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Progress report on Southern Hemisphere Blue Whale Catalogue: Period April 2022-March 2023

Barbara Galletti Vernazzani, Paula A. Olson and Chandra P. Salgado

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Barbara Galletti Vernazzani[1,2] (SHBWC curator), Paula A. Olson[3] and Chandra P. Salgado[4,5]

[1]Centro de Conservación Cetacea, Concon, Chile
[2]Pacific Whale Foundation, Concon, Chile
[3]Marine Mammal and Turtle Division, Southwest Fisheries Science Center NMFS/NOAA, 8901 La Jolla Shores Drive, La Jolla, CA 92037 USA
[4]Oceans Blueprint, Perth, Autralia
[5]Centre for Marine Ecosystems Research, School of Science, Edith Cowan University, Perth, Australia

ABSTRACT

The Southern Hemisphere Blue Whale Catalogue has a total of 2697 individual blue whale photo-identifications (photo-IDs) that include regions off Antarctica, Chile, Peru, Ecuador-Galapagos, Eastern Tropical Pacific (ETP), Australia, Timor-Leste, New Zealand, southern Africa, Madagascar and Sri Lanka. From April 2022 to March 2023, new collections of photo-identifications have been received (488 new IDs) from areas off Chile, Ecuador, Australia, Costa Rica Dome and Madagascar, representing a 22% of increase. Photo-ID comparisons were focused on new entries from Chile and have been completed. A total of 82 additional matches have been found for the entire Chilean datasets. Quality control of datasets from Australia, New Zealand and Chile has also been completed and data are now being prepared to be used for regional blue whale assessments. Important new collections from Australia have been received and matching is currently a priority to include these new data on the ongoing assessment. Other regions that have contributed important data but have still not been compared are Timor Leste, Sri Lanka, ETP, Galapagos and Madagascar.

INTRODUCTION

In the Southern Hemisphere, the pygmy blue whale (*Balaenoptera musculus brevicauda*) in the Indian Ocean and western Pacific Ocean, and the Antarctic blue whale (*B. m. intermedia*) in the Southern Ocean, are currently recognized as two subspecies by the Taxonomy Committee of the Society for Marine Mammalogy[1]. In addition, the yet unnamed subspecies or Chilean blue whale has been proposed as a separate subspecies (*B. m*. spp.) because it is morphologically (Branch *et al.* 2007; Leslie *et al*. 2020; Pastene *et al.* 2020), genetically (LeDuc *et al.* 2007; LeDuc *et al.* 2017), and acoustically (McDonald *et al.* 2006) distinct.

Since 2008, the International Whaling Commission (IWC) has been supporting the project "Southern Hemisphere Blue Whale Catalogue (SHBWC)" as an international collaborative effort to facilitate cross-regional comparisons of individual blue whale photo-identification catalogues and contribute to Southern Hemisphere blue whale assessments (IWC, 2009).

The SHBWC uses specially designed online software that allows for simultaneous upload and comparisons between catalogues from regions off Antarctica, Chile, Peru, Ecuador-Galapagos, in the Eastern Tropical Pacific, Australia, Timor-Leste, New Zealand, Madagascar and Sri Lanka. Therefore, the SHBWC has become the largest repository of Southern Hemisphere blue whale photo-identifications (Galletti Vernazzani *et al*., 2019a).

Comparisons among different regions will improve the understanding of basic questions relating to blue whale populations in the Southern Hemisphere. The IWC Scientific Committee is currently conducting blue whale assessments on non-Antarctic blue whales. Major comparisons off Australia, New Zealand, Sri Lanka have been completed with data received prior to 2018 (Galletti Vernazzani *et al*., 2019b). Comparisons within ETP and South America have been completed with data received prior to 2020 (Galletti Vernazzani *et al.*, 2022).

[1] https://www.marinemammalscience.org/species-information/list-marine-mammal-species-subspecies/

The matching process and quality control for these regional datasets have been finalized, except for some newly contributed photo-ID catalogues. These datasets are therefore almost ready to be used on recaptures models to estimate abundance. Last year, the Scientific Committee decided to undertake an intersessional analysis of whale abundance (IWC, 2022), led by Professor Rachel Fewster at the University of Auckland.

This report summarizes the progress made between April 2022 to March 2023 on the work of the SHBWC.

USERS & UPLOADING OF CATALOGUES

Catalogues currently maintained in the SHBWC include those 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. A total of 2,697 blue whales are currently in the SHBWC (1980 left side, 1930 right side and 135 flukes), representing a 22% increase from last year (Table 1).

