







A happy, healthy and safe community

2022





ANNUAL FIELD REPORT

WHALE

CHI WHALE ST

LONG-TERM RESEARCH OF SOUTHERN **RIGHT WHALE (EUBALAENA AUSTRALIS) IN PRIMARY CALVING GROUNDS**

OUR MISSION IS TO DELIVER WORLD CLASS LONG TERM RESEARCH FOR THE PROTECTION AND MANAGEMENT OF ENDANGERED SOUTHERN RIGHT WHALES, WHILST SHARING THEIR STORY THROUGH SCIENCE, COMMUNITY ENGAGEMENT, EDUCATION AND POLICY REPORT AUTHORS:

BRIDGETTE O'SHANNESSY-1,2,3, CLAIRE CHARLTON-1,2*, ROBERT MCCAULEY-1, WILLIAM GILMORE-3, STEPHEN BURNELL-4

- 1. CENTRE FOR MARINE SCIENCE AND TECHNOLOGY, CURTIN UNIVERSITY, BENTLEY, WESTERN AUSTRALIA, AUSTRALIA
- 2.CURRENT ENVIRONMENTAL, PERTH, WESTERN AUSTRALIA, AUSTRALIA
- 3.CETACEAN ECOLOGY, BEHAVIOUR AND EVOLUTION LAB, COLLEGE OF SCIENCE AND ENGINEERING, FLINDERS UNIVERSITY, ADELAIDE, SOUTH AUSTRALIA, AUSTRALIA
- 4. EUBALAENA PTY LTD, TENNYSON, SOUTH AUSTRALIA, AUSTRALIA

Disclaimer:

This document has been prepared for Minderoo Foundation and copyright and intellectual property of this document is vested with Primary Investigators Dr. Claire Charlton of Current Environmental and Dr. Stephen Burnell of Eubalaena Pty. Ltd. However, the views expressed herein are solely those of the authors.

*CONTACT PERSON

CLAIRE CHARLTON, PHD SENIOR SCIENTIST / DIRECTOR T: +61 476 146 394 E: CLAIRE@CURRENTENVIRONMENTAL.NET



ACKNOWLEDGEMENT OF COUNTRY

We acknowledge the sovereign Countries of the First Nations peoples across Australia where the Southern right whales visit. We honour their connection to the land, sea and whales, and pay our respects to their Elders past and present. We acknowledge the Far West Coast Aboriginal People and are incredibly grateful to the Yalata People for generously providing land access and support for us to complete our research on their lands. We also acknowledge the Ramindjeri and Ngarrindjeri People of the Southern Fleurieu Coast on which the Encounter Bay Right Whale Study is undertaken.











FURTHER ACKNOWLEDGEMENTS

Minderoo Foundation Flourishing Oceans are primary sponsors and funders since 2021.

This research is a highly collaborative, multi-national and multidisciplinary program. Project collaborators within Australia include Curtin University, Flinders University, Murdoch University, Aarhus University, South Australian (SA) Museum, Western Australian (WA) Museum, Australian Antarctic Division, CSIRO, Department of Environment, National Environmental Science Program (NESP), Department of Environment Land, Water and People Victoria, Eubalaena Pty. Ltd., and Current Environmental.

The 2022 SRW research program was supported through funding from Minderoo Foundation, Current Environmental and Curtin University's Centre for Marine Science and Technology. Research funding for Encounter Bay Right Whale Study in 2021/2022 was provided by Australian Marine Conservation Society, Whale and Dolphin Conservation, Conservation Council SA, Wilderness Society, Save Our Marine Life and Sea Shepherd. We thank the Yalata Anangu people for their partnersip and support in the Great Australian Bight. In kind support provided by Yalata, Aboriginal Lands Trust, Rod and Simone Keogh from Fowlers Bay EP Cruises, Eubalaena Pty. Ltd., and the SA Museum. The 2022 field team, Bridgette O'Shannessy, Claire Charlton, William Gilmore, Connor McGarry, Solomon Meyer, Eva Robinson, Sacha Guggenheimer, Penni Howard, and Steve Hart are acknowledged. Thank you to Eugene and Jess the Head of Bight Whale Centre Managers for their on-the-ground support.

The team celebrates 32 years of consecutive research at Head of Bight and acknowledges all of those who have contributed and supported the research, to make this success possible. Luciana Moller and Guido Parra from Flinders University provided input to research at Encounter Bay and supervision of honours student. Thank you to the Encounter Bay Right Whale Study Citizen Scientists for their valuable contribution.

This research was completed under the SA Department of Environment Water and Natural Resources Scientific Permit to complete research in SA (M26085-12) with Animal Ethics approval from Curtin University (ARE2022-8).

Contents

Deliverable	1
Executive Summary	1
Background	3
Research objectives	4
Methods	6
Study Site	6
Head of Bight	7
Fowlers Bay	8
Encounter Bay	9
Sightings data: relative abundance and distribution1	0
Photo Identification: life histories, residency, site fidelity, connectivity and movement1	1
Fine scale movement and behaviour1	3
Results1	3
Head of Bight14	4
Relative abundance14	4
Distribution1	5
Life histories: photo ID1	6
Calving intervals1	6
Fine scale movement and behaviour1	8
Other Observations1	9
Fowlers Bay20	0
Sightings and photo ID20	0
Encounter Bay2	2
Sightings and photo ID2	2
Our Impact	5
Application to management and policy2	5
Science communication	6
Publications and reports 2021/202224	6
Media2	7
Community engagement and outreach2	7
Discussion	8
Next steps and future research goals	1
References	3

Table of Tables

Table 1. 2022 field season effort and sighting statistics at each study site for Cow-Calf pairs (CC),	
Unaccompanied Adults (UA) and Calves (CA)	.13
Table 2. 2022 inter-annual calving intervals available for 51 females at Head of Bight 2022	. 17
Table 3. Connectivity of SRWs photo-identified in Encounter Bay (n=26)	.24

Table of Figures

Figure 1. Identified SRW (Eubalaena australis) aggregations in Australian as identified in the CMP for
the SRW 2011-2021 (DSEWPaC, 2012)6
Figure 2. Australian Marine Park Network7
Figure 3. Head of Bight study area in the Great Australian Bight, South Australia
Figure 4. Fowlers Bay study area in the Great Australian Bight, SA9
Figure 5. Encounter Bay study area in the Encounter Marine Park, SA9
Figure 6. 2022 field season at Head of Bight and Fowlers Bay, SA.
Figure 7. Callosity patterns located on the rostrum, lip line and posterior to the blowhole used to
identify SRWs
Figure 8. a) UAV image taken of a SRW during survey and b) the callosity patterns coded for
matching in BigFish12
Figure 9. SRW relative abundance at Head of Bight, SA, between 17 July and 30 August 202214
Figure 10. Long term abundance trend of SRWs at the Head of Bight, SA15
Figure 11. SRW female and calf pairs counted for the south-western population from annual aerial
surveys 1993-2021 (Smith et al., 2022) and relative abundance counts from Head of Bight 1993-
2022
Figure 12. Sighting locations of SRW cow-calf pairs and unaccompanied adults at Head of Bight in
2022
Figure 13. Annual mean apparent calving intervals 1996-2022 for southern right whales in Australia
Figure 14. Frequency histogram of mean calving intervals observed for calving female SRWs,
comparing years 1996-2014 (grey) with years 2015-2020 (blue)
Figure 15. Fine scale movement (top figure) and behaviour (bottom figure) of SRWs (n=10) at Head
of Bight during 20-minute minimum focal follows
Figure 16. Southern right whale relative abundance at Fowlers Bay, SA, between 18 July and 31
August 2022.
Australian Museum parial survey data and 2014 2021 may daily sounts from vessal based surveys
Australian Museum aerial survey data and 2014-2021 max daily counts from vessel based surveys
Figure 18 Sighting locations of SPW cow-calf pairs and unaccompanied adults at Fowlers Bay in
2022
Figure 19 Location of SRW sightings collected during systematic land-based surveys at Encounter
Bay in 2019 2021 and 2022 Group classes were senarated into cow-calf pairs and unaccompanied
adults
Figure 20. Spatial distribution of cow-calf pairs and unaccompanied adults SRWs in Encounter Bay.
displaying representative ranges (95% UD) and core areas (50% UD) in 2019. and 2021-2022
Figure 21: Research volunteers 2022

Deliverable

The purpose of this report is to deliver deliverable to primary sponsors Minderoo Foundation Project CLB-2004 - MERL - Southern Right Whales and Climate Change Flourishing Oceans (# MF-196197) Tranche 2: Completion of 2022 field research and submission of the annual project field report.

The Annual Field report specifically reports on preliminary findings from the 2022 field research program which directly addresses project objective 1 and collects data to contribute to objectives 2&3 (outlined below).

The 2022 Annual Narrative Report (Tranche 3 deliverable) provides a broad overview of the project and progress towards the three key project objectives and can be viewed online at <u>www.southernrightwhales.com.au</u>.

Executive Summary

The Minderoo Foundation funded southern right whale (SRW, *Eubalaena australis*) research project ensures the continuation of the long-term annual research to assess distribution, abundance and life histories of SRWs in primary Australian calving ground, which started in 1991. SRWs are a keystone species in the Southern Ocean food web and this unbroken 32-year dataset enables research into the Australian population and contributes to the global assessment of SRW health and links to climate change.

