory)

Figure 6. Cross-sections of ovaries from (a) ULYS, (b) ATNA, and (c) FHIS. None of the ovaries contained estrogen-producing follicles, though all animals had at least one ovary that contained *corpora albicantia*, and ATNA's left ovary contained a regressing *corpus luteum* ([b], arrow). (Photos courtesy of Mote Marine Laboratory)

bottlenose dolphins of multiple species in other parts of the world (Bloom, 1991; Connor et al., 1992; Samuels & Spradlin, 1995; Mann et al., 1996; Smolker & Connor, 1996; Moors, 1997; Wells, 2013; Cords & Mann, 2014; Robinson, 2014). Though Sarasota Bay dolphins practice a polygamous, promiscuous mating system and are sexually dimorphic with larger males (Wells et al., 1987; Tolley et al., 1995), the male dolphins have not been documented using aggressive tactics to successfully copulate with females, in contrast to the aggressive mating behaviors exhibited by Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) in areas such as Shark Bay, Australia (Connor et al., 2005; Wells, 2013).

Necrocoitus has been documented in a wide array of species, though it is not common in any one species. Most observed instances of necrocoitus span reptiles, amphibians, and birds (e.g., How & Bull, 1998; Costa et al., 2010; Izzo et al., 2012; Tomita & Iwami, 2016; Swift & Marzluff, 2018; Ashaharraza et al., 2020). Dolphins are highly intelligent mammals with complex social systems (Marino, 2004; Connor, 2007; Wells, 2013) and are, therefore, unlikely to have the same motivating factors behind instances of necrocoitus as other taxa. For example, male anurans (*Rhinella proboscidea*) copulate with female corpses to fertilize and express viable oocytes (Izzo et al., 2012), which can be ruled out as a benefit of this behavior for mammals and other viviparous species. It has been questioned whether animals have a concept of death (Monsó & Osuna-Mascaró, 2021), but there is evidence that dolphins experience grief toward dead conspecifics (Bearzi et al., 2017). It can therefore be assumed that the male dolphins were aware that the females were dead in each case and were not trying to mate in earnest. While many species across taxa have exhibited necrocoitus in response to conspecific carcasses in mating posture (Dickerman, 1960; Russell, et al., 2012; Tomita & Iwami, 2016; Wang & Meyer-Rochow, 2020), the belly-up position of the female carcasses discussed here would not have led the males to believe they were alive and sexually receptive.

There is little evidence to support altruistic acts in the cases presented here, contrary to reports of dolphins aiding ill or distressed live conspecifics or attempting resuscitation (Park et al., 2013; Kuczaj et al., 2015). In addition to the finding that F178 and F188 may have killed ULYS, none of the female dolphins occupied the same home ranges as the respective male pairs, nor did they have significant prior associations (Table 1). While the dolphins in and around Sarasota Bay tend to have relatively discrete home ranges, they do not tend to defend specific territories (Wells & Scott, 1990; Samuels & Spradlin, 1995; Wells, 2013), so the presence of unfamiliar females is unlikely to have incited aggressive behavior in contrast to reports in southern sea otters (Staedler & Riedman, 1993; Harris et al., 2010). Given the minimal overlap of home ranges and small COAs between the male pairs and the females, grief is also not a viable explanation for the observed behavior. In cases where grief behavior has been documented in cetaceans, the grieving animals were known to have prolonged relationships of evolutionary significance (e.g., mother–calf) with the dead animals (Archer, 2001; Bearzi et al., 2017).

Since the male dolphins in the cases presented here were presumably aware the females were dead, it is unlikely that they were reacting to perimortem pheromone expression, which has been posited as an explanation for necrocoitus in several taxa (Costa et al., 2010; Siqueira et al., 2015; Ashaharraza et al., 2020; Colombo & Mori, 2020), including Florida manatees, who occasionally pursue females to the point of exertional myopathy and death (Bills et al., 2013; Walsh & de Wit, 2015; Reynolds et al., 2018). This was investigated through ovary examination. The ovaries of all four females were preserved in 10% buffered formalin and examined grossly; and those of ULYS, ATNA, and FHIS were examined histologically (Figure 6). Three of the four encounters documented here occurred during breeding season (Owen et al., 2002), but none of the ovaries had follicles of sufficient size to produce estrogen (Robeck et al., 2005). Given that the females were not producing estrogen at the time of death, the theory that the males were responding to hormonal stimulation can be ruled out (T. Robeck, pers. comm., 6 April 2022).

Regardless of season, sexual behavior is part of dolphins' normal social repertoire (Wells et al., 1987; Mann et al., 1996; Furuichi et al., 2014). Sexual arousal and aggression have been correlated with displays of dominance in cetaceans (Pack et al., 1998; Connor et al., 2005; Furuichi et al., 2014; Bearzi et al., 2017; Methion & Díaz López, 2021; Volker & Herzing, 2021). The male pairs may have been exhibiting dominance over the females if they were alive at first contact and continued the behavior after the females died.

The four pairs of males had few to no previous sightings together (Table 1), so this is not believed to be a learned behavior. Play can be ruled out as a possible explanation for these events as the observed behaviors of the pair-bonded adult males toward the female carcasses are inconsistent with reports of cetacean social or object play (Ross & Wilson, 1996; Paulos et al., 2010; Greene et al., 2011).

In more than 50 years' worth of data collected by the SDRP and 35 years' worth of data collected by SIP, only these four observations have been made of necrocoitus in the Sarasota Bay area. This is clearly the exception and not the rule regarding bottlenose dolphin behavior toward dead conspecifics and constitutes an unusual opportunity to investigate extremely rare behavior. Additionally, the similarities among the four females' genital slit characteristics upon postmortem examination may provide evidence against which future cases can be compared to determine if a similar behavior occurred.

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Unexpected Opportunities for Manatee (*Trichechus manatus latirostris*) Education and Citizen Science

Yvanna M. Strait and Amy C. Hirons

Nova Southeastern University, 8000 N. Ocean Drive, Dania Beach, FL 33004, USA
E-mail: hirons@nova.edu

The Florida manatee (*Trichechus manatus latirostris*) mainly resides within the state's coastal waters, but sharing this habitat with thousands of watercrafts, either registered, unregistered, or visiting, has proven challenging for its survival (Bassett et al., 2020). The primary source of mortality for the Florida manatee is collisions with boats (Runge et al., 2007). The boating industry is extensive within Florida, and the state hosts multiple international boat shows annually, including the Miami International Boat Show (MIBS). MIBS attracts over 700 vendors from more than 60 different countries as well as over 100,000 attendees. An important component of the MIBS is vessel sea trials where vendors take potential buyers on test rides. During MIBS 2022, the location for these sea trials was within a State Manatee Protection Zone with regulations stating, "slow speed all year" (Florida Fish and Wildlife Conservation Commission [FWC], 1991).

Stakeholders during boat show sea trials include local and state agencies and government officials tasked with manatee and participant protection, vendors whose aim is to sell their product, a mix of vessel captains and crews who may or may not know manatee safety laws, and show attendees interested in the charismatic manatees. All these interests led to the same question: How do we best protect the manatees? At the 2022 MIBS, one answer came in the form of a manatee observation team. This group of observers also provided a venue to educate members of the general public, some who had never seen a manatee.

Manatees are found within the estuaries, springs, rivers, and coastal waters of Florida (Lefebvre et al., 2001; Deutsch et al., 2003) where they feed on aquatic plants, predominantly seagrasses (Alves-Stanley et al., 2010). Manatee movements within the water column are typically slow and driven by resting, traveling, foraging, thermoregulation, mating, and calving. Within the water column, that depth is normally very shallow (< 1.25 m) (Edwards et al., 2016), increasing the likelihood of manatee–boat interactions (Bassett et al., 2020). Slow travel rates for manatees often occur in shallow areas, while faster travel speeds normally occur in deeper water (Edwards et al., 2016).

From 1974 through 2016, 21% of manatee deaths reported in Florida were watercraft related. Collisions occur so often that one in four adult manatees have been hit by a watercraft at least 10 times in their life, and approximately 96% of all adult manatees have been hit at least once by a watercraft (Bassett et al., 2020). An important effort put forth to protect manatees from watercraft collisions is regulation zones regarding the operation and speed of motorized watercrafts within specific areas (Calleson & Frohlich, 2007; Calleson, 2014; Rycyk et al., 2018; Udell et al., 2019).

Sea Isle Marina, the originating site for the 2022 MIBS sea trials, is located along the western edge of the Intracoastal Waterway as it transects Miami and Miami Beach, Florida. It is located within a State Marine Protection Zone, largely due to the immediate proximity of seagrass beds surrounding the marina. A recent flora survey found seagrass beds extending north and east of Sea Isle Marina containing two types of seagrasses: (1) paddle grass (*Halophila decipiens*), the dominant species, and (2) manatee grass (*Syringodium filiforme*) (The Chappelle Group, 2022).

Informa, the parent company of U.S. Boat Shows, including MIBS, worked with the authors to create an action plan for manatee monitoring during the 5-day show in February 2022 when vessel sea trials occurred. This placed an emphasis on manatee safety during the show. The plan included a team of observers, comprised of 15 to 25 people per day, who were tasked with spotting manatee(s) in the marina's vicinity, inside and out. Manatee observers consisted of undergraduate and graduate students and alumni from Nova Southeastern University's Department of Marine and Environmental Sciences.

The manatee observation team, wearing graphically identifiable manatee observer t-shirts, monitored for manatees from three different locations during show hours: (1) Sea Isle Marina, (2) commercial water taxis, and (3) sea trial vessels. Observers within Sea Isle Marina continuously patrolled the seawall and piers during show hours. For the commercial water taxis, there were five that traveled a set route consisting of four stops in the vicinity of the boat show, with Sea Isle Marina as one of the stops. Each water taxi had an observer positioned on the bow near the captain to watch for manatees within the Intracoastal Waterway (Figure 1). All sea trial vessels also had a required manatee observer while underway. All observations, whether a manatee was present or not, were recorded every hour on a data log at all three monitoring platforms. Data consisted of time, general location, animal description (length, markings), and movement/direction.

Because initially no photo-identification techniques were employed to distinguish individual manatees, an absolute number of animals could not be ascertained. Over the course of the show, a minimum of 18 individual manatees and a maximum of 23 manatees were spotted. Observations were made daily from 0900 to 1800 h, with most manatees spotted from 0900 to 1100 h closest to shore, followed by sightings farther from the coastal margin from 1200 to 1600 h. These times corresponded to slack high tide and the ebbing tide (www.tides.net). Two-thirds (*n* = 11 to 16) of the manatees were spotted from the docks in Sea Isle Marina. One manatee was spotted during a single sea trial out of more than 300 trials in the Intracoastal Waterway, and six manatees were spotted from the water taxis in the Intracoastal Waterway. Manatees were spotted most often on the north and northeast side of the marina closest to the seagrass bed (Figure 2). These data concur with other studies where manatees were more likely observed near seagrass as it is their main food source (Axis-Arroyo et al., 1998; Jiménez, 2005; Olivera-Gómez & Mellink, 2005; Bauduin et al., 2013). Sightings and manatee movement diminished with distance from the seagrass beds.

While many members of the public expressed excitement at seeing manatees and gratefulness for the extra protection the MIBS employed by using dedicated manatee observers, not all people were happy with the extra manatee protection added for the show. Some vendors were annoyed with the need to wait for a manatee to leave the area before they could begin their sea trial. There were also times when a vessel returning from a sea trial had to remain outside the marina as a manatee was either near their boat slip or at the entrance of the marina.

Manatee observations, including time, location, and movement, were also recorded on a whiteboard positioned at the observer tent within the marina (Figure 3). Boat show attendees and workers who

Figure 1. A manatee observer departing on a vessel for a sea trial (*Photo credit:* Sierra Potts)

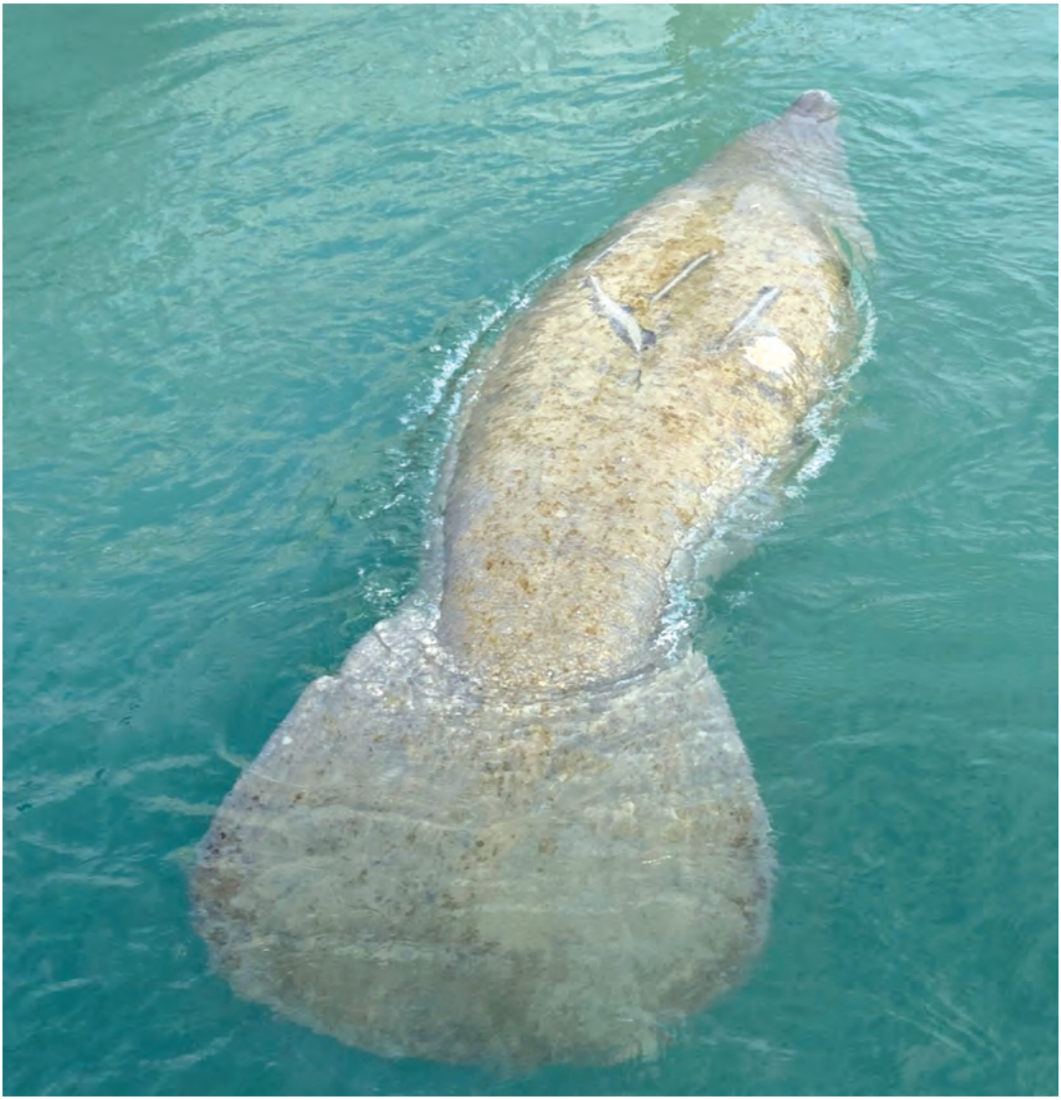

Figure 2. Adult manatee (*Trichechus manatus latirostris*) foraging along the Sea Isle Marina seawall, February 2022 (*Photo credit:* Sierra Potts)

passed by the tent located along the main marina thoroughfare could follow the manatee sightings and ask questions about the animals. This visual information prompted public interest and served as an educational venue. The manatee observation tent also displayed manatee fact placards and the manatee data log used by the observers.

Observers stationed at the tent and throughout the marina were educated in manatee facts prior to the boat show; they were regularly approached by the public throughout the show for information related to manatees. These interactions included informing the public about what manatees are, why they are threatened, and the role manatee observers were conducting at the show. These people were then welcomed to volunteer as an informal manatee observer during the show. The only requirements were that they wear the provided manatee observer t-shirt and when they spotted a manatee, they needed to report the sighting to an observer on the marina piers or at the observer tent. This opportunity prompted many patrons who were curious about manatees to become engaged as either they had never before seen a manatee or they enjoyed seeing the manatees that frequented areas where they live.

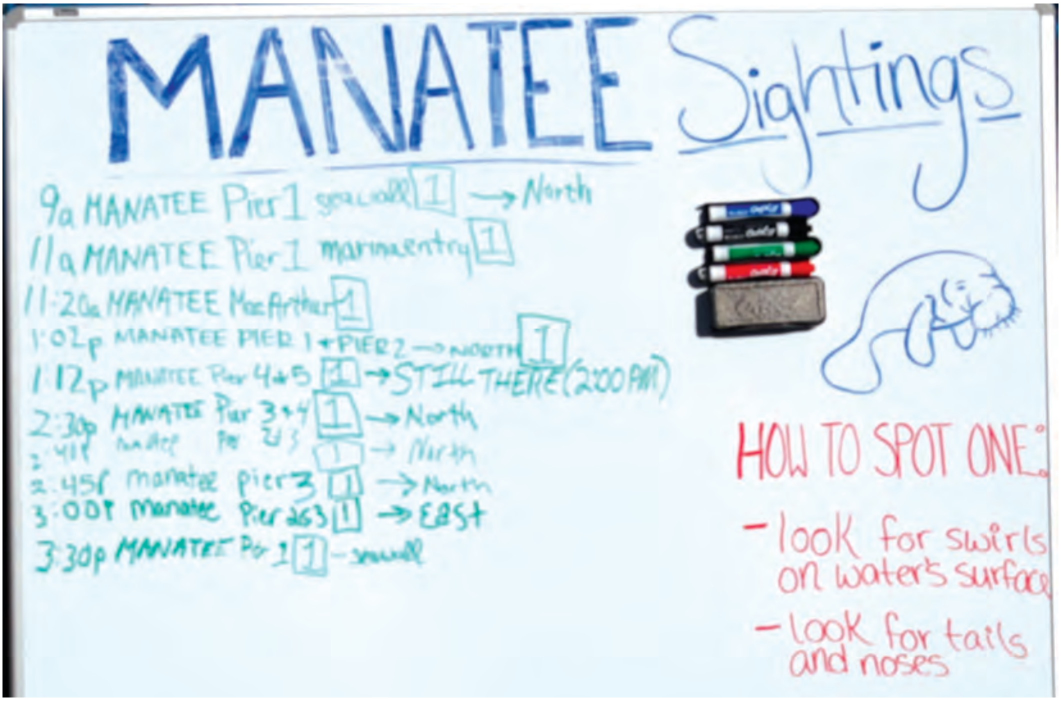

Figure 3. Manatee observation whiteboard used during MIBS 2022 for boat show attendee information (*Photo credit:* Sierra Potts)

With the prospect that manatee observers will be utilized in subsequent boat shows and sensing an avenue to promote public engagement in manatee conservation, the development of a citizen science platform as well as a data gathering venue are being explored. Persons dedicated to providing manatee information to the attendees, including educational talks, will be incorporated throughout the sea trial site and boat show venue. They will be available to answer questions and, when a manatee is present anywhere at the site, inform the public present about manatee conservation. The use of a manatee data log will be demonstrated as well as how data are collected during an observation.