Overall, 25 blue whale research groups from all regions are contributing to the SHBWC (Annex 1).

488 new blue whale photo-ID entries have been received from Blue Whale Center (BWC, Chile), Center for Whale Research (CWR, Australia), Universidade Nacional Timor Lorosa'e (UNTL, Timor-Leste) and other research groups with opportunistic photo-ID from Ecuador and Madagascar. Photo-IDs from the IWC-SOWER cruise on the Madagascar Plateau have also been uploaded (Olson and Cerchio, 2023).

Photograph collections from the BWC off southern Chile, consisting of 206 individuals between 2003-2015 (Torrez-Flores *et al*., 2021), were received during July 2022. The photographs and associated metadata were not directly uploaded at the SHBWC platform, and the regional coordinator undertook the uploading of the photo-ID catalogue to make them available through the SHBWC. Associated metadata did not include specific location (latitude and longitude) and the catalogue holders instead provided general locations such as Golfo de Cordovado, west of Isla de Chiloé, etc. Consequently, this dataset is not as accurate as the rest of the blue whale catalogues housed under the SHBWC, which contain accurate latitude and longitude position data.

Finally, the information received was from 205 individuals but at least 9 individuals were found to be duplicates, corresponding to 5 right side and 7 left side duplicates. In addition, some right sides were associated with left sides under the same individual and after undertaking the matching process, it was found that these associations were not correct. These sides were separated into different whale IDs within the SHBWC platform. Therefore, the BWC catalogue is comprised of at least 200 individuals, including 140 right sides and 150 left sides.

Details on contributing groups' catalogues, areas and general data can be found on Table 1.

MATCHING PROGRESS

Individual blue whales are identifiable from unique patterns of mottling on both sides of the body near the dorsal fin (Sears *et al*., 1990) and from the highly variable dorsal fin shape (Gendron and Ugalde de la Cruz, 2012). In some cases, permanent scars can be used to identify or confirm resighted individuals. The SHBWC holds photo-IDs from left and right sides of blue whales as well as from the fluke, when available.

Comparisons have been underway among all regions (Galletti and Cabrera, 2011; Galletti Vernazzani and Olson, 2013; Galletti Vernazzani *et al.,* 2016), but with increasing contributions from catalogue holders, the matching process has focused on blue whale populations off Australia, New Zealand and Chile-ETP to be used for assessment purposes (IWC, 2021).

During all matching processes, it has been found that several catalogues included duplicate individuals; these have been corrected, and the contributors notified. It is not an unusual situation, particularly with large catalogues, and may affect abundance estimates. Photo-quality control can play an important role in reducing this source of error, but sometimes duplicate photo-IDs may all be of good quality and inadvertently included. The effect of duplicated animals on abundance estimates produced by recapture models may need consideration.

Chile

Comparisons of 872 photo-identified blue whales from six different research groups working in southern and northern Chile and the ETP, as well as opportunistic sightings, provided 38 re-sightings. One match revealed information on the connectivity and migration of blue whales from southern Chile to the southern ETP. Other matches were found within southern Chile (n=22) and within northern Chile (n=15), providing further evidence for strong site fidelity to feeding areas (Galletti Vernazzani *et al*., 2022).

Left and right side photographs from the BWC catalogue off southern Chile (n=200) were compared to the CCC catalogue from northern and southern Chile (n=621), MERI Foundation from southern Chile (n=60), Phantalassa from northern Chile (n=37), Eutropia from northern Chile (n=34), IWC-Chile 1997/1998 SOWER Cruise from along Chile (n=21) and opportunistic sightings from the South East Pacific that includes sightings from Peru to southern Chile (n=16).

After the matching process, a total of 82 matches (approximately 40% of the BWC catalogue) were found with other southern Chile catalogues. This includes 56 right side recaptures and 65 left side recaptures. The BWC catalogue contributed an additional 83 new individuals identified through right side and 85 left side photographs to the Chilean blue whale combined datasets.

All matching for Chilean catalogues has now been completed and the resulting data are ready to be used in abundance estimation models.

Australia

Comparisons of 698 photo-identified blue whales from seven different research groups working in the Perth Canyon (southwestern Australia), Geographe Bay (southwestern Australia), Bonney Upwelling (southern Australia), around New Zealand, and Sri Lanka provided eighteen whales resighted between different areas. Matches were found within Australian catalogues and within New Zealand catalogues, but no matches were found between those two regions or with Sri Lanka (Galletti Vernazzani *et al*., 2019b).

