SC/69B/PH/04

Sub-committees/working group name: PH

Happywhale – Status of Data Collections with emphasis on Photo Identification of Humpback Whales (Megaptera novaeangliae)

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INTERNATIONAL
WHALING COMMISSION

Happywhale – Status of Data Collections with emphasis on Photo Identification of Humpback Whales (*Megaptera novaeangliae*)

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In 2016 (SC/66b/SH/06), 2017 (SC/67A/PH/02) and 2018 (SC/67B/PH/05) we described development and status of Happywhale (www.happywhale.com), a web-based marine mammal photo ID crowd-sourcing platform online since August 2015. Since that time and especially with implementation of fast and accurate automated image recognition of humpback whale fluke photo-ID (Cheeseman et al., 2022), this web platform has now received over one million photos and has seen wide adoption as a research collaboration platform for humpback whale fluke photo-ID, with greatest extent in the North Pacific Ocean (Cheeseman et al., 2023). Here we present a brief statement of the status of data collections accessible via Happywhale.com as of March 2024. Note some data is accessible only within defined collaborations, such as for example in the North Pacific, 65,339 of 257,859 encounters are currently accessible only to members of the North Pacific Photo-ID collaboration for use with permission under terms of a MOA.

Table 1. Global status of collections of photo-identified humpback whales. Collections are negligible for regions unrepresented in the table. Approximate capture probability conservatively estimates the likelihood of any adult captured within the region to be found within the known set of individuals within the full dataset. *In the North Pacific, this is the approximate minimum capture probability for any samples in the entire ocean basin. The collection is described in detail in (Cheeseman et al., 2023). **In the South Pacific and Southern Ocean, capture probabilities vary, with possible effort bias such as, for example, a humpback whale sampled in coastal waters on the West Antarctic Peninsula has a consistent 56% chance of being known, however due to lack of data we cannot estimate the capture probability of humpback whales feeding in the Bellingshausen Sea. ***Brazil dataset described in (Ramos et al., 2023). ****Due to an abundance of research groups in the North Atlantic with photo-ID catalogs in various states of mutual collaboration, we have not actively pursued a research agenda in the region and remain a resource for adoption and use as benefits any and all research efforts.

Region	Ocean Basin	n =	Approximate capture probability
Entire basin	North Pacific Ocean	35,142 individuals in 257,859 ID'd encounters	> 63%*
East Australia	South Pacific Ocean	14,627 individuals in 30,282 ID'd encounters	~ 40%**
Oceania	South Pacific Ocean	4,906 individuals in 6,981 ID'd encounters	~ 20%**
Central and South American west coasts	South Pacific Ocean	6,841 individuals in 9,893 ID'd encounters	~ 35%**
Southern Ocean, concentrated on West Antarctic Peninsula	Southern Ocean	6,932 individuals in 11,692 ID'd encounters	~ 56%**
Brazil***	South Atlantic Ocean	8,234 individuals in 9,354 ID'd encounters	~ 15%
Scotia Sea	South Atlantic Ocean	513 individuals in 550 ID'd encounters	< 10%
Southwest Africa	South Atlantic Ocean	3,467 individuals in 5,804 ID'd encounters	~ 20%
Entire basin	North Atlantic Ocean	8,357 individuals in 16,744 ID'd encounters	(no estimate made) ****
Southeast Africa east to Mauritius	Indian Ocean	4,759 individuals in 5,844 ID'd encounters	~ 15%
Western Australia	Indian Ocean	3,145 individuals in 3,525 ID'd encounters	~ 10%

Global		96,064 individuals in 272,428 ID'd encounters	(no estimate made)

The initial result of building a globally integrated humpback whale photo-ID dataset was discovery a number of unexpected long-range matches. Examples: West Antarctic Peninsula (WAP) to Nicaragua, the farthest northerly migration of any Antarctic mammal (De Weerdt et al., 2020), Ecuadorian to Brazilian breeding grounds (Felix et al., 2020), Straits of Magellan to WAP feeding areas (Acevedo et al., 2021), Brazil to WAP (Sousa-Lima et al., IWC 2021), WAP to Eastern Australia (Acevedo et al., 2022), Iceland and Turks and Caicos (Bacon et al., 2023), West Indies to the Mediterranean Sea (Violi et al., 2021), Azores and the Barents Sea (Peres dos Santos et al., 2022), Hawaii and Mexico breeding areas in the same season (Darling et al., 2022), Marianas and Mexico via Russia (Ransome et al., 2023b) and several others, manuscripts in preparation.

