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Annual Report of the Southern Ocean Research Partnership (IWC-SORP) 2022/23

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Annual Report of the Southern Ocean Research Partnership (IWC-SORP) 2022/23

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ABSTRACT

The Southern Ocean Research Partnership (IWC-SORP) is a multi-lateral, non-lethal scientific research programme established in 2009 to improve the coordinated and cooperative delivery of science to the IWC. There are 13 Partners: Argentina, Australia, Belgium, Brazil, Chile, France, Germany, Italy, Luxembourg, New Zealand, Norway, South Africa, and the United States. This paper reports on the continued progress of IWC-SORP and its seven Commission-endorsed research themes¹ in 2022/23. Progress includes publication of ca. 43 peer-reviewed scientific papers, bringing the total number produced since the start of the initiative to ca. 291. Moreover, >200 IWC-SORP related papers have been submitted to the Scientific Committee, >14 of them this year. IWC-SORP has directly contributed to at least 11 PhD, 8 Masters and 8 honours theses and the work of at least 5 postdoctoral fellows.

The COVID-19 pandemic disrupted all IWC-SORP projects but field and lab work have now resumed. Expeditions were conducted around the western Antarctic Peninsula, sub-Antarctic Marion Island and Prince Edwards Islands, the shelf waters from the South Orkney Islands/ Las islas Orcadas del Sur to the South Shetland Islands/ Las islas Shetland del Sur, the French Sub-Antarctic Territories, in the waters off South Africa, Western Australia, and around Península Valdés, Argentina. Southern right whale aerial surveys occurred in South Africa, Australia and Brazil. Images for photo-identification were collected; satellite tags deployed on killer whales, southern right and fin whales; biopsy samples collected from killer, southern right, fin and humpback whales; long-term acoustic moorings were deployed and hundreds of hours of cetacean acoustic recordings made and analysed.

KEYWORDS: SOUTHERN OCEAN RESEARCH PARTNERSHIP, IWC-SORP, ANTARCTICA, ABUNDANCE, ACOUSTICS, BIOPSY SAMPLING, PHOTO-IDENTIFICATION, SATELLITE TAGGING, MOVEMENT, CONNECTIVITY, RESEARCH VOYAGE, BLUE, KILLER, HUMPBAC, MINKE, SOUTHERN RIGHT, FIN, WHALE

INTRODUCTION

In 2008, the development of regional non-lethal cetacean research partnerships was proposed to the International Whaling Commission (IWC). These research partnerships would use modern, non-lethal, scientific methods to provide the information necessary to best conserve and manage cetacean species. The proposal was received very positively by IWC member nations. As a result, the Southern Ocean Research Partnership (IWC-SORP), a multi-lateral, non-lethal, scientific whale research program was established in March 2009 and has been supported by financial contributions from the Governments of Australia, the United States of America, Chile, the Netherlands, France, and the NGOs WWF-Australia and International Fund for Animal Welfare. The aim of IWC-SORP is to deliver coordinated and cooperative Southern Ocean science to the IWC. Partnership members include Argentina, Australia, Belgium, Brazil, Chile, France, Germany, Italy, Luxembourg, New Zealand, Norway, South Africa, the United States of America. IWC-SORP is an open Partnership that welcomes new members. Its ethos is one of open collaboration, communication and data sharing.

The objectives, research plan, and procedural framework for the Partnership were developed through a workshop held in Sydney, Australia in March, 2009. Subsequently, a framework and set of objectives for IWC-SORP were endorsed by the IWC at its Annual Meeting in June 2009. Project plans (SC/63/O13) were presented to the IWC in 2011 and 2012 and reports summarising the activities of IWC-SORP research themes have been presented annually to the Scientific Committee (SC/63/O12; SC/64/O13; SC/65a/O11; SC/65b/SH12; SC/66a/SH8; SC/66b/SH10; SC/67a/SH04; SC/67b/SH21; SC/68a/SH10; SC/68b/SH04; SC/68c/SH12; SC/68d/SH07; this paper).

This paper reports on the progress and results of the seven Commission endorsed research themes¹ since the last, virtual, annual meeting of the Scientific Committee in 2022. Further details of all seven IWC-SORP themes can be found at <https://iwc.int/sorp>.

IWC-SORP RESEARCH FUND

In 2022/23, no Calls for Proposals were opened. A single discretionary allocation of £3750 GBP was made from the IWC-SORP Research Fund. Details of allocations and project progress reports were presented previously in SC/68a/SH11, SC/68b/SH05, SC/68c/SH13, SC/68d/SH08 and are presented this year in SC/69a/SH0X.

At IWC68 in October 2022, a voluntary contribution to the IWC-SORP Research Fund of ca. £39,500 GBP (45,000 Euro) was made by the Belgian Government.

In April 2023, a donation of £140 GBP was made by Emma Abel of *abelmosaics*, UK. This donation represented 10% of the sale of a mosaic depicting an endangered blue whale:



A financial report of the IWC-SORP Research Fund is detailed in the IWC Research Fund Financial Report (SC/69a/O0X). Approximately, £60,734 GBP remain unassigned and unspent. This figure includes interest and bank fees.

IWC-SORP sincerely thanks the Governments of Australia, Belgium, France, the Netherlands, WWF-Australia, the International Fund Animal Welfare and Emma Abel for financial contributions to the IWC-SORP Research Fund.

VESSEL TIME

The following vessel time has been awarded to IWC-SORP researchers and either has taken place in the last reporting period or will when COVID-19 restrictions allow:

1. NSF-funded and opportunistic voyages to the Antarctic Peninsula – 2022/23 (Friedlaender, Pallin et al.)
2. Argentinean *ARA Almirante Irizar* voyage along Western Antarctic Peninsula – 24 February - 3 April 2023 (Iniguez et al.)
3. *RV Maria S. Merian* (*Rescheduled due to COVID-19*) to the shelf area from the South Orkney Islands/ Las islas Orcadas del Sur to the South Shetland Islands/ Las islas Shetland del Sur – 15 February- 17 March April 2023 (Herr et al.)
4. *RSV Nuyina* to the waters off Davis and Mawson Stations, 2023/24 (Kawaguchi, Double et al.)
5. NSF-funded and opportunistic voyages to the Antarctic Peninsula – 2023/24 (Friedlaender et al.)

¹There are currently seven IWC-SORP Themes (formerly referred to as Projects) covering 1) blue whales, 2) killer whales, 3) baleen whale foraging, 4) humpback connectivity, 5) blue and fin whale acoustics, 6) southern right whales and 7) fin whales.



IWC-SORP THEME 1 PROGRESS REPORT – 2022/23. Antarctic Blue Whale Project (ABWP)

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Introduction

About a third of a million Antarctic blue whales (*Balaenoptera musculus intermedia*) were taken during commercial whaling in the Southern Hemisphere. In 1964 the International Whaling Commission banned the hunting of blue whales, although some were still caught illegally until 1973. The Antarctic blue whale is currently classified as critically endangered by the International Union for Conservation of Nature (IUCN) and is of global interest as one of the most at-risk species of baleen whale in the Southern Ocean.

Currently our understanding of Antarctic blue whale ecology, behaviour and post-exploitation recovery is very poor. Only two abundance estimates for Antarctic blue whales (ABW) have been derived since 1964, each with low precision. The Antarctic Blue Whale Project is a coordinated, international research programme, focused on applying a multi-disciplinary approach to understand both the recovery of Antarctic blue whales and their important role in the Southern Ocean ecosystem through an investigation of their foraging ecology, distribution, movements and habitat preferences. These data will ultimately contribute toward a precise estimation of Antarctic blue whale circumpolar abundance and their rate of recovery.

Overall objectives

The objectives of the Antarctic Blue Whale Project are to:

- Identify the most appropriate and efficient method to deliver a new circumpolar abundance estimate of Antarctic blue whales;

- Develop and refine methods to improve survey efficiency;
- Deliver a new circumpolar Antarctic blue whale abundance estimate;
- Improve understanding of Antarctic blue whale population structure;
- Improve understanding of linkages between Antarctic blue whale breeding and feeding grounds;
- Characterise the behaviour of Antarctic blue whale on the feeding grounds.

Project activities in 2022/23

Due to the COVID-19 pandemic, work on the Antarctic Blue Whale Project has largely focused on analyses of data collected during previous IWC-SORP voyages, analyses of movements of Antarctic blue whales from recent and historic data, and photo-identification of whales from research datasets and platforms of opportunity.

ARA Almirante Irizar voyage 2023 - Habitat use, seasonality and population structure of baleen and toothed whales in the Scotia Sea and the western Antarctic Peninsula using visual and passive acoustic methods and genetics

Report pending post-voyage.

IWC-SORP and PIs of this project would like to thank the following persons and institutions: Ministry of Foreign Affairs of Argentina, Dirección Nacional del Antártico, Instituto Antártico Argentino, Dirección de Consejería Legal, COCOANTAR, Capitán de Navío Maximiliano Mangiaterra and crew of the icebreaker “ARA Almirante Irizar”, Dr. Antonio Curtosi, colleagues from Fundación Cethus, ECOPELAGOS/PROANTAR (Brazil), Centro Ballena Azul/ Universidad de Chile, Scripps Institution of Oceanography and Whale and Dolphin Conservation. This work was funded by the IWC/SORP funds, the Prince Albert II of Monaco Foundation and the Whale and Dolphin Conservation. This project is under the Programa Antártico Argentino / Plan Annual Antártico 2019 – 2020.

New Krill and Krill Ecosystems project

The Australian Antarctic Division has initiated a highly collaborative 10-year Krill and Krill Ecosystems research project to contribute to the sustainable and ecosystem-based management of the developing East Antarctic krill fishery, assess climate change impacts on the krill-based ecosystem, and establish a long term monitoring program for krill and krill predators (mesopelagic fish, seabirds, seals and cetaceans) in the Southern Ocean.

This ambitious project will involve:

- Krill and ecosystem surveys off East Antarctica to study krill dynamics and predator-krill interactions on *RSV Nuyina* and other research vessels.
- Collection of live krill for use in aquarium-based experiments.
- Mooring deployments to collect long-term data on krill and krill predator populations.
- Development and implementation of new technology and innovative methods to study krill and their predators: KOMBI, gliders, drones deployment systems, automated camera systems, Artificial Intelligence and Deep Learning
- Collection, analysis and dissemination of data: long-term acoustic datasets, active acoustics, telemetry, etc.

More details can be found in **SC/69a/SHXX**.

Photo-identification of Antarctic blue whales

Photo-identification of Antarctic blue whales was undertaken during the IWC-SORP ENRICH 2019 voyage, the 2015 and 2013 Antarctic Blue Whale Voyages, and during IWC IDCR/SOWER surveys. Photographs from these cruises, and from those collected from other sources, are compiled in the Antarctic Blue Whale Catalogue (e.g. Olson et al., 2016; Olson et al., 2020). Eight new IDs were added to the catalogue over the past year, bringing the total number of identified Antarctic blue whales in the catalogue up to 570. This represents 25% of the most recent population estimate of 2,280 (Branch, 2007). These photo-ID data are being used in a new capture-recapture estimate of abundance, presented to the Scientific Committee during the SC/69a meeting. These data are also being used, in combination with Discovery tag data, in an investigation of inter- and intra-



annual movement patterns of Antarctic blue whales (e.g. Olson et al., 2022). Intra-seasonal photo-ID recapture data from the IWC-SORP voyages in 2019, 2015 and 2013 were also used in an analysis of movement patterns of Antarctic blue whales during the summer feeding season (Calderan et al., 2023).

One of the research objectives of the IWC-SORP ENRICH voyage was to collect identification photos of Antarctic blue whales at a number sufficient toward estimating abundance using mark-recapture methods. Obtaining a current estimate of abundance is considered fundamental for the assessment of the status of the Antarctic blue whale population and in monitoring its recovery (SC/68D/SH07Rev).

During 2022/2023, 8 new whale IDs (6 left sides, 4 right sides) were added to the Antarctic Blue Whale Catalogue from photographs collected opportunistically by naturalists aboard tourist vessels in the Southern Ocean. The current total number of identified blue whales in the catalogue is 570, represented by 427 left side and 417 right side photographs. Data from the Antarctic Blue Whale Catalogue are being used in a capture-recapture estimate of abundance, presented to the Scientific Committee during the SC/69A meeting. The data are also being used, in combination with Discovery tag data, in an investigation of intra- and inter-annual movement patterns of Antarctic blue whales.

ABWP-related IWC-SORP Research Fund projects

Work continued to conduct a long-term, circumpolar comparison of call-densities of Antarctic blue and fin whales (Project 17, SC/69a/SHXX); infer the demographic history of blue and fin whales in the Antarctic using mitogenomic sequences generated from historical baleen (Project 18, SC/69a/SHXX); to develop statistical and technical methods to support the use of long-range UAVs to assess and monitor cetacean populations in the Southern Ocean (Project 21, SC/69a/SHXX), to investigate the use of remote aerial deployment and sampling as a new sampling platform for large cetaceans (Project 26, SC/69a/SHXX) and provide insights into Antarctic blue whale population structure and movements from photo-identification, Discovery marks and satellite tags (Project 28, SC/69a/SHXX).

Platforms of opportunity

Partnerships with tourist ships, fishing vessels and naval vessels are essential for augmenting data for the circumpolar estimation of Antarctic blue whale abundance and other IWC-SORP projects. The COVID-19 pandemic has reduced such opportunities but it is anticipated that the use of platforms of opportunity by IWC-SORP researchers will increase again in coming years, once international travel resumes.

Project outputs

Peer-reviewed papers

- Andrews-Goff V, Bell EM, Miller BS, Wotherspoon SJ, Double MC (2022) Satellite tag derived data from two Antarctic blue whales (*Balaenoptera musculus intermedia*) tagged in the east Antarctic sector of the Southern Ocean. Biodiversity Data Journal 10: e94228. <https://doi.org/10.3897/BDJ.10.e94228>
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<https://doi.org/10.1029/2020GB006921>

Smith AJR, Nelson T, Ratnarajah L, Genovese C, Westwood K, Holmes TM, Corkill M, Townsend AT, Bell E, Nicol S, Wuttig K, Lannuzel D (*Submitted*) Identifying potential sources of iron-binding ligands in coastal Antarctic environments and the wider Southern Ocean. *Frontiers Special issue: Metal-Organic Interactions in Seawater under Changing Anthropogenic and Climate Conditions*.

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IWC papers

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Branch TA, Monnahan CC (2020) Sex ratios in blue whales from conception onward: a comparative analysis across space, time, and size. IWC paper SC/68b/SH01. 24 pp.

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Branch TA, Monnahan CC, Širović A, Al Harthi S, Allison C, Balcazar NE, Barlow DR, Calderan S, Cerchio S, Double MC, Dréo R, Gavrilov AN, Gedamke J, Hodge KB, Jenner KCS, Leroy EC, McCauley RD, Miksis-Olds JL, Miller BS, Panicker D, Rogers T, Royer J-Y, Samaran F, Shabangu FW, Stafford KM, Thomisch K, Torres LG, Torterotot M, Tripovich JS, Warren VE, Willson A, Willson MS (2021) Monthly movements and historical catches of pygmy blue whale populations inferred from song detections. IWC paper SC/68c/SH/17

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Olson PA, Kinzey D, Double MC, Matsuoka K, Findlay K (2023) Capture-recapture estimates of abundance of Antarctic blue whales. IWC paper SC/69a/SHXX.

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Melcón M, Reyes Reyes V, Iñíguez M (2017) Bioacoustic techniques applied to odontocete conservation and management in Argentina. In: M. Rossi-Santos and C. Finkl (eds.) *Advances in Marine Research in Latin America: Technological Innovation in Ecology and Conservation*, pp.149-167. doi:10.1007/978-3-319-56985-7_6

Reports

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Hevia M, Marino A, Reyes Reyes, V. *Informe preliminar de actividades realizadas durante la navegación en el guardacostas GC-189 "Prefecto García.* Report presented to the Argentinean Coastguard.

Marino A, Albalat A, Bedriñana-Romano L. *Informe de actividades realizadas en el marco del Consorcio para la Investigación del Océano Austral perteneciente a la Comisión Ballenera Internacional (IWC-SORP).* Report presented to Dirección Nacional del Antártico in Argentina.

Marino A, Valse NV, Genoves R, Hevia M (2020) *Informe de actividades realizadas en el marco del Consorcio para la Investigación del Océano Austral perteneciente a la Comisión Ballenera Internacional (IWC-SORP) Enero – febrero 2020.*

Smith JN (2019) *ENRICH voyage Unmanned Aerial Vehicle (UAV) Data analysis report.* Report to the Australian Marine Mammal Centre, Australian Antarctic Division, 10 pp.

Students and theses

Douglas C (2017) *Investigation of blue whale (*Balaenoptera musculus intermedia*) diving behaviour in a patchy krill (*Euphausia superba*) landscape.* Honours Thesis, University of St Andrews, Scotland, United Kingdom.

Conference presentations

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- Širović A, Wood M, Warren JD, Stafford KM, Miller BS (2019) Mesoscale dynamics of blue and fin whales and Antarctic krill off East Antarctica. World Marine Mammal Science Conference. Barcelona, Spain, 9-12 December 2019 (Presentation).
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- Thomisch K, Boebel O, Clark CW (2013) Spatio-temporal patterns of Antarctic blue whale (*Balaenoptera musculus intermedia*) vocal behaviour in the Weddell Sea. Oral presentation at the Biennial Conference on Marine Mammals, Dunedin, New Zealand, 9-13 December 2013.

Posters

- Andrews-Goff V, Olson PA, Gales NJ, Zerbini AN, Double MC (2013) Movements of satellite tagged Antarctic blue whales. Poster presented at the Biennial Conference on Marine Mammals, Dunedin, New Zealand, 9-13 December 2013.
- Reyes Reyes MV, Hevia M, Zuazquita E, Trickey J, Iñíguez Bessega M (2014) Encounter rates of mysticetes in Antarctic waters of the Scotia Sea and western Antarctic Peninsula: preliminary results. Poster presentation to the XVI Conference on Specialists on Aquatic Mammals from South America and 10th SOLAMAC Congress, December 2014, Cartagena de Indias, Colombia.
- Trickey JS, Baumann-Pickering S, Hildebrand JA, Reyes Reyes MV, Melcón M, Iñíguez MA (2015) Echolocation signals of an Antarctic beaked whale. Poster presentation to the Southern California Marine Mammal Conference, January, Newport Beach, United States.
- Trickey JS, Baumann-Pickering S, Hildebrand JA, Reyes Reyes MV, Melcón M, Iñíguez MA (2015) Diversity and occurrence of beaked whale echolocation signals in the Southern Ocean. Poster presentation to the 21st Biennial Conference on the Biology of Marine Mammals. 13-18 December, San Francisco, United States.
- Trickey JS, Baumann-Pickering S, Hildebrand JA, Reyes MV, Melcón M, Iñíguez M (2017) Beaked whale acoustic presence at three recording sites in the South Shetland Islands/Islands Shetland del Sur. 22nd Biennial Conference on the Biology of Marine Mammals. Halifax, Nova Scotia, Canada, October 2017.

Popular talks

- Branch TA. *A glimmer of hope for Antarctic blue whales: the largest of them all*. Monterey Bay chapter of the American Cetacean Society, December 2020.
- Branch TA. *Sex ratios in blue whales from conception onward: effects of space, time, and body size*. Marine Mammal Science Editors' Select Series, January 2021.
- Branch TA. *A glimmer of hope for Antarctic blue whales*. San Diego chapter of American Cetacean Society, 9 June 2021.
- Branch TA. *How many and where were they? The value of sightings and other data in assessing status of marine mammals*. Virtual gear-down workshop for marine naturalists, The Whale Museum, 13 November 2021.
- Branch TA. *Blue whales: in crisis or increases?* Bevan Series: Living with Marine Mammals, School of Aquatic and Fishery Sciences, 6 January 2022.



Popular articles

Cahalan S (2013) Protecting the icons of the deep. International Innovation: Environment April 2013.

Cahalan S (2013) Out of the Blue. Island, Issue 133.

Pyper W (2012) Listening to the blues. Australian Antarctic Magazine, Issue 23.

Pyper W (2013) Songs reveal elusive giants. Australian Antarctic Magazine, Issue 24.

Fundación Cethus' blogs:

<https://cethusnews.wordpress.com/2013/05/03/fundacion-cethus-in-antarctica/>

<https://cethusnews.wordpress.com/2013/04/24/new-sorp-meeting/>

Media

<https://www.antarctica.gov.au/news/2021/hide-and-seek-with-giants/>

<https://www.abc.net.au/news/2021-05-12/studying-dugongs-with-drones/100122416>

Argentinean Navy's newspaper:

<http://gacetamarinera.com.ar/el-trabajo-de-los-investigadores-a-bordo-del-irizar/>

<https://gacetamarinera.com.ar/el-rompehielos-traslado-equipo-cientifico-y-personal-que-lo-opera-hasta-belgrano-ii/>

<https://gacetamarinera.com.ar/el-irizar-arribo-a-ushuaia/> (includes video images of staff working)

<https://gacetamarinera.com.ar/finalizo-la-segunda-etapa-de-la-campana-antartica-de-verano-2/> (includes video images of staff working)

<https://gacetamarinera.com.ar/cientificos-a-bordo-del-irizar/>

<https://www.facebook.com/FundacionCethus/> post from 28/02/2020

The successful 2015 Joint New Zealand-Australia Antarctic Ecosystems Voyage attracted considerable media attention. The voyage webpage including voyage sitreps and news items can be found here:

<http://www.antarctica.gov.au/science/southern-ocean-ecosystems-environmental-change-and-conservation/wildlife-conservation/new-zealand-australia-antarctic-ecosystems-voyage-2015>

and

<http://www.niwa.co.nz/antarctic-ecosystems-voyage>

ABWP scientists conducted a feature interview on the ABC Radio programme Off Track AMMC's Antarctic blue whale research and Antarctic blue whale song:

<http://www.abc.net.au/radionational/programs/offtrack/the-biggest-underwater-choir-in-the-world/6914940>

and

<http://www.abc.net.au/radionational/programs/offtrack/antarctic-blue-whale-song-worlds-biggest-choir/6919222>

The ABWP was represented at the sold-out panel discussion, Discovering the Deep, at the World Science Festival in Brisbane, Australia:

<http://www.worldsciencefestival.com.au/program/events/discovering-the-deep/>

Antarctic Circumnavigation Expedition (ACE):

<http://www.antarctica.gov.au/news/2016/australian-scientists-to-join-international-colleagues-for-antarctic-circumnavigation-voyage>

and

<http://www.businessinsider.com.au/the-first-circumnavigation-of-antarctica-to-study-whales-and-ocean-plastics-2016-4>

Social media

Science outreach: the PI uses social media (Twitter, @bluewhalenews) extensively to post about his research on blue whales, and other blue whale papers published each month. On average this activity amounted to 20 tweets per month, and over the course of the project so far (May 2019-present) these tweets have been viewed 936,000 times.