Additional data have been received from whales found off Australia (n=16) after the 2018 matching process was finalized and recently CWR updated their catalogue including additional photo-ID from 2011 to 2022 (n=161).

These photo-IDs have not yet been matched to any catalogue. One of the next priorities for assessment includes Australian datasets and therefore matching for these photo-ID data will follow.

New Zealand

Comparisons of 164 photo-identified blue whales from three research groups working off New Zealand provided three re-sightings. In addition, four individual whales' photographs from the OSU catalogue and opportunistic sightings off New Zealand were identical and can be considered duplicated rather than matches.

The New Zealand dataset matching process has also been completed and the resulting data are ready to be used for modelling abundance estimates.

Other regions

Regional comparisons within the Southern Ocean have been systematically conducted by Olson (Olson *et al*., 2020) under the IWC Antarctic Blue Whale Catalogue project, that also includes photo-ID data from the IWC-SOWER cruises, IWC-SORP voyages, the Institute of Cetacean Research's expeditions (JARPA,

JARPAII, NEWREP-A), the South African Antarctic Blue Whale Survey, and from photographs contributed by naturalists and citizen scientists. Sixteen whales from the Southern Ocean were re-sighted in multiple years (one whale in two subsequent years); six of the whales were re-sighted within 19 to 753 km from their original location and two whales had a 12-year interval between sightings (Olson *et al.*, 2020).

New data from Timor-Leste (a lower-latitude part of the SE Indian Ocean population) has also been received but no comparisons have been conducted yet for any of the contributed photo-ID for this region. Recent acoustic and telemetry data have shown important migratory movements of blue whales from Australia to Timor-Leste (Thums *et al.*, 2022; Sahri *et al.* 2022). Connectivity between individual blue whales photographed off Timor-Leste and those photo-ID's off Australia may be considered relevant and with implications for assessment purposes of Australian datasets.

New photo-ID data from Eastern Tropical Pacific and Galapagos have been provided by the WHET Lab and Cascadia Research Collective. Additionally, one opportunistic sighting off coastal waters of Ecuador (1,5ºS-80,8ºW) taken on 22 January 2023 has been contributed by Pacific Whale Foundation from Ecuador. Increasing evidence from acoustic, telemetry and photo-identification data (Douglas, *et al.* 2015; Buchan *et al*., 2015; Torres-Florez *et al*., 2015; Hucke-Gaete *et al.*, 2018; Galletti Vernazzani *et al.,* 2022.) has shown migratory connections between whales off Chile with ETP/Galapagos. To date most of the Chilean and ETP/Galapagos catalogues have been compared, however, the new photo-IDs provided from ETP/Ecuador have not yet been compared to any of the catalogues, nor has the BWC catalogue been compared with any of the ETP/Ecuador catalogues (this due to funding constraints and work priorities).

Biosphere Foundation photographs and dataset from Sri Lanka from 1983-1984 and 2010-2015 have been received by the curator in the past. Due to the priority given on 2022-2023 to complete the matching process of the remaining Chilean datasets, consolidation of this catalogue is still ongoing and must be completed before uploading the photos into the SHBWC.

PROGRESS TOWARD POPULATION ASSESSMENTS

Priorities for the Sub-committee on other Southern Hemisphere whale stocks currently include blue whales off Australia and Chile (IWC, 2018), and more recently New Zealand (IWC, 2021). All matching of photographs uploaded before January 2018 and March 2021 for these regions have been completed (Galletti Vernazzani *et al.* 2019b, 2022). Matching for the New Zealand and Chilean regions were finalized in 2022. Comparisons of new entries from Australia should be undertaken as the highest priority.

Last year, the Scientific Committee decided to undertake an intersessional analysis of whale abundance, led by Professor Rachel Fewster at the University of Auckland. The recapture models use multiple marks (i.e combining images from left and right sides of whales) and data from New Zealand blue whales was being considered as these datasets had already completed the photo-ID matching and quality control processes (IWC, 2022).

During a preparatory meeting held with Dr. Fewster to analyze the combined New Zealand datasets, it was noted that it was unlikely these could be useful to conduct a test case on the upcoming study. It was suggested that the first trial of the new model should use a dataset with a higher number of recaptures. The Chilean blue whale combined dataset was selected instead and the matching process for the remaining catalogues was accelerated. After modelling trials have been conducted, the results will be used to inform the future direction for modelling, and define relevant parameters for potential use in models applied to the New Zealand dataset.

