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Building a National Picture of Southern Right Whales in Australia

Insights from the Australasian Right Whale Photo Identification Catalogue (ARWPIC) and Cross-Regional Collaboration

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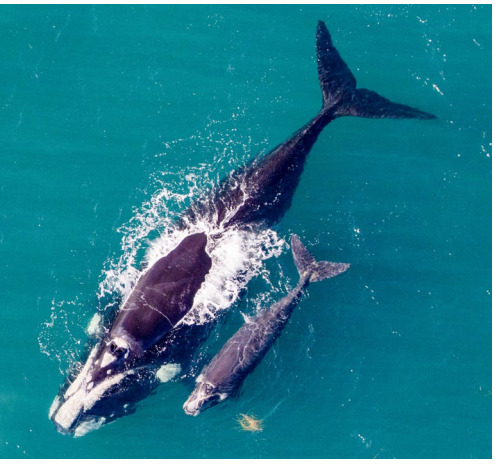

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NESP Marine and Coastal Hub partners

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Disclaimer

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Executive summary

Southern right whales (*Eubalaena australis*) remain a priority species for marine conservation in Australia, yet their populations are still far below pre-whaling levels and face increasing anthropogenic pressures. Effective management under the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act), the National Recovery Plan, and spatial planning tools such as Biologically Important Areas (BIAs) and Commonwealth Marine Parks depends on robust, up-to-date knowledge of the species' abundance, distribution, habitat use, and connectivity. This study addresses critical knowledge gaps on southern right whales that seasonally occupy Australian waters by updating the Australasian Right Whale Photo Identification Catalogue (ARWPIC) and conducting targeted intra-seasonal surveys in previously under-surveyed regions off Western Australia.

To advance our understanding of southern right whale population ecology and inform management, this project focused on updating and optimising ARWPIC, which is a national database that stores curated photo-identification records and long-term sighting histories of individual whales based on unique, distinctive callosity patterns in the region of the rostrum and head. Through these sighting histories, ARWPIC provides a database for tracking individual whale movements, site fidelity (i.e., returning to the same location in subsequent years), and demographic parameters for the Australian population. In this project, more than 28,000 photo-identification images (video or photos) from eastern and western Australia, contributed by a wide range of organisations and individuals, including researchers, Indigenous rangers and volunteers, were processed and curated. The contributions resulted in an integration of historical and contemporary datasets from eight regions over the period between 1994 and 2024. ARWPIC system and functionality enhancements enabled improved and time saving (>90 hours) data integration through bulk upload and automated curation and streamlined workflows. These improvements have positioned ARWPIC for more efficient data integration required for broad cross-regional and cross-population analyses, including demographic estimates that are critical for adaptive conservation management and species assessments.

Preliminary comparisons of updated individual sightings histories within ARWPIC across eastern and western Australia support previous indications of limited exchange between the eastern and western southern right whale populations, reinforcing the need for population-specific management. Off Western Australia, systematic surveys conducted in 2024 across several data-poor regions that the western population occupies, including Esperance to Israelite Bay, Cheynes Beach to Point Ann, and Flinders Bay, documented high mother-calf pair presence (ranging from 38% to 92% of adults encountered having a calf). Analysis of regional catalogue images from Western Australia from 2004 to 2024, contributed to ARWPIC, resulted in a documented minimum seasonal residency of up 3.5 months, as well as strong site fidelity across all regions with multi-year image records (including the region between Albany and Hopetoun, Geographe Bay, the West Coast north of Geographe Bay, and Flinders Bay), with resight periods ranging from 1 to 20 years. Overall 'discovery' of new identified individuals was high, indicating a high proportion of new individual whales not previously catalogued in ARWPIC, highlighting the need for dedicated data collection effort and continued data reconciliation. Analyses of resight histories so far undertaken in the western region of the western population of southern right whales revealed repeated returns

to key reproductive habitats for extended periods during the reproductive season. While there was evidence of strong sight fidelity within regions off Western Australia, movement between regions (within seasons and among years) confirmed connectivity across broad spatial scales, reinforcing the need for region-specific management in addition to the population-level management.

The continued broad spatial movement documented here, including observed increase in individuals resighted along the west coast of Western Australia between Mandurah and Exmouth since 2010, supports the concept of a recovering population re-establishing former breeding grounds. These sightings, however, still fall short of historical whaling data records documenting north of Exmouth and past Port Hedland, suggesting that a full historical range recovery for the western population may not yet have been achieved. Finally, images processed during this project provided evidence of direct human impacts on southern right whales, including entanglements, vessel collision, and disturbance from vessels and water activities that continue to threaten population recovery.

A key component of this work was the extensive collaboration and substantial in-kind contributions from established community programs, agencies, Indigenous ranger groups, and citizen scientists across southern Australia. Key partnerships, including the New South Whales National Parks and Wildlife Service Right Whale ID (NSW RWID) program, the Organisation for the Rescue and Research of Cetaceans in Australia (ORRCA), WhaleFace, Encounter Bay Right Whale Study (EBRWS), South West Whale Ecology Study (SouWEST), South Coast Cetaceans, and the Right Whale Tracker Project, greatly expanded spatial coverage of data collection and strengthened regional stewardship. Through coordinated volunteer training, community supported monitoring, and longstanding local engagement, these collaborations not only generated the image contributions and ecological insights that underpin this report, but also were and continue to be critical for stakeholder and community engagement, education and awareness that support ongoing conservation of southern right whales in Australia.

Findings from this study have direct management implications. They support maintaining two distinct management units for the western and eastern populations, implementing regional management including strengthening seasonal protections in core wintering calving habitats (i.e., recognised Biologically Important Areas in Australia) where these are absent or insufficient, through measures such as vessel speed restrictions and spatial buffers (e.g., sanctuary zones), and updating management of areas to mitigate vessel collision, entanglement, disturbance and underwater noise impacts. The findings of this study also provide updated information for environmental impact assessments for offshore renewables, aquaculture, and coastal development, although many gaps in knowledge continue to exist.

To sustain progress and enable adaptive conservation, addressing knowledge gaps for southern right whales requires a coordinated set of priority actions. These include a comprehensive cross-regional assessments of population attributes using current updated ARWPIC datasets to inform region- and population-specific management under the Southern Right Whale National Recovery Plan and EPBC Act. In addition, modelling population demographic parameters using fully reconciled life history data in a common model framework across Southern Hemisphere populations will inform global priority species assessments. Strengthening Indigenous and community capacity for monitoring southern

right whales through training and robust data governance is also essential to ensure quality and scalability. Integrating systematic, multi-platform surveys across representative regions, with photo-identification data analysed through ARWPIC, will improve demographic inference, support the transition from minimum to absolute estimates, and provide behavioural data critical for updating BIAs. In addition, habitat-use models that incorporate environmental, biological, and anthropogenic drivers will help anticipate ecological change and refine risk assessments.

Underpinning all these actions is the sustained contribution, curation, and optimisation of ARWPIC, which provides the foundation for scaling future projects and integrating additional datasets – a process made possible through government, industry, and community support. Continued investment remains vital to achieving National Recovery Plan objectives and ensuring adaptive conservation strategies that safeguard southern right whale populations under changing environmental and anthropogenic pressures.

1. Introduction

Effective conservation of wide-ranging marine mammals relies on robust knowledge of their seasonal abundance, distribution, habitat use, and movement patterns. This knowledge underpins international and national management tools designed to protect marine mammals and mitigate human impacts. Examples of tools include ecosystem-based marine protected areas (MPAs) and Important Marine Mammal Areas (IMMAs; designated by the IUCN SSC/WCPA Marine Mammal Protected Areas Task Force; Hoyt and Notarbartolo di Sciara 2014; Notarbartolo di Sciara and Hoyt 2020). Within Australia, examples include Commonwealth and state marine parks and Biologically Important Areas (BIAs). Commonwealth marine parks aim to conserve biodiversity and natural, cultural, and heritage values and include zoning that mitigate threats and protect key habitats. BIAs, which are spatially and temporally defined zones critical for life-history functions (DCCEEW 2024), are a tool used to inform environmental impact assessments, marine spatial planning, and conservation management under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), Australia's primary environmental legislation. All of these tools use the best knowledge available at the time they are developed and must be regularly updated with current data to reflect improved understanding as well as changes in population dynamics and habitat use in response to biological, environmental, and anthropogenic pressures.

Southern right whales (*Eubalaena australis*) are a priority species in marine conservation efforts and are the focus of several conservation management tools. Individuals of this species migrate thousands of kilometres between foraging and breeding grounds, and spend extended periods in austral winter calving areas which extend mostly around the southern half of Australia, where they give birth to and nurse their young. Historically, southern right whales were heavily exploited for commercial whaling from the late 1700s until 1970 (Jackson et al. 2008). In fact, the common name in the English language, that refers to the species across its southern hemisphere distribution, reflects terminology from the whaling era, when they were referred to as 'right whales' because they were considered the right whales to hunt due to their relative ease of capture, tendency to float after death, and high yield of oil and baleen.

The scale of the southern right whale exploitation is evident in population estimates. Pre-whaling numbers across Southern Hemisphere breeding grounds ranged from approximately 47,000 to 120,000 individuals (depending upon the approach) and fell to a possible 300 to 400 by 1920 (IWC 2001; IWC 2013; Tulloch et al. 2017). Since being granted international protection under the International Convention for the Regulation of Whaling (ICRW) in 1931 that took effect in 1946 (DCCEEW 2023), through the moratorium on commercial whaling by the IWC in 1980's, and following cessation of Soviet illegal hunting by the 1970s, southern right whales have been recovering, though their abundance remains far below pre-exploitation levels (Tormosov et al. 1998).

Estimates published in 2017 indicate that the species' global population was only around 11% of its estimated pre-whaling abundance, and assuming current and future pressures do not change recovery rates, may not approach recovery until around 2100 (Tulloch et al. 2017). Recovery is further complicated by pronounced regional variation across the species' range (Arias et al. 2018; Bannister 2001; Best 2000; Brandão et al. 2023; Charlton et al.

2022; Findlay et al. 2017; IWC 2001; Romero et al. 2022; Smith et al. 2023; Grundlehner et al. 2025; Stamation et al. 2020; Vermeulen et al. 2023a; Watson et al. 2021). While populations in New Zealand (Carroll et al. 2013), South Africa (Brandão et al. 2018, 2023), Argentina/Brazil (Cooke et al. 2001; Groch et al. 2005) and southern and western Australia (Bannister 1990, 2001) experienced relatively steady growth following the end of commercial whaling (IWC 2013); others, including those in Chile–Peru and eastern Australia, remain small (Stamation et al. 2020).

More recent indications of slowing growth rates and increased mortality at major aggregation areas (Cooke et al. 2001; Crespo et al. 2019; Findlay et al. 2017; Germishuizen et al. 2024; Grundlehner et al. 2025; van den Berg et al. 2019; Vermeulen et al. 2023b), combined with rising interannual variability in Australian birth rates (Smith et al. 2021) and increasing calving intervals (Charlton et al. 2022), have recently heightened concerns given that these regions within the Southern Hemisphere support much of the global population (IWC 2001, 2013). Together, these patterns underscore the species' continued vulnerability and highlight the importance of effective, contemporary protection frameworks to support population recovery.

Today, southern right whales benefit from multiple international conventions and management frameworks. Under the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), this species is protected from over-exploitation through international trade. The Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) considers cetaceans, including southern right whales in scientific advice and conservation measures, including in relation to fisheries management (i.e., krill) and marine protected area development. The International Convention for the Regulation of Whaling (ICRW) grants international protection from commercial whaling and within International Whaling Commission (IWC) sanctuaries, such as the Indian Ocean and Southern Ocean Sanctuaries. The Convention on the Conservation of Migratory Species of Wild Animals (CMS) promotes cooperation among countries to conserve endangered migratory species and their habitats, including southern right whales, while the United Nations Convention on Biological Diversity (UN CBD) provides a broader framework for biodiversity conservation and sustainable development.

In Australia, southern right whales are listed as both *Endangered* and *Migratory* species under the EPBC Act 1999, along with the Commonwealth marine environment, making them Matters of National Environmental Significance (MNES). This listing provides legal protections in Australia, including a National Recovery Plan that government agencies and that proponents undertaking activities that may impact whales are legally required to follow. Any activity likely to significantly impact the species must undergo formal EPBC assessment and approval, with projects required to demonstrate consistency with the Recovery Plan. The Act also prohibits killing, harming, or taking the species in Commonwealth-managed areas without a permit. Additionally, the Australian Whale Sanctuary, declared under the EPBC Act in Commonwealth waters, and State Government legislated measures extend protective measures such as vessel exclusion zones, noise restrictions, and regulated whale-watching to prevent disturbance. In addition, Australia is required to report all known vessel collisions, entanglements, and other incidents involving southern right whales through its annual IWC National Progress Report, which forms part of the IWC Scientific Committee's global monitoring of whale mortality, threats, and conservation status.

Despite these protections, the abundance of southern right whales that occupy Australian waters remains low. The last estimate undertaken in 2020 suggested that the total Australian count was under 3,400 individuals (Stamation et al. 2020; Smith et al. 2020, 2023, 2024, 2025), with current abundance estimated to still be less than 20% of historic levels. These individuals make up two genetically distinct populations (commonly referred to as subpopulations, and in this report referred to as 'populations') occur in Australian waters: the western and eastern. They are differentiated by mitochondrial DNA (Carroll et al. 2011; Carroll et al. 2015; Carroll et al. 2019), geographic range, historic whaling pressures, and varying population growth rates (Stamation et al. 2020; Smith et al. 2020, 2022, 2023, 2024, 2025).

The most recent estimate for the western population is 2,242 individuals (Smith et al. 2025). Trends since 2016 show slowing population growth, declining annual birth rates, and an abundance estimate similar (though slightly lower) than those reported over the previous five years (Bannister et al. 2016; Grundlehner et al. 2025; Smith et al. 2024, 2025). Estimates for the eastern population are much lower, with ~268 individuals and an annual population growth rate last estimated at 4.7% using data up to 2018 (Stamation et al. 2020). More recent estimates are not available.

The two Australian southern right whale populations are seasonally present in all state coastal waters, from Hervey Bay in Queensland across the southern Australian coastline, including Tasmania, to Exmouth Gulf in Western Australia (IWC 2013; DCCEEW 2024). For management purposes, the western population occupies waters west of the Victorian border and includes waters off South and Western Australia, while the eastern population occurs in waters off Victoria, Tasmania, New South Wales, and Queensland. From May to October, whales aggregate in shallow coastal reproductive areas to calve and nurse young (Charlton et al. 2019; Smith et al. 2022). These aggregation areas (i.e., areas with 'distinctly clumped or clustered pattern in the distribution of animals'; DCCEEW 2024) are typically characterised by shallow, gently sloping sandy bays that offer shelter from prevailing winds and weather (Elwen and Best 2004; Pirzl 2008). Although southern right whales historically were more widespread, their current habitat use off the coast of Australia is considered comparatively restricted, and knowledge of habitat preferences for both populations remains limited.

The limited population recovery, combined with restricted habitat use, and life history traits that make them slow to reproduce (e.g., long lifespan, late maturity, low reproductive output, the repeated use and return to geographic locations by individuals over time otherwise called site fidelity), means southern right whales are particularly vulnerable to human threats. The slowing population growth of southern right whales in Australia (Grundlehner et al. 2025) and reproductive decline (increased calving intervals) has been suggested to be linked to climate variation (Charlton et al., 2022).

Ongoing threats for southern right whales that occupy coastal waters off Australia include climate change and variability, entanglement in fishing and aquaculture gear, habitat degradation from coastal and offshore development, underwater noise, vessel collisions, and prey depletion (DCCEEW 2024). These pressures can increase energetic stress for this capital breeder (i.e., a species that relies on stored energy reserves from foraging grounds to sustain growth, maintenance, and reproduction during the breeding season; Jönsson 1997), further reducing body condition (Christiansen et al. 2020).

To address these threats, southern right whale BIAs, which define spatial and temporal zones for critical life functions across Australia's marine environments, are used to guide decision-making in habitats where breeding, migration, feeding, and resting occur (DCCEEW 2024). Additionally, the National Recovery Plan outlines interim recovery objectives and actions aimed at reducing threats and supporting population recovery, with the ultimate goal of removing the species from the EPBC threatened list. Interim recovery objectives include: maintaining or strengthening legislative and management protections; managing human impacts in line with ecologically sustainable development principles; monitoring population dynamics using standardised best-practice methods; defining population structure and connectivity between western and eastern groups and other regions; and building capacity among First Nations Australians, researchers, citizen scientists, and community groups to support recovery actions.

This study addresses critical knowledge gaps by implementing high priority actions aligned with the Recovery Plan objectives, including: monitoring population demographics, characterising population structure, and building capacity for monitoring southern right whales among First Nations Australians, researchers, and citizen scientists. To address the these objectives, Recovery Plan actions (listed in Table 1) are addressed by updating the Australasian Right Whale Photo-Identification Catalogue (ARWPIC, hosted and maintained by the Australian Marine Mammal Centre and Australian Antarctic Data Centre of the Australian Antarctic Division, Department of Environment and Energy; AMMC 2013) and conducting systematic surveys in data-poor regions within the western distributional extent of the population.

ARWPIC serves as the species' Australia-wide photo-identification and sightings database. The catalogue compiles images and corresponding metadata that enable the identification of individual whales and the documentation of their sighting histories. Individual identification is achieved through photographs of distinctive callosity patterns on the rostrum and adjacent head surfaces, which provide reliable markers for distinguishing or re-identifying whales across encounters (Payne et al. 1983; Bannister 1990). By providing an online platform for the efficient management and sharing of southern right whale images and sighting information, ARWPIC has enabled a robust, non-invasive tool for tracking individual movement histories throughout Australia, commencing as far back as 1978.

This study updated ARWPIC with archived images dating back to 1994 and incorporated newly collected images. This ensures the catalogue remains up-to-date for population abundance, movement and connectivity assessments and demographic parameters estimates that reflect current population attributes. Complementary systematic surveys, included in this study, provide targeted, effort-based data that allow direct comparisons with other standardised studies. This study introduces multiple surveys within a single season in areas east of Esperance to Israelite Bay (one of Australia's three largest calving aggregation areas) and the eastern sector of Flinders Bay, where more than single seasonal systematic surveys have been absent for over two decades. By combining data from updates made to ARWPIC and multiple within-season systematic surveys, this study provides a preliminary cross-population assessment, and updates regional estimates of abundance, residency, site fidelity, and connectivity in the western extent of the western southern right whale population (i.e., off Western Australia).

Table 1: National Recovery Plan for Southern Right Whale Objectives and Actions this study addresses.

Region	Recovery Plan Action	Priority Rating
Interim objective 3: Population dynamics, including demographics, distribution, residency, and coastal movement across the species range are monitored and quantified using robust, standardised, best-practice methodology to assess population recovery.	**Action Area B1:** Measure and monitor population demographics and recovery.	Very High
Interim objective 4: The population structure of southern right whales in Australian waters is clearly characterised, including the level of interchange of individuals among coastal reproductive areas, to evaluate the degree to which the western and eastern populations are separate populations and inform the degree of connectivity with other southern right whale populations (e.g., New Zealand).	**Action Area B2:** Characterise population structure	Very High
Interim objective 5: Capability of First Nation Australians, research, citizen science, and general community groups is improved to assist in addressing recovery actions of southern right whales in Australia.	**Action Area B4**: Improve capability of First Nation Australians, research, citizen science, and general community groups to assist management of southern right whales.	High

This information is critical for updating the national conservation plan, threats database, BIA maps, and supporting risk assessments and mitigation of threats related to marine industries (including renewable energy projects and tourism) as Australia transitions toward reducing its carbon footprint and building a blue economy. Additionally, the study engages citizen scientists and other members of the public, and collaborates with partners supporting Indigenous ranger capacity building in image collection. The resulting monitoring data contribute to the evidence base used by Indigenous sea country managers and government agencies to meet monitoring objectives and inform management decisions in co-managed marine parks. Updated resight histories will also inform future Australia-wide and global assessments of demographic parameters such as population size, survival, and calving intervals, which are key for detecting population changes and guiding adaptive management.

These contributions extend to global conservation through the Southern Right Whale Consortium (SRWC), established under the IWC-SORP initiative to promote international collaboration, standardise data quality, and develop a global photo-identification catalogue. The consortium compares demographic patterns across major Southern Hemisphere wintering grounds to explore links between reproductive success and environmental factors.

Given limited and variable recovery across the Southern Hemisphere, recent declines in calving ground use, extended calving intervals, and trends highlighting increasing vulnerability under projected climate change scenarios (Agrelo et al. 2021; Albouy et al. 2020; Burnell 2001; Jackson et al. 2016; Sousa et al. 2021; Tulloch et al. 2018, 2019), coordinated international research and management are urgently needed to address global threats and ensure effective conservation.

2. Aims and Objectives

Building on significant prior contributions to ARWPIC and collecting new data on two of several key data-poor regions across Australia, this study aims to update knowledge of southern right whales through the following specific objectives:

1. Update ARWPIC by: a) integrating ARWPIC system enhancements to improve automation, management efficiency, and workflows, and b) collating, processing, migrating, and curating outstanding opportunistic, citizen science, and aerial and vessel surveys photo-identification datasets from the eastern and western populations (dating back to 1994).