An interactive app with multiple tabs can be created for manatee observations. One tab on the app would be available strictly for manatee observers to digitally report data on manatees observed within the boat show venue. A second tab would be used as the platform for citizen science. Show attendees would be able to report and post pictures of manatees that they have spotted; the site would prompt specific information in easy-to-follow language. This tab would be monitored by observer team members to filter posted material. The date/time stamp of the post and associated photos would be cross-referenced with manatee observer data to more closely monitor manatee movement and allow for easier identification of individual animals. A third tab would provide factual information about manatees to help dispel inaccuracies the public may possess.

The use of multiple drones would be beneficial for furthering manatee data collection during the boat show. During MIBS 2022, a team of three drones was used to assist with manatee observations, but the drones were not used to collect detailed data at this show. Unmanned aerial vehicles, such as drones, are a low-cost and noninvasive way to track an animal in a shallow area as well as to assess a manatee's body condition (Ramos et al., 2022). Drones would be better able to track and monitor manatee movement than humans can at sea level. Aerial data could also be used to confirm if multiple manatee sightings per day are distinct individuals or repeated sightings of one or more manatees. The drone footage will also be a way to confirm any sightings reported by a manatee observer or a citizen scientist.

The future of manatee research among scientists and citizen scientists has strong potential. By taking advantage of venues of opportunity such as boat shows, not only is local population data gathered, but a stronger positive relationship with the public is forged. When people feel they have a stake in the conservation of a species or habitat, they will likely become and remain engaged.

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Feeding Association Between Harbour Porpoise (*Phocoena phocoena*) and Flyshoot Fishing

Pieke Molenaar and Jip Vrooman

Wageningen Marine Research, Haringkade 1, 1976 CP, IJmuiden The Netherlands

Human fishing activities can provide easily accessible food resources for predators and scavengers such as fish, crustaceans, birds, and marine mammals. Feeding associations between cetaceans and fishing activities have been recorded for both passive (stationary nets or lines) and active (gears are moved, towed, or dragged to catch the fish) fishing methods (Northridge, 1984, 1991; Fertl & Leatherwood, 1997; Tixier et al., 2021; Bonizzoni et al., 2022). Cetaceans may, for example, eat fish out of gill- and trammel nets, take fish from long-lines, or trail behind trawlers that discard unwanted catch or lose fish that slip through the cod-end mesh (Fertl & Leatherwood, 1997; Tixier et al., 2021; Bonizzoni et al., 2022). Such associations provide easily accessible prey, though such interactions may also increase the risk of cetacean bycatch (Northridge, 1984, 1991; Waring et al., 1990; Lowry & Teilmann, 1994; Morizur et al., 1996; Fertl & Leatherwood, 1997; Read, 2008; Tixier et al., 2021; Bonizzoni et al., 2022). Dolphins, for example, have been recorded to swim into a trawl to catch fish and are occasionally bycaught while doing so (Jaiteh et al., 2013; Santana-Garcon et al., 2018). For some fisheries, it also poses a socioeconomic issue if fishery catches are reduced (Tixier et al., 2021).

While there are records of baleen whales exploiting fishing or aquaculture activities (National Marine Fisheries Service [NMFS], 1991; Fertl & Leatherwood, 1997; Chenoweth et al., 2017), most cetacean–fisheries interactions concern odontocetes. Examples include killer whales (*Orcinus orca*) interacting with purse seine nets targeting herring (*Clupea harengus*) in Norway (Similä, 2005; Mul et al., 2020); northern bottlenose whales (*Hyperoodon ampullatus*), sperm whales (*Physeter macrocephalus*), and pilot whales (*Globicephala* sp.) depredating on Greenland halibut (*Reinhardtius hippoglossoides*) fisheries in Canada (Karpouzli & Leaper, 2004; Johnson et al., 2021); and Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) associating with prawn (*Penaeidae*) trawlers in Australia (Broadhurst, 1998; Chilvers & Corkeron, 2001). Bonizzoni et al. (2022) recently reviewed the literature on odontocete feeding behind trawl nets and found records for more than 19 species of odontocetes.

The harbour porpoise (*Phocoena phocoena*) is one of the smallest odontocetes and is considered to be shy and elusive. Although there are records of harbour porpoises associating with passive gill- and trammel nets (Higashisaka et al., 2018; Maeda et al., 2021; Macaulay et al., 2022), literature mentions only one record of a harbour porpoise interaction with towed fishing gear (Bonizzoni et al., 2022; also see Fertl & Leatherwood, 1997). In this paper, we provide evidence for the first time of harbour porpoise associations with flyshoot (Scottish seine) fisheries in the English Channel.

Scientific observers were on board a flyshoot trawler (31.5 m; 680 hp) operating in the English Channel (Figure 1) to study fish behaviour. On 29 and 30 March 2022, harbour porpoises were seen following the cod-end of the net. To obtain information on their behaviour underwater, an underwater camera (GoPro Hero 4) was mounted on top of the cod-end (Figures 2 & 3), with the lens aimed in the current's direction and towards the cod-end rope. During one haul, an additional Big Blue dive light was mounted besides the camera. One observation was made with another underwater camera (GoPro Hero 8), which offered additional footage *inside* the trawl net. Harbour porpoise footage was collected during eight hauls dispersed over both days of which seven recordings were of sufficient quality for further analyses.

The flyshoot trawl is towed over the sea floor, where the cod-end of the trawl (where the fish is collected) hovers a few meters above the sea floor. Water depth on the recorded locations was between 46 and 56 m. The fishing technique is similar to Danish anchor seining (Seafish, 2022a) but uses a buoy instead of an anchor. The flyshoot fishing gear consists of two long weighted seining ropes, a trawl net, and a large buoy (Seafish, 2022b; Figure 3). There are three phases in the flyshoot fishing process: (1) setting the seining ropes and trawl, (2) herding the fish, and,

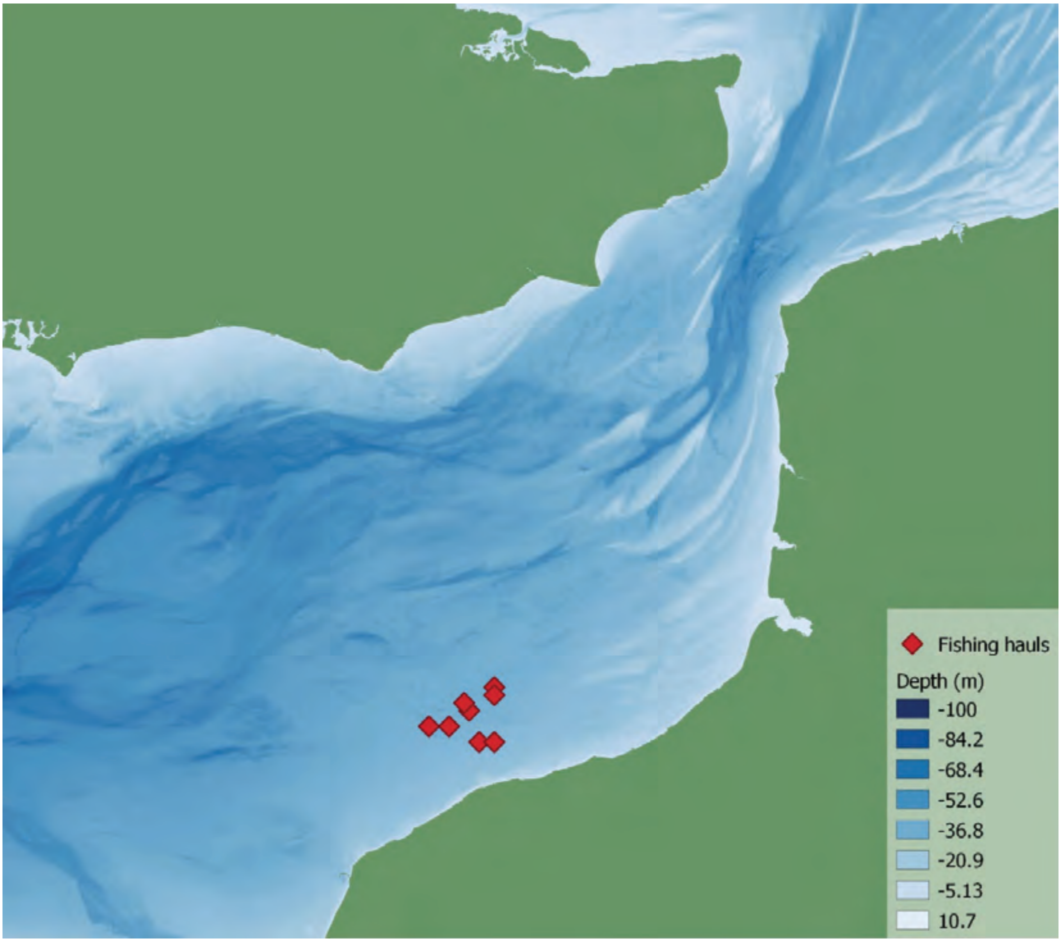


Figure 1. Locations in the English Channel of the eight flyshoot hauls where the video footage was collected. Depth profile in blue.

finally, (3) hauling in the net and capturing the fish (Figure 3). On the fishing ground, the trawler sets in a consecutive order: a buoy, the first 3,500 m seining rope, the trawl, and the second 3,500 m seining rope. This gear is set in a diamond shape (Figure 3). After setting the gear, the buoy is picked up, and both seining ropes are slowly retrieved. The fish herding phase starts with retrieving both seining ropes (45 m/min) while the vessel is moving forward at a speed (over ground) of 0.5 to 1.5 kts (1 to 2.7 km/h). When both seining ropes have straightened, fish are herded in the trawl path, followed by the fish capture phase (Figure 3). During this last phase, the retrieval speed of the seining ropes and trawl net are increased stepwise up to 110 m/min.

One flyshoot haul takes ~90 min, and the technique is only effective during daylight hours since fish can only be herded when they can visually observe the moving seining ropes. Fishing occurs primarily from April until October in the North Sea, and during other months in the English Channel. A flyshoot cod-end mesh size of 80 mm is used to catch a mix of demersal and pelagic fish. The main target species are red mullet (*Mullus* sp.), squid (*Loligo* sp.), gurnards (*Chelidonichths* sp.), and cuttle fish (*Sepiida* sp.), but valuable non-target catch includes more than 20 species. Based on landed weights, those species include mackerel (*Scomber scombrus*), horse mackerel (*Trachurus trachurus*), whiting (*Merlangius merlangus*), seabass (*Dicentrarchus labrax*), and a mix of other roundfish and flatfish. The total catch weight (marketable and unwanted catch combined) is highly variable and ranges between 200 up to 4,000 kg per haul.

The acquired raw video footage was rendered to one video file per haul using *Adobe Première Pro*, Version 2022. From those files, a selection

Figure 2. Impression of camera set-up positioned on the upper side of the cod-end prior to setting the flyshoot trawl net. (*Photo credit:* P. Molenaar)

of suitable footage was made for further analyses. Footage per haul was reviewed visually, and the presence of harbour porpoises was noted. Every time the minimum number of porpoises present increased, the time was noted. Caught fish species were identified if possible. For other species, such as northern gannets (*Morus bassanus*), their time of first appearance was noted. The time of recorded events was subtracted from the time the cod-end was lifted, so the appearance of those events could be related to the capture process within a haul.

Data on harbour porpoise behaviour could be obtained during seven hauls (Figures 4 & 5; supplementary video; the supplementary video for this paper is available in the "Supplemental Material" section of the *Aquatic Mammals* website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147). The images showed harbour porpoises swimming behind the cod-end, moving in and out of the camera frame. The animals were seen chasing and/or catching fish that escaped through the mesh (Figure 5b; supplementary video). There was no record of harbour porpoises picking fish that were meshed in the cod-end. As the haul proceeded towards the end of the capture phase, more fish were collected in the cod-end, leading to increased numbers of small fish passing through the cod-end mesh. Simultaneously with the proceeding capture phase, the (minimum) number of porpoises observed at the same time increased (Figure 4). The number of harbour porpoises visible at once (in one frame) ranged from zero to nine (Figures 4 & 5c; supplementary video), but most of the time, one, two, or three harbour porpoises were visible concurrently (Figure 4b).

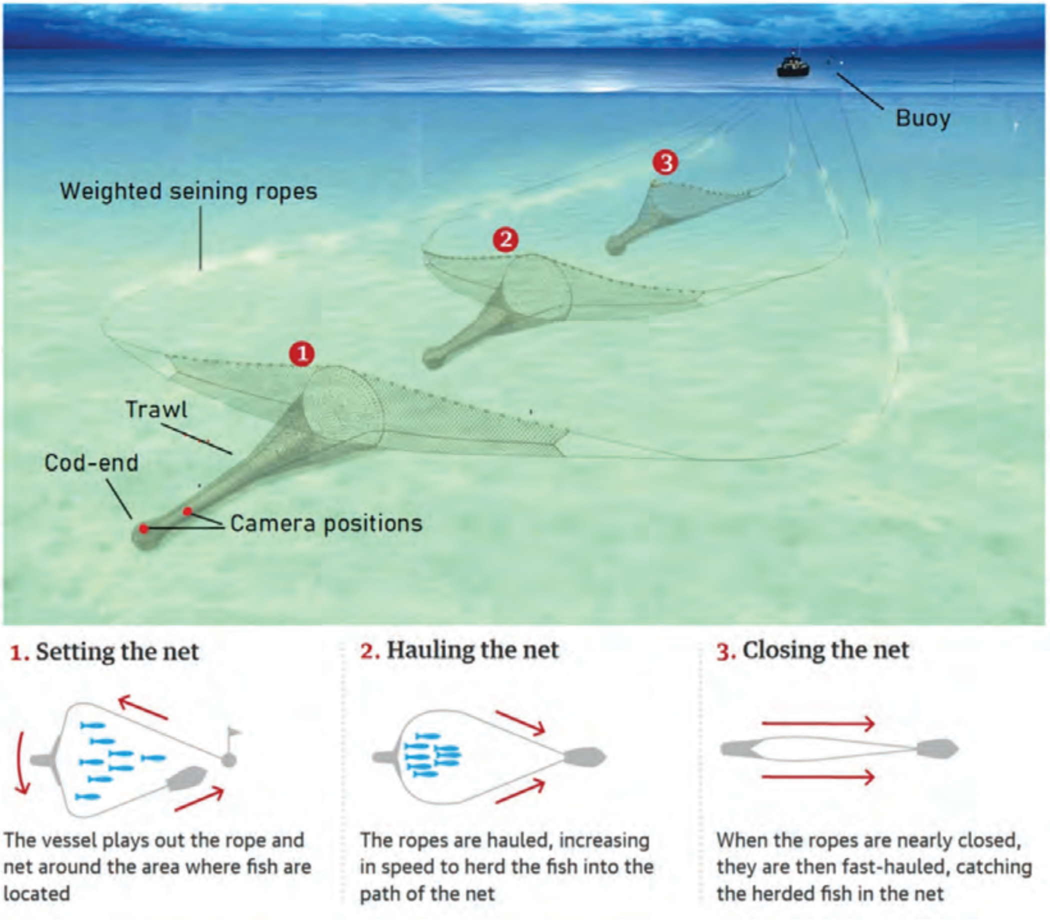
Observed fish species that were taken as prey by harbour porpoises included red mullet, whiting, and poor cod (*Trisopterus minutus*). Other fish species identified escaping through the mesh included lesser spotted dogfish (*Scyliorhinus canicula*), horse mackerel, and black seabream (*Spondyliosoma cantharus*). In the analysed footage, there was no clearly visible capture of those species, but species identification was often difficult. Porpoises feed on a wide range of fish species, and red mullet, whiting, and poor cod have all been documented before as prey (Börjesson et al., 2003; Angerbjörn et al., 2006; Sveegaard et al., 2012; Leopold, 2015).

Of the 90 min that a flyshoot haul requires, harbour porpoises were observed following the cod-end for 20 up to 50 min (Figure 4a). During all observed hauls, 1 to 3 min before the cod-end is lifted from the water (at approximately 10 m depth), northern gannets were observed diving to catch fish that escaped from the cod-end (Figure 5d; supplementary video). At this point, harbour porpoises moved away from the cod-end area and were either visible farther away or not seen in the video frames (Figure 5d), but they had been observed from the vessel moving away from the cod-end.

This paper is the first documentation of harbour porpoises following flyshoot fishing vessels and preying on fish escaping the net's cod-end. To our knowledge, there is only one other publication describing porpoises following active fishing gear (Bonizzoni et al., 2022; see also Fertl & Leatherwood, 1997). Fishers, however, state that they frequently observe harbour porpoises during their flyshoot fishing operations—both in the English Channel and the North Sea. In the latter sea basin, fishers mention similar observations from twin-rig otter trawl fisheries targeting plaice (P. Molenaar, pers. comm., 2022).

Harbour porpoises generally have high metabolic rates and have been shown to forage at high rates (catching many fish per hour and feeding nearly continuously) (Lockyer, 2003; Wisniewska et al., 2016; Hoekendijk et al., 2017). These flyshoot fishery operations provide prey at relatively low energetic costs. It minimizes necessary search time, and the escaping fish are easier to catch since they are likely fatigued or disoriented when they slip through the 80 mm mesh. Each haul seems to provide feeding opportunities for at least 20 to 50 min.

Cetaceans are acoustic animals that use echolocation for catching prey, navigation, and communication. Sound thus plays a major role in the foraging and socializing behaviour of cetaceans. It can be hypothesized that the harbour porpoises have learned to recognize the sound of setting the trawl net as this is generally accompanied by chain "noise." The observed increase of animals when a haul is proceeding could indicate that animals arrive from



The vessel plays out the rope and net around the area where fish are located

The ropes are hauled, increasing in speed to herd the fish into the path of the net

When the ropes are nearly closed, they are then fast-hauled, catching the herded fish in the net

Figure 3. Schematic view of flyshoot or Scottish seining and the camera positions. The vessel first sets the seining rope and the trawl net, which rest on the sea floor. After that, the lines and trawl net are retrieved to herd and catch the fish. (*Picture sources:* Seafish [www.seafish.org] and the Food and Agriculture Organization of the United Nations [FAO]; courtesy of Guardian News & Media Ltd).

different locations, having associated the net setting with a foraging opportunity. Sperm whales appear to respond to acoustic cues from fishing activities, and the same is suggested for killer whales (Thode et al., 2015; Mul et al., 2020). Dolphins can also be attracted to the sound of trawlers, and it is reported that dolphins appear to locate trawlers from considerable distances (Bonizzoni et al., 2022).

The harbour porpoises seemed to increase their distance to the cod-end once the northern gannets started predating on the escaped fish. The northern gannets appear in the final minutes of each haul. At this stage, the cod-end is near the surface and within the diving range of the gannets. Although northern gannets can dive over 25 m deep, their average dive depth is shallower than 20 m (Brierley & Fernandes, 2001). It could be hypothesised that the accompanied withdrawal of the harbour porpoises is due to the risk of being "hit" by one of the diving birds. An alternative hypothesis could be that the gannets catch the fish before the porpoises have the opportunity to do so and the latter lose interest.