The research directly addresses international, national and local priority objectives for species assessments, recovery planning and marine park management. The objectives are closely aligned to the Commonwealth Conservation Management Plan for the SRW, and the objectives of several Minderoo Foundation initiatives including: Flourishing Oceans, Research and Generation One and Building Community.

Research objectives include:

- 1. Continuation of the long-term research to assess distribution, abundance and life histories of SRWs in their primary calving ground at Head of Bight South Australia
- 2. Complete a visual health assessment of SRWs in Australia to inform broader assessments of links between demographics and health
- 3. Assess links between Southern Ocean climate variates and trends in abundance and reproduction of SRWs off Australia

This field report presents a summary and preliminary data from the 2022 field season and directly addresses objective 1 outlined above, and contributes data towards addressing objectives 2&3. The report also provides an overview of science communication (publications, outreach and media) and community engagement initiatives achieved during 2021/2022. Specifically, the 2022 Annual Field Report is delivering on funding milestone Tranche 2: completion of 2022 field research and submission of the annual project field report.

Field work in 2022 was undertaken during May to November in primary calving grounds for the south western population of SRWs including Head of Bight, Fowlers Bay and Encounter Bay in South Australia (SA). The 2022 season represented the 32nd consecutive year of research at Head of Bight, the 10th year at Fowlers Bay and the third year of systematic surveys at Encounter Bay. The study collects

population count, photo identification (photo-ID) and behavioural data, and provides an unbroken time series dataset on fine scale distribution, relative abundance trends, life history data, residency, site fidelity, behaviour, movements, and connectivity of SRWs.

The 2022 field season included 59 survey days across three sites, 21 daily surveys were completed at Head of Bight, 9 surveys (two vessel, two aerial and five land-based) at Fowlers Bay and 31 surveys at Encounter Bay. Over 20,000 photographs were collected across SA through systematic land-based survey, Unmanned Aerial Vehicles (UAV) photo-ID surveys and citizen science contributions. Data processing and within and across season photo ID matching was completed. This resulted in 1,165 whale sightings including 90% cow-calf pairs (1054) and 10% unaccompanied adults (112) and 135 unique individuals including 91 cow-calf pairs and 39 unaccompanied adults photo ID'd. All individuals were matched to available long term photo ID catalogues (HOB regional catalogue and partially matched to the Australasian Right Whale Photo Identification Catalogue (ARWPIC)), with 59% matches detected across years. The major aggregation area at Head of Bight represents around 30% of the overall south western population of SRW. Data collected during the extended field season (May-Oct, 1991-2022) provides a systematic, unbroken dataset that increases in value with every year of data collection.

Data processing is underway to contribute sightings and photo ID data to ARWPIC, the national data repository managed by the Australian Antarctic Division. ARWPIC currently includes 6,843 sightings of 2,586 unique individuals. The contribution and curation of Head of Bight data post 2018 will be achieved under the Minderoo funded research objectives.

Long term relative abundance trends reveal high inter-annual variation. Anomalous years of low whale numbers are potentially becoming more frequent in recent years. The increase in mean apparent calving intervals is contributing to high variation in annual abundance trends and may be a driver of slowed rates of increase observed (Smith et al., 2022). Contribution and curation of major photo-ID datasets in the national repository ARWPIC is required for a complete assessment of calving intervals using all available life history data. At Head of Bight, 19.7% less female and calf pairs (max daily count = 47) and 22.2% less unaccompanied adults (max daily count = 10) were recorded compared to 2021. At Fowlers Bay numbers were 10% higher for cow-calf pairs (max daily count = 11) compared to 2020 and very few unaccompanied adults (n=8) were sighted across all surveys. Whilst the population is increasing from commercial whaling at around 5% per year (Smith et al., 2022), the lower-thanexpected numbers is a concern for population recovery and the drivers of change need to be investigated.

Long-term monitoring of SRW populations across the Southern Hemisphere wintering grounds have revealed fluctuations in abundance and a lengthening of calving intervals, which has been associated with signs of reduced rates of population growth (Brandao et al., 2018; Vermeulen et al., 2019; Carroll et al., 2020; Charlton, 2021; Watson et al., 2021; Smith et al., 2022). In 2022, the mean apparent calving interval observed was 4.5 years (+/- 95% CI 4.3, 4.7) years, with no breeding females observed on a three-year cycle. There was a significant increase in mean apparent calving intervals from 3.2 years (+/- 95% CI 2.9, 3.6) during 1996-2014 to 3.9 years (+/- 95% CI 3.8, 4.1) during 2015-2020 (Charlton et al., 2021). The observed increase in mean calving intervals for SRWs off Australia in recent years requires investigation to assess potential correlations between reproductive success and climate variation. Links between climate anomalies and reproductive success have been documented for SRW

populations in their wintering grounds off Argentina, Australia, Brazil, and South Africa (Leaper et al., 2006; Pirzl et al., 2009; Seyboth et al., 2016; Van den Berg et al., 2019). Current research is underway to examine the correlation and lag times between calving success and climate anomalies including Oceanic Niño Index, Antarctic Oscillation and Antarctic Sea ice extent.

This research directly applies to management and policy of threatened species in Australia. Expertise and data are directly informing the updated Conservation Management Plan (CMP) for the SRW and updates to the Biologically Important Areas (BIAs) framework and boundaries (currently underway by Department of Climate Change, Energy, the Environment and Water [DCCEEW]). Project outputs include scientific publications, presentations and national and international conferences, community events and student projects. Outputs will contribute directly to the International Whaling Commission (IWC) Southern Ocean Research Partnership IWC-SORP Theme 6: The Right Sentinel for Climate Change, a multi-ocean assessment of foraging ecology, demographics, health and climate. Data contributes directly to the Australasian Right Whale Photo Identification Catalogue (ARWPIC), marine park management and planning, IUCN important marine mammal area development, key biodiversity areas, and global comparative studies. The project aligns with the DCCEEW National Environmental Science Program (NESP) and primary-investigators are contributing expertise and in-kind support to southern right whale research topics.

There is a strong community component to the project with the support of Yalata Aboriginal community and the Aboriginal Lands Trust since the project's inception, with a key outcome being community awareness and education, training and stewardship. A key project focus is to strengthen collaborations with Australian SRW researchers to build on community and citizen science initiatives and most effectively address research objectives.

With an expanding population of SRWs, there is a need to investigate potential impacts from human disturbances and climate related changes that could ultimately affect the recovery of this endangered species.

Background

SRWs are listed as endangered and migratory under the Australian Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and are an Australian Matter of National Environmental Significance. In Australia the population estimate is 2,549 individuals increasing at around 5.4% per annum for reproductive females, which is an estimated 15% of pre-whaling abundance (Smith et al. 2022). The increasing population along the Australian coastline requires ongoing research and monitoring to inform conservation management and risk mitigation. The Commonwealth CMP for the SRW (DSEWPaC, 2012) lists the following threats to the population recovery: entanglement, vessel disturbance, climate variability and change, noise interference and habitat modification.

To assess potential impacts to a population from human activities, an understanding of baseline distribution, abundance, movements and health is required. SRWs are long lived, slow to reproduce, migratory marine mammals that require long term monitoring on an annual basis to detect changes to the population over time and identify drivers of change.

SRWs feed in temperate and Antarctic waters and migrate to the southern coastline of Southern Hemisphere continents to calve, mate and nurse their young in the austral winter (between May and

October) (Charlton et al., 2019a). Two sub-populations of SRWs occupy coastal aggregation areas in Australia: the south western sub-population (WA and SA) and the south eastern sub-population (Victoria, New South Wales [NSW], and Tasmania) (DSEWPaC, 2012). Calving females are known to have high site fidelity and reside in calving grounds for up to three and a half months with the majority of calving presumed to have occurred by mid–August (Burnell, 2001; Charlton et al., 2017). However, movement of calving and non-calving adults has been recorded across broad distances both within and across seasons (Pirzl et al., 2009). Long-term annual research on SRWs in their winter calving grounds enables impact assessment of a changing climate to marine mammals.

Global warming and increased sea surface temperature has significantly reduced krill production in the Southern Ocean. Prey reduction is a key threat to migratory and endangered marine life including great whales. Fluctuations in reproductive rates and recovery of SRWs in the Southern Ocean provide an opportunity to assess the impact that climate variation has on migratory and endangered marine mammals. The 32-year research dataset on the SRW enables assessment of links between Southern Ocean climate variables and marine mammal health and recovery in Australia and globally. Understanding environmental and anthropogenic stressors are critical to the effective management and protection of marine mammals.

The project utilises 31 years of existing data at Head of Bight and adjacent areas and significant contribution of in-kind support from government, Yalata Aboriginal community, industry, research organisations and private business. The project leverages previous data collection totalling millions of dollars of prior investment.

The project promotes data sharing, data availability and global collaboration. The 31-year dataset on SRW population and recovery in Southern Australia provides a unique opportunity to utilise long term datasets on abundance, distribution, and life histories (Burnell and Bryden, 1997; Burnell, 2001; Charlton, 2017; Charlton et al., 2019a). The project uses new technologies such as UAVs, photogrammetry, and is assisting in the advancement of artificial intelligence software for photo-ID matching.