2. Conduct targeted systematic surveys (in 2024) in two data-poor regions in the western extent of the population – Israelite Bay to Esperance and eastern Flinders Bay – and generate new photo-identification records contributed to ARWPIC.

3. Using the combined dataset, update population ecology attributes including: 1) a preliminary evaluation of connectivity across the eastern and western populations, and 2) for the western extent of the western population, evaluate minimum abundance, residency, site fidelity, calving intervals, and connectivity, distribution, and group composition (the latter two using only the systematic survey effort-based data).

Together, these objectives provide an updated understanding of southern right whales in Australian waters. This work prioritises generating estimates for regions within the western population where population and behavioural ecology knowledge have remained unpublished or limited, providing preliminary insights into connectivity across the eastern and western populations, and updating ARWPIC across Australia to prepare for an integrated, comprehensive Australia-wide assessment – a key priority for advancing conservation, management, and species recovery targets.

3. Methods

3.1 Study regions

This study updated individual sighting histories (i.e., records of when and where individual whales have been observed throughout their lives) across Australia, including eastern Australia, southern Australia (e.g., Head of Bight, Yalata, situated within the Yalata Indigenous Protected Area, Fowlers Bay, and Encounter Bay), and western Australia, by collecting and processing data from eight focal regions (Figure 1, Table 2) and consolidating

them with existing records in ARWPIC. The eight focal regions included three within the area in which the eastern population is distributed and five in which the western population is distributed. Regions are defined in this study as waters off New South Wales, Tasmania and Victoria (for the eastern population) and off Esperance to Israelite Bay, from Albany to Hopetoun, within Flinders Bay, within Geographe Bay, and north of Geographe Bay up to Exmouth (for the western population; Figure 1). Regions in this study reflect either state-based jurisdictional divisions (for the eastern regions), spatially distinct areas known to support reproductive aggregations (in the south and southwest coastal regions of Western Australia), or are comprised of an extended stretch of coastline where sightings have increased in recent years and may indicate historical aggregation areas now being revisited (e.g., north of Geographe Bay to Exmouth).

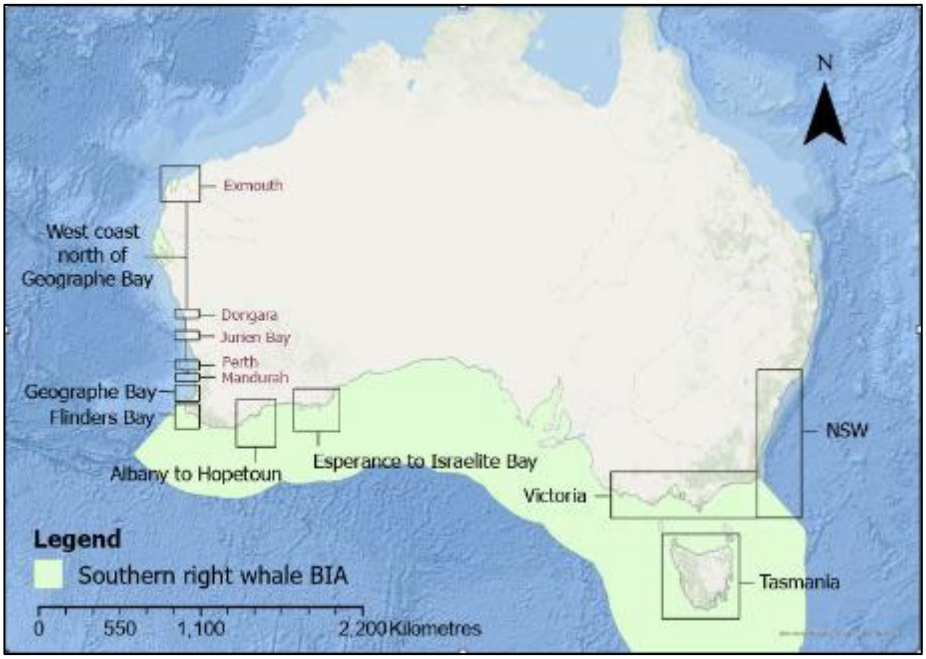


Figure 1 Eight regions within the southern right whale distribution (and BIA) in which data were collated, processed and consolidated within ARWPIC.

3.2 ARWPIC Updating

The workflow in Figure 2 outlines the process used to update regional catalogues and integrate new photo-identification data into ARWPIC. This multistep approach enabled images from diverse sources to be collated, processed, matched, and curated consistently, optimising the creation and tracking of individual whale histories across regions.

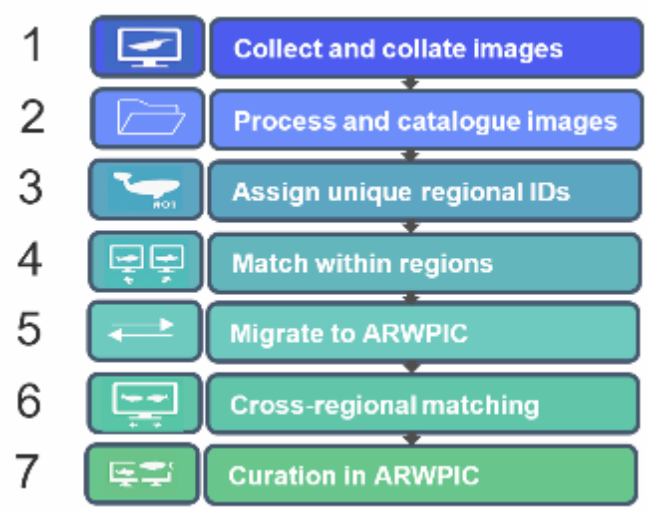


Figure 2 Workflow outlining the process used to update the Australasian Right Whale Photo-Identification Catalogue (ARWPIC).

3.2.1 Collating images

ARWPIC was updated using large collections of archived and newly collected images (e.g., photographs or videos) of southern right whales and their associated data across the eight study regions described above (see Figure 1). Because southern right whales visiting Australian waters primarily occur in shallow coastal areas, they are relatively accessible for capturing on camera by citizen scientists from community-based cetacean research programs, researchers, Indigenous rangers, government departments, and members of the public. The collections were comprised of images arising from across these sources. Images were comprised of DSLRs still images or were captured from videos, taken from land, vessels, drones, or aircrafts (i.e., from various platforms with varied elevation), depending upon the nature of the contribution.

Updating ARWPIC with the extensive image collection first required collating all available images, including those already provided to the researchers and those held by other contributors. This process involved reviewing existing images and obtaining images not yet provided to contributors, requesting permission for use of images in the public domain from members of the public, and collecting additional images during planned surveys conducted as part of this or other studies. Coordinating with contributors involved arranging a time and place to copy files or providing hard drives for transferring images to the researchers. Additionally, information on location, platform, date, and any additional relevant details on methods of collection needed to be consolidated with contributors and accurately recorded.

3.2.2 Processing and cataloguing images

Processing collated images involved a preliminary review and creation of a subset of all images of suitable quality for reliable individual southern right whale identification (i.e., photo-identification). The subset of images was then imported into one of three regional catalogues for processing and preparation for ARWPIC migration, depending upon the location from which the image data were obtained. All images from the eastern states were catalogued in the South East Australian Southern Right Whale Photo Identification Catalogue (SEA SRW

PIC; curated by contributing author Mandy Watson), all from the southwest regions of WA were catalogued in the Southwest Whale Ecology Study (SouWEST) Southern Right Whale Catalogue (SouWEST SRW Catalogue; curated by Western Whale Research or WWR), and those from the south coast of WA were catalogued in the South Coast WA Southern Right Whale Catalogue (SC WA SRW Catalogue; curated by Edith Cowan University).

SEA SRW PIC integrates images and data provided by the Victorian, Tasmanian and New South Wales (NSW) Governments and collaborating programs (e.g., Victoria's WhaleFace program; the NSW National Parks and Wildlife Service Right Whale ID program, Organisation for the Rescue and Research of Cetaceans in Australia (ORRCA), Marine Wildlife Rescue Central Coast, Marine Mammal Research Jervis Bay, NSW National Parks & Wildlife Service, NSW Department of Primary Industries and Regional Development (DPIRD) Fisheries), and consists of images from government employees, citizen scientist projects, whale watch operators, and members of the public.

The SouWEST SRW Catalogue consists of images and data contributed by WWR, independent researchers, volunteer citizen scientists, whale watch operators, researchers from Curtin University and Edith Cowan University, and from opportunistic sightings. The South Coast WA SRW Catalogue integrates images and data contributed by South Coast Cetaceans, the Right Whale Tracker Project (a collaboration between South Coast Cetaceans, South Coast Natural Resource Management, Oceans Blueprint and Edith Cowan University, and supported by funding from the Western Australian Government's State NRM Program), Edith Cowan University, whale watch operators, volunteer citizen scientists, and obtained from opportunistic sightings. A full list of organisations and individuals that contribute to these catalogues is presented within the Acknowledgements section of this report.

Processing within the regional catalogues involved importing, adjusting image orientation and cropping the image if required. Images were then annotated with their associated data. Data consisted of all information available, including where possible the date, time, and location each image was captured, the contributor information (e.g., name, contact), collection platform (drone, vessel, land, aircraft), the camera make and model, photo quality, group composition and behaviour. Location information ranged from precise latitude and longitude coordinates to land-based vantage points where whales were observed, launch sites for drones used to capture images, names of bays, coastal landmarks, and broader regional descriptors. Photo quality was assigned as per ARWPIC guidelines. The perspective in which images were taken was also recorded. Images taken from a vessel and from land generally consisted of lateral perspectives of the whales' bodies, while images collected from drones and aircrafts consisted of aerial overhead or frontal images.

An 'event' number was assigned to each image. An event was defined, consistently with the definition in ARWPIC, as an instance where photo-identification data had been collected for one or more whales, regardless of the mode of collection (e.g., citizen science observations, opportunistic images from public sources, dedicated surveys – from land, vessel, drone, or aircraft platforms). Events were characterised by a unique date and start and end time, platform used for data collection, a single location (latitude and longitude), and the total group size and composition (e.g., number of unaccompanied adults, number of mothers and calves) involved in the event.

Adult whales (either unaccompanied, or accompanied by a calf that was not captured in the image) and mother-calf pairs were then assigned a unique number called a 'sighting' number, with the definition of sighting consistent to that in ARWPIC. A sighting within ARWPIC is defined as either a whale that appears unaccompanied (i.e., where a single whale has been captured in an image) or a mother-calf pair. Multiple sightings can occur within an event, as sightings refer to individual whales or each mother-calf pair observed during the event. This differs from the terminology frequently used in cetacean research and citizen science, where sightings may refer to an entire event or encounter. For each sighting, the sex and age class (adult/sub-adult) or calf association of the individual, if available, was recorded.

Most images used for identification featured adults (either mothers accompanied by calves or adults without calves), as callosity patterns typically do not stabilise until calves are at least six months old (Kraus et al. 1986). In a few cases, calves were re-identifiable within seasons, due to distinctive white dorsal pigmentation anomalies. Multiple photos showing different perspectives of each sighting were included where possible. From these photos, features were defined and coded for each individual whale, including information regarding callosity location, pattern, shape, number, and coverage, among other attributes. These and additional details regarding feature coding and processing images within regional catalogues are described in Watson et al. (2021) for SEASRW PIC and in Salgado Kent et al. (2022) for SouWEST SRW and SC WA SRW Catalogues.

3.2.3 Regional catalogue matching

Once data were processed, they were ready for matching within regional catalogues. Matching allowed for unique identification numbers (i.e., IDs) to be assigned to individual whales and for their resights to be recorded. Only high-quality images were included in assignment of IDs and matching to ensure individual whales could be identified reliably (following ARWPIC guidelines). Feature filters (i.e., filters that select for codes specifying callosity pattern or pigmentation attributes of a whale of interest) within regional catalogues were applied to narrow the quantity of images requiring comparison where relevant, and only when the risk of missing potential matches not included in a filter was considered negligeable. Comparisons were conducted by an experienced researcher, and individual identifications and matches were independently verified by a second experienced curator. Individual whales that were not matched with any other whale were assigned a unique regional ID number that was recorded within the catalogue, while individuals matched with previously identified animals were assigned the same number as first recorded. All suggested and validated unique individuals and matches were recorded within an Excel spreadsheet containing individual sighting histories that was formatted for analysis.

3.2.4 Migrating to ARWPIC

Once processed and matched within the regional catalogues, high-quality images from each catalogue were imported into ARWPIC (following the protocol detailed in ARWPIC_protocols_11_curator). Within ARWPIC, images were assigned their 'event' and 'sighting' numbers from the regional catalogues. Sightings were allocated to events by creating a sightings folder for each event and dragging and dropping images into the relevant folder. Assigning event and sighting information was either undertaken manually using drop-

down menus or tables in the ARWPIC GUI, or using a bulk event system enhancement, developed as part of the scope of the work included here. The enhancement enabled a bulk event upload function that added many events from an Excel sheet formatted according to a provided template, with each row representing event data. Once events and sightings were allocated to the images, and each individual whale's data migrated (including sex, feature coding, etc.), individuals were ready for comparing and matching with all others contributed to ARWPIC from across Australia.

3.2.5 ARWPIC cross-regional matching

For matching within ARWPIC, once events and sightings were allocated, they were matched using BigFish CodeCompare (Pirzl et al. 2006), a computer-assisted matching tool within ARWPIC that filters individuals in the catalogue according to their callosity feature attributes, to compare each individual against all others selected for comparison within the ARWPIC catalogue. Matches were suggested through the CodeCompare GUI, and feature coding was checked and updated if the individual matched a previously sighted whale. After all individual and image information was entered, these processed events, sightings, and proposed matches were submitted for curation. Bulk submissions rather than event-by-event submission were made possible within ARWPIC as an additional system enhancement as part of this project, in addition to bulk acceptance (of data as being accurate and complete) by curators.

All submitted data and proposed matches were reviewed by at least one curator that was not the original contributor to ensure cross-validation and minimisation of identification error. The independent curator validation was undertaken once contributed events and associated sightings entered a curation queue, where curators assessed metadata completeness and image suitability, and evaluated and accepted or rejected submitted proposed matches and individual identification using the BigFish CodeCompare tool. Validation histories of proposed matches were recorded within an Excel spreadsheet so that errors or suggested changes could be tracked by regional data and ARWPIC curators, addressed and resolved where required, and updates could be made to the catalogues and the spreadsheet accordingly. Once all events and sightings in a queue were resolved and approved, data migration and matching within ARWPIC for the respective dataset was completed.

3.3 Systematic surveys

Two regions within Western Australia were identified as not having had systematic surveys conducted over the last decade or more, apart from the annual single flight from Perth in Western Australia to Ceduna in South Australia that crosses them (e.g., NESP Project 3.15, Subcomponent 1; Smith et al. 2020, 2023, 2024, 2025). To obtain within-season resight information within these regions, two aerial surveys were conducted in 2024 from Esperance to Israelite Bay, timed to occur one month before and one month after the annual aerial survey that is timed to coincide with the anticipated peak of southern right whales (Figure 3). By conducting them one month before and one month after the peak, information such as minimum residency and relative abundance over the calving season could be obtained. Similarly, two vessel surveys extending to the eastern region of Flinders Bay (beyond the previously surveyed area falling within Ngari Capes Marine Park) were undertaken in 2024

(Figure 3). An additional opportunity to undertake a survey in the region between Albany to Hopetoun presented itself, as the aircraft used to survey the Esperance to Israelite Bay region had to be brought from Perth, and required a stop-over in Albany to collect an observer. Thus, on the way to Esperance, the Albany to Hopetoun coast was surveyed opportunistically (Figure 3). Survey effort was concentrated between Cheynes Beach just east of Albany and was cut short at Point Ann prior to reaching Hopetoun (see Appendix A-2).

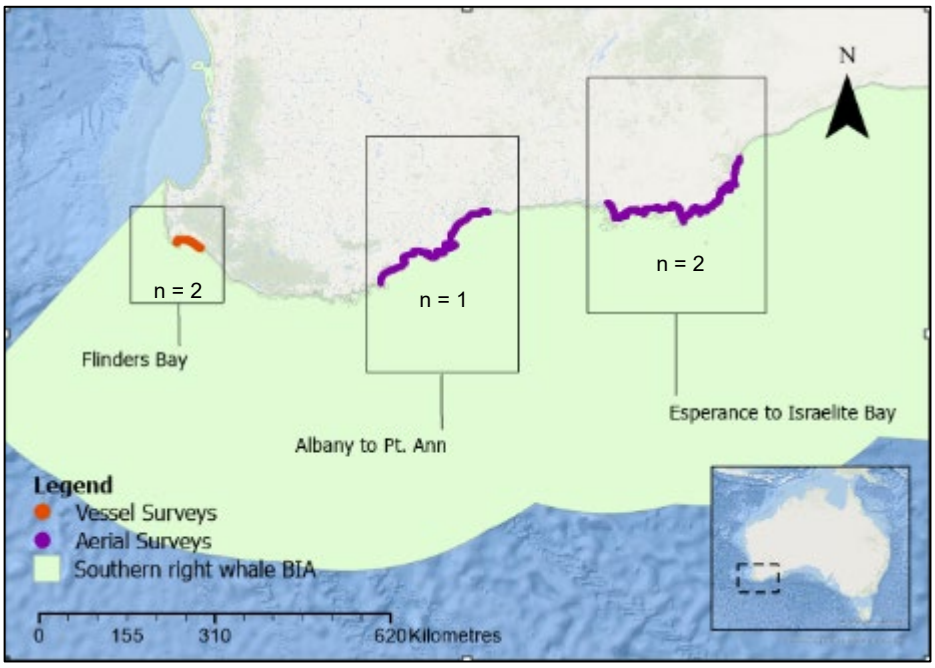


Figure 3 Vessel and aerial tracks for systematic surveys conducted in 2024 within Flinders Bay, Albany to Pt. Ann and Esperance to Israelite Bay, Western Australia.

All surveys complement the yearly single survey conducted from Perth to Ceduna in South Australia (Subcomponent 1, NESP Project 3.15; Smith et al. 2025). Aerial surveys were undertaken with a high wing, single engine Cessna 182 aircraft. Aerial surveys followed established protocols from aerial surveys since 1993 (Smith et al. 2023). Crew included a pilot/observer, photographer/observer and data scribe. Flights followed the contour of the coastline within approximately 1 nautical mile (i.e., 1.85 km) of the coast. Surveys were flown at an altitude of 1000 feet and photographs of the unique callosity patterns in the region of the head of whales for identifying individual whales were taken at 500 feet. Vessel surveys were undertaken with an 11.4 meter Steber monohull vessel and a 10 meter Naiad RIB with 2 x 4-stroke outboard engines. Sea state conditions (Beaufort) were 3 or less for vessel surveys, while they were up to 4 in some areas of the coast during aerial surveys. Photographs were taken using a 7D Mark II Canon camera (cropped sensor) with a Canon EF 100-400mm lens.

Images collected from Flinders Bay were contributed to the SouWEST SRW Catalogue, while images collected during the Albany to Pt. Ann and Esperance to Israelite Bay surveys were contributed to the SC WA SRW Catalogue. All images were processed within regional catalogues and migrated and matched within ARWPIC as described in Section 3.2.

3.4 Population ecology attribute analyses

With the exception of a preliminary analyses of connectivity between eastern and western southern right whale populations (described at the end of Section 3.4), population ecology attributes were calculated for regions within the western population where ARWPIC has been updated, including areas off Esperance to Israelite Bay, Albany to Hopetoun, Flinders Bay, Geographe Bay, and north of Geographe Bay up to Exmouth. For Geographe Bay and Flinders Bay, the reported attributes update those presented by Salgado Kent et al. (2022), building on that dataset by incorporating data collected between 2021 and 2024 and applying ARWPIC curation to all images, including those collected prior to 2021. This process has produced a refined dataset aligned with ARWPIC protocols, ensuring cross-regional comparability and representing an expanded and more robust version of the dataset used in 2022.

Analyses of abundance, residency, site fidelity, and connectivity presented used regional catalogue data (SouWEST and SC WA SRW Catalogues). For the purposes of this report, residency is defined as an individual whale's tendency to remain within a particular area during a reproductive season. Site fidelity refers to an animal's tendency to repeatedly use, or return to, a specific geographic region across multiple years. Connectivity describes the degree to which regions are linked through the movements of individual whales, creating opportunities for interactions between individuals from different populations and among aggregation areas (i.e., supporting cultural exchange and gene flow).

Throughout this report, the terms abundance, residency, site fidelity, and connectivity are presented as 'apparent' metrics, meaning they reflect observed values within a defined area and do not account for variation in survey effort or whales present but undetected. These apparent metrics are used because, aside from systematic surveys, effort data were limited or unavailable for most data sources. Apparent metrics are also referred to as 'minimum' metrics in this study, as they represent the lowest possible estimates. For example, without knowing whether whales were missed in a given area, we can say only that at minimum the whales observed occupied that area. In contrast, absolute abundance, which is the total number of whales present regardless of detection, is expected to have been greater than the minimum values reported here.