Associations between fisheries and cetaceans fall into different categories, being detrimental or beneficial to one or both of the involved parties. In this case, harbour porpoises are feeding on escaping fish, so no depredation of the catch takes place. We did not observe harbour porpoises picking meshed fish from the cod-end; only fish that slipped through the mesh were taken. It is therefore unlikely that this behaviour causes any income loss to the fisheries. There was one shot at the beginning of one haul where a porpoise swam

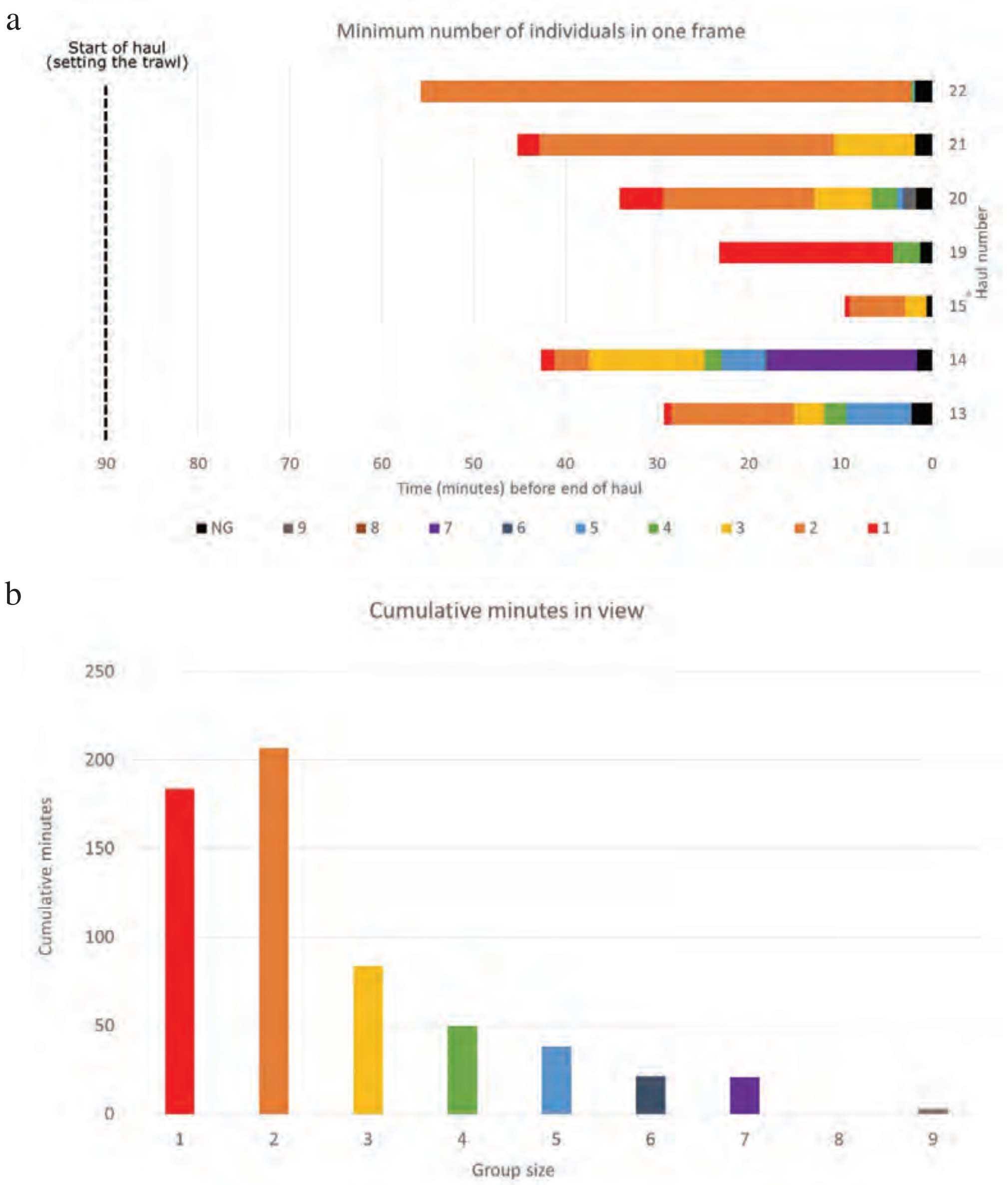


Figure 4. (a) Minimum number of individuals present as the haul proceeds for each haul separately and an indication of the time when the northern gannets (*Morus bassanus*; NG) "enter" the footage and the harbour porpoises (*Phocoena phocoena*) stay further away. *During the first phase of haul 15, a twisted cod-end obstructed the video frame. Only during the last minutes of the haul did the cod-end straighten, enabling good footage; and (b) cumulative minutes (summed over all hauls) for each number of harbour porpoises simultaneously in view.

inside the trawl net before the actual hauling of the trawl started. At this moment, there were no fish in the trawl net yet. This porpoise was not seen inside the net following the start of the haul. Such behaviour might be detrimental to the fishers in case catch is predated on, and it may increase the chance of accidental bycatch. Harbour porpoise bycatch is most common in gillnet fisheries and is considered a substantial threat to the species in some areas (Berggren, 1994; Jefferson & Curry, 1994; Lowry & Teilmann, 1994; Vinther & Larsen, 2004; Bjørge et al., 2013; IJsseldijk et al.,

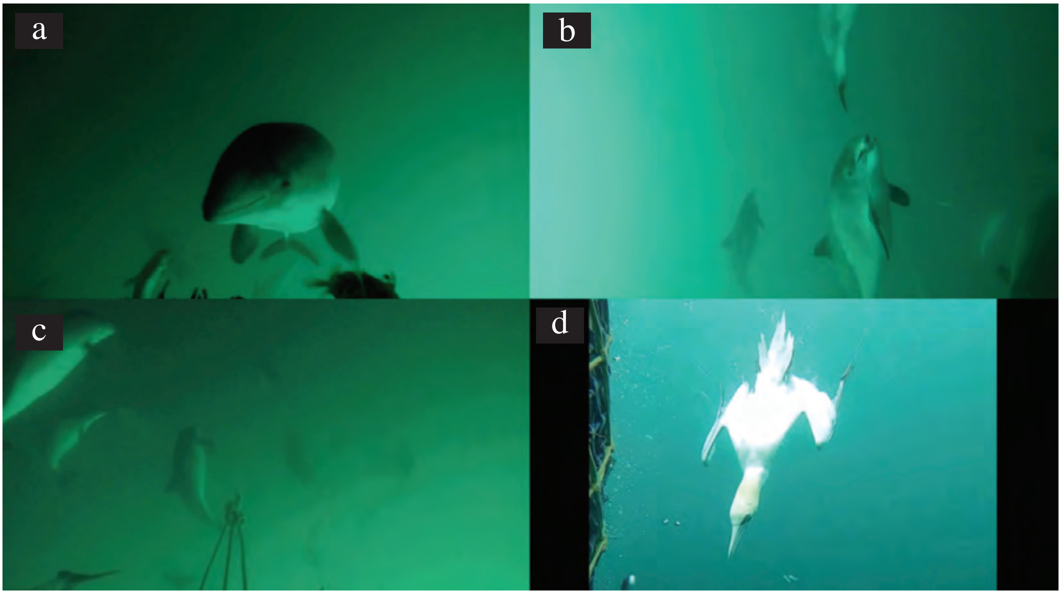


Figure 5. (a) Shot of harbour porpoise close to the camera and the cod-end (bottom of image); (b) multiple harbour porpoises in frame with one catching fish; (c) nine harbour porpoises observed simultaneously; and (d) a northern gannet joining in. (Photos provided by P. Molenaar)

2021). However, reports of catches in active fishing gear, such as trawls, are rare and include (parts of) carcasses that lie on the seabed (P. Molenaar, pers. obs., 2022). There are some anecdotal observations of harbour porpoises incidentally being bycaught in this fishery, but fishers state that it hardly ever occurs, even though harbour porpoises are frequently present around their vessels. There is low observer coverage in the described flyshoot fishery, and systematic monitoring and higher observer coverage could provide more insight.

The recorded association provides new insights into harbour porpoise behaviour at sea. The method presented in this paper provides an easy, cost-efficient approach to collect behavioural observations. Multiple cameras mounted to the cod-end and application of additional lighting could improve identification of both harbour porpoises and caught prey species. Future monitoring could provide information on porpoise group composition (including identifying the sex of the animals), species they prey on, food intake, (potentially cooperative) hunting behaviour, and potential interspecies interaction with northern gannets, for example. An alternative or supplementary method to detect/monitor this kind of porpoise interaction would be to use passive acoustic monitoring devices (e.g., C-POD, F-POD, Soundtrap). The partly automated analysis of C-POD and F-POD data allows for extraction of both harbour porpoise presence and feeding behaviour.

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Drone Observations of a Mother–Calf Humpback Whale (*Megaptera novaeangliae*) Pair Synchronous Feeding in the Bay of Fundy, Canada

Lindsey S. Jones,[1] Toby A. Stephenson,[1] Ann M. Zoidis,[1,2] and Sean K. Todd[1]

[1]*Allied Whale, College of the Atlantic, 105 Eden Street, Bar Harbor, ME 04609, USA*
E-mail: ljones@coa.edu
[2]*Cetos Research Organization, 51 Kebo Ridge Road, Bar Harbor, ME 04609, USA*

Drones, or Unmanned Autonomous Vehicles, have become a commonly used and powerful tool in capturing observations of wild marine mammals (Torres et al., 2018; Fiori et al., 2019). Herein, we present the first drone-documented case of parallel lunge feeding by a mother–calf humpback whale (*Megaptera novaeangliae*) pair in the Bay of Fundy within the Gulf of Maine. The behavior observed suggests that the calf is using mimicry to learn the complex lunge feeding behavior. This anecdotal observation adds to the current paucity of recorded social learning events in humpback calves.

On 4 September 2021, during field research in the Bay of Fundy aboard the M/V *Osprey* (a 14 m research vessel), we encountered a small aggregation of humpback whales feeding on the Grand Manan Banks (Figure 1). The Grand Manan Banks are a known feeding ground for multiple marine

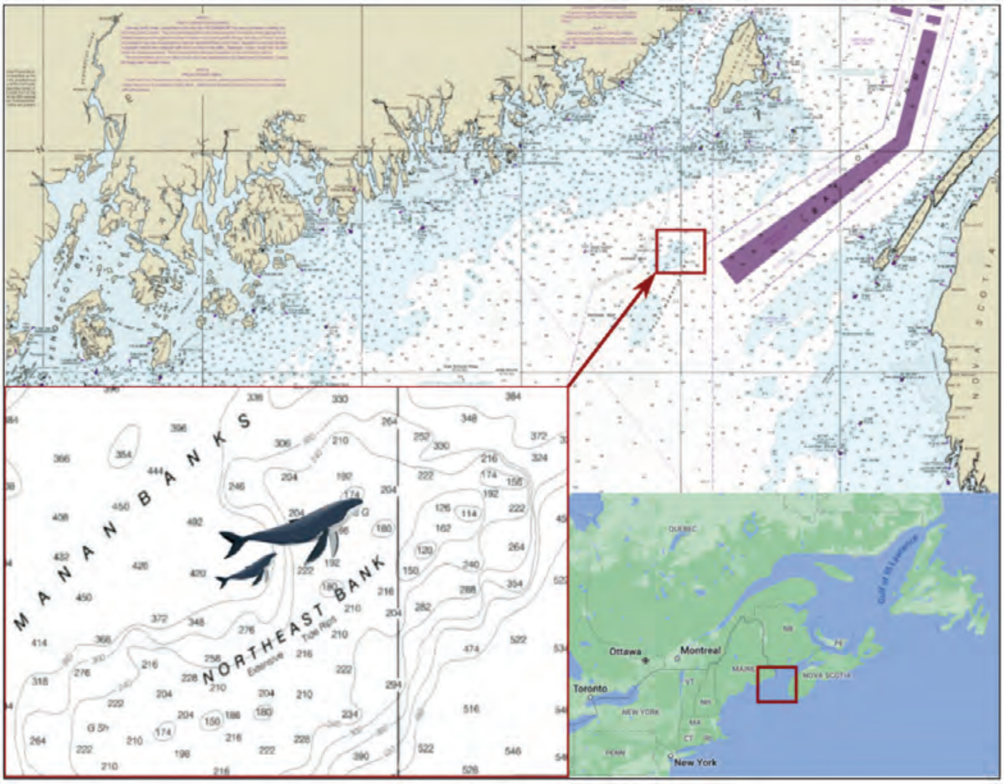

Figure 1. Location of observation in the eastern Gulf of Maine (based on NOAA Chart #13260). *Inset left:* Northeast Bank of the Grand Manan Banks (NOAA Chart #13392). *Inset right:* Region of northwestern Atlantic.

mammal species (Arnold & Gaskin, 1972; Woodley & Gaskin, 1996; Ingram et al., 2007). This sighting included three humpback whales identified as "Lascaux" (*North Atlantic Humpback Whale Catalog* #na08308), Lascaux's calf of 2021 (no catalog number yet), and "Tongs" (#na00837). During the lunge feeding observation, Tongs was more than two body lengths away from the mother–calf pair and did not appear to influence their behavior.

A licensed drone operator (coauthor TAS) flew a DJI Phantom 4 with a 12.4 MP camera over the mother–calf pair, collecting 4K (4,096 × 2,160) video at an altitude of 34 m and a 90° angle to the water's surface. Approximately 3 min into the recorded video, we opportunistically recorded the mother and calf exhibiting synchronous lunge feeding (at 44.2712°N, 67.0344°W; Figure 2). Prey sampling was not conducted concurrently, but based on the video images and common humpback prey sources in the Bay of Fundy, the food source was likely northern krill (*Meganyctiphanes norvegica*).

We reviewed the video frame-by-frame in *iMovie* (Version 10.3.4) on a 4K resolution monitor to optimize event details. Our video sequence initially reveals Lascaux approaching a patch of clearly visible krill from below, at an oblique angle, in a clockwise motion on her side (left side up). As her mouth opens and the gular or ventral feeding pouch expands, she rotates counterclockwise, just below the surface, until she is dorsal side up. Her calf is seen swimming ventrally to the left of its mother in a similar aspect and direction. The calf performs a gulp maneuver twice, the second time more vertically toward the surface as Lascaux completes her foraging sequence. The calf's lunge is slightly delayed to the mother's by 2 to 3 s but

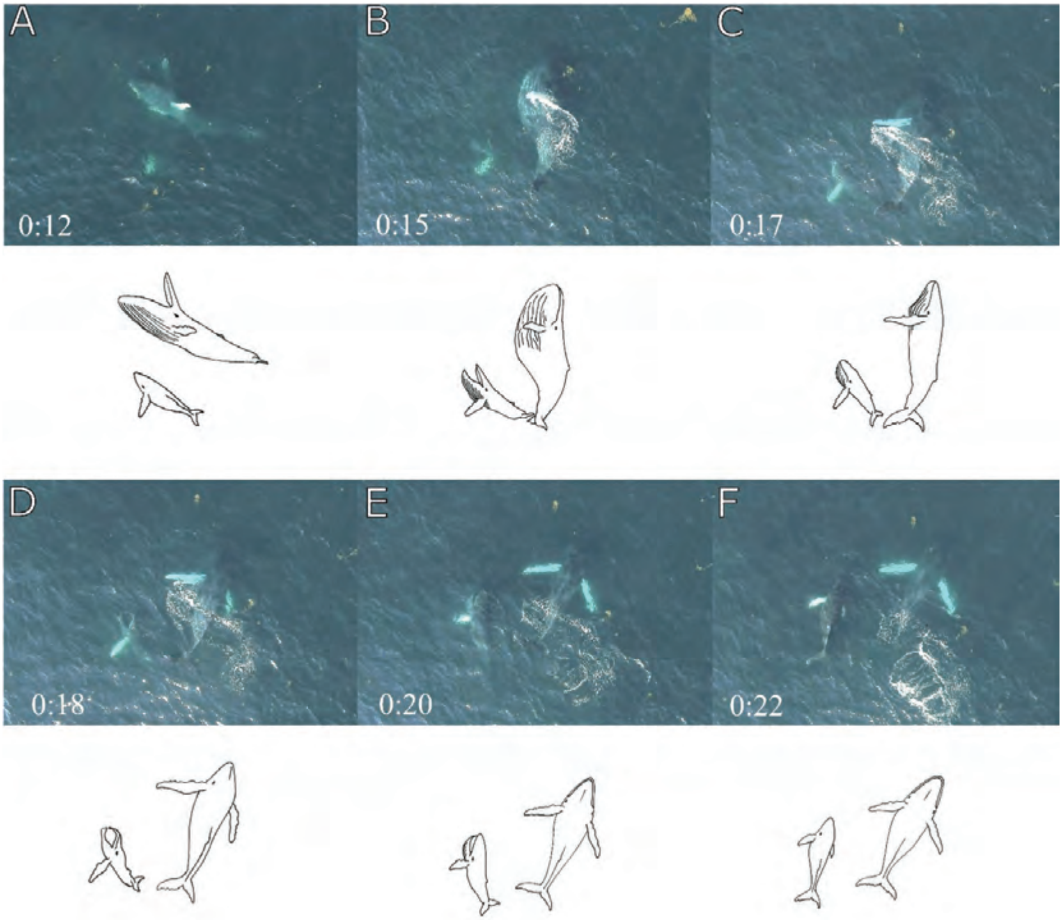

Figure 2. Sequence of mother–calf humpback (*Megaptera novaeangliae*) pair lunge feeding on krill with (A) calf slightly delayed behind mother, (B) calf's first gulp event, (C) calf completing first gulp event, (D) calf's second gulp event, (E) calf's distended gular pouch visible, and (F) foraging sequence end. For each panel, an additional graphic clarifies the whales' positions.

clearly mimics the mother's actions in aspect of approach, three-dimensional body disposition, and choreography of the gulp sequence (Figure 2).

Our observation shows the calf duplicating its mother's behavior in a manner suggestive of socially learned imitation/mimicry under the conventions proposed by Whiten & Ham (1992). While we cannot be certain that the calf is filtering food, its gular pouch is distended, its activity is synchronous with the mother's feeding maneuver, and the calf made two attempts vs one execution by the mother, which potentially indicates practice of this behavior by the calf. The krill patch cohesiveness is disrupted by the mother's lunge (see Figure 3 & Supplemental Video; the Supplemental Video for this paper is available in the "Supplemental Material" section of the *Aquatic Mammals* website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147), which we hypothesize offers a potential benefit to the practicing calf.

Documenting learning *in situ* or capturing the ontogeny of an apex skill—such as learning to capture food—in baleen whale young is a challenge since most activities occur subsurface. It is difficult to know definitively how or when a calf or juvenile mysticete acquires feeding skills. There is one documented instance when researchers, with the use of Dtags over a ~20 h period, were able to document a Southern Ocean humpback whale calf appearing to experiment by mimicking its mother's swimming motion while foraging (Tyson et al., 2012). Whether or not the calf in that study was engaging in lunge feeding was inferred by the recorded swim patterns of below-water lunges, surmised by the rapid increase and decrease of water flow past the built-in hydrophone of the tag. While Tyson et al.'s (2012) findings were not derived from direct observation, the use of thrust as a proxy for feeding—as determined by acoustics—is widely accepted (Goldbogen et al., 2006, 2011); their study did not sample prey, likely Antarctic krill (*Euphausiia superba*), in the water column, but tag data confirm that lunge feeding occurred. Another anecdotal report of a humpback calf appearing to mimic its mother's feeding lunges was recorded from the surface using a handheld digital video recorder by observers on a vessel off New South Wales, Australia (Stamation et al., 2007).

Figure 3. Detailed sequence of the feeding behavior. The composition of the krill is outlined with white dashed lines as surmised from detailed and enhanced video examination. Red arrows indicate the calf's mouth in various stages of attack. Feeding behavior sequence: (1) mother's attack on krill, (2) calf's opening mouth, (3) calf's second opening mouth, and (4) calf's distended gular pouch as sequence ends. For timestamps of each image, see panels A, B, D, and E in Figure 2.

