

Annex S

Report of the Photo-Identification Subcommittee

Participants: Olson (Convenor), Baird, Banga, Bell, Bernus, Branch, Brownell, Buss, Cassani, Cerchio, Charlton, Cheeseman, Cisternino, Citta, Collins, Cremer, Dalla Rosa, Davies, Donovan, Evangelista, Fernández, Fruet, Fyfe, Galletti, Genov, Goetz, Han, Herr, Hielscher, Holmberg, Huss, Iñíguez, Jones J., Jones, L., Katara, Kawai, Kelly, Lang, Leal, Li, Lundquist, Lysenko, Mallette, Marmontel, Minton, Mizroch Natoli, Naylor, Nelson, Øien, Oloughlin, Otarashvili, Palazzo, Panigada, Passadore, Pinder, Porter, Reeves, Robson, Rojas, Schubert, Seakamela, Seyboth, Stack, Staniland, Sutaria, Torres Florez, Urbán, Urnau, Vermeulen, Wade, Webster, Weinrich, Weller, Zerbini.

1. INTRODUCTORY ITEMS

1.1 Opening remarks

Olson welcomed participants and introductions were made.

1.2 Election of the chair

The Subcommittee formally approved the nomination of Olson as Chair.

1.3 Appointment of the rapporteur

Buss agreed to undertake duties as Rapporteur.

1.4 Adoption of the agenda

The adopted agenda is given in Appendix 1.

1.5 Available documents

SC/69B/PH/01, SC/69B/PH/02Rev1, SC/69B/PH/03-04, SC/69B/PH/07-08, SC/69B/SAN/03rev2, SC/69B/SH/01, Patton *et al.* (2023), Cheeseman *et al.* (2024), Olson *et al.* (2017) and Olson *et al.* (2020).

2. GUIDELINES FOR IWC CATALOGUES AND PHOTO-ID DATABASES

The IWC Guidelines for Photo-identification Catalogues were prepared in support of the Committee's work in conducting population assessments utilising photo-identification databases. The aim is that catalogues adhere to common standards for photograph subject and quality, data submission and reporting, at a level sufficient to allow the Committee to meet its population assessment goals. The Guidelines were first drawn up in 2017 (Olson *et al.* 2017) and made available on the IWC website.

Photo-identification is an evolving methodology and a revision of the Guidelines became necessary. The lead authors (Olson and Donovan) drafted a revised version (SC/69B/PH/01) and presented to the Subcommittee. The Group reviewed and edited the document and pertinent updates were made. A final draft was reviewed and accepted by the Group. The revised Guidelines will be made available on the IWC website.

3. PROGRESS WITH EXISTING OR PROPOSED NEW CATALOGUES

3.1 Right whale photo catalogues

Vermeulen provided a report on the current status of further development and implementation of an AI matching system to compare the huge photo catalogues of southern right whales from the South America, South Africa and Australia, and a workplan for the future. Previously, deep learning and AI have been tested for southern right whales based on the algorithms developed for North Atlantic right whales through Deep Sense AI and Flukebook (Blount *et al.*, 2022; Kahn *et al.*, 2022). The results of testing indicated that because of the large size of the photo-identification datasets and variation in data collection, an AI matching algorithm for southern right whales would require substantial further development.

A collaborative team studying southern right whales in regions around the Southern Hemisphere have devised and are finalising a workplan with AI developers from Happywhale and ARWPIC (Australasian Right Whale Photo-identification Catalogue) to develop and trial an advanced, fully automated photo-identification system specifically for southern right whales. The work plan includes with a three phases:

1. preparing a fully curated southern right whale dataset for training and testing AI models;
2. lowering the matching times for individuals by developing, training, and testing various AI models and comparing the results; and
3. algorithm implementation and data integration in an online web-based application.

Only algorithms trained on the vertical perspective will be used at this stage as they contain the most callosity information. Most images of the long-term datasets fit these criteria as they come from aerial surveys. Lateral-perspective photographs collected from land and boat-based surveys require a separate project and algorithms to solve. It is envisioned that data management systems will be standardised among all catalogue holders to facilitate multiple-catalogue comparisons and reconciliations, as well as the application of a common modelling framework to all available long-term datasets to assess southern right whale population parameters on a consistent hemisphere wide scale.