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IWC-SORP THEME 2 PROGRESS REPORT – 2022/23. Distribution, relative abundance, migration patterns and foraging ecology of three ecotypes of killer whales in the Southern Ocean

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Introduction

Five different ecotypes of killer whales have been described in Antarctic waters, any or all of which could eventually be recognized as separate species. Killer whales are large apex predators that are commonly found in Antarctic waters; although relatively little is known about the distribution, abundance, habitat and prey preferences of each of the different ecotypes, cumulatively they are expected to play a key role in the Antarctic marine ecosystem. This Theme is investigating the ecosystem impact the different ecotypes of killer whales that occur in Antarctic and adjacent waters, by focusing on their systematic relationships, abundance, demographics, distribution, movement patterns, health, and prey preferences.

Progress and results for 2022/23

Giancarlo Lauriano and Simone Panigada, Terra Nova Bay, Ross Sea, Antarctica

Introduction

Knowledge on the distribution, foraging habits and the abundance of Type B (both pack ice and Gerlache) and Type C (Ross Sea) killer whale ecotypes in the Antarctic is scant. Moreover, information on the species seasonal distribution and occurrence, as well as its and residency patterns in the region, are lacking. The impact of killer whales on the ecosystem depends on their movements, abundance, diet and prey requirements. A decrease in the prevalence of Type C individuals has been inferred following the depletion of Antarctic toothfish, *Dissostichus mawsoni*, as one of the main prey; this would force the species to compete more directly with other top predators.

Objectives

Assess the dynamics and role of killer whales in the highly local productive marine ecosystem of Terra Nova Bay, through the understanding of their fine and large scale movements (satellite tagging), prey-related distribution (photo-ID and behavioural sampling), dietary preferences (fatty acids and stable isotopes), toxicological status, and to estimate their abundance (mark recapture).

Results

No fieldwork was conducted during the 2022/23 austral summer.

Outlook for the future

Funding is sought to continue this work.

Luciano Dalla Rosa, West Antarctic Peninsula and Powell Basin.

Introduction

Luciano Dalla Rosa and colleagues (*Projeto Baleias*, Brazilian Antarctic Program) have been conducting cetacean research around the Antarctic Peninsula since 1997. Research on killer whales has included line transect surveys to investigate distribution and relative abundance, photo-identification, acoustics, and biopsy sampling for genetics, contaminant and stable isotope analyses.

Objectives

The specific objectives include investigating killer whale distribution and relative abundance around the Antarctic Peninsula; investigating the species-habitat relationships, and their acoustics; biopsy sampling for genetics, contaminant and stable isotope analyses; photo-identification. In addition, ongoing cetacean satellite tagging efforts, which have focused on fin whales, may opportunistically include killer whales depending on ecotype and area.

Results

No fieldwork was conducted in 2022/23.

Outlook for the future

Long term cetacean research is expected to continue in the northern Antarctic Peninsula. Additional funding and ship time is sought for future seasons.

P.J.N. (Nico) de Bruyn and Ryan R. Reisinger, Marion Island, sub-Antarctic

Introduction

Killer whales (*Orcinus orca*) are alpha predators which can exert significant top-down influences on marine ecosystems (e.g., Reisinger et al. 2011b). However, their influence on ecosystems is modulated by their movement patterns, diet and abundance, since these determine the structure and dynamics of their trophic linkages with other species. Given killer whales' high mobility (e.g., Reisinger et al. 2015) and dietary flexibility (reviewed in de Bruyn et al. 2013), these factors become even more important in determining what impacts killer whales may have.

However, there is a significant gap in our understanding of the structure, movement and distribution of killer whale populations in the Subantarctic and how their movements, dietary specialization and phylogenetics interact as drivers or consequences of the observed population structure. Of particular interest is any ecotype divergence or convergence in response to environmental conditions, which could address the proximate mechanisms responsible for ecotype dynamics in this species.

The Prince Edward Islands, Crozet Islands and South African coastal waters provide a regional system with environmental similarities and contrasts that will allow us to test hypotheses about the mechanisms that determine population structure in the context of environment and ecology. This is facilitated by long-term photographic identification studies (Guinet et al. 2015, Reisinger et al. 2017), which provide socio-demographic context (e.g., Reisinger et al. 2015, 2016, 2017, Tixier et al. 2015, 2017) together with existing telemetry (Reisinger et al. 2015) and genetic data (Moura et al. 2014a, b; A.R. Hoelzel, unpubl. data).

Objectives

- To provide sufficient integrative data on ecology (through stable isotope, photo-identification and telemetry data), population history and connectivity (through genetic analyses) to test alternative hypotheses about the evolutionary mechanisms that determine population structure and dynamics in this region. The relatively high diversity found off South Africa in contrast to lower levels at the Prince Edward Islands and the Crozet Islands permits a key hypothesis to be tested about the relative importance of long-term demographic stability and population mixing.
- To consider the transferable inference from these data in the context of extensive data on the ecology and population genetics of killer whales elsewhere in the world. While regional systems differ (e.g. strong natal fidelity in the piscivorous ecotype in the North Pacific, not seen to the same extent elsewhere), we don't yet understand if the key drivers are associated with resource use or ancestry or some other combination of factors.
- Provide data with direct relevance to the conservation and management of regional killer whale populations through the provision of data on their distribution, population connectivity and evolutionary diversity (including diversity at functional loci).

Results

Detailed results from 2022/23 work are provided in the IWC-SORP Research Fund: 2023 progress reports from funded projects, Project 22 (SC/69a/SHXX).

Conclusions

Analysis of photographic identification data from the subantarctic are providing updated information on demographic parameters, social structure and population connectivity. Analyses of data from South Africa are yielding novel longitudinal data on individuals in this region. Genetic results will soon give insights into the comparative ecology of killer whale populations in the southern Atlantic and Indian Oceans.

Challenges

In the past year it has again been challenging to deploy satellite tags in South African waters and no additional biopsy samples were collected. A more dedicated effort, which is more feasible now that travel restrictions have eased, is required to tag killer whales, since the responsive mode we have used to date has been unsuccessful for tagging.

Outlook for the future

Biopsy sampling and satellite tagging of killer whales in South African waters remains challenging – a more dedicated effort will be attempted when additional funding is secured through other sources.

At Crozet, the long-term photo-identification monitoring of killer whales will continue from the fishing vessels (conducted by fishery observers) and from Possession Island (conducted by fieldworkers). In addition, field activities including biopsy sampling, satellite tag deployment and behavioural tests will be conducted through dedicated trips on both fishing vessels and Possession Island in 2023 as part of a new project funded by the French Agence Nationale de la Recherche (ANR) for 2022-2025. This funding includes a PhD project that started in 2022 (the candidate is co-supervised by Tixier at MARBEC and by Guinet at CEBC). It aims at investigating behavioural heterogeneity across killer whale individuals and social groups of the Crozet population in regard to interactions with fisheries and its effects on the demography of the population. Concomitantly, biopsy sampling on killer whales of Saint Paul and Amsterdam islands will be attempted in 2023-2024 from a fishing vessel.

Tixier will spend a month in South Africa in 2023 to facilitate data sharing and build/strengthen the collaborative work on killer whale throughout the southwest Indian Ocean, with Elwen, de Bruyn and Reisinger. This includes the goal of a PhD student starting in 2024.



The funds for the purchase of SPLASH10-292B tags and to assist with travel and fieldwork expenses were awarded from the IWC-SORP Research Fund (Project 22: SC/67b/SH18; SC/68a/SH11; SC/68b/SH05; SC/68c/SH13; SC/68d/SH08; SC/69a/SHXX).

Project outputs

Students and theses

Rowan Jordaan completed his PhD at the University of Pretoria (lead supervisor: de Bruyn): Jordaan RK (2021) *The demography and sociality of killer whales Orcinus orca at subantarctic Marion Island*. PhD thesis. University of Pretoria, Pretoria.

A third-year project student under Reisinger's supervision at the University of Southampton is analysing killer whale movements in relation to fishing activity in the region.

Peer-reviewed Papers

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IWC-SORP THEME 3 PROGRESS REPORT – 2022/23. Foraging ecology and predator-prey interactions between baleen whales and krill: a multi-scale comparative study across Antarctic regions

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Executive summary

Since its inception, IWC-SORP has created unique opportunities for international collaboration and the development of a robust long-term ecological research program to study baleen whales around the Antarctic and understand how they are impacted by changes in their environment, and specifically how they are affected by the availability of their main prey (Antarctic krill). Over time, this theme has grown and supported a large number of science partnerships, student opportunities, and scientific publications aimed at developing more precautionary and appropriate conservation strategies to ensure the health of baleen whales and the entire marine ecosystem in the Antarctic.

Introduction

Recent technological advances in the miniaturisation of sensors have allowed for the development of tags that can measure, in fine detail, the underwater movement patterns and behaviours of marine mammals. Likewise, satellite-linked telemetry and analytical tools have advanced to allow for greater understanding of how the broad scale movement patterns and behaviours of marine mammals links to changes in the physical and biological seascape. Understanding both fine and broad scale behaviour of baleen whales in Antarctic waters is critical to understanding the ecological role of cetaceans and how these are being affected by climate-driven changes to their environment. Combined with traditional oceanographic sampling and remote sensing tools we can now link the movements, behaviour, ecology, and life history of marine mammals to their changing environment across a range of spatio-temporal scales.

Objectives

The objectives of our research program are to use technological advances in animal biotelemetry to elucidate the behaviour and ecological role of cetaceans in the nearshore waters around the Antarctic Peninsula and to relate these to climate-driven changes that are currently occurring.

Results

Below are summaries of some of the major research findings that have occurred under this theme in 2022/23. As our research expands among species and questions, there is more and more interdisciplinary and cross-cutting work that helps us understand how the relationship between whales and their prey leads to changes in behaviour, ecology, physiology, reproduction, migration, and conservation.

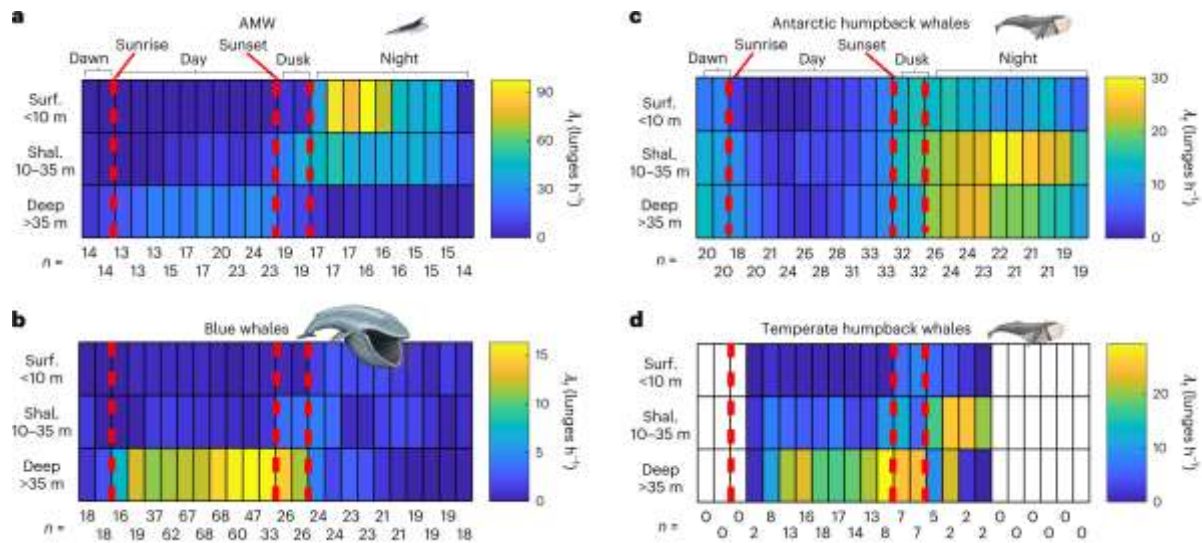


Figure 1 Differences in the diel foraging patterns of Antarctic minke and humpback whales (along with blue and humpback whales from other regions) to show how diel migration patterns of krill and changes in patch composition affect the timing, frequency, and depth of foraging (From Cade et al. 2022).

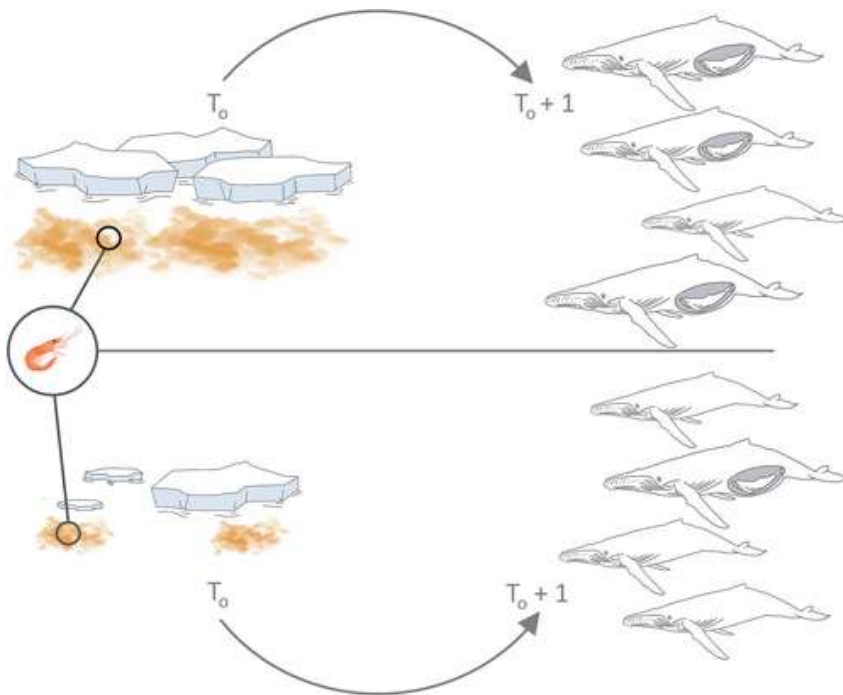


Figure 2 An illustration of a generalized linear model relating interannual variation in humpback whale pregnancy rates with winter sea ice and krill recruitment the previous year. We show that in years with low ice cover and poor krill recruitment significantly decreased pregnancy rates in whales the following year (From Pallin et al. 2022).

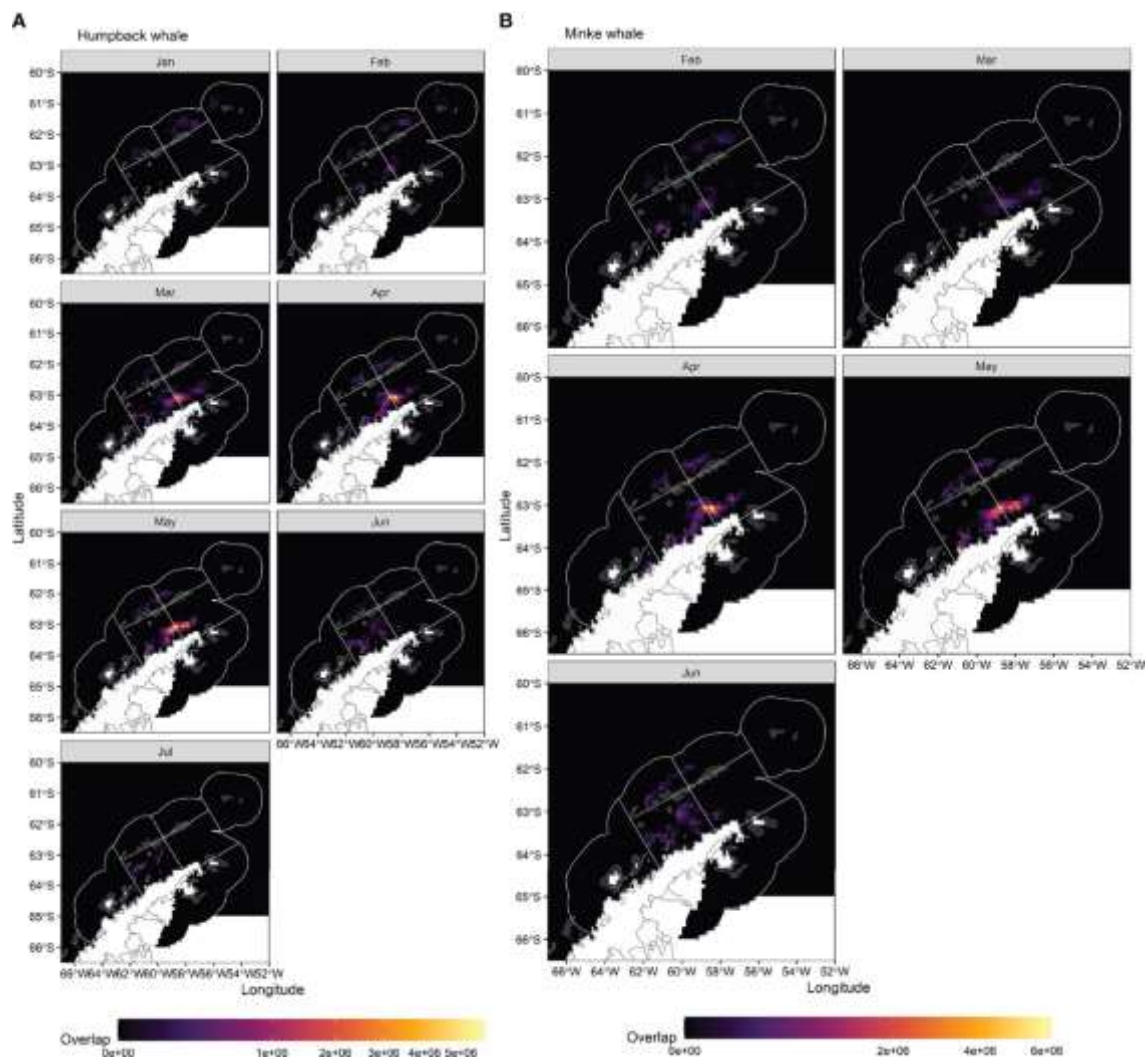


Figure 3 The amount of spatio-temporal overlap between the krill fishery and the distribution of Antarctic minke and humpback whales in CCAMLR Management Sub-Area 48.1. This figure is critical and compelling in that it is able to show how the amount and location of overlap between foraging whales and krill fisheries increases throughout the summer into winter (From Reisinger et al. 2022).

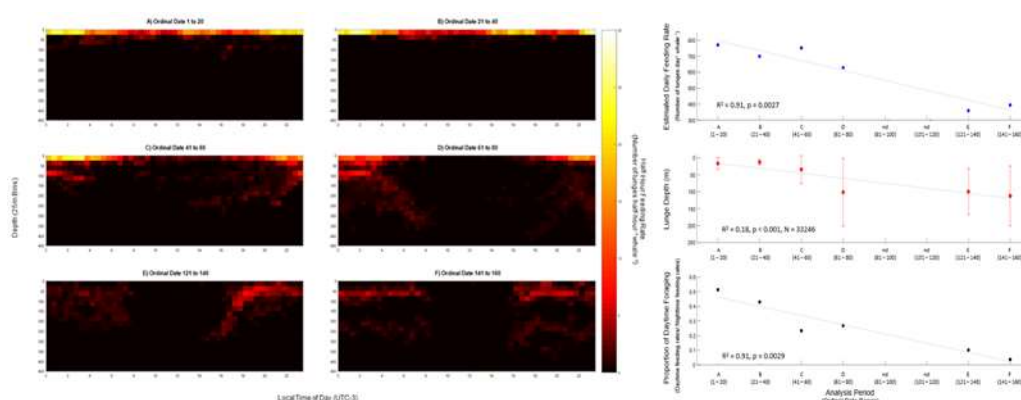


Figure 4 Frequency of foraging by humpback whales relative to depth and time of day throughout the foraging season from January to June (left). A clear trend from nearly continuous surface feeding to extreme diurnal patterns is demonstrated. On the right, the daily foraging rates are plotted, showing a significant decrease throughout the feeding season (From Nichols et al. 2022).



Challenges

The main challenges that we have all faced as a society related to the global pandemic significantly affected our science, communication, field work, funding, and output. Moving forward we are working hard to find the necessary resources to continue this critical work and move towards new species for which data is very sparse, like fin whales.

Outlook for the future

It is my opinion that this has been an incredibly successful program and research theme that has been mutually beneficial to the main research groups as well as the IWC and IWC-SORP. In the future, the challenges that I foresee are gaining the necessary logistic support for field research that is required to continue the outstanding trajectory of this work. More and more, ship time is becoming difficult to secure through National Science programs and there is a growing reliance on alternative platforms and private vessels to support dedicated work. There is also a continued need to support student participation in this project as well as the non-trivial support required for field equipment like tags. I am encouraged at how well we have managed to leverage IWC-SORP funding in the past and hope to be able to continue this effort moving forward. I am committed to this project and continuing to pursue our scientific and conservation goals.

Project outputs

Students and theses

Students who were supported by or worked directly on projects for this IWC-SORP theme include: Logan Pallin, Ross Nichols, Michelle Modest, Kevin Beirlich, David Cade, Emily Nazario, Jake Linsky, Emma Levy, Max Czapanskiy, Shirel Kahane-Rapport, Ryan Reisinger, Trevor Joyce, Sara Wiendorf, William Oestreich, and Will Gough.

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Weinstein B, Johnston D, Double M, Friedlaender AS (2017) Identifying overlap between humpback whale foraging grounds and the Antarctic krill fishery. *Biological Conservation* 210: 184-191. <http://dx.doi.org/10.1016/j.biocon.2017.04.014>

Students and theses

Logan Pallin. Using tissue biomarkers to better understand the population demography and recovery of historically extirpated baleen whales in a rapidly changing ecosystem. PhD Thesis ongoing. NSF Graduate Research Fellow, Bio-Telemetry & Behavioral Ecology Laboratory, Department of Ecology and Evolutionary Biology, University of California, Santa Cruz.

Conference presentations

Albertson GR, Friedlaender AS, Steel DJ, Nowacek DP, Read AJ, Johnston DP, Poole MM, Cypriano-Souza AL, Bonatto SL, Engel MH, Caballero S, Garrigue C, Constantine R, Robbins J, Flórez-González L, Olavarria C, Tagarino A, Ward J, Baker CS (2015) Mixed-stock analysis and genetic identification of humpback whales (*Megaptera novaeangliae*) in the nearshore waters of western Antarctic Peninsula. 2015 Biennial Conference on Marine Mammals, 13-18 December, San Francisco, United States.

Curtice C, Friedlaender A, Johnston D, Halpin PN, Gales N, Ducklow H (2013) Spatially and temporally dynamic humpback feeding areas in Antarctica. Oral presentation at the Symposium on Animal Movement and the Environment, 5-7 May 2014, North Carolina Museum of Natural Sciences in Raleigh, North Carolina. United States.