As datasets have matured, this effort has supported regional studies of migratory pattern and abundance estimation such as in Mexico (Martien et al., 2021; Martínez-Loustalot et al., 2022; Ransome et al., 2024), Central America and Southern Mexico (Curtis et al., 2022; Taylor et al., 2021), El Salvador (Ransome et al., 2023a), Nicaragua (De Weerdt et al., 2023), the Coral Sea (Garrigue et al., 2020), South Atlantic (Marcondes et al., 2021; Ramos et al., 2023), and a study of the impact of entanglement on survivorship along the US West Coast (Tackaberry et al., 2022). In high sample-effort sub-regions such as Southeast Alaska, capture probabilities above 90% are enabling studies dependent upon a high recapture rate, such as body condition assessment between breeding and feeding grounds.

System development and WhaleID accessibility

To enable accessibility for practical use of automated image recognition based photo-ID, we built a mobile app "WhaleID" enabling near-instantaneous ID of humpback whale flukes in the field, as long as internet or cell service is available. For system details, see https://happywhale.com/whaleid; this mobile app is not available via Apple's App Store or Google Play. System development has depended on methodology development, described in several publications about image recognition of humpback whales (Cheeseman et al., 2022; Kierdorf et al., 2020; Marcos et al., 2022), and multi-species lateral view/dorsal fin image recognition (Patton et al., 2023).

Other cetacean data collections

94% of the Happywhale data collection, by encounter numbers, consists of humpback whales; the other 6%, 21,273 of 334,701 global cetacean encounters, includes encounters of 75 species and ecotypes (Table 2, Fig. 1). The data included here originates primarily from opportunistic citizen science contributions but also includes efforts from research collaborators. Collections of most species are minimal in number but in some cases, such as some beaked whale species and ecotype D killer whales, represent worthwhile observations of extremely rare species. Unlike with humpback whales, Happywhale does not currently have automated photoidentification fully implemented for most of these species, though active development and implementation of recently developed algorithms developed (Patton et al., 2023) show promise. Individual identification has been applied either (1) opportunistically, where contributors have notified Happywhale data managers of unique individuals, (2) from research collaborators with specific projects (Bryde's, fin (Falcone et al., 2022), sei and sperm whales), (3) through manual matching efforts by data managers, or (4) with newly implemented image recognition for sperm whales flukes and multi-species dorsal fin. In particular, we would like to acknowledge and thank Emma Luck for volunteer efforts with all ecotypes of killer whales, and Lisa Steiner and Ella McKhann with Azores sperm whales. Most encounters are supported by photo-documentation, with varying portions of these of sufficient quality for individual photo-ID. Examples of research use of opportunistic photo-ID data use include over a dozen individuals added to the Antarctic Blue Whale catalog (Olson *pers comm*) and the finding of a southern right whale (*Eubalaena australis*) encountered both along the Antarctic Peninsula and off the island of South Georgia, the first recorded migratory connectivity for this area for the species (https://happywhale.com/individual/45049). This match was found by Amy Kennedy of the South Georgia Right Whale Project (Jackson et al., 2020; Kennedy et al., 2023).

Other marine mammal collections

As with most cetacean species, data collections of other marine mammal species in Happywhale are opportunistic and for most species, few in number. The two exceptions are specific efforts on leopard seals (1370 encounters, 529 individuals) and Weddell seals (971 encounters, 48 individuals). We would like to thank and acknowledge Pippa Low for efforts with leopard seals.

Table 2. Global status of non-humpback whale collections of cetacean encounters in the Happywhale database. "Individuals", where present, are cases where photo-ID supported encounter records have been manually identified to individual. Individual identification has been applied either (1) opportunistically, where contributors have notified Happywhale data managers of unique individuals, (2) from research collaborators with specific projects (Bryde's, fin, sei and sperm whales), (3) through manual matching efforts by data managers, or (4) with newly implemented image recognition for sperm whales flukes and multi-species dorsal fin. Some cetacean species with less than 10 encounters have been omitted from the table.

Species: Common name	Species: Latin name	Encounters	Individuals	Region (in general order of volume of collection)
Arnoux's Beaked Whale	*Berardius arnuxii*	28	2	Antarctic Peninsula, Ross Sea, Weddell Sea and South Georgia
Atlantic Spotted Dolphin	*Stenella frontalis*	34		Atlantic, north and south
Atlantic White-sided Dolphin	*Lagenorhynchus acutus*	42		Atlantic, north
Baird's Beaked Whale	*Berardius bairdii*	22		Pacific, north
Beluga	*Delphinapterus leucas*	33		Arctic, North Pacific, North Atlantic
Blainville's Beaked Whale	*Mesoplodon densirostris*	5		Atlantic, north and south and Pacific, north and south
Blue Whale	*Balaenoptera musculus*	1727	116	Pacific, north and south, Atlantic, north and south, and Antarctic and Indian
Boto	*Inia geoffrensis*	3		Amazon
Bottlenose Dolphin	*Tursiops truncatus*	445	20	Global
Bowhead Whale	*Balaena mysticetus*	60	2	Arctic, North Pacific
Bryde's Whale	*Balaenoptera brydei*	178	80	Atlantic, south and Pacific, north
Chilean Dolphin	*Cephalorhynchus eutropia*	7		Chile, coastal
Clymene dolphin	*Stenella clymene*	2		Atlantic, south
Commerson's Dolphin	*Cephalorhynchus commersonii*	26		Atlantic, south
Common Dolphin	*Delphinus delphis*	97	4	Pacific, north and south, Atlantic, north, Black Sea
Cuvier's Beaked Whale	*Ziphius cavirostris*	13		Pacific, north and south, Atlantic, north
Dall's Porpoise	*Phocoenoides dalli*	39		Pacific, north
Deraniyagala's Beaked Whale	*Mesoplodon hotaula*	1		Indian Ocean
Dusky Dolphin	*Lagenorhynchus obscurus*	18		Argentina and Chile, coastal