The Subcommittee thanked the Vermeulen and her colleagues for providing this information to the Committee. It was recognised that this work was essential to the ongoing population assessment of southern right whales. Also see Item 8.2.2.

Attention: SC, R

*The Subcommittee **strongly recommended** that the development and trial of a fully automatic photo-identification system designed specifically for southern right whales be advanced before SC70.*

3.2 Happywhale database

SC/69B/PH/04 summarises the data that have currently been contributed to and housed at Happywhale.com. Humpback whales currently dominate the encounter numbers in the catalogue (~94%), whilst the remaining 6% is represented by 75 species/ecotypes of cetaceans worldwide. It was evident from this report (SC/69B/PH/04) and the peer-reviewed literature (Cheeseman *et al.*, 2024) that this dataset provides an enormous resource that can be used to estimate abundance over regional and ocean-basin wide scales. In Patton *et al.* (2023), the authors estimate that humpback whales have been steadily increasing in the North Pacific over a 40-year period with a current abundance estimate of 26,662, providing one example of many possible applications that such a wide and continuously updated collaborative photo-identification catalogue can provide. He also noted that historical datasets (e.g.,

pre-2000s) are starting to be contributed so it is possible in the future to look at demographic changes over time. Cheeseman also introduced Cheeseman *et al.* (2024), which describes the high value of multi-species matching in terms of increasing photo matching algorithm capabilities.

It was explained that the sheer volume of humpback whales that died (~7000 humpbacks) during the 2014-16 marine heatwave in the North Pacific would not have been identified without such a catalogue, displaying the value of such a platform for identifying relationships between whale movements, survival and population demographics in relation to environmental change.

The Subcommittee recognised that AI developments by talented individuals have revolutionized photo-identification as a research tool and educational opportunity for the community. The Group **commended** this work and how far it has come since presentations in 2020.

In discussion, concerns about contributing photographs into a system that was not future proof as they are dependent on continued long-term support, maintenance, and funding. Moreover, the discrepancies in the types of meta-data currently housed between the two platforms is currently not clear. It was suggested to draft language for Happywhale and Flukebook encouraging the standardisation of their systems to enable an easy exchange of datasets should the need arise. The Subcommittee was not in agreement about this but did agree to undertake discussion at future meetings.

3.3 Flukebook

SC/69B/PH/07 describes the AI photo-identification matching platform, Flukebook. Flukebook is a non-profit, open-source cetacean data-management and photo-identification tool developed under the larger open source Wildbook platform that uses computer vision and machine learning to facilitate rapid identification of individual animals in the wild. In 2023, Flukebook received significant upgrades in its machine learning pipeline, increasing throughput, speed and AI accuracy for individual ID. It leveraged individual data from 23 species to create a single, new AI model called 'MiewID' with improved or comparable ID accuracy for all species (versus single species training) and speeding inference to reach a new peak throughput potential of 2,778 ID jobs in a single day on a single GPU. We also deprecated or entirely removed several legacy algorithms (CurvRank v2, finFindR, Hotspotter, etc.) that did not scale with increasing demand and data volumes in asking the question 'Which individual cetacean is in this photo?'. These improvements in AI for cetacean photo ID have had a cascading benefit to other Wildbook communities, launching new multispecies models for wildlife face ID (13 species) and terrestrial carnivore ID (nine species) and helping terrestrial biologists simultaneously gain the benefit of advanced AI developed under Flukebook. The results also demonstrate a potential ability for zero-shot learning on individuals of data-deficient species that the AI model has never seen. The multispecies, multi-platform approach provides a path forward for improving accuracy through greater data volume and diversity while decreasing training time and complexity. Our work culminated in the deployment of new AI models to Flukebook.org with improved or added support for 34 species now available to users.

The Subcommittee **commended** the authors for their presentation and supported their initiatives to share data and make models openly available to the public and research community.