Durban JW, Pitman RL, Friedlaender AS (2013) Out of Antarctica: Dive data support 'physiological maintenance migration' in Antarctic killer whales. Oral presentation at the 2013 Biennial Conference on Marine Mammals, Dunedin, New Zealand.

Friedlaender AS (2014) Seeing below the surface: using tag technology and visualisation tools to understand the underwater behaviour of whales. American Cetacean Society.

Friedlander AS (2016) Understanding the foraging ecology of baleen whales around the Antarctic Peninsula. American Cetacean Society.

Friedlaender AS (2016) I have no idea if I'm doing this right, but I've been a marine mammal scientist for 20 years now. (2016) Student Chapter of the Society for Marine Mammalogy.

Friedlaender, AS. (2017) New methods for marine mammal research. UC Santa Cruz Invited Lecture.

Friedlaender AS (2017) Spatio-temporal patterns of baleen whale foraging ecology around the Antarctic Peninsula. Polar Marine Science Gordon Research Conference.

Friedlaender AS, Heaslip S, Johnston DW, Read AJ, Nowacek DP, Durban JW, Pitman RL, Pallin L, Gales N (2014) Using animal movement models to compare the foraging ecology of humpback and Antarctic minke whales around the Antarctic Peninsula. XXXIII SCAR Open Science Conference, 1-3 September 2014, Auckland, New Zealand.

Friedlaender AS, Goldbogen J, Nowacek D, Read A, Tyson R, Bowers M, Johnston D, Gales N (2013) Breaking the ice: the foraging behaviour and kinematic patterns of Antarctic minke whales. Oral presentation at the 2013 Biennial Conference on Marine Mammals, Dunedin, New Zealand.

Friedlaender AS, Heaslip S, Johnston D, Read A, Nowacek D, Durban JW, Pitman RL, Pallin L, Gales N (2015)



Using animal movement models to compare the foraging ecology of humpback and Antarctic minke whales around the Antarctic Peninsula. 2015 Biennial Conference on Marine Mammals, 13-18 December, San Francisco, United States.

Friedlaender AS, Andrews-Goff V, Double MC, Johnston D (2015) Does rapid warming and diminished sea ice cover around the Antarctic Peninsula promote over-wintering of humpback whales on a feeding ground? 2015 Biennial Conference on Marine Mammals, 13-18 December, San Francisco, United States.

Friedlaender et al. (2016) The dawn of cetacean research in the Palmer LTER. NSF Palmer LTER Annual Meeting.

Friedlaender et al. (2017) The dawn of cetacean research in the Palmer LTER. South Pacific Whale Research Consortium.

Heaslip SG, Johnston DW, Curtice C, Gales NJ, Friedlaender AS (2015) Distribution and relative density estimates of humpback whales (*Megaptera novaeangliae*) for the Western Antarctic Peninsula derived from satellite-based location data using a Markov chain approach. 2015 Biennial Conference on Marine Mammals, 13-18 December, San Francisco, United States.

Narazaki T, Isojunno S, Nowacek DP, Swift R, Friedlaender AS, Ramp C, Smout S, Aoki K, Sato K, Miller PJO (2015) Body density of feeding aggregations of humpback whales (*Megaptera novaeangliae*) in Antarctica and the Gulf of St Lawrence estimated from hydrodynamic gliding performances. 2015 Biennial Conference on Marine Mammals, 13-18 December, San Francisco, United States.

Pallin L, Johnston DW, Nowacek DP, Read AJ, Robbins J, Friedlaender AS (2014) Progesterone Levels of Humpback Whales Along the Western Antarctic Peninsula. XXXIII SCAR Open Science Conference, 1-3 September 2014, Auckland, New Zealand.

Pallin L, Johnston DW, Nowacek DP, Read AJ, Robbins J, Friedlaender AS (2015) Progesterone Levels of Humpback Whales Along the Western Antarctic Peninsula. 2015 Biennial Conference on Marine Mammals, 13-18 December, San Francisco, United States.

Logan J, Pallin, C. Scott Baker, Debbie Steel, David W. Johnston, Doug P. Nowacek, Andrew J. Read, Nick Kellar, Megan Cimino, Ari S. Friedlaender. (2019) Ecological drivers of reproductive rates in humpback whales (*Megaptera novaeangliae*) along the Western Antarctic Peninsula. 2019 World Marine Mammal Conference, 13-17 December, Barcelona, Spain (Oral).

Weinstein B, Friedlaender AS (2016) Considering whales as emergent oceanographic processes around the Antarctic Peninsula. NSF Palmer LTER Annual Meeting.

Social Media

Blog Stats

Direct links to our most popular blog posts:

[Steady Hands](#)

[Welcome to Minke City](#)

[Tagging Days](#)

The full blog can be accessed here: medium.com/in-search-of-minkes

It currently features eight published posts, and will continue to be updated with new content for the remainder of the trip, and periodically over the next year.

Since the beginning of the trip, the blog has received over 1,500 views.

Twitter

The main accounts generating original tweets from our content are:

@MarineUAS

@Goldbogenlab

@mlparkermedia



So far, over 100 tweets have been posted about the trip. Here are a few examples of our most impactful tweets/content:

On Feb 28, @MarineUAS posted [this tweet including an aerial photo of humpback whales](#), which generated 38 retweets and 137 likes.

On March 1, @Goldbogenlab posted [this tweet showing video of tagging a minke whale](#) which generated 98 retweets, over 220 likes, and over 5,000 views of the video.

On March 7, @mlparkermedia posted [this tweet highlighting a blog post about our field work](#), which generated 20 retweets, 61 likes, and 275 views of the blog.

@AntarcticReport (which has over 17,500 followers) has also tweeted some of our content.

On March 8, they [tweeted our photo](#) which generated 35 retweets and 87 likes.

On March 6, they [tweeted our photo](#) which generated 30 retweets and 88 likes.

It should also be noted that @MarineUAS won the #Tech4Wildlife challenge hosted by @WILDLABSNET by [posting about our work in Antarctica](#).

Instagram

The main accounts generating original Instagram posts using our content are:

@insearchhofminkes

@emmahattonlevy

@mlparkermedia

@marine_uas

The official [Instagram account](#) for the research group helps drive traffic to our blog site. The account currently has 150 followers and gains new followers each day. One of [our most recent photos](#) (of a tagged minke whale) received 50 likes. So far, the [#insearchhofminkes](#) hashtag has 85 posts. The most popular post received 186 likes and 17 comments.

Media

National Geographic Channel Documentary Series: *Continent 7*

Antarctic Edge: 70° South

- Best in Festival, Princeton Environmental Film Festival 2015
- <https://beyondtheice.rutgers.edu/>
- <http://news.1ternet.edu/Article3233.html>

BBC: *Ocean Giants*

World's Biggest Beasts, National Geographic Channel/Smithsonian Networks.

Selected recent media coverage relating to whale research in Antarctica

<http://www.wwf.org.au/news/blogs/the-wonderful-world-of-working-with-whales>

<http://www.bbc.com/news/world-us-canada-39633489>

<https://www.facebook.com/bbcnews/posts/10154595310467217>

<http://www.wwf.org.au/news/news/2017/whale-eye-view-of-antarctica>

<http://www.msn.com/en-au/news/watch/breathtaking-images-from-whale%E2%80%99s-point-of-view/vi-BBzDwSD?ocid=st>

<https://www.youtube.com/watch?v=us9RGKaOOVI>

<http://www.themercury.com.au/news/tasmania/underwater-cameras-capture-whale-of-a-time-off-antarctic-peninsula/news-story/37f376677bca4ee01b24f732358ac17a>

<https://au.news.yahoo.com/a/34998763/watch-incredible-footage-of-what-life-is-like-as-a-whale/#page1>

<https://www.rte.ie/news/2017/0411/866858-whales/>

<https://www.facebook.com/wwfaustralia/videos/10156028685408712/>

<http://news.sky.com/story/tiny-cameras-monitor-humpback-whale-feeding-habits-in-antarctic-10833509>

<https://phys.org/news/2017-04-whale-cams-reveal-secret-antarctic.html>

<http://a.msn.com/01/en-au/BBzDwSD?ocid=st>

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<http://www.wwf.org.au/news/news/2017/whale-eye-view-of-antarctica>
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<https://www.youtube.com/watch?v=us9RGKaOQVI>
<http://www.themercury.com.au/news/tasmania/underwater-cameras-capture-whale-of-a-time-off-antarctic-peninsula/news-story/37f376677bca4ee01b24f732358ac17a>
<https://au.news.yahoo.com/a/34998763/watch-incredible-footage-of-what-life-is-like-as-a-whale/#page1>
<https://www.rte.ie/news/2017/0411/866858-whales/>
<https://www.facebook.com/wwfaustralia/videos/10156028685408712/>
<http://news.sky.com/story/tiny-cameras-monitor-humpback-whale-feeding-habits-in-antarctic-10833509>
<https://phys.org/news/2017-04-whale-cams-reveal-secret-antarctic.html>
<http://a.msn.com/01/en-au/BBzDwSD?ocid=st>
<http://www.eglobaltravelmedia.com.au/antarctic-scientific-whale-research-reaches-new-heights-during-popular-expedition-cruise/>

Antarctic minke whale diving behaviour

<http://news.nationalgeographic.com/news/2014/08/140813-minke-whale-feeding-antarctica-animals-ocean-science/>
<http://news.sciencemag.org/biology/2014/08/minke-whales-extreme-feeding-habits-observed-first-time>
<http://www.abc.net.au/news/2014-08-15/scientists-spy-on-antarctic-minke-whales-eating-habits/5673620>
<http://discovermagazine.com/2014/julyaug/5-frolicking-with-the-whales>
<http://news.stanford.edu/news/2014/august/minke-whales-feeding-081414.html>
<http://www.japantimes.co.jp/news/2014/08/16/world/science-health-world/minke-whales-feeding-frenzy-observed/>
<http://www.futurity.org/whales-size-evolution-feeding-748022/>
<http://www.redorbit.com/news/science/1113213553/minke-whale-feeding-behaviour-081514/>
<http://www.redorbit.com/news/science/1113213553/minke-whale-feeding-behaviour-081514/>
<http://theconversation.com/minke-whales-discovered-to-skim-below-sea-ice-to-feed-30522>
<http://www.businessinsider.com.au/incredible-video-shows-researchers-chasing-and-tagging-minke-whales-in-the-antarctic-2014-8>
<http://phenomena.nationalgeographic.com/2014/08/13/little-giant-whales-take-100-gulps-an-hour/>
<http://www.delhidailynews.com/news/Tags-reveal-feeding-habits-of-Minkes-1408163342/>
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http://thenewage.co.za/135002-1021-53-Study_reveals_Antarctic_minke_whales_feeding_frenzy
<http://technology.iafrica.com/news/954852.html>
http://www.sciencecodex.com/minke_whales_lunge_100_timeshour_to_feed_under_sea_ice-139539
<http://nicholas.duke.edu/news/minke-whales-lunge-100-times-hour-feed-under-sea-ice>
<http://www.antarctica.gov.au/news/2014/krill-on-the-menu-for-antarctic-minke-whales-lunge-diet>
<http://news.stanford.edu/news/2014/august/minke-whales-feeding-081414.html?view=print>
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<http://www.dailynewsen.com/science/minke-whales-lunge-100-times-per-hour-to-feed-under-sea-ice-h2548665.html>

Antarctic minke whale acoustics

<http://www.livescience.com/45033-mystery-of-ocean-duck-sound-revealed.html>
<http://www.abc.net.au/science/articles/2014/04/23/3989875.htm>
<https://www.sciencenews.org/article/submariners-bio-duck-probably-whale>
<http://www.bbc.com/news/science-environment-27117669>
<http://news.sciencemag.org/biology/2014/04/scienceshot-mystery-quacking-caller-antarctic-solved?rss=1>
<http://www.independent.co.uk/news/science/50year-mystery-of-the-ocean-quack-finally-solved-by-scientists-9277824.html>
<http://www.zeit.de/wissen/umwelt/2014-04/antarktis-zwergwal-geraeusch-walfang>



SC/69a/SH0X

http://www.fisheries.noaa.gov/podcasts/2014/04/minke_whales.html#.U1e9kqYUC-4
<http://news.discovery.com/earth/oceans/mysterious-underwater-sounds-that-have-stumped-scientists-140423.htm>
<http://phys.org/news/2014-04-mysterious-bio-duck-southern-ocean-minke.html>
http://www.huffingtonpost.com/2014/04/23/bio-duck-sound-antarctic-minke-whales_n_5198053.html
<http://www.csmonitor.com/Science/2014/0423/Scientists-unravel-mystery-of-bizarre-bio-duck-sound>
<http://newswatch.nationalgeographic.com/2014/04/23/whales-animals-sounds-bioduck-science-antarctica/>
<http://www.theguardian.com/environment/2014/apr/23/whales-ocean-quacking-sound?commentpage=1>

Interviews or news on Antarctic research and climate change:

<http://www.cbc.ca/quirks/episode/2011/04/30/april-30-2011/>
<http://www.plumtv.com/videos/vail-work-ari-friedlander>
<http://www.youtube.com/watch?v=8le3BPiZJoY>
<http://www.sciencedaily.com/releases/2011/04/110427171503.htm>
<http://news.sciencemag.org/sciencenow/2011/04/biggest-ever-assemblage-of-whale.html>



IWC-SORP THEME 4 PROGRESS REPORT – 2022/23. What is the distribution and extent of mixing of Southern Hemisphere humpback whale populations around Antarctica? Phase 1: East Australia and Oceania

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15. Marine Mammal Institute, Oregon State University, Hatfield Marine Science Center, 2030 SE Marine Science Dr, Newport, Oregon 97365, USA
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17. Department of Environmental Affairs, Branch Oceans and Coasts, Victoria & Alfred Waterfront, Cape Town, South Africa

*denotes Theme Leader

Executive summary

The objectives of the Theme for Oceania have been met. There is now an opportunity for the humpback whale connectivity research to move to another ocean basin. The circum-polar analysis of tag data establishes a platform upon which we can use changes in Southern Ocean productivity to understand the future mixing of stocks and movements of whales. The large, collaborative partnerships formed, alongside well established regional collaborations in other regions, mean that there is a bright future for data sharing and open access arrangements to inform management of humpback whales into the future. The future of this Theme will be discussed at the annual meeting of the IWC-SORP Scientific Steering Committee in the margins of IWC/SC69a (2023). The results from the now completed project, *Circum-polar analysis of foraging behaviour of humpback whales in Antarctica* (IWC-SORP Project 16) are summarised in **SC/69a/SHXX**.

IWC-SORP gratefully acknowledges the South Pacific Whale Research Consortium (SPWRC) for their substantial and collaborative contribution to this project.

Project outputs

Students and theses

Leena Riekola, University of Auckland. PhD Thesis.

University of Southampton, under supervision of Reisinger:

2022-2023 academic year:

Amanda Madrigano Furlani (third year independent project)

2023-2024 academic year:

Joseph Simons (MSci independent project)

Freya Burleigh (MSci independent project)

Peer-reviewed papers

Andrews-Goff V, Bestley S, Gales NJ, Laverick SM, Paton D, Polanowski AM, Schmitt NT, Double MC (2018) Humpback whale migrations to Antarctic summer foraging grounds through the southwest Pacific Ocean. *Scientific Reports* 8:12333.

Caballero S, Steel D, Pallin L, Botero-Acosta N, Felix F, Olavarria C, Diazgranados MC, Bessudo S, Friedlander A, Baker CS (2021) Migratory connections among breeding grounds off the Eastern Pacific and feeding areas in the Antarctic Peninsula based on genotype matching. *Bulletin of Marine and Coastal Research-Invemar* 50: 31-40.

Constantine R, Jackson JA, Steel D, Baker CS, Brooks L, Burns D, Clapham P, Hauser N, Madon B, Mattila D, Oremus M, Poole M, Robbins J, Thompson K, Garrigue C (2012) Abundance of humpback whales in Oceania using photo-identification and microsatellite genotyping. *Marine Ecology Progress Series* 453:249-261.

Constantine R, Steel D, Allen J, Anderson M, Andrews O, Baker CS, Beeman P, Burns D, Charrassin J-B, Childerhouse S, Double M, Ensor P, Franklin T, Franklin W, Gales N, Garrigue C, Gibbs N, Harrison P, Hauser N, Hutsel A, Jenner C, Jenner M-N, Kaufman G, Macie A, Mattila D, Olavarria C, Oosterman A, Paton D, Poole M, Robbins J, Schmitt N, Stevick P, Tagarino A, Thompson K and Ward J (2014) Remote Antarctic feeding grounds important for east Australia humpback whales. *Marine Biology* 161: 1087-1093.

Gales N, Double M, Robinson S, Jenner C, Jenner M, King E, Gedamke J, Paton D, Raymond, B. (2009) Satellite tracking of southbound East Australian humpback whales (*Megaptera novaeangliae*): challenging the feast or famine model for migrating whales. Paper SC/61/SH17 presented to the IWC Scientific Committee 2009.

Garland EC, Gedamke J, Rekdahl ML, Noad MJ, Garrigue C, Gales N (2013) Humpback Whale Song on the Southern Ocean Feeding Grounds: Implications for Cultural Transmission. *PLoS One* 8:e79422

Garrigue C, Constantine R, Poole M, Hauser N, Clapham P, Donoghue M, Russell K, Paton, Mattila DK, Robbins J, Baker CS (2011) Movement of individual humpback whales between wintering grounds of Oceania (South Pacific), 1999 to 2004. *Journal of Cetacean Research and Management (Special Issue)* 3:275-281.

Garrigue C, Derville S, Bonneville C, Baker CS, Cheeseman T, Millet L, Paton D, Steel D (2020) Searching for humpback whales in a historical whaling hotspot of the Coral Sea, South Pacific. *Endangered Species Research* 42: 67-82. DOI: <https://doi.org/10.3354/esr01038>

Garrigue C, Peltier H, Ridoux V, Franklin T, Charrassin J-B (2010) CETA: a new cetacean observation program in East Antarctica. Paper SC/62/SH3 presented to the IWC Scientific Committee 2010.

- Garrigue C, Petier H, Chambellant M, Dodemont R, Perard V, Ridoux V, Charrassin JB (2014) An update of the CETA project: cetacean observation program in East Antarctica 2010-2014. SC65b/SH5.
- Garrigue C, Zerbini AN, Geyer Y, Heide-Jørgensen M-P, Hanaoka W, Clapham P. (2010) Movements of satellite-monitored humpback whales from New Caledonia. *Journal of Mammalogy* 9:109-115.
- Garrigue C, Clapham PJ, Geyer Y, Kennedy AS, Zerbini AN (2015) Satellite tracking reveals novel migratory patterns and the importance of seamounts for endangered South Pacific humpback whales. *Royal Society open Science*, 2 150489; doi: 10.1098/rsos.150489.
- Garrigue C, Derville S, Bonneville C. (2018). Searching for humpback whales two centuries post-whaling: what is left in the Chesterfield-Bellona archipelago? Paper SC/67b/SH17 presented to the IWC Scientific Committee 2018.
- Hauser N, Zerbini AN, Geyer Y, Heide-Jørgensen M-P, Clapham P (2010) Movements of satellite-monitored humpback whales, *Megaptera novaeangliae*, from the Cook Islands. *Marine Mammal Science* 26:679-685.
- Horton TW, Holdaway RN, Zerbini AN, Hauser N, Garrigue C, Andriolo A, Clapham PJ (2011) Straight as an arrow: humpback whales swim constant course tracks during long-distance migration. *Biology Letters*. doi:10.1098/rsbl.2011.0279
- Lindsay RE, Constantine R, Robbins J, Hauser N, Mattila DK, Tagarino A, Dennis TE (2016) Characterising essential breeding habitat for whales informs the development of large-scale Marine Protected Areas in the South Pacific. *Marine Ecology Progress Series* 448: 263-275.
- Reisinger RR, Friedlaender AS, Zerbini A, Palacios D, Andrews-Goff V, Dalla Rosa L, Double M, Findlay K, Garrigue C, How J, Jenner C, Jenner M-N, Mate B, Rosenbaum H, Seakamela SM, Constantine R (2021) Combining Regional Habitat Selection Models for Large-Scale Prediction: Circumpolar Habitat Selection of Southern Ocean Humpback Whales. *Remote Sensing* 13:2074. DOI: 10.3390/rs13112074
- Reisinger RR, Zerbini A, Friedlaender AS, Andrews-Goff V, Dalla Rosa L, Double M, Findlay K, Garrigue C, How J, Jenner C, Jenner M-N, Mate B, Palacios D, Rosenbaum H, Seakamela SM, Constantine R (*Under revision*) A circumpolar analysis of habitat-use variation among humpback whales in the Southern Ocean.
- Riekkola L, Zerbini AN, Andrews O, Andrews-Goff V, Baker CS, Chandler D, Childerhouse S, Clapham P, Dodemont R, Donnelly D, Fiedlaender A, Gallego R, Garrigue C, Ivashchenko Y, Jarman S, Lindsay R, Pallin L, Robbins J, Steel D, Tremlett J, Vindenes S, Constantine R. (2018) Application of a multi-disciplinary approach to reveal population structure and Southern Ocean feeding grounds of humpback whales. *Ecological Indicators* 89: 455-465.
- Riekkola L, Andrews-Goff V, Friedlaender A, Constantine R, Zerbini AN. (2019) Environmental drivers of humpback whale foraging behaviour in the remote Southern Ocean. *Journal of Experimental Marine Biology and Ecology* 517: 1-12. <https://doi.org/10.1016/j.jembe.2019.05.008>
- Robbins J, Dalla Rossa L, Allen JM, Matilla DK, Secchi ER, Friedlaender AS, Stevick PT, Nowacek DP (2011) Mammalian migration record: implications for the recovery of an endangered species. *Endangered Species Research* 13:117-121.
- Schmitt NT, Double MC, Jarman SN, Gales N, Marthick JR, Polanowski AM, Baker CS, Steel D, Jenner KC, Jenner M-N, Gales R, Paton D, Peakall R (2014) Low levels of genetic differentiation characterize Australian humpback whale (*Megaptera novaeangliae*) populations. *Marine Mammal Science* 30(1): 221–241. doi: 10.1111/mms.12045
- Steel D et al. (2011) Initial genotype matching of humpback whales from the 2010 Australia/New Zealand Antarctic Whale Expedition (Area V) to Australia and the South Pacific. Paper SC/63/SH10 presented to the IWC Scientific Committee 2011.

Steel, D., Anderson, M., Garrigue, C., Olavarria, C., Caballero, S., Childerhouse, S., et al. (2018). Migratory interchange of humpback whales (*Megaptera novaeangliae*) among breeding grounds of Oceania and connections to Antarctic feeding areas based on genotype matching. *Polar Biology*, doi.org/10.1007/s00300-017-2226-9.

