National Parks South Australia

Marine Parks

Statewide baseline report

DEWNR Technical report 2017/06

SOUTH AUSTRALIA

Government of South Australia
Department of Environment, Water and Natural Resources

Baseline and predicted changes for the South Australian Marine Parks Network

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Department of Environment, Water and Natural Resources

June 2017

DEWNR Technical report 2017/06

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Foreword

The Department of Environment, Water and Natural Resources (DEWNR) is responsible for the management of the State's natural resources, ranging from policy leadership to on-ground delivery in consultation with government, industry and communities.

High-quality science and effective monitoring provide the foundation for the successful management of our environment and natural resources. This is achieved through undertaking appropriate research, investigations, assessments, monitoring and evaluation.

DEWNR's strong partnerships with educational and research institutions, industries, government agencies, Natural Resources Management Boards and the community ensure that there is continual capacity building across the sector, and that the best skills and expertise are used to inform decision making.

Sandy Pitcher
CHIEF EXECUTIVE
DEPARTMENT OF ENVIRONMENT, WATER AND NATURAL RESOURCES

Acknowledgements

The following staff from the Department of Environment, Water and Natural Resources (DEWNR) are thanked for their input and feedback on the 19 baseline reports that formed the basis of this statewide report (in alphabetical order of surnames): David Armstrong, Dr Michelle Bald, Kirsty Bevan, Elijah Bravington, Danny Brock, Andrew Burnell, Colin Cichon, Dimitri Colella, Jon Emmett, Doug Fotheringham, Shane Holland, Dirk Holman, Vera Hughes, Glenn Jackway, Celeste Klose, Danny Male, Dr Jane McKenzie, David Miller, Dr Shelley Paull, David Pearce, Jonathan Phillips, Matt Royal, Glen Scholz, Chris Thomas, Roman Urban, Patricia von Baumgarten, and Dr Annelise Wiebkin.

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Summary

The Government of South Australia has developed a network of 19 marine parks as the South Australian component of the National Representative System of Marine Protected Areas. In accordance with the objects of the *Marine Parks Act 2007*, the 19 marine parks across South Australia provide for biodiversity conservation and public appreciation and allow ecologically sustainable development and use of marine resources. Different zones dictate the activities that can occur in each marine park. The zones have differing levels of restrictions, ranging from General Managed Use Zone (GMUZ) – lowest level of restriction, through to Habitat Protection Zone (HPZ), Sanctuary Zone (SZ) and Restricted Access Zone (RAZ) – highest level of restriction. Different types of Special Purpose Area (SPA), which allow selected activities (such as shore-based recreational line fishing, transhipment, or harbour activities), are also designated in some of the parks. Each park has a management plan that was finalised in 2012. The marine park network was fully implemented on 1 October 2014 when fishing restrictions inside SZs came into effect as prescribed by the *Marine Parks (Zoning) Regulations 2012*.

The marine parks network covers a total area of 26,937 km^2. Of this, 267 km^2 comprises coastal lands and islands and the remaining 26,670 km^2 covers 44% of South Australia's state waters. The network includes 83 SZs and 26 RAZs (9 in state waters and 17 on land), comprising 5% and 1% of state waters, respectively. There are 59 HPZs and 42 GMUZs comprising 25% and 14% of state waters, respectively. The network also includes 52 SPAs which allow for harbour activities, transhipment, significant economic development and shore based recreational line fishing.

The marine park management plans indicate that a monitoring, evaluation and reporting program (hereafter MER program) must be implemented to measure the effectiveness of each management plan in achieving the objects of the *Marine Parks Act 2007*. A review of each plan must be completed within 10 years of the plan's adoption. The MER program is guided by an adaptive management framework, which aims to improve the management of marine parks. One of the main objectives of the marine parks MER program is to assess the effectiveness of the marine parks network, by providing critical ecological, economic, social and management information to inform the review of the management plans. A MER program is required to target specific components of the marine parks network, based upon a variety of considerations including predicted changes, community expectations, the logistics and budget of the MER program, strategies in the marine park management plans, and the objects of the *Marine Parks Act 2007*.

This baseline report is an overarching statewide consolidation of a series of baseline reports (Baseline Reports) completed for each of South Australia's 19 marine parks. These baseline reports inform the marine parks MER program by providing predictions and indicators of change based upon the relationships between six components: ecological values, social and economic (socio-economic) values, physical drivers, socio-economic drivers, human-mediated pressures and marine park management plans. A comprehensive MER program requires baseline and monitoring information on the ecological and socio-economic values and the drivers and pressures that are not influenced by the marine park management plans. The marine parks MER program will monitor some of the values, drivers and pressures. For example, ecological indicators may be used to measure the condition of a reef ecosystem to determine if condition of the reef changes due to the marine park. Socio-economic indicators may measure the catch of particular fisheries or the values of residential properties in the area near the marine park to determine whether they have been impacted. Indicators of environmental and socio-economic drivers, e.g. changes in the strength of the Leeuwin Current, foreign exchange rates and climate change, will provide context for assessing changes in values.