Therefore, intersessional work on abundance estimation modelling will be using the combined Chilean blue whale datasets. All Chilean catalogues contributed prior to 2020 have already been processed and with the 2022 work on BWC catalogue completed, the entire Chilean blue whale datasets are now ready to be used.

Some important aspects need to be addressed to prepare the database for a capture-recapture analysis. These include photo quality control and data management, as well as signing an MoU for data sharing.

Data management
Data on dates are key for mark-recapture abundance estimation models. This information is confidential under the data sharing agreement. To date, metadata on date and location from all research group from Australia, New Zealand and Chile has already been received.

However, it is very important to make sure that re-sightings between years of identified whales are all included in the data submitted by each research group. In addition, it seems there may be some typographical errors when uploading the metadata to the SHBWC. Therefore, data need to be checked by each group before any abundance estimates can be carried out.

The process to check metadata is underway for Chile and New Zealand research groups. There have been some groups that confirmed data accuracy or their required modifications, and there are other groups that still need to double check or confirm that data are accurate.

MOU agreement
All research groups that contribute to the SHBWC have signed the SHBWC ToR and data sharing agreement prior to contributing their photo-ID catalogue. However, since the abundance estimates modelling work involves the disclosure of metadata to the principal researcher, Dr. Fewster, it will be necessary to develop an MOU for each region that would allow the datasets to be used for these purposes.

All New Zealand research groups have already signed an MoU and Chilean research groups are in the process of signing the respective MoU.

Photo-quality control
A photo quality control guide was developed for the SHBWC (Olson *et al*., 2021). Photo-IDs were evaluated based on angle (of the whale to the photographer), exposure (light), and focus. A photo-ID expert evaluated all the images. After completing each regional catalogue, all categories were double-checked to maximize standardization.

Photo-IDs are now categorized into four categories: 1=Excellent, 2=Good, 3=Fair, and 4=Poor. Excellent and Good categories comprise the best photo-IDs for mark-recapture analyses. Fair category includes images that could be useful to match whales but will require more time and will need further efforts by the analyst (like image editing). The Poor category includes images considered unacceptable for use in abundance estimates.

Photo-quality control has been completed for Chile and New Zealand catalogues. Photo-quality control of almost all Australia and ETP/Galapagos are completed, except for the newly contribute photo-IDs that have not yet being matched. About 80% of the photographs archived in the SHBWC are of Excellent and Good photo quality. Only 5% of the photos were considered of Poor quality and about 15% of Fair quality.

It is important to highlight that the SHBWC requests that only the best photo-ID of an individual is uploaded, so it is no surprise that the catalogue comprises 80% of high-quality photographs.

A summary of the status of different catalogues, including uploading of photo-IDs, matching and data management is shown in Table 2.

SOFTWARE IMPROVEMENTS

Over the years, improvements to the software have been continually identified and additional information integrated in order to fulfill the new IWC photo-ID catalogue guideline requirements (Olson *et al*. 2017) and the requirements of the Scientific Committee. Several improvements have already been implemented and others have been postponed in order to give priority to those needed for assessment purpose. Priority issues included migration to the IWC server and integration of a photo-quality control tool. Migration to the IWC server was completed in 2020. A new photo-quality control tool has also been integrated in the software and

reporting formats have been adapted to allow for photo-quality control filtered data (Galletti Vernazzani, *et al.* 2022).

The SHBWC software also includes a special report function that produces encounter histories of selected groups to be used for the purpose of abundance estimates. However, Dr. Fewster required a different reporting format that provides all the information contained in the database, for each side and photo-quality control category. To progress the intersessional work on abundance estimation, addressing this new requirement was identified as a high priority and the IT team focused on its implementation of the reporting system during 2022-2023. The function has now been developed, its performance testing completed, and it is already available and ready to use within the SHBWC online version.

It is expected that the next IT work focus on upgrading/re-writing the software language. Software upgrades have been postponed over the past few years as new urgent requirements have been prioritised for assessment purposes.

CONCLUSIONS AND NEXT STEPS

The matching process and photo-quality coding have been completed for New Zealand and Chile. Checking of metadata is underway and MoUs have been signed by most of these research groups contributing to these regional catalogues. Therefore, these data are almost ready to be used for abundance estimates.