This report provides the results from the 2022 annual SRW research at the Head of Bight, Fowlers Bay and Encounter Bay, the 32nd consecutive year of research at the major aggregation and calving ground.

Research objectives

Project objectives address key priorities of the Commonwealth CMP for the SRW (DSEWPaC, 2012), including:

- 1. Continuation of long-term studies at known aggregation areas to assess trends in abundance, distribution, life histories, health and recovery
- 2. Characterisation of small and emerging aggregation areas in Australia and better understanding of coastal connectivity and movement
- 3. Identify offshore distribution, migration corridors and foraging ecology
- 4. Assess links between foraging ecology, demographics, health and climate.

The objectives are closely aligned to the objectives of several Minderoo Foundation initiatives, specifically:

• Flourishing Oceans:

- Understand and quantify impact of human induced climate change on marine ecosystems and food webs in the Southern Ocean. This aligns with our objective to assess links between Southern Ocean climate variates and trends in abundance and reproduction of SRWs off Australia. This project is currently underway which utilises our long-term data that provides information on reproductive success, calf production, and calving intervals, and modelling of climate variates to investigate the correlation and lag times between reproductive success and climate anomalies including Oceanic Niño Index, Antarctic Oscillation and Antarctic sea ice extent.
- Promote Marine Protected Area development and planning in Australia
- Ensure the continued recovery of endangered and threatened marine species, and the conservation of key habitats
- Inform risk assessment and impact mitigation of human activities, industry and environmental protection in key habitats
- Directly engage indigenous groups around Australia's southern coastline in ranger programs and protection of sea country
- Provide a potential research foundation for a new Minderoo Research Centre on the southern WA coast (e.g., Esperance or Bremer Bay).
- Research:
 - Facilitate world class research in Australia and supporting valuable long-term datasets and international collaborations
 - Contribute to multi-lateral climate modelling, global data sharing and federated data analyses
 - Deploy new technologies in support of conservation science, including use of advanced drones, aerial photogrammetry / telemetry and the application of ML/AI in image analysis.
- Generation One and Building Community:
 - Connection to sea country long-term community engagement and stewardship at our primary research site on Yalata Wiringu land at the Head of Bight in SA
 - Opportunity to embrace communities along the south coast (WA, SA, Victoria, Tasmania and NSW) where indigenous connection to SRWs is strong and many opportunities for education, training and mentoring exist
 - Multiple small communities along Australia's southern coastline benefit from the winter migration and coastal breeding of this iconic species and related eco-tourism and community engagement in marine conservation.

Specific project objectives include:

- 1. Continuation of the long-term research to assess distribution, abundance and life histories of SRWs in their primary calving ground
- 2. Assess links between Southern Ocean climate variates and trends in abundance and reproduction of SRWs off Australia
- 3. Complete a visual health assessment of SRWs in Australia to inform broader assessments of links between demographics and health.

Methods

Study Site

Research was completed at three study sites within the south western population of SRW including: Head of Bight, Fowlers Bay and Encounter Bay, SA (Figure 1). The study overlaps with the following marine parks within the Australian Marine Park Network: Great Australian Bight Marine Reserve Marine Mammal Sanctuary Zone and Far West Coast State Marine Park, Nuyts Archipelago State Marine Park and Encounter State Marine Park (Figure 2).



Figure 1. Identified SRW (Eubalaena australis) aggregations in Australian as identified in the CMP for the SRW 2011-2021 (DSEWPaC, 2012).



Figure 2. Australian Marine Park Network.

Head of Bight

The Head of Bight (31.29 S, 131.08 E) is in SAs far west on Yalata Aboriginal lands, within the Marine Mammal Protection Zone of the Great Australian Bight Commonwealth Marine Reserve, and Far West Coast State Marine Park. The Great Australian Bight Commonwealth Marine Reserve was established in 1995 to protect SRWs in the major calving ground, with vessel and access closures between 01 May to 31 October. Daily surveys were completed from land-based vantage points of 33 m to 53 m elevation, spanning approximately 15 km east to west and 8 km offshore (Figure 3 and Figure 6).



Figure 3. Head of Bight study area in the Great Australian Bight, South Australia.

Fowlers Bay

Fowlers Bay (32.00 S, 132.31 E) in the Nuyts Archipelago Marine Park, is approximately 170 km southeast of Head of Bight located in the far west region of SA. Located in the habitat protection zone (HPZ) of the Nuyts Archipelago State Marine Park, Fowlers Bay lies adjacent to the Great Australian Bight Marine Reserve. Vessel based surveys have been undertaken annually on board the tour operator charter vessel at Fowlers Bay since 2013 to assess population dynamics and underwater acoustics of SRWs at the small established aggregation area (Charlton et al., 2019b; Ward et al., 2019). Population count and photo ID data were also obtained during the 2022 field season using UAVs from land and data from the WA Museum annual aerial surveys. Habitat characteristics include a sheltered sandy bay with depths of 0 m to 20 m within approximately 5 km offshore. Vessel based surveys were conducted utilising the EP Cruises tour vessel and land-based surveys were conducted from various locations along the Fowlers Bay beach (Figure 4 and Figure 6). Aerial survey methods are described in Smith et al., (2022).



Figure 4. Fowlers Bay study area in the Great Australian Bight, SA.

Encounter Bay

Encounter Bay (35.56 S, 138.63 E) is in SA, located 87 km south of Adelaide. The study site is situated within the Encounter Marine Park in a Sanctuary Zone. A Sanctuary Zone is defined as a 'no-take zone', prohibiting the removal of marine flora and fauna in the area (National Parks and Wildlife Service SA, 2022), and BIAs are defined as areas were important behaviours such as breeding, mating, resting, and migration occur (Commonwealth of Australia, 2020) (Figure 5).



Figure 5. Encounter Bay study area in the Encounter Marine Park, SA



Figure 6. 2022 field season at Head of Bight (top four images) and Fowlers Bay (bottom two images), SA.

A brief overview of field methodologies is outlined below. For further details, please refer to Charlton et al. (2019a and 2019b), Charlton et al. (2022) and Gilmore (2022).

Sightings data: relative abundance and distribution

At all study sites, daily counts of SRWs were undertaken to monitor calf production, relative abundance, group composition (number in group and population class, i.e., cow-calf pairs, unaccompanied adults, sub-adults), spatial and temporal use patterns, and behaviour. At Head of Bight, the counts were carried out from 16 vantage points between 33 m and 53 m high; each were selected to ensure full visual coverage of the study site based on topographic features. At Encounter Bay, systematic surveys were conducted along a 28 km stretch of coast which included 11 vantage points from Goolwa to Waitpinga Cliffs. At Fowlers Bay, counts were completed on board the tourist charter vessel along a 10km stretch of coast within 2km from shore.

At each observation station observers scanned the area with 10x50 Bushnell binoculars and the naked eye for a minimum of 10 minutes. The observation period was timed to avoid glare in the early morning and sea breeze in the afternoon.

For each sighting, distance and bearing of the whale to the observer was recorded using a Bushnell 1600 laser range finder and marine grade 10x50 binoculars fitted with a compass and reticle. In

instances where the whale was outside the rangefinder detection range, reticle binoculars were used to measure increments below the horizon to the whale. For each SRW sighting the following variables were recorded: date, time, observation station (1–16), group composition (number, age class, and group type, which included cow-calf pairs, unaccompanied adult, or unknown status), and behaviours. Weather was reported at the start and end of the field day and surveys were conducted in less than 15 knot winds (Beaufort Sea state 3). Daily counts were completed across the survey period and provide a snapshot of whales utilising the study site in a single day. The maximum daily count is an underestimation of the true maximum of individuals in the study site due to immigration and emigration in the study site throughout the season. Therefore, the maximum daily count is considered to represent the minimum of individuals utilising the study site. Photo ID data is also used to inform the minimum number of individuals that use the area during the study period.

Whale distribution was mapped using location data collected from each vantage point which included range (m) or reticles and bearing inbuilt in binoculars. Estimates of the latitude and longitude for each SRW recorded were derived from the range (m), horizontal bearing of whale and latitude and longitude of the observer. This was achieved using formulae implemented in the Position Estimator Microsoft Excel workbook with the 'GEOFUNC' Add-In (MacLeod, 2011), accounting for the curvature of the Earth and the elevation and angle of the observer to the sighting. Maps were generated using ArcGIS Pro 3.0.3. At Head of Bight there is a slight error in the accuracy of latitude and longitude estimates at vantage point 16 between 1° and 120° (horizontal angle), land obscurers the horizon, resulting in an estimated error in range between 1 - 300 m.

To calculate 95% and 50% utilization distributions (UDs) for cow-calf pairs, and unaccompanied adults (2019–2022) at Encounter Bay a polygon was created for each kernel and the area was calculated for each UD. To calculate area of spatial overlap between kernels, the 'count overlapping feature' tool calculated the spatial overlap between the polygons. The spatial overlap of two polygons was calculated as the percentage overlap for both 95% and 50% UDs. At Fowlers Bay, boat-based surveys were conducted onboard EP Cruises (depending on vessel availability) and photo ID, location and behavioural data were collected onshore using UAVs. On board the vessel two observers scanned the area with Bushnell 10x50 binoculars from the boat foredeck. Variables recorded included date, time, location of whale (range, bearing and GPS location of the vessel), group number and classification (either cow-calf, unaccompanied adult or unknown), and behaviour. To reduce bias, count surveys were conducted in Beaufort sea state 3 or less, and minimal rain and fog with weather conditions monitored throughout the survey.