The Subcommittee emphasised how important the Happywhale and Flukebook platforms have been for the work of the Committee.

Attention: SC, R

The Subcommittee **encouraged** continued collaboration between the Committee, Flukebook and Happywhale.

It was suggested that it would be useful to have a document that offers a cross-reference to the two platforms (similar to Olson *et al.* (2020) - now outdated). A user-friendly, introductory guide to the two platforms was also suggested. An Intersessional Correspondence Group (ICG) under Olson and Minton was organised to explore the development of these documents further.

3.4 Southern Hemisphere Blue Whale Catalogue

The Southern Hemisphere Blue Whale Catalogue (SHBWC) holds photo-IDs from left and right sides and flukes of 2,697 blue whales from waters off Antarctica, Chile, Peru, Ecuador-Galapagos, in the Eastern Tropical Pacific (ETP), off southeastern Australia, Western Australia, Timor-Leste, New Zealand, Southern Africa, Madagascar, Indonesia and Sri Lanka. It is the result of the collaboration of over 30 research groups and individuals with blue whale photo-identification throughout the Southern Hemisphere. SC/69B/SH/01 presents a progress report of the Catalogue from April 2023 to February 2024.

The matching of Chilean datasets from northern (2006-19) and southern Chile (2003-18) was completed. Encounter histories ranged between 294 and 560 unique blue whale IDs in southern Chile, depending on photo-quality and left or right side, and 31 to 66 unique whale IDs for northern Chile. These data are used in abundance estimate models reported in (SC/69B/SH/16). The comparisons of new Australian photo datasets have been completed. The compiled Australian data consists of 654 individuals from waters off Perth, from Geographe Bay and the Bonney upwelling area. No comparisons have been made yet with new data from Timor-Leste. With the blue whale migratory connection between Timor-Lest and Australia, there may implications for assessment purposes of the Australian dataset. A MoU is still required for all of the Australian groups. The compiled New Zealand dataset consists of 164 individuals. The process-checking metadata are underway for Australia and New Zealand. New photographs from the Eastern Tropical Pacific/Galapagos and Sri-Lanka are also waiting to be compared.

In was questioned whether there were enough data in the New Zealand dataset for Fewster *et al.* (SC/69B/SH/16) to conduct an abundance estimate. It was explained that once Fewster's team refines their methods on a larger dataset, that modeling the New Zealand dataset will be re-visited. The Subcommittee **thanked** Galletti for the invaluable contribution to the work of the Committee and **commended** the large annual workload.

Priority of matching specific geographic regions was discussed. Given the recently identified linkage between Timor-Leste and Australia, matching photos between these areas would increase the understanding of the population structure and movement patterns of the Australian population. Similarly, following the results presented in Attard *et al.* (2024) in the SD-DNA Subcommittee, a comparison of photographs between regions in the eastern Pacific would clarify movement patterns and residency of blue whales in those regions. See discussion in Item 8.2.1.

Attention: SC, R

*The Subcommittee **recommended** that blue whale identification photos from Timor-Leste be moved to high priority for matching with Australia in the Southern Hemisphere Blue Whale Catalogue. The Group also **recommended** that matching be conducted between regions in the eastern tropical Pacific.*

3.5 Antarctic Blue Whale Catalogue

SC/69B/PH/02Rev1 provides new information on the Antarctic Blue Whale Catalogue from 2022 to 2024. Between 2021-2024, 29 new individual Antarctic blue whales were identified and compared with the existing catalogue of 552 individuals. There were no re-captures, bringing the total number of identified whales up to 581 whales (434 left and 426 right sides). This represents between 19-25% of the total population, based on the most recently accepted abundance estimate (2,280 whales, Branch, 2007). All 29 of the recent identification photos were collected opportunistically and add valuable data to IWC Management Areas I, II and VI, which are underrepresented in the Catalogue. The Catalogue has benefitted from the contribution of opportunistically collected photographs. Currently 15% (88/581) of the identified whales in the Catalogue come from opportunistic photographs. There are now 51 identifications from the sub-Antarctic island at 54°15'S 36°45'W but with no re-sightings. The data from the catalogue have been used in peer-reviewed studies on movement and to estimate abundance. The data have also been used in numerous SC papers for pre-assessment purposes.