New photo-ID data from Australia need to be compared with previous Australian datasets and photo-quality coded. Research groups from Australia will need to check and confirm the accuracy of their metadata and an MoU for this region will need to be developed and signed. After all these tasks are completed, the combined datasets for Australia will be ready to be used to model abundance estimates.

Abundance estimates will be generated using a combined datasets for each of these regions and multiple marks recapture models (i.e., using images from left and right sides of the whales, and the combination of both where available). Due to the high recaptures found on the Chilean combined datasets, this region will be used as a case study for the first trial of this new multi-mark recapture model. This analysis will be conducted intersessionally and presented at the next Scientific Committee meeting. After the modelling trials are conducted, the results are anticipated to be used to define relevant parameters, with the models potentially applied to the New Zealand dataset. Australia region will follow once the pending work is completed and the combined datasets are ready to be used. The potential effect on results from duplicated individuals, if this source of error is indeed significant, may be considered when modelling abundance estimates.

The dataset from Biosfere Foundation (BF) off Sri Lanka is being processed and analyzed to finish the catalogue reconciliation, and matching with other catalogues from the region are expected to be completed by 2024.

Consideration should be given to priorities in the short term to include commencement of comparisons between Timor-Leste and Australia catalogues, as well as progression of pending comparisons between catalogues from the ETP/Galapagos/Costa Rica Dome and Chile regions. Both areas likely have important connections that could have implications on abundances estimates for Chile and Australia and merit further investigation.

REFERENCES

Branch, T.A., Abubaker, E.M.N., Mkango, S. and Butterworth, D.S. 2007. Separating southern blue whale subspecies based on length frequencies of sexually mature females. *Mar. Mammal Sci.* 23(4): 803-33.

Buchan, S.J., Stafford, K. M. and Hucke-Gaete, R. 2015. Seasonal occurrence of southeast Pacific blue whale songs in southern Chile and the eastern tropical Pacific. *Marine Mammal Science,* 31(2): 440-458.

Douglas, A.B., Sears, R., Denkinger, J., Dobson, E., Olson, P., Gerrodette, T., Calambokidis, J. 2015. Movement of a blue whale (*Balaenoptera musculus*) between the Costa Rica Dome and the Galapagos: management implications of the first documented cross-equatorial movement. 21st Biennial Conference on the Biology of Marine Mammals, San Francisco, CA, USA, December 13-18, 2015.

Galletti Vernazzani, B. and Cabrera, E. 2011. Long term mark-recapture of blue whales in Chilean Waters. Paper SC/63/SH8 presented to the IWC Scientific Committee, June 2011 (unpublished). 10pp. [Available from the authors]

Galletti Vernazzani, B. and Olson, P. 2013. Progress on Southern Hemisphere Blue Whale Catalogue. Paper SC/65a/SH23 presented to the IWC Scientific Committee, June 2013 (unpublished). 5pp. [Available from the authors]

Galletti Vernazzani, B., Burton, C., Double, M., Gill, P., Jenner, C., Jenner, M., Olson, P. and Salgado-Kent, C. 2016. Comparisons among Southern Hemisphere Blue Whale Catalogue off Australia and New Zealand. Paper SC/66b/SH/27 presented to the IWC Scientific Committee, June 2016 (unpublished). 6pp. [Available from the IWC]

Galletti Vernazzani, B., Olson, P. and Salgado-Kent, C. 2019a. Progress report on Southern Hemisphere Blue Whale Catalogue: Period May 2018-April 2019. Paper SC/68a/SH/09 presented to the IWC Scientific Committee, May 2019 (unpublished). 6pp. [Available from the IWC]

Galletti Vernazzani, B., Attard, C.R.M., Barlow, D.R., Burton, C., de Vos, A., Double, M., Gill, P., Jenner, C., Jenner, M-N., Moller, L.M., Olson, P., Salgado-Kent, C. and Torres, L.G. 2019b. Southern Hemisphere Blue Whale Catalogue: preliminary results of IWC comparisons between Australia, New Zealand and Sri Lanka regions. Paper SC/68a/SH/04 presented to the IWC Scientific Committee, May 2019 (unpublished). 9pp. [Available from the IWC]