Documentation of such a rarely observed mother–calf pair behavior in the Gulf of Maine provides greater understanding of essential behavioral development in the North Atlantic population of humpback calves. Parallel lunge feeding by the mother and calf is evident from this first such drone-captured documentation. In marine mammal science, drones were initially used for quantification studies such as photogrammetry (Christiansen et al., 2016), population estimates (Goebel et al., 2015), and physiological applications in capturing blow samples (Acevedo-Whitehouse et al., 2010), but they also have great potential for use in behavioral studies (Torres et al., 2018). Drones are a useful tool for providing an aerial view of behaviors not visible from other platforms and for providing substantively more detailed viewing of activities occasionally sighted in part from surface observations. Drones are a complementary tool for studying marine mammals and will aid future research on social learning, including studies that may focus on similar feeding events in humpbacks. While our observation successfully utilized aerial drone technology, caution should always be taken when using drones to limit disturbance and potential harm to marine mammals. This recording demonstrates how drone-captured video can uniquely enrich our understanding of behavioral development in humpback whales.

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Social Transmission of Innovative Sound Production in Walruses (*Odobenus rosmarus*)

Colleen Reichmuth[1] and Debbie Quihuis[2]

[1]*Long Marine Laboratory, Institute of Marine Sciences, University of California, Santa Cruz, CA 95060, USA*
E-mail: coll@ucsc.edu
[2]*Long Beach Aquarium, 100 Aquarium Way, Long Beach, CA 90802, USA*

Within a zoological setting, a male Pacific walrus (*Odobenus rosmarus divergens*) spontaneously used a toy as an instrument to produce an underwater sound in a specific manner and location. This peculiar behavior persisted over several years and was eventually acquired by two of three same-aged conspecific females. We believe this opportunistic finding demonstrates tool-based innovation in sound production and establishes the potential for social transfer of complex behaviors in this species. Given limited available documentation of similar occurrences in other mammals, these observations of walruses are described within the context of social learning and species-typical behavior.

Examples of acoustic plasticity, tool use, and social transmission of arbitrary behaviors remain rare for non-human mammals (see Heyes & Galef, 1996; Janik & Slater, 2000; Byrne, 2002) and especially for carnivores (see Box & Gibson, 1999). Anecdotal descriptions can help determine the possible relevance of these topics to different animal groups. Pinnipeds are amphibious carnivores with notable cognitive skills (Schusterman & Kastak, 2002; Cook et al., 2021; Hanke & Reichmuth, 2022) and demonstrated flexibility in sound production (see Reichmuth & Casey, 2014). However, there is no substantive evidence that pinnipeds use tools (Mann & Patterson, 2013) or learn through observation of actions performed by others.

Walruses are among the most vocal marine mammals and the most social pinnipeds. They live more than 30 y and have an extended period of maternal dependency, with calves gradually weaned by 3 y of age. Little is known about their fine-scale social structure, but accumulating evidence suggests the potential for long-term bonds (see Miller & Kochnev, 2021) that could provide opportunities for learning from familiar individuals.

Males and females produce social sounds in air and water that vary in amplitude, duration, pitch, bandwidth, frequency modulation, and other characteristics (see Charrier, 2021). Not all sounds have laryngeal origins or involve the expulsion of air through the nostrils or mouth (Schusterman, 2008). Features of the mouth, lips, tongue, and muzzle related to suction feeding and specializations of the respiratory tract related to buoyancy and breath control support the production of unusual and graded sounds (Tyack & Miller, 2002), including buzzes, clicks, rasps, whistles, barks, growls, and moans (see Fay, 1960; Schevill et al., 1966; Schusterman & Reichmuth, 2008). Additionally, mature males emit complex underwater "songs" during the breeding season. These non-vocal acoustic displays comprise predictable sequences of intense knocks, taps, clanging gong-like sounds, and harsh whistles that are relevant to male competition and possibly female choice within a polygynous breeding system (Sjare et al., 2003).

Herein, we describe the invention and social transfer of an unusual sound-producing behavior within a group of four adolescent Pacific walruses, a male and three females, that were reared in human care at Six Flags Marine World in Vallejo, California. These individuals were highly interactive with one another and with their environment. It is well known that captive walruses orally explore and often damage structural features in their living spaces, presumably as a byproduct of natural suction feeding behavior (Fay, 1982). In this situation, a bolt associated with a window frame was removed by one or more of the walruses, leaving a space in the wall behind the frame where the bolt had been. This surface defect remained accessible to the walruses for several years until the pool was repaired.

During the time this feature was present, the walruses had occasional access to a rubber "tug" toy as part of routine behavioral enrichment (Figure 1). While all four walruses carried and manipulated this toy, the male spontaneously began to use it in a purposeful way in 1999 when he was 5 y old. He would carry the toy in

Figure 1. The male walrus (*Odobenus rosmarus*), "Sivuqaq," photographed through the window with the instrument he used for sound production. See Supplementary Video 1 for examples of his sound-producing behavior. (*Photo credit:* C. Reichmuth, 10 January 2006)

his mouth to the window, carefully position it at the position of the bolt hole, and "buzz" the toy in such a way that a sharp trumpeting sound was produced. This sound was continuous (> 1 s duration) or patterned in discrete pulses (see Supplementary Video 1; this video is available in the "Supplemental Material" section of the *Aquatic Mammals* website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147). The sound amplitude was greater than the common moan vocalizations produced by this individual (> 166 dB re 1 µPa; Reichmuth et al., 2009). The behavior always occurred in the same location. It persisted intermittently for more than 3 y during periods when the toy was available in the enclosure until the window frame was repaired.

The male's unusual sound production elicited strong and immediate responses from the conspecific females, who oriented to the male and crowded tightly around him as he performed the behavior (Supplementary Video 1). All three females were observed to produce components of the male's actions (Supplementary Video 1). Eventually, two females performed the complete behavioral sequence demonstrated by the male—carrying the toy to the appropriate location at the window frame, placing the rubber toy carefully at the position marked by the bolt hole, and emitting similar trumpeting sounds. The females' acquisition of the trumpeting behavior occurred within a year of our initial observations. While not captured to video, the females' responses were documented in behavioral records and verified by at least two observers on the animal care staff (one of the authors, DQ, and T. Rael, pers. comm., 16 May 2022).

The mechanism of sound production in these instances was unclear. No air bubbles were visibly released during the behavior, suggesting the vibration of the toy was not a consequence of air exhalation through pursed lips. Rather, the walruses may have produced the sound by sucking water over the rubber toy into the mouth or by jetting water out of the mouth over the toy. The role of the anomalous surface feature in the pool where the behavior occurred is also ambiguous from our observations and limited recordings. What is apparent is the consistent use of the toy as an instrument or tool to create a novel, attention-getting sound in a predictable and directed manner.

This odd form of sound production has several aspects that are relevant to social transmission of complex behavior. First, the behavior is both arbitrary and complex (multi-stage) and does not occur as an innate or species-typical behavior. Therefore, we can be relatively certain that expression by observers would not occur by chance. The behavior was expressed exclusively in a particular location, suggesting that local enhancement (facilitation of learning that results from drawing attention to a place) might play a role in behavioral transfer. Similarly, as the behavior occurred only with a particular toy, it is possible that stimulus enhancement (facilitation of learning that results from drawing attention to an object) could play a further role (see Zentall, 2006). However, given the specificity and arbitrary nature of this goal-directed behavior, the most likely explanation for behavioral transfer may be true imitation. Social transmission of behavior through imitation is difficult to demonstrate in animals. It occurs when an individual copies the form of an observed behavior, particularly an otherwise improbable action or utterance for which there is no instinctive tendency (Zentall, 1996).

In this case, we note the absence of food reinforcement and the apparent significance of social cues (attention, vocalizations, tactile stimulation) provided by the observing or “listening” individuals. The male’s sound-producing behavior captured our own attention immediately as we observed him through the window. It seems likely that the male’s innovative behavior created a very salient signal that provided the opportunity for the female walruses to closely attend to his actions, the object, and the specific location.

Interpreting these observations in relation to the typical behavior of walruses is difficult. There are few descriptions of behavioral development in walruses, including responses associated with feeding, communication, and social interactions. The suction and hydraulic jetting used during underwater feeding on bivalves (Levermann et al., 2003) certainly seems related to the expression of this acoustic behavior. Novelty in sound production may have additional relevance to walruses as they are known to exhibit acoustic plasticity (Schusterman & Reichmuth, 2008). Further, the patterned songs of wild males are known to vary contextually and over successive seasons (Sjare et al., 2003). It is possible that social learning of complex behavior occurs among walruses in natural situations but has not yet been documented in the field. By sharing this anecdote from our time spent with walruses in a zoological setting, we highlight the unique nature of these marine mammals and add to early descriptive reports of their unusual behavior and sociality (see Fay, 1982).

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First Record of Predation on an Oilfish and a Previously Unknown Cephalopod Prey by a Short-Finned Pilot Whale in East Nusa Tenggara, Indonesia

Putu Liza Kusuma Mustika,[1, 2, 3] Kathryn Kazuko High,[4, 5] I Made Jaya Ratha,[2, 3]
Maria Margaretha Siko,[6] Jo Marie Acebes,[7, 8] Ronaldo Meko Li Makin,[6]
Satri Nirma Meo,[6] Evensius d'Alxandro,[6] and Pieter Robert Ebenhaezar Didok[9]

[1]*College of Business, Law and Governance, James Cook University,*
Townsville, Queensland, Australia
E-mail: putuliza@gmail.com
[2]*Cetacean Sirenian Indonesia, Jakarta, Indonesia*
[3]*Whale Stranding Indonesia, Jakarta, Indonesia*
[4]*California Academy of Sciences, Golden Gate Park, San Francisco, CA, USA*
[5]*San Francisco State University, San Francisco, CA, USA*
[6]*Animal Health Division, the Sikka Agriculture Office, Sikka, East Nusa Tenggara, Indonesia*
[7]*Zoology Division, the National Museum of the Philippines, Manila, Philippines*
[8]*BALYENA.ORG, Bohol, Philippines*
[9]*Area Conservation Section IV, the Natural Resource Conservation Agency (KSDA),*
Sikka, East Nusa Tenggara, Indonesia

Attention to marine mammal stranding events in Indonesia has increased in the last decade. Some efforts have been made to improve the country's stranding responses, including publishing the stranding data online through the Whale Stranding Indonesia website (www.whalestrandingindonesia.com) and conducting training workshops on stranding response. Nevertheless, despite having the second longest coastline in the world (54,716 km; CIA, n.d.), Indonesia has a relatively low number of recorded stranding events. Only 638 stranding events were recorded between 1995 and 2021, an average of 24.5 events per year or 0.012 event per km of coastline. In contrast, the United Kingdom, with only 12,429 km coastline (CIA, n.d.), has had more than 20,000 stranding events since 2013 (*sensu* Coombs et al., 2019)—that is, almost 200 events per year or 0.016 events per km of coastline. Taiwan, with 1,566 km of coastline (CIA, n.d.), had an average of 50 stranding events per year between 1994 and 2013 (Li et al., 2021) or the equivalent of 0.6 events per km of coastline.

Considering the length of Indonesia's coastline, the recorded stranding event trend is likely attributed to the relatively scarce information flow or news coverage and a comparatively lower response effort instead of a true representation of the number of stranding events in the country. Due to this scarcity, any stranding event and its related information deserve prompt investigation.

Between 1996 and 2021, the Whale Stranding Indonesia database included at least 638 recorded marine mammal stranding events, including 48 mass stranding events. The most frequently recorded stranded species in Indonesia are as follows: Irrawaddy dolphins (*Orcaella brevirostris*; mostly along the Mahakam River, East Kalimantan; total 114 events), sperm whales (*Physeter macrocephalus*; 74 events), dugongs (*Dugong dugon*; 71 events), and short-finned pilot whales (*Globicephala macrorhynchus*; 29 events) (Whale Stranding Indonesia, 2022). One sperm whale stranding event was a mass stranding involving 10 animals on 13 November 2017 (ID 333; Whale Stranding Indonesia, 2022). Ten short-finned pilot whale stranding events were mass stranding events involving 322 individuals. Of these 10 mass stranding events, the latest one was a mass stranding of ~52 individuals in the southern part of Madura Island (East Java, Indonesia) on 18 February 2021 (ID 576; Whale Stranding Indonesia, 2022). However, by 2021, only approximately 34 necropsies (5.3% of all marine mammal stranding events) were conducted on stranded marine mammals (all cetaceans), mostly in Bali, East Kalimantan, and Java, thus limiting our understanding of marine mammals in the country (Supplemental Table 1 & Supplemental Figure 1; the Supplemental Material for this paper is available in the "Supplemental Material" section of the *Aquatic Mammals*

Figure 1. (a) The short-finned pilot whale (*Globicephala macrorhynchus*) found on 2 October 2020, with the caudal fin of an oilfish (*Ruvettus pretiosus*) in its mouth (screen shot obtained from a measurement video from Area Conservation Section IV, the Natural Resource Conservation Agency [KSDA], East Nusa Tenggara, Indonesia in Sikka [Live Informasi, 2020]); and (b) a crane was used to reposition the specimen for necropsy and burial on 3 October 2020 (Photo courtesy of Ebed de Rosary, Mongabay, Indonesia).

website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147).

On 2 October 2020, a fisher found a freshly dead short-finned pilot whale floating in Sikka waters in East Nusa Tenggara, Indonesia. With the intention to sell, the carcass was towed to shore. However, upon learning that all whales and dolphins are protected in Indonesia, the fisher relinquished the specimen to Area Conservation Section IV of the Natural Resource Conservation Agency (Balai Konservasi Sumber Daya Alam [BKSDA]). A necropsy was later conducted upon the BKSDA's request (Figure 1).

Figure 2. The necropsy process of the short-finned pilot whale (Photos courtesy of the Sikka Agriculture Office)

Table 1. External measurements of the short-finned pilot whale (*Globicephala macrorhynchus*) (following Figure 10.7 of Geraci & Lounsbury, 2005)

Aspect	Length (cm)	Measurement remarks
Total length	430	From the start of the melon to the notch of the tail
Pectoral fin length (left)	76	From the anterior insertion of the pectoral fin to the tip of the pectoral fin, diagonal line; the right pectoral fin was not measured.
Abdominal girth	110	From the anterior insertion of the dorsal fin, around the stomach cavity

Note: All aspects measured with a stiff tradesman tape measure (Live Informasi, 2020). The dorsal fin height (component #15 of Geraci & Lounsbury [2005], Figure 10.7) is not provided because it was measured incorrectly.

Local veterinarians from the Sikka Agriculture Office, the Animal Health Division, conducted the necropsy at Urunpigan, Wailiti, West Alok, Sikka Regency, East Nusa Tenggara, on 3 October 2020. Due to the unexpected nature of the event, the team was not equipped with proper marine mammal necropsy tools, except for some personal protective equipment (PPEs) for their protection (Figure 2). External examination of the carcass was conducted in right lateral recumbency.

The animal was male with a total length of 430 cm (Table 1). The carcass condition was fresh (Code 2) (Geraci & Lounsbury, 2005). There were several lacerations on the ventral part of the body and fluke and scratches and lacerations around the mouth. Ecchymosis was found on the tongue. The caudal fin or tail of a fish could be seen protruding from the partly opened mouth. The fish, identified as an oilfish (*Ruvettus pretiosus*), was 1 m long and 20 cm wide (Figures 1a & 3). Two incisions at the mandibular and abdominal regions were made on the pilot whale carcass. Upon making an incision at the upper and lower left mandibular joint, the oilfish was found lodged tightly inside the pharynx and could not be extracted. In the absence of proper cutting instruments, the veterinarians could not proceed further. A skin sample from the ventral lateral area near the peduncle was collected and preserved in formaldehyde, hence not useful for further genetic analysis.

An incision was made in the abdominal region to expose the main stomach and the gastro-intestinal organs. The lining of the stomach was unremarkable with no observed lesions. The following prey were found: another undigested whole oilfish (no measurement was taken for this prey), partially digested fish (suspected oilfish), and two large squid of ~80 cm long, including appendages (Figure 4), with an estimated squid mantle length of ~55 cm. Based on available video and photographs, and upon consultation with Dr John Bower from Hokkaido University, the squid were confirmed to be diamond-back squid (*Thysanoteuthis rhombus*; Figure 4). No foreign objects such as plastics were found. A necropsy video is available in the Supplemental Material.

The intestines were partially filled with digested prey, and the linings were unremarkable with no observed lesions. Due to time constraints and logistical limitations, no further examination was conducted, and no samples were taken. Based on these findings, the probable cause of death is asphyxiation due to obstruction of the upper airway. We could not ascertain whether the fish dislodged the goose beak or blocked the nasal passage because the necropsy was only partially completed. However, there have been some precedents where the prey was found lodged inside the esophagus, and asphyxiation was postulated as the cause of death (Elliser et al., 2020).

To our knowledge, del Carmen García-Rivas et al. (2014) is the only prior report on oilfish-related asphyxiation in short-finned pilot whales, and odontocetes in general, while no prior report of short-finned pilot whale consumption of diamond-back squids was found. No publication of short-finned pilot whale prey is available for Southeast Asian waters either. Thus, our report sheds some important light into the ecology of these species, particularly in Southeast Asia.

Short-finned pilot whales can grow to 7.3 m (Carwardine, 2020), with subadults reaching 5 m (Shirihai & Jarrett, 2006); thus, our specimen was likely a subadult. Predominant prey items of this species are squid, octopus, and fish (Shirihai & Jarrett, 2006; Mintzer et al., 2008; Carwardine, 2020). In the western North Atlantic, short-finned pilot whales mostly feed on deep-water species and would mostly feed off the continental shelf prior to stranding (Mintzer et al., 2008). This species is found in open nearshore areas adjacent to deep water, specifically 0 to 15 km to the 1,000 m isobath (Putra & Mustika, 2020); the maximum dive record was 1,019 m (Soto et al., 2008). This species is also believed to be capable of a "deep sprints" tactic to catch fast moving prey such as giant squid

Figure 3. One of the two oilfish inside the stomach of the short-finned pilot whale. Screen shots were obtained from the necropsy video from the Sikka Agriculture Office. The video is available in the Supplemental Material for this paper.

(Soto et al., 2008). Since diamond-back squids usually inhabit epipelagic and upper mesopelagic depths up to 800 m (Jereb & Roper, 2010), its consumption corroborates short-finned pilot whales as deep-water foragers in Southeast Asia and makes this record the first record of a diamond-back squid predation by short-finned pilot whale.

Due to the scant literature of the feeding mechanism of short-finned pilot whales, we examined the feeding mechanism of long-finned pilot whales (*Globicephala melas*) to better understand this lethal predation. The long-finned pilot whales are suspected to be suction feeders, using their hyoid and tongue to create a negative pressure within the mouth to capture prey (Werth, 2000; Johnston & Berta, 2011). Since our necropsy revealed the relatively intact features of the oilfish and the diamond-back squids (Figures 3 & 4), short-finned pilot whales are also likely "'capture' suction feeders" (*sensu* Johnston & Berta, 2011, p. 493), although more investigations are needed to confirm this hypothesis.

The oilfish is a temperate and tropical marine benthopelagic fish species that is either solitary or found in pairs near the sea floor (Gomez, 2019), with lengths between 53 to 139 cm (Acarli et al., 2017; Gomez, 2019). Oilfish are deep-water dwellers, found in the 65 to 700 m isobath (Nakamura & Parin, 1993; Acarli et al., 2017). Since short-finned pilot whales can dive up to 1,019 m (Soto et al., 2008), it is plausible that the Sikka pilot whale might have encountered its two oilfish prey while deep-water foraging.

Oilfish have been recorded several times in the stomachs of sperm whales (Best, 1999). Roughly three times the size of a pilot whale, sperm whales are large enough to handle a sizeable oilfish.