Photo Identification: life histories, residency, site fidelity, connectivity and movement

Photo ID images of SRWs were collected opportunistically during surveys from shore and shore-based platforms using digital SLR cameras and UAVs.

The callosity patterns located on the dorsal surface of the rostrum, the lip line of the lower jaw and just posterior to the blowhole, provide individually unique markings on SRWs that allow researchers to identify them (Figure 7). These patterns are keratinised skin patches colonised by cyamids that persist throughout life (Payne et al., 1983). Dorsal and ventral photographs are also obtained wherever possible. A Nikon 7100 or D100 digital SLR camera with a Nikon or Sigma 500 mm (effective 750 mm) lens, and a UAV (Multi-rotor, DJI Phantom Pro 4 v2, Mavic 3 or Mavic 2 Pro) were used for the photography of identifiable SRW features.

Digital photo ID images were sorted daily in the field following data sorting and quality protocols. Within season cross matching of individuals was achieved daily to document the total number of individuals identified in that year. Each individual was then matched against the long-term catalogue (BigFish V.6 Microsoft Access), including all calves photographed in previous years to document previously and newly sighted whales. Each callosity pattern has a unique code, once an individual was coded (Figure 8) a six-step cross-checking matching process was followed using the computer-assisted matching system "Code Compare" in BigFish (Pirzl et al., 2006). All photo ID matching was validated by at least two experienced SRW experts. ARWPIC codes were assigned for known individuals, and data was pre-processed ready for contribution to ARWPIC. The Encounter Bay photo ID data was matched to ARWPIC for connectivity assessment following data processing protocols described in ARWPIC (https://data.marinemammals.gov.au/arwpic).



Figure 7. Callosity patterns located on the rostrum, lip line and posterior to the blowhole used to identify SRWs.



Figure 8. a) UAV image taken of a SRW during survey and b) the callosity patterns coded for matching in BigFish.

12 | Page

Fine scale movement and behaviour

Fine scale movement and behavioural assessments were completed using UAVs at all sites. During flight, the UAV approached the cow-calf pair at 60m and maintained an altitude between 20 and 30 m with the camera positioned vertically down. The UAV was rotated to face north, and once in position up to 20-minutes of video photography was recorded, the UAV hovered directly over the cow-calf pair for the duration of the recording. Still image photo ID was captured and images cross matched to individuals sighted within and across seasons. During the flight time, distance to pilot (m), bearing and altitude (m) were recorded. UAVs were only flown in Beaufort Sea state of 3 or less, wind speeds under 15 knots and no precipitation. Presence or absence of vessel or aircraft were recorded. Preliminary data was analysed to assess behavioural states, respiration rates, travel speeds, mother and calf interaction. Changes to behaviour were recorded in line with scientific permit requirements to monitor behaviour in the presence of UAV.

Results

Field effort and sighting statistics for the 2022 field season at three study sites are summarised in

Table 1. A total of 61 surveys days were conducted between May and October, including 207 hours and 1,165 SRW sightings recorded.

At Head of Bight, a total of 21 daily surveys were completed between 17 July and 30 August 2022. Two intensive survey periods were completed during mid-late July and mid-late August. The field season was broken into three 15-day blocks, aiming for 10 surveys in the two intensive periods and four in the non-intensive period. Ten surveys were conducted in the first intensive period in July, there were numerous no survey days in August due to poor weather, and a total of 21 daily surveys were achieved. Daily count effort ranged between 3.3 hours and 4.9 hours (mean = 3.9) and start time was roughly 08:30 and finish time ranged between 12:30 and 15:00.

Study site	Survey period	No. field days	No. hours	No. sightings (CC and UA)	Max daily count (CC)	Max daily count (UA)	No. individuals photo ID'd	No. resights within field season	No. resights across field seasons
Head of Bight	17 Jul – 30 Aug	21	83	995	49	10	71 CCs 19 UAs 35 CA	423	66
Fowlers Bay	26 Jul – 31 Aug	9	18	91	11	5	14 CCs 7 UAs	46	6
Encounter Bay	25 May – 22 Sept	31	106	79	5	8	6 CCs 12 UAs	308	5
Total	25 May – 22 Sept	61	207	1165	65	23	164	777	77

Table 1. 2022 field season effort and sighting statistics at each study site for Cow-Calf pairs (CC), Unaccompanied Adults (UA) and Calves (CA).

Head of Bight

Relative abundance

During the 2022 field season, a total of 1032 SRW sightings were recorded. The maximum daily count for total individuals (all population classes) sighted in one day was 105 (range 76–105, mean 93) on 18 July. The maximum daily count was lower (22.2%) than the 2021 maximum count (135 individuals). A maximum of 49 cow-calf pairs (range 36–49, mean 43), 10 unaccompanied adults (range 0–10, mean 4) and five individuals of unknown status (range 0–5, mean 2) were recorded on one day (Figure 9 and Figure 10). The period of peak relative abundance of SRW at Head of Bight occurs between mid–July and end–August. There was low within season variability in relative abundance from daily counts during the 6 week field season at Head of Bight in 2022.

Long term relative abundance trends reveal high inter-annual variation, based on a cohort structured breeding cycle with mean apparent calving intervals ranging from 2 to 5 years (Figure 10). Anomalous years of low whale numbers are potentially becoming more frequent in recent years. Based on historical population trends of SRWs at Head of Bight, 2022 was expected to represent a low breeding cohort. However, there was a 3.7% decrease in the maximum count for the corresponding cohort year in 2019 (max 109 individuals). The calf count in 2022 (n=49) was 7.5% less than the corresponding cohort year in 2019 (n=53) and 19.7% lower than the previous year in 2021 (n=61). Relative to the overall south western population of SRW cow-calf pairs, Head of Bight represents on average 30% (1993–2021, Figure 11).



Figure 9. SRW relative abundance at Head of Bight, SA, between 17 July and 30 August 2022.



Figure 10. Long term abundance trend of SRWs at the Head of Bight, SA.



Figure 11. SRW female and calf pairs counted for the south-western population from annual aerial surveys 1993–2021 (Smith et al. 2022) and relative abundance counts from Head of Bight 1993–2022.

Distribution

Distribution data shows that SRWs at the Head of Bight are predominantly distributed within the 10 m depth contour, within 2 km from shore (Figure 12). The distribution of SRWs sighted in the Head of Bight study area was recorded for 898 cow/calf pairs and 83 unaccompanied adults. The mean group

size was 2 individuals (range 1–5; median 2). The mean group size for cow/calf pairs was 2 (range 2– 5, SD = 0.27, 95% CI = 0.02) and for unaccompanied whales was 1.5 (range 1–5, SD = 0.94, 95% CI = 0.2). Inter- or intra-annual variation in distribution was not observed.



Figure 12. Sighting locations of SRW cow-calf pairs and unaccompanied adults at Head of Bight in 2022.

Life histories: photo ID

A total of 75 cow-calf pairs and 20 unaccompanied adults were individually identified at Head of Bight in 2022. Within season mark-recapture resulted in a total of 84.2% of SRWs photo ID'd being resighted at least once (89.2% of cow-calf pairs were resighted and 60% of unaccompanied adults were resighted). The number of within season resights ranged from 1–17 (mean 6.3) for cow-calf pairs and 1–5 (mean 2.4) for unaccompanied adults. The number of individuals photo ID'd exceeded the maximum daily count of cow-calf pairs by 34.7%, and for unaccompanied adults by 50%. Photo ID data shows that a greater number of individuals were photographed during the field season compared to the max number of individuals counted on one day, indicating a degree of movement in and out of the area.

Cross-matching of photo ID images from 2022 with the long-term Head of Bight photo ID catalogue resulted in across year resights of 74.6% of cow-calf pairs and 40% of unaccompanied adults. A total of 62 individuals were added to the Head of Bight Photo ID catalogue as first sighted in 2022 (19 cow-calf pairs, 8 unaccompanied adults, 35 calves).

Cow-calf pairs are known to reside in the area for up to four months (Charlton 2017), whilst the unaccompanied adults are more transient through the area. During the 7-week survey the mean residency for cow-calf pairs was 25 days (range 1–49) and for unaccompanied adults 5 days (range 1–25).

Calving intervals

Inter-annual calving interval data was available for 51 females that calved in 2022 at Head of Bight. The predominant calving interval was four (41.1%) (n=21) and five years (41.1%) (n=21), with no

females recorded on a two or three-year calving interval Table 2). In 2022, the mean apparent calving interval observed was 4.5 years (+/- 95% CI 4.3, 4.7) years (n=42, excluding intervals of six or greater).

Calving intervals for females in 2022	Number of breeding females observed on interval in 2022	Percentage of females on calving interval in 2022
2 years	0	0%
3 years	0	0%
4 years	21	41%
5 years	21	41%
6 years	3	6%
9 years	1	2%
14 years	3	6%
16 years	1	2%
19 years	1	2%

 Table 2. 2022 inter-annual calving intervals available for 51 females at Head of Bight 2022.