Galletti Vernazzani, B., Cabrera, E., Olson, P., Español-Jiménez, S., Toro, F., Perez-Alvarez, M.J., Pavez, G., Moraga, R., Cortés-Peña, D., Clegg, I.L.K, Häussermann, V. Findlay, K., Wright, S., and Brownell Jr., R.L. 2022. Blue whale photo-identifications reveal strong site fidelity to feeding areas from the Southeast Pacific and connectivity between southern Chile and Eastern Tropical Pacific. Paper SC/68d/SH/10 presented to the IWC Scientific Committee, May 2022 (unpublished). 12pp. [Available from the IWC]

Gendron, D. and A. Ugalde de la Cruz. 2012. A new classification method to simplify blue whale photo-identification technique. *J. Cetacean Res. Manage.* 12(1):79–84International Whaling Commission. 2009. Report of the Scientific Committee. 1-13 June 2008, Santiago, Chile. *J. Cetacean Res. Manage. 11* (Suppl.). 74pp. [Available from the IWC]

Hucke-Gaete, R. Luis Bedrinana-Romano, L., Viddi, F.A., Ruiz, J.E., Torrez-Florez, J.P. and Zerbini, A.N. 2018. From Chilean Patagonia to Galapagos, Ecuador: novel insights on blue whale migratory pathways along the Eastern South Pacific. *PeerJ* 6:e4695; DOI 10.7717/peerj.4695

International Whaling Commission. 2009. Report of the Scientific Committee. 1-13 June 2008, Santiago, Chile. *J. Cetacean Res. Manage.* 11 (Suppl.). 74pp. [Available from the IWC]

International Whaling Commission. (IWC). 2018. Report of the Scientific Committee. 09-21 May 2017, Bled, Slovenia. *J. Cetacean Res. Manage. 19* (Suppl.). 618pp. [Available from the IWC]

International Whaling Commission. (IWC). 2019. Report of the Scientific Committee. 10-23 May 2019 Nairobi, Kenya. 91pp. [Available from the IWC]

International Whaling Commission. (IWC). 2021. Report of the Virtual Meeting of the Scientific Committee. May 2021. [Available from the IWC]

International Whaling Commission. (IWC). 2022. Report of the Virtual Meeting of the Scientific Committee. May 2022. [Available from the IWC]

LeDuc, R.G., Dizon, A.E., Goto, M., Pastene, L.A., Kato, H., Nishiwaki, S., LeDuc, C. and Brownell Jr., R.L. 2007. Patterns of genetic variation in Southern Hemisphere blue whales and the use of assignment test to detect mixing on the feeding grounds. *J. Cetacean Res. Manage.* 9:73-80.

LeDuc, R. G., Archer, F. I., Lang, A. R., Martien, K. K., Hancock-Hanser, B., Torres-Florez, J. P., Hucke-Gaete, R., Rosenbaum, H. C., Van Waerebeek, K., Brownell, R. L. and Taylor, B. L. 2017. Genetic variation in blue whales in the eastern Pacific: implication for taxonomy and use of common wintering grounds. *Molecular Ecology* 26:740-751.

Leslie, M. S., Perkins-Taylor, C. M., Durban, J. W., Moore, M. J. and others. 2020. Body size data collected non-invasively from drone images indicate a morphologically distinct Chilean blue whale (*Balaenoptera musculus*) taxon. *Endangered Species Research* 43:291-304. https://doi.org/10.3354/esr01066

McDonald, M.A., Mesnick, S.L. and Hildebrand, J.A. 2006. Biogeographic characterisation of blue whale song worldwide: using song to identify populations. *J. Cetacean Res. Manage* 8:55-65.

Olson, P.A. and Cerchio, S. 2023. Photo-identification of Madagascar blue whales. Paper SC/69A/SH01 submitted to the IWC Scientific Committee, April 2023. [Available from IWC]

Olson, P.A., Jackson, J., Donovan, G. 2017. IWC guidelines for photo-identification catalogues. Paper SC/67a/PH05 submitted to the IWC Scientific Committee, May 2017. [Available from IWC]

Olson, P.A., Double, M.C., Matsuoka, K., Pastene, L., and Findlay, K. 2020. The Antarctic Blue Whale Catalogue: new data from 2015-2019. Paper SC/68b/PH04 presented to the IWC Scientific Committee, May 2020. [Available from IWC]

Olson, P.A., Galletti Vernazzani, B., and Torres Florez, J.P. 2021. SHBWC blue whale photo quality coding guide. Paper SC/68c/PH02 presented to the IWC Scientific Committee, May 2021. [Avalailable from IWC]

Pastene, L.A., Acevedo, J., and Branch, T.A. 2020. Morphometric analysis of Chilean blue whales and implications for their taxonomy. *Marine Mammal Science* 36:116-135.