Steel, D., Gibbs, N., Carroll, E., Childerhouse, S., Olavarria, C., Baker, C.S., Constantine, R. (2014). Genetic identity of humpback whales migrating past New Zealand. Paper SC/65b/SH07 presented to the IWC Scientific Committee 2014.

Popular articles

Reisinger RR, Friedlaender AS, Palacios DM (2022) Whale migrations: how new UN treaty aims to protect species on the high seas. *The Conversation*. <https://theconversation.com/whale-migrations-how-new-un-treaty-aims-to-protect-species-on-the-high-seas-178805>

Conference presentations

Constantine R, Friedlaender A, Reisinger R, Andrews-Goff V, Cerchio S, Collins T, Dalla Rosa L, Diazgranados MC, Double M, Findlay K, Garrigue C, Jackson J, Jenner C, Jenner M-N, Rosenbaum H, Seakamela M, Zerbini A (2019) Circum-polar analysis of Southern Ocean humpback whales. World Marine Mammal Conference, 13-17 December, Barcelona, Spain (Oral).

Logan J, Pallin, C, Scott Baker, Debbie Steel, David W. Johnston, Doug P. Nowacek, Andrew J. Read, Nick Kellar, Megan Cimino, Ari S. Friedlaender. (2019) Ecological drivers of reproductive rates in humpback whales (*Megaptera novaeangliae*) along the Western Antarctic Peninsula. 2019 World Marine Mammal Conference, 13-17 December, Barcelona, Spain (Oral).

Riekkola et al. (2018) New Zealand Marine Sciences Society Conference, Wellington, New Zealand, July 2018 (Oral).

Riekkola et al. (2017) New Zealand Marine Sciences Society Conference, Christchurch, New Zealand, July 2017 (Oral).

Riekkola et al. (2017) Australasian Society the Study of Animal Behaviour Conference, Katoomba, NSW, Australia, July 2016 (Oral; **Best student presentation award**).

Riekkola et al. (2017) Poster presented at the Biologging Conference, Lake Constance, Germany, October 2017.

Schmitt N, Double M, Baker S, Gales N, Childerhouse S, Polanowski A, Steel D, Albertson R, Olavarria C, Garrigue C, Poole M, Hauser N, Constantine R, Paton D, Jenner C, Jarman S, Charrassin J-B, Peakall R (2013) Mixed-stock analysis of humpback whales (*Megaptera novaeangliae*) on Antarctic feeding grounds. IWC-SORP special session at the Biennial Conference on Marine Mammals, Dunedin, New Zealand, 9-13 December 2013 (Oral).

Steel D, Carroll E, Constantine R, Anderson M, Childerhouse S, Garrigue C, Double M, Gibbs N, Hauser N, Olavarria C, Poole MM, Robbins J, Schmitt N, Tagarino A, Ward J, Baker S (2013) Genetic identity of humpback whales migrating past New Zealand. IWC-SORP special session at the Biennial Conference on Marine Mammals, Dunedin, New Zealand, 9-13 December 2013 (Oral).

Meeting presentations

An update on samples and preliminary results of migratory interchange was presented to regional collaborators at the 2019 meeting of the South Pacific Whale Research Consortium, 4-6 February, Auckland, New Zealand.

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IWC-SORP THEME 5 PROGRESS REPORT – 2022/23. Acoustic trends in abundance, distribution, and seasonal presence of Antarctic blue whales and fin whales in the Southern Ocean

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Executive summary

The main focus of the Acoustic Trends Working Group (ATWG) is to use passive acoustics to monitor and discover trends in Antarctic blue and fin whales. The ATWG has continued to make progress this year and we report here project updates specific to 2022/23. The group has conducted 3 main intersessional meetings and regular sub-meetings to progress specific projects. In 2022/23, group members contributed 7 papers, including in-prep, and in-press manuscripts. In 2022/23, group members deployed instrumentation at three long-term recording sites. The ATWG's continued work to improve detection algorithms, develop a data analysis framework, continue long-term data collection, and other work of the group is progressing the ATWG's ability to use passive acoustics to monitor trends in Antarctic blue and fin whales throughout the Southern Hemisphere.

Introduction

The Acoustic Trends Project and Acoustic Trends Working Group (ATWG) was one of the original five IWC-SORP projects that commenced in 2009. The focus of this project has been to use passive acoustics to monitor and discover trends in Antarctic blue and fin whales. Blue and fin whales are well-suited to passive acoustic studies because they frequently make distinctive, loud, low-frequency sounds that can be detected over large distances. Since conception, group members have built capacity for passive acoustics through supervision of at least 8 students, 1 postdoctoral researcher and development of novel analytical methods, and expansion of data collection efforts.

Objectives

The group's overarching objective/mission statement remains to 'address key knowledge gaps for Antarctic blue whales and southern hemisphere fin whales using passive acoustics'. The ATWG has identified four key knowledge gaps: 1) Distribution & occupancy; 2) Population structure; 3) Animal behaviour; 4) Abundance & density estimation.

Related to these knowledge gaps, the ATWG objectives fall into four output streams: generation of biological/ecological knowledge; development of methods and protocols; collection of data; and building capacity & strategic links for future work.

Results

Generation of knowledge

Analysis of frequency and temporal characteristics of fin whale 20-Hz and Antarctic blue whale song calls in the Southern Ocean recorded off Elephant Island, and the Weddell Sea has been extended by a PhD student Svenja Woehle at the AWI (Ilse Van Opzeeland & AWI Ocean Acoustics Team) and University of Oldenburg starting

late 2022 to expand analyses to the full AWI Weddell Sea data set (spanning 21 positions and 10 years of recordings) to explore geographical distribution of two fin whale populations across the Weddell Sea and (possible) spatio-temporal overlaps in their acoustic occurrence.

PhD student Meghan Aulich, in collaboration with ATWG members Miller & Samaran amongst others outside the ATWG, is finalising her thesis on, *Acoustic ecology of fin whales in Australian and Antarctic waters*. A manuscript on the seasonal distribution of fin whales in Australian and East Antarctic waters was published in 2022 in *Frontiers in Marine Science*. The datasets in this work span years 2002-2019 latitudes from 65-19°S and longitudes from 70°E -180° and include nearly 900,000 verified detections of fin whale 20 Hz pulses. Antarctic detections rates varied strongly by site with (central Indian sector) site South Kerguelen Plateau having the highest detection rates, and (eastern Indian sector) site Casey having the fewest detections. After investigation of Antarctic and Australian detections, Aulich et al. (2022) hypothesize that there are potentially two acoustic populations of fin whales that use Antarctic waters, with each migrating along different coasts of Australia. A second manuscript by Aulich et al. on diel patterns in detection of fin whale 20 Hz pulses has recently been accepted. Further manuscripts are under preparation and nearly ready for submission, the topics being: environmental drivers of fin whale detections in the Antarctic; and long-term trends in fin whale acoustic presence from Comprehensive Nuclear Test Ban Treaty Organization (CTBTO) data from Cape Leeuwin. All of these papers have been submitted to IWC-SC69a as a single 'ForInfo' package (SC/69a/ForInfo AA,BB, CC, DD).

A manuscript was submitted to *Diversity & Distributions* focusing (El-Gabbas et al., submitted) on the spatiotemporal distribution of Antarctic blue whales in the Weddell Sea, using presence-only dynamic species distribution models (SDMs), using visual sightings and passive acoustic monitoring (PAM) detections in independent models. The results demonstrate the potential of PAM data to predict year-round marine mammal habitat suitability at large spatial scales. Furthermore, visual and PAM data prove complementary, as indicated by a low spatial overlap between daily predictions and the low predictability of each model at detections of the other data type.

Method development

Standardised Framework

Dr Franciele Castro, a post-doctoral scholar supervised by Buchan, Harris, and Miller has successfully completed her project under the IWC- SORP grant entitled, *A standardised analytical framework for robustly detecting trends in passive acoustic data: A long-term, circumpolar comparison of call-densities of Antarctic blue and fin whales*. Her work tackled some of the long-standing shortcomings inherent in nearly all prior passive acoustic studies of ABW and fin whales, namely the challenges presented by incredibly variable noise levels and sound propagation that affect detectability of the blue and fin whale sounds and ultimately call density estimation. This work is now being finalised for publication (Castro et al., in prep). The final draft has been submitted to SC/69a as a ForInfo paper (SC/69a/ForInfoXX). A natural extension to this project would be to expand the framework to more sites and years across the Southern Ocean.

Improved detectors

Several group members have participated in projects with a goal of delivering improvements to detection algorithms. These include improvements to traditional or established signal processing techniques, and the implementation of newer machine learning algorithms.

Miller et al. (2022) published a paper in *Remote Sensing in Ecology and Conservation* that included a new method for comparing detector performance and a new detector for blue whale D-calls. This method allows for direct comparison of any number of human analysts and/or automated algorithms without relying on the assumption that detections from any one detector comprises an absolute ground truth. This involves having an expert judge determine whether the detections from the independent detectors are true or false positives, and then using double observer (mark-recapture) methods to estimate the total number of true positive detections in the dataset. In this study they also introduced a new Deep Learning detector for blue whale D-calls trained on Southern Hemisphere D-calls from the IWC-SORP Annotated Library of Blue and Fin Whale Sounds. The double observer analysis revealed that the new Deep Learning detector performed better than the manual analyst on the test dataset, which was recorded off East Antarctica. Taken together, these methods offer a path forward



to address problem of ‘floating ground-truth’ of manual annotations, and the rising number of machine learning algorithms that can perform at the same level or better than humans.

Schall (AWI Ocean Acoustics Team) and Parcerisas (2022) presented and compared robust algorithms for the automatic detection of fin whale choruses and pulses which yield good performance results (i.e., false positive rates < 3% and true positive rates > 76%) when applied to real-world passive acoustic datasets characterised by vast amounts of data, with only a small proportion of the data containing the target sounds, and diverse soundscapes from the Southern Ocean.

Maximising the use of existing and new monitoring technologies

The ATWG is interested in maximising the use of opportunistic and existing monitoring technologies. The Comprehensive Nuclear Test Ban Treaty Organization International Monitoring System (CTBTO IMS) and Ocean Bottom Seismometers (OBS) also detect blue and fin whales and are a great potential source of opportunistic monitoring data (e.g., Harris et al., 2013; Dréo et al., 2019). ATWG members are actively engaged in continuing research into the use of CTBTO IMS and OBS for monitoring blue and fin whales. For example, the project CORTADO: Combining global OBS and CTBTO recordings to estimate abundance and density of fin and blue whales (PI. Danielle Harris, co-funded by the US Navy’s Office of Naval Research and Living Marine Resources Program) is running until 2025.

Data collection in 2022/23

Antarctic data collection (>60°S)/Southern Ocean Hydrophone Network: specific 2022/23 updates

The Australian Antarctic Division recovered three AAD moored acoustic recorders in 2022 and deployed two replacement units at long-term recording sites, South Kerguelen Plateau and Casey.

The Alfred Wegener Institute Antarctic deployed 17 instruments (14 SonoVaults and 3 Aurals) in the Weddell Sea in early 2022. The HAFOS network of hydrophones has been expanded over the years since 2008. In February 2022, the coastal permanent acoustic observing station PALAOA stopped recording when the ice shelf tip on which the observatory is located broke off. To continue this time series, redrilling was attempted for the 2022/23 season without success, but a retry with a different set up is being prepared for the 2023/24 field season.

A Masters student from NTNU participated in a month-long fin whale expedition along South Shetland Islands lead by Dr. Herr. Passive acoustic data were opportunistically collected in the vicinity of fin whale aggregations using a floating SoundTrap. Approximately 13 h of data were collected over multiple deployments. Analysis of the data is underway.

Conclusions

The improved detection algorithms, standardised analysis framework, and continued long-term data collection, are each individually strong achievements. However, when taken together, they also represent a step-change in the ATWG’s ability to deliver on the promise of using passive acoustics to monitor trends in Antarctic blue and fin whales throughout the Southern Hemisphere.

Challenges

Funding remains the major challenge for the ATWG, given that participation in ATWG by most steering group members is conducted as an in-kind contribution. The group has increased capacity for acoustic analysis by training PhD students and employing post-doctoral fellows, however, additional funding is still required to fully leverage this increase in capacity for knowledge generation.

Outlook for the future

The ATWG is in the process of revising its 3-5 year work plan. Provided that the group can obtain sufficient funding, the next steps will be to begin to apply the new detection algorithms, and the standardised framework for call-density to circumpolar datasets to investigate and quantify any spatio-temporal trends in call density of



blue and fin whale sounds. We are looking forward to an in-person meeting in 2024 if we can find the funds to do so.

Project outputs

Students and theses

ATWG members have built capacity for passive acoustics through supervision of at least 8 students and 1 postdoctoral researcher (**Franciele Castro**).

Students and theses

Emmanuelle Leroy (2014) Comportement vocal des baleines bleues Antarctique en mer de Ross: Répertoire vocal et évaluation du rôle des vocalises. Master Thesis, University of Rennes and Observatoire PELAGIS UMS 3462.

Lisa Ganz (2018) Analysis of passive acoustic recordings from Elephant Island. Masters Thesis University of Bremen- Alfred-Wegener Institute Bremerhaven.

Maele Torterotot (2020). Analysis of bioacoustic data recorded in the southern Indian Ocean. PhD Thesis, Institut Universitaire Européen de la Mer (IUEM) Géosciences – Océan, Plouzané, France.

Victoria Field (2021) Analysis of the geographic variation in fin whale (*Balaenoptera physalus*) calls reveals population identities. Master University of Bremen, Germany.

Constanza Alarcon (2022) Calling depth of fin whales (*Balaenoptera physalus*) in a feeding ground of Isla Chañaral, Northern Chile, using acoustic tags. Undergraduate in Marine Biology, University of Concepcion, Chile.

Meghan Aulich (2022) The soundscape ecology of the fin whale (*Balaenoptera physalus*) in Antarctic and Australian waters. Ph.D. candidate, Curtin University, Australia.

Paul Nguyen Hong Duc (2022) Ph.D. candidate, Sorbonne University, France.

Masters student from NTNU participated in a month-long fin whale expedition along South Shetland Islands (2023) lead by Dr. Herr.

Peer-reviewed papers - Papers from 2022/23

Aulich MG, Mccauley RD, Miller BS, Samaran F, Giorli G, Saunders BJ, Erbe C, Davis G (2022) Seasonal Distribution of the Fin Whale (*Balaenoptera physalus*) in Antarctic and Australian Waters Based on Passive Acoustics. 9: 1–15.

Aulich MG, Miller BS, Samaran F, McCauley RD, Saunders BJ, Erbe C (*Accepted*, 2023) Diel patterns of fin whale 20 Hz acoustic presence in Eastern Antarctic waters. Royal Society Open Science.

Castro, F. Harris D.V., Buchan, S., Miller, B.S, Balcazar, N. et al. (*In preparation*) Beyond counting calls: estimating detection probability for Antarctic blue whales reveals biological trends in seasonal calling.

El-Gabbas A, Thomisch, K., Van Opzeeland I, Burkhardt E, Boebel O (*Submitted*) Dynamic species distribution models of Antarctic blue whales in the Weddell Sea using visual sighting and passive acoustic monitoring data. Diversity & Distributions.

Miller BS, Madhusudhana S, Aulich MG, Kelly N (2022) Deep learning algorithm outperforms experienced human observer at detection of blue whale D-calls: a double-observer analysis. Remote Sensing in Ecology and Conservation 9(1): 104-116. <https://doi.org/10.1002/rse2.297>

Schall E, Parcerisas C (2022) A Robust Method to Automatically Detect Fin Whale Acoustic Presence in Large and Diverse Passive Acoustic Datasets. *Journal of Marine Science and Engineering*, 10(12): 1831.

Torterotot M, Samaran F, Royer J-Y (2023) Long-term acoustic monitoring of non-stereotyped blue whale calls in the southern Indian Ocean. *Marine Mammal Science* 1–17. <https://doi.org/10.1111/mms.12998>

Peer-reviewed papers

Balcazar N, Nieukirk S, Leroy EC, Aulich M, Shabangu FW, Dziak RP, Lee WS, Hong JK (2021b) An open access dataset for developing automated detectors of Antarctic baleen whale sounds and performance evaluation of two commonly used detectors. *Scientific Reports* 11:1–18. <http://www.nature.com/articles/s41598-020-78995-8>

Buchan SJ, Huckle-Gaete R, Stafford KM, Clark CW (2018) Occasional acoustic presence of Antarctic blue whales on a feeding ground in southern Chile. *Marine Mammal Science* 34(1): 220-228.

Buchan SJ, Balcazar-Cabrera NE, Stafford K (2020) Seasonal acoustic presence of blue, fin and minke whales off the Juan Fernández Archipelago, Chile (2007-2016). *Marine Biodiversity* 50(5): 76.

Burkhardt E, Van Opzeeland I, Cisewski B, Matmueller R, Meister M, Schall E, Spiesecke S, Thomisch K, Zwicker S, Boebel O (2021) Seasonal and diel cycles of fin whale acoustic occurrence near Elephant Island, Antarctica. *Royal Society Open Science*, 8, 201142. DOI: <https://doi.org/10.1098/rsos.201142>.

Dréo R, Bouffaut L, Leroy EC, Barruol G, Samaran F (2018) Baleen Whale distribution and seasonal occurrence revealed by an ocean bottom seismometer network in the Western Indian Ocean. *Deep Sea Research II*, 10.1016/j.dsr2.2018.04.005

El-Gabbas A, Van Opzeeland I, Burkhardt E, Boebel O (2021) Static species distribution models in the marine realm: the case of baleen whales in the Southern Ocean. *Diversity and Distributions*. DOI: <https://doi.org/10.1111/ddi.13300>.

El-Gabbas, A., Van Opzeeland, I., Burkhardt, E., & Boebel, O. (2021). Dynamic species distribution models in the marine realm: Predicting year-round habitat suitability of baleen whales in the Southern Ocean. *Frontiers in Marine Science*, 1880

Fregosi S, Harris DV, Matsumoto H, Mellinger DK, Negretti C, Moretti DJ, Martin SW, Matsuyama B, Dugan PJ, Klinck H (2020) Comparison of fin whale 20 Hz call detections by deep-water mobile autonomous and stationary recorders. *Journal of the Acoustical Society of America*, 147(2): 961-977. <https://doi.org/10.1121/10.0000617>

Gavrilov AN, McCauley RD, Gedamke J (2012) Steady inter and intra-annual decrease in the vocalization frequency of Antarctic blue whales. *Journal of the Acoustical Society of America* 131: 4476-4480.

Harris DV, Fregosi S, Klinck H, Mellinger DK, Thomas L (submitted to *Journal of Remote Sensing*) Assessing the effect of ocean glider movement on distance sampling assumptions.

Harris D et al. (*In preparation*) Estimating the detection probability of long-ranging baleen whale song using a single sensor: towards density estimation.

Harris DH, Miksis-Olds J, Vernon J, Thomas L (*Accepted*) Fin whale density and distribution estimation using acoustic bearings derived from sparse arrays. *Journal of the Acoustical Society of America*.

Leroy E, Bonnel J, Samaran F, Royer J-Y (2016) Seasonal and diel vocalization patterns of Antarctic blue whale (*Balaenoptera musculus intermedia*) in the Southern Indian Ocean: a multi-year and multi-site study. *Plos One* 11 (11) doi: 10.1371/journal.pone.0163587

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IWC-SORP THEME 6 PROGRESS REPORT – 2022/23. The right sentinel for climate change: linking foraging ground variability to population recovery in the southern right whale

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Executive summary

IWC67 endorsed a new IWC-SORP research theme: *The right sentinel for climate change: linking foraging ground variability to population recovery in the southern right whale.*

The specific objectives of the theme are to:

- 1) Increase our understanding of southern right whale foraging habitats and ecology
- 2) Update our knowledge on southern right whale population dynamics in a comparative framework
- 3) Pursue integration of health assessment indicators with long-term monitoring data
- 4) Investigate the impact of climate variation at foraging grounds on population recovery

The Theme is led by Drs Emma Carroll and Els Vermeulen, in close collaboration with colleagues from Argentina, Australia, Brazil, New Zealand and South Africa. Work has been undertaken against all four objectives including:

1. Objective 1:
 - a. Finalisation of the project related to the circumpolar foraging ecology of southern right whales: past and present (see SC/68a/SH11 for details). The results were published in the Proceedings of the National Academy of Sciences (PNAS)
 - b. Further collation of biopsy samples for stable isotope analyses
 - c. The usefulness of radiocarbon (^{14}C) as an environmental indicator was assessed using baleen samples of adult male and female southern right whales
 - d. Further deployments of satellite transmitters in Argentina, Australia, New Zealand and South Africa
2. Objective 2
 - a. Further progress towards the IWC-SORP funded project “Multi-ocean assessment of southern right whale demographic parameters and environmental correlates” including trials for a common demographic model and the collation of major datasets.
 - b. Further collection of photo-ID data
3. Objective 3
 - a. Further photogrammetry data collection and analyses to assess southern right whale body condition
 - b. Further assessments of reproductive cycles using endocrine data
 - c. Further developments regarding a standardized visual health assessment protocol
 - d. Information on an unusual mortality event in Argentina
 - e. Published information on the energetic cost of female reproduction, and the temporal reduction of maternal body condition in South Africa.
4. Objective 4
 - a. Ongoing analyses of links between annual abundance and body condition with climatic timeseries datasets.

Introduction

The Southern Right Whale Theme was established in 2018 following endorsement at IWC67. It aims to provide an over-arching research programme linking southern right whale population dynamics and health with foraging ecology and assessing these linkages on a global scale. Its main goal is to leverage the existing long-term datasets from the primary wintering grounds with new knowledge on the species’ foraging ecology and linkages between migratory habitats, with the goal of investigating the impact of past and future climate variation on right whale recovery.