A total of 1144 reproductive females and 694 inter-calving intervals were analysed to assess mean apparent calving intervals during 1996–2022 (allowing for a 5-year lag from start of surveys in 1991). There was a significant increase in mean apparent calving intervals from 3.2 years (+/- 95% Cl 2.9, 3.6) during 1996–2014 to 4.1 years (+/- 95% Cl 3.9, 4.3) during 2015–2022 (Figure 13).

Three-year calving events were most frequently observed between 1996 and 2014, followed by four, five and six years (Figure 13). The frequency of four- and five-year calving events and a reduction in three-year calving events was observed since 2015 (Figure 14). Of particular interest is the absence of any three-year calving intervals observed for breeding females at Head of Bight in 2022, and the increase in the proportion of four- and five-year intervals. The proportion of breeders on a four- and five-year interval (41% and 41% respectively) has significantly increased in recent years compared to an average of 22% and 7.1% respectively for four and five year intervals during 1996–2020.



Figure 13. Annual mean apparent calving intervals 1996–2022 for southern right whales in Australia



Figure 14. Frequency histogram of mean calving intervals observed for calving female SRWs, comparing years 1996–2014 (grey) with years 2015–2020 (blue).

Fine scale movement and behaviour

Average speed of cow-calf pairs recorded from ten focal follows of 20 minutes minimum (301.2 minutes of data analysed) was 1.627 ± 1.951 (km/h ±SD). The maximum recorded speed for mother and calf pair was 19 km/h. Cow-calf pairs were distributed between 100 and 1000m from the shore at the Bunda cliffs at Head of Bight. The average distance from shore was 472.3m, with cow-calf pair averages ranging from 236.2m–683.5m from shore. Respiration rates for calves ranged from 39–94 seconds (mean= 52 seconds) and for mothers ranged from 127–376 seconds (mean=167 seconds) (Figure 15)



Figure 15. Fine scale movement (top figure) and behaviour (bottom figure) of SRWs (n=10) at Head of Bight during 20-minute minimum focal follows.

Other Observations

Other observations recorded during the 2022 field season at Head of Bight included humpback whales, Australian sea lions, long-nosed fur seals, bottlenose dolphins, seabirds, sun fish, great white sharks, bronze whaler shark, little blue penguins, Australian salmon, dingos and wombats. The 2022 season had a higher number of humpback whales sightings than previous years, most sightings occurred 2km+ offshore. One whale mortalities was recorded prior to the beginning of the field season. A deceased neonatal calf was reported washed ashore a Head of Bight beach at the

beginning of July. Due to the remote location and decomposition before survey team arrived, no samples or measurements were taken for analysis. Other observations are summarised in Annex A. Category, number of individuals, location and behaviour of opportunistic marine fauna (and other) sightings were recorded and archived in sightings database.

Fowlers Bay

Sightings and photo ID

A total of nine surveys were undertaken at Fowlers Bay, including two boat-based surveys, five land based surveys and two aerial survey (by WAM), between 18 July and 31 August 2022. The highest daily count was 24 individuals, including 10 cow-calf pairs and four unaccompanied adults (Figure 16 and Figure 17). Aerial surveys were conducted as part of the WA Museum aerial survey on 14 and 15 August 2022, with a count of 11 cow-calf pairs. Photo ID data revealed a total of 14 cow-calf pairs and eight unaccompanied adults that were individually identified at Fowlers Bay in 2022. Four cow-calf pairs sighted in July at Fowlers Bay were later sighted in August at Head of Bight.

Cross matching of photo ID images from 2022 with the long-term Head of Bight Photo ID catalogue resulted in across year resights of 35.7% of cow-calf and 12.5% of unaccompanied adults, with one yearling born at Head of Bight in 2022 sighted at Fowlers Bay. Within season mark-recapture resulted in a total of 77.3% of SRWs photo ID'd being resighted at least once (92.9% of cow-calf pairs were resighted and 50% of unaccompanied adults were resighted). The number of within season resights ranged from 1–6 (mean 3.6) for cow-calf pairs and 1–3 (mean 1.9) for unaccompanied adults. One unaccompanied adult was identified as a yearling born the Head of Bight in 2021. Cow-calf pairs are known to reside in the area for up to four months whilst the unaccompanied adults are more transient through the area (Burnell, 2001; Charlton, 2017). Inter annual calving interval data were available for four females that calved previously at the Head of Bight and calved at Fowlers Bay in 2022. The predominant calving interval was four (75%) (n=3), then five years (25%) (n=1).

The distribution of SRWs in Fowlers Bay was recorded for sightings of 53 cow/calf pairs and 14 unaccompanied adults (Figure 18). There was little variation in the distribution off cow-calf pairs and unaccompanied adults during 2022. Sightings occurred within the 10 m depth contour within 1–2km from shore, and most commonly within a few hundred metres of shore within 1–5km south east of the Fowlers Bay Jetty (Figure 18).



Figure 16. Southern right whale relative abundance at Fowlers Bay, SA, between 18 July and 31 August 2022.



Figure 17: Relative abundance of southern right whales at Fowlers Bay 1993–2013 using Western Australian Museum aerial survey data and 2014–2021 max daily counts from vessel based surveys onboard Eyre Peninsula Cruises.



Figure 18. Sighting locations of SRW cow-calf pairs and unaccompanied adults at Fowlers Bay in 2022.

Encounter Bay

Sightings and photo ID

During daily surveys at Encounter Bay between 2013 and 2022, an average of 4.5 female and calf pairs (n=45, range = 1–9) and 15.5 unaccompanied adults (n=155, range = 7–40) were observed. The mean apparent calving intervals of returning females was 4 years and Encounter Bay recorded a return rate of 24.24% (n=8) of calving females identified since 2013. Residency periods were greater for cow-calf pairs (2–126, mean = 47.4 days) than unaccompanied adults (2–57, mean = 11.5 days).

Core areas (50% utilisation density) (KDE) for CC pairs displayed a smaller core area (1.6km²) between Basham Beach and Goolwa than UAs (15.73km²) extending between Petrel Cove and Rosetta Head (Figure 19 and Figure 20). Core areas for marine vessels (private and commercial, and whale watching vessels) overlapped with SRW representative ranges and core areas throughout the aggregation. Core areas and benthic habitat overlap demonstrated that cow-calf pairs (99% overlap) and unaccompanied adults (78% overlap) occurred mainly over unconsolidated sand substrates.

Individuals (n=26) sighted in Encounter Bay in addition to other aggregations displayed a greater connectivity to the south-west (78.43%) population than the south-east (21.57%) population (Table 3).



Figure 19. Location of SRW sightings collected during systematic land-based surveys at Encounter Bay in 2019, 2021 and 2022. Group classes were separated into cow-calf pairs and unaccompanied adults.



Figure 20. Spatial distribution of cow-calf pairs and unaccompanied adults SRWs in Encounter Bay, displaying representative ranges (95% UD) and core areas (50% UD) in 2019, and 2021–2022.

Population	Bioregion	Aggregation	Other Location	% Of Sightings (n=26)
		Flinders Bay		
		Hassel Beach		3.92
		Cheyne, Wray, Dilion,		11.76
		Bremer Bays		11.70
	South-west Shelf Province	Doubtful Island Bay		
		Yokinup Bay Area		
South-West		Israelite Bay		5.88
			Cape Arid	9.80
		Twilight Cove		
	Great Australian Bight Shelf	Head of Bight		35.29
	Transition			
		Fowlers Bay		3.92
	Spencer Gulf Shelf Province	Sleaford Bay		3.92
	(Sw)			
			Adelaide Metro	3.92
			Total	78 /3
			Connectivity %	78.45
		Portland		5.88
	Western Bass Straight	Port Fairy, Warrnambool		7.84
	THISHON	Port Campbell, Peterborough		
South-East			Cape Nelson	1.96
			•	
	Bass Straight Shelf Province		× 1 m	
	South-east Shelf Transition		Lake Tyers	3.92
	Tasman Shelf Province		Adventure Bay	1.96
			Total	19.61
			Connectivity %	
			Total Sightings	51

Table 3. Connectivity of SRWs photo-identified in Encounter Bay (n=26) and resighted in other bioregions and aggregations between 2006 and 2022.