As there was high variability in spatial resolution of data from the different survey platforms and data sources, analyses were conducted over several spatial resolutions to allow for the capture of relevant statistics. For data consisting of direct counts of whales observed, described further below, the survey tracks and locations (i.e., that latitude and longitude) of whales observed were recorded using a GPS, thus the abundance and distribution of sighted locations in relation to survey effort are reported. For analyses incorporating images from all sources (systematic surveys, land and vessel-based *ad hoc* surveys, and citizen science and community observations), the spatial resolution of the data varied widely; ranging from precise GPS coordinates of whales or of land-based vantage points and drone launch locations from which whales were observed, to bays or coastal landmark names, and in some cases broad regional descriptors. As a result of this, images were assigned a region that captured all levels of resolution (including the lowest) and that were extents of coastline where relatively large calving aggregations are known to occur, and are separated by extents of coastline with lower documented densities of whales. These regions included Esperance

to Israelite Bay, Albany to Hopetoun, Flinders Bay and Geographe Bay (Table 2 and Figure 1).

The only region included here that did not consist of a known aggregation area was 'West coast north of Geographe Bay', which included a range of sightings from Mandurah to Exmouth Gulf. For the purpose of this report, the term location refers to landmarks, towns, bays, or other identified feature, and includes the surrounding environment, while region refers to broader areas defined in Table 2 and Figure 1. The word 'site' has been reserved for use in the context of the behavioural ecology term *site fidelity*. While the statistical analyses presented here are based on regional groupings, specific place names were retained in the dataset wherever recorded to preserve the highest available spatial resolution for images that lacked GPS latitude and longitude data, to inform future analyses and conservation management. Regions and locations are listed in Table 2.

Table 2: Regions and locations assigned to images resulting from systematic aerial and vessel surveys, *ad hoc* vessel surveys, vessel and land-based citizen science observations, and opportunistic data collected from the community.

Regions	Locations recorded
Esperance to Israelite Bay	-
Albany to Hopetoun	Cheynes Beach, King George Sound
Flinders Bay	-
Geographe Bay (GB)	Gannet Rock, Castle Rock, Meelup Beach, Point Piquet, Eagle Bay, Rocky Point, Bunker Bay, Shelly Cove, Cape Naturaliste, Sugar Loaf, Three Bears, Yallingup, Sandpatches, Canal Rocks, Wyadup, Injidup
West coast north of GB	Between Mandurah, off and around Perth, Jurien Bay, Geraldton, Exmouth

The image-based analyses included attributes computed for each demographic category (i.e., 'Adult' and 'Mother accompanied by a calf'), and the term 'Adult' refers to individuals that were either unaccompanied or adults for which a calf was not observed or captured in an image, whereas 'Mother accompanied by a calf' refers to confirmed mother-calf pairs.

Abundance and distribution

Where dedicated surveys were undertaken, abundance was calculated using counts from systematic aerial and vessel surveys, as well as from the number of uniquely identified individuals. Because systematic surveys were only undertaken in the Esperance to Israelite Bay region, Cheynes Beach to Pt. Ann and in Flinders Bay (see Table 3), systematic survey counts are reported for these regions. They are accompanied by summary statistics on number and proportion of uniquely identified individuals during systematic surveys.

Table 3: Abundance metrics reported for regions off Western Australia.

Region	Abundance metric
Esperance to Israelite Bay region	
Albany to Pt. Ann	
Flinders Bay	
Geographe Bay	
West coast north of Geographe Bay	

Counts and number of identified unique individuals
Number of identified unique individuals only

To complement this, the total number of uniquely identified individuals from images across all survey types (systematic surveys, *ad hoc* vessel surveys and land- and vessel-based citizen science and community observations) for all regions (see Table 3) were computed. While the total number of identifications reported here reflects the breadth of identification data obtained, this does not represent the total number of identified individuals, as some whales were identified from only one perspective (e.g., left side) and may not be distinguishable from those identified from another perspective (e.g., dorsal). To estimate the minimum number of unique individuals, a discovery curve showing the rate of new identifications per season was generated for each perspective. Minimum estimates were produced for each perspective, and assumed left-side images (including oblique and lateral views) were comparable, as were right-side images, and that all photographs were of sufficient quality to match resighted individuals and differentiate new individuals from previously recorded ones.

Finally, the spatial distribution of individuals was visualised by mapping the location of whales sighted during systematic surveys.

Residency, site fidelity, and calving intervals

Residency within each region was quantified as the time between the first and last sighting within a breeding season for each whale. This approach assumes that emigration outside of the regions did not take place between sightings. Residency was also considered a minimum (resulting from limitations in the duration of the survey period and observer coverage), with many whales likely occupying a region over a longer period than observations were made.

Site fidelity (including mothers returning to give birth to a new calf at the same location as previously occupied to calve; i.e., calving fidelity) was quantified for each region by identifying the frequency and period over which individual whales were resighted within the same region over different breeding seasons.

Observed (i.e., apparent) intervals between resights were also quantified, including for adults and mothers accompanied by a calf, the latter of which represents the calving interval if at both times the female had a calf. Resight intervals were calculated regardless of the number of years that had elapsed between resights, while calving intervals only included intervals of five years or less (as per Charlton et al. 2022) and six years or less (as per Watson et al.

2021), which assumes that greater observed intervals reflect missed events (Bannister 1990; Cooke et al. 2001; Brandão et al. 2011; Charlton et al. 2022).

Movement and connectivity

Western extent of the Western Population: Movement and connectivity was quantified across regions on the south coast of Western Australia (i.e., Albany to Hopetoun and Esperance to Israelite) and across regions off the southwest coast of Western Australia (i.e., Flinders Bay and Geographe Bay), by identifying individual whales that were photo-identified in more than one region. At the time of preparation of this report, it was not possible to do this collectively for the southwest and south coast regions, as final curation of matches between the SouWEST SRW and SC WA SRW Catalogues was just reaching completion. Individual whales recorded on the west coast north of Geographe Bay, however, were compared to those in both the southwest and south coast. Each resighting of the same individual in a different location was considered evidence of connectivity between those locations. The number of individuals observed in multiple regions were calculated to assess spatial linkage.

Across eastern and western populations: A preliminary evaluation of movement and connectivity between calving grounds occupied by the eastern southern right whale population and westerly calving grounds (off the south coast of WA) of the western populations, was undertaken to quantify the proportion of identified individuals that have been sighted at both locations.

A comprehensive assessment of connectivity between the south coast and southwest regions, and across the full extent of the southern right whale range along the Australian coast, has yet to be undertaken.

3.4.1 Analytical software

All data related to systematic surveys and catalogue images, including events, sightings, identified individuals and matches were recorded in Microsoft® Excel® for Microsoft 365 MSO (Version 2204) spreadsheets. The SouWEST SRW and SC WA SRW Catalogues were maintained in Lightroom Classic® in Adobe® Creative Cloud Pro (Version 9.1; Adobe Inc.). Analyses and associated visualisations were produced using R v4.5.0 (R Core Team 2025) in RStudio Version 2025.09.1 Build 401 - © 2009-2025 RStudio Posit Software, PBC, Inc. or Microsoft® Excel® for Microsoft 365 MSO (Version 2204). ArcGIS Pro 3.5.0 (© 2025 Esri Inc.) was used to create all maps.

4. Results

Within this section, enhancements to ARWPIC data management processes designed to improve workflow and operational efficiency are first presented, followed by the ARWPIC database updates for the eastern and western populations dating back to 1994. For the western population, minimum abundance, distribution, residency, and site fidelity for locations within Western Australia are then reported, drawing on sightings from systematic research efforts (aerial and vessel surveys) as well as *ad hoc* and citizen science contributions (vessel, drone, and land-based observations). Preliminary cross-population connectivity is reported between the eastern and western regions of Australia, along with

evidence of anthropogenic impacts identified through image-based review – an outcome not originally anticipated within the scope of this project.

4.1 ARWPIC data management and processing enhancements

To reduce administrative burden and enhance overall data management efficiency, this project introduced several system enhancements into ARWPIC, including a bulk image and associated data upload process, automated bulk submission of processed images and associated data for curator review, and automated bulk curator acceptance functionality. These improvements significantly streamlined workflows.

Firstly, the new batch upload process now enables large numbers of files to be uploaded simultaneously to the ARWPIC server where they are queued for processing. The addition of this functionality is estimated to have saved over 60 hours of catalogue upload time during this project, based on 50% of the uploaded ARWPIC images being processed through this bulk upload approach.

Once uploaded for processing, the images require assignment to ‘sightings’ within ‘events’. While assigning event and sighting information has been undertaken in the past manually using drop-down menus or tables in the ARWPIC GUI, an additional system enhancement now includes a bulk event upload function that allows many events to be added from a formatted Excel sheet. System enhancements now allow bulk submissions of suggested matches and unique individuals, rather than event-by-event submission within ARWPIC. Additionally, bulk acceptance by curators has now been added. Combined, the bulk event upload feature and the automated bulk submission and acceptance functionalities saved contributors and curators over 30 hours of processing time for this study.

4.2 Image collation and processing

All regional catalogues within the scope of this report, including SEA SRW PIC, SouWEST SRW Catalogue, and SC WA SRW Catalogue, were updated to 2023, with the catalogues from Western Australia (SouWEST and SCWA SRW Catalogues) additionally updated to 2024, which included some opportunistic images as recent as from 2025.

In total, 28,848 images of southern right whales were processed, which included raw and reconciled images, resulting in 521 confirmed identifications (Table 4). These identifications include newly identified individuals and resights of previously catalogued whales.

4.2.1 Eastern population

For the eastern population, 469 southern right whale sightings from years 2009 – 2023 were processed, catalogued and matched in SEA SRW PIC and uploaded, processed, matched and catalogued in ARWPIC from raw and reconciled data provided by the Victorian, Tasmanian and New South Wales Governments. This included 433 raw citizens science sightings from 2022 and 2023 provided by the Victorian Government, 20 reconciled sightings from 2022 and 2023 from the NSW Government’s Right Whale ID program, and 16 reconciled sightings from 2019-2023 inclusive, collected primarily by Tasmanian Government

employees. Additionally, 85 SEA SRW PIC sightings previously uploaded and sitting in the ARWPIC contributor queue from 2009, 2018, 2019, 2020, 2021 were matched and catalogued bringing ARWPIC up to date with southeastern Australian sightings to the end of 2023.

The Victorian data consisted almost entirely of lateral images taken from land, whereas images from NSW and Tasmania were dorsal images collected using either drones or aircraft. Processing of the raw data from Victoria included removal of sightings of other species and of southern right whales that had images that were not of sufficient quality for identification. For curation within SEA SRW PIC, sightings of individuals consisting of lateral images of only one side of the head were removed. Data received from NSW and Tasmania contributors were already processed and sorted into folders of unique individuals.

Processing of the entire outstanding SEA SRW PIC dataset resulted in 137 unique individuals matched and catalogued in ARWPIC.

4.2.2 Western population

For the western population, ARWPIC was updated with images of southern right whale sightings from locations off Western Australia taken between 1994 and 2025. The number of sightings themselves was not documented for the majority of the dataset, as most images were opportunistic photos provided with just the image and date. Images were from the Esperance and the Israelite Bay region (2024), Albany and Hopetoun (2004-2024), Flinders Bay (1994-2024) and Geographe Bay (1994-2024), and off Mandurah (3), Perth (5), Jurien Bay (2), Geraldton (2) and Exmouth (6), and contributed to the SouWEST SRW and SCWA SRW regional catalogues by researchers and volunteer citizen scientists. A total of 28,391 raw and reconciled images spanning 21 years were processed. Many of these were historical contributions from the South Coast Cetaceans community project in Albany (now linked to the Right Whale Tracker Project), and had not previously been processed (2004-2024). Others were new or previously reconciled images from Geographe Bay and Flinders Bay that required consolidating and matching within ARWPIC. Processing of the entire outstanding datasets resulted in an approximate 406 unique individuals matched and catalogued in ARWPIC, the exact number of which will be available upon final curation of the SouWEST SRW at the time this report is published.

The dataset from locations off Western Australia consisted of 54% lateral identifications (207) mostly taken from land, and 46% (175) dorsal identifications collected using either drones or aircrafts. For the SouWEST SRW and SCWA SRW catalogues, sightings with only lateral images of one side of the head (34%) were retained in the regional catalogues to maximise opportunities for building regional resight histories and to capture orientations that can later be complemented by additional views collected in subsequent years. However, individuals with only a right-side image were not uploaded to ARWPIC to maintain consistency with the catalogue's protocol.

4.3 Curation

Photo-identification data were successfully curated within ARWPIC following the structured, multi-step quality-assurance protocol described in Section 3.2, designed to maintain data

integrity and consistency across contributors. The curation and validation process within regional catalogues and within ARWPIC, involving independent validation of proposed matches and individuals that remained unmatched, was found to be particularly important to maintain consistency, due to the widely varying image quality and whale orientations in which features were captured (e.g., left side or dorsal perspectives) across platforms (land-based, drone, and aerial photography).

Submissions from land and vessels tended to have greater instances of containing errors in correct assignment of feature codes resulting in insufficient detail or misassigned individuals (i.e., mismatched) than images from drones and systematic aerial surveys. Misassigned individuals were either “soft-rejected” for correction and resubmission, or “hard-rejected” when unsuitable for inclusion. For all accepted records, individual histories were successfully updated by curators, who also selected representative images and integrated the data into the searchable ARWPIC database. At the time of completion of this report, ARWPIC contained 4,470 events, comprising 9,673 sightings of 3,566 individuals, documented in 23,393 images collected between 1978 and 2025.

The systematic curation and validation process applied in ARWPIC continues to be key to reliable long-term individual identification that enables reliable demographic and ecological analyses.

Table 4: Southern right whale image metadata; including the population known to present in the region from which images were collected, region of collection, collection platform, source of images, years of image collection, number of images available for processing, and resulting number of identifications contributed to ARWPIC.

SRW population	Region	Platform	Source	Years of collection	Number of raw ([raw]) and reconciled ([rec]) images available	Number of SRW identifications contributed to ARWPIC
Eastern Australia*	Victoria	Land, drones	Citizen scientists, researchers	2009, 2022-2023	~1299 raw & rec	
	Tasmania	Aircraft	Researchers	2019-2023	16 rec	137*✹
	NSW	Land, drones	Researchers, citizen scientists, opportunistic	2022-2023	20 rec	
Western Australia◆▫	Esperance-Israelite Bay	Aircraft	Researchers	2024	1,527 raw	
	Albany- Hopetoun - Cheynes Beach - King George Sound	Aircraft, land and drones Vessels	Researchers, citizen scientists Whale watch operators	2008-2024 2004-2020	20,571 raw 5,257 raw	
	Flinders Bay	Vessels	Researchers, whale watch operator	1994-2020 2021-2024	174 raw & rec 313 raw	406^ (227▫, 179◆✹^)
	Geographe Bay	Land, drones, vessels	Researchers, citizen scientists, whale watch operator	1994-2021 2021-2024	362raw & rec 711 raw	
	North of GB - Mandurah - Perth - Jurien Bay - Dongara - Exmouth	 Drones Drones, vessels Drones Drones Aircraft	 Opportunistic citizen scientists, Opportunistic Opportunistic Opportunistic Opportunistic	 2024 2025 2025 2025 2018-2023	 3 raw 5 raw 2 raw 2 raw 26 raw	

Note: 'Opportunistic' = images provided by community members. 'Researchers' = independent, university or government researchers and their teams. *SEA SRW PIC, ◆SouWEST SRW, ▫SCWA SRW regional catalogues. ✹Includes sightings in the curator queue that were processed. ^Approximation awaiting final curation.

4.4 Abundance and distribution

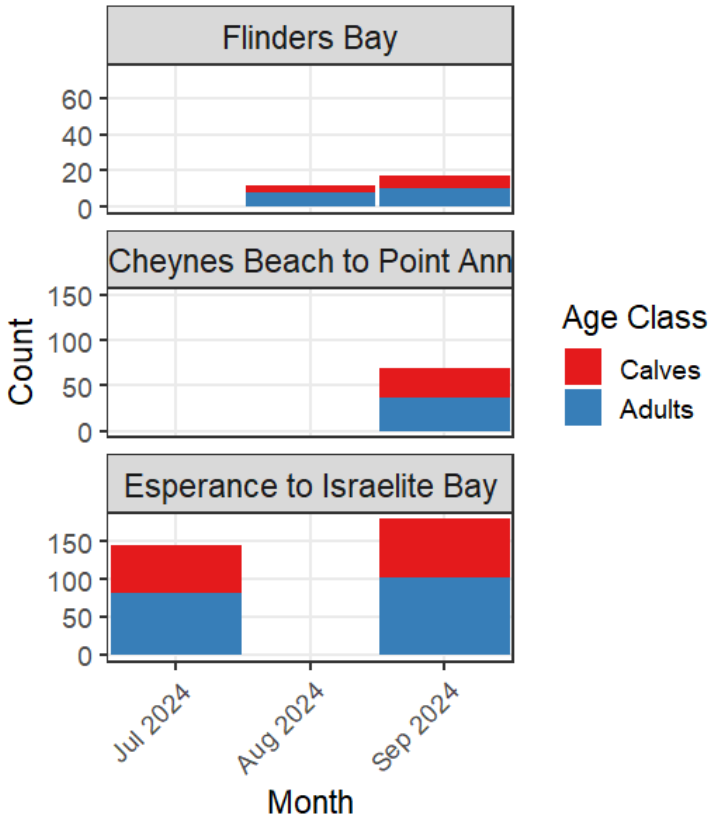
Minimum abundance, distribution, residency, and site fidelity are reported here for locations within Western Australia, using sightings data from systematic research (aerial and vessel surveys) and *ad hoc* surveys and citizen science contributions (from vessels, drones and land).

Counts from systematic surveys: A total of five systematic surveys, including three aerial and two vessel surveys, were conducted between July and September 2024 (Table 5). Aerial surveys were conducted on 14 July and 16 September 2024 between Esperance and Israelite Bay, and on 15 September 2024 between Cheynes Beach and Pt. Ann. Systematic vessel surveys were conducted in Flinders Bay on 21 August and 9 September 2024 (Table 5). A total distance of 1579 km was covered over all surveys combined, which included a mean distance of 39.5 (SD = 6.6) in Flinders Bay, 339.0 km for Cheynes Beach to Point Ann, and a mean of 580.5 (SD = 4.0) for Esperance to Israelite Bay.

Aerial and vessel-based surveys recorded a total of 240 adults and 183 calves across the three regions, some of which were the same individuals resighted in the second surveys conducted in two of the regions (Table 5, Figure 4). September was the only month that included all regions surveyed, with counts across all locations totalling to 266 southern right whales, including 150 adults and 116 calves (all of which were sited once only). The highest counts were observed in the Esperance to Israelite Bay region, where 82 adults and 63 calves were counted in mid-July, which increased to 101 adults and 78 calves by mid-September. Cheynes Beach to Point Ann showed relatively moderate counts, with 36 adults and 33 calves recorded in September. Flinders Bay had 8 adults and 4 calves in August and 13 adults and 5 calves in September (Figure 4). Calves were consistently present within all regions, indicating widespread calving activity during the survey period.

The percentage of adults that were mothers accompanied by a calf was greatest in the region of Cheynes Beach to Point Ann surveyed in September (92%), followed by Esperance to the Israelite Bay region (77% in July and September), and lowest in Flinders Bay (50% in August and 38% in September; Table 5).

Of the adult whales counted during surveys, 38% were photo-identified, with 62-63% identified during vessel surveys and 24-50% identified during aerial surveys (Table 5). All photo-identifications were of the dorsal region of the head, except for six individuals; two that were identified by their left and right sides (taken in September in Flinders Bay), two by their left sides only, (in August in Flinders Bay), and two by their right sides only (one in August in Flinders Bay and one in July in the Esperance to Israelite Bay region survey).



Note: Adults here include mothers and unaccompanied adults.

Figure 4 Counts of southern right whales within regions along the south coast of Western Australia during aerial surveys in July, August and September 2024.

In Flinders Bay, the distribution along the coast was between the mouth of Hardy Inlet near Augusta eastward for approximately 10 km, despite transects extending eastward over two-fold the distance. During the September survey, the distribution was shifted by approximately 7 km eastward compared to the August survey (Figure 5, Appendix A-1).

In the region between Cheynes Beach and Pt Ann, aggregations were most prominent in Doubtful Island Bay, Point Ann, Bremer Bay, and Cheynes Beach (Figure 5, Appendix A-2).

Between Esperance and the Israelite Bay region, aggregations were most prominent along the beach extending up to approximately 35 km northeast of Israelite Bay, followed by those at Tagon Bay and Sandy Bight (Figure 5, Appendix A-3). Aggregations were more pronounced during the September survey along the beach northeast of Israelite Bay for approximately 20 km and in Tagon Bay, compared to the August survey (Figure 5, Appendix A-1).