Objectives

1. Increase our understanding of southern right whale foraging ecology
2. Update our knowledge on southern right whale population dynamics in a comparative framework
3. Pursue integration of health assessment indicators with long-term monitoring data
4. Investigate the impact of past and future climate variation at foraging grounds on population recovery

Progress to date

Information provided by: Dr Els Vermeulen, Dr Emma Carroll, Dr Macarena Agrelo, Dr Fredrik Christiansen, Dr Karina Groch, Dr Will Rayment, Dr Claire Charlton, Prof Doug Butterworth, Dr Chandra P. Salgado Kent, Dr Alexandre Zerbini, Dr Kate Sprogis

Objective 1: Increase our understanding of southern right whale foraging ecology

Global

1.1 - During the 2018 IWC-SORP Call from Proposals, the first research project was funded under the auspices of IWC-SORP Theme 6, entitled, *Circumpolar foraging ecology of southern right whales: past and present* (see SC/68a/SH11 and the update provided in SC/69a/SHXX for details). This has resulted in a publication in the Proceedings of the National Academy of Sciences (PNAS), available as Derville et al. (2023; SC/69a/ForInfo36). The abstract, significance statement and figures showing foraging ground locations inferred from isotopic signatures in whale skin are displayed below:

Abstract

Assessing environmental changes in Southern Ocean ecosystems is difficult due to its remoteness and data sparsity. Monitoring marine predators that respond rapidly to environmental variation may enable us to track anthropogenic effects on ecosystems. Yet many long-term datasets of marine predators are incomplete because they are spatially constrained and/or track ecosystems already modified by industrial fishing and whaling in the latter half of the 20th century. Here we assess the contemporary, offshore distribution of a wide-ranging marine predator, the southern right whale (SRW, *Eubalaena australis*), that forages on copepods and krill from ~30°S to the Antarctic ice edge (>60°S). We analysed carbon and nitrogen isotope values of 1,002 skin samples from six genetically distinct SRW populations using a customized assignment approach that accounts for temporal and spatial variation in the Southern Ocean phytoplankton isoscape. Over the past three decades, SRW increased their use of mid-latitude foraging grounds in the south Atlantic and southwest Indian oceans in the late austral summer and autumn, and slightly increased their use of high-latitude (>60°S) foraging grounds in the southwest Pacific, coincident with observed changes in prey distribution and abundance on a circumpolar scale. Comparing foraging assignments with whaling records since the 18th century showed remarkable stability in use of mid-latitude foraging areas. We attribute this consistency across four centuries to the physical stability of ocean fronts and resulting productivity in mid-latitude ecosystems of the Southern Ocean compared with polar regions that may be more influenced by recent climate change.

Significance Statement

Assessing change in Southern Ocean ecosystems is challenging due to its remoteness. Large-scale datasets that allow comparison between present-day conditions and those prior to large-scale ecosystem disturbances caused by humans (e.g., fishing/whaling) are rare. We infer the contemporary offshore foraging distribution of a marine predator, southern right whales (n=1002), using a novel, customized stable-isotope based assignment approach based on biogeochemical models of the Southern Ocean. We then compare the contemporary distributions to whaling catch data representing historical austral summer and autumn distributions. We show remarkable consistency of mid-latitude distribution across four centuries, but shifts in foraging grounds in the past 30 years, particularly in the high latitudes that are likely driven by climate-associated alterations in prey availability.

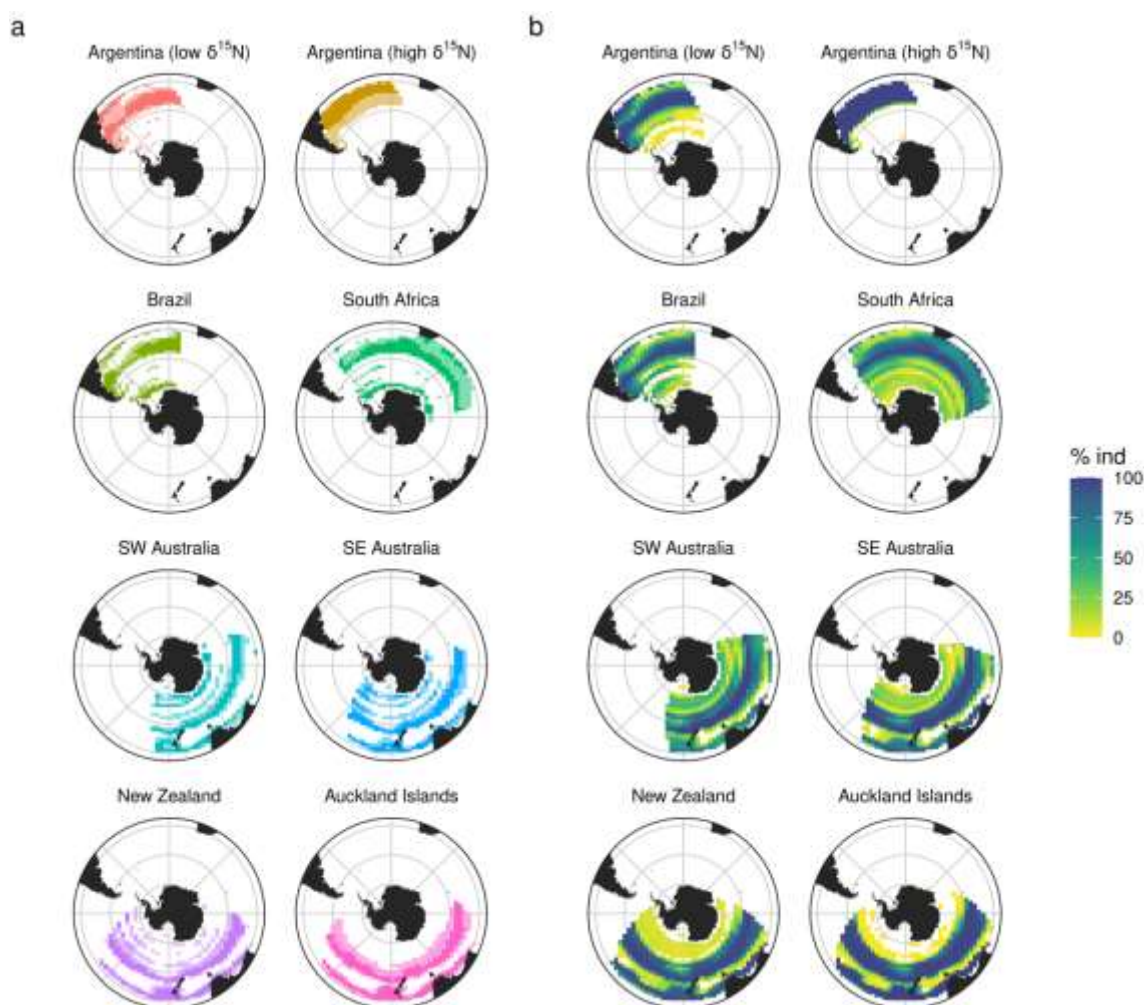


Figure 1 Isotopically assigned foraging grounds for each southern right whale wintering ground across all years (see Table S1 for sample sizes). (a) Population-level average core and general foraging areas in dark and light colors representing highest 25% and 50% probability pixels, respectively. (b) Individual-level summary of foraging grounds shown with a colour scale representing the percent of sampled individuals that were assigned to each grid cell based on binary transformation of the 50% highest probability pixels. Note Australia wintering grounds are divided in southwest (SW) and southeast (SE). Parallels of latitude represented in grey in each map mark 30°S, 50°S, and 70°S.

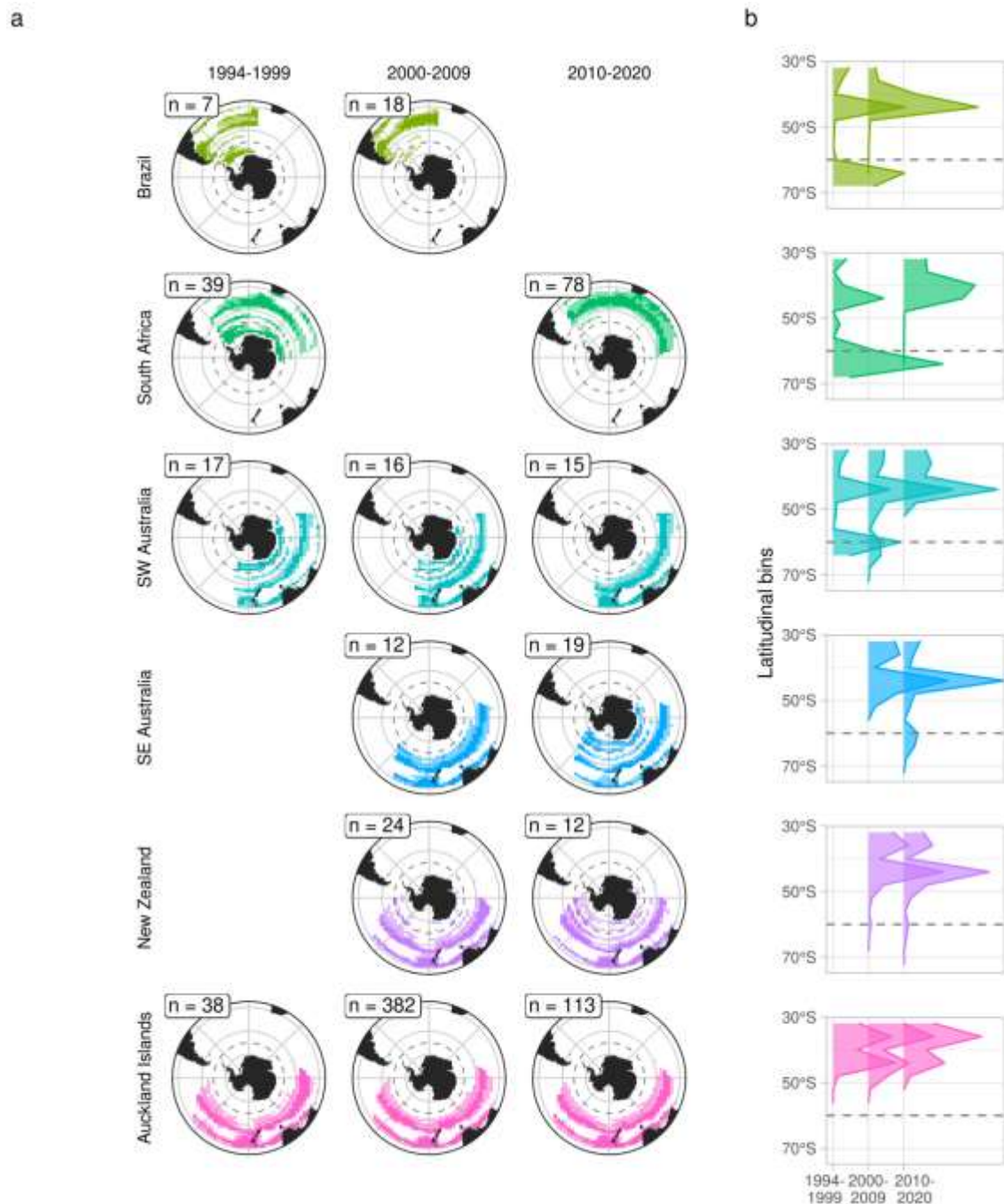


Figure 2 Southern right whale foraging grounds assignments by wintering ground and decade. (a) Maps of assigned general and core foraging areas. Sample size is indicated in each panel. Population-level average core and general foraging areas are represented for each decade by population combination in dark and light colours, respectively. (b) Distribution of the population-level foraging probabilities summed over all pixels (i.e., thresholds) in latitudinal bins of 4°, for each decade. Argentinian samples were collected over only one decade (2000-2009) and are therefore not represented in this figure. Note Australia wintering grounds are divided in southwest (SW) and southeast (SE). Parallels of latitude represented in grey in each map mark 30°S, 50°S, and 70°S, and the dashed line delineates the 60°S latitude.

South Africa

1.2 - In October 2021, a total of 4 female southern right whales were tagged with Wildlife Computers SPOT-372 transdermal ('Type C', as defined by Andrews et al., 2019), location-only satellite tags. Deployments

occurred at the end of the whale season to maximize the chances of tracking whales after they departed from the wintering grounds, during their migration and throughout the summer feeding season. Tag transmission duration ranged from 165 to 369 days, with an average of 251.8 days. Two of the tagged individuals migrated to well-known foraging grounds of South African southern right whales (Crozet Island and the vicinity of Bouvet Island), whereas the other two individuals migrated substantially long distances towards foraging grounds typically known to be used by western South Atlantic right whales (e.g., the Patagonian shelf and the South Sandwich Islands/Islands Sandwich del Sur); but not those from the eastern South Atlantic (Figure 3). For more detailed information, please see SC/69a/ForInfo38.

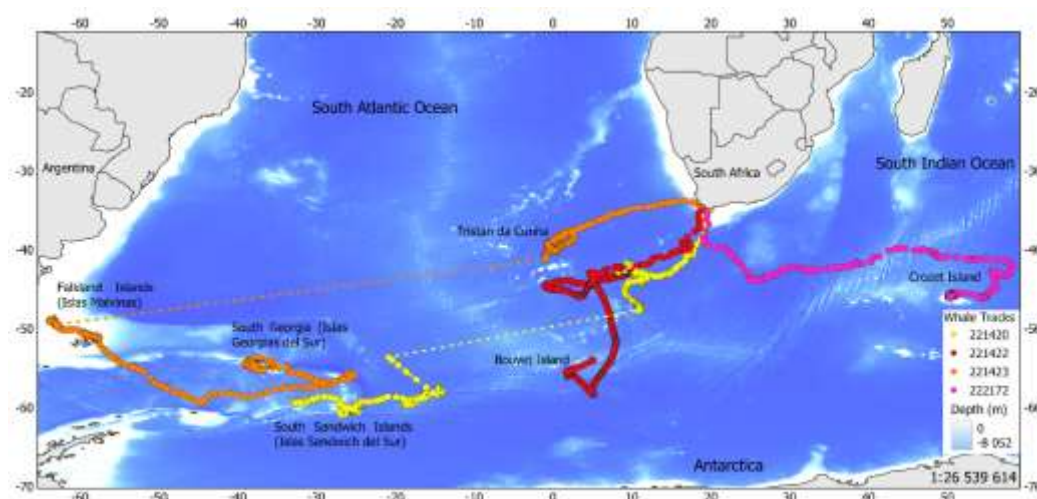


Figure 3 Map indicating the movement patterns of the four adult female southern right whales tagged on the South African coast in October 2021.

1.3 - In October 2022, satellite transmitters were deployed on 11 adult female southern right whales in South Africa, to further assess migratory pathways and foraging locations. As in 2021, this research project is run in collaboration with Dr Alex Zerbini and Dr Amy Kennedy from the National Oceanic and Atmospheric Administration (NOAA), University of Washington's Cooperative Institute for Climate, Ocean and Ecosystem Studies (CICOES/UW), and the Marine Ecology and Telemetry Research (MarEcoTel). In 2022, funding and tags were provided by WWF Australia, a private donor and the MRI Whale Unit. Updated locations of these whales can be seen at www.mammalresearchinstitute.science/whale-unit. The map below indicates the position of these whales in February 2023 (Figure 4).

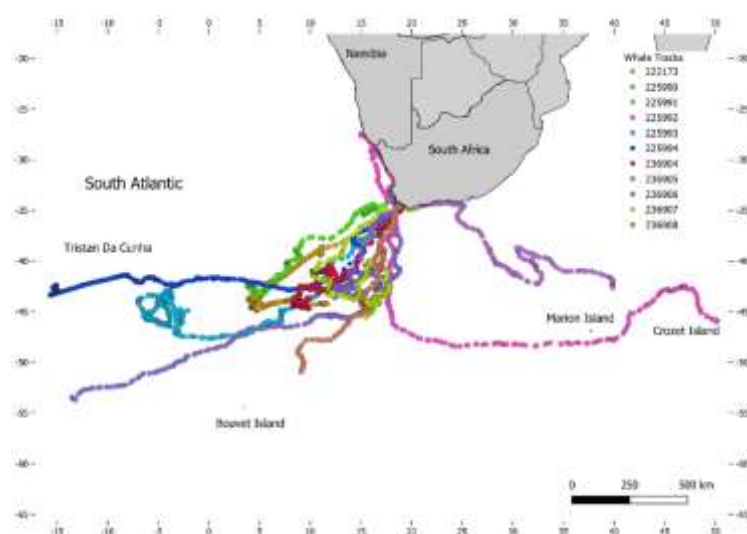


Figure 4 Tracks of the southern right whales instrumented with satellite transmitters off the South African coast in 2022.

1.4 - Boat-based fieldwork in South African waters during 2022 allowed for the collection of 61 skin and blubber samples, including from 35 calves. These samples will be processed for stable isotope and mtDNA, in conjunction with samples collected in previous years to investigate maternally directed site-fidelity to foraging grounds in the South African population. Results of these analyses should be finalised by end of 2023.

1.5 - Baleen of eight southern right whales that stranded along the South African coast were sampled at regular intervals to generate longitudinal stable isotope profiles. The aim was to investigate foraging behaviour and assess possible niche partitioning among different demographic groups. Most animals showed oscillations in both $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values, indicating migratory cycles between foraging and calving grounds. Results further suggest that while there is overlap in the niche space of all individuals, females seem to be more restricted in their foraging behaviour than males. Among the males, juveniles had narrower foraging niche space compared to adults although the sample size for this analysis was small and the results could also be attributed to individual preference. For adult females, foraging activities seemed more restricted post-partum, and broadened when at rest. These results point towards a different foraging behaviour among different demographic groups and are highly relevant when evaluating the effects of climate change-induced changes in prey availability of this Southern Ocean predator.

1.6 - Baleen plates of an adult male and female southern right whale were sampled at 2 cm intervals to explore the usefulness of radiocarbon (^{14}C) as an environmental indicator. For this, radiocarbon analysis was done in conjunction with stable isotope analysis in the scope of an honours project at MRI Whale Unit, to assess if there are any variations or clarification when compared to the traditionally used stable isotope analysis. Results of this exploratory study showed that radiocarbon profiles provide a better separation and therefore classification of the stable isotope data. Specifically for the two baleen assessed, we were able to identify specific geographical regions used by each whale in the last years of their lives. These preliminary results indicated that these whales did not remain in one feeding region but travel between many. Specifically, the migration pattern from the adult female seemed primarily influenced by the reproductive cycle (assessed with progesterone and oestrogen cycles). Data from the adult male suggest a profound shift over time from one region to another in which he remained for most of his final years. When comparing this shift to environmental data we found that his migration change was most likely caused a dip in the ocean productivity during that time. This exploratory study was successful in that it showed that ^{14}C may provide a more detailed understanding of the southern right whale behaviour and migration, and how the current changing environment is affecting them. The approach refines the deciphering of where these whales have been feeding, where they fell pregnant and when they are changing between diets. The project is aimed to continue in the scope of an MSc, in which more baleen plates will be processed for ^{14}C longitudinal profiles.

1.7 - Fieldwork was conducted in November 2022 and January 2023, to assess southern right whale foraging behaviour in the Benguela Large Upwelling System, on the South African west coast. For this, southern right whale behaviour was observed, photo-ID data obtained and prey and poo samples collected. Additionally, suction-cup biologging tags were deployed in January 2023 on 11 adult southern right whales and 2 calves. Average tag duration was 139 min, ranging between 10 min and 5 hours. Preliminary assessments indicate clear skim feeding foraging behaviour at depth; the full dataset is currently being processed and should be finalised at the end of 2023. This work is conducted in collaboration with Dr Paolo Segre and Dr Matthew Savoca of Stanford University.

Argentina

1.8 - As part of her Ph.D. dissertation at the University of California Santa Cruz, Florencia Vilches, Principal Investigator at the Instituto de Conservación de Ballenas from Argentina, will aim to determine how oceanographic parameters affect southern right whales' feeding grounds, migration, and diet. She will conduct carbon and nitrogen stable isotope analysis of bulk tissue and amino acids in baleen plates. Detailed time-series of isotope-ratio samples from this population could significantly improve our understanding of yearly variations in foraging opportunities and the whales' responses to those challenges. Results will be presented in future meetings as they become available.

1.9 - A long-term study to satellite track southern right whales wintering near Peninsula Valdés (Zerbini et al., 2015, 2016, 2018) has been developed by research teams from Argentina (CENPAT/CONICET, Escuela Superior de Ciencias Marinas – U.N. Comahue, Instituto de Conservación de Ballenas (ICB), Wildlife Conservation

Society – Argentina, Fundación Patagonia Natural), Brazil (Instituto Aqualie) and the United States (Cooperative Institute for Climate, Ocean and Ecosystem Studies-University of Washington, Marine Ecology and Telemetry Research, Marine Mammal Laboratory/AFSC-NOAA, and University of California, Davis). The objectives of this study include determining migratory destinations of whales breeding off Argentina, assessing performance and effects of “transdermal” (type C, Andrews et al., 2019) satellite tags and developing minimally invasive (“blubber-only”) implantable tags for right whales. Between 2 and 9 September 2022, a total of 7 blubber-only tags and 9 transdermal tags were deployed on 10 females with calves, and four adults and two juveniles for which sex will be determined from biopsy samples. All whales were tagged in the area around Puerto Pirámides in Golfo Nuevo, Península Valdés. Average duration of blubber-only tags was 25 days (range: 15-38) and all tags have now stopped transmitting. Three transdermal tags have stopped transmitting and six transdermal tags were still transmitting at the time this report was prepared, indicating minimum transmission durations 66 to 192 days. Follow-up of tagged whales to assess potential effects of transdermal and blubber tags was performed since tagging and until early December when the tagged whales left Golfo Nuevo. Information from follow-up studies will be used to assess improvements in new satellite tags to minimize potential welfare issues associated with the use of invasive devices. Tracks of whales tagged with transdermal and blubber-only instruments are illustrated in Figs 5 and 6, respectively. Long-term tracking of southern right whales from Argentina (65 tags deployed in 2014-2017, 2019, 2021 and 2022) indicates that these whales use the Patagonian shelf (including the Falkland Islands/Islas Malvinas), the Southwest Atlantic basin, and areas around South Georgia/Georgias del Sur islands and the Weddell Sea as migratory destinations /foraging grounds. Interpretation of movement patterns depicted by tags deployed in 2022 will be presented to the IWC SC once all tags stop transmitting and data are fully analysed. This project has been supported by the US Office of Naval Research, NOAA, Instituto Aqualie, CONICET, ICB, and the governments of Argentina and of the Provinces of Chubut and Rio Negro.

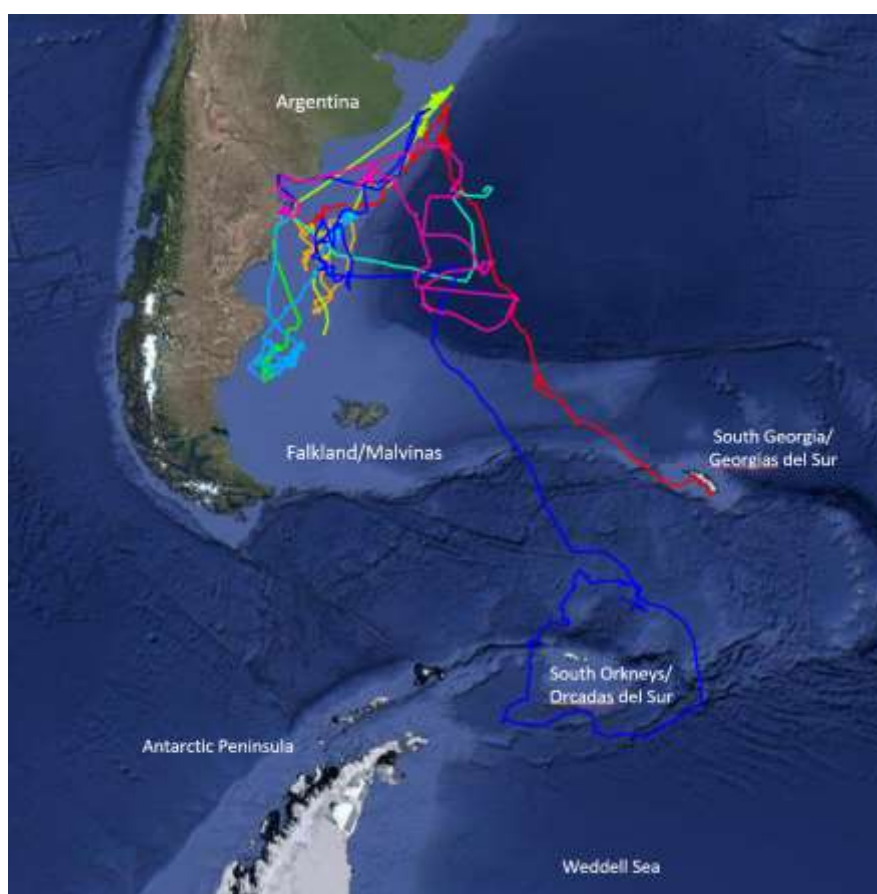


Figure 5 Track of right whales instrumented in the western South Atlantic with “transdermal” tags.