Species: Common name	Species: Latin name	Encounters	Individuals	Region (in general order of volume of collection)
False Killer Whale	*Pseudorca crassidens*	23		Pacific, north, Atlantic, north and south, and Indian
Fin Whale	*Balaenoptera physalus*	1662	193	Pacific, north and south, Atlantic, north and south, and Mediterranean
Gray Whale	*Eschrichtius robustus*	3175	142	Pacific, north
Guiana Dolphin	*Sotalia guianensis*	7		Brazil
Harbor Porpoise	*Phocoena phocoena*	96		Pacific, north, Atlantic, north
Hector's Dolphin	*Cephalorhynchus hectori*	9		New Zealand
Hourglass Dolphin	*Lagenorhynchus cruciger*	10		Atlantic, south, Southern Ocean
Indian Ocean Humpback Dolphin	*Sousa plumbea*	73	41	South Africa, Indian Ocean
Indo-Pacific Bottlenose Dolphin	*Tursiops aduncus*	1		Indian Ocean
Killer Whale - Antarctic Type A	*Orcinus orca*	96	18	Antarctic Peninsula, Atlantic, south, and Pacific, south
Killer Whale - Antarctic Type B1	*Orcinus orca*	71	5	Antarctic Peninsula and South Georgia
Killer Whale - Antarctic Type B2	*Orcinus orca*	384	25	Antarctic Peninsula and South Georgia
Killer Whale - Antarctic Type C	*Orcinus orca*	48	5	Ross Sea
Killer Whale - Antarctic Type D	*Orcinus orca*	30		Drake Passage/Scotia Sea, and off New Zealand
Killer Whale - Eastern Tropical Pacific	*Orcinus orca*	123	27	Pacific, north
Killer Whale - Northern Hemisphere Bigg's (transient)	*Orcinus orca*	1445	225	Pacific, north
Killer Whale - Northern Hemisphere Offshore	*Orcinus orca*	22	1	Pacific, north (California)
Killer Whale - Northern Hemisphere Resident	*Orcinus orca*	718	190	Pacific, north
Killer Whale - type unknown	*Orcinus orca*	1656	23	Pacific, north and south, Atlantic, north and south, and Indian
Long-finned Pilot Whale	*Globicephala melas*	78	13	Atlantic, north and south and Pacific, south
Melon-headed Whale	*Peponocephala electra*	2		Atlantic, south and Pacific, south
Minke Whale	*Balaenoptera acutorostrata*	676	4	Pacific, north and south, Atlantic, north and south

Species: Common name	Species: Latin name	Encounters	Individuals	Region (in general order of volume of collection)
North Atlantic Right Whale	*Eubalaena glacialis*	14	1	Atlantic, north
North Pacific Right Whale	*Eubalaena japonica*	2		Pacific, north
Northern Bottlenose Whale	*Hyperoodon ampullatus*	21		Atlantic, north
Northern Right Whale Dolphin	*Lissodelphis borealis*	13		Pacific, north
Omura's Whale	*Balaenoptera omurai*	12		Indian
Pacific White-sided Dolphin	*Lagenorhynchus obliquidens*	68		Pacific, north
Pantropical Spotted Dolphin	*Stenella attenuata*	27		Atlantic, south and Pacific, north
Peale's Dolphin	*Lagenorhynchus australis*	29		coastal South America and Falklands (Malvinas)
Pygmy Blue Whale	*Balaenoptera musculus brevicauda*	1		west Australia
Risso's Dolphin	*Grampus griseus*	365	6	Pacific, north and south, Atlantic, north and south
Rough-toothed dolphin	*Steno bredanensis*	5		Brazil
Sei Whale	*Balaenoptera borealis*	312	91	Atlantic, south (especially, Falkland Islands) and north, and Pacific, north and south
Short-finned Pilot Whale	*Globicephala macrorhynchus*	118	4	Atlantic, north and south and Pacific, north and south
Southern Bottlenose Whale	*Hyperoodon planifrons*	11		Atlantic, south and Antarctic Peninsula
Southern Right Whale	*Eubalaena australis*	297	10	Atlantic, south, Antarctic Peninsula and Pacific, south
Southern Right Whale Dolphin	*Lissodelphis peronii*	5		Pacific, south and Atlantic, south
Sowerby's beaked whale	*Mesoplodon bidens*	3		Atlantic, north
Sperm Whale	*Physeter macrocephalus*	6445	2704	Atlantic, north, south and Pacific, north, south, Indian
Spinner Dolphin	*Stenella longirostris*	18		Atlantic, north, south and Pacific, north, south, Indian
Strap-toothed Whale	*Mesoplodon layardii*	4		Atlantic, south and Antarctic Peninsula
Striped Dolphin	*Stenella coeruleoalba*	7		Atlantic, north
White-beaked Dolphin	*Lagenorhynchus albirostris*	44		Atlantic, north