Table 5: Counts of southern right whale adults and calves within regions along the south coast of Western Australia from systematic vessel and aerial survey in July, August and September 2024.

Date	Location	Platform	Track Distance (km)	Survey counts				Adults identified from photo-ID	
				Adults	Calves	Total	Proportion adults that were mothers with a calf	Number	Proportion
21 Aug 2024	Flinders Bay	Vessel	34.8	8	4	12	0.50	5 (f=5, u=0)	0.63
14 Jul 2024	Esperance to Israelite Bay region	Aircraft	583.3	82	63	145	0.77	41 (f=33, u=8)	0.50
9 Sep 2024	Flinders Bay	Vessel	44.1	13	5	18	0.38	8 (f=5, u=3)	0.62
15 Sep 2024	Cheynes Beach to Point Ann	Aircraft	339.0	36	33	69	0.92	13 (f=10, u=3)	0.36
16 Sep 2024	Esperance to Israelite Bay region	Aircraft	577.7	101	78	179	0.77	24 (f=21, u=3)	0.24

Note: f = females, u = undetermined sex

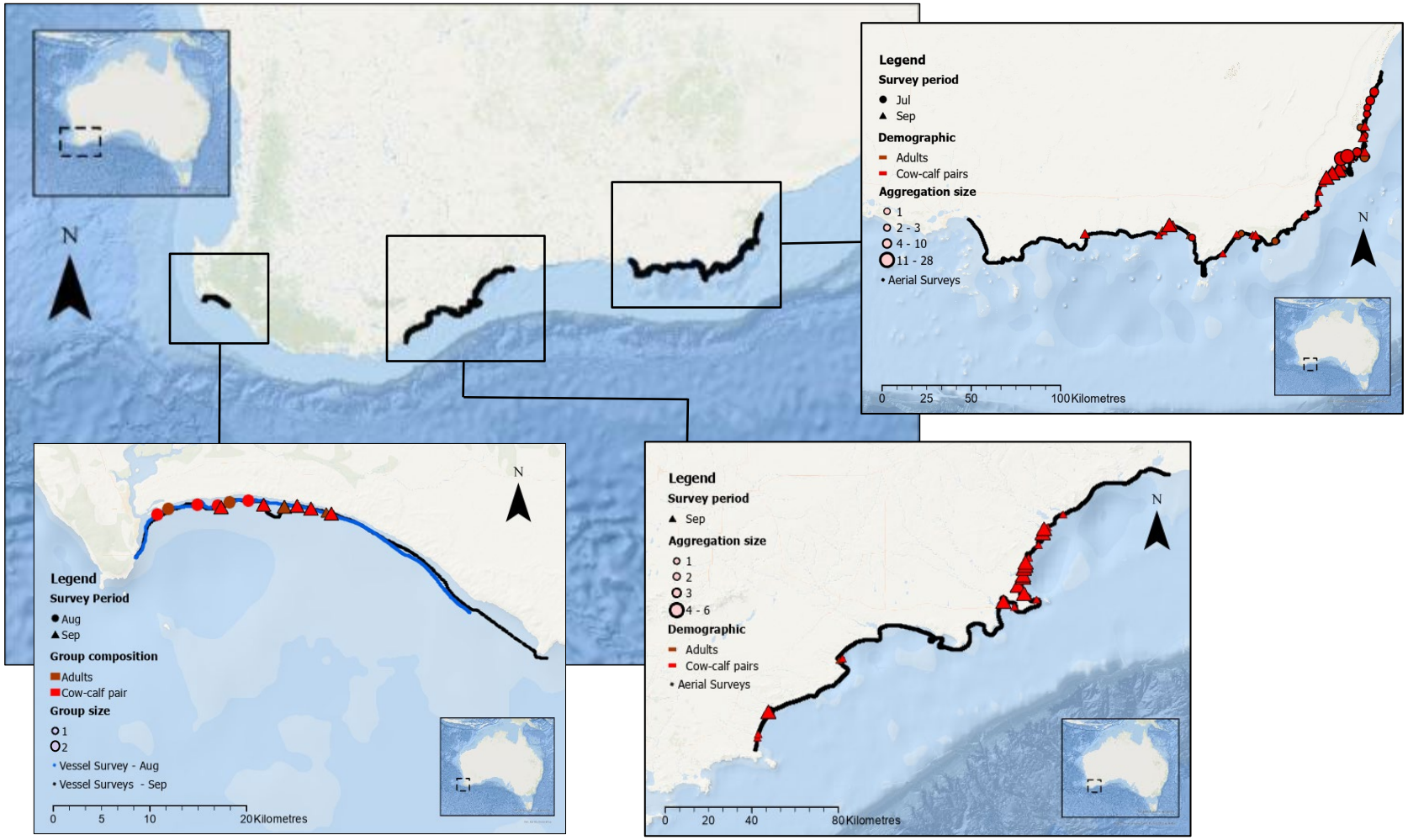


Figure 5 Locations of southern right whales sighted, their group composition and size in Flinders Bay, Cheynes Beach to Point Ann and Esperance to Israelite Bay regions in Western Australia during vessel and aerial surveys undertaken in 2024.

Minimum abundance from systematic and ad-hoc survey and citizen science photo-identified individuals: A total of 355 adult whale perspective-specific photo-identifications were obtained between 1994 and 2025 across all regions; including 188 right side, 191 left side, 120 dorsal, and 50 front perspectives. In this context, perspective-specific photo-identifications refer to individual images from a single viewing angle (i.e., perspective) in which a whale can be reliably identified (i.e., left side, right side, dorsal, front). Thus, the 355 perspective-specific identifications represent both whales photographed from only one perspective as well as multiple perspectives of the same whale (e.g., dorsal, left, and right sides) where they had been obtained. The majority of individuals were photographed from multiple perspectives (e.g., dorsal, right and left sides), however, some only relied on one perspective (e.g., left side only). In such cases, these could only be compared with photo-identified individuals of the same perspective to determine whether the individual was a new or a resighted individuals.

A minimum of 187 adults were identified as unique from analyses of the Esperance to Israelite Bay and Albany to Hopetoun regions (based on right side images having the greatest number of unique individuals recorded), 64 of which were mothers with calves, totalling 251 individuals (including calves). From analyses of the Flinders Bay and Geographe Bay regions and north along the west coast, the minimum number of individuals was 79 based on left side only comparisons, 63 of which were mothers accompanied by a calf totalling 205 individuals (including calves).

Across regions, the photographed perspective that resulted in greatest numbers of uniquely identified adult southern right whales varied greatly, with the dorsal area in the Esperance to Israelite Bay region, the right side in the Albany to Hopetoun region, the left side in Flinders Bay, and the dorsal perspective in Geographe Bay and north along the west coast. The Albany to Hopetoun region had the greatest number of uniquely identified adult individuals of 185 (based on right side), followed by 99 (based on left side) in Geographe Bay, 58 in Esperance to Israelite Bay (based on the dorsal perspective), 57 at Flinders Bay (based on left side), and 11 on the west coast of Western Australia north of Geographe Bay (based on the dorsal perspective; Table 6).

Table 6: Number of identified individual adult southern right whales for each region in Western Australia, based on each perspective photographed between 1994 and 2025.

Region	Perspective			
	Dorsal	Left side	Right side	Front
Esperance to Israelite Bay region	58	0	2	1
Albany to Hopetoun region	64	150	185	57
Flinders Bay	7	57	53	6
Geographe Bay	99	87	63	3
West coast north of Geographe Bay	11	3	3	1

Overall, the number of identified individuals varied over years (Figure 6), with a marked increase in 2024 on the south coast due to the aerial survey conducted between Esperance and Israelite Bay. The proportion of confirmed mothers accompanied with a calf also varied among years, but were relatively consistent when comparing collectively across the south coast regions (i.e., Esperance to Israelite Bay and Albany to Hopetoun; $\bar{x}$ = 0.53, SD = 0.34) and the southwest regions (i.e., Flinders Bay and Geographe Bay) and along the west coast north of Geographe Bay ($\bar{x}$ = 0.56, SD = 0.28), despite the aerial survey in the Esperance to Israelite Bay region in 2024 having a much greater proportion of adults that were mothers accompanied with a calf (0.81) than Albany to Hopetoun, Flinders Bay, and Geographe Bay ($\bar{x}$ = = 0.52, SD = 0.33; $\bar{x}$ = 0.59, SD = 0.27, and $\bar{x}$ = 0.45, SD = 0.28, respectively).

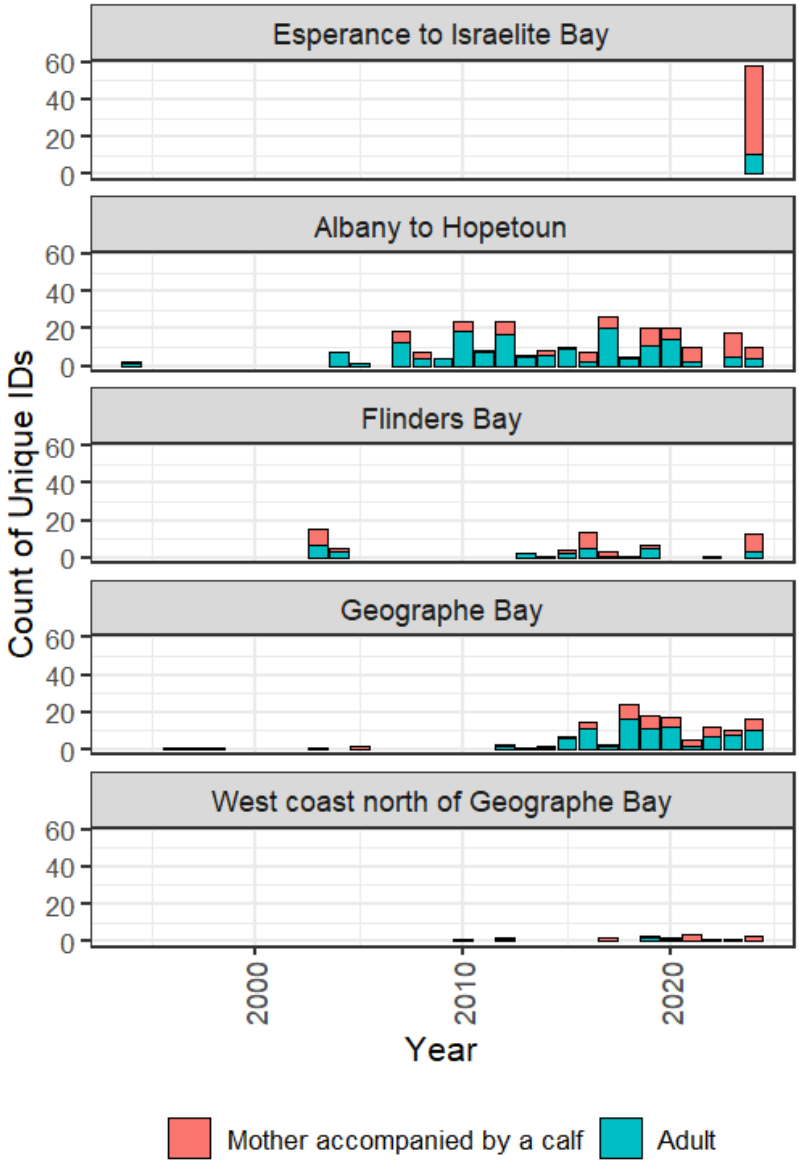


Figure 6 Number of uniquely identified individuals per year in the Albany to Hopetoun, Esperance to Israelite Bay, Flinders Bay, Geographe Bay and the west coast north of Geographe Bay regions between 1994 and 2025.

The discovery rate of unique individuals since 1994 has not reached a plateau, regardless of perspective photographed (Figure 7). A marked increase in discovery of the dorsal perspective occurred in 2024 due to the dedicated aerial surveys, as did in Flinders Bay in years with dedicated systematic surveys that tracked further east beyond the region where opportunistic whale watch contributions were made.

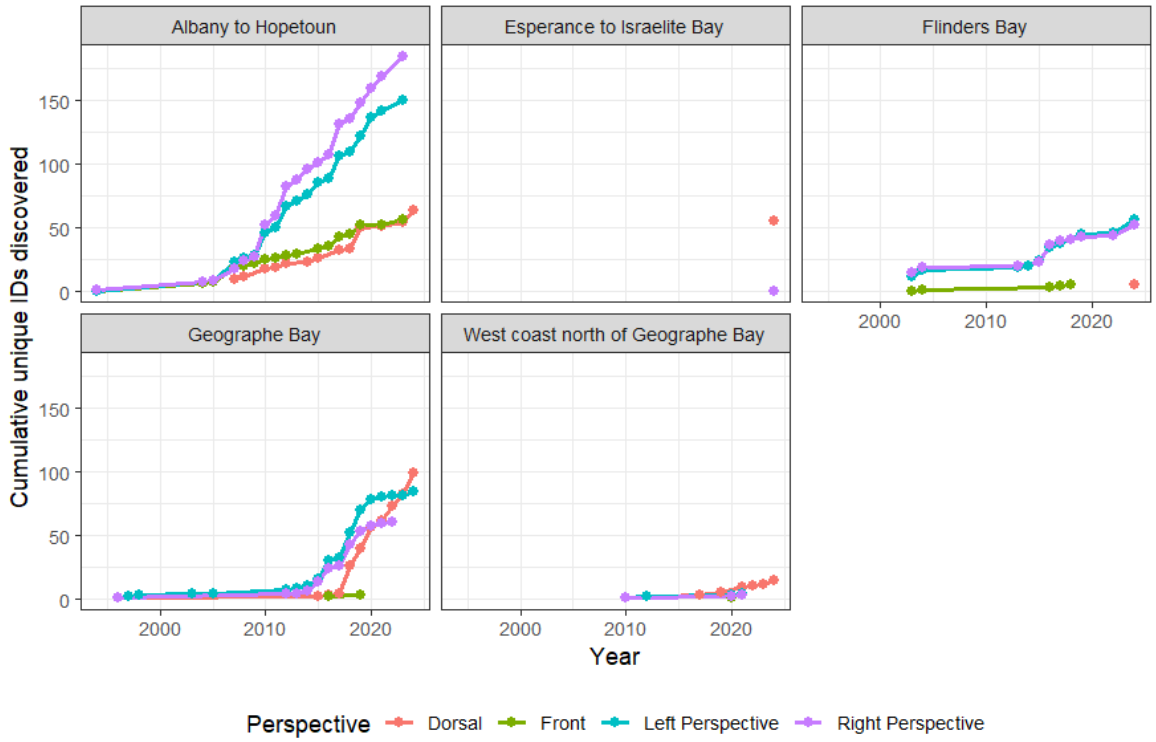


Figure 7 Discovery curve for the Albany to Hopetoun, Esperance to Israelite Bay, Flinders Bay, Geographe Bay and the west coast north of Geographe Bay regions based on data collected between 1994 and 2025.

4.5 Residency, site fidelity, and calving intervals

Based on photos taken during the 2024 aerial surveys, 4 resights were recorded (Table 7), including one in Flinders Bay, 20 days from when first sighted, and three in the Esperance to Israelite Bay region, 63 days from when first sighted. The shortest distance of recorded movement between the first sighting and the resight was 4.2 km (Flinders Bay) and the longest was 95.5 km (Esperance to Israelite Bay region).

Using all available photo-identification images from all sources, within region comparisons resulted in 139 resights within seasons. The greatest number of resighted individuals were in the Albany to Hopetoun (n = 52) region, followed by Geographe Bay and Flinders Bay regions (n = 42 and n = 40, respectively), and the Esperance to Israelite Bay region, having the fewest (n = 3) (Table 8, Figure 8). The greatest observed mean residency was observed within the Esperance to Israelite Bay region and had a duration of two months ($\bar{x}$ = 62, SD = 0), while the overall greatest observed residency consisting of a period of 105 days and was observed in the Albany to Hopetoun region (Table 8).

Table 7: Southern right whale minimum residency based on within season resights during systematic surveys within each region between July and September 2024.

Regional Catalogue ID	Demographic class	Region		Date		Time between sightings (days)	Distance between the first sightings and resights (km)
		First sighting	Resight	First sighting	Resight		
SRW295	Mother	Flinders Bay	Flinders Bay	21 Aug 2024	9 Sep 2024	20	4.2
ECU141	Mother	Esperance-Israelite Bay region	Esperance-Israelite Bay region	15 Jul 2024	16 Sep 2024	63	14.2
ECU148	Mother	Esperance-Israelite Bay region	Esperance-Israelite Bay region	15 Jul 2024	16 Sep 2024	63	11.4
ECU162	Adult	Esperance-Israelite Bay region	Esperance-Israelite Bay region	15 Jul 2024	16 Sep 2024	63	95.5

Note: Each region was only surveyed twice, which constrained observed residency periods to the number of days between surveys. The distances between first sightings and resights are straight-line distances.

Table 8: Southern right whale minimum residency within each region based on within season resights using all available images (systematic surveys, *ad hoc* surveys, citizen science observations and opportunistic images) between 1994 and 2025.

Region	n	Minimum Residency (days)			
		Mean	sd	min	max
Esperance to Israelite Bay	3	63.0	0.0	63	63
Albany to Hopetoun	52	17.6	23.5	1	105
Flinders Bay	40	15.5	13.0	1	45
Geographe Bay	42	13.8	14.9	1	62
West Coast North of Geographe Bay	2	43.5	2.12	42	45

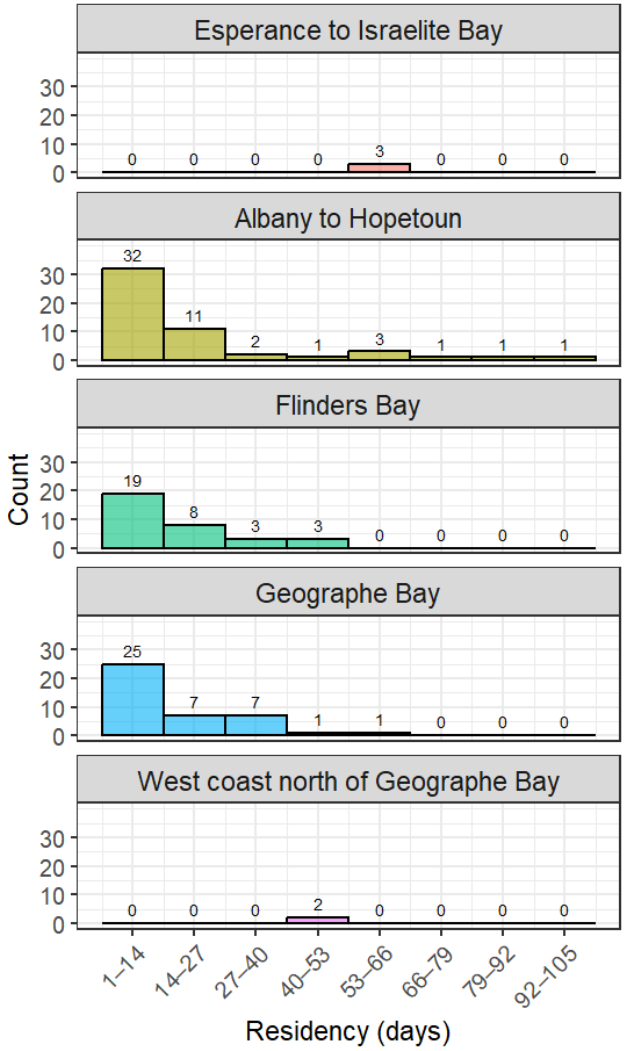


Figure 8 Distribution of minimum days of residency for photo-identified southern right whales in the Esperance to Israelite Bay, Albany to Hopetoun, Flinders Bay, Geographe Bay and the West coast north of Geographe Bay regions based on data collected between 1994 and 2025.

Evidence of site fidelity resulted from resighted individuals within all regions in which there were images collected over multiple years, with the Albany to Hopetoun region having the greatest number of resighted individuals across years (16), followed by Geographe Bay (3), West Coast north of Geographe Bay (2), and Flinders Bay (1) (Figure 10). The resight period ranged from 1 (in Albany to Hopetoun and West Coast north of Geographe Bay regions) to 20 years (in Flinders Bay).

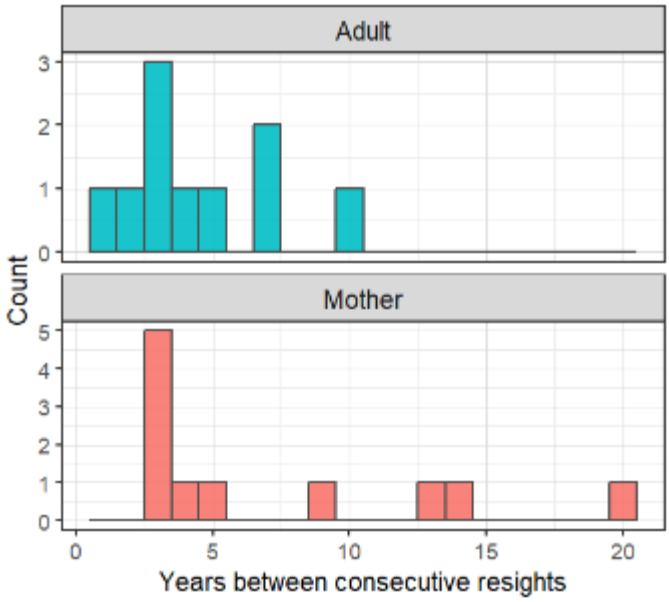


Figure 9 Distribution of minimum years between resights within the same region for photo-identified southern right whales across all regions (Esperance to Israelite Bay, Albany to Hopetoun, Flinders Bay and Geographe Bay, and West coast north of Geographe Bay) based on data collected between 1994 and 2025.