Figure 4. The two diamond-back squids (*Thysanoteuthis rhombus*) inside the stomach of the short-finned pilot whale (*Photo credits:* Photos a, b, and c were screen shots of the necropsy video from the Sikka Agriculture Office [the video is available in the Supplemental Material]; and photo d is courtesy of Area Conservation Section IV, KSDA, East Nusa Tenggara, Indonesia in Sikka)

However, consumption of such a large-sized oilfish can be lethal to smaller cetaceans such as short-finned pilot whales (del Carmen García-Rivas et al., 2014). In our case, the short-finned pilot whale swallowed the fish whole, which could have led to the large prey fish becoming lodged in the pharynx and cranial esophagus. The large size of the oilfish could cause obstruction and compression of the esophagus, blocking the larynx, compromising the airway, and leading to asphyxiation and death soon after feeding.

Asphyxiation of other odontocetes due to other prey has been observed. Dolphin deaths due to upper airway obstruction have been well-documented in common bottlenose (*Tursiops truncatus*) and Indo-Pacific bottlenose (*Tursiops aduncus*) dolphins (Byard et al., 2010; Stolen et al., 2013; Stephens et al., 2017). A common bottlenose dolphin died after consuming a black margate (*Anisotremus surinamensis*), which dislodged the dolphin's larynx, resulting in an agonal death (Mignucci-Giannoni et al., 2009). Another common bottlenose dolphin died after consuming a slender-spined porcupine fish (*Diodon nichthemerus*) due to an upper airway obstruction (both the posterior pharynx and upper esophagus; Byard et al., 2010). Asphyxiation was identified in 14 common bottlenose dolphins for which the fish lodged in the esophagus were associated with a dislocated and obstructed or compressed larynx (Stolen et al., 2013). Other cetaceans have had their fair share of lethal predation as well. Consumption of common soles (*Solea solea*) caused fatal asphyxiation in long-finned pilot whales (IJsseldijk et al., 2015). A beluga whale (*Delphinapterus leucas*) died due to asphyxiation of a starry flounder (*Platichthys stellatus*; Rouse et al., 2018), and harbor porpoise (*Phocoena phocoena*) deaths were linked to asphyxiation of American shad (*Alosa sapidissima*; Elliser et al., 2020) and flatfish (Gross et al., 2020).

The information presented in this paper would have been lost without the initiative of the local BKSDA office and local veterinarians. However, only one measurement of the prey items was available (i.e., of the oilfish lodged in the mouth), and the method of morphometric measurements of the carcass was not clear. Measurements were taken with a stiff tradesman tape measure, thus adding to possible measurement errors. No further examination or sampling was conducted on other organs, and no stomach or gastro-intestinal tract contents analyses were conducted. The skin sample collected for genetic analysis was preserved in formaldehyde, rendering it useless for analysis. These issues are linked to the impromptu nature of the necropsy. This obstacle might have been improved had the team received proper training on how to conduct a necropsy on a marine mammal and other marine megafauna. Thus, this paper emphasizes the importance of improving local capacity in conducting necropsies, including training workshops on collecting morphometrics and writing necropsy reports specifically for marine mammals.

This paper also highlights the governance overlap within marine mammal conservation management in Indonesia. The stranding network was handled by the Ministry of Marine Affairs and Fisheries, the veterinarians were from the Ministry of Agriculture, and general marine mammal species conservation is still handled by the Ministry of Forestry. Despite the presence of the Indonesian stranding network, trained personnel to respond to live and dead strandings are few. Even fewer individuals are trained to conduct necropsies. Standardized protocols for data and sample collection are either insufficient or not widely disseminated. Funding limitations also restrict the ability to collect, preserve, and transport samples for analysis.

More training on marine mammal stranding response and investigation is vital. Due to the generally insufficient ecological data on marine mammals in Southeast Asia, it must be emphasized that any data, including from strandings, is valuable. Spatial and temporal data on occurrences of marine mammals alive or dead, at sea or stranded, would be very helpful for future management decisions. Communications and negotiations must be made to ensure that future stranding events are sampled as extensively as possible. More thorough investigations on gastro-intestinal contents during necropsies would improve our understanding of the ecology of the cetacean species and their prey.

Finally, raising awareness on proper stranding response methods for human and animal safety is crucial for the success of marine mammal stranding networks in developing countries. Indonesia has two ends of the spectrum in terms of responding to stranded marine mammals. At one end of the spectrum, spectators were riding on stranded animals and taking selfies on or around stranded animals (live and dead alike) ("Three Pilot Whales Survive Mass Stranding," 2021). At the opposite end of the spectrum, we have Good Samaritans wanting to help the stranding response. We see that the presence of an active stranding network does increase public awareness. Thus, raising awareness on proper stranding response methods for the safety of the animals and the people alike is critical for the success of marine mammal stranding networks in developing countries, particularly in Southeast Asia.

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Bubble Bursts, a Potential Foraging Strategy for Bottlenose Dolphins (*Tursiops truncatus*) in Cardigan Bay

Katrin Lohrengel,[1] Claudia M. Afeltra,[1] and Peter G. H. Evans[2, 3]

[1]*Sea Watch Foundation, Paragon House, Wellington Place, Ceredigion SA44 4BH, Wales, UK*
E-mail: katrin.lohrengel@seawatchfoundation.org.uk
[2]*Sea Watch Foundation, Ewyn y Don, Bull Bay, Amlwch, Anglesey LL68 9SD, Wales, UK*
[3]*School of Ocean Sciences, Bangor University, Menai Bridge, Anglesey LL59 2AB, Wales, UK*

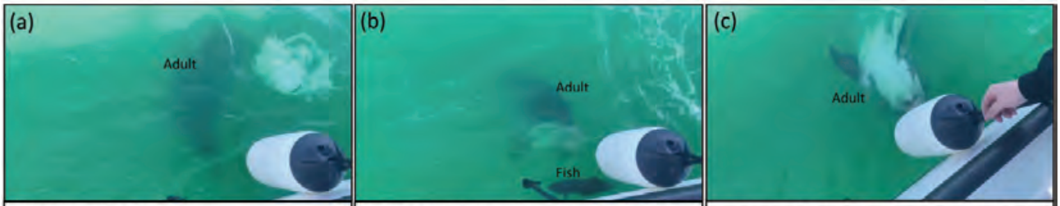
Bubble netting in humpback whales (*Megaptera novaeangliae*) is probably the best known and most studied cetacean foraging strategy relying on the emission of bubbles to secure prey (Jurasz & Jurasz, 1979; Wiley et al., 2011; Pirotta et al., 2021). However, some delphinid species, such as bottlenose dolphins (*Tursiops truncatus*; Fertl & Wilson, 1997), Atlantic spotted dolphins (*Stenella frontalis*; Fertl & Würsig, 1995), killer whales (*Orcinus orca*; Similä & Ugarte, 1993; Visser et al., 2008), dusky dolphins (*Lagenorhynchus obscurus*; Trudelle, 2010), and false killer whales (*Pseudorca crassidens*; Zaeschmar et al., 2013), have also been recorded utilising bubbles for communication to facilitate prey capture.

Bottlenose dolphins are known to engage in complex foraging strategies such as sponge feeding (Smolker et al., 1997), kerplunking (Connor et al., 2000; Weiss, 2006), barrier feeding (Weiss, 2006), mud plume feeding (Lewis & Schroeder, 2003), and systematic depredation of recreational fishing lines (Powell & Wells, 2011). These distinct foraging strategies are thought to be driven by both ecological factors and social learning (Wells, 2019), with mother-to-calf transmission the most significant pathway of information transfer (Sargeant & Mann, 2009).

Bottlenose dolphins using bubble bursts during foraging events are relatively poorly documented, with few examples in published literature (Fertl & Wilson, 1997; Zaeschmar et al., 2013) and none in British waters. There are only two semi-resident coastal populations of bottlenose dolphins in the United Kingdom: one in East Scotland, particularly around the Moray Firth (Cheney et al., 2013, 2014, 2018); and one in Cardigan Bay, Wales (Lohrengel et al., 2018). Both populations have been the subject of extensive monitoring efforts; however, unlike other populations, such as in Sarasota Bay (Wells, 2019) and Shark Bay (Smolker et al., 1997; Sargeant & Mann, 2009), there have been no observations of specialised foraging strategies in the UK. As part of long-term monitoring efforts, the Sea Watch Foundation has worked closely with platforms of opportunity such as wildlife tour boats and fishing vessels, incorporating data collected by volunteers or members of the public and via the Sea Watcher app into the main Sea Watch Foundation sightings database. Herein, we describe the occurrence of repeated bubble bursts during attempted prey capture by two bottlenose dolphins as observed from such a platform of opportunity. The video footage was opportunistically taken using a mobile phone camera and reviewed using Quicktime media player (the video footage for this paper is available in the "Supplemental Material" section of the *Aquatic Mammals* website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147).

During a fishing charter run by Epic Fishing on 28 July 2021 at 1208 h (BST), their boat, M/V *Legend*, was approached by two bottlenose dolphins, a mother and a juvenile, ~300 m off the main pier (Figure 1). Concurrently, Sea Watch observers aboard a visitor passenger boat recorded a sighting of three dolphins (two adults and one juvenile) in the area, describing their behaviour as suspected feeding or foraging. Photographs taken by observers during this sighting were matched with the Sea Watch Foundation bottlenose dolphin catalogue, and the adult with the juvenile was identified as 003-07R or "Berry." The timing of this sighting and colouration of the adult fin suggest the two dolphins in the video may be Berry and her juvenile (nicknamed "Luna"). Berry was first recorded in 2007, and Luna is her third known calf, thought to be born in 2019.

One of the fishing boat passengers noticed a salmon (*Salmo salar*) at the side of the boat, beneath the boat's fender adjacent to the hull. The adult dolphin, suspected to be Berry, approached the boat, repeatedly circling close to the fenders, and blew eight bubble bursts within the 1 min of



00:04 – Initial bubble burst

00:08 – Adult dolphin positioning under fender after emitting bubble burst towards sheltering fish

00:16 – Adult dolphin rolls on back and jerks head forward. The dolphin's mouth is open.

00:18 – Fish sheltering under fender

00:26 – Adult dolphin approaches the boat; juvenile is behind the adult.

00:45 – Adult emitting final bubble burst while approaching fender

Figure 1. Bottlenose dolphin (*Tursiops truncatus*) approaches the boat emitting bubbles

video footage. The bursts were short (~1 to 2 s duration) and forceful, taking the shape of bubble rings before dispersing at the surface:

1. *00:00-005* – First observed were two bubble bursts emitted within 3 s of each other from the adult dolphin positioning itself underneath the fender and jerking its head several times (Figure 1a).

2. *00:08-00:17* – The adult dolphin, suspected to be Berry, turned away from the boat to surface, and then immediately returned to the boat, emitted a bubble burst (00:12) on approach, rolled on her back, and jerked her head underneath the fender (00:15). Berry then left the boat to surface while emitting a whistle (Figure 1b & c).

3. *00:18-00:21* – The dolphins were no longer in view, but the video revealed the salmon sheltering under the fender at the side of the boat (Figure 1d).

4. *~00:21* – The juvenile dolphin surfaced and seemed to turn towards the side of the boat where the salmon was located.

5. *00:23-00:26* – The adult dolphin thought to be Berry surfaced facing the side of the boat, then submerged blowing a bubble burst while approaching the boat (00:24), and again directly next to the fender (00:26) (Figure 1e).

6. *00:27-00:35* – The adult dolphin thought to be Berry faced away from the boat and surfaced (00:31) about 1 m from the side of the boat; the juvenile dolphin could be seen coming up close to it and surfacing, also facing away from the side of the boat (00:32) at ~2 m away.

7. *00:36-00:49* – The adult dolphin suspected to be Berry surfaced facing the side of the boat, emitted two bubble bursts while approaching the boat (00:38, 00:42), and again once next to the fender (00:45). The juvenile surfaced in the background (0:39, 00:47) about 4 m away and then approached the boat (00:49), appearing underneath the adult briefly (Figure 1f).

8. *00:49-01:00* – The adult dolphin continued to approach the fender, positioning on her side while moving her head, before swimming out of frame where the prey item was eventually captured.

Although there were two bottlenose dolphins present in this video, only the adult emitted bubble bursts. The third dolphin that was observed in the vicinity of the boat by observers was not involved in this observation. The bursts were not emitted in the direction of the juvenile but always on approach to the boat and the prey item. Following the boat approach and bubble bursts, the adult was seen positioning itself underneath the fender, rolling on its side and upside down, and forcefully jerking its head several times.

Several hypotheses have been proposed for the bottlenose dolphins' use of bubble bursts during foraging events: keeping schooling prey together, displacing prey, or as a social cue to conspecifics (Fertl & Wilson, 1997). In other contexts, bubble bursts have been associated with social interactions (particularly aggression), responses to objects, or as an expression of interest or excitement (Moreno & Macgregor, 2019). Given the context of this encounter, the bubble bursts are likely to have served to displace the prey from an inaccessible location; to display excitement, agitation, or interest; or to attract the attention of the juvenile.

From the video, it is clear that the dolphins were unable to access the fish in its location directly under the fender. Emission of bubble bursts in the direction of inaccessible prey has been reported in killer whales (Visser, 1999, 2005; Visser et al., 2008), while Weddell seals (*Leptonychotes wedellii*) have been documented to use bubbles to flush fish out from underneath the sea ice (Stone, 1998). It is possible that the adult dolphin was attempting to use bubble bursts to displace the fish from its protective position beside the boat's hull. However, although all bubble bursts were emitted during the approach to the fender, they were not always aimed directly at the fish. A similar behavior employing bubble formation has been observed by one of the authors (PGHE); these were utilised by a minke whale (*Balaenoptera acutorostrata*) in the presence of shoaling herring next to the vessel.

Alternatively, the bubble bursts may be an indication of excitement or interest. In two cases, bubble bursts were followed by head jerks that are often associated with aggressive displays in bottlenose dolphins (Mann & Smuts, 1999; Scott et al., 2005), and it is possible that the visible but inaccessible prey was eliciting an excitement response. It is also possible that these movements were attempts to "head scan" for the fish using echolocation (Diercks et al., 1971; Wei et al., 2021), although no clicks were heard at the time. While the purpose of the bubble bursts in this video is not entirely conclusive, it provides a rare insight into foraging behaviour in Cardigan Bay bottlenose dolphins, recording a previously unknown behaviour in this well-studied population.

It is also possible that the adult bottlenose dolphin was attempting to draw the juvenile's attention to the prey with its positioning and bubble emissions. Bottlenose dolphins have been shown to cooperatively hunt—in some cases, with each dolphin taking on distinctive roles such as the "driver" and the "barrier" dolphin (Gazda et al., 2005). The bubbles may have served as a combination of these two factors, attracting the juvenile's attention and serving as the first part of a "flush and ambush," a cooperative hunting approach employed by species such as Harris hawks (*Parabuteo unicinctus*; Bednarz, 1988).

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Cetacean Mortality Related to Ship Traffic in the Mexican Central Pacific

Camila Lazcano-Pacheco,[1] Mario A. Onofre-Díaz,[2] Raziel Meza-Yañez,[3]
Myriam Llamas-González,[4] Luis M. Bautista-Moreno,[5] Aramis Olivos-Ortiz,[3]
and Christian D. Ortega-Ortiz[3]

[1]*Centro Universitario de Ciencias Biológicas y Agropecuarias, Universidad de Guadalajara, Jalisco, México*
[2]*Universidad Autónoma Agraria Antonio Narro, Torreón, Coahuila, México*
[3]*Facultad de Ciencias Marinas, Universidad de Colima, Manzanillo, Colima, México*
E-mail: christian_ortega@ucol.mx
[4]*Centro Universitario de la Costa Sur, Universidad de Guadalajara, San Patricio-Melaque, Jalisco, México*
[5]*Instituto Oceanográfico del Pacífico, Sexta Región Naval, Secretaría de Marina, Manzanillo, Colima, México*

Ship traffic can negatively affect marine wildlife, including cetaceans, especially in areas where these mammals carry out relevant ecological activities (Halliday et al., 2022). Specifically, ship strikes can be caused by several types of large vessels (e.g., cargo, tankers, cruise ships, and fishing boats), as well as by smaller recreational boats (~10 m). Cetacean mortality caused by ship strikes has been documented on stranded carcasses collected from beaches or the bow of a vessel upon arrival at a port (Laist et al., 2001; Jensen et al., 2004; Silber et al., 2010; Schoeman et al., 2020; Ransome et al., 2021). Sometimes, the impact may leave no external evidence and cause of death must be confirmed via necropsy (Laist et al., 2001; Panigada et al., 2006); however, the carcass must be fresh since an advanced state of decomposition masks the signs of a ship strike (Glass et al., 2009).

Cetacean mortality related to ship traffic is increasing since the co-occurrence of cetaceans and ships is becoming more widespread (Guzmán et al., 2013; Redfern et al., 2013; Thomas et al., 2016), which is likely due to increased ship traffic worldwide and the recovery of certain cetacean populations (e.g., *Eschrichtius robustus, Megaptera novaeangliae*, and *Balaenoptera musculus* from the Northeast Pacific; Calambokidis & Barlow, 2004; Punt & Wade, 2012).

The commercial port of Manzanillo is located in the Mexican Central Pacific (MCP) in the eastern tropical Pacific (Figure 1). It is the most important port in the country with ship traffic capacity over 2.1 million cargo containers or twenty-foot equivalent units (TEUs) annually (Secretaría de Comunicaciones y Transportes [SCT], 2014). In addition, two companies that store liquefied gas (Z Gas and KMS) are present in the southeast zone (Figure 1), and tourist and fishing activities are also common in the region (Secretaría de Turismo [SECTUR], 2014). Therefore, the MCP presents high maritime traffic where three species of mysticetes and 11 odontocetes have been recorded (Ortega-Ortiz et al., 2013). As a result, the MCP is an area where interactions between cetaceans and vessels are frequent and mortality events can occur.

The aim of this paper is to report the mortality of six individual cetaceans in the MCP caused by interactions with ships (Table 1). Data were obtained from an indirect monitoring program that we have been conducting since 2010. In each stranding event, data such as date, time, site, animal decomposition state (i.e., alive, fresh, early decomposition, advanced decomposition, and mummified), species, size class, sex, and evidence of human interactions (e.g., wounds by ship strikes; Moore et al., 2013) were recorded (ACCOBAMS, n.d.).

Two Events Involving Humpback Whales

The first event on 10 March 2013 occurred when a sport fishing boat closely approached a humpback (*Megaptera novaeangliae*) mother–calf pair at the entrance of Manzanillo Bay, Colima (Figure 1). During the sighting, the calf was jumping and, due to its proximity, fell on the boat's deck. It broke the bow's hatch glass (Figure 2) and caused a laceration to its ventral area as it slid into the water. On 12 March, personnel of the Secretaría de Marina (SEMAR) sighted the carcass floating in the middle of Manzanillo Bay, which later stranded in Playa Azul, Manzanillo Bay, with moderate decomposition (Figure 1, blue circle 1). The calf was a male with trauma to the ventral area and a ~50 cm cut on the left side of its abdominal area (Figure 2).