Figure 6 Tracks of right whales instrumented near Peninsula Valdés, Argentina, with “blubber-only” tags.

Brazil

1.10 - A project to collect new skin biopsy samples to use stable isotopes to investigate the foraging locations and diet of right whales in Santa Catarina State, southern Brazil, began in 2020 (funding from Petrobras, the Brazilian Oil Company, to Projeto Franca Austral/Instituto Australis). The project started to collect samples in September 2020, with 81 samples collected up to the field season 2022. The project is ongoing through 2023 and 2024. The research is being coordinated by MSc Thaise Albernaz, and will be subject of her Doctoral research to be started in 2021.

New Zealand

1.11 - Maungahuka Auckland Islands surveys 2022: To understand how climate change could impact southern right whales that winter in the subantarctic Maungahuka – Auckland Islands, a field team from the University of Auckland – Waipapa Taumata Rau (UoA) organised by Emma Carroll and led by Rochelle Constantine undertook the final planned field season to the Maungahuka – Auckland Islands in July 2022. Continuing the genetic monitoring work on tohorā initiated by the UoA in 1995, the research team collected 135 skin biopsy samples, 28 of which are linked to individual whale size and health measurements. Microchemical analyses from the skin samples, combined with the tracks of eight whales satellite tagged this season, will be used to understand the migratory routes and offshore feeding grounds of tohorā. Tracking data already available from the 2020 and 2021 show regions south of Australia are key. By linking information on individual whale health, size, age, kinship and feeding grounds, we aim to understand how feeding ground changes influence tohorā recovery. Over the 2020, 2021 and 2022 field seasons, 734 skin biopsy samples were collected, and 25 satellite tags were deployed.

Australia

1.12 - Western Australia winter surveys 2022: To update our understanding of the genetic identity, connectivity, foraging ecology and migratory behaviours of the Western Australian wintering grounds, a team from the University of Western Australia and Macquarie University, in collaboration with the University of Auckland, undertook a field season to collect skin biopsy samples and deploy satellite tags. This involved training local wildlife officers to drive boats around whales and collect skin samples for future work and capacity building. A total of 6 biopsy samples were collected and 5 tags that produced good deployments are viewable at : <https://tohoravoyages.ac.nz/track-the-australian-whales/>. Further information available in SC/69a/XX.



Figure 7 Tracks of five southern right whales satellite tagged off Western Australia in 2022. Three were transmitting as of 3 March 2023.

1.13 - Satellite tagging and genetic studies are planned for Western Australia and South Australia in 2023/2024 to further investigate southern right whale movements, connectivity and microbiome research in collaboration with Australian researchers from University of Western Australia, Macquarie University, University of Auckland, Flinders University, South Australia and the Australian Antarctic Division. Funding (2023/2024) has been sourced through SeaWorld, the Australian National Environmental Science Programme.

Objective 2: Update our knowledge on southern right whale population dynamics in a comparative Framework

Global

2.1 - Multi-ocean assessment of southern right whale demographic parameters and environmental correlates – Common Model: A common demographic population model is in development with funding support from IWC-SORP. The aim is to compare population demographics across the main Southern Hemisphere (SH) wintering grounds, by applying a common demographic model to the populations in each region, in order to eventually investigate correlations between reproductive success and environmental variables. The regional populations with available long-term photo identification (ID) databases to be included are: (1) SW Atlantic (Brazil/Argentina); (2) SE Atlantic (South Africa); (3) Australia; (4) New Zealand. This project directly contributes to the IWC-SORP Theme 6, Objective 2, to update our knowledge on southern right whale population dynamics in a comparative framework.

Progress made in 2022/2023 includes:

- The Southern Right Whale Consortium is fully active, with a Memorandum of Understanding signed by 18 SRW scientific researchers of 9 countries. The consortium meets twice per year online to share knowledge, enhance collaboration and information sharing. In such meetings, presentations on progress

made for each region have been shared by key researchers. At the moment, a website is in development for encouraging collaboration and outreach.

- Development of a Common demographic model is well advanced, and various intersessional (online) meetings have been held and work completed. Regular communications were maintained between key project investigators (Butterworth, Brandão, Ross-Gillespie, Charlton, Vermeulen) to discuss and progress with the Common model framework. However, application to the SW Atlantic was limited by the team member availability and specialist expertise offered by key team members.
- A MARAM model developed from Brandão et al. (2018) and based on the model from Cooke et al. (2001) was developed further to incorporate an additional δ parameter to allow for the possibility of an early abortion and used to fit the South African photo-ID data. This “Delta-loop” model will be published in Brandão et al. (In press). Model outputs using the Delta-loop and Common model for the South African right whale dataset show slight differences over the most recent years, the reasons for which have still to be fully investigated. The Common model has not yet been applied to the Australian dataset.
- The collation of published and available information regarding confirmed SRW offshore sightings south of 40°S was finalised in 2022 to inform the selection of environmental variables for further investigation of links between demographic parameters (i.e., reproductive success) and climate. For more info, see SC/68D/SH/03

A full report on the *Multi-ocean assessment of southern right whale demographic parameters and environmental correlates* is presented in the IWC-SORP project progress report (Project 30, SC/69a/SHXX).

South Africa

2.2. - A manuscript published regarding an updated photo-identification assessment model of southern right whales surveyed in South African waters, with a focus on some recent low counts of mothers with calves (see reference list below)/.

2.3 - The 43rd annual southern right whale aerial survey was successfully conducted along the South African coast between 1 and 5 October 2022, during which 354 southern right whales were photo-identified, of which 304 were cows. A full report is provided in SC/69a/SHXX.

Argentina

2.4 - A manuscript was prepared regarding the effect of kelp gull micropredation on southern right whale calf survival. This paper, authored by Agrelo et al., analysed five decades of capture-recapture data for whales photo-identified in their years of birth to assess calf survival. The paper is currently under review and results will be presented as they become available.

2.5 - A funding application has been recently approved by IWC to Agrelo et al. to perform a population dynamic assessment of Southwest Atlantic southern right whales. The analysis combines photo-ID data from the long-term individual-based studies of southern right whale population carried out by the Right Whale Program (ICB – Ocean Alliance) at Península Valdés, Argentina, by ProFRANCA (Instituto Australis) in southern Brazil, and the matches between both calving grounds. Efforts are underway to assess movement rates between these two calving grounds over years, region-specific survival and recapture probabilities applying multi-states capture-recapture methods. Research efforts are also focusing to understand the effects of micropredation by kelp gulls, calf mortality and density-dependence processes at Península Valdés on movement rates between Argentina and Brazil. The results of this study will be presented in future meetings as they become available.

Brazil

2.6 - Southern Brazil aerial survey - winter 2022: Survey was conducted as part of the long-term monitoring of the Right Whale Research Program. In 2022, surveys were funded by Petrobras (Brazilian Oil Company), as part of a sponsorship to the Projeto Franca Austral/Instituto Australis. The survey was conducted in 20-21 September at the peak of the right whale season, from Florianópolis on the central-southern coast of Santa Catarina State, to Cidreira on the north coast of Rio Grande do Sul State, covering 380 km of coastline.

During the survey, 228 right whales were photo-identified (including possible double counts), including 113 mothers accompanied by calves, and two lone adults. Groups of 2 to 10 whales, consisting of mother and calf pairs, were recorded, with the exception of one group, formed by 2 whales, where it was not possible to confirm the group composition. The photographs will be analysed for the identification and cataloguing of individuals in the Brazilian Photoidentification Catalog of Right Whales.

Australia

2.7 - Long term monitoring of southern right whale distribution, abundance and life histories in south-western Australia through count and photo-identification were successfully completed in 2022.

- Annual aerial survey of the south western population to assess population estimate and life histories of southern right whales (1976-2022) were completed by Murdoch University, Australian Antarctic Division Western Australian Museum and CSIRO with funding support from the Australian National Environmental Science Program. More details are presented in the IWC [SC/69a/XXXX](#).
- Annual long term cliff based research was undertaken at major calving ground at the Head of the Great Australian Bight (1991-2022) between July 15 and 31 August, 2022. Mean apparent calving intervals of 4.5 years were observed with no three year intervals recorded again in 2023. A total of 1,165 sightings and 164 unique individuals were photo identified across three sites (Head of Bight, Fowlers Bay and Encounter Bay) and data is available for the national data repository, the Australasian Right Whale Photo Identification Catalogue (ARWPIC). Photo-ID data was matched to regional and national catalogues and resulted in 89% successful matches for reproductive females. Relative abundance of unaccompanied adults was lower than expected again in 2022. A full report is provided in [SC/69a/SHXX](#) and O'Shanessy et al. (2023). Funding was provided by Minderoo Foundation Flourishing Oceans.
- Systematic vessel and land based population surveys were undertaken at small aggregation areas in South Australia at Fowlers Bay (2013-2022) and Encounter Bay (2019-2022) by Curtin University and Flinders University (lead by Charlton) with funding from Minderoo Foundation. Details are provided in [SC/69a/SHXX](#). Flinders University honours student completed Thesis on 'Relative abundance, group composition spatial distribution, and connectivity of Southern Right Whales, *Eubalaena australis* in Encounter Bay, South Australia' (Gillmore et al. 2022). Honours project is currently underway comparing relative abundance trends in a comparative framework across south Australian key aggregation areas by Flinders University honours Student B. O'Shanessy.

2.8 - Opportunistic surveys and photo-identification was completed for the South-Eastern population of southern right whales, a citizen science program managed by M. Watson of the Victorian Department of Environment, Land, Water and Planning.

2.9 - Surveys were completed in South Western Australia small and emerging calving grounds around Geographe Bay using boat based and UAV platforms. Surveys have been underway by C. Burton since the 1990's in south-western Australia and continue with a range of researcher, volunteer and student contributors. With funding through NESP in 2022, C. Salgado Kent and C. Burton have progressed processing photo-identification data and matching in the SouWEST (South Western Whale Ecology Study) catalogue. This project has processed 3,000 whale photographs taken between 1994 and 2020. A total of 141 unique individuals were identified in Geographe Bay (GB) and 88 in Flinders Bay (FB) over this period. Residency varied among years, with a maximum recorded mother-calf stay in Geographe Bay over two-month period. Matches between GB and FB are completed up to 2020 and photos of individuals have been uploaded to the National repository (ARWPIC). This work is ongoing, with anticipated processing of historic photos taken between Albany and Esperance and matching among regions to gain insight on habitat connectivity and movement. Further detail on the work so far conducted is available through a 2023 project report (Salgado Kent et al. 2023): <https://www.nespmarinecoastal.edu.au/project-1-22-final-report-2/>

Objective 3: Pursue integration of health assessment indicators with long-term monitoring data

Substantial progress was also made toward Objective 3 of IWC-SORP Theme 6, related to the integration of health assessment indicators with long-term monitoring data.

Global

3.1 - IWC endorsed global, standardised southern right whale visual health assessment protocol is in development for publication, led by Vermeulen and Charlton.

South Africa

3.2 - Boat-based surveys were conducted in Walker Bay during the months July, August and September 2022 during which drone footage of females with calves was collected, for photogrammetry purposes using the methods of Christiansen et al., 2018, 2019, as well as biopsy samples for endocrine analyses. These data will be processed to build on the information regarding maternal body condition and commence assessments of calf growth rates in relation to maternal body condition and stress hormone levels. Funding has been obtained to continue data collection in 2023. Data will be processed in the scope of a relevant PhD project which commenced in 2023.

3.3 - A short note is being finalised on the visual observation of a successful southern right whale birth in Walker Bay, South Africa, with photographic evidence. This note will be submitted to the African Journal of Marine Science next month.

3.4 - A paper was published regarding a temporal reduction in maternal body condition of southern right whales calving off the coast of South Africa. See reference below.

3.5 - Longitudinal profiles of progesterone and oestrogen metabolite concentrations from four adult female southern right whales were created from baleen and assessed individually as well as against stable isotope profiles (see figure 8). In the absence of information related to gestation and parturition-related reproductive hormone concentrations, we identified individual pregnancies as periods of elevated baleen progesterone metabolite (bPM) concentrations with a bimodal distribution. Sharp increases in baleen oestrogen metabolite (bEM) concentrations, seen near the end of elevations in bPM concentrations, were presumed to be an indication of parturition. A successful pregnancy was estimated to last between 15 – 18 months and all but one unsuccessful reproductive cycle appeared to be the result of late-term pregnancy failure or the death of a calf soon after birth. When overlaying endocrine profiles with longitudinal stable carbon ($\delta^{13}\text{C}$) and nitrogen ($\delta^{15}\text{N}$) isotope profiles, results supported the observational data that successful reproductive cycles last for three annual migratory cycles between offshore summer foraging grounds and coastal calving grounds. These data highlights that conception appears to occur at higher latitudes near the end of the feeding season, rather than on the coastal breeding grounds as was previously believed. These novel insights into the reproductive biology of southern right whales are critical for conservation efforts, particularly considering the increased reproductive failure currently observed among the South African population. These results are available at UP libraries in the form of a MSc thesis (Shuttleworth, 2022), and are currently being written up for publication.

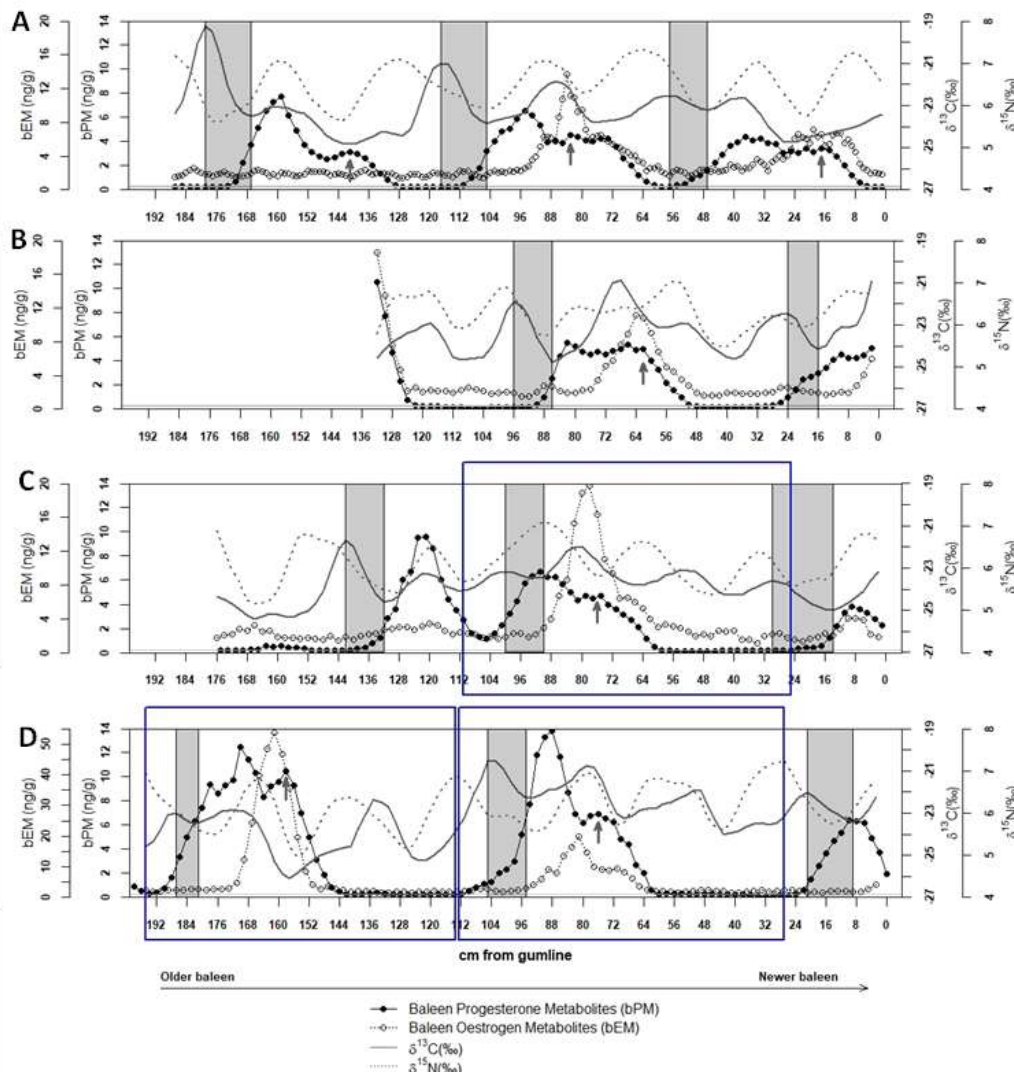


Figure 8 Longitudinal bPM, bEM, $\delta^{13}\text{C}$, and $\delta^{15}\text{N}$ value profiles of the baleen plates of individual female southern right whales that stranded along the South African coastline. The x-axis depicts samples from the distal point of the baleen on the left moving to the proximal point towards the right so that the profiles can be interpreted chronologically. The horizontal line parallel to the x-axis represents the bPM baseline value unique to each individual. Grey arrows indicate assumed parturition. Grey bars indicate decreasing $\delta^{13}\text{C}$ values near the onset of pregnancy. Reproductive cycles that last for the duration of approximately three nitrogen cycles i.e. migration cycles have been boxed off in blue. **A)** Individual F1 (n=187), **B)** Individual F2 (n=66), **C)** Individual F3 (n=89) and **D)** Individual F4 (n=99); note the different scale used for bEM in Figure 3.2D).

3.6 - A project was conducted, in the scope of a course MSc, to assess the different visual health parameters used in the southern right whales visual health assessment protocol (SC/68C/SH/21) in relation to quantitative data on body condition. Results showed that there is a moderate relationship between qualitative and quantitative body condition measurements, but only on 2 levels. This suggests that body condition of southern right whales can be scored visually relatively accurately to be either good or poor, allowing retrospective analyses of historical aerial images. Results of the study further showed that the other visual health parameters, known to be indicators of health in the species, did not correlate with quantitative, nor qualitative measurements of body condition. This suggests that, at least in South African southern right whales poor body condition does not necessarily reflect poor health, and that thus all health parameters need to be evaluated in order to assess health condition of individual whales. This study advances our knowledge and understanding of how to assess

visual health in southern right whales and concludes that body condition alone may not be enough to detect individuals in poor health.

Argentina

3.7 - Body condition sampling of southern right whales using drone photogrammetry (following the approach of Christiansen et al. 2018, 2019) continued in Península Valdés. The project now has four years of data (2018, 2019, 2021, 2022). Between May and November 2022, 685 flights were successfully completed and recorded >2,200 body condition measurements, from ~600 mother-calf pairs and ~350 juveniles/adults. The 2022 data are still being organized, a process which includes identifying all the photographed individuals and matching to the existing photo-ID catalogue in Península Valdés that currently contains >4,000 individuals; assessing the number of resighted known lactating females between 2018 and 2022, which will allow to measure the rate of recovery in energy stores of southern right whale females between calving events; comparing the body condition of mother-calf/yearling pairs between seasons, which will allow to measure the growth of the calf and the change in maternal body condition; measuring the size and extent (surface area) of the gull lesions on the backs of the whales, which will allow to investigate if calves with a higher exposure to gull attacks are growing at a slower rate compared to less affected calves.

3.8 - From body condition data collected in 2018 and 2019 at Península Valdés, Christiansen *et al.*, (2022) published a new study investigating the energetic costs of gestation for southern right whales. From repeated measurements of individual southern right whale females before (when they were late-pregnant) and after they gave birth (when they were lactating), Christiansen *et al.*, were able to estimate the birth size of calves and the effect of maternal body size on both birth size and foetal growth rates. The results of this study were published in the *Journal of Physiology* (see relevant articles published in 2022/2023).

3.9 - Over the course of two weeks between 24 September and 11 October 2022, the Southern Right Whale Health Monitoring Program have recorded 30 adult and juvenile whale deaths in Península Valdés, Argentina. The current dead whale count is at 26 adults (most of them were females) and 4 juveniles. The leading cause of death hypothesis is toxicity from a Harmful Algal Bloom (HAB), involving *Alexandrium* spp and *Pseudo-nitzschia* spp. The investigation of the unusual mortality event of southern right whales at Península Valdés is ongoing. A preliminary report can be seen at [SC/69a/CMP/XX](#).

New Zealand

3.10 - Images from unmanned aerial vehicles were used to characterise variation in individual size and shape, and to quantify the size structure of the subset of southern right whales in Port Ross, Auckland Islands, during winter 2016. Of 108 whales photographically identified we gained a comprehensive set of measurements from 63 individuals, as well as length measurements for 29 calves and six non-calf whales for which the full suite of measurements were not obtainable. Lactating females ($n = 32$) ranged in length from 11.84 to 15.22 m, apparent non-breeding adults ($n = 9$) were between 11.96 and 14.92 m, while subadults ($n = 28$) were between 8.82 and 11.72 m long. Calves were between 5.15 and 7.53 m. Principal component analysis of the measurement data showed that widths (particularly at the positions of 30–80% along total body length) were most influential in PC1 (40.3% variance explained). Measurements of structural features (i.e. head and flukes) related more closely to PC2 (18.2% variance explained) and PC3 (14.8% variance explained). We, therefore, interpret PC2 and PC3 as representing structural size, while PC1 represents body condition. Subadults and non-breeding adults showed more variation in body condition than lactating females, highlighting the need for this demographic to maintain their body condition within a tighter range to meet the high nutritional demands of raising calves. See Johnston et al. (2022).

Australia

3.11 - Work is underway to assess links between body condition and reproductive success using 5 years of photogrammetry data from South Australia and 32 years of life history data (Christiansen, Charlton et al. in prep).