While the number of years between resights within regions observed varied among individuals and between adults of unknown sex and adults that were confirmed females, the most frequently observed interval was 3 years regardless of demographic (Figure 9, Table 9). The most frequent calving interval was also 3 years. The mean calving interval was 3.42 years (SD = 0.79), regardless of whether the mean was based on assuming intervals of five and less years or six and less years, were valid for inclusion. All intervals included in the calculation, with the exception of one, were observed over relatively recent years (since 2017).

Table 9: Southern right whale statistics for minimum years between resights for adults (of unknown sex and confirmed females) using all available images (systematic surveys, citizen science observations and opportunistic images) collected between 1994 and 2025.

Demographic	n	Minimum years between resights				
		Mode	Mean	sd	min	max
Adult (unknown sex)	9	3	4.5	2.8	1	10
Adult (females)	10	3	7.3	5.9	1	20

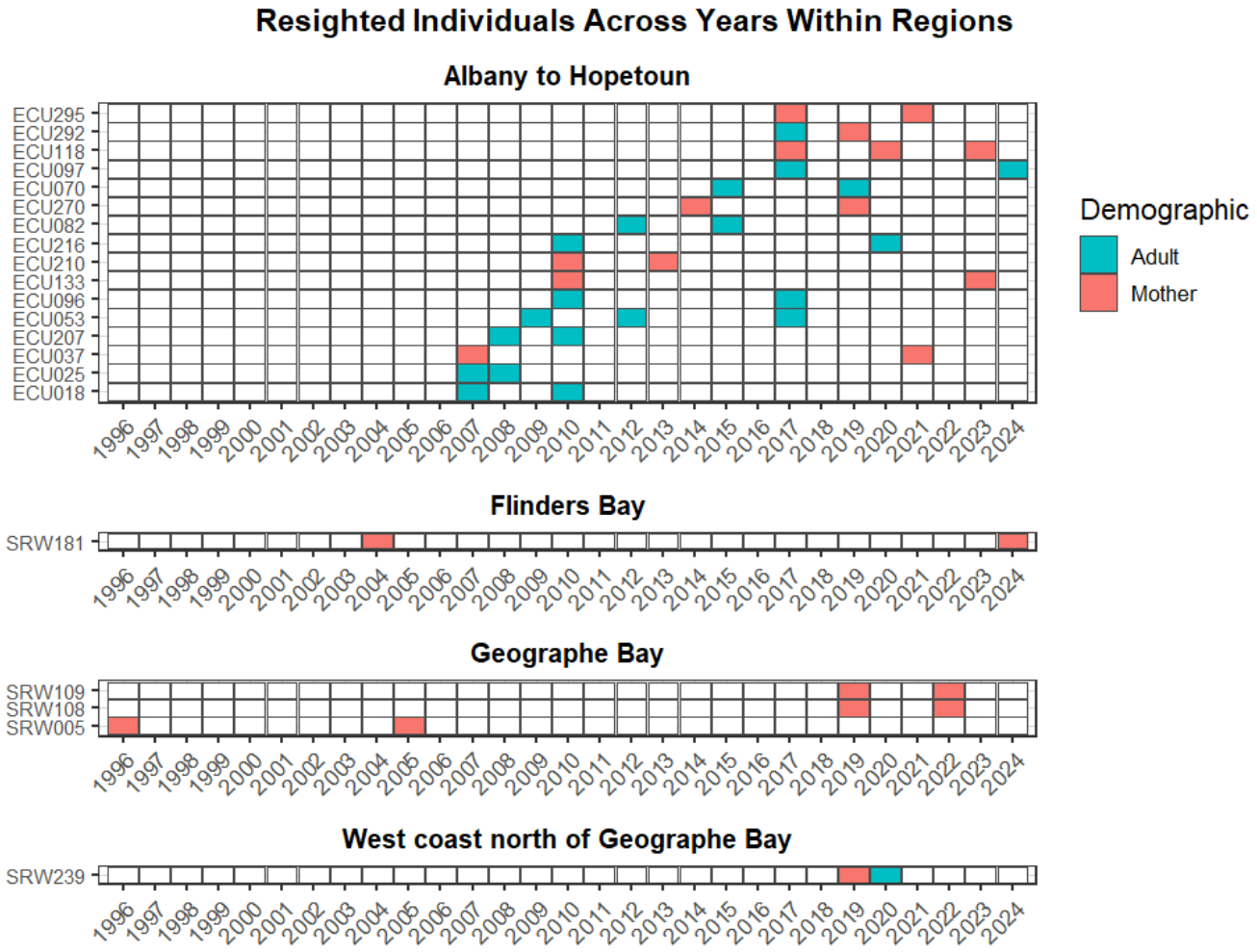


Figure 10 Site fidelity recorded in the Albany to Hopetoun, Flinders Bay and Geographe Bay, and West coast north of Geographe Bay regions based on data collected between 1994 and 2025.

4.6 Movement and Connectivity

Observed movement and connectivity of southern right whale within waters off Western Australia was low. When comparing identified individuals within the SouWEST SRW and SC WA SRW catalogues, resights across multiple regions was only reported for two individuals.

Movement within season between Flinders Bay and Geographe Bay was recorded for one southern right whale (SRW205) in 2016 (Figure 11), and for one (SRW017) between Geographe Bay and West coast north of Geographe Bay up to waters off Bunbury, both of which were mothers accompanied by a calf.

Connectivity between locations over different years was observed, including two individuals first sighted in the Albany to Hopetoun region and resighted in the Esperance to Israelite Bay region. Resights for these individuals were 7 and 14 years from when first sighted. Another individual was sighted in Flinders Bay and resighted in Geographe Bay two years later (Figure 11).

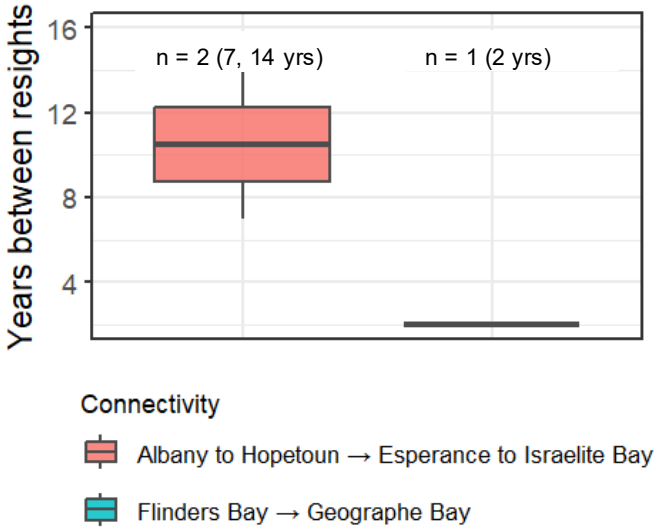


Figure 11 Regional connectivity recorded between regions along the south and the southwest coasts of Western Australia based on data collected between 1994 and 2025.

Movement and connectivity have yet to be evaluated across the southwest and south coast of Western Australia, as they are pending final curation in ARWPIC of the SouWEST regional contributions.

4.6.1 Across eastern and western populations

Preliminary comparison between images updated in ARWPIC as part of this study from eastern and western regions of Australia resulted in 0.63% of 790 identified individuals that matched (Table 10) between the eastern regions (off NSW, Victory, and Tasmania) and the south coast of WA (i.e., Albany to Hopetoun and Esperance to Israelite Bay regions). These include contributions to ARWPIC from the SEA SRW PIC and SC WA SRW Catalogues, with further analyses to include all regions across the distribution of southern right whales pending.

Table 10: ARWPIC matches of photo-identified southern right whales sighted on the south coast of Western Australia (between Albany and Israelite Bay; contributed through SC WA SRW Catalogue) and off eastern Australia (contributed through SEA SRW PIC).

ARWPIC ID	Sex	Western Australia			Eastern Australia		
		Demographic	Year	Location	Demographic	Year	Location
126	f	Mother-calf	2024	Israelite Bay, WA	Adult	1995	Otway coast, Victoria
328	f	Adult	2004	Albany area, WA	Adult	2005	Portland area, Victoria
822	Unknown	Adult	2004	Albany area, WA	Adult	2005	SE bays/channels, Tasmania
1900	f	Mother-calf	2017	Hassel Beach to Bremer Bay area, WA	Adult	2010	Tasmania
5641	f	Adult	2011	Hassel Beach to Bremer Bay area, WA	Adult, Mother-calf	2017, 2022	Far south coast NSW (2017), far south coast NSW & Otway Coast and Portland Victoria (2022)

4.7 Recorded Injuries and Disturbance

Images processed during this project provided evidence of direct human impacts on southern right whales, including entanglements, vessel collision, and disturbance from vessels and water activities (including swimmers). Three individuals photographed off Western Australia displayed distinct propeller strike scars across the dorsal area (see example in Figure 12). Image analysis also revealed a confirmed southern right whale entanglement off New South Wales in 2023. Although not part of the ARWPIC image set processed for this project, numerous additional images collected during photo-identification activities captured recreational vessel and drone interactions occurring at distances shorter than those stipulated in regulatory separation guidelines.

Figure 12 Individual southern right whale (GB161) observed with a propeller injury on 28 August 2023 in Geographe Bay, Western Australia.

5. Discussion

5.1 ARWPIC update, data management and curation

This study provides an important update to the Australasian Right Whale Photo Identification Catalogue (ARWPIC), with contributions of historical records and newly collected datasets, including from systematic surveys in two relatively data-poor regions within the western extent of the southern right whale population. While images from some collections across Australia are still to be contributed to ARWPIC, reflecting the ongoing nature of annual updates as new images are collected, the majority of the outstanding large regional datasets have now been consolidated and matched, including those of the Southeast Australia Southern Right Whale Photo Identification Catalogue (SEA SRW PIC), the South Coast Western Australia Southern Right Whale Catalogue (SC WA SRW Catalogue), and the South West Whale Ecology Study Southern Right Whale Catalogue (SouWEST SRW Catalogue). This brings ARWPIC substantially up to date, with decades of photo-identification data from these key regions added. The principal remaining dataset to be incorporated comprises the 2015-2025 collection originally managed by the Western Australian Museum (John Bannister) and, more recently, by Murdoch University (Smith et al.) and the Australian Antarctic Division (AAD). The updates presented here, which will be further strengthened by the full reconciliation of this outstanding collection, positions ARWPIC to support comprehensive, population-wide assessments of connectivity, demographic patterns, and population dynamics across Australia.

The systems enhancements made to ARWPIC as part of the scope of work reported here improve efficiencies for ongoing contributions, which translate to lower processing costs in the future. The enhancements not only reduce manual workload through automated processes, but also improve data integrity and consistency by minimising human error arising from contributors doing repetitive tasks. The efficiency gains also allow contributors and curators to focus more on quality assurance and analytical work rather than administrative processes. Additionally, the rigorous curator validation protocol required for each event and sighting that ensures standardisation, minimises inconsistencies arising from variable image quality and diverse data collection platforms. The combined improvements in time savings and data quality ultimately strengthen the capacity to update the catalogue regularly, which is critical for closely monitoring the population and producing timely research outputs that are essential for addressing the Southern Right Whale National Recovery Plan (DCCEEW, 2024) objectives.

As a result of ARWPIC enhancements and established protocols, it was possible in this study to integrate image collections from eight focal regions around Australia, spanning both the eastern and western southern right whale populations off New South Wales, Tasmania, Victoria, and in regions off Western Australian including Esperance to Israelite Bay, Albany to Hopetoun, Flinders Bay, Geographe Bay, and the west coast north of Geographe Bay. More than 28,000 images were processed from these regions, adding several hundred confirmed identifications and their associated resight histories to ARWPIC.

5.2 Abundance, distribution and movement in regions off Western Australia

Analyses of data from Western Australia (including intra-seasonal systematic surveys in 2024 and *ad hoc* surveys, citizen science, and/or opportunistic contributions dating back to 1994), indicated that during the southern right whale calving period each season, at least tens and up to nearly two hundred individuals can use these regions, the number of which was region- and seasonal-dependent in this study. True abundance of whales in these regions almost certainly was greater than that reported here, as these figures do not account for undetected whales. In fact, in the Esperance to Israelite Bay region, numbers (also not accounting for undetected whales) were reported to have exceeded 200 during the peak period (Smith et al. 2025).

While all contributions, including from systematic surveys, citizen science and opportunistic photo-identification, yielded complementary information, the source and survey platform used influenced minimum abundance calculated from individual identifications obtained. Where effort (either spatial and/or temporal) was known to be low (e.g., observations at Pt. Ann from systematic surveys, citizen science and opportunistic photo-identification), minimum abundance was low. Systematic aerial surveys produced a very large number of identifications from relatively few hours of effort compared to vessel and land surveys and citizen science and opportunistic contributions, due to the much broader spatial coverage achievable over a very short period (e.g., hours) of time during an aerial survey.

Regardless of overall numbers reported, high percentages of mothers accompanied by calves were observed to occupy these regions. Percentages based on direct counts from systematic surveys (i.e., 77% in Esperance to Israelite Bay, 92% between Cheynes Beach to Pt. Ann, and 38%-55% in Flinders Bay) are consistent with past recorded reproductive use (Pirzl 2008; Fannei 2021; Fabry 2023; Salgado Kent et al. 2022; Smith et al. 2020, 2023, 2024, 2025). Percentages based on photo-identification corroborate findings from systematic surveys, although they are more variable ranging between 26% and 81% across regions off Western Australia (81% between Esperance to Israelite Bay, 26% between Albany and Hopetoun, 56% in Flinders Bay, 33% in Geographe Bay, and 68% along the west coast north of Geographe Bay). Uncertainty remains whether the relatively higher proportion of mother-calf pairs observed during systematic surveys compared to photo-identifications from *ad hoc* vessel surveys, citizen science and opportunistic contributions reflects differences in detection probabilities or true proportions.

Mother-calf pairs typically spend more time at the surface than adults, and while aerial surveys capture only a single moment in time, vessel surveys and land-based observations allow longer observation periods due to the static position of the observer or slower survey speeds, increasing the likelihood of detecting cohorts that spend longer times under the surface of the water (e.g., unaccompanied adults). Regardless of this uncertainty, the consistent evidence from all data sources of sustained reproductive use underscores the importance of all regions as significant calving habitats.

Based on aerial surveys, this study also identified Israelite Bay, Tagon Bay, Bremer Bay to Dempster Inlet (inclusive of Doubtful Island Bay and Pt. Ann), and Cheynes Beach, in particular, as having had a very high proportion of confirmed mother-calf pairs (see Appendix

A). Spatial aggregations observed at specific locations and across broader regional scales in this study add to and corroborate previous findings from Western Australia (Pirzl 2008; Fennai 2020; Fabry 2023; Salgado Kent et al. 2022; Smith et al. 2020, 2023, 2024, 2025). Combined with spatial-use patterns documented across other regions occupied by the western population (Burnell and Bryden 1997; Charlton 2017; Evans et al. 2021;, Watson et al. 2021; O'Shannessy et al. 2025), these results support the concept of a recovering population re-establishing former breeding grounds. This is further supported by increasingly regular sightings in areas north of Geographe Bay where at least 24 whales, including 10 mother-calf pairs and one adult, have been recorded between Mandurah and Exmouth since 2010, and most since 2017. The greatest number recorded in any one year was eight individuals (four mother-calf pairs and one adult without a calf confirmed in 2021). These sightings still fall short, however, of historic whaling data with southern right whales recorded from Shark Bay to North West Cape and north past Port Hedland, extending to 17°S (Richards 2009).

Comparatively, contemporary observations of the western South Atlantic population extend to around 23°S in southern Brazil (Oliveira Santos et al. 2001), whereas historic records reached as far north as 5°S (Richards 2009). In the western Indian Ocean, reported sightings also suggest northern limits remain restricted to temperate South African waters, well south of historical records from as far north as 12°S off Madagascar (Richards 2009). In contrast, eastern South Atlantic observations off Gabon between 1971-1990 extended to 17°S (Roux et al. 2001), similar to historic records (Richards 2009). Recent records of the Eastern South Pacific population show a sighting furthest north to 0.6°N in Ecuador, beyond earlier limits off Peru and Chile (Ayala et al. 2024; Richards 2009). While historic and contemporary latitudinal extents of sightings may be associated with shifts in environmental conditions, population expansion, shifts in movement and distribution of the species, increased effort, or a combination of these, current data suggests that the northern limits in many regions remain more restricted than former pre-whaling distributions, indicating that full historical range recovery has not yet been achieved.

Within season spatial shifts observed during this study ranged from fine scale shifts of several kilometres to broad scale movement over 100 km. Although fine-scale shifts observed between surveys conducted one month apart in Flinders Bay, two months apart in the Esperance to Israelite Bay region, and documented in other regions included in this study previously (e.g., Pirzl 2008; Salgado Kent et al. 2022; Fabry 2023), may reflect weather-related movements toward more sheltered waters (as reported by Pirzl 2008), limited temporal sampling prevented confirmation. Broad-scale movements, including an unaccompanied adult in the Esperance to Israelite Bay region sighted almost 100 km from its original location two months prior, a mother-calf pair occupying both Flinders Bay and Geographe Bay in the same season and another using Geographe Bay and areas northward in the same seasons (also reported in Salgado Kent et al. 2022), indicate extensive movement across large areas over the period of calf development. As systematic surveys were limited to two within each region and photo-identification effort was variable and largely unquantified, it was not possible to determine the drivers of intra-seasonal shifts, such as environmental factors, calf developmental stage, or a combination of these. Nevertheless, these findings demonstrate that key calving areas cannot be delineated based on limited surveys and that calving habitats extend beyond aggregation areas.

Collectively, these findings indicate that an important component of the Australian southern right whale population occupies Western Australian coastal regions, exhibiting site fidelity while also undertaking broad-scale movements between regions. These attributes highlight reliance on these regions, in addition to a potential ongoing search for new mating opportunities, cultural exchange and the re-establishment of former calving grounds.

5.3 Residency, site fidelity, calving intervals, and connectivity in regions off Western Australia

Observed patterns of abundance and distribution off the coast of Western Australia described above confirm the persistence of historically recognised calving aggregation areas and broad spatial use along the coast. Observations during this study also revealed enduring occupancy within these regions during the calving season, as well as evidence of high site fidelity in particular regions and connectivity across them.

Minimum residency within regions documented here expanded on those reported previously for waters off Western Australia (Salgado Kent et al. 2022; Fabry 2023; coauthors unpublished data) as a result of systematic survey effort and particular highly dedicated volunteers at certain locations. Most residency periods ranged from several days to at least 2 months (Esperance to Israelite Bay), with the longest interval between resights of over three months (105 days at Cheynes Beach) which was comparable to a drone-based intra-seasonal study in the region (Fabry 2023). While these likely represent underestimates of residency, they indicate extended within-season occupancy by southern right whales, including significant numbers of mother-calf pairs with prolonged seasonal presence in the largest aggregation area off Western Australia – the region around Israelite Bay – as well as at locations with long-term and increasing sighting records, such as at Cheyne's Beach and in Flinders and Geographe Bays, and even along the west coast north of Geographe Bay.

While variability in residency across regions could not be evaluated due to variable temporal survey effort, counts from systematic surveys undertaken one month before and after the anticipated peak in Esperance to Israelite Bay, Albany to Hopetoun and in Flinders Bay mostly showed lower numbers compared to peak counts in corresponding regions during the annual Perth-to-Ceduna survey conducted by Smith et al. (2025) in the same year (2024). In the Esperance to Israelite Bay region, counts were 62% and 76% of the annual survey totals for this region one month before and after the peak, respectively. The Albany to Hopetoun region had the lowest percentage, with only 41% of the annual count for the region recorded in the survey conducted one month after the peak. As the aerial survey in this region was an unplanned opportunistic effort (conducted *en route* to the Esperance to Israelite Bay survey the following day), weather conditions were suboptimal for detection (Beaufort 4). While this likely resulted in more missed detections than would occur under favourable conditions, counts were comparable to those from surveys conducted by Fennai and Fabry in 2021 and 2022 (pers. comm.), despite similar or greater estimated abundance for the western population in those years (Smith et al. 2025) than in 2024.