The Subcommittee **commended** the authors for hard work and invaluable contribution to the Committee and Antarctic blue whale assessments. The Group noted that it was excellent to have received opportunistic data contributed from underrepresented areas.

Attention: SC, R

*The Subcommittee **encouraged** future contributions of opportunistically collected photographs for the Antarctic Blue Whale Catalogue, noting the value these data provide to population assessments.*

Discussion was undertaken on how best to encourage citizen science identification contributions (e.g., birding groups, private charters, wildlife charity members/donors). The Subcommittee agreed that outreach to encourage photo contributions from members of the public via various avenues, including Antarctic tour operators, would be beneficial. Pursuant of this an ICG was established under Olson to decide how to best move forward with this.

3.6 Fin whale photo catalogues

Herr introduced author Huss and SC/69A/PH/08. Traditional manual photo-matching techniques are generally time-consuming and have thus become increasingly inefficient with growing database sizes. Recent advances in machine learning have demonstrated highly accurate and efficient performances of automated individual identification based on lateral images of dorsal fin features. Following the introduction of drone-based techniques in cetacean research, new aerial perspectives have become available for photo-ID, enabling the analysis of morphological features and pigmentation patterns that were previously difficult to capture. The authors propose a deep learning-based framework for identifying Southern Hemisphere fin whale (SHFW) individuals using aerial drone footage of characteristic dorsal pigmentation patterns. By focusing on the central chevron pattern (CCP) and blaze, the authors aim to develop a novel aerial photo-ID approach by leveraging a semi-supervised workflow and thereby reducing manual labelling efforts. The aim is to identify key feature regions with high inter-individual variability and

to explore subsequent automation. Model predictions will then be yielded by employing a deep convolutional neural network (CNN) architecture for (human) facial recognition to ensure robust individual discrimination.

The authors explained that this was still in an early developmental stage. When it's complete, they hope to make the software open access. The Group thanked the authors for bringing this forward and **welcomed** future updates on this work.

In discussion it was mentioned how it would be important to maintain a workflow whereby other data (e.g., biopsy, fecal samples etc.) could still be linked with imagery as researchers moved towards more automated systems.

It was acknowledged that these data and results of this project will be valuable for the population(s) of Antarctic fin whales as they will shortly be moving into a pre-assessment phase.

3.7 Humpback whale photo catalogues

The latest results from the North Atlantic Humpback whale catalogue (NAHWC) were presented in SC/69A/PH/03. The NAHWC currently includes photographs and data from 50,000 sightings of 11,690 individual non-calf humpback whales identified by ventral fluke photos. This report highlights the collaborative efforts of over 850 contributors across the North Atlantic Ocean basin and details the current methods used for photographic-identification (photo-ID) and cataloging. Notably, advancements in digital photo-ID analysis techniques have enhanced the cataloging process, incorporating AI algorithms through Happywhale while maintaining stringent comparison standards. SC/69A/PH/03 also discusses recent findings on North Atlantic humpback whale movement patterns, including inter-regional migrations, preliminary results from stranded humpback whales, and sightings from areas of increasing importance.

The Subcommittee thanked the authors for presenting this work and called attention to the extremely high value of these large photo-identification datasets in understanding whale movements, population connectivity and abundance.

In discussion, it was explained that high quality tail flukes on deceased humpback whales are useful as deceased individuals can be removed from the catalogue matching process.

Attention: SC, R

*The Subcommittee **encouraged** collaborators/researchers to take and contribute photographs of deceased humpback whale tail flukes to the NAHWC (nahwc@coa.edu) and, where possible, to collate additional photographs from stranding networks that may not yet have contributed their data (e.g., United Kingdom, Azores).*

In response to a question about private and public portions of Happywhale, Jones confirmed that the entire NAHWC cannot be made public due to sharing agreements between the various data contributors and thereby it sits in a 'private area' of the Happywhale catalogue.