Our Impact

Application to management and policy

We do what we do because we want it to make a difference. Our work directly applies to conservation management and policy, through our publications and input to committees and expert panels. In 2022, the application of our research to the conservation management of SRWs includes input to the following:

- 2022 data is submitted to the Biological Databases of South Australia (BDBSA) which manages specimen and observation records, data supports decision making on environmental issues within the South Australian and Australian governments as well as the wider community with an interest in biodiversity conservation.
- Relative abundance trends, distribution and life history traits collected from 1991–2022 are being used to directly inform policy makers to ensure there is appropriate conservation management within established, small and emerging calving grounds through the DECCEW update to the SRW Conservation Management Plan (CMP). Charlton is an expert committee member for the 2022 update to the SRW CMP that was drafted in 2022. The updated CMP heavily references the outcomes from this research to inform SRW management.
- Our long-term population monitoring contributes to DECCEW updates to Biologically Important Areas. The research team sit on the national expert committee for revising the BIA structure and advising the updates to the SRW BIAs. Charlton and O'Shannessy contributed to national online workshops in 2023 and will attend expert committee workshop in Canberra in March 2023.
- ARWPIC Steering Committee Member and Curator and 2022 photo ID data will be submitted into ARWPIC, sightings and resight data is being compiled as part of an analysis of mark recapture information in establishing trends in the population and spatial connectivity of individuals across southern Australia. Charlton is a contributor and one of three curators of the national data repository.
- 2022 data directly contributes to Australia's annual Scientific Progress Report submitted to the IWC. Scientific Progress Reports make a vital contribution to the work of the IWC Scientific Committee and the Commission, it also supports cross-collaboration with global southern right whale research and conservation actions. During 2018–2022 primary investigators have been invited guests to the IWC Science Committee and research outputs presented to contributed to the Southern Hemisphere priority to undertake a species assessment of southern right whales.
- IWC-SORP primary collaborators on the Theme 6 'The Right Sentinel to Climate Change', research collected in 2022 on life history traits directly informs population parameters critical for population modelling and assessing links between climate anomalies and reproductive success.
- IUCN Marine Mammals Protected Areas Taskforce Committee
- NESP 2.0 Co-investigator on southern right whale research projects to address national research priorities

- The WA Environment Protection Authority Technical guidance for marine fauna impact assessment (expert panel member)
- Expert witness in the senate enquiry to Oil & Gas in the Great Australian Bight
- Stakeholders for numerous nearshore and offshore coastal developments and out work provides a robust baseline dataset for before and after impact assessment.

Science communication

Publications and reports 2021/2022

The research team published the following scientific literature to advance our knowledge of southern right whales during 2021/2022:

- Charlton, C., McCauley, R.D., Brownell, R.L. Jr., Ward, R., Bannister, J.L., Salgado Kent, C., Burnell, S. (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
- Charlton, C., Marsh, O., O'Shannessy, B., McCauley, R., Burnell, S. (2021). Long term southern right whale research at Head of Bight, South Australia 1991–2020. Report presented to the 68C IWC scientific committee (Southern Hemisphere Subcommittee). SC_68C_SH_11.
- Charlton, C., Vermeulen, E., Carroll, E.L., 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. (2021) 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_SH_68C_06
- 4. 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. Mar Ecol Prog Ser 687:173-194. https://doi.org/10.3354/meps14009
- 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.
- 6. Gilmore, W. (2022). Relative abundance, group composition spatial distribution, and connectivity of Southern Right Whales, Eubalaena australis in Encounter Bay, South Australia. Flinders University, South Australia. Honours Thesis. Pp. 80
- Kemper, C. M., 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
- 8. Smith J., Double, M., Kelly, N., Charlton, C., Bannister, J. (2022). Project 1.26 Relative abundance of the 'western' population of southern right whales from an aerial survey

off southern Australia - Final Report on activities for 2021 to the National Environmental Science Program.

9. Watson, M., Stamation, K., Charlton, C., Bannister, J. (2021). Calving rates, long-range movements and site fidelity of southern right whales (*Eubalaena australis*) in south eastern Australia. Journal of Cetacean Research and Management

Media

National and regional media coverage was achieved in 2022, with the following stories released:

- Research summary: 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-historicbirthing-grounds/101396206
- Indigenous engagement and connection to country: 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
- Celebrating Citizen Science: Meet whale whisperer Rod Keogh and the southern rights in his 'front yard' at Fowlers Bay. ABC Regional. November 7, 2022 <u>https://www.abc.net.au/news/2022-11-06/fowlers-bay-southern-right-whale-</u> whisperer-rod-keogh/101588560

Education and public outreach is achieved through the study's online presence through webpage, you tube channel, and social media, including:

- Website: <u>www.southernrightwhales.com.au</u>
- Website: <u>www.ebrws.com.au</u>
- You tube channel: <u>https://www.youtube.com/@gabrightwhalestudy1162</u> and <u>https://www.youtube.com/playlist?list=UU7WZQX7oNhlQhMezTk_tjAA</u>
- Instagram @southernrightwhales
- Facebook <u>@southernrightwhales</u>

Community engagement and outreach

Our research is supported by a strong First peoples collaboration through the Yalata Aboriginal Community and the Aboriginal Lands Trust, which has been consistent since the project's inception. our key reciprocation being community awareness, education, training and stewardship. Community engagement initiatives and events in 2022 included:

- Annual outreach with Yalata Aboriginal Community and the far west coast aboriginal people including annual community day at Head of Bight Whale Centre, knowledge sharing through SRW scientific presentation and training students how to collect scientific data
- Whale festival education stall at Victor Harbor, South Australia
- Science Week Education Stall at Victor Harbor Markets

Citizen science is a core part of our research program. We work closely with the local tourism operators of Eyre Peninsula Cruises at Fowlers Bay. Rod and Simone have supported the research in Fowlers Bay for 10 years and contribute through data submission, vessel use, and UAV operations.

The Encounter Bay Right Whale Study is a is a citizen science program established in 2018, designed to address research priorities that will inform conservation management and protection of SRW.

In 2022, the project supported two honours students, six research interns and dozens of citizen scientists and community volunteers (Figure 21).



Figure 21: Research volunteers 2022. Top left image Head of Bight 2022 field interns Eva Robinson, Solomon Meyer and Connor McGarry, top right image volunteers at National Science Week stall at Victor Harbor Famers Market August 2022, bottom left image Will Gilmore presenting honours thesis at Flinders University November 2022 and bottom right image Whale Day with Anangu Yalata school children at Head of Bight August 2022.

Discussion

The successful completion of the 2022 SRW field season marks the 32nd year of consecutive research at the major calving ground, Head of Bight (1991–2022), 10th year at Fowlers Bay and third year of systematic surveys at Encounter Bay. The study collects population count and photo ID data and provides an unbroken time series dataset on fine scale distribution, relative abundance trends, life history data, movements, and connectivity of SRWs. This research directly addresses key priorities and objectives outlined in the Commonwealth CMP for the SRW, to characterise calving aggregation areas, understand life history parameters and measure population growth.

The 2022 Head of Bight cliff-based surveys resulted in lower counts and photo ID of cow-calf pairs and unaccompanied adults compared to previous years. SRW numbers at Fowlers Bay in 2022 appeared to be high relative to previous years. Charlton et al., (2019b) documented the increase in abundance of SRWs at Fowlers Bay from 1993–2016 and the mean number of cow-calf pairs per year was 5.6

(range = 0–16, 95% CI 2.9, 8.3). Inter annual variation in abundance at Fowlers Bay is common. In 2015 and 2016, no whales were sighted during the WA Museum aerial surveys of Fowlers Bay (Charlton et al., 2019b). Ongoing research at Fowlers Bay is needed to understand drivers of inter-annual variability in abundance, distribution, and residency.

Long term relative abundance trends reveal high inter-annual variation. Anomalous years of low whale numbers are potentially becoming more frequent in recent years. The increase in mean apparent calving intervals is contributing to high variation in annual abundance trends and may be a driver of slowed rates of increased observed (Smith et al., 2022). Contribution and curation of major photo-ID datasets in the national repository ARWPIC is required for a complete assessment of calving intervals using all available life history data. It is possible that calving events are missed at Head of Bight due to the open nature of the population, and increased movement observed in recent years with the site reaching saturation capacity based on density dependence (Charlton et al., 2019a). However, the increase in four- and five-year calving intervals and absence of any three-year cycles in 2022, suggests that females are extending their breeding cycle and requiring and additional rest year before becoming receptive, or there is an increase in failed pregnancies. It is interesting that an increase in two-year intervals is not observed when a five year interval suggests that a calf was lost and female calved on a two followed by a three year interval (Brandao et al., 2012).

Long-term monitoring of SRW populations across the main wintering grounds reveal fluctuations in sightings and an increase of calving intervals in recent years (Charlton, 2017; Brandao et al., 2018; Vermeulen et al., 2019; Watson et al., 2021). In 2022, the mean calving interval observed was 4.5 years, in recent years the mean apparent calving interval at Head of Bight has increased from three years (1996–2014) to four years (2015–2020). Apparent mean calving intervals of four years were also observed for the south eastern Australian population of SRWs during 2007–2018 (Watson et al., 2021). Direct links between a decreased calving success in SRWs and decreased krill densities at feeding grounds due to climate anomalies were found for the breeding areas off Argentina (Leaper et al., 2006), Brazil (Seyboth et al., 2016). Correlations between El Niño-Southern Oscillation Index, specifically the Oceanic Niño Index, sea ice extent and ocean productivity, and calf numbers were documented for the South African population of SRWs (Van den Berg et al., 2019). Inter-annual variability observed in the Australian population of SRWs showed correlation to Oceanic Niño Index and Antarctic Oscillation Index (Pirzl et al., 2009). The observed increase in mean calving intervals for SRWs off Australia requires investigation to assess potential correlations to climate variation. Research is underway to examine the correlation and lag times between reproductive success and climate anomalies including Oceanic Niño Index, Antarctic Oscillation and Antarctic Sea ice extent.