In contrast to regions east of Albany, counts in Flinders Bay one month (approx. mid-September) after the anticipated peak (approx. mid-August) were almost double (1.9 times) those recorded during the annual survey in the same region (Figure 13). In addition, the first

vessel survey in Flinders Bay occurred just one day before the aerial survey and reported 15% more whales. Although these counts do not account for detectability bias, the discrepancies in minimum abundance during the peak between the two surveys in Flinders Bay conducted one day apart, and the substantially greater numbers of whales observed one month later in the same region highlight the need for multiple within-seasonal surveys to obtain a better understanding of variability in detection bias and timing of the peak in southern right whales among years (also noted by Fabry 2023) and across regions, as these factors may influence true abundance estimates that rely on accurate timing of the survey and standard multipliers (IWC 2013; Smith et al. 2025). Regardless of which counts are considered, all indicate that although numbers generally declined before and after the peak, significant numbers of whales continued to use these regions over extended periods for reproductive activity.

Site fidelity was observed in all regions where intra-annual photo-identification comparisons were conducted (e.g., Albany to Hopetoun, Flinders Bay, Geographe Bay, and the west coast north of Geographe Bay), regardless of whether these regions contained aggregation areas or not. The longest period between resights spanned up to two decades, providing supporting evidence in these regions of females (and adults of unknown sex) retaining a cultural memory of long-used calving grounds, and repeatedly returning (Carroll et al. 2015; Harcourt et al. 2019). Some individuals returned as early as the following year; however, the most frequent return interval was three years, regardless of whether the individual was a mother with a calf or an adult without a calf.

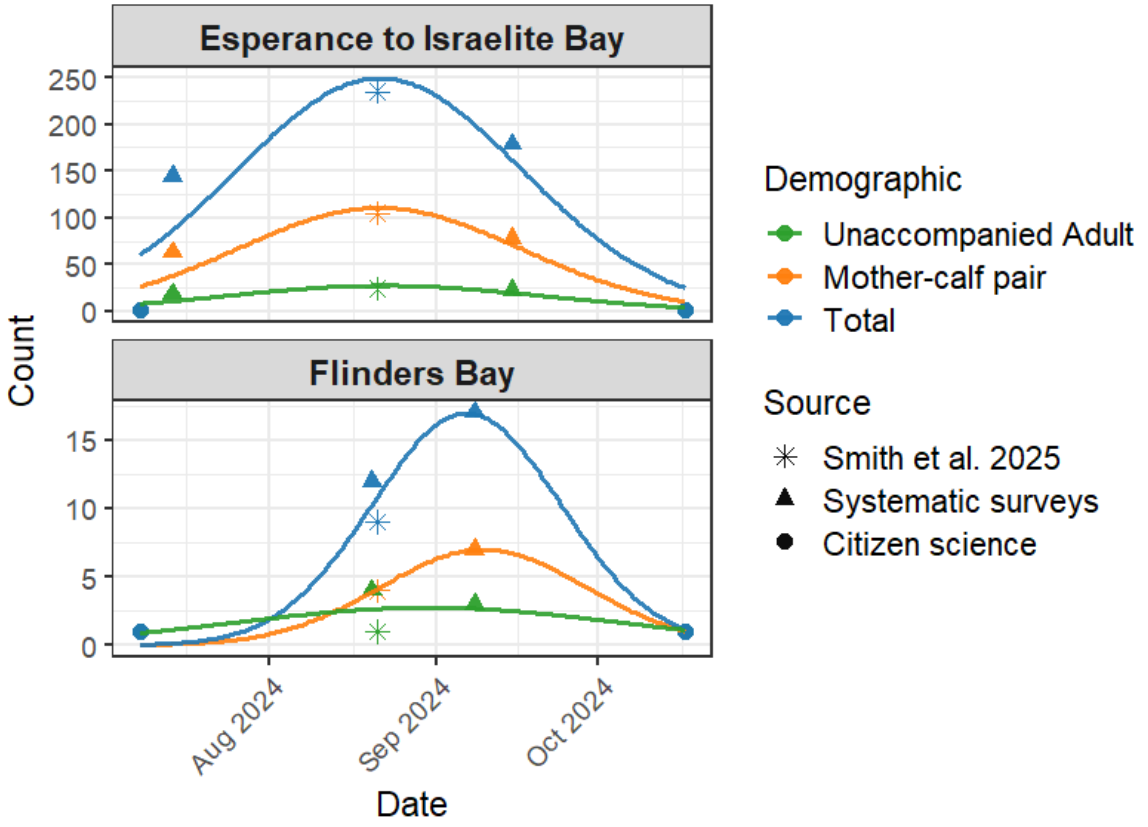


Figure 13 Fitted normal distribution to counts of mother-calf pairs, unaccompanied adult and total whales (including calves) in the Esperance to Israelite Bay and Flinders Bay regions between July and October 2024. Counts are from this study (with first and last sightings reported by citizen scientists on the south coast of Western Australia assumed to be the start and end of the season) and sourced from Smith et al. (2025).

The mean minimum observed resight interval, including for mothers calving, was longer than the predominant intervals (4.5 years for adults of unknown sex and 6 years for confirmed females), largely due to several resights with gaps far exceeding five years. If assuming that observed sighting intervals over five years of females sighted with a calf (initially and upon resighting her) reflect missed calving events (Bannister 1990; Cooke et al. 2001; Brandão et al. 2011; Charlton et al. 2022), and calculating the average calving interval using gaps of five years or less (or even six years or less, as per Watson et al. 2021), the observed minimum mean calving interval was 3.43 years. While this is comparable to mean calving intervals of 3.5 ± 0.2 years for southern right whales off Logans Beach in eastern Australia based on sightings between 1980 and 2018 (Watson et al. 2001), this contrasts with mean intervals reported by Charlton et al. (2022) for Head of Bight over the years 1996-2016, reporting mean minimum calving intervals of 4 years.

Notably, since 2015, all observed calving intervals of five years or less – with one exception – were three years, indicating that three-year calving intervals have predominated among females with repeated calving records during this period.. Consistent with past studies, calving intervals shorter than three years, which are considered rare (Bannister 1990; Cooke et al. 2001; Brandão et al. 2011; Charlton et al. 2022), were not observed here. While females are generally assumed to rest during the year following calving and return the next year to mate (Burnell 2001; Cooke et al. 2001; Brandão et al. 2018), one female returning the

following year (without a calf) after calving was observed. Indeed, a third of the breeding population was reported in non-calving years at Head of Bight during the period 1991-2022, demonstrating that the reproductive BIAs are important for whales in non-calving years, for socialising, mating and nursing (Charlton et al. 2025). Additionally, a significant increase in natal site fidelity for individuals that returned within the first three years of birth has been reported for the Head of Bight (Charlton et al. 2025). Such patterns of repeated returns and variability in calving intervals observed here and elsewhere, in context with prolonged calving intervals observed in other locations that coincide with shifts in global environmental conditions (Charlton et al. 2026), underscore the importance of monitoring site fidelity, return rates and calving intervals.

While residency and site fidelity analyses indicated that individual whales were resighted more frequently within than between regions off Western Australia, suggesting strong local site fidelity, movement between regions in different years confirmed connectivity across broad spatial areas. Inter-seasonal connectivity was observed in this study, with connectivity along the south and southwest coast of Western Australia evident from several resighted whales, with intervals ranging from 2 to 14 years. Notably, resights linking the Albany to Hopetoun and Esperance to Israelite Bay regions suggest cultural and/or genetic exchange through reproduction across at least hundreds of kilometres. While greater distances have not yet been reported off Western Australia, it may well be that individuals recorded traveling to Exmouth may have occupied Flinders Bay or Geographe Bay *en route*, which would represent movement over approximately 1,400 km. These patterns underscore the fluidity of whale movements between regions.

In summary, the extended residency, repeated returns, calving intervals and inter-regional connectivity observed in this study underscore the dynamic nature of southern right whale habitat use documented off Western Australia, some attributes of which are comparable and others that vary with those observed in other regions across the species' distribution off Australia (e.g., Charlton et al. 2022; Charlton et al. 2025; Watson et al. 2021), highlighting the need for flexible, regionally integrated management strategies that account for movement within and across aggregation areas.

5.4 Connectivity across populations

From a broader perspective, preliminary cross-population comparisons, albeit restricted in this study to comparison between eastern Australia and the south coast of Western Australia, indicate limited movement between eastern and western populations. This supports previous finings (Bannister 2001; Charlton 2017; Watson et al. 2021) and documented population-level genetic differentiation (Carroll et al. 2011; Carroll et al. 2015). While a full comparative analyses of the entire ARWPIC catalogue is still pending, the limited interchange between the populations supports the continued need for population-specific management as has been recommended previously (Brownell et al. 1986; Carroll et al. 2015).

5.5 Injuries and disturbance

Southern right whales continue to face a range of anthropogenic pressures across their Australian range. This report demonstrates the important role of photo-identification activities

in detecting, documenting, and monitoring these impacts. Through the process of collecting, collating and processing images used in this study, evidence of injuries and disturbance events, including vessel collisions, entanglements, and close-approach interactions, provided evidence of threats affecting this endangered species. The results highlight that human activities remain a persistent source of risk, especially in regions in which recreational vessel-use and coastal tourism are high.

While evidence of these incidents is provided here, it represents only a portion of the events known to have occurred over the period of this study. In addition, many cases are managed and documented internally by government departments charged with the responsibility of responding to incidents, and are not regularly published, if they do become published.

A comprehensive analysis of images used in this study, for the purpose of documenting incident rates and outcomes, fell outside the scope of this project. In addition, many incidents captured in images fall outside the years of image analysis for this project. This gap is particularly relevant for New South Wales, Tasmania, and Victoria, where images analysed for this project spanned 2019-2023. For example, off New South Wales in 2025, a mother and, nine days later, her calf were photographed with fresh, confirmed vessel-collision lesions (Figure 14), underscoring the continued vulnerability of this species to injury and mortality from vessels. While vessel collisions may appear relatively uncommon relative to the extensive recreational vessel activity along populated coastal areas, confirmed incidents such as the 2025 mother-calf collision described here reinforce the ongoing and genuine threat that vessels can pose to southern right whales.

In addition, imagery collected during field activities captured frequent close-approach interactions involving recreational vessels, swimmers, and drones at distances much shorter than those stipulated by regulatory separation guidelines. In New South Wales and Western Australia (including in Geographe Bay and Cheynes Beach), high levels of human activity continue to pose disturbance risks to these vulnerable individuals.

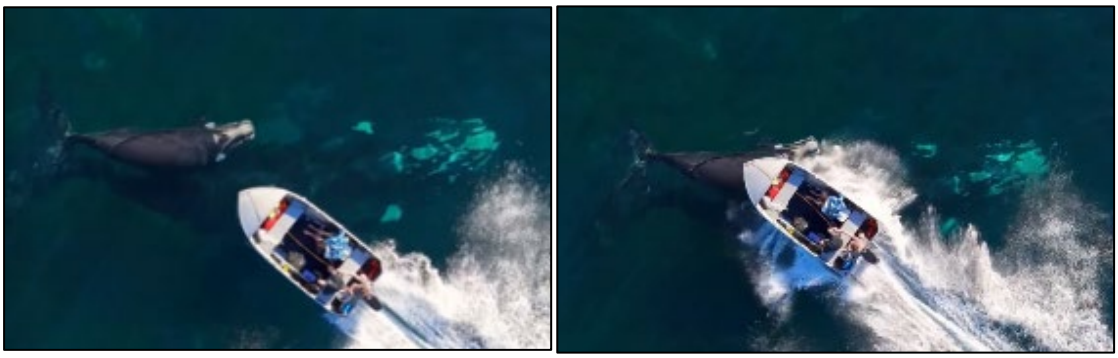


Figure 14 Vessel collision with a calf captured by drone off Stanwell Park, New South Wales, following earlier identification of collision injuries on its mother off Merimbula, in July 2025 (Image courtesy of: Michael Hatte).

Entanglement remains another significant concern and has been captured in images. Although southern right whales are entangled less frequently than humpback whales, the risk is magnified by the species' endangered status and small population. Any entanglement event carrying an elevated likelihood of poor outcomes, ranging from chronic injury to mortality, can have consequential impacts on population recovery.

Together, the findings presented in this report emphasise that the documented events represent only part of a wider pattern of human-related pressures that warrant a comprehensive evaluation, continued monitoring, mitigation efforts, and public awareness. Strengthening regulatory compliance, enhancing surveillance, and continued documentation and analysis of evidence (including from images) and reporting are key to reducing harm and supporting the long-term conservation of this species.

5.6 Stakeholder engagement, knowledge sharing and southern right whale monitoring collaborations

A key component of this work was engagement, training, knowledge exchange and monitoring facilitated through collaborations with researchers, whale-watch operators and non-government, government and Indigenous organisations. These activities were largely supported through substantial in-kind contributions, which significantly enhanced the outcomes of this study through the provision of data, expertise, training, education and ongoing communication with project stakeholders. The sightings, photo-identification records, and associated data generated through these collaborations contribute to ARWPIC and underpin many of the analyses presented in this report. Research findings and project updates were communicated throughout the study through presentations, workshops, school visits, community events, ranger activities, festivals, and ongoing engagement with participating organisations. Key collaborators included the NSW National Parks and Wildlife Service Right Whale ID (RWID) program, the Organisation for the Rescue and Research of Cetaceans in Australia (ORRCA), WhaleFace, Flinders University, the Australian Right Whale Research Program, the Encounter Bay Right Whale Study (EBRWS), South Coast Cetaceans, the Right Whale Tracker Project and the South West Whale Ecology Study (SouWEST).

5.6.1 Research, government and non-government organisation contributions

Citizen science projects and volunteered contributions coordinated by researchers and non-governmental and governmental organisations play a critical role in southern right whale monitoring capacity building and data contributions across Australia. These contributions have substantially increased the spatial and temporal coverage of sightings, behavioural observations and photo-identification images that were available for this research and inclusion in ARWPIC (Table 11).

Table 11: Summary of programs contributing to southern right whale monitoring capacity building, data collection contributed to this project and project-related stakeholder communication.

Region	Key contributing programs	Contribution	Impact and participation
NSW	RWID, NPWS, ORRCA	Sighting records, behavioural observations and photo-identification images	Volunteer drone pilot network operating since 2021, substantially increasing sighting detection and data collection capacity along the NSW coast, with southern right whale sightings and high-quality photo-identification images contributed to this project and ARWPIC.
Victoria	WhaleFace	Community sightings and photographs	More than 500 registered users contributing hundreds of sightings and photographs annually, including images in this study.
South Australia	Flinders University, Australian Right Whale Research Program, EBRWS	Monitoring data and photo-identification records	13 research assistants, interns, and 15 citizen scientists and volunteers. Contributions from EBRWS and tourism operators, including Eyre Peninsula Cruises, provided sightings, photo-identification records, vessel access, drone support and local ecological knowledge the contributed to encounter histories this project contributed to across Australia. Educational materials on southern right whale monitoring were also developed and displayed at the Head of Bight Whale Watching Centre. Three information sessions to stakeholders, public and community communicated information about the program and value of long-term population monitoring for national and international species conservation (~50 attendees).
Western Australia	Right Whale Tracker Project, SouWEST	Surveys, sightings and photo-identification images	Right Whale Tracker developed and delivered a southern right whale monitoring training toolkit through four workshops, training 36 citizen science volunteers. Three information sessions communicated how volunteer-collected data contributed to this study and its outcomes. SouWEST engaged >60 volunteers and shared project progress and findings through seven community presentations and the 2025 WA Coastal Forum (~70 attendees)

Note: RWID = Right Whale ID Program; NPWS = National Parks and Wildlife Service (New South Wales); ORRCA = Organisation for the Rescue and Research of Cetaceans in Australia; EBRWS = Encounter Bay Right Whale Study; SouWEST = South West Whale Ecology Study; ARWPIC = Australasian Right Whale Photo-Identification Catalogue.

In New South Wales, the RWID program coordinates volunteer drone pilots to collect southern right whale sightings, behavioural observations and photo-identification images that contribute directly to conservation initiatives and national photo-identification catalogues, including ARWPIC. Supported by NPWS and ORRCA, RWID has substantially increased sighting detection and data collection capacity along the NSW coast (Table 11).

In Victoria, WhaleFace strengthens community-based monitoring by providing a public reporting platform through which hundreds of users contribute sightings and photographs annually, including images used in this study (Table 11). In South Australia, Flinders University, the Australian Right Whale Research Program, the Encounter Bay Right Whale Study and tourism operators continue to provide valuable sightings, photo-identification

records, vessel access and local knowledge that support long-term monitoring efforts and communication of outputs (Table 11).

In Western Australia, the Right Whale Tracker Project and SouWEST support citizen science-based monitoring through training, surveys, citizen science participation and public engagement activities that resulted 36 additional trained citizen science volunteers, 38 trained Indigenous rangers across five ranger groups, 270 whale surveys (56 vessel based and 214 land based), and 229 photos submitted for processing in the 2025 season and community outreach with detailed participation metrics summarised in Table 11.

5.6.2 Indigenous collaborations, knowledge exchange and Sea Country monitoring

Indigenous Peoples are recognised as rights holders and custodians of Sea Country whose knowledge, stewardship and management responsibilities contribute to marine conservation and monitoring. Throughout this project, knowledge sharing with Indigenous organisations and communities facilitated the exchange of information on southern right whales and project findings, which informed and supported complementary activities presented in Table 12.

Knowledge sharing with the Yalata Anangu Aboriginal Corporation and Aboriginal Lands Trust has continued to inform and support complementary stewardship, knowledge exchange, and monitoring activities at Head of Bight. Broader project significance and findings were communicated through activities including Yalata Community Whale Day, Yalata Anangu School presentations, ranger engagement activities, and participation in the Winter Whale Festival, including events involving Ngarrindjeri Elders and Artists (Table 12).

Figure 15 Yalata Anangu Aboriginal Community engagement initiatives in 2025, including Whale Day at Head of Bight, Yalata (top image and bottom middle and right), and Yalata Anangu School Presentations (bottom left).

Table 12: Summary of complementary activities informed and/or supported by knowledge sharing with Indigenous organisations and communities during this project.

Region	Key Indigenous organisations and groups	Activity	Impact and participation
South Australia	Yalata Anangu Aboriginal Corporation, Aboriginal Lands Trust	Monitoring, knowledge exchange at Head of Bight	Research conducted on Yalata Indigenous Protected Area in partnership with the Yalata Anangu Aboriginal Corporation offering in kind support, collaboration and land access. Support for monitoring at Head of Bight, including ranger activities and research updates at the Head of Bight Whale Watching Centre.
	Yalata Anangu School	Education and communication of project progress	School presentations, participation in Whale Day activities, and the annual naming by the School students of a white calf during 2025.
	Ngarrindjeri Elders and Artists	Cultural and knowledge-sharing activities	Knowledge exchange through participation in the Winter Whale Festival through Kondoli Lantern Workshops and the Kondoli Dreaming Parade.
Western Australia	Esperance Tjaltjraak Native Title Aboriginal Corporation, Ngowanjerindj Rangers, Southern Aboriginal Corporation, Kadadjiny Aboriginal Corporation, Nowanup Rangers	Ranger engagement, consultation, monitoring participation and southern right whale monitoring training	38 Indigenous rangers trained in southern right whale monitoring across five ranger groups through four Indigenous consultation sessions, four face-to-face training workshops. Project progress was shared in three information sessions.

In Western Australia, project knowledge sharing occurred through the complementary Right Whale Tracker Project, coordinated by South Coast Natural Resource Management, which collaborates with Indigenous ranger groups through knowledge sharing, training workshops, monitoring, and information sessions. Between 2024 and 2025, project knowledge was shared with 38 Indigenous rangers across five ranger groups participating in Right Whale Tracker Project training and monitoring activities (Table 12).

The monitoring information generated through these complementary activities contributes to the evidence base used by government agencies and Indigenous Sea Country managers to support management decisions, conservation monitoring and management objectives within marine parks and other protected areas.

5.7 Knowledge gaps and recommended future research

To support effective management and adaptive conservation planning under the National Recovery Plan, key knowledge gaps not addressed in this study are outlined below.

Firstly, this study has updated and positioned ARWPIC to enable a revised, Australia-wide assessment of population demographics, movement, and connectivity. To fully realise this capability, completing the reconciliation of the 2015-2025 dataset originally collected and managed by the Western Australian Museum (John Bannister) and, more recently, by Murdoch University (Smith et al.) and the Australian Antarctic Division is recommended, including upload and matching within ARWPIC. Prioritising the integration of outstanding data contributions and advancing the associated analyses is essential for supporting timely and effective management responses, particularly given increasing coastal pressures on a population already showing declining recovery rates (Smith et al. 2025) and evidence of lengthening calving intervals (Charlton et al. 2022).

This study demonstrates the importance of supporting citizen science programs (often based on land-based observations) and Indigenous capacity-building initiatives, which contribute valuable observations at times and in locations not necessarily covered by formal surveys and frequently generate rich, long-term datasets for specific localities. These programs also enhance public engagement, awareness, and stewardship while expanding spatial and temporal coverage. In addition, vessel- and drone-based data collection provide high-resolution, close-range imagery that yields detailed information on local behaviours, mother-calf interactions, individual health, incident and injury documentation, and fine-scale habitat use, in addition to a platform from which to deploy sensors to gain insight on whale behaviours and habitats they occupy. Together, these sources have contributed a substantial wealth of data that has enabled the construction of a substantial dataset of sighting histories across Australia within ARWPIC.