SC/69B/SAN/03Rev2 provided information on recent efforts by the IndoCet Consortium to upload and match regional Southwest Indian Ocean humpback whale photo-identification data on the Happywhale platform. The effort is being conducted under a collaborative strategy to improve estimates of abundance

and interchange among sub-stocks of Breeding Stock (BS) C and to improve current understanding of linkages to other IWC Southern Hemisphere breeding regions. The number of identification photographs from Breeding Stocks B and C has grown from 89 encounters of 73 individuals in 2018 to 14,017 encounters of 8,172 individuals as of March 2024. For BS-C, this comprises a total of 4,503 individuals (6,669 encounters), with data from South Africa, Mozambique, Kenya, Tanzania, Comoros/Mayotte, Madagascar and Reunion. Additional data from Madagascar are still to be uploaded. Data for BS-C comprises a total of 3,669 individuals (7,348 encounters), with contributions from western South Africa, Namibia, Angola, Equatorial Guinea and Gabon. A total of 57 matches were found among sub-stocks of BS-C and further matches were discovered between BS-C and other breeding stocks including BS-A, BS-B and BS-D. Also see Item 5.1

The Subcommittee **commended** the work.

Attention: SC, R

*The Subcommittee **encouraged** the continuation of the successful and highly collaborative work of the Indocet Consortium in collecting and providing photographic data on humpback whales from the Southwest Indian Ocean.*

3.8 Other photo-identification catalogues

Wade provided the Subcommittee with a brief presentation on cross-platform (lateral and vertical aspects) matching of beluga identification photos from Cook Inlet.

The topic of cross-platform identification was discussed several times in the Subcommittee. The Group raised concerns that research groups that move solely to drone drone footage will make comparisons with the existing catalogues redundant.

Attention: R

*Research groups conducting photo identification were **encouraged** to continue with lateral photography until ground-truthing cross-platform (AI) tools are fully developed for their catalogue. This supports the continued use of long-term catalogues even after a switch in preferred perspective.*

4. BIENNIAL WORKPLAN

Table 1 Workplan

Topic	Intersessional 2024-25	2026 Annual Meeting (SC70)
Developments with AI and computer-assisted matching (21.2)	Review progress	Report(s)
Southern Hemisphere Blue Whale Catalogue (SHBWC) (21.2.4)	Continue inter-regional photo comparisons	Report
Antarctic Blue Whale Catalogue (21.2.5)	Continue acquisition of new photos; compare photos; upload to SHBWC	Report

Table 2
Intersessional Email Groups

Annex Item Subcommittee	Type	Group short name	Terms of reference	Members
Item 3.2 & 3.3 PH	ICG	User guides to AI platforms	Development of 1) a user-friendly guide to using Flukebook & Happywhale and 2) an updated cross-reference document.	Olson & Minton (Co-convenors), Cheeseman, Natoli, Vermeulen
Item 3.5 PH	ICG	Outreach to facilitate photo contributions	Develop ways of expanding reach to citizen scientists to encourage photo contributions.	Olson (Convenor), Bell, Brownell, Buss, Collins, Double, Herr, Weinrich, Weller

The Report was adopted at 11:25 on 29 April 2024.

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Appendix 1
AGENDA

1. INTRODUCTORY ITEMS

- 1.1. Opening remarks
- 1.2. Election of the chair
- 1.3. Appointment of the rapporteur
- 1.4. Adoption of the agenda
- 1.5. Available documents

2. GUIDELINES FOR IWC CATALOGUES AND PHOTO-ID DATABASES (PH)

3. PROGRESS WITH EXISTING OR PROPOSED NEW CATALOGUES

- 3.1. Right whale photo catalogues
- 3.2. Happywhale database
- 3.3. Flukebook
- 3.4. Southern Hemisphere Blue Whale Catalogue (SHBWC)
- 3.5. Antarctic Blue Whale Catalogue (ABWC)
- 3.6. Fin whale photo catalogues
- 3.7. Humpback whale photo catalogues
- 3.8. Other photo-identification catalogues

4. BIENNIAL WORKPLAN