A greater number of individuals were photo ID'd at the Head of Bight field site than the maximum daily counts, indicating movement of whales into and out of the area during the 2022 field season, which was common in previous years (Charlton et al., 2019a). This is also supported by photo ID of four cow-calf pairs sighted at Fowlers Bay in July and at Head of Bight in August. Cow-calf pairs are known to reside in the area for up to four months, whilst the unaccompanied adults are more transient through the area. During the 7-week survey period the mean residency observed was 25 days (1–49) for females accompanied by a calf and 5 days (1–25) for unaccompanied adults. The elevated Bunda cliffs provide a unique non-invasive and cost-effective research platform, and the use of UAVs has substantially improved the photo ID success and quality in recent years.

Our research shows that the Head of Bight aggregation area has reached a saturation capacity based on density dependence (when greater than 63 pairs are present in the core distribution area) (Charlton et al., 2019a). As a result, the SRW distribution range has expanded in recent years into small and emerging aggregation areas along the coast, such as Fowlers Bay (Charlton et al., 2019b) and Encounter Bay (Kemper et al., 2022). The SRW population at Head of Bight is an open population and represents a declining proportion of the overall south western population, as the population increases (Charlton et al., 2019a). Slightly lower than expected abundance at Head of Bight and high numbers at Fowlers Bay in 2022 may be attributed to changes in the distribution of SRWs in the Australian population through shifts in selected calving grounds due to the Head of Bight aggregation area reaching saturation capacity based on density dependence (Charlton et al., 2019a). A comparative analysis is needed to investigate shifts in distribution and abundance across established and emerging aggregation areas in Australia.

Expansion of SRW habitat along the coast has resulted in increased interactions with humans outside of the protection of the Great Australian Bight Commonwealth Marine Reserve Marine Mammal Protection Zone, which provides protection to the whales at Head of Bight with completely no access between May and October. Under the current CMP for the SRW 2011–2021 there is a need to characterise whales in small and emerging calving grounds and demonstrate that the abundance and areas of occupancy are increasing. With an update to the CMP for SRWs due in 2023, long term objectives are focused on monitoring the expanding population and managing threats to enable population increase. Threats identified in the Commonwealth CMP for the SRW include vessel disturbance, noise disturbance, entanglement, ship strike and prey availability. There is a need to quantify the occurrence of human-induced impacts to SRWs along the Australian coastline. Research should also prioritise characterisation of small and emerging aggregation areas outside of the wellstudied Head of Bight aggregation area. The outcomes of this project will provide the current SA Labor Government with documented published literature to inform their commitment to investigate increased protection for whales in coastal waters of SA.

The Head of Bight photo ID data and sightings histories are contributed to ARWPIC. Funding from NESP in 2019–2021 enabled around 70% of the Head of Bight photo ID catalogue to be inserted and cross matched to the ARWPIC. The NESP funded collaborative project aims to assess national abundance and connectivity of SRWs in Australia, using photo ID sightings data. Data curation and maintenance is becoming increasingly difficult with an increasing population.

The Minderoo Foundation funded the 2022 field season and is funding current research objectives to describe the life history, distribution and relative abundance at major calving grounds in SA, assess the correlation between Southern Ocean climate variation and SRW calving intervals, and provide a visual health assessment of reproductive females. We aim to utilise artificial intelligence software to continue to upload the major Australian photo ID datasets into ARWPIC. Future funding should prioritise this objective to allow for ongoing catalogue curation.

To detect changes in the rates of increase and recovery of SRWs, long-term monitoring in the order of decades is required. Detecting changes in the rate of increase in SRWs requires annual monitoring due to their cohort structured breeding cycles and subsequent inter-annual variability in abundance (Bannister et al., 2011; Charlton, 2017). To detect change on a time scale relevant for management, assessment of each breeding cohort is required (Bannister et al., 2011). Recovery planning for the

endangered SRWs would benefit from an Australia wide assessment with detailed mark-recapture analysis and correlations to calving intervals, health, and climate factors. Future monitoring and research should consider the full distribution of SRWs in Australia and connectivity between all the coastal wintering grounds in Australia and New Zealand.

Demographic parameters for SRWs off Australia are being modelled by Butterworth and Cooke et al., for the multi-ocean assessment of SRW population demographics, funded through IWC-SORP. The study contributes to the IWC-SORP Theme 6 The Right Sentinel to Climate Change, which aims to assess the links between demographics, foraging ecology, health, and climate variates.

The long term SRW research is committed to communicating science and education through publication of scientific literature, presentations at national and international conferences, community engagement and media. In August 2022, researchers participated in the Whale Day with the Yalata Anangu School held at the Head of Bight Whale Centre, informing the local community of the current study objectives, outcomes and within season research findings. The team worked in collaboration with Yalata rangers to foster relationships with the Yalata community. The Encounter Bay Right Whale Study participated in National Science Week hosting a stall at the Victor Harbour Farmers Market. We offered four field internships enabling early career marine scientists to gain industry experience in marine science and encourage future leaders in SRW research. The team at Fowlers Bay work closely with eco-tourism operators at EP Cruises. Working alongside operators, our research is maximised through photo ID from across the entire season. In collaboration with the ABC, this research has been showcased in three ABC media reports during the 2022 SRW season, highlighting the importance of the ongoing research, connection to community and tourism in the area. Progress has been made to strengthen collaborations with Australian SRW researchers to build on community and citizen science initiatives and most effectively address research objectives.

There is a critical need to continue long-term research to understand changes to the SRW population over time. It is particularly important to investigate potential impacts from human disturbances and climate related changes that could ultimately affect the recovery of this endangered species. This work is crucial for national and global comparative studies and SRW species assessments.

Next steps and future research goals

Our mission is to deliver world class long term research for the protection and management of endangered SRWs, whilst sharing their story through science, community engagement, education and policy.

Our future goals are centred around delivering on the Minderoo Foundation Flourishing Oceans partnership and funding for advancing our understanding of SRWs and Climate change, as an indicator flagship species for the health of the Southern Ocean.

To achieve this, robust data on long term trends in relative abundance, distribution and life histories for SRW in primary calving grounds is needed. Visual health assessments of SRWs are a global research priority with a comparative project to compare the visual health of SRWs from South Africa, Australia and the critically endangered North Atlantic right whale currently underway. Minderoo funds are contributing to the data processing, analysis and write up on the Australian dataset for contribution into national and international studies to assess visual health of SRWs. Data from long-term photo-ID catalogues are leveraged to assess visual health. The qualitative body condition scores collected from

photogrammetry will be compared to quantitative visual health scores. Health will be tracked over years and correlated to reproductive success and climate variates. An IWC Science Committee endorsed global, standardised SRWs visual health assessment protocol is in development. Data processing underway and will continue in 2023.

Specifically, we aim to fulfil the following project milestones in 2023:

- Submit the Project 2022 Annual Narrative Report by (March 2023, Tranche 3)
- Complete the first phase of analysis of relative abundance, reproduction and climate variates using historical data (March 2023, Tranche 3)
- Complete data processing and submission of visual health assessment report (June 2023, Tranche 4)
- Undertake 2023 field research program and deliver annual field report (December 2023, Tranche 5)
- Develop a draft manuscript for publication on visual health assessment, and; distribution, abundance and life histories of southern right whales in their primary calving ground (December 2023, Tranche 5).
- Lodge 50% of long term Head of Bight data in national repository (December 2023, Tranche 5).

Our broader research goals in collaboration with national and international collaborators include:

- Continue the long-term monitoring programs to understand population demographics and measure population recovery
- Characterise SRWs in small and emerging aggregation areas along the Australian coastline
- Assessment of the residency and site fidelity of SRWs at major calving ground
- Understand offshore distribution and movement patterns
- Quantify the effects from threats on SRWs including noise pollution, habitat disturbance, presence of vessels and risk of entanglement and ship strike, prey availability and climate change
- Increase legislative protection for the species conservation management
- Technological advancement using artificial intelligence to support the processing of increasingly large datasets so that data can be made publicly available and used on a time scale relevant for management
- Work collaboratively with national and international researchers to address priority research
- Understand cultural and indigenous connection to SRWs in Australia and build on partnerships with traditional owners.