The second event on 11 March 2022 involved a carcass in advanced decomposition observed

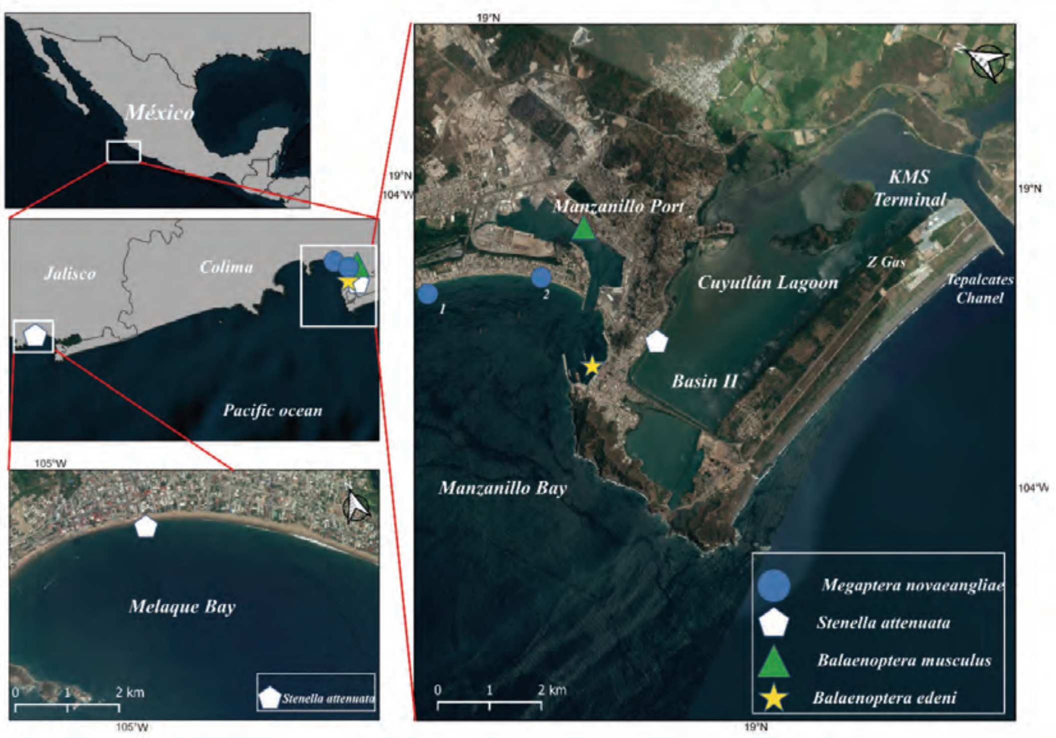

Figure 1. Locations of dead cetaceans related to ship strikes in the Mexican Central Pacific. In the map on the right, blue circle 1 indicates the humpback whale (*Megaptera novaeangliae*) calf stranding site of 12 March 2013, and blue circle 2 indicates the calf stranding site of 11 March 2022.

Table 1. Potential cetacean mortalities caused by ship strikes in the Mexican Central Pacific

Species	Event date	Location	Sex	Total length (m) and age class	Carcass decomposition state	Ship type
Megaptera novaeangliae	12 March 2013	-104.1926 W, 19.055 N	Male	4.7 calf	Moderate	Sport fishing boat
	11 March 2022	-104.3034 W, 19.0708 N	Female	4.6 calf	Advanced	Boat
Stenella attenuata	16 April 2013	- 104. 7051 W, 19. 2222 N	Female	~1.47 subadult	Moderate	Boat
	13 March 2014	-104.3048 W, 19.0466 N	Female	2.05 adult	Fresh	Gas tanker vessel
Balaenoptera musculus	23 April 2019	-104.2917 W, 19.0679 N	Male	~16.0 juvenile	Fresh	Container vessel
Balaenoptera edeni	24 October 2021	-104.3140 W, 19.0553 N	Male	11.3 subadult	Advanced	Vessel

Figure 2. Humpback whale calf stranded at Playa Azul, Manzanillo, Colima, on 12 March 2013: (A) injuries sustained in the ventral and peduncle area during the incident are indicated with red circles; and (B) sport fishing boat with damages to the glass of the bow hatch due to the impact of the calf's body falling on it. (Photos taken by Christian D. Ortega-Ortiz, Universidad de Colima)

floating in front of Manzanillo Bay, Colima, which stranded the same day on Las Brisas Beach (Figure 1, blue circle 2). It was a female calf with propeller lacerations on the dorsal peduncle and ventral flukes (Figure 3). Based on their shape, size, and position (4 to 8 cm apart), these injuries could have been from a strike by a small boat with a four-stroke engine.

Humpback whales are distributed in several coastal regions during winter–spring, engaging in breeding activities of the Mexican Distinct Population Segment (Baker et al., 2013; Bettridge et al., 2015; Ortega-Ortiz et al., 2022). Therefore, this species (both adults and calves) has the highest number of interactions with boats. Calves may die due to injuries caused by small tourist boats (Ransome et al., 2021). Whale-watching activities in México have increased (Urbán & Viloria-Gómora, 2021), even with a Mexican law (NOM-131-SEMARNAT-2010) that regulates this activity. However, few sites have certified companies, with most operating illegally. In addition, private non-tourist operators do not abide by the rules and speed limits. Currently, the Colima coasts are not official whale-watching sites, but the Manzanillo Bays have been identified as important areas for mother–calf pairs during February and March (Meza-Yañez, 2022). Calves spend more time at the surface, are less visible due to their small body size, and are more susceptible to vessel interaction because of their curious nature (Glockner & Venus, 1983; Laist et al., 2001; Lammers et al., 2013). Thus, humpback calves in the MCP are affected by boat collisions and likely other anthropogenic activities (Valencia-González, 2014; Arroyo-Salazar, 2017; Llamas-González, 2019).

Two Events Involving Spotted Dolphins

The first mortality of a spotted dolphin (*Stenella attenuata*) occurred on 16 April 2013 at Melaque Beach, Jalisco (Figure 1). The female subadult carcass had moderate decomposition, and the following injuries were evident: two deep lacerations and an abrasion on the dorsal area proximal to the peduncle. One laceration was rhomboid-shaped with loss of a large section of skin and subdermal tissue as well as tearing of the outer muscle layers without clear

Figure 3. Humpback whale calf stranded at Las Brisas Beach, Manzanillo, Colima, on 11 March 2022: (A) injuries from the collision with the propeller of a small boat, with wounds on the peduncle; and (B) injuries in the ventral region of the flukes. (Photos taken by Raziel Meza-Yañez, Universidad de Colima)

Figure 4. Spotted dolphin (*Stenella attenuata*) individual stranded at Melaque Beach, Jalisco, on 16 April 2013; presence of lacerations in the dorsal area near the peduncle: rhomboidal wound with loss of skin and subdermal tissue, with tearing of the outer muscle layers (upper box), and diffuse subcutaneous hematoma ~3 cm deep with muscle tearing, potentially caused by a propeller incision (bottom box). (Photo taken by Christian D. Ortega-Ortiz, Universidad de Colima)

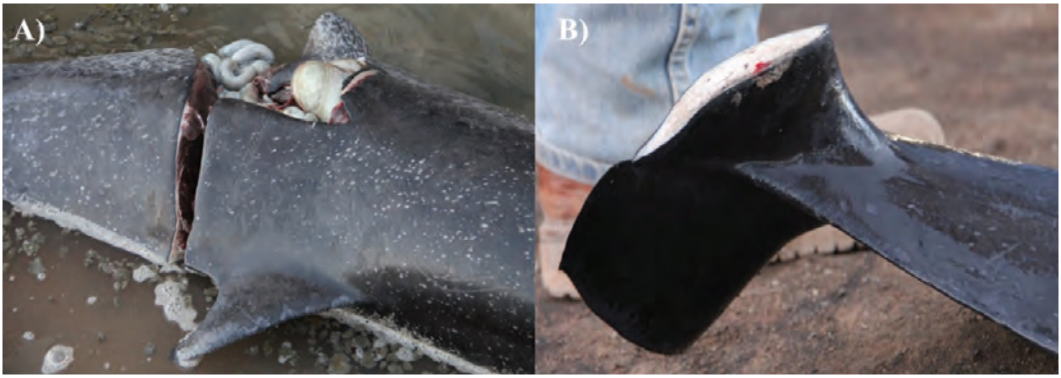

Figure 5. Spotted dolphin individual stranded at Basin II of Cuyutlán lagoon, Colima, on 13 March 2014. Injuries due to collision with a gas tanker vessel are shown in (A) left flank, with a clean cross-section and some organs extruding from the body; and (B) flukes, with wounds on both lobes. (Photos taken by Tadashi Kono Martínez, Universidad de Colima)

evidence of hematoma or inflamed wound edges. The second laceration was ~3 cm deep showing a diffuse subcutaneous hematoma with muscle tear. Cause was not identified, but the laceration might have been caused by a propeller (Figure 4).

The second event was an adult female that stranded inside the Cuyutlán lagoon, Colima (northwest of Basin II), on 13 March 2014 (Figure 1). The carcass was fresh and showed two large, deep transverse cuts in the middle of the body posterior to the dorsal fin, which exposed viscera and the vertebral column, as well as a mutilated fluke. The severity of the wounds was compatible with a large vessel propeller (Figure 5). The dolphin could have been struck by a vessel inside the lagoon or near the entrance of the Tepalcates channel. Coincidentally, the gas tanker *Sevilla* arrived at the KMS terminal at 0700 h that day. It is hypothesized that, based on the direction of the pattern of surface currents in the lagoon (SEMAR, 2013), the carcass was displaced into Basin II.

The spotted dolphin is the most dominant species in the area; its distribution is mainly associated with prey availability (Juárez-Ruiz, 2014; Kono-Martínez et al., 2017; Díaz-Torres et al., 2022). During winter coastal surveys, at least three sightings of spotted dolphin individuals in the Cuyutlán lagoon were recorded (20 March, 21 April, and 12 May 2016; unpub. data provided by Alejandro Reyes, Director of Environment of the Municipal Council of Manzanillo, Colima, México). This area might be a feeding ground for this dolphin species since there is a considerable abundance of fish in the lagoon in winter (Cabral-Solís, 2011). This explanation coincides with the high number of fish found in its stomach, which was observed during an impromptu necropsy on the carcass.

These two spotted dolphin mortalities likely involved two vessel types that caused different types of damage. However, both carcasses presented extensive injuries in the lumbar–caudal region that were fatal (Long et al., 1997).

One Event Involving a Blue Whale

On 23 April 2019, the *Rotterdam Express*, a container vessel from Long Beach, California, arrived at the commercial port of Manzanillo, Colima (Figure 1). Upon docking, workers notified port and environmental authorities that a whale was on the vessel's bulb. The carcass was identified as a male blue whale (*Balaenoptera musculus*) in fresh condition; hemorrhage was visible in some body parts (Figure 6).

The Northeast Pacific subpopulation of blue whales migrates each winter–spring to the coasts of the Baja California Peninsula, the Gulf of California, and the Costa Rican Dome for breeding activities (Gendron, 2002). Given that sightings of this species have not been documented in the MCP coastal region, it is presumed that its transit to the Costa Rican Dome must occur through oceanic zones. Trajectories of large cargo vessels also use oceanic regions where the blue whale was presumably encountered ("wrapped" on the bow). Examination of one baleen plate allowed assessment of its isotopic ratio that suggested that this whale came from the Dome (Blevins et al., 2022); thus, its vessel interaction likely occurred during its northward migration.

This blue whale subpopulation has shown recovery from the commercial overexploitation of the last century (Calambokidis & Barlow, 2004); however, this species may be vulnerable to anthropogenic stressors seasonally due to its migratory patterns. Collisions with vessels have historically affected blue whales in Californian (Redfern et al., 2013) and Mexican (Ransome et al., 2021)

Figure 6. (A) Blue whale (*Balaenoptera musculus*) individual struck and hooked on the bulb (see red circle) of the container vessel *Rotterdam Express*, which arrived on 23 April 2019 at the port of Manzanillo, Colima; and (B) hemorrhages in some parts of the body, mainly in the mid-section, were present where an apparent fracture due to the impact was also observed (red circles). (Photos taken by Luis M. Bautista-Moreno, Secretaría de Marina [SEMAR])

waters. Vessel collision is currently considered the main cause of death for blue whales on the United States' west coast due to high maritime traffic between the ports of Long Beach/Los Angeles and San Francisco (Monnahan & Branch, 2015; Carretta et al., 2016; Hazen et al., 2016).

One Event Involving Bryde's Whale

On 24 October 2021, the carcass of a Bryde's whale (*Balaenoptera edeni*) was reported under the tourist dock of Manzanillo, Colima (Figures 1 & 7). This species was identified through morphological characteristics (e.g., small pectoral fins, absence of fluke coloration, and presence of three longitudinal ridges on the head). Although the carcass showed advanced decomposition, there were areas of trauma on the head, the peduncle (next to the dorsal fin), and the ventral region. All wounds could be linked to a likely vessel strike or possibly to the pressure exerted between the sea and a vessel's bulb that might have transported the carcass into Manzanillo Port.

Like blue whales, this species is usually distributed in oceanic environments of the Mexican Pacific (Villegas-Zurita et al., 2016), and it is unlikely that it was struck or hooked by a vessel in the local area. Also because of its oceanic distribution, this species is one of the least studied baleen whales; it is protected by national (NOM-059-SEMARNAT-2010) and international (International Union for Conservation of Nature [IUCN], 2020) laws.

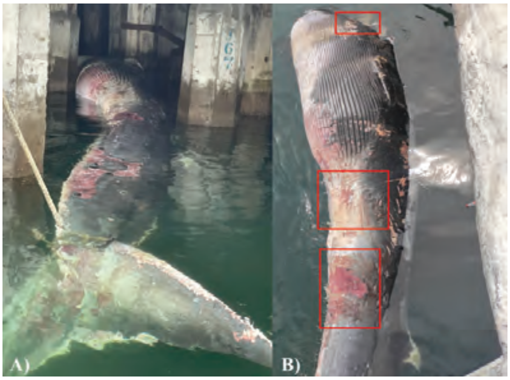

Figure 7. (A) Bryde's whale (*Balaenoptera edeni*) carcass trapped in the pillars of the dock in Manzanillo, Colima, on 24 October 2021, with injuries potentially caused by a collision with a vessel; and (B) possible vessel impact wounds on the peduncle, the side of the dorsal fin, and the ventral part of the abdominal area indicated by red boxes. (Photos taken by Javier Martínez-Rivera, Procuraduría Federal de Protección al Ambiente [PROFEPA-Colima])

Ship strikes involving Bryde's whales are rare, assumed so because of their fast swimming and smaller size compared to other more frequently affected baleen species (Félix & Van Waerebeek, 2005). Despite this, there are three reports of interactions between Bryde's whales and vessels in the Pacific Ocean. An example of one is a whale stuck on the bow of a boat in Ecuador. The animal was removed ventrally, still fresh, showing diffuse bruises, suggesting the animal was alive at collision (Félix, 2009; Ransome et al., 2021). This is the first observation of a Bryde's whale likely struck by a vessel in the Mexican Pacific.

Herein, we report on the only six cetacean mortality events related to ship strikes observed in the MCP during 12 years of monitoring. Our count might be an underestimate as similar events could be masked by (1) the inability to observe lesions in specimens with advanced stages of decomposition, (2) the lack of systematic necropsies by specialists, and (3) events in which struck animals sink and do not beach strand (Alzueta et al., 2001; Laist et al., 2001; Van Waerebeek et al., 2007; Silber et al., 2012). The high maritime traffic in the MCP undoubtedly represents a threat to cetaceans that use the region for ecological purposes. Traffic will likely increase in the coming years with the expansion of the port area towards Basin II of the Cuyutlán lagoon (Administración Portuaria Integral [API], 2019). This expansion will allow for the arrival of more offshore vessels, which could increase the number of cetaceans affected.

Currently, there are no mitigation measures in place for this region. Mitigation measures for this problem are difficult to establish due to the complexity of all contributing factors. Nonetheless, certain ship restrictions such as the following could reduce negative cetacean encounters: (1) reduced speed, (2) traffic separation devices, (3) restricted navigation areas, (4) a mandatory vessel notification system, and (5) establishment of natural protected areas (without navigation) (Silber et al., 2012; Guzmán et al., 2013). In this regard, monitoring should be increased in areas of potential interaction between ships and cetaceans, mainly to gather enough information to carry out a local or regional mitigation plan prepared by all the institutions involved to reduce the probability of collisions.

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Observations of Hypopigmented Dolphins Sighted in Mexican and Alaskan Waters (2012-2013)

Christian D. Ortega-Ortiz,[1] Raziel Meza-Yañez,[1] Bertha Alicia Calleros-Negrete,[2]
Leonard G. H. Sonten,[3] Marco A. Liñán-Cabello,[1] Aramis Olivos-Ortiz,[1]
and Karina Acevedo-Whitehouse[4]

[1]*Facultad de Ciencias Marinas, Universidad de Colima, Manzanillo, Colima, México*
E-mail: christian_ortega@ucol.mx
[2]*Centro Universitario de Ciencias Biológicas y Agropecuarias, Universidad de Guadalajara, Jalisco, México*
[3]*Van Hall Larenstein, Agora 1, 8934 CJ, Leeuwarden, Netherlands*
[4]*Facultad de Ciencias Naturales, Universidad Autónoma de Querétaro, Querétaro, México*

Mammalian integument coloration mainly depends on the amount and type of melanin which is regulated by the enzyme tyrosinase. The dark coloration of cetaceans is mainly a result of the presence of melanocytes (Behrmann, 1998). Melanocytes produce melanin, which is stored in the dorsal part of the skin of cetaceans, while white body parts (e.g., the ventrum) do not contain melanin due to anomalies in the tyrosinase (Behrmann, 1998). If tyrosinase is defective, pigmentation patterns can differ markedly from the typical colorations of a given species (Fertl & Rosel, 2009). Approximately 100 possible mutations in the tyrosinase gene can cause a phenotypic anomaly called hypopigmentation that can manifest in different ways (Oetting et al., 2009).

Albinism, or the complete absence of pigmentation in the body, including the iris that appears red or pink, is one of those manifestations. In contrast, leucism is a skin and hair pigmentation anomaly that does not affect eye color and is caused by defects in pigment cell differentiation (Miller, 2005). Moreover, there is a reduction in melanin production with leucism. As some parts of the body can match symptoms of albinism, many white animals with normally colored eyes are incorrectly assumed to be albinos. Another phenotypic pigmentation anomaly is piebaldism or partial leucism in which only certain parts of the body lose their color (Miller, 2005; Fertl & Rosel, 2009; Peters et al., 2016).

These kinds of hypopigmentation are not common in wildlife; however, they have been reported in different vertebrate species (Hain & Leatherwood, 1982; McCardle, 2012). Approximately 25 cetacean species, eight mysticetes, and 17 odontocetes have been observed with hypopigmentation (Fertl et al., 2004; Acevedo et al., 2009; Fertl & Rosel, 2009; de Boer, 2010; Kautek et al., 2019).

Hypopigmented cetacean individuals are rare in natural populations (Hain & Leatherwood, 1982; Fertl et al., 1999). These organisms could be detected earlier by their prey, which would complicate their feeding success as well as decrease opportunities for social behavior and potentially increase intraspecific rejection. Furthermore, these individuals are more conspicuous to predators (Hain & Leatherwood, 1982; Hubbard et al., 2010). Reduced heat absorption in cold waters would be an additional problem for hypopigmented cetaceans (Hain & Leatherwood, 1982; Fertl et al., 1999). Additionally, melanin protects the skin from excessive exposure to ultraviolet light, and a darker pigmentation is advantageous in protecting whale skin from sun damage (Martinez-Levasseur et al., 2011, 2013). Another possibility is that if hypopigmentation is associated with inbreeding, then affected individuals could be at a fitness disadvantage due to inbreeding depression (Peters et al., 2016). Altogether, it is evident that pigmentation anomalies might impact an individual's Darwinian fitness. Thus, knowledge regarding this issue is necessary to improve our understanding about ecological and physiological implications of this condition in cetaceans (Fertl et al., 2004). Cases of hypopigmentation in juvenile and adult cetaceans have been observed, which indicates survival may be more likely than previously expected (Polanowski et al., 2012; Hauser-Davis et al., 2020). However, genetic samples are often difficult to collect from these marine mammals, preventing robust examination of the genetic mechanisms that cause pigmentation changes (Peters et al., 2016). Thus, all records of cetacean sightings with this anomalous condition are valuable.