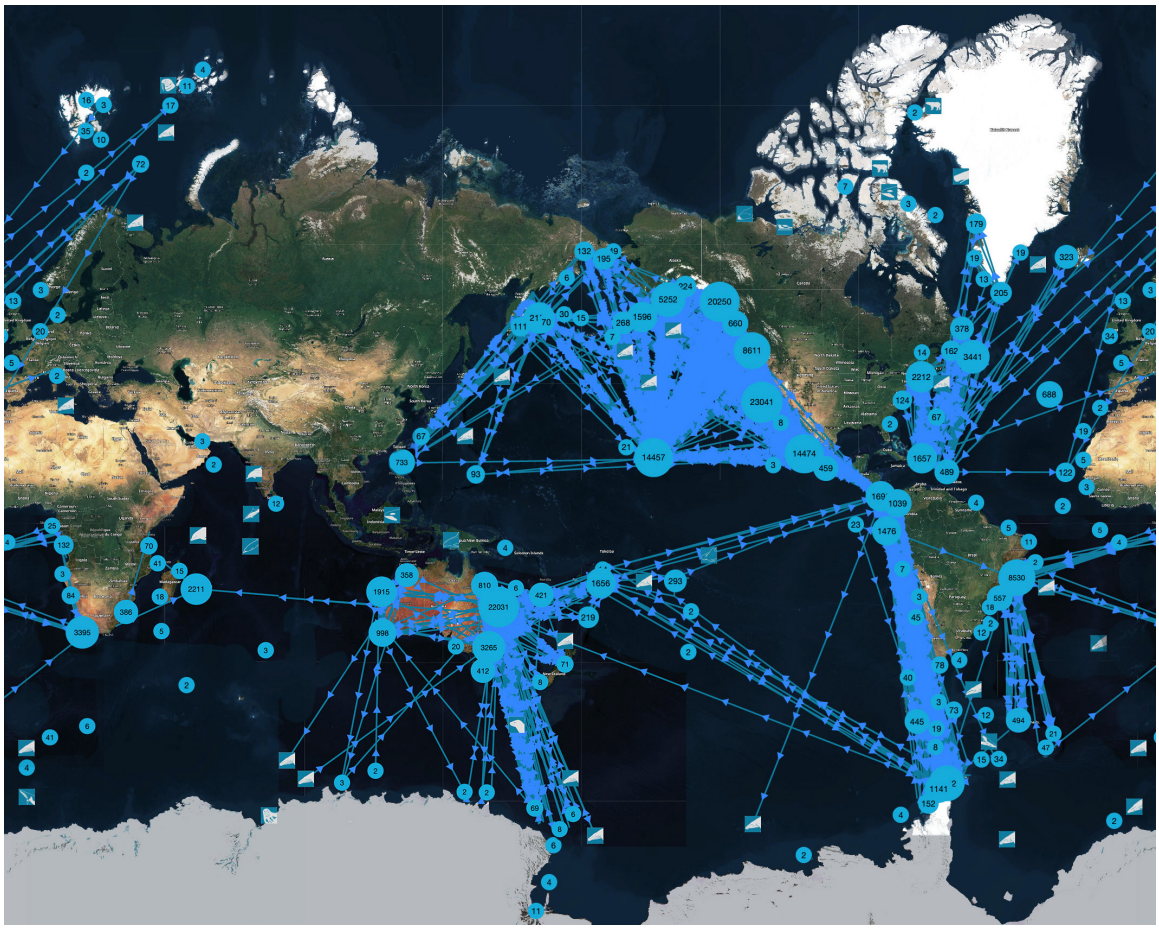

Figure 1. Global map of marine mammal encounter data in the Happywhale database. Numbers represent a count of identified encounters irrespective of the number of individuals shown. Arrows show chronology of migratory connections, and do not necessarily represent actual migratory path followed.

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