References

- Bannister, J. L. (1990). Southern right whales off Western Australia. International Whaling Commission document (Special Issue 12), 279–288.
- Bannister, J. L. (2001). Status of southern right whales (*Eubalaena australis*) off Australia. *Journal of Cetacean Research and Management (Special Issue)*, *2*, 103–110.
- Bannister, J. L. (2018). Project A7- Monitoring Population Dynamics of 'Western' Right Whales off Southern Australia 2015-2018. *Final report to National Environment Science Program, Australian Commonwealth Government*.
- Bannister, J. L., Hedley, S. L., Bravington, M. V. & Burnell, S. R. (2011). Monitoring population dynamics of right whales off southern Australia Project 2009/41: Final Report to The Australian Marine Mammal Centre. 23pp.
- Best, P. B., Brandão, A. & Butterworth, D. S. (2001). Demographic parameters of southern right whales off South Africa. *Journal of Cetacean Research and Management*, *2*, 161–169.
- Burnell, S. R. (2001). Aspects of the reproductive biology, movements and site fidelity of right whales off Australia. *Journal of Cetacean Research and Management (Special Issue)*, *2*, 89–102.
- Burnell, S. R., and Bryden, M. M. (1997). Coastal residence periods and reproductive timing in southern right whales, *Eubalaena australis. Journal of Zoology*, London 241, 613–621.
- Brandão, A., Vermeulen, E., Ross-Gillespies A., Findlay, K. and Butterworth, D. S. (2018). Updated application of a photo-identification based assessment model to southern right whales in South African waters, focussing on inferences to be drawn from a series of appreciably lower counts of calving females over 2015 to 2017. Report presented at the 67Bth IWC scientific committee (Southern Hemisphere subcommittee, Bled Slovenia).
- Carroll, E., Patenaude, N., Alexander, A., Steel, D., Harcourt, R., Childerhouse, S., Smith, S., Bannister, J., Constantine, R. & Baker, C. S. (2011). Population structure and individual movement of southern right whales around New Zealand and Australia. *Marine Ecology Progress Series*, 432: 257–268.
- Caroll, E. L., Baker, C. S., Watson, M., Alderman, R., Bannister, J., Gaggiotti, O. E., Gröcke, D. R., Patenaude, N., Harcourt, R. (2015). Cultural traditions across a migratory network shape the genetic structure of southern right whales around Australia and New Zealand. *Scientific Reports*, 5:16182.
- Carroll, E., Charlton, C., Vermeulen, E., Jackson, J. A., & Clarke, P. (2020). Roadmap to success for the International Whaling Commission - Southern Ocean Research Partnership (IWC-SORP) Theme 6 - the Right Sentinel for Climate Change: linking southern right whale foraging ecology to demographics, health and climate (SC68B/SH/07).
- Charlton, C. M. (2017). Population demographics of southern right whales (*Eubalaena australis*) in Southern Australia. Doctorate of Philosophy Thesis. Dissertation, Curtin University, Centre for Marine Science and Technology.

- Charlton, C., Ward, R., McCauley R., Brownell, R. L., Salgado Kent, C., & Burnell, S. (2019a). Southern right whale (*Eubalaena australis*), seasonal abundance and distribution at Head of Bight, South Australia. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 29(4), 576–588.
- Charlton, C., Ward, R., McCauley R., Brownell, R. L., Salgado Kent, C., & Bannister, J. (2019b). Southern right whales (*Eubalaena australis*) return to a former wintering calving ground: Fowlers Bay, South Australia. *Marine Mammal Science*, *35*(4), 1438–1462.
- Charlton, C., McCauley, R. D., Brownell, R. L. Jr., Ward, R., Bannister, J. L., Salgado Kent, C. et al., (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" https://doi.org/10.1002/aqc.3771.
- Charlton, C., Ward, R., Christiansen, F., Morrison, A., Brownell, R. L., Burnell, S. R., & McCauley, R. Residency, site fidelity and date of calving of southern right whales (*Eubalaena australis*) at the Head of the Great Australian Bight, South Australia 1991-2019. *Journal of Cetacean Research and Management*. In preparation.
- Christiansen, F., Vivier, F., Charlton, C., Ward, R., Amerson, A., Burnell, S., Bejder, L. (2018). Maternal body size and condition determine calf growth rates in southern right whales. *Marine Ecology Progress Series*, 592:267–281.
- 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. <u>https://www.int-res.com/abstracts/meps/v687/p173-194/</u>
- Cooke, J. G., Rowntree, V. J., Payne, R. (2001). Estimates of demographic parameters for southern right whales (*Eubalaena australis*) observed off Peninsula Valdes, Argentina. *Journal of Cetacean Research and Management (Special Issue)*, *2*, 125–132.
- Dawbin, W. H. (1986). Right whales caught in waters around south-eastern Australia and New Zealand during the nineteenth and early twentieth centuries. *International Whaling Commission document (Special Issue)*, 10, 261–67.
- Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). (2012). Conservation Management Plan for the Southern Right Whale: A Recovery Plan under the *Environment Protection and Biodiversity Conservation Act 1999* (2011–2021). Available at: <u>http://www.environment.gov.au/system/files/resources/4b8c7f35-e132-401c-85be-</u> 6a34c61471dc/files/e-australis-2011-2021.pdf.
- Evans, E., 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.
- Gilmore, W. (2022). Relative abundance, group composition spatial distribution, and connectivity of Southern Right Whales, Eubalaena australis in Encounter Bay, South Australia. Flinders University, South Australia. Honours Thesis. Pp. 80

- International Whaling Commission (IWC). (2013). Report of the workshop on southern right whales. International Whaling Commission document, SC/65A/Rep05.
- Kemper, C. M., 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*, 1–21. https://doi.org/10.1080/03721426.2021.2018759.
- Leaper, R., Cooke, J., Trathan, P., Reid, K., Rowntree, V., & Payne, R. (2006). Global climate drives southern right whale (*Eubalaena australis*) population dynamics. *Biology letters*, *2*, 289–92.
- Patenaude, N. J., Portway, V. A., Schaeff, C. M. Bannister, J. L., Best, P. B., Payne, R. S., Rowntree, V. J., Rivarola, M., & Baker, C. S. (2007). Mitochondrial DNA diversity and population structure among southern right whales (*Eubalaena australis*). *Journal of Heredity*, *98*(2), 147–157.
- Payne, R., Brazier, O., Dorsey, E., Perkins, J., Rowntree, V., & Titus, A. (1983). External features in southern right whales (*Eubalaena australis*) and their use in identifying individuals in Communication and behaviour of whales. Westview Press: Boulder, Colorado, pp 371–445.
- Pirzl, R., Murdoch, G., Lawton, K. (2006). BigFish: Computer assisted matching software and data management system for photo-identification. Skadia Pty Ltd, Horsham, Australia.
- Pirzl, R. (2008). Spatial ecology of *Eubalaena australis*: habitat selection at multiple scales Ph.D. thesis, School of Life and Environmental Sciences, Deakin University, Melbourne.
- Pirzl, R., Patenaude, N. J., Burnell, S. & Bannister, J. (2009). Movements of southern right whales (*Eubalaena australis*) between Australian and subantarctic New Zealand populations. *Marine Mammal Science*, 25, 455–461.
- Seyboth, E., Groch, K. R., Rosa, L. D., Reid, K., Flores, P. A. C., & Secchi, E. R. (2016). Southern Right Whale (*Eubalaena australis*) Reproductive Success is Influenced by Krill (*Euphausia superba*) Density and Climate. *Scientific Reports*, 6, 28205.
- Smith J., Travouillon, N., Kelly, M., & Double, M. (2019). Project A7 Monitoring Population Dynamics of 'Western' Right Whales off Southern Australia 2018-2021 Final Report on activities for 2018.
- Smith J., Double, M., Kelly, N., Charlton, C., & Bannister, J. (2022). Project 1.26 Relative abundance of the 'western' population of southern right whales from an aerial survey off southern Australia - Final Report on activities for 2021 to the National Environmental Science Program.
- Stamation, K., Watson, M., Moloney, P., Charlton, C. & Bannister, J. (2020). Population estimate and rate of increase of southern right whales *Eubalaena australis* in southeastern Australia. *Endangered Species Research*, 41, 373–383.
- Tormosov, D. D., Mikhalev, Y. A., Best, P. B., Zemsky, V. A., Sekiguchi, K., & Brownell Jr, R. L. (1998). Soviet catches of southern right whales, *Eubalaena australis*, 1951-1971; biological data and conservation implications. *Biology Conservation*, 86(2), 185–97.
- Van den Berg, G. L., Vermeulen, E., Hui, Cang., Findlay, K., Von der Heyden, S., & Midgley, G. (2019). Linking climate and ocean productivity to the prevalence of southern right whales (*Eubalaena*

australis) in South African waters. Report presented to the 68Ath IWC scientific committee (Southern Hemisphere Subcommittee), Nairobi, Kenya.

- Vermeulen, E., Wilkinson, C., & Thornton, M. (2019). Report of the 2018 South African southern right whale aerial surveys. Report presented to the 68Ath IWC scientific committee (Southern Hemisphere Subcommittee), Nairobi, Kenya. Doi: 10.13140/RG.2.2.35060.17284.
- Watson, M., Stamation, K., Charlton, C., & Bannister, J. (2021). Calving rates, long-range movements and site fidelity of southern right whales (*Eubalaena australis*) in south-eastern Australia. *Journal of Cetacean Research and Management*, 22(1), 17–28.
- Ward. R., McCauley, R., Gavrilov, S., & Charlton, C. (2018). Underwater sound sources and ambient noise in Fowlers Bay, South Australia during the austral winter. *Acoustics Australia*, 47, 21–3

Category	Species type	Number of sightings	Total individuals sighted
Marine mammal	Australian sea lion	10	14
	Long-nosed fur seal	6	6
	Bottlenose dolphin	34	253+
	Humpback whale	16	25
Fish	Great white shark	3	3
	Bronze whaler shark	1	1
	Australian salmon	6	880+
	Sun fish	2	2
Seabird	Nankeen kestrel	4	5
	Australasian gannet	13	37
	Little blue penguin	23	~23
	White-bellied sea eagle	8	9
	Galah	1	2
	Tern	3	23+
Other mammals	Wombat	1	1
	Dingo	1	1

ANNEX A: Marine fauna observations during the 2022 field season at Head of Bight, South Australia.







2022 ANNUAL FIELD REPORT TO MINDEROO FOUNDATION LONG-TERM RESEARCH OF SOUTHERN RIGHT WHALE (EUBALAENA AUSTRALIS) IN PRIMARY CALVING GROUNDS DECEMBER 2022