We report herein sightings of hypopigmentation for an adult spinner dolphin (*Stenella longirostris*) and an adult Risso's dolphin

Table 1. Cases of odontocetes with hypopigmentation recorded in Mexican waters

Record #	Species	Location	Description	Age class	Citation
1	*Lagenorhynchus obliquidens*	Baja California	Possible leucistic	None provided	Brown & Norris, 1956
2	*Grampus griseus*	Banderas Bay	Leucistic	Calf	Esquivel et al., 1992
3	*Tursiops truncatus*	Gulf of California	Leucistic	Subadult	Pérez-Puig et al., 2019
4	*Stenella longirostris*	Mexican Central Pacific	Piebaldism	Adult	This report
5	*Grampus griseus*	Mexican Central Pacific	Leucistic	Adult	This report

(*Grampus griseus*) in the Mexican Central Pacific (MCP), and a killer whale calf (*Orcinus orca*) in Alaska (Juneau). Our observations offer evidence that odontocetes with an anomalous coloration pattern can survive to adulthood. This implies avoidance or compensation of the previously mentioned ecological and physiological limitations posed by hypopigmentation, which coincides with information proposed for albino terrestrial vertebrates (Sazima & Pombal, 1986; Sazima & Di-Bernardo, 1991).

Case 1. Spinner Dolphin

A hypopigmented spinner dolphin was sighted on 25 July 2013 during a marine mammal survey program in waters with a bottom depth of ~595 m, 24 km offshore Cuyutlán Beach, Colima (south of Manzanillo Bays) in the MCP (Table 1; Figure 1). The group was composed of ~100 to 150 dolphins, mainly adults in sailing activity. One of the individuals (an adult > 1.5 m in size) displayed an anomalous coloration; it was pale and had white patches on its flanks and dorsal region, from the head to the peduncle (Figure 2). Piebaldism is a plausible explanation for this anomalous pattern (Miller, 2005; Fertl & Rosel, 2009), and it is the most common hypopigmentation disorder for the order Cetartiodactyla (Abreu et al., 2013). However, another possibility for this skin condition is focal skin disease (Sanino et al., 2014; Onofre-Díaz et al., 2022).

There have been at least seven reports of hypopigmented spinner dolphins between 1970 and 1993 (Hain & Leatherwood, 1982; Fertl et al., 1999). One was an adult white spinner dolphin observed close to Panama (Fertl et al., 2004), similar to what has been reported for other odontocetes such as bottlenose dolphins (*Tursiops truncatus*; Pérez-Puig et al., 2019), rough-toothed dolphins (*Steno bredanensis*; Cardoso et al., 2019), and harbor porpoises (*Phocoena phocoena*; Keener et al., 2011; Robinson & Haskins, 2013; Gil et al., 2019). The present report of a spinner dolphin is the first documented case of piebaldism or focal skin disease in an odontocete in the MCP.

Case 2. Risso's Dolphin

During a survey conducted in the MCP on 7 December 2012 in waters with a bottom depth of ~470 m and approximately ~13 km from San Juan de Alima, Michoacán (Table 1; Figure 1), a mixed-species aggregation of 20 to 25 Risso's dolphins, five to eight bottlenose dolphins, and eight to ten rough-toothed dolphins was sighted, perhaps involved in feeding activity in association with seabirds.

Risso's dolphins are distributed in tropical and cold waters worldwide (Leatherwood et al., 1980), particularly in oceanic habitats where neritic and oceanic squids are abundant (Baird, 2009). The coloration pattern variation on Risso's dolphins is one of the most distinctive characteristics of the species; they are born with gray skin but become pale gray as juveniles and dark brown/black as subadults (Leatherwood et al., 1980; Baird, 2009). One individual (probable adult ~3 m in size) sighted in a mixed-species aggregation showed an anomalous white color pattern that included its dorsal fin (Figure 3), similar to what would be expected in cases of albinism (Miller, 2005). However, analysis of photographs of this individual indicated the presence of several dark spots close to the blowhole, on the ventrum close to the anus, and on the ventral flukes (Figure 3). These spots suggest the production of melanin, at least partially, implying that (1) tyrosinase is not completely defective; (2) the dolphin is affected by leucism or reduced pigmentation (Reissmann & Ludwig, 2013), similar to what was described in a humpback whale off Norway (Lydersen et al., 2013); or (3) this is partial albinism or vitiligo (Fistarol & Itin, 2010), which to our knowledge has not been reported in cetaceans. Furthermore, this oddly pigmented individual was observed swimming alone during the sighting duration (around 1 h), while other dolphins were integrated into subgroups. A consequence reported for

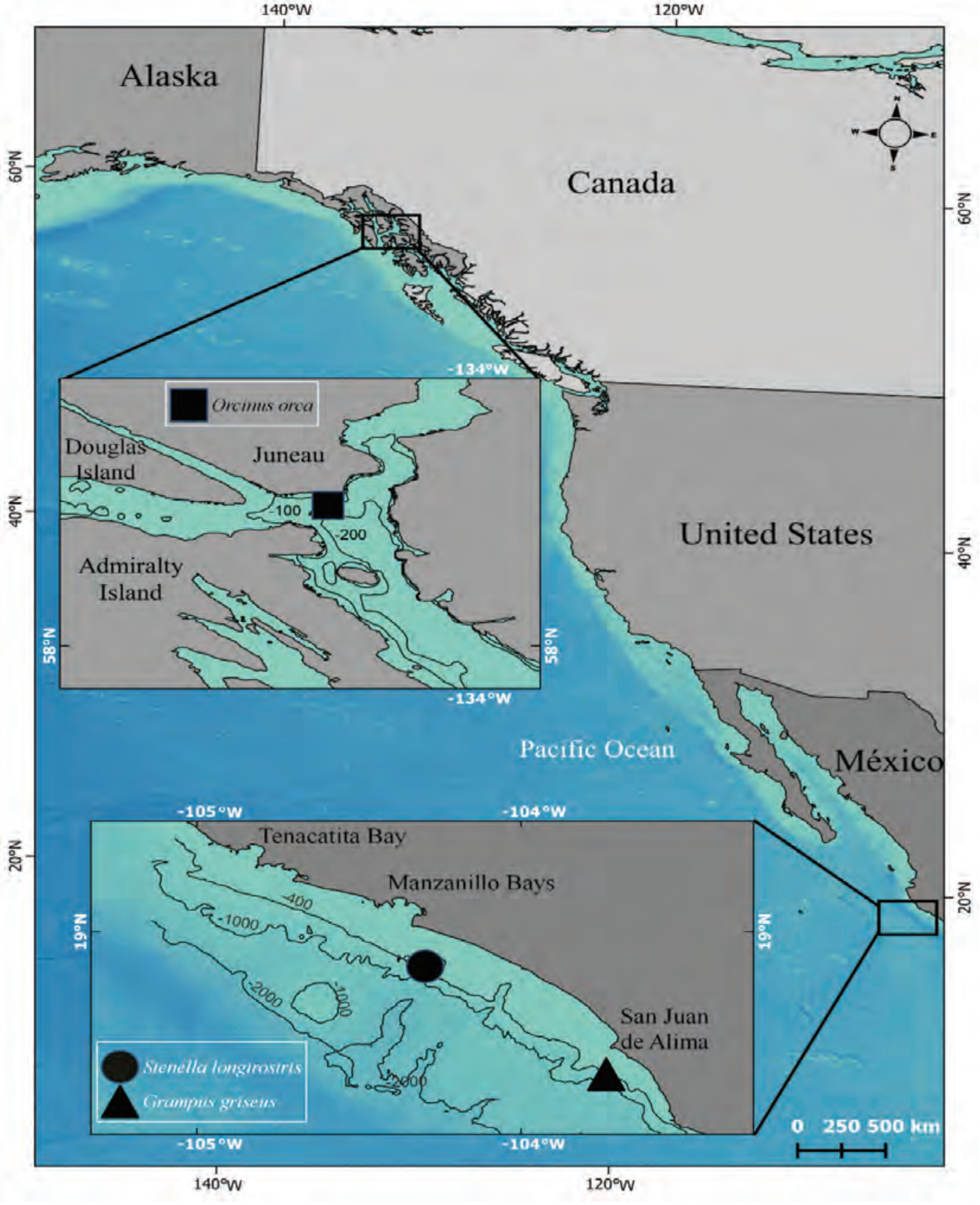

Figure 1. Location of hypopigmented odontocetes: the spinner dolphin (*Stenella longirostris*) and Risso's dolphin (*Grampus griseus*) from the Mexican Central Pacific, and the killer whale (*Orcinus orca*) from Juneau, Alaska

individuals with hypopigmentation is limited social relationships with peers (Hubbard et al., 2010). No other conspicuous behavior was observed.

Along the coast of Japan, Funasaka et al. (2017) reported three male Risso's dolphins with hypopigmentation, and all three cases corresponded to leucism. A Risso's dolphin with hypopigmentation was observed in 2015, 2017, and 2018 in Monterey Bay, California (Marine Bay Whale Watch, 2018). The identity of this individual was

Figure 2. Photographs of the spinner dolphin (*Stenella longirostris*) with a lighter coloration and white patches on both sides of the body. Animal was observed on 25 July 2013 near Cuyutlán Beach in Colima, México. (Photographs provided by Grupo Universitario de Investigación de Mamíferos Marinos [GUIMM] of the U de C)

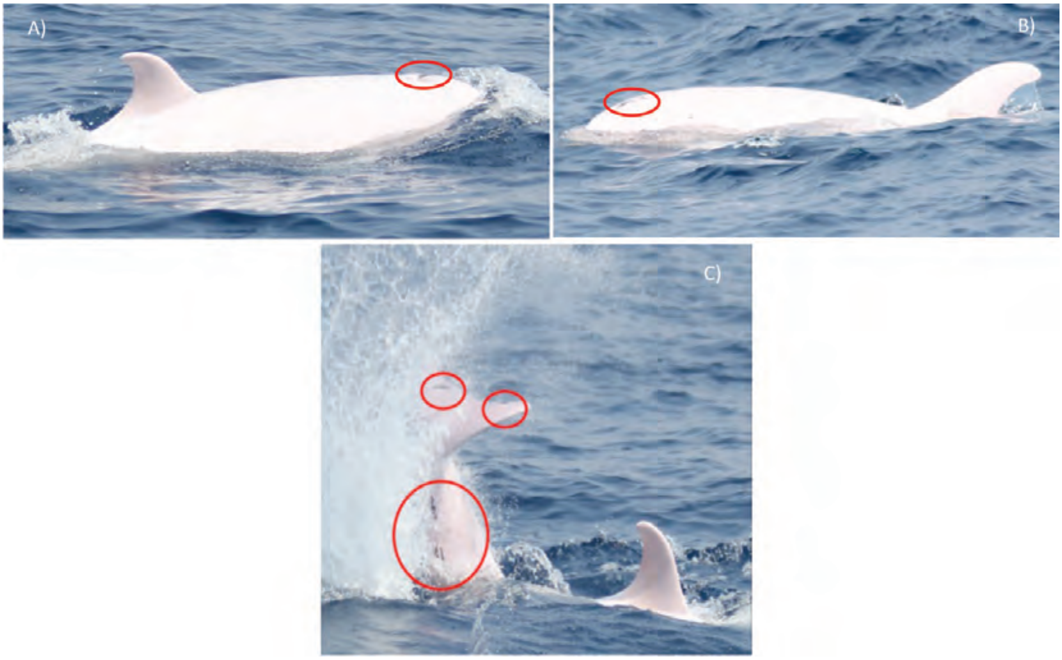

Figure 3. Photographs of the hypopigmented Risso's dolphin (*Grampus griseus*), which was sighted on 7 December 2012 near San Juan de Alima, Michoacán, México. Red circles show parts of the body with colorful spots close to the blowhole (A & B), on the ventral part close to the anus, and on the ventral flukes (C). (Photographs provided by GUIMM of the U de C)

different from the individual observed in the MCP based on dorsal fin comparison. There are only three records of leucistic dolphins off the coast of Mexico: (1) a white Pacific white-sided dolphin seen off Baja California (Brown & Norris, 1956); (2) in an unpublished summary, Esquivel et al. (1992) reported the sighting of three Risso's dolphin calves in Banderas Bay that appeared to be affected by leucism (albinism condition was not confirmed as the sighting was from a considerable distance; Luis Medrano, pers. comm., 5 May 2016); and (3) Perez-Puig et al. (2019) reported sighting a leucistic bottlenose dolphin in the Gulf of California (Table 1).

Case 3. Killer Whale

The crew of a private boat (M/V *Cielo Mare*) sighted a pod of six killer whales (two adult males, one mature female, two females [or juveniles], and one calf; presumably based on their total size and dorsal fins) in early August 2012 in a site with a bottom depth of ~200 m and ~2 km from the coast of Juneau, Alaska (Table 1; Figure 1). The calf

Figure 4. Hypopigmented killer whale (*Orcinus orca*) calf sighted during August 2012 in Juneau, Alaska (Photo courtesy of M/V *Cielo Mare* crew)

presented anomalous coloration and remained close to the adult female, presumably its mother, who displayed normal coloration and was identified as "M5" in the NOAA's killer whale catalogue from the North Pacific (Marilyn Dahlheim, pers. comm., 12 July 2015; Figure 4). The calf's skin was lighter than the other members of the group but not completely white. Similarly, an Atlantic spotted dolphin (*Stenella frontalis*) with lighter coloration but not completely white was reported in Madeira Island, Portugal (Alves et al., 2017).

White killer whales have been sighted in different parts of the world with ~24 scientific cases reported (see Supplementary Table S1; the supplementary table for this paper is available in the "Supplemental Material" section of the *Aquatic Mammals* website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147), and others recently commented upon in social networks (a calf in Washington in October 2019: Andrew, 2019; and a calf in California in August 2021: Osborne, 2019). Considering those from scientific research, one case corresponds to a calf with abnormal pigmentation, similar to the calf of this report, that died due to the Chédiak-Higashi Syndrome (record #7 in Supplementary Table S1), an inherited fatal disorder characterized by diluted pigmentation and reduced life span (Taylor & Farrell, 1973). These reports show that hypopigmented killer whales can reach adulthood (~30% of cases; Supplementary Table S1). To further understand the intrinsic and extrinsic mechanisms that can lead to cetacean pigmentation disorders, studies based on genetic and histological analysis of skin biopsies are encouraged for future research.

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First Reported Encounter of Bryde's Whale and Interaction with Humpback Whales in the Gulf of Tribugá, Chocó, Northern Colombian Pacific

Ann Carole Vallejo,[1] Dalia C. Barragán-Barrera,[1] Nohelia Farías-Curtidor,[2]
Ashley Moss,[1] Sara Castano,[1] Jenny Bachmann,[1] Edwin Gonzáles Murillo,[1, 3]
Luis Antonio Lloreda,[1, 3] and Yerson Gonzáles Murillo[1, 3]

[1]*R&E Ocean Community Conservation, 2580 Valleyridge Drive, Oakville, ON L6M 5H5, Canada*
E-mail: carole.vallejo@oceancommunityconservation.org
[2]*Independent researcher, Bogotá, Colombia*
[3]*Local fisherman, Jurubirá, Colombia*

Various species of cetaceans annually visit the Pacific coast of Colombia. Some only visit seasonally, while others are present throughout the year (Avila et al., 2013). Humpback whales (*Megaptera novaeangliae*) belonging to breeding stock G (BSG), recognized by the International Whaling Commission (Félix et al., 2021), are commonly seen in the Gulf of Tribugá (northern Colombian Pacific; Figure 1) on an annual basis—as early as May and as late as December (Avila et al., 2020). Other commonly sighted cetaceans in this area include various species of dolphins, such as bottlenose dolphins (*Tursiops truncatus*), spinner dolphins (*Stenella longirostris*), and pantropical spotted dolphins (*Stenella attenuata*) (Avila et al., 2013; Caicedo-Herrera et al., 2018), which are seen throughout the year (E. Gonzáles, pers. comm., 18 May 2022), though appear more frequently in certain months than others. Research is still ongoing to determine these dolphins' populations, abundance, distribution, and habitat use within the region.

Figure 1. Location of encounter between humpback whales (*Megaptera novaeangliae*) and a Bryde's whale (*Balaenoptera edeni*) within the Gulf of Tribugá (northern Colombian Pacific)

Within the Gulf of Tribugá, there have been various encounters with less-frequent cetacean travelers, including killer whales (*Orcinus orca*), false killer whales (*Pseudorca crassidens*), and sperm whales (*Physeter macrocephalus*) (Avila et al., 2013). The infrequent mysticetes seen in or around the gulf include minke whales (*Balaenoptera acutorostrata*), fin whales (*Balaenoptera physalus*), sei whales (*Balaenoptera borealis*), and, rarely, blue whales (*Balaenoptera musculus*) (Avila et al., 2013; Caicedo-Herrera et al., 2018). Sightings of these species are important to record to add to the collective scientific community's knowledge as well as because this area appears to be a target for a multipurpose port that could imply a future high impact on marine fauna, including cetaceans (Rey-Baquero et al., 2021).

Due to the presence of numerous different sympatric cetaceans in the area, it is possible that interspecies interactions occur (Deakos et al., 2010). The reason for these associations remains unknown, but some explanations may be feeding opportunities (Kasamatsu et al., 2000; Clua & Grosvalet, 2001; Quéroil et al., 2008), play (Deakos, 2002), sexual harassment or antagonistic behaviors (Acevedo-Gutiérrez et al., 2005; May-Collado, 2010), predation (Bowers et al., 2018), and others (Deakos et al., 2010; MacKay

& Bacon, 2019). Some authors define harassment or antagonistic behavior as an aggressive action by one species towards another that elicits a hostile response indicative of agitation, annoyance, or distress, including, but not limited to, a change in direction, chuffing, or percussive activity (Silber, 1986; Smultea et al., 2014; MacKay, 2015; MacKay & Bacon, 2019).

For the past two years, a community science program has been ongoing through which locals (fishermen) are trained to carry out monthly cetacean monitoring transects in a 9-m motorboat throughout the Gulf of Tribugá. The goal was to strengthen knowledge about cetacean presence, occurrence, and distribution along the Colombian Pacific. During one routine monitoring assessment, on the morning of 28 July 2021, the blows of two humpback whales (a mother–calf pair) were spotted as they were moving south (Table 1). The research vessel left the transect line and followed the pair. Mother and calf displayed dives, resurfacing, (respiration) blows, and tail slaps (Table 1). A third individual of a different species (Figure 2a & b) was encountered entering the area after 20 min of observation of the humpback pair. This species was identified through photos and video as a Bryde's whale (*Balaenoptera edeni*). This whale's identification was based on the erect sickle-shaped dorsal fin that had a deeply concave trailing edge and its three distinctive parallel rostrum ridges (Shirihai, 2006; Figure 3).

The interaction's initial sighting position (03° 46' 39.4" N, 77° 21' 40.599" W) was located where the humpback pair deviated from their path, and the research vessel followed all three individuals swimming around one another (Table 1). After 13 min, another much larger adult humpback whale (Figure 4) joined the mother–calf pair. The complete interaction is described in Table 1 and shown in Figures 3 and 4; it concluded when the third humpback and Bryde's whale also separated and swam slowly away (Table 1). The final sighting position (05° 46' 8.2" N, 77° 21' 41.098" W) was ~9.2 km west from the shore of Tribugá (Figure 1; Table 1).