3.12 - Visual health assessment is underway for parous females in Australia. Data processing is underway and methods will align with the IWC science committee endorsed global, standardised southern right whale visual health assessment protocol.

Objective 4: Investigate the impact of past and future climate variation at foraging grounds on population*South Africa*

4.1 A study is underway to assess linkages between southern right whale reproductive success and environmental variables in the scope of a PhD at the University of Pretoria

Australia

4.2 Funding is secured through the Minderoo Foundation to investigate links between Southern Ocean climate variates and trends in abundance and reproduction of southern right whales off Australia. The long-term count and photo-identification data provides information on reproductive success, calf production, and calving intervals. Modelling of climate variates will include Southern Oscillation El Nino, Southern Annual Mode and the Indian Ocean Dipole.

Project outputs*Students and theses finalised in 2022*Postgraduate

Lorraine Shuttleworth - A new insight into southern right whale reproduction via baleen endocrine and stable isotope analysis - Master of Science in Zoology and Entomology, Mammal Research Institute - University of Pretoria (under supervision of Dr Els Vermeulen and Prof. A. Ganswindt)

Macarena Agrelo - How important is the individual history? Population ecology of Southwest Atlantic southern right whales (*Eubalaena australis*): 50-year of ongoing research - PhD in Ecology - Laboratório de Mamíferos Acuáticos - Santa Catarina Federal University (under main supervision of Prof. Paulo Simões-Lopes and Fábio Daura-Jorge)

Matej Moles - Developing a visual health assessment protocol for southern right whales – Masters of Science in Applied Marine Biology – University of Cape Town (under supervision of Dr Els Vermeulen)

Undergraduate

Gilmore W, Moller L, Parra G, Charlton C (2022) Relative abundance, group composition spatial distribution, and connectivity of Southern Right Whales, *Eubalaena australis* in Encounter Bay, South Australia. Honours thesis submitted to Flinders University pp 80.

Redman Shirean – Continued habitat suitability of the southern Cape coast as a calving ground for southern right whales in light of climate change – Honours – University of Pretoria (under supervision of Dr Els Vermeulen and Dr Christel Hansen)

Robertson Nicole – Assessment of southern right whale migration patterns by means of radio carbon isotopes in baleen plates – Honours – University of Pretoria (under supervision of Dr Els Vermeulen and Prof Stephan Woodborn)

Students and theses previously finalised

Terriann Thavar - Southern right whale (*Eubalaena australis*) body condition and glucocorticoid levels at the South Africa breeding ground - Master of Science in Zoology and Entomology, Mammal Research Institute - University of Pretoria (under main supervision of Prof. A. Ganswindt)

Gideon Van den Berg - Foraging ecology of South Africa's southern right whales (*Eubalaena australis*) in relation to calving success and global climate variability - Master of Science in Zoology and Entomology, Mammal Research Institute - University of Pretoria (under main supervision of Prof. A. Ganswindt)

Meghan Van Zyl - Southern right whale baleen male hormone profiles – Honours - University of Pretoria (under main supervision of Prof. A. Ganswindt)

Cuyler Van Jaarsveld – Contemporary southern right whale sightings South of 40°S – a global database - Honours - University of Pretoria (under main supervision of Prof. A. Ganswindt)

Thaise Albenaz - Ph.D. candidate, ProFRANCA/INstituto Australis, Brazil.

David Johnson – Ph.D. candidate, University of Otago, New Zealand.

Macarena Agrelo – Ph.D. candidate, Federal University of Santa Catarina, Brazil.

Peer-reviewed papers in 2022/23

Brandão A, Ross-Gillespie A, Vermeulen E, Butterworth D (*In press*) A photo-identification based assessment model of southern right whales (*Eubalaena australis*) surveyed in South African waters, with a focus on some recent low counts of mothers with calves. African Journal of Marine Science.

Carroll EL, Riekkola L, Andrews-Goff V, Baker CS, Constantine R, Cole R, Goetz K, Harcourt R, Lundquist D, Meyer C, Ogle M, O'Rourke R, Stuck E, van der Reis AL, Zerbini AN, Childerhouse SJ (2022) New Zealand southern right whale (*Tohorā nō Aotearoa*) habitat use in Port Ross, Auckland Islands, over three decades. Polar Biology 45: 1441-1458. <https://doi.org/10.1007/s00300-022-03076-7>

Christiansen F, Bejder L, Burnell S, Ward R, Charlton C (2022) Estimating the cost of growth in southern right whales from drone photogrammetry data and long-term sighting histories. Marine Ecology Progress Series 687: 173-194.

Christiansen F, Uhart MM, Bejder L, Clapham P, Ivashchenko Y, Tormosov D, Lewin N, Sironi M (2022) Fetal growth, birth size and energetic cost of gestation in southern right whales. The Journal of Physiology 600(9): 2245-2266.

Derville S, Torres LG, Newsome SD, Somes C, Valenzuela LO, Vander Zanden HB, Baker CS,... , Carroll EL (2023) Long-term stability in the foraging range of a Southern Ocean predator between the eras of whaling and Anthropocene climate change. Proceedings of the National Academy of Sciences. <https://doi.org/10.1073/pnas.2214035120>

Houegnigan L, Merino ER, Vermeulen E, Block J, Safari P, Moreno-Noguer F, Nadeu C (*In Review*) Wildlife and Marine Mammal Spatial Observatory: Observation and automated detection of Southern Right Whales in multispectral satellite imagery. <https://doi.org/10.1101/2022.01.20.477141>

Johnston DR, Rayment W, Dawson SM (2022) Morphometrics and body condition of southern right whales on the calving grounds at Port Ross, Auckland Islands. Mammalian Biology. <https://doi.org/10.1007/s42991-021-00175-6>

Kennedy A, Carroll EL, Zerbini AN, Baker CS, ... Jackson JA (*In Review*) Photo-ID and satellite tracking connect South Georgia (Islas Georgias del Sur) southern right whales with multiple feeding and calving grounds in the southwest Atlantic. Marine Mammal Science.

Khan C, Blount D, Parham J, Holmberg J, Hamilton P, Charlton C, Christiansen F, Johnson D, Rayment W, Dawson S, Vermeulen E, Rowntree V, Groch K, Levenson JJ, Bogucki R (2022) Artificial intelligence for right whale photo identification: from data science competition to worldwide collaboration. Mammalian Biology 102: 1025-1042. <https://doi.org/10.1007/s42991-022-00253-3>

Neveceralova P, Carroll EL, Steel D, Vermeulen E, Elwen S, Zidek J, Stafford SK, Chivell W, Hulva P (2022) Population changes in a whale breeding ground revealed by citizen science non-invasive genetics. Global Ecology and Conservation 37 (e02141). <https://doi.org/10.1016/j.gecco.2022.e02141>

- Salgado Kent C, Burton C, Giroud M, Elsdon B (2023) A photo-identification study of Southern Right Whales to update aggregation area classification in south-western Australia. Project 1.22 report to the National Environmental Science Program. <https://www.nespmarinecoastal.edu.au/project-1-22-final-report-2/>
- Vermeulen E, Germishuizen M, Kennedy A, Wilkinson C, Weir C, Zerbini A (*Submitted*) Swimming across the pond: First documented transatlantic crossing of a female southern right whale. *Marine Mammal Science*.
- Vermeulen E, Jouve E, Best P, Cliff G, Dicken M, Kotze D, McCue S, Meyer M, Seakamela SM, Thompson G, Thornton M, Wilkinson C (2022) Mortalities of southern right whales (*Eubalaena australis*) and related anthropogenic factors in South African waters, 1999 – 2019. *JCRM* 23(1): 149-6. <https://doi.org/10.47536/jcrm.v23i1.357>
- Vermeulen E, Thavar T, Glarou M, Ganswindt A, Christiansen F (2023) Decadal decline in maternal body condition of a Southern Ocean capital breeder. *Scientific Reports*. <https://doi.org/10.1038/s41598-023-30238-2>
- Peer-reviewed papers – previous years*
- Agrelo M, Daura-Jorge FG, Rowntree VJ, Sironi M, Hammond PS, Ingram SN, Marón CF, Vilches FO, Seger J, Payne R, Simões-Lopes PC (2021) Ocean warming threatens southern right whale population recovery. *Science Advances*, 7(42). <https://doi.org/10.1126/sciadv.abh2823>
- Carroll EL, Dunshea G, Ott PH, Valenzuela LO, Baker CS, Childerhouse SJ, Gaggiotti OE, Flores PAC, Groch K, Gröcke DR, Hindell MA, Lundquist D, Oliveira LR, Rowntree V, Sironi M, Newsome SD (2021) Variation in $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values of mothers and their calves across southern right whale nursery grounds: the effects of nutritional stress? *Marine Mammal Science*. <https://onlinelibrary.wiley.com/doi/10.1111/mms.12871>
- Charlton C, McCauley RD, Brownell RL Jr., Ward R, Bannister JL, Salgado Kent C (2022) Southern right whale (*Eubalaena australis*) population demographics at major calving ground Head of Bight, South Australia, 1991–2016. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 1–16. <https://doi.org/10.1002/aqc.3771>
- Christiansen F, Uhart MM, Bejder L, Clapham P, Ivashchenko Y, Tormosov D, Lewin N, Sironi M (2022a, *In Press*). Foetal growth, birth size and energetic cost of gestation in southern right whales. *Journal of Physiology*.
- Christiansen F, Bejder L, Burnell S, Ward R, Charlton C (2022b, *In Press*) Estimating the cost of growth in southern right whales from drone photogrammetry data and long-term sighting histories. *Marine Ecology Progress Series*.
- Christiansen F, Dawson SM, Durban JW, Fearnbach H and others (2020) Population comparison of right whale body condition reveals poor state of the North Atlantic right whale. *Marine Ecology Progress Series* 640: 1-16. <https://doi.org/10.3354/meps13299>
- Evans K, Charlton C, Townsend A, Watson M, Carroll E, Double M, Upston J, Carlyon K, Alderman R (2021) Estimation of population abundance and mixing of southern right whales in Australian and New Zealand regions. Report to the National Environmental Science Program, Marine Biodiversity Hub and CSIRO Oceans and Atmosphere.
- Johnston DR, Rayment W, Dawson S (2022) Morphometrics and body condition of southern right whales on the calving grounds at Port Ross, Auckland Islands. *Mammalian Biology Special Issue*. <https://doi.org/10.1007/s42991-021-00175-6>
- Kemper CM, Steele-Collins E, Al-Humaidhi A, Segawa Fellowes T, Marsh O, Charlton C (2022) Encounter Bay, South Australia, an important aggregation and nursery area for the southern right whale, *Eubalaena*

australis (Balaenidae: Cetacea), Transactions of the Royal Society of South Australia, DOI: 10.1080/03721426.2021.2018759

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van den Berg GL, Vermeulen E, Valenzuela LO, Bérubé M, Ganswindt A, Gröcke DR, Hall G, Hulva P, Neveceralova P, Palsbøll PJ, Carroll EL (2021) Decadal shift in foraging strategy of a highly migratory marine capital breeder. Global Change Biology 27: 1052-1067 <https://doi.org/10.1111/gcb.1546>

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IWC papers

Agrelo M, Sironi M, Groch K, Vilches F, Marón C, Rowntree V, Cooke J. (2021). Working plan for assessing movement rates between breeding grounds of southwest Atlantic southern right whales applying multi-state analysis. Report presented to the 68c IWC scientific committee (Southern Hemisphere subcommittee). SC/68C/SH16.

Butterworth D, Cooke J, Charlton C, Vermeulen E, Ross-Gillespie A, Brandão A, Groch K, Meaper R, Rayment W, Rowntree V, Sironi M, Agrelo M, van den Berg G, Watson M, Carroll EL, Carlyon K, Burnell S, Double M, Jackson J. (2021) Progress report: Multi-ocean assessment of southern right whale demographic parameters and environmental correlates. Report presented to the 68c IWC scientific committee (Southern Hemisphere subcommittee). SC/68C/SH06.

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Carroll E., Steel D, Andrews-Goff V, Baker C. Scott, Cole R, Riekkola L, van der Reiss A, Stuck E, Zerbini AN, Harcourt R, Olavarria C, Torres L, Childerhouse S. (2021). Tohorā nō Aotearoa – New Zealand southern right whale Auckland Islands expedition report, with genotype matching to 1995-2009 catalogue. Report presented to the 68c IWC scientific committee (Southern Hemisphere subcommittee). SC/68C/SH03.

Charlton C, Vermeulen E, Carroll EL, Butterworth D, Justin C, Ross-Gillespie A, Brandao A, Groch K, Leaper R, Rayment W, Rowntree V, Sironi M, Van den Berg G, Watson M, Double M, Jackson J (2020) Progress Report on the intersessional working group “Multi-ocean assessment of southern right whale demographic parameters and links to environmental correlates”, June 2019 to May 2020. Report



presented to the 68B IWC scientific committee (Southern Hemisphere Subcommittee), Cambridge, UK. SC/68B/SH15.

Charlton C, Vermeulen EL, Hoerbst, Gregory, Christiansen F, Findlay K, Moore M, Leslie, Minton G, Hamilton P, Pettis H (2021) Global, standardised southern right whale qualitative visual health assessment protocol. Report presented to the 68c IWC scientific committee (Southern Hemisphere Subcommittee). SC/68C/SH21.

Kennedy AS, Carroll EL, Baker S, Bassoi M, Buss D, Collins MA, Calderan S, Ensor P, Fielding S, Leaper R, MacDonald D, Olson P, Cheeseman T, Groch K, Hall A, Kelly N, Miller BS, Moore M, Rowntree VJ, Stowasser G, Trathan P, Valenzuela LO, Vermeulen E, Zerbini AN, Jackson JA (2020) Whales return to the epicentre of whaling? Preliminary results from the 2020 cetacean survey at South Georgia (Islas Georgias del Sur). Report presented to the 68B IWC scientific committee (Conservation Management Plan Subcommittee), Cambridge, UK. SC/68B/CMP22. <http://doi.org/10.13140/RG.2.2.25246.15687>

Khan C, Holmberg J, Hamilton P, Pettis H, Blount D, Parham J, Mucha M, Charlton C, Rowntree V, Vermeulen E, Rayment W, Dawson S, Johnston D, Groch K (2020) From Competition to Collaboration: Automated Identification of Right Whales. Report presented to the 68B IWC scientific committee (Photo-identification Subcommittee), Cambridge, UK. SC/68B/PH03.

Remedios N, Smith C, Carroll EL. (2021), Preliminary genomic and istopic insights from whaling era southern right whale bone from mainland Aotearoa New Zealand. Report presented to the 68c IWC scientific committee (Southern Hemisphere subcommittee). SC/68C/SH01.

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Smith JN, Kelly N, Double M, Charlton C, Bannister JL (2022) Relative abundance of the ‘western’ population of southern right whales from an aerial survey off southern Australia: Final Report on 2021 survey. Report to the National Environmental Science Program, Murdoch University (lead organisation).

Conference presentations

Agrelo M, Sironi M, Marón CF, Vilches FO, Rowntree V, Groch KR, Renault-Braga EP, Torrez-Florez JP, Cooke JG (2022) Assessing movement rates of Southwest Atlantic southern right whales between Argentina and Brazil (working plan). SWA SRW CMP Workshop, Curitiba.

Cranswick A, Newsome S, Baker CS, Busquets-Vass G, Childerhouse SJ, Dunshea G, Carroll EL (2021) Foraging flexibly or consuming conservatively? Foraging ecology of New Zealand southern right whales over three decades using stable carbon $\delta^{13}\text{C}$ and nitrogen $\delta^{15}\text{N}$ isotopes. Oral presentation to the Stable Isotope Network for New Zealand Hui, December 2021.

Germishuizen M, Vermeulen E, Vichi M (2022) Southern right whale foraging ecology and migratory behaviour in a changing climate. Poster presentation at South African Marine Science Symposium, 20-24 June 2022, Durban, South Africa.

Hörbst S, Charlton C, Gregory E, Christiansen F, Dawson S, Hamilton P, Salgado Kent S, Minton G, Rowntree V, Sironi M, Uhart M, Weir C, Vermeulen E (2022) Developing a global, standardised qualitative visual health assessment protocol for southern right whales. Video presentation at the 24th Biennial Conference on the Biology of Marine Mammals, 1 -5 August 2022, Palm Beach, Florida, USA.

Marón CF, Vilches F, Alzugaray L, Donini A, Di Martino M, Muñoz Moreda C, Rowntree VJ, Uhart M, Sironi M (2022) Anthropogenic injuries in southern right whales (*Eubalaena australis*) off Argentina: a preliminary analysis. SWA SRW CMP Workshop, Curitiba.

Shuttleworth L, Van Zyl M, Ganswindt A, Ajó AF, Carroll EL, Hunt K, Saekamela M, Valenzuela L, Vermeulen E (2022) A new insight into southern right whale reproduction via baleen endocrine and stable isotope analysis. Oral presentation at South African Marine Science Symposium, 20-24 June 2022, Durban, South Africa.

Shuttleworth L, Vermeulen E, Ajó AF, Carroll EL, Hunt K, Saekamela M, Valenzuela L, Ganswindt A (2022) Assessing temporal changes in southern right whale foraging ecology and female reproductive cycles. Poster presentation at the 24th Biennial Conference on the Biology of Marine Mammals, 1 -5 August 2022, Palm Beach, Florida, USA.

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Van Zyl M, Ganswindt A, Hunt K, Ajó AF, Vermeulen E (2022) Assessing androgen cycles in male southern right whales through baleen analysis. Poster presentation at South African Marine Science Symposium, 20-24 June 2022, Durban, South Africa.

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- Vermeulen E, Charlton C, Burnell S, Carlyon K, Galetti B, Groch K, Rayment W, Rowntree V, Sironi M, Smith J, Watson M (2022) The Southern Right Whale Consortium. Oral presentation at the 24th Biennial Conference on the Biology of Marine Mammals, 1 -5 August 2022, Palm Beach, Florida, USA.
- Vermeulen E (2022) Recent changes in the South African southern right whale population – what do we know so far? Oral presentation at South African Marine Science Symposium, 20-24 June 2022, Durban, South Africa.
- Vilches FO, Muñoz Moreda C, Orce A, Sironi M, Marón CF, Rowntree JV (2022) Península Valdés southern right whale photo-ID catalogs: an update on the analysis of aerial survey and whale-watch photographs. SWA SRW CMP Workshop, Curitiba.

Media interest – South Africa

- IOL - University of Pretoria Mammal Research Whale Unit to save southern right whales, other cetaceans - <https://www.iol.co.za/pretoria-news/news/university-of-pretoria-mammal-research-whale-unit-to-save-southern-right-whales-other-cetaceans-bb4122a3-6820-465e-9e53-5a9940710d32>
- Die Groot Ontbijt - Partnership with WWF
- The Sunday Times (online) - Partnership with WWF
- WWF - South Africa's southern right whales need our help <https://africa.panda.org/?38502/South-Africas-southern-right-whales-need-our-help>
- IOL - South Africa's southern right whales need our help - <https://www.iol.co.za/travel/travel-news/south-africas-southern-right-whales-need-our-help-fa439a95-22a9-4f92-9cc0-ffe0bad98bbf>
- Radio 768 - live interview Radio - Partnership with WWF
- Cape Talk - live interview Radio - Partnership with WWF
- SABC radio - live interview - Partnership with WWF
- Impact FM - live interview - Partnership with WWF
- Getaway - Climate change is impacting South Africa's southern right whales <https://www.getaway.co.za/travel-news/climate-change-is-impacting-south-africas-southern-right-whales/>
- El Diario Nuevo Dia - Nunca visto: una ballena franca austral etiquetada en Sudáfrica apareció en la Patagonia <https://www.eldiariounuevodia.com.ar/regionales/info-general/2022/4/23/nunca-visto-una-ballena-franca-austral-etiquetada-en-sudafrica-aparecio-en-la-patagonia-177608.html>
- IOL - Southern right whale makes remarkable journey <https://www.iol.co.za/capetimes/news/southern-right-whale-makes-remarkable-journey-096504f6-6a7f-4f3a-8528-163f6f748b56>
- Mail and Guardian - Whale makes unprecedented 10 000km journey from SA to Argentina <https://mg.co.za/environment/2022-04-27-whale-makes-unprecedented-10-000km-journey-from-sa-to-argentina/>
- Mas Rio Negro - Increíble recorrido de una ballena franca austral desde Sudáfrica hasta la Patagonia <https://www.masrionegro.com/2022/05/21/Increible-recorrido-de-una-ballena-franca-austral-desde-sudafrica-hasta-la-patagonia/>
- WWF - Championing the cause of the southern right whale https://www.wwf.org.za/our_news/our_blog/championing_the_cause_of_the_southern_right_whale/
- Marine Dynamics - Celebrating the Southern Right Whale Season with Marine Dynamics. <https://sharkwatchsa.com/en/blog/category/503/post/4391/>
- 50/50 – TV Documentary - Southern right whales in a changing climate
- Network 24 - What to do when whales wash up <https://www.network24.com/network24/za/hermanus-times/nuus/what-to-do-when-whales-wash-up-20220823-2>
- Tourism Update - Overstrand capitalises on whale season as numbers grow <https://www.tourismupdate.co.za/article/overstrand-capitalises-whale-season-numbers-grow>
- MatieMedia - Why we are catching whales for conservation <https://www.matiemediia.org/whales/>
- NatGeo – TV documentary - SRW migration

14/08/2021	eNCA	Count survey
20/08/2021	The Village News	Whale season in full swing - Do not fear, the whales are here
17/09/2021	RSG radio	Live interview Dr Vermeulen
17/09/2021	Daily Maverick	Researchers cite climate crisis as possible reason behind decreased southern right whale migration to SA
17/09/2021	Radio 786	Live interview Dr Vermeulen
2/10/2021	Maritime Review Africa	Whale watching in the 21st century
2/10/2021	Business Tech Africa	Drones making waves
3/10/2021	RapportW esternCape	Hommeltuie help met walvisnavorsing
1/10/2021	EWN	UP whale unit to start world's longest aerial survey of southern right whales
5/10/2021	Beeld, Daily	Groot walvis-tellery het begin
4/10/2021	Cape Times	The first stretch of the MRI Whale Unit aerial survey is complete
5/10/2021	Die Burger	Jaarlikse opname van walvisse langs Kaapse kusgebied begin
5/10/2021	Volksblad	Groot walvis-tellery het begin
14/10/2021	AM	Live interview with John Matham
29/10/2021	The Village News	Following our whales via satellite
1/11/2021	Gansbaai Courant	Aerial survey of southern right whales completed
09/07/2020	Cape Argus	Experts warn of ongoing threat to marine species
09/05/2020	The Saturday Star	Expert's letter calls for action to save cetaceans
09/07/2020	Independent online	Expert's letter calls for action to save cetaceans
09/14/2020	PDBY	UP Whale Institute researcher organises open statement against marine life extinction
09/23/2020	Conservation Magazine	Protecting Whales and Dolphins from Extinction: Call for Global Action
09/29/2020	Cape Times	Surveying SRW in SA
29/09/2020	Yiba	UP Whale Unit to gather data on dwindling southern right whale populations
02/10/2020	RSG radio	Live interview with Gideon Van den Berg
02/10/2020	Times Live	Whale numbers off SA down again as scientists warn of ecosystem turmoil
07/10/2020	The Village News	Whale survey findings published
07/10/2020	Hermanus times	Whale numbers down by half
14/10/2020	Amazonanws (Pril)	Whales are washing up along Cape coast
14/10/2020	Netwerk 24	Minder walvisse langs SA kus weens klimaat - opname
19/10/2020	JuniorTukkie	2020 Annual Aerial Survey of southern right whales
19/10/2020	Science at One	Interview - South African southern right whales
09/12/2020	Cape Talk	Decline in whale migration is due to less calving and lack of energy, say UP researchers
09/12/2020	Cape Times	Alarm over slump in number of visiting southern right whales
09/12/2020	Amazonaws	Study tackles the decline in the migration of whales to South Africa
10/12/2020	eNCA	TV interview - South Africa's southern right whales