Rice, D.W. 1998. Marine Mammals of the World: Systematics and Distribution, Special Publication Number 4, The Society for Marine Mammalogy. Allen Press, USA. ix+231pp

Sahri, A., Charlotte, J., Iqbal Herwata Putra, M., Murk, A.J., Andrews-Goff, V., Double, M.C., and van Lammeren, R.J. 2022. Telemetry-based home range and habitat modelling reveals that the majority of areas important for pygmy blue whales are currently unprotected. *Biological Conservation 272*. 109594. https://doi.org/10.1016/j.biocon.2022.109594

Sears, R., Williamson, J.M., Wenzel, F.W., Bérubé, M., Gendron, D. and Jones, P. 1990. Photographic identification of the blue whale (*Balaenoptera musculus*) in the Gulf of St. Lawrence, Canada. *Rep. int. Whal. Commn (special issue)* 12: 335-42.

Society for Marine Mammalogy.SMM. 2017. Committee on Taxonomy. List of marine mammal species and subspecies. www.marinemammalscience.org consulted on 25th April 2017

Thums, M., Luciana C. Ferreira, L.C., Jenner, C., Jenner, M., Harris, D., Davenport, A., Andrews-Goff, V., Double, M., Moller, L., Attard, C.R.M., Bilgmann, K., Thomson, P.G. and McCauley, R. 2022. Pygmy blue whale movement, distribution and important areas in the Eastern Indian Ocean. *Global Ecology and Conservation 35*. e02054. https://doi.org/10.1016/j.gecco.2022.e02054

Torres-Florez, J.P., Olson, P.A., Bedrinana-Romano, L., Rosenbaum, H.C., Ruiz, J., LeDuc, R., and Hucke-Gaete, R. 2015. First documented migratory destination for eastern South Pacific blue Whales. *Marine Mammal Science, 31*(4): 1580–1586

Torres-Florez, J.P., Ruiz, J., Hucke-Gaete, R. 2021. Reconciling a long-term photo-id database for blue whales in Chilean Patagonia. Paper SC/68C/PH05 presented to the IWC Scientific Committee, May 2021. [Available from IWC]

Table 1 – Summary of blue whale photographic collections and catalogues in the SHBWC as of March 2023

Region	Group	Fluke	Left Side	Right Side	Area
ETP-South America	SWFSC	0	64	54	Peru, Ecuador, ETP
	CRC	16	51	54	Costa Rica Dome
	WHET Lab	0	12	9	Galapagos
	CCC	0	469	484	Chile
	IWC Chile	0	14	9	Chile
	MERI	9	48	45	Chile
	CBA-UACH	0	151	140	Chile
	Eutropia	0	16	25	Chile
	Phantalassa	2	16	28	Chile
	Opportunistic Southeast Pacific	0	12	6	All
	Sub-total	**27**	**853**	**854**	
Sri Lanka-Australia-New Zealand-Coral Triangle	BWS	5	84	84	Australia
	WWR	0	30	23	Australia
	CWR	69	301	337	Australia
	FLINDERS	0	15	12	Australia
	AAD-Australia	0	35	36	Australia
	KWA	1	6	10	Australia
	Oceans Blueprint	0	4	4	Australia
	OSU	13	97	91	New Zealand
	AAD-NewZealand	0	12	11	New Zealand
	NIWA	1	7	2	New Zealand
	Opportunistic New Zealand	0	19	12	New Zealand
	UNTL	19	132	84	Timor-Leste
	APEX/Oceans Blueprint	0	0	0	Timor-Leste
	APEX	0	0	0	Indonesia
	Asha de Vos	0	89	79	Sri Lanka
	BF	0	0	0	Sri Lanka
	NARA	0	0	0	Sri Lanka
	Sub-total	**108**	**831**	**785**	
Southern Ocean	IWC SOWER	0	158	157	Antarctica
	MRI-SO	0	19	13	Antarctica
	AAD-Antarctica	0	83	94	Antarctica
	Opportunistic Southern Ocean	0	20	20	All
	KWA_SO	0	0	0	Antarctica
	Sub-total	**0**	**280**	**284**	
West and Central Indian Ocean	MRI-SA	0	0	0	South Africa, Madagascar
	Gardline	0	0	0	South Africa, Madagascar
	Opportunistic Madagascar	0	16	7	
	Sub-total	**0**	**16**	**7**	
	TOTAL	**135**	**1980**	**1930**	