While citizen science and opportunistic photo-identification remain essential for long-term tracking and population-modelling applications, they alone cannot provide the spatially and temporally coverage required for robust ecological inference. Regular, standardised intra- and inter-seasonal surveys, conducted with sufficient spatial and temporal intensity across representative areas, are critical for filling outstanding knowledge gaps and ensuring effective ongoing monitoring across the species' distribution. In practice, systematic surveys

and citizen science must play complementary roles, as both contribute unique and necessary information for reliable demographic assessment.

The importance in this complementary approach is demonstrated in the Western Australian analysis presented here, where uneven intra-seasonal coverage across regions, seasons, and observation platforms, arising from reliance on *ad hoc* surveys and citizen science contributions, restricted estimates of abundance, residency, site fidelity, and connectivity to minimum values. Although citizen science and opportunistic imagery confirm observed patterns, they can miss individuals or behaviours occurring outside observation periods. Moreover, uncertainty persists as to whether unobserved patterns reflect true absence or simply undetected presence, because effort information (e.g., duration and spatial coverage of observations) is typically unavailable.

Furthermore, the continued upward trajectory of discovery curves observed in this study reinforces the need for systematic effort. Many individuals remain uncatalogued, and the sharp increases in “new” individuals during years with aerial-survey coverage indicate that repeating such surveys regularly throughout the season over multiple years would rapidly advance progress toward a detection plateau. Low resight rates within and across many regions likely reflect restricted spatial and temporal coverage relative to the number of whales using these habitats. The substantial increase in resights that would result from multiple within-season aerial surveys across strategically selected regions would significantly improve population-parameter estimates and support the development of updated absolute-abundance models. Systematic aerial surveys would also help clarify whether the increasingly broad spatial use documented in this study reflects true range expansion or improved detection driven by increasing human presence (including drone use, recreational vessels, and citizen-science participation).

Implementing complementary systematic surveys alongside other data-collection sources would also support the development of analytical models capable of detecting changes in distribution and movement patterns within and across regions and for evaluating changes in association with environmental, biological, and anthropogenic drivers of habitat use. Such analytical frameworks are essential for adaptive management and effective conservation planning. Although these knowledge gaps are discussed here in the context of the western portion of the subpopulation, they are present in both the western and eastern populations and require attention across all relevant regions of the southern right whale distribution in Australia.

Looking forward, significant gains in catalogue efficiency, through improved ARWPIC database functionality and integration of automated image-matching tools (e.g., artificial intelligence; NESP Project 3.15, Subcomponent 1), are expected to expedite robust demographic inference. These advances, combined with strategic integration of systematic surveys with citizen science and community-driven contributions, will support a transition from apparent or minimum intra-seasonal estimates to robust estimates of absolute abundance, distribution, residency, site fidelity, return rates, and connectivity. When coupled with behavioural data, these improved metrics will provide essential habitat-use context and support ongoing updates of Biologically Important Areas (BIAs).

Finally, evaluating pressures, including quantifying and characterising incidents of vessel collision, entanglement, and disturbance, is required to assess key threats to the southern right whale population. Addressing these gaps will not only advance alignment with the National Recovery Plan but also strengthen the scientific foundation needed for effective conservation strategies that safeguard southern right whale populations in Australian waters.

5.8 Management implications

Findings from this study have direct relevance for refining conservation measures under the EPBC Act, the National Southern Right Whale Recovery Plan, and for updating Biologically Important Areas (BIAs). Preliminary analyses continue to demonstrate two distinct management units, the western and eastern, reinforcing the need for region-specific strategies due to low interchange and differing abundance trends between populations. Documented seasonal occupancy windows and high mother-calf proportions support strengthening seasonal protections in core calving habitats such as between Esperance and Israelite Bay, Albany and Hopetoun (including Cheynes Beach and Doubtful Island Bay to Point Charles), Flinders Bay, and Geographe Bay through vessel speed restrictions, approach limits, and spatial buffers such as sanctuary zones. This study documented vessel-collisions injuries, consistent with previous reports (DCCEEW 2024), and disturbance that is known to reduce resting opportunities for mother-calf pairs, increasing energy expenditure and potentially affecting calf fitness (Sprogis et al. 2023). These require effective management strategies to reduce their impacts.

Variation in photo-identification success and detectability across platforms highlights the need for multi-method baseline and monitoring data for impact assessments related to offshore renewable developments, aquaculture, coastal infrastructure, and tourism, to reduce bias in abundance, distribution, and residency estimates. Updated ARWPIC records and individual resight histories provide the robust evidence base needed to support ongoing monitoring, inform marine park zoning, and guide mitigation strategies aligned with Recovery Plan objectives and Indigenous Sea Country stewardship. Maintaining a robust, long-term ARWPIC dataset is essential for informing environmental assessment processes, particularly as cumulative pressures in the marine environment continue to increase and demand consistent, evidence-based evaluation of population status, trends, and vulnerability.

6. Conclusions and recommendations

This project has substantially strengthened the evidence base needed to support management of southern right whales in Australian waters. By consolidating historical and contemporary photo-identification datasets, improving ARWPIC workflows, and conducting targeted multi-season surveys in data poor regions, the study provides a strong platform for updating BIAs, informing EPBC assessments, and supporting region specific protections within Commonwealth marine parks and prospective MPAs. The combined findings (including high mother-calf presence in key aggregation areas, extended seasonal residency, strong site fidelity, and evidence of connectivity between regions) align with Recovery Plan research objectives and highlight the importance of continued place-based management for both eastern and western populations, whose numbers remain well below historical levels

(DCCEEW 2024) and show signs of slowing recovery (Smith et al. 2025; Guggenheimer et al. 2025) and potential climate linked reproductive decline (Charlton et al., 2022).

The project has reinforced partnerships among Indigenous groups, citizen scientists, conservation groups, and researchers that contribute to living regional catalogues that are consolidated within ARWPIC for Australia-wide assessments. These collaborations support ongoing monitoring, early detection of changes in aggregation use, and rapid reporting of human-whale interactions. Practical training provided to community and collaborators in image preprocessing and annotation has improved data quality, streamlined workflows, and strengthened capacity for future scaling of nationwide efforts.

To address key knowledge gaps and ensure management keeps pace with ecological change and expanding coastal and offshore activities, the following research needs are identified:

- **Cross-regional assessment:** Refine abundance, residency, site fidelity, and connectivity estimates across all regions across Australia using a fully reconciled ARWPIC to address management actions consistent with the Recovery Plan and EPBC Act.

- **Population demographic assessment:** Update demographic inputs, including rate of increase, calving intervals, survival, and mortality, to refine population models for the Australian population, enabling detection of future changes supporting adaptive management. This will also allow comparison across Southern Hemisphere populations to inform IWC priority species assessments.

- **Strengthen Indigenous and the broader community capacity:** Continue supporting Indigenous leadership in Sea Country stewardship, community capacity, and expand training for Indigenous Rangers and citizen scientists in image collection and preprocessing, while maintaining clear feedback loops to ensure data quality.

- **Implement systematic, multiplatform surveys:** Conduct standardised intra- and inter-season aerial surveys across representative regions to improve demographic inference, reduce uncertainty, and support transitions from minimum to absolute estimates of population attributes, while providing behavioural data needed for regular BIA updates.

- **Evaluate drivers of habitat use:** Integrate environmental, biological, and anthropogenic factors into habitat use models to ensure BIAs and risk assessments reflect contemporary and projected conditions.

- **Document baseline health and injury indicators:** Establish a baseline for monitoring human induced mortalities, injuries, scarring, and body condition to inform risk assessment, spatial planning, mitigation, and adaptive management.

Finally, sustaining ARWPIC contribution, curation, and optimisation is central to advancing these research needs and scaling future projects. Progress to date, made possible through substantial in-kind contributions from government agencies, organisations, industry,

individuals and community members (see Acknowledgements), underscores the value of continued national support to meet Southern Right Whale Recovery Plan objectives and guide management that safeguards this species into the future.

References

Adobe Inc. (2025). *Adobe Lightroom* (Version 9.1). Adobe Systems. https://www.adobe.com

Agrelo, M., Daura-Jorge, F.G., Rowntree, V. J., Sironi, M, Hammond, P., Ingram, S., Marón, C., Vilches, F., Seger, J., Payne, R., Simões-Lopes, P. (2021). Ocean Warming Threatens Southern Right Whale Population Recovery. *Science Advances* 7, no. 42: eabh2823. https://doi.org/10.1126/sciadv.abh2823.

Albouy, C., Delattre, V., Donati, G., Frölicher, T.L., Albouy-Boyer, S., Rufino, M., Pellissier, L., Mouillot, D., Leprieur, F. Global vulnerability of marine mammals to global warming. Sci Rep. 2020 Jan 17;10(1):548. doi: 10.1038/s41598-019-57280-3. Erratum in: Sci Rep. 2020 Mar 3;10(1):4257. doi: 10.1038/s41598-020-61227-4. PMID: 31953496; PMCID: PMC6969058.

Arias, M., M. A. Coscarella, M. A. Romero, Sueyro, N., Svendsen, G.M., Crespo, E.A., González, R.A.C. (2018). Southern Right Whale *Eubalaena australis* in Golfo San Matías (Patagonia, Argentina): Evidence of Recolonisation. *PLoS One* **13**, no. 12: e0207524-. https://doi.org/10.1371/journal.pone.0207524.

Bannister, J.L, (1990). Southern right whales off Western Australia. Rep. int. Whal. Commn (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. DOI: https://doi.org/10.47536/jcrm.vi.273.

Bannister, J. (2016). Monitoring Population Dynamics of 'Western' Right Whales off Southern Australia 2015- 2018 - Progress Report on activities for 2016. Report to the National Environmental Science Programme, Marine Biodiversity Hub. Western Australian Museum (lead organisation), 8pp.

Brandão, A., Best, P.B. and Butterworth, D.S. (2011). Monitoring the Recovery of the Southern Right Whale in South African Waters. Paper SC/S11/RW18 presented to the IWC Scientific Committee, May 2011.

Brandão, A., Vermeulen, E., Ross-Gillespie, 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, Focusing on Interferences to Be Drawn from a Series of Appreciably Lower Counts of Calving Females over 2015 to 2017. Paper SC/67B/SH/22 presented to the IWC Scientific Committee, April 2018.

Brandão, A, Ross-Gillespie, A, Vermeulen, Els, Butterworth, DS (2023). A photo-identification-based assessment model of southern right whales *Eubalaena australis* surveyed in South African waters, with a focus on recent low counts of mothers with calves

African Journal of Marine Science, vol 45. DOI: https://doi.org/10.2989/1814232X.2023.2172455.

Best, P.B. (2000). Coastal Distribution, Movements and Site Fidelity of Right Whales *Eubalaena Australis* Off South Africa, 1969–1998. South African Journal of Marine Science 22, 1, 43- 55. DOI: https://doi.org/10.2989/025776100784125618.

Brownell, R.L., Best, P.B. and Prescott, J.H., (Ed). (1986). Right Whales: Past and Present Status. Proceedings of the Workshop on the Status of Right Whales. Report of the International Whaling Commission (Special Issue 10). Cambridge, UK.

Burnell, S.R. (2001). Aspects of the reproductive biology, movements and site fidelity of right whales off Australia. Journal of Cetacean Research and Management, 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 241, 4, 613-621. DOI: https://doi.org/10.1111/j.1469-7998.1997.tb05736.x.

Carroll, E., Patenaude, N., Alexander, A., Steel, D., Harcourt, R., Childerhouse, S., Smith, S., Bannister, J., Constantine, R., and Baker, S.C. (2011). Population structure and individual movement of southern right whales around New Zealand and Australia. Marine Ecology Progress Series. 432: 257-68.

Carroll, E.L., Childerhouse, S.J., Fewster, R.M., Patenaude, N.J., Steel, D., Dunshea, G., Boren, L. and Baker, C.S. (2013). Accounting for female reproductive cycles in a superpopulation capture–recapture framework. Ecological Applications, 23: 1677-1690. https://doi.org/10.1890/12-1657.1

Carroll, E.L., Alderman, R., Bannister, J.L., Bérubé, M., Best. P.B., Boren, L., Baker, C.S., Constantine, R., Findlay, K., Harcourt, R., Lemaire, L., Palsbøll, P.J., Patenaude, N.J., Rowntree, V.J., Seger, J., Steel, D., Valenzuela, L.O., Watson, M. and Gaggiotti, O.E. (2019). Incorporating Non-Equilibrium Dynamics into Demographic History Inferences of a Migratory Marine Species. Heredity 122, 1, 53-68. DOI: https://doi.org/10.1038/s41437-018-0077-y.

Carroll, E.L., Baker, C.S., Watson, M., Alderman, R., Bannister, J., Gaggiotti, O.E., Grocke, D.R., Patenaude, N. and 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. DOI: https://doi.org/10.1038/srep16182.

Charlton, C.M. (2017). Population demographics of southern right whales (*Eubalaena australis*) in Southern Australia (PhD thesis). Curtin University, Bentley, WA, Australia.

Charlton, C., Ward, R., McCauley, R.D., Brownell, R.L., Jr., Salgado Kent, C. and Burnell, S. (2019). 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., 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, 32(4), 671–686. DOI: https://doi.org/10.1002/aqc.3771.

Charlton, C., Ward, R., O'Shannessy, B., Christiansen, F., Morrison, A., Brownell Jr, R.L., McCauley, R., and Burnell, S. (2025). Southern right whale (*Eubalaena australis)* residency, site fidelity and date of calving in South Australia (1991-2022). Journal of Cetacean Research and Management, 26:101-112. DOI: https://doi.org/10.47536/jcrm.v26i1.943.

Christiansen, F., Dawson, S.M., Durban, J.W., Fearnbach, H., Miller, C.A., Bejder, L., Uhart, M., Sironi, M., Corkeron, P., Rayment, W., Leunissen, E., Haria, E., Ward, R., Warick, H.A., Kerr, I., Lynn, M.S., Pettis, H.M., Moore, M.J. (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.

Charlton, C., Germishuizen, M., O'Shannessy, B., McCauley, R., Vermeulen, E., Seyboth, E., Brownell, R., and Burnell, S. (2026). Climate-driven reproductive decline in Southern right whales. Scientific Reports. 16. 10.1038/s41598-026-36897-1.

Cooke, J.G., Rowntree, V.J. and Payne, R. (2001). Estimates of Demographic Parameters for Southern Right Whales (*Eubalaena Australis*) Observed Off Peninsula Valdes, Argentina. Journal of Cetacean Research Management, 125-132. DOI: https://doi.org/10.47536/jcrm.vi.297.

Crespo, E.A., Pedraza, S.N., Dans, S.L., Svendsen, G.M., Degrati, M. and Coscarella, M.A. (2019). The southwestern Atlantic southern right whale, *Eubalaena australis*, population is growing but at a decelerated rate. Mar. Mam. Sci., 35: 93-107. DOI: https://doi.org/10.1111/mms.12526.

Department of Climate Change, Energy, the Environment and Water (DCCEEW) (2024). National Recovery Plan for the Southern Right Whale. https://www.dcceew.gov.au/sites/default/files/documents/national-recovery-plan-southern-right-whale.pdf.

Elwen, S.H. and Best, P.B. (2004). Environmental Factors Influencing the Distribution of Southern Right Whales (*Eubalaena Australis)* on the South Coast of South Africa Ii: Within Bay Distribution Marine Mammal Science 20, 3, 583-601. DOI: https://doi.org/10.1111/j.1748-7692.2004.tb01181.x.

Evans, K., Charlton, C., Townsend, A., Watson, M., Carroll, E., Double, M., Upston, J., Carlyon, K. and 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.

Fabry, M. (2023). Within-season assessment of abundance, residency, and coastal movement of southern right whales (*Eubalaena australis*) in a reproductive area in south west Australia. MSc Thesis. University of Western Australia.

Fannei, K. (2021). Within-season variation in abundance, distribution, and habitat use of Southern Right Whales (*Eubalaena australis*) in Western Australia. MSc Thesis. University of Western Australia.

Findlay, K., Thornton M., Wilkinson C., Vermeulen E., and Hoerbst S. (2017). Report on the 2016 Mammal Research Institute Whale Unit Southern Right Whale Survey, Nature's Valley to Lamberts Bay, South Africa. Report Presented to the 67th IWC Scientific Committee (Southern Hemisphere Subcommittee), Bled, Slovenia.

Germishuizen, M., Vichi, M. and Vermeulen, E. (2024). Population changes in a Southern Ocean krill predator point towards regional Antarctic sea ice declines. Scientific Repeports 14, 25820. https://doi.org/10.1038/s41598-024-74007-1.

Groch, K.R., Palazzo, Jr. J.T., Flores, P.A.C., Adler, F.R., Fabian, M.E. (2005). Recent rapid increases in the right whale (*Eubalaena australis)* population off southern Brazil. Latin American journal of aquatic mammals, 4(1): 41-47.

Grundlehner, A., Smith, J.N., Bannister, J.L., Andrews-Goff, V., Brasier, M., Double, M.C., Corney, S.P. (2025). The End of an Era? Trends in Abundance and Reproduction of Australian Southern Right Whales (*Eubalaena australis*) Suggest Failure to Re-Establish Pre-Whaling Population Size. Global Change Biolology;31(5):e70218. PMID: 40304046; PMCID: PMC12042069. DOI: https://doi.org/10.1111/gcb.70218.

Harcourt, R., van der Hoop, J., Kraus, S. and Carroll, E.L. (2019). Future Directions in *Eubalaena* spp.: Comparative Research to Inform Conservation. Frontiers in Marine Science 5. DOI: https://doi.org/10.3389/fmars.2018.00530.

Hoyt, E., Notarbartolo di Sciara, G. (eds) (2014). Report of the workshop for the development of Important Marine Mammal Area (IMMA) criteria. IUCN Marine Mammal Protected Areas Task Force and International Committee on Marine Mammal Protected Areas. http://icmmpa.org/wp-content/uploads/2014/03/Report_Marseille_Workshop_IMMA_MMPATFICMMPA_web.pdf (accessed 31 May 2022).

IWC (2001). Report of the Workshop on the Comprehensive Assessment of Right Whales: A Worldwide Comparison. J. Cetacean Res. Manage. https://journal.iwc.int/index.php/jcrm/article/view/270.

IWC (2013). Report of the IWC Workshop on the Assessment of Southern Right Whales. Journal of Cetacean Research Management Supplement 14. DOI: https://archive.iwc.int/pages/home.php.

Jackson, J.A., Patenaude, N.J., Carroll, E.L. and Baker, C.S. (2008). How Few Whales Were There after Whaling? Inference from Contemporary MtDNA Diversity. Molecular Ecology 17, 1, 236- 251. DOI: https://doi.org/10.1111/j.1365-294X.2007.03497.x.

Jackson, J.A., Carroll, E.L., Smith, T.D., Zerbini, A.N., Patenaude, N.J., and Baker, C.S. (2016). An integrated approach to historical population assessment of the great

whales: Case of the New Zealand southern right whale. Royal Society Open Science, 3, 150669. DOI: https://doi.org/10.1098/rsos.150669.

Jönsson, K.I. (1997). Capital and income breeding as alternative tactics of resource use in reproduction. Nordic Society Oikos, 78(1): 57–66.

Notarbartolo di Sciara, G. and Hoyt, E. (2020). Healing the wounds of marine mammals by protecting their habitat. Ethics in Science and Environmental Politics. 20. DOI: https://doi.org/10.3354/esep00190.

Oliveira Santos, M., Siciliano, S., Souza, S.,Pizzorno, J. (2001). Occurrence of southern right whales (*Eubalaena australis*) along southeastern Brazil. Journal of Cetacean Research and Management. 2: 153-156. DOI: https://doi.org/10.47536/jcrm.vi.299.

O'Shannessy, B., Moller, L., Parra, G., McCauley, R., Smith, J., Burnell, S., and Charlton, C. (2025) Decadal Shifts in Southern Right Whale (*Eubalaena australis*) Recovery in South Australian Waters: Implications for Conservation and Management. Marine Mammal Science, 41(4), e70045. https://doi.org/https://doi.org/10.1111/mms.70045.

Payne, R., Brazier, O., Dorsey, E.M., Perkins, J.S., Rowntree, V.J. and Titus, A. (1983). External features in southern right whales (*Eubalaena australis*) and their use in identifying individuals, pp. 371-445. In: R. Payne (ed.) Communication and Behavior of Whales. AAAS Selected Symposium 76, Westview Press, Boulder, Colorado.

Pirzl, R. (2008). Spatial ecology of *E. australis*: habitat selection at multiple scales. PhD thesis, Deakin University, Victoria.

Pirzl, R., Murdoch, G., Lawton, K. (2006). BigFish: Computer assisted matching software and data management system for photo-identification. Skadia Pty Ltd, Horsham, Australia.

R Core Team (2025). R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/.

Richards, R., (2009). Past and present distributions of southern right whales (*Eubalaena australis*). New Zealand Journal of Zoology - New Zealand Journal of Zoology. 36: 447–459. DOI: https://doi.org/10.1080/03014223.2009.9651477.