Media interest – New Zealand

Guardian article: <https://www.theguardian.com/world/2021/aug/27/bill-and-tags-excellent-adventure-a-year-in-the-life-of-one-southern-right-whale>

New Zealand Geographic Articles

<https://www.nzgeo.com/stories/the-whales-are-back/>

<https://www.nzgeo.com/stories/double-bill/?state=requireSubscription>

<https://www.nzgeo.com/stories/revisiting-tohora/>

<https://www.nzgeo.com/stories/tracks-of-the-tohora/>

Radio New Zealand - Kim Hill Interview:

<https://www.rnz.co.nz/national/programmes/saturday/audio/2018814769/dr-emma-carroll-following-the-whale-that-crossed-three-oceans>

ABC article: <https://www.abc.net.au/news/2021-11-23/tracking-southern-right-whales/100630866>

BBC video: <https://www.bbc.com/news/av/world-australia-59646562>

Media interest – Argentina

New Scientist: <https://www.newscientist.com/article/2293979-climate-change-could-slow-recovery-of-southern-right-whales/>

Popular Science: <https://www.popsoci.com/animals/climate-change-threatens-whale-populations/>

Mongabay: <https://news.mongabay.com/2021/12/el-nino-takes-a-toll-on-southern-right-whales-in-the-atlantic-ocean/>

Ocean care: <https://www.oceancare.org/en/whale-recovery-threat-from-climate-change-the-antarctic-evidence/>

Vía País, Argentina: <https://viapais.com.ar/rawson/por-primera-vez-se-monitoreo-la-migracion-de-una-ballena-en-dos-etapas-de-su-vida/>

Página 12, Argentina: <https://www.pagina12.com.ar/480139-record-de-ballenas-en-la-peninsula-valdes-el-mayor-numero-en>

El País, Spain: <https://elpais.com/argentina/2022-09-08/argentina-registra-el-mayor-numero-de-ejemplares-de-ballena-franca-austral-en-50-anos.html>

La Nación +, Argentina: <https://www.lanacion.com.ar/sociedad/muerte-de-las-ballenas-en-puerto-madryn-motivos-y-preocupacion-de-expertos-nid01102022/>

El País, Spain: <https://elpais.com/argentina/2022-10-06/argentina-investiga-la-muerte-de-15-ballenas-en-10-dias-en-una-reserva-natural-de-la-patagonia.html>

NatGeoPristineSeas: <https://www.instagram.com/reel/Cj12OhojYtE/?igshid=NjQxMzA2Mjk%3D>

TV Pública, Argentina:

https://www.youtube.com/watch?v=5e_SF6tl_Yw&ab_channel=Televisi%C3%B3nP%C3%BAblica

Australia

More southern right whales are returning to their original birthing grounds across Australia as population rebounds| ABC News National. September 3, 2022 <https://www.abc.net.au/news/2022-09-03/southern-right-whales-return-to-historic-birthing-grounds/101396206>

Whale-watching on Nullarbor's rugged coastline holds special significance for Anangu Yalata children. ABC Regional. October 27, 2022 <https://www.abc.net.au/news/2022-10-23/whales-celebrated-by-anangu-yalata-at-nullabor-head-of-bight/101543066>

Meet whale whisperer Rod Keogh and the southern rights in his 'front yard' at Fowlers Bay. ABC Regional. November 7, 2022 <https://www.abc.net.au/news/2022-11-06/fowlers-bay-southern-right-whale-whisperer-rod-keogh/101588560>

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IWC-SORP THEME 7 PROGRESS REPORT – 2022/23. Recovery status and ecology of Southern Hemisphere fin whales

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Executive summary

The fin whale theme was established in 2019 and is the youngest of all the IWC-SORP themes. It currently comprises only one project, which investigates the fin whales in the Scotia Sea and Antarctic Peninsula region. In the current reporting period, five peer-reviewed papers were published in Scientific Journals, and one paper received considerable media attention with a minimum of 183 different news features reporting about it. Preparations for upcoming fieldwork were undertaken, including another abundance survey, photo-ID, satellite telemetry and biopsy sampling will be carried out during a voyage in 2023.

Introduction

Southern Hemisphere fin whales (SHFW) were severely exploited and nearly depleted by 20th century commercial whaling. Until today, recovery rates of the population remain unknown. Fin whales have been the target of relatively limited research in the Southern Hemisphere over recent decades. Very little is known about their population structure, ecology, habitat use and migratory behaviour. The fin whale theme aims to integrate different fields of fin whale research to work towards elucidating the population status of Southern Hemisphere fin whales in the post-whaling era. It aims to bring together information on population structure, migratory behaviour and destinations, current population numbers and feeding ecology.

Objectives

The Southern Hemisphere fin whale theme aims to bring together research results from past, current and future projects providing an opportunity for coordination, cooperation and joint outcome analyses. While little dedicated research has been conducted on fin whales in the Southern Hemisphere, several research groups have been collecting data on fin whales opportunistically during other research efforts. One objective of this theme is to collate these data from different groups and sources, and to analyse them together. Furthermore, dedicated research is required to gain insights into population structure, to investigate ecological drivers of fin whale distribution and to understand their movement patterns and migratory pathways.

The specific objectives are:

1. Enhancing the understanding of distribution patterns and local abundance estimates.
2. Investigation of the population structure.
3. Identification of migration routes and migratory destinations.
4. Understanding feeding ecology: drivers for fin whale distribution, spatial relationships between fin whale and krill distribution, prey selectivity.

Results (Status as of 22 March, 2023):

A functional and active network of fin whale researchers and fin whale data holders has been established as the basis for the fin whale theme and source for data.

Fin whale sighting records collected opportunistically as well as during dedicated research efforts in the Scotia Sea and Antarctic Peninsula region over the past 40 years have been compiled from members of the network for a comprehensive analysis. The results provide an overview of fin whale distribution in the area, as well as hotspots of seasonal abundance around the island groups along the Antarctic Peninsula and were published as Viquerat et al. (2022).

Two cruises to the Antarctic Peninsula region in 2018 (*RV Polarstern*) and 2019 (*Pelagic Australis*) were dedicated to investigating the repeatedly reported aggregations of fin whales around Elephant Island. Both expeditions re-encountered large aggregations of fin whales. A dedicated aerial survey during the *RV Polarstern* voyage estimated fin whale abundance in the area. These results were published as Herr, Viquerat, et al. (2022) and received considerable media attention (see Project Outputs below).

High resolution footage of the aggregations was analysed to investigate the skin condition of the filmed individuals. Skin analyses revealed a high number of cookie-cutter shark bite lesions suggesting migration of fin whales to latitudes lower than 40°S, providing first hints on migratory destinations. These results were published as Herr et al. (2023)

In 2021, four satellite transmitters were deployed on fin whales at the feeding grounds off Elephant Island in 2021. Two transmitters lasted until the animals started migrating, revealing migration into the Pacific Ocean. These results were now published as Herr, Hickmott, et al. (2022).

At the time of writing, MSM115 FINWAP (25 February - 30 March 2023) was underway (see also [SC/69a/SHXX](#)). The voyage traversed the northern shelf edge area along the western Antarctic Peninsula, from the South Shetland Islands to the South Orkney Islands, 60-63°S, spanning a longitudinal range from 44° to 65°W. A sighting survey was conducted along a set of track lines zig-zagging over the shelf-edge, the area where most fin whales are expected based on previous results (Herr, Viquerat, et al., 2022; Viquerat et al., 2022). A concurrent, CCAMLR-standardised krill net trawl survey was conducted along the same transects, for later comparison of whale and krill distribution. The surveys were interrupted for small boat work when fin whale groups are encountered, in order to collect biopsy samples, photo-ID data and to deploy satellite transmitters. By 22 March 2023, eleven tags had been deployed on fin whales off Elephant Island: six Standard Mk10; one Fast-Loc Mk10; two SPOT tags and two Stingray Camera Tags. Furthermore, 20 fin whale biopsy samples and 4 faecal samples had been collected. Visual surveys had been successfully conducted, acoustic recordings made and drone flights carried out; and 51 krill stations (net trawls) had been sampled. Detailed analyses of these data will be presented next year.

Linkages between the fin whale theme exist with IWC-SORP Theme 5, '*Acoustic trends in abundance, distribution, and seasonal presence of Antarctic blue whales and fin whales in the Southern Ocean*', investigating the characteristics of fin whale song. Information on geographic variation in fin whale song to aid population identification contributes to analyses of population structure.

Conclusions

Research on fin whales in the Antarctic Peninsula and Scotia Sea region is progressing and providing new information. Results include new insights into distribution, abundance and migration. More information is expected in the near future as the results of MSM115 FINWAP (2023) are analysed, including tagging efforts, biopsy sampling, photo-ID data collection and acoustic recordings.

Challenges

The fin whale theme currently hosts only one fin whale project. More fin whale projects would be desirable, particularly for information from other areas than the Antarctic Peninsula and Scotia Sea region, to complement available information and for a bigger picture of the fin whale population status in the Southern Hemisphere.

Outlook for the future

Research voyage MSM115 FINWAP in March 2023 has collected a variety of data from different disciplines, allowing for further investigations of migration patterns, feeding ecology, acoustic repertoire and population structure. The theme invites contributions from other research initiatives investigating fin whales in the Southern Ocean, and is always open to new members joining the fin whale network.

Project outputs

Students and theses

One student conducted an analysis of video imagery collected within the framework of this project a semester project. The results of the project have been compiled in a report (Rychwalski 2023) and are currently being prepared for submission as a manuscript to a scientific journal.

Alexander N. Rychwalski. Laterality analysis of southern fin whales (*Balaenoptera physalus quoyi*) during surface lunge feeding aggregations in the Antarctic. Semester project report, University of Hamburg, Germany, 2023.

Peer-reviewed papers

Bamford C, Kelly N, Herr H, Seyboth E, Jackson JA (2023) The recovery of Antarctica's giants – baleen whales. Antarctic Environments Portal. <https://doi.org/10.48361/edgj-pp83>

Herr H, Hickmott L, Viquerat V, Panigada S (2022) First evidence for fin whale migration into the Pacific from Antarctic feeding grounds at Elephant Island. Royal Society Open Science 9(9), 22072. <https://doi.org/10.1098/rsos.220721>

Herr H (2020) Rückkehr der Finnwale in die Antarktis - 30 Jahre nach Beendigung des kommerziellen Walfangs (Return of the fin whales to Antarctica). Biologie in unserer Zeit 50(5): 338-345. <https://doi.org/10.1002/biuz.202010716>

Herr H, Viquerat V, Lees A, Wells L, Devas F, Gregory B, Meyer B (*Accepted*) Large fin whale aggregations at Southern Ocean feeding grounds five decades after the end of commercial whaling in the Southern Ocean. Scientific Reports.

Herr H, Viquerat S, Naujocks T, Gregory B, Lees A, Devas F (2023) Skin condition of fin whales at Antarctic feeding grounds reveals little evidence for anthropogenic impact and high prevalence of cookiecutter shark bite lesions. Marine Mammal Science, 39(1) 299-310. <https://doi.org/10.1111/mms.12966>

Herr H, Viquerat V, Lees A, Wells L, Devas F, Gregory B, Meyer B (2022) Return of Large fin whale feeding aggregations to historical whaling grounds in the Southern Ocean. Scientific Reports 12(1), 9458. <https://doi.org/10.1038/s41598-022-13798-7>

Viquerat, S, Waluda CM, Kennedy A, Kelly N, Jackson J, Hevia M, Carroll E, Buss D, Thain S, Smith P, Secchi E, Santora J, Reiss C, Lindstrøm U, Krafft B, Gittens G, Dalla Rosa L, Biuw M, Herr, H (2022) Identifying seasonal distribution patterns of Southern Hemisphere fin whales from multiple data sources using a novel approach combining habitat suitability models and ensemble learning methods. Frontiers in Marine Science. <https://doi.org/10.3389/fmars.2022.1040512>

Reports

Herr H, Viquerat S, Kesselring T, Krieger C, Gischler M, Zillgen C, Richter R, Santos V (2019) Large whale distribution around South Georgia and the South Sandwich Islands in the post-whaling era. In: Bohrmann G (Ed) The Expedition PS119 of the Research Vessel POLARSTERN to the Eastern Scotia Sea in 2019. Berichte zur Polar- und Meeresforschung (= Reports on polar and marine research)

Bremerhaven, Alfred Wegener Institute for Polar and Marine Research, 736, 236.

https://doi.org/10.2312/BzPM_0736_2019

Alexander N. Rychwalski. Laterality analysis of southern fin whales (*Balaenoptera physalus quoyi*) during surface lunge feeding aggregations in the Antarctic. Semester project report, University of Hamburg, Germany, 2023.

Conference presentations

Herr H, Viquerat S, Lees A, Devas F, Meyer B (2019) Return of the fin whales: Feeding aggregations of fin whales around the Northern Antarctic Peninsula (oral). World Marine Mammal Conference 2019, 9-12 December, Barcelona, Spain.

Herr, Helena (2022) Invited talk: Return of the fin whales. Evidence for population recovery 35 years after the end of commercial whaling in the Southern Ocean. 28th International Polar Conference, 1-5 May, Potsdam, Germany.

Media interest

The paper 'Return of large fin whale feeding aggregations to historical whaling grounds in the Southern Ocean' received considerable media attention. Upon publication, Herr gave 21 interviews with the following news outlets, which all produced articles or news features:

- The New York Times (USA)
- The Wall Street Journal (USA)
- The Times (UK)
- Agence France Press (AFP) (France)
- Les Temps (Switzerland)
- The New Scientist (USA)
- Inside Climate News (USA)
- The World (US Radio News)
- iTV (UK)
- ZDFheute (Germany)
- BR Nachrichten (Germany)
- BR Wissen (Germany)
- WDR Quarks (Germany)
- Deutschlandfunk (Germany)
- Publico (Portugal)
- Japanese Daily News (Japan)
- NewsOmatic (USA)
- Republik.ch (Switzerland)
- Worlds Best News DK (Denmark)
- 2050 (Germany)
- Current Affairs Times (USA)

In addition, the study was also featured in e.g., Die Zeit, Der Spiegel, The Guardian, NBC News, N-TV, National Geographic, Bangkok Post, ElPeriodico, Newsweek, Brisbane Times, Der Tagesspiegel, JapanToday, Geo, Hamburger Abendblatt, Bildzeitung, etc.

Altimetric (<https://nature.altmetric.com/details/130806825>) counts 182 stories appeared in 137 different news outlets (not yet counting most of the non-English language features)

The paper 'Return of large fin whale feeding aggregations to historical whaling grounds in the Southern Ocean' was featured as a Research Highlight in NATURE: <https://www.nature.com/articles/d41586-022-01910-w>

Herr was guest in a German radio talk show speaking about fin whales. WDR Quarks – Wissenschaft und mehr,



12 October 2022, Germany

Herr was guest in a live talk show and talked about fin whales. 'Wahnsinn trifft Methode', 31 October 2022, Ernst Deutsch Theater, Hamburg, Germany

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- Herr H, Viquerat S, Naujocks T, Gregory B, Lees, A, Devas F (2023) Skin condition of fin whales at Antarctic feeding grounds reveals little evidence for anthropogenic impacts and high prevalence of cookiecutter shark bite lesions. Marine Mammal Science 39(1): 299-310. <https://doi.org/10.1111/mms.12966>
- Viquerat, S, Waluda CM, Kennedy A, Kelly N, Jackson J, Hevia M, Carroll E, Buss D, Thain S, Smith P, Secchi E, Santora J, Reiss C, Lindstrøm U, Krafft B, Gittens G, Dalla Rosa L, Biuw M, Herr, H (2022) Identifying seasonal distribution patterns of Southern Hemisphere fin whales from multiple data sources using a novel approach combining habitat suitability models and ensemble learning methods. Frontiers in Marine Science. <https://doi.org/10.3389/fmars.2022.1040512>

IWC-SORP PUBLICATIONS

Overall, IWC-SORP themes have produced at least 43 peer-reviewed scientific papers, bringing the total number produced since the start of the initiative to ca. 291. Moreover, >200 IWC-SORP related papers have been submitted to the Scientific Committee, >14 of them this year. IWC-SORP has directly contributed to at least 11 PhD, 8 Masters and 8 honours theses and the work of at least 5 postdoctoral fellows.

List of IWC-SORP related papers submitted to SC/69a for consideration

- SC/69a/ForInfoXX Andrews-Goff V, Bell EM, Miller BS, Wotherspoon SJ, Double MC (2023) Satellite tag derived data from two Antarctic blue whales (*Balaenoptera musculus intermedia*) tagged in the east Antarctic sector of the Southern Ocean.
- SC/69a/SHXX Bell E (2023) Annual Report of the Southern Ocean Research Partnership 2022/23.
- SC/69a/SHXX Bell E (2023) IWC-SORP Research Fund: progress reports.
- SC/69a/ForInfoXX Calderan et al. (2022) Surfacing rates, swim speeds, and patterns of movement of Antarctic blue whales.
- SC/69a/ForInfo36 Derville et al. Long-term stability in the circumpolar foraging range of a Southern Ocean predator between the eras of whaling and rapid climate change.
- SC/69a/SHXX Double MC et al. (2023) A new Krill and Krill Ecosystem project (KaKE).
- SC/69a/ForInfo42 Viquerat et al. Identifying seasonal distribution patterns of fin whales across the Scotia Sea and the Antarctic Peninsula region using a novel approach combining habitat suitability models and ensemble learning methods.
- SC/69a/ForInfo43 Herr et al. Skin condition of fin whales at Antarctic feeding grounds reveals little evidence for anthropogenic impacts and high prevalence of cookiecutter shark bite lesions.
- SC/69a/ForInfo44 Herr et al. Return of large fin whale feeding aggregations to historical whaling grounds in the Southern Ocean.
- SC/69a/ForInfo45 Herr et al. First evidence for fin whale migration into the Pacific from Antarctic feeding grounds at Elephant Island.
- SC/69a/SHXX Olson PA, Kinzey D, Double MC, Matsuoka K, Findlay K (2023) Capture-recapture estimates of abundance of Antarctic blue whales.
- SC/69a/SH02 Sprogis KR, Harcourt R, Riekkola L, Andrews-Goff V, Vermeulen E, Zerbini AN, Kennedy AS, Gales N, Carroll EL (2023) Investigating western Australian southern right whale foraging grounds through satellite telemetry.
- SC/69a/ForInfo37 Vermeulen et al. Decadal decline in maternal body condition of a Southern Ocean capital breeder.
- SC/69a/ForInfo38 Vermeulen et al. Swimming across the pond: First documented transatlantic crossing of a female southern right whale.

IWC-SORP related papers submitted to the SC in previous years

- SC/61/SH17 Gales N, Double M, Robinson S, Jenner C, Jenner M, King E, Gedamke J, Paton D, Raymond, B. (2009) Satellite tracking of southbound East Australian humpback whales (*Megaptera novaeangliae*): challenging the feast or famine model for migrating whales.
- SC/62/SH3 Garrigue C, Peltier H, Ridoux V, Franklin T, Charrassin J-B (2010) CETA: a new cetacean observation program in East Antarctica.
- SC/63/O12 Childerhouse S (2011) Annual Report of the Southern Ocean Research Partnership 2011.
- SC/63/O13 Childerhouse S (2011) Southern Ocean Research Partnership Revised project plans.
- SC/63/SH16 Constantine R *et al.* (2011) Comprehensive photo-identification matching of Antarctic Area V humpback whales.
- SC/63/SH10 Steel D et al. (2011) Initial genotype matching of humpback whales from the 2010 Australia/New Zealand Antarctic Whale Expedition (Area V) to Australia and the South Pacific.
- SC/64/O13 Bell E (2012) Annual Report of the Southern Ocean Research Partnership 2011/12.
- SC/64/O14 Baker CS, Galletti B, Childerhouse S, Brownell RL Jr, Friedlaender A, Gales N, Hall A, Jackson J, Leaper R, Perryman W, Steel D, Valenzuela L and Zerbini A (2012) Report of the Living Whales Symposium: Advances in non-lethal research techniques for whales in the Southern Hemisphere.

- SC/64/SM06 Chambellant M, Garrigue C, Peltier H, Charrassin JB, Ridoux V (2014) First photo-ID catalogue of killer whales (*Orcinus orca*) in East Antarctica.
- SC/64/IA10 Kelly N, Murase H, Kitakado T, Kock K-H, Williams R, Feindt-Herr H and Walløe L (2012) Estimating abundance and distribution of Antarctic minke whales within sea ice areas: data requirements and analysis methods.
- SC/64/SH10 Kelly N, Miller B, Peel D, Double MC, de la Mare W and Gales N (2012) Strategies to obtain a new circumpolar abundance estimate for Antarctic Blue Whales: survey design and sampling protocols.
- SC/64/SH11 Miller BS, Kelly N, Double MC, Childerhouse SJ, Laverick S and Gales N (2012) Development of acoustic methods: cruise report on SORP 2012 Antarctic Blue Whale voyages.
- SC/64/SH12 Miller BS (2012) Real-time tracking of Blue Whales using DIFAR sonobuoys.
- SC/64/SH13 Wadley V, Lindsay M, Kelly N, Miller N, Gales N, de la Mare W and Double MC (2012) Abundance estimation of Antarctic Blue Whales: preliminary voyage plan for SORP in March 2013.
- SC/64/SH14 de la Mare WK (2012) Estimating relative abundance from historic Antarctic whaling records.
- SC/64/SH15 Schmitt NT, Double MC, Baker CS, Steel D, Jenner KCS, Jenner M-NM, Paton D, Gales R, Jarman SN, Gales N, Marthick JR, Polanowski AM and Peakall R (2012) Low levels of genetic differentiation characterize Australian humpback whale (*Megaptera novaeangliae*) populations.
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