Table 2 – Status of catalogue management and matching process, March 2023

Group	Area	Years	Uploaded Photo-ID	Uploaded Data (Date/Location)	Checked Data (Date/Location)	Matching Status
SWFSC	Peru, Ecuador, ETP	1992-2009	Yes	No	No	Completed
CRC	Costa Rica Dome	1999 and 2008/2009	Yes	Yes	No	No
WHET Lab	Galápagos	1993 and 2003/2004	Yes	Yes	No	No
CCC	Chile	2004-2015	Yes	Yes	Yes	Completed
IWC Chile	Chile	1997-1998	Yes	Yes	Yes	Completed
MERI	Chile	2014-2017	Yes	Yes	Yes	Completed
CBA-UACH	Chile	2003-2015	Yes	Yes	Yes	Completed
Eutropia	Chile	2006-2019	Yes	Yes	Yes	Completed
Phantalassa	Chile	2010-2019	Yes	Yes	No	Completed
Opportunistic Southeast Pacific	All	2010-2018	Yes	Yes	Yes	Completed
BWS	Australia	1998-2011	Yes	Yes	Yes	Completed
WWR	Australia	1999-2003	Yes	Yes	Yes	Completed
CWR	Australia	1996-2022	Yes	Yes	No	In progress 2023-2024
FLINDERS	Australia	2015	Yes	Yes	No	Completed
AAD-Australia	Australia	2012	Yes	Yes	No	Completed
KWA	Australia	2007-2018	Yes	Yes	No	In progress 2023-2024
Oceans Blueprint	Australia	2017-2018	Yes	Yes	No	In progress 2023-2024
OSU	New Zealand	2009-2017	Yes	Yes	In progress	Completed
AAD-NewZealand	New Zealand	2013 and 2015	Yes	Yes	Yes	Completed
NIWA	New Zealand	2018	Yes	Yes	No	Completed
Opportunistic New Zealand	New Zealand	2004-2018	Yes	Yes	Yes	Completed
UNTL	Timor-Leste	2014-2020	Yes	Yes	No	No
APEX/Oceans Blueprint	Timor-Leste	2018-2020	No	No	No	No
APEX	Indonesia	1999-2019	No	No	No	No
Asha de Vos	Sri Lanka	NA	Yes	No	No	In progress 2023-2024
BF	Sri Lanka	1983-1984 and 2010-2015	No	No	No	In progress 2023-2024
NARA	Sri Lanka	NA	No	No	No	No
IWC SOWER	Antarctica	1987-2009	Yes	No	No	Completed
MRI-SO	Antarctica	NA	Yes	No	No	Completed
AAD-Antarctica	Antarctica	2013-2019	Yes	Partially	No	Completed
Opportunistic Southern Ocean	Antarctica	2005-2020	Yes	Yes	No	Completed
KWA_SO	Antarctica	NA	No	No	No	No
MRI-SA	South Africa, Madagascar	NA	No	No	No	No
Gardline	South Africa, Madagascar	NA	No	No	No	No
Opportunistic Madagascar	South Africa, Madagascar	1996 and 2012	Yes	Yes	No	No

Annex 1 – List of Research Groups Names and Acronyms

Group	Acronym
NOAA Southwest Fisheries Science Center	SWFSC
Cascadia Research Collective	CRC
Whale Habitat, Ecology, and Telemetry Laboratory, Marine Mammal Institute, Oregon State University	WHET
Centro de Conservación Cetacea	CCC
Fundación MERI	MERI
Centro Ballena Azul, Universidad Austral de Chile	CBA-UACH
Centro de Investigación Eutropia	Eutropia
Phantalassa	Phantalassa
Blue Whale Study Inc.	BWS
Western Whale Research	WWR
Center for Whale Research Western Australia	CWR
Flinders University	FLINDERS
Australian Antarctic Division	AAD
Killer Whales Australia	KWA
Oceans Blueprint	Oceans Blueprint
Oregon State University, Marine Mammal Institute	OSU
National Institute of Water and Atmospheric research Ltd	NIWA
Asha de Vos	Asha de Vos
Biosphere Foundation	BF
National Aquatic Resources Research and Development Agency	NARA
Universidade Nacional Timor Lorosa'e	UNTL
APEX Environmental Pty	APEX
International Whaling Commission	IWC
Mammal Research Institute Whale Unit, University of Pretoria	MRI
Cardline	Cardline