Although Bryde's whales have been reported previously within the Colombian Pacific, this is the first reported encounter of a Bryde's whale in the Gulf of Tribugá and the first interspecies interaction documented with humpback whales. Local fishermen have previously seen other whale species in the gulf during April and May, which perhaps overlaps with the presence of migrating sardine schools (N. Botero, pers. comm., 12 April 2022). Bryde's whales are cosmopolitan species

Table 1. Description of an encounter between humpback whales (*Megaptera novaeangliae*) and a Bryde's whale (*Balaenoptera edeni*) in the Gulf of Tribugá (northern Colombian Pacific)

Time	Behavior description
08:05	Two blows from humpback whales were spotted, followed by a mother–calf pair heading south. Observers departed from monitoring trackline and began following the whales, marking the geographic location upon arrival at the observation location (~50 m from the whales).
08:09	Humpback pair fluked for a deep dive.
08:11	Humpback pair resurfaced with a series of blows.
08:13	Humpback pair began tail slapping at the surface.
08:23	A large unidentified cetacean (identified as a Bryde's whale) came within 50 m of the humpback mother–calf pair. The humpbacks deviated from their original path south, and all three whales began swimming around one another within 30 m.
08:36	A third adult humpback whale joined the mother–calf pair. This third humpback exhibited aggressive behaviors (e.g., pectoral fins slapping and tail slapping against the water). These behaviors are typically observed between a group of males in fierce competition for a female. Cetaceans were breathing frequently and changing directions causing surface water disturbance, but all stayed within the same area. Shortly after the third humpback arrived, the mother–calf pair began to distance themselves and moved away from the area. The third humpback and the Bryde's whale were in very close proximity to one another (~10 m), and images show the humpback swimming directly behind the unidentified whale. There was also a moment when both whales were side-by-side. Many blows from the humpback whales were observed, but no blows from the Bryde's whale were observed.
08:46	End of sighting: Geographic location was recorded before heading back to the trackline to resume regular monitoring activities.

Figure 2. Bryde's whale in the Gulf of Tribugá (northern Colombian Pacific): identifying details of the (a) dorsal rostrum and (b) dorsal fin were documented. (*Photo credit:* ©Ashley Moss)

(Acevedo et al., 2007) that inhabit tropical and subtropical waters of more than 16ºC; they are considered both pelagic and offshore whales (Kato & Perrin, 2018; NOAA Fisheries, 2021). In Colombia, Bryde's whales have been reported in both the Caribbean and Pacific Ocean (Vidal, 1990; Trujillo & Avila, 2013), likely represented by the large form *B. edeni brydei*, which is widely distributed, including in South American waters (Pastene et al., 2015). However, because this species is so elusive (Shirihai, 2006), little is known about its habits or behaviors, particularly in areas like Colombia where no long-term monitoring programs exist. Thus, this paper provides relevant data to help overcome the prevailing information gaps about this species.

This is also the first reported interaction between humpback whales and a Bryde's whale during the humpback whale breeding season in the Colombian Pacific. This observation describes an apparently uncommon interspecies encounter between two large cetaceans. There are reports of humpback whales interacting with other cetacean species in different locations such as Brazil, Hawaii, Norway, and Puerto Rico, and in other coastal areas of the United States with odontocetes such as bottlenose dolphins, clymene dolphins (*Stenella clymene*), killer whales, melon-headed whales (*Peponocephala electra*), pantropical spotted dolphins, pilot whales (*Globicephala* sp.), and rough-toothed dolphins (*Steno bredanensis*) (Jefferson et al., 1991; Ciano & Jørgensen, 2000; Rossi-Santos et al., 2009; MacKay & Bacon, 2019). Thus, it is possible that more interactions between baleen whale species occur in the Gulf of Tribugá, but the lack of research or published data reflects a non-interaction scenario.

Figure 3. Humpback whale behavior during interaction with a Bryde's whale in the Gulf of Tribugá (northern Colombia): behaviors included (a) flipper slapping, (b) tail slapping, and (c) tail slashing at surface. (*Photo credit:* ©Ashley Moss)

For instance, off Gorgona Island, a Colombian Pacific area with a greater marine mammal research tradition, an observation in September 1991 reported an attack by killer whales to what was identified as a humpback whale mother, escort, and calf (Flórez-González et al., 1994). This prey/predator interaction caused erratic movements, forceful exhalations, and snorting from the humpbacks (Flórez-González et al., 1994). Similar antagonistic behavior, such as slashing tail flukes at the predator, rolling, and moving their pectoral flippers and head shaking, have been observed by baleen whales when killer whales attack (Ford & Reeves, 2008). In an interaction of 50 pilot

Figure 4. Side-by-side swimming interaction between a large humpback whale and a Bryde's whale within the Gulf of Tribugá (*Photo credit:* ©Ashley Moss)

whales and a humpback, the pilot whales made a tight formation around the humpback whale; the humpback was observed side-fluking, seemingly in an attempt to disengage from the pilot whales (Ciano & Jørgensen, 2000). Rossi-Santos et al. (2009) observed another interaction between humpbacks and a northern minke whale in a breeding area off Brazil, where both were spotted side-by-side, surfacing together though not exposing their flukes while swimming. Conversely, during the encounter reported here, different behaviors were observed: the mother–calf pair changed direction rapidly and slapped their flukes. Such behavior (e.g., fluke slaps, peduncle slaps, head slaps, head lunges) has been described as antagonistic when in the presence of whale-watching boats or during swimming activities with baleen whales (Scheidat et al., 2004; Sprogis et al., 2017). Therefore, and because no boats were present, we concluded they seemed distressed by the Bryde's whale's presence, and the presence of the third humpback seemed to be a defensive and/or protective behavior or a distraction for the mother and calf to leave.

The behavior observed during this sighting showed that humpbacks have a wide variety of behaviors that they display at the surface, which makes it easier to spot them—for example, pectoral fin and tail slapping, large blows above the surface, and tails that often break the surface before diving deep. These actions may also include erratic changes of direction, forceful exhalations, and snorting—actions that have been tied to antagonistic behavior (Flórez-González et al., 1994; Ford & Reeves, 2008; Sprogis et al., 2017). Conversely, during this observation, the Bryde's whale did not exhibit many behaviors at the surface other than breathing, which occasionally exposed the dorsal fin above the surface. Bryde's whales do not exhibit many superficial activities (Shirihai, 2006), thus they are typically much more difficult to spot. Also, they are often alone, though they may occasionally be sighted in pairs (NOAA Fisheries, 2021).

In conclusion, despite cetacean interspecific interactions being similar between some dolphin species and humpback whales along the Colombian Pacific coast and in the Gulf of Tribugá (E. Gonzáles, pers. comm., 7 July 2021; N. Botero, unpub. research, April 2010–ongoing), this is the first report of an interspecies interaction between humpback whales and a Bryde's whale in the Gulf of Tribugá, and, of particular note, the first report of a Bryde's whale in the area. Our observations highlight the need to gather more information to strengthen and understand Bryde's whale distribution, behavior, ecology, and habitat use, especially within the Gulf of Tribugá and along the Pacific Colombian coast. The community science program conducted in the area showed the relevance of including local communities to effectively monitor cetacean occurrence, particularly in developing areas where no established cetacean monitoring programs exist. This encounter and the interaction are key to strengthening the community science program in the region as a tool to broaden knowledge about cetaceans' occurrences and interspecies interactions.

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Male–Male Sexual Interactions Between an Adult and a Calf Killer Whale (*Orcinus orca*) of the Falkland Islands

Simona Sanvito and Filippo Galimberti

Elephant Seal Research Group, Sea Lion Island, Falkland Islands
E-mail: simo_esrg@eleseal.org

Same-sex behaviour has been documented in a wide range of animal taxa (mammals: reviewed in Dagg, 1984; birds: reviewed in MacFarlane et al., 2006) and is a common feature of social species (Poiani & Dixson, 2010). The functional and evolutionary significance of same-sex behaviour in animals is uncertain (Monk et al., 2019). Same-sex behaviour can be used to promote social bonds between same-sex individuals, to maintain dominant/subordinate relationships without aggression or to promote reconciliation after it, and to improve reproductive skills of young individuals, or it can be a simple byproduct of sexual drive or arousal (reviewed in Bailey & Zuk, 2009). The presence and frequency of same-sex behaviours are related to a species' life history (Poiani & Dixson, 2010), to their social and mating systems (MacFarlane at al., 2006), and to their level of parental care (MacFarlane at al., 2010).

In most marine mammal species, information about male–male sexual behaviour is rather scarce, although male–male mounting and mating attempts have been observed in various species of pinnipeds. A well-documented example is the northern elephant seal (*Mirounga angustirostris*) in which male–male mounting is very rare among breeding individuals, but males frequently attempt to copulate with weaned pups or yearlings of both sexes, and male–male mounting is very common among moulting or resting juveniles (Le Boeuf, 1972; Rose et al., 1991). In cetaceans, male–male behaviour is probably related mostly to the establishment and maintenance of social bonds in analogy to what happens in various primate species that have complex social systems with long-term bonds among related individuals (Furuichi et al., 2014).

The presence of male–male sexual behaviours in cetaceans is supported mostly by anecdotal evidence (reviewed in Bagemihl, 1999), single event observations (D'Agostino et al., 2017), or very small sample sizes (Pack et al., 2002), with the notable exception of bottlenose dolphins (*Tursiops* spp.) for which male–male sexual behaviours happen at high frequency and have been extensively studied (Connor et al., 2000; Mann, 2006; Furuichi et al., 2014). In resident killer whales (*Orcinus orca*) of British Columbia, male–male social interactions happen more frequently between adolescent non-related individuals, usually involve body contact, are usually reciprocated, and show components of both play and sexual behaviour, but rarely include penis extrusion/erection (Rose, 1992). To our best knowledge, there is no description of occurrences of male–male sexual behaviours between killer whale adults and calves in the scientific literature.

On 21 November 2018, we observed a series of bidirectional sexual interactions that involved one adult male killer whale and one male calf. We made our observation at Sea Lion Island (SLI hereafter; 52° 26' S, 59° 05' W), the southernmost inhabited island of the Falkland Islands, which is regularly visited by killer whales (see Elephant Seal Research Group website: www.eleseal.org). The observation was carried out by three observers: one taking notes about killer whale identity, location, and activity; one flying an unmanned aerial vehicle (UAV; Mavic Pro Platinum, DJI); and one taking digital photos and videos of the killer whales from land (Olympus EM-10 Mark III, 75-300 mm lens, RAW format) and communicating by radio to the UAV pilot the killer whale's identity and behaviour as observed from land. We validated the visual killer whale identifications by comparing photos of saddle patch and dorsal fin to an established photographic killer whale catalogue (see www.eleseal.org/KW_SLI_catalogue.pdf). Due to the small number of killer whales observed at SLI (~40 individuals), individual identification was fully reliable. We operated the UAV at variable altitudes above the killer whales (10 to 40 m) in full compliance with local regulations and under a specific research license (R16/2017, Environmental Officer, Falkland Islands Government; see Galimberti & Sanvito, 2020, for details about UAV protocol). The UAV pilot recorded audio comments on identity, activity, and behaviour of the killer whales as observed from the UAV. We processed the UAV video footage in video editing software (*Adobe Premiere 2020*) and synchronized it with the recorded audio notes. We reviewed the UAV video, the video and photos taken from land, and the audio notes to produce a full transcript of the observation. All killer whales involved in the observation were identified, and some have been regular visitors of SLI at least since 2004 (see photo-identification catalogue link above).

The observation of male–male sexual behaviours that we describe was part of a longer observation that began at 13:43:35 (local time) on the south coast of SLI and involved three killer whale pods (two comprised of females and calves; one of males only) and one isolated male (13 individuals total). One of these pods (comprised of five individuals—one female with one calf, plus one female with two calves) left the area before the beginning of the sexual interactions described herein. Thus, it is not included in the following description. The part of the observation that we describe began at 18:58:09 on the north coast of SLI and ended at 20:39:40 when light was too low to take UAV videos and all operators left the area. The killer whales were in shallow water at close distance (5 to 50 m) from a sand beach. During the entire observation, they moved back and forth, generally very slowly, in the same area (along less than 1 km of coastline).

The first UAV flight began at 19:10:49, and we conducted three consecutive flights (apart from short pauses between one flight and the next), the last of which ended at 20:32:42. For this period, we have continuous video from the UAV, though not all video was of the adult male and calf killer whales engaging in same-sex behaviours. For about 14 min, the UAV followed another adult male ("PN"; see below) that was present in the area to check whether he also engaged in this kind of sexual behaviour; this did not occur. The UAV pilot opportunistically chose the adult male that showed same-sex behaviours as the focal animal because he is an individual that visits SLI only occasionally. The observation from land was continuous for the entire time the killer whales were in view.

During the male–male sexual behaviour observation, eight killer whales were in the area: (1) a pod of five killer whales regularly observed at SLI (PU pod) comprising a mature female ("PU": identified first time in 2004, seen last time in 2021) and her four calves ("TA": female, identified first time in 2010, now mature female, gave birth first time in 2021; "NE": probably female from morphology, identified first time in 2013 but not newborn that year; "PI": male, born 2014, age 4; "MI": sex unknown, born 2017, age 1); (2) two adult males usually observed together (PN pod; PN: very large male, identified first time in 2004; and "TO": much smaller, identified first time in 2013, regularly observed at SLI); and (3) one solitary adult male ("OV": very large male, identified first time in 2015 and occasionally observed at SLI, usually alone).

For most of the observation, the three males showed different behaviours. The largest and likely oldest of the males, PN, spent most of the time alone, often resting, apparently lying on the sandy bottom, and for only a portion of the time slowly following the PU pod but without interacting with them nor with the other two males. The smallest of the males, TO, was almost constantly associated with the PU pod but did not show any sexual behaviour towards the females and/or the calves. The last male, OV, did not interact with the other two males and showed particular interest in one of the male calves (PI), exhibiting same-sex behaviours towards him and being reciprocated with sexual behaviours by him. Both OV and PI showed bouts of swimming side-to-side or belly-to-belly (often with one animal swimming belly up under the other), often inverting the roles and sometimes with a penis erect (Figures 1 & 2). On one occasion, PI swam belly up with an erect penis (for a few seconds) under NE. We observed no sexual behaviours between the adult males, and OV in particular, and the adult female (PU) or the oldest of the female calves (TA).

The behavioural interaction between OV and PI was documented on video by the UAV (video footage and a more detailed description of this event are available in the "Supplemental Material" section of the *Aquatic Mammals* website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147). The main behaviours exhibited by these two males during this interaction are summarized below:

1. OV showed clear sexual behaviours (e.g., penis erection) only when swimming together with PI at close distance (~1 to 10 m) or in contact with him.

2. OV showed no sexual behaviour towards the adult female of the pod (PU), the largest female calf (TA), the other female calf (NE), the younger (unknown sex) calf (MI), nor the other males (PN and TO).

3. Although OV and NE were seen together at close distance (~1 to 10 m), they did not show any significant social interaction.

4. During the observation, PI interacted with NE, and he once swam under NE with an erect penis. This happened between different bouts of sociosexual interactions with OV.

Figure 1. Penis erection by adult male OV with PI above him (image taken from UAV footage)

5. Aside from a very brief erect penis towards NE, PI showed sexual behaviours only towards OV.

6. PI showed no sexual behaviour towards TO or PN who were regular male visitors of SLI, while OV is an occasional visitor.

7. There were at least two occasions when PI displayed an erection while close to OV, and two occasions when OV alone displayed an erection while close to PI. There was also one occasion when both had erect penises—one shortly after the other. These are minimum estimates because those two individuals were not in the UAV footage for the entire observation (see above). There were also two occasions when PI and TO swam in close contact, belly-to-belly, one under the other, and penises were not visible due to their positions or water turbidity.

8. Although we observed erect penises, and the two killer whales swam belly-to-belly, we did not observe intromission by either male into the genital slit of the other.

9. There was no aggressive component observed between OV and PI apart from short chases (following at high speed) with no clear aggression and no sign of sexual harassment or sexual coercion. All sexual behaviours were reciprocated. Moreover, notwithstanding the presence of potentially breeding males and females, no actual breeding behaviour was observed.

Our observation of these two males interacting with each other sexually showed some aspects of same-sex behaviours similar to previous reports in other cetaceans, but they also showed peculiarities. For example, in bottlenose dolphins that show male alliances, the asymmetry in same-sex sociosexual interaction rates is the product of a strong preferential association among specific male–male pairs (Botero Acosta, 2015); and in our observation, there was a clear preferential association between OV and PI, even though potential breeding partners for OV were present. Moreover, juveniles are often the most involved in sociosexual interactions by bottlenose dolphins (Botero Acosta, 2015) and cetaceans in general (Connor et al., 2000), but they usually show a preference for other juveniles, not adults, as in our case. Male–male sociosexual

Figure 2. Penis erection by male calf PI while he and adult male OV were swimming belly-to-belly (image taken from UAV footage)

behaviour has been reported in resident killer whales of British Columbia but involved mostly adolescent males, and erections were very rare (Rose, 1992). To our best knowledge, same-sex behaviours between male adults and calves have not been reported before among killer whales and are rare for cetaceans at large. Previous reports of male–male sexual behaviour included non-calf individuals and involved an aggressive/dominance component (humpback whale [*Megaptera novaeangliae*]; Pack et al., 2002) or were cases of sexual coercion in which the calf did not reciprocate the sexual behaviour (southern right whale [*Eubalaena australis*]; D'Agostino et al., 2017). During our observation, no overt aggression or coercion was observed, and the younger individual fully reciprocated the sexual behaviour of the older one.

Rose (1992) reports just two cases of penis erections in an extensive field study of the resident killer whales of British Columbia, none of which involved an adult male. Although the frequency of occurrence of same-sex behaviour in the killer whales that visit SLI is unknown, we carried out intensive observations (including UAV flights) of killer whales for many years (2013 to 2022), and the event reported here is the only case in which we observed same-sex behaviour and erect penises between adults and calves. The context of the event was somehow peculiar because many killer whales were present. The killer whales of SLI are mammal-eating individuals, regularly observed only during and immediately after the southern elephant seal (*Mirounga leonina*) breeding season; their main prey are elephant seal weanlings (Yates et al., 2007; own unpub. data, 2013-2021). Mammal-eating killer whale groups are size constrained due to energy requirements (Baird & Dill, 1996), and, in fact, SLI killer whales are usually observed in small family groups (own unpub. data, 2013-2021). During this event, there were various males, and one of them (OV) was an individual that is rarely observed and is not regularly associated with any of the other killer whales. This new social situation may have generated a high level of social/sexual arousal in the younger individuals; and for PI in particular, this facilitated the observed unusual sociosexual behaviour shown by him. It has been suggested that for cetaceans, same-sex behaviours may be more frequent among kin individuals (Connor et al., 2000; Furuichi et al., 2014), although the contrary is apparently happening in British Columbia resident killer whales (Rose, 1992). Although no genetic data are available for SLI killer whales, due to his irregular pattern of presence, OV is an unlikely candidate for the role of PI kin.

From a practical point of view, our observation confirms that UAV footage can greatly increase the understanding of cetacean behaviour (Torres et al., 2018) because the sequence of same-sex behaviours that we described were not seen by the land observers, notwithstanding the very short distance between them and the killer whales (max. 250 m) and their extensive experience of killer whale behaviour. The UAV is a game changer with respect to allowing observations of cetacean social behaviour as this observation would not have been possible without the UAV footage.

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