Romero, M.A., Coscarella, M.A., Adams, G.D., Pedraza, J.C., González, R.A., Crespo, E.A. (2022). Historical reconstruction of the population dynamics of southern right whales in the southwestern Atlantic Ocean. Scientific Reports 12, 3324. DOI: https://doi.org/10.1038/s41598-022-07370-6.

Roux, J.P. & Best, P.B. & Stander, P.E. (2020). Sightings of southern right whales (*Eubalaena australis*) in Namibian waters, 1971-1999. J. Cetacean Res. Manage. 181-185. DOI: https://doi.org/10.47536/jcrm.vi.290.

Salgado Kent, C.P., Burton, C., Giroud, M. and Elsdon, B. (2022). A photo-identification study of southern right whales to update aggregation area classification in the

southwest of Australia. Report to the National Environmental Science Program. Edith Cowan University. Pp. 35.

Smith, J.N., Double, M., Evans, K. and Kelly, N. (2023). Relative Abundance of the 'Western' Population of Southern Right Whales (*Eubalaena australis)* from an Aerial Survey Off Southern Australia: Final Report on 2022 Survey. Report to the National Environmental Science Program. Murdoch University (Lead organisation).

Smith, J.N., Double, M. and Kelly, N. (2024). Relative abundance of the 'western' population of southern right whales (*Eubalaena australis*) from an aerial survey off southern Australia: Final Report on 2023 survey. Report to the National Environmental Science Program. Murdoch University (Lead organisation).

Smith, J.N., Double, M., Kelly, N., Charlton, C. and Bannister, J. (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). https://www.nespmarinecoastal.edu.au/project-1-26- final-report-2/.

Smith, J.N., Double, M. and Townsend, A. (2025). Aerial survey of the Australian southern right whale (*Eubalaena australis*) 'western' population and development of AI for photo identification. Report to the National Environmental Science Program. Murdoch University (Lead organisation).

Smith J.N., Jones D., Travouillon K., Kelly N., Double M. and Bannister, J.L. (2020). Monitoring Population Dynamics of 'Western' Right Whales off Southern Australia 2018-2021 - Final Report on activities for 2019. Report to the National Environmental Science Program, Marine Biodiversity Hub. Western Australian Museum (lead organisation).

Smith, J.N., Jones, D., Travouillon, K., Kelly, N., Double, M. and Bannister, J.L. (2021). Monitoring Population Dynamics of 'Western' Right Whales off Southern Australia 2018-2021 - Final Report on activities for 2020. Report to the National Environmental Science Program, Marine Biodiversity Hub. Western Australian Museum (lead organisation).

Sousa, A., Alves, F., Arranz, P., Dinis, A., Fernandez, M., González García, L., Morales, M., Lettrich, M., Encarnação Coelho, R., Costa, H., Capela Lourenço, T, Azevedo, N.M.J., Frazão Santos, C. (2021). Climate Change Vulnerability of Cetaceans in Macaronesia: Insights From a Trait-Based Assessment. Science of the Total Environment 795: 148652. DOI: https://doi.org/10.1016/j.scitotenv.2021.148652.

Sprogis, K.R., Holman, D., Arranz, P. and Christiansen F. (2023). Effects of Whale-Watching Activities on Southern Right Whales in Encounter Bay, South Australia. Marine Policy 150, 105525. DOI: https://doi.org/10.1016/j.marpol.2023.105525.

Stamation, K., Watson, M., Moloney, P., Charlton, C. and 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., Mikhaliev, Y.A., Best, P.B., Zemsky, V.A., Sekiguchi, K. and Brownell, R.L. (1998). Soviet Catches of Southern Right Whales *Eubalaena australis*, 1951-1971. Biological Data and National Recovery Plan for the Southern Right Whale (*Eubalaena australis*) 94 Conservation Implications. Biological Conservation 86, 2, 185-197. DOI: https://doi.org/10.1016/S0006-3207(98)00008-1.

Tulloch, V.J.D., Plagányi, É.E., Matear, R., Brown, C.J., and Richardson, A.J. (2017). Ecosystem modelling to quantify the impact of historical whaling on Southern Hemisphere baleen whales. Fish and Fisheries. DOI: https://doi.org/10.1111/faf.12241.

Tulloch, V.J.D., Plagányi, É.E., Matear, R., Brown, C.J., Richardson, A.J. (2018). Ecosystem modelling to quantify the impact of historical whaling on Southern Hemisphere baleen whales. Fish and Fisheries 19: 117–137. DOI: https://doi.org/10.1111/faf.12241.

Tulloch, V.J.D., Plagányi, É.E., Brown, C., Richardson, A.J. and Matear, R. (2019). Future Recovery of Baleen Whales Is Imperiled by Climate Change. Global Change Biology 25, 4, 1263-1281. DOI: https://doi.org/10.1111/gcb.14573.

Van den Berg, G., 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.

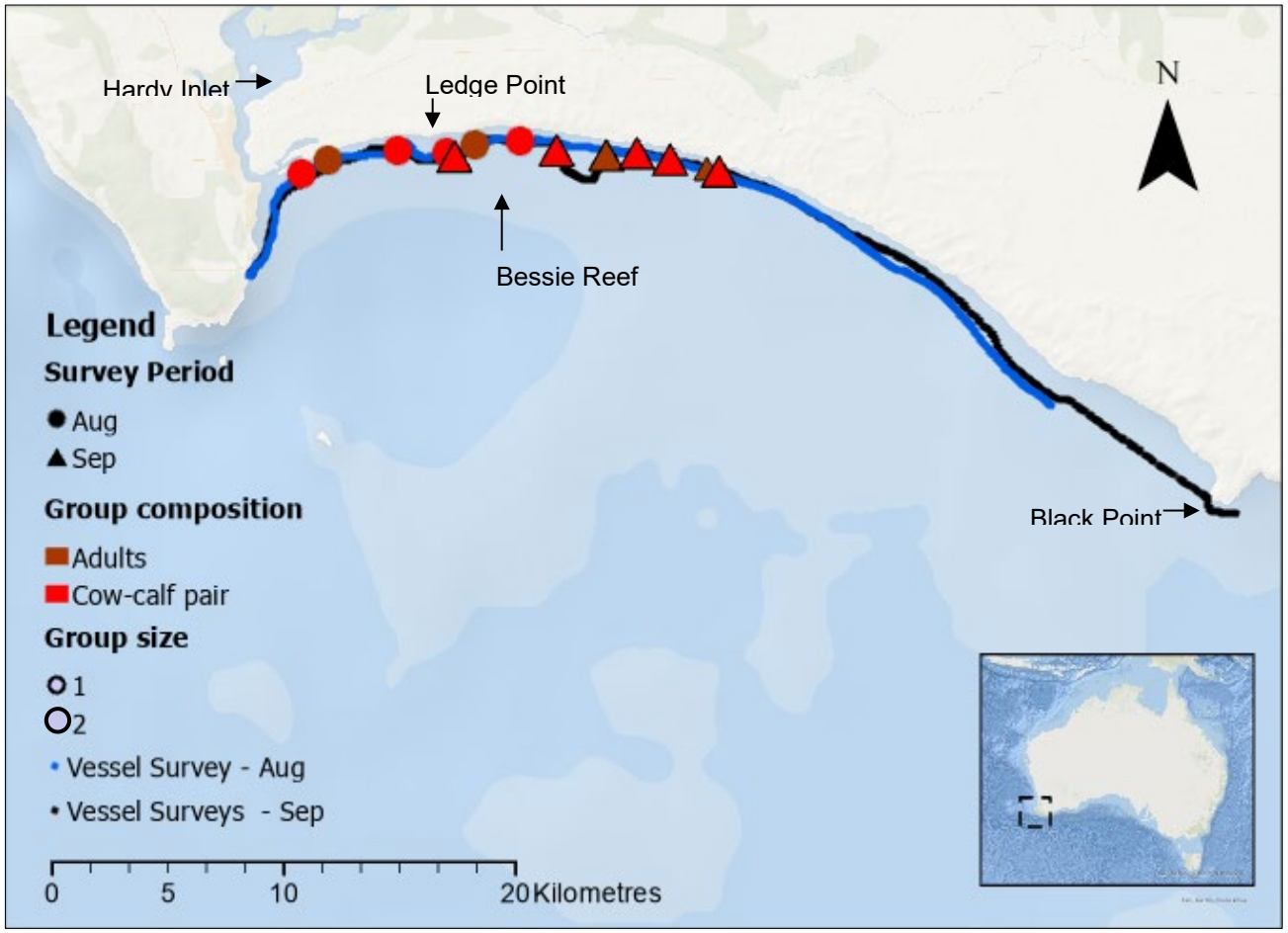
Vermeulen, E., Wilkinson, C. and Shuttleworth, L. (2023a). Report of the southern right whale aerial surveys - 2022. DOI: https://doi.org/10.13140/RG.2.2.13742.69446.

Vermeulen, E., Thavar, T., Glarou, M., Ganswindt, A., Christiansen, F. (2023b). Decadal decline in maternal body condition of a Southern Ocean capital breeder. Scientific Reports 13: article 3228. DOI: https://doi.org/10.1038/s41598-023-30238-2.

Watson, M., Stamation, K. and Charlton, C. (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.

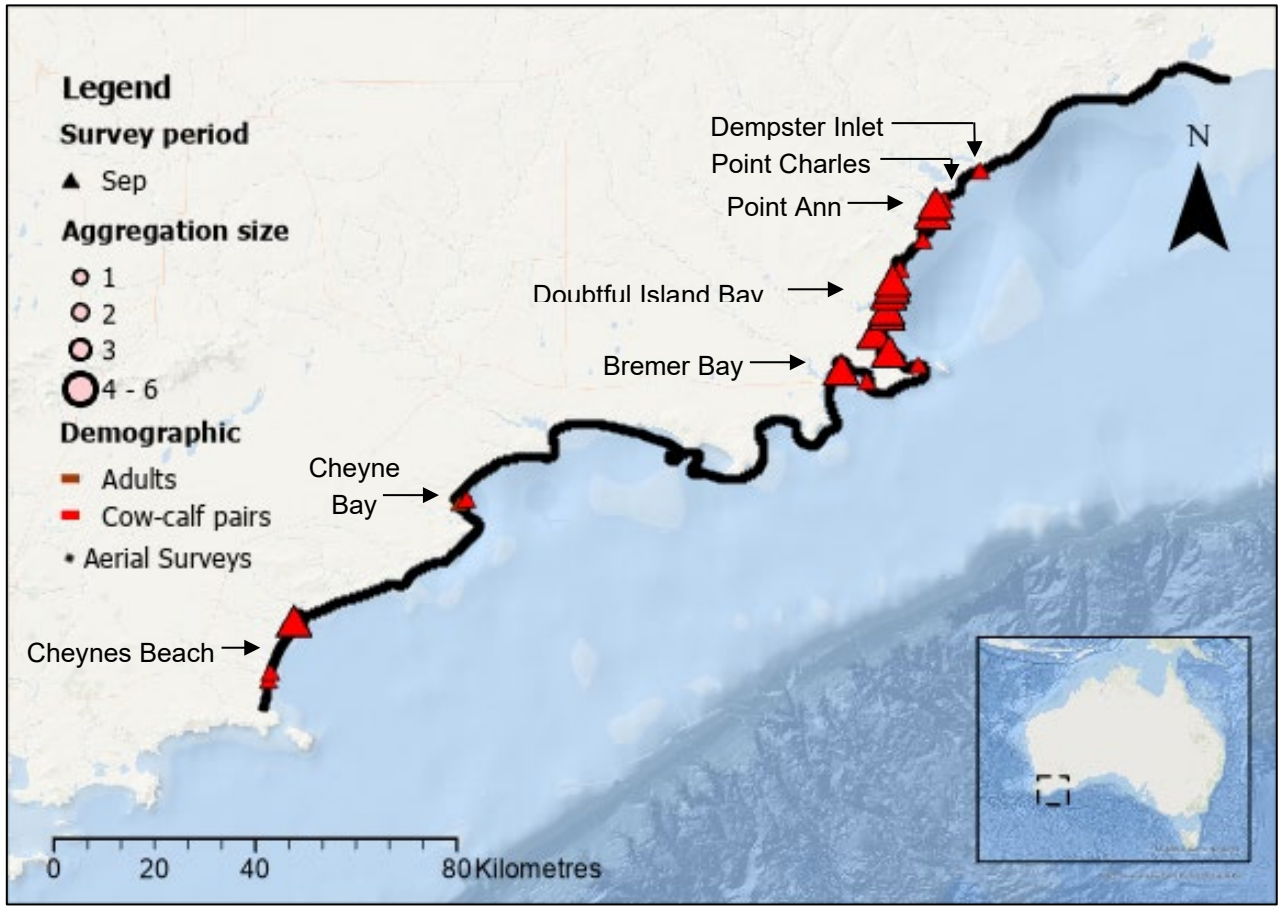
Appendix A - 1

Observed southern right whale distribution in 2024 based on counts from two vessel surveys (one in August and one in September) conducted in the Flinders Bay region, Western Australia.



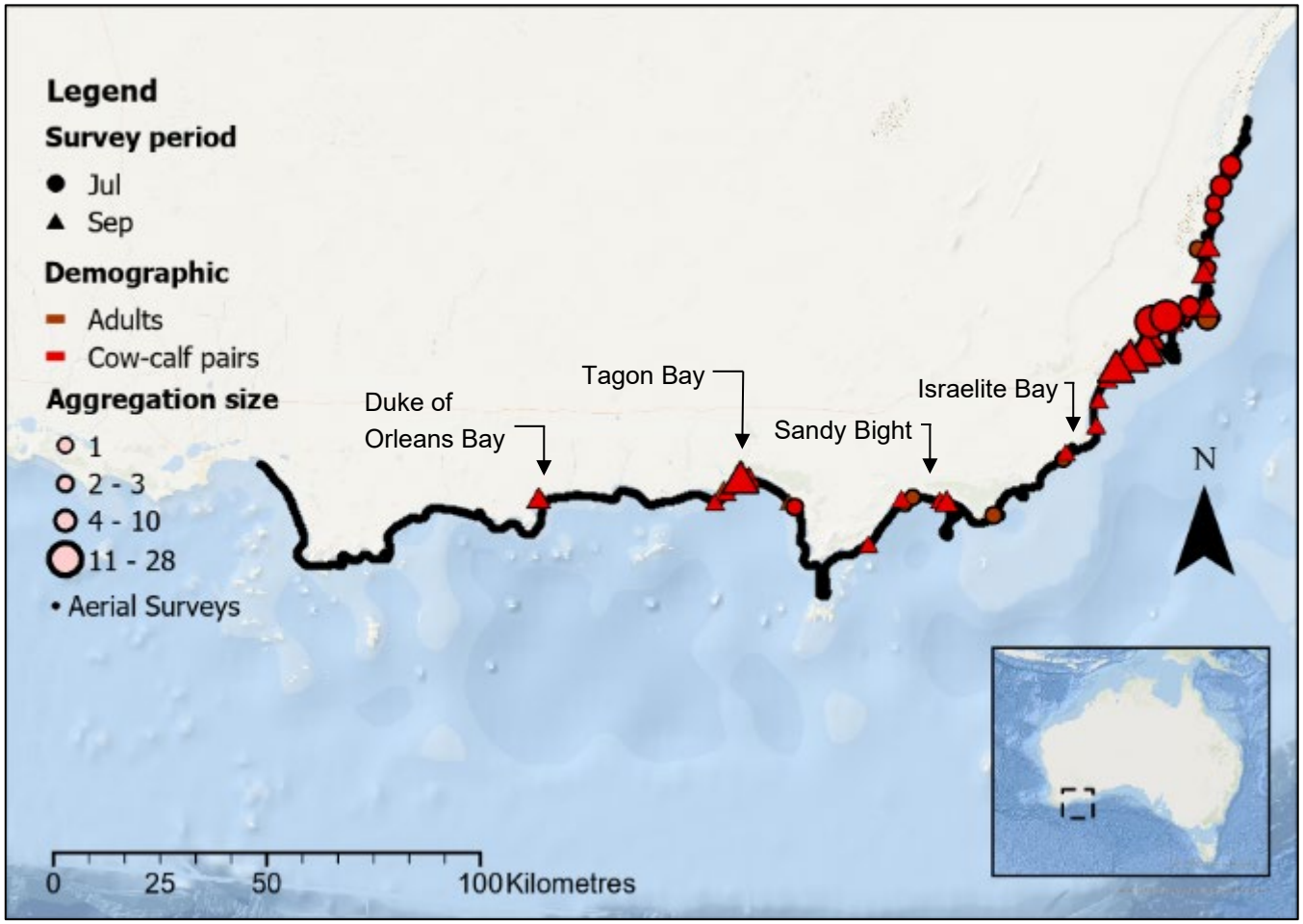
Appendix A - 2

Observed southern right whale distribution in 2024 based on counts from a single aerial survey conducted in September between Cheynes Beach and Pt. Ann, Western Australia.



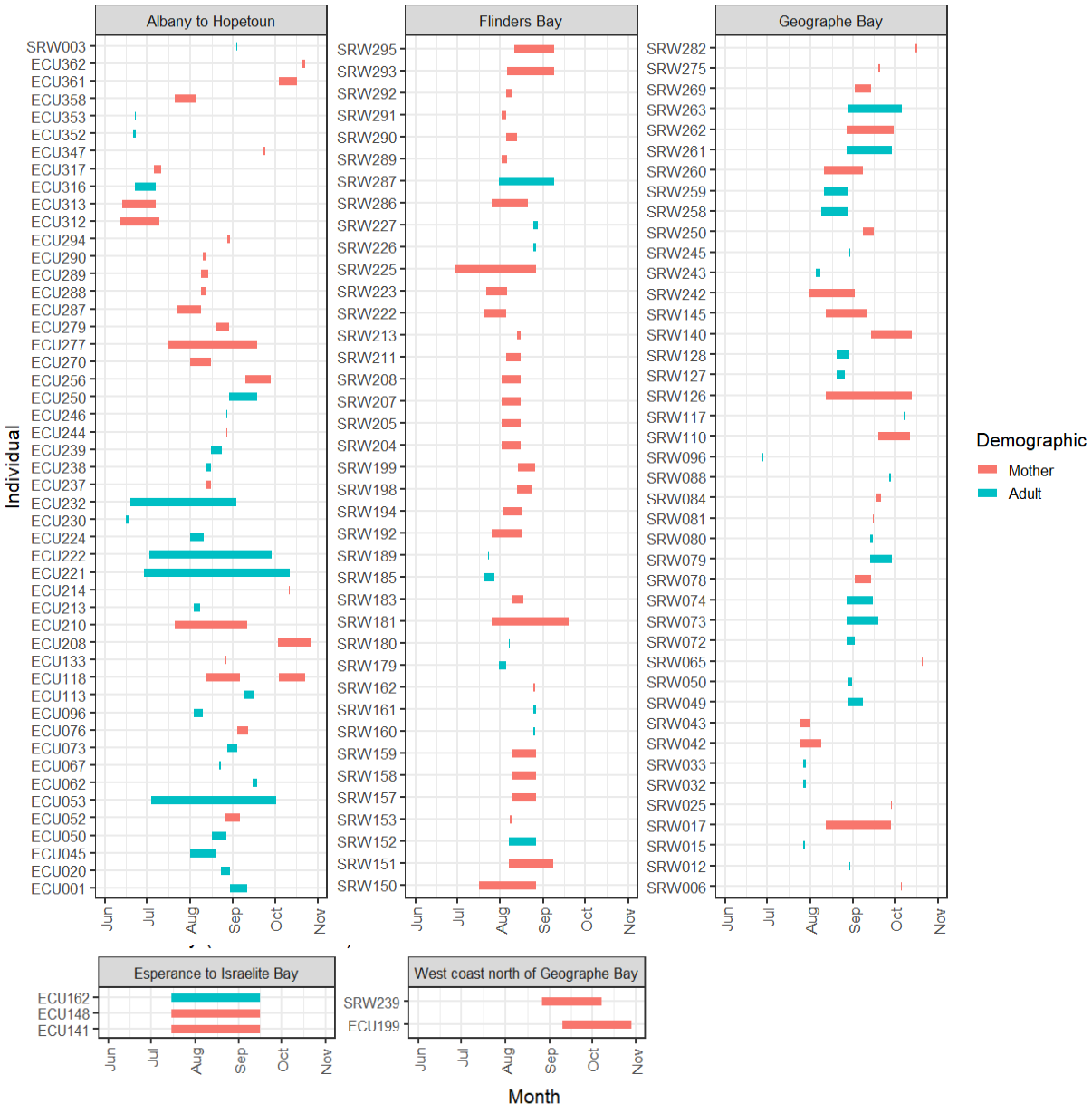
Appendix A - 3

Observed southern right whale distribution in 2024 based on counts from two aerial surveys (one in July and one in September) conducted in the Esperance to Israelite Bay region, Western Australia.



Appendix B

Southern right whale minimum residency for resighted individuals in the Albany to Hopetoun, Flinders Bay, and Geographe Bay regions between 1994 and 2025.



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