The report summarises the available baseline information and indicators for the values, drivers and pressures that are identified in the conceptual models. The report provides an inventory of the available information and examples of the current state of knowledge and historical trends, with an emphasis on the nature and scale (temporal and spatial) of information and indicators that may be used in the MER program.

1 Background

1.1 Marine parks in South Australia

The Government of South Australia has developed the South Australian Representative System of Marine Protected Areas (SARSMPA) as part of the National Representative System of Marine Protected Areas (ANZECC 1998).

> *The primary goal of the National Representative System of Marine Protected Areas is to establish and manage a comprehensive, adequate and representative system of marine protected areas to contribute to the long-term ecological viability of marine and estuarine systems, to maintain ecological processes and systems, and to protect Australia's biological diversity at all levels.*

Overarching policies for the SARSMPA include *South Australia's Strategic Plan 2011*, (Government of South Australia 2011) the *Living Coast Strategy for South Australia* (DEH 2004a) and the *Blueprint for the South Australian Representative System of Marine Protected Areas* (DEH 2004b). In conjunction with the community and stakeholders, the Government has designed and implemented a network of 19 marine parks encompassing the major ecosystems and habitats across 8 marine bioregions in South Australian waters (http://www.environment.sa.gov.au/marineparks, Figure 1, Figure 2).

In accordance with the objects of the *Marine Parks Act 2007*, the 19 marine parks provide for biodiversity conservation and public appreciation, and allow ecologically sustainable development and use of marine resources. The objects of the Act are:

(a) to protect and conserve marine biological diversity and marine habitats by declaring and providing for the management of a comprehensive, adequate and representative system of marine parks

(b) to assist in:

(i) the maintenance of ecological processes in the marine environment

(ii) the adaptation to the impacts of climate change in the marine environment

(iii) protecting and conserving features of natural or cultural heritage significance

(iv) allowing ecologically sustainable development and use of marine environments

(v) providing opportunities for public appreciation, education, understanding and enjoyment of marine environments.

Different zones dictate the activities that can occur in each marine park. The zones have differing levels of restrictions, ranging from General Managed Use Zone (GMUZ) – lowest level of restriction, through to Habitat Protection Zone (HPZ), Sanctuary Zone (SZ) and Restricted Access Zone (RAZ) – highest level of restriction. Different types of Special Purpose Area (SPA), which allow selected activities (such as shore-based recreational line fishing, transhipment, or harbour activities), are also designated in some of the parks.

The marine park network was fully implemented on 1 October 2014 when fishing restrictions inside SZs came into effect as prescribed by the *Marine Parks (Zoning) Regulations 2012*. Milestones leading up to this point included:

- In 2000, the Government of South Australia released a *Guide to Marine Protected Areas*, which would underpin the concepts and design of the representative network.
- In 2004, the technical report *Towards a System of Ecologically Representative Marine Protected Areas in South Australian Marine Bioregions* (Baker 2004) was released, recommending areas for conservation as part of a comprehensive, adequate and representative system.

- In 2004, the *Blueprint for the South Australian Representative System of Marine Protected Areas* which outlined the Government of South Australia's commitment to the concepts and design principles of marine protected area network development was released following an extensive public consultation and engagement process.
- In 2005, the pilot *Encounter Marine Park Draft Zoning Plan* was released for public consultation to develop and test key concepts for a statewide marine parks network.
- In 2008, the *Marine Parks Act 2007* came into operation, providing for the establishment of a comprehensive, adequate and representative system of marine parks.
- In 2009, the outer boundaries of 19 marine parks were proclaimed following statewide public consultation.
- Between 2009 and 2011, fourteen Marine Park Local Advisory Groups worked with Government and the broader community to provide local advice for the development of draft management plans with zoning for each of the 19 marine parks in the network.
- In August 2012, 19 draft management plans and zoning were released for public comment along with economic, social and environmental impact statements, based upon the draft zoning (Bailey et al. 2012a, b).
- In November 2012, following further statewide public consultation, the 19 marine parks management plans and zoning of the marine parks was finalised with 42 GMUZs, 59 HPZs, 83 SZs, 27 RAZs and 52 SPAs designated across the parks. The zoning (except for fishing restrictions inside SZs) took effect when the *Marine Parks (Zoning) Regulations 2012* commenced in March 2013.
- In 2014, the SA Marine Parks Commercial Fisheries Voluntary Catch / Effort Reduction Program was completed. Because the SZs displaced some commercial fishing, the voluntary catch and effort reduction program was implemented to ensure that any redistribution of commercial fishing did not threaten the sustainability of other areas (PIRSA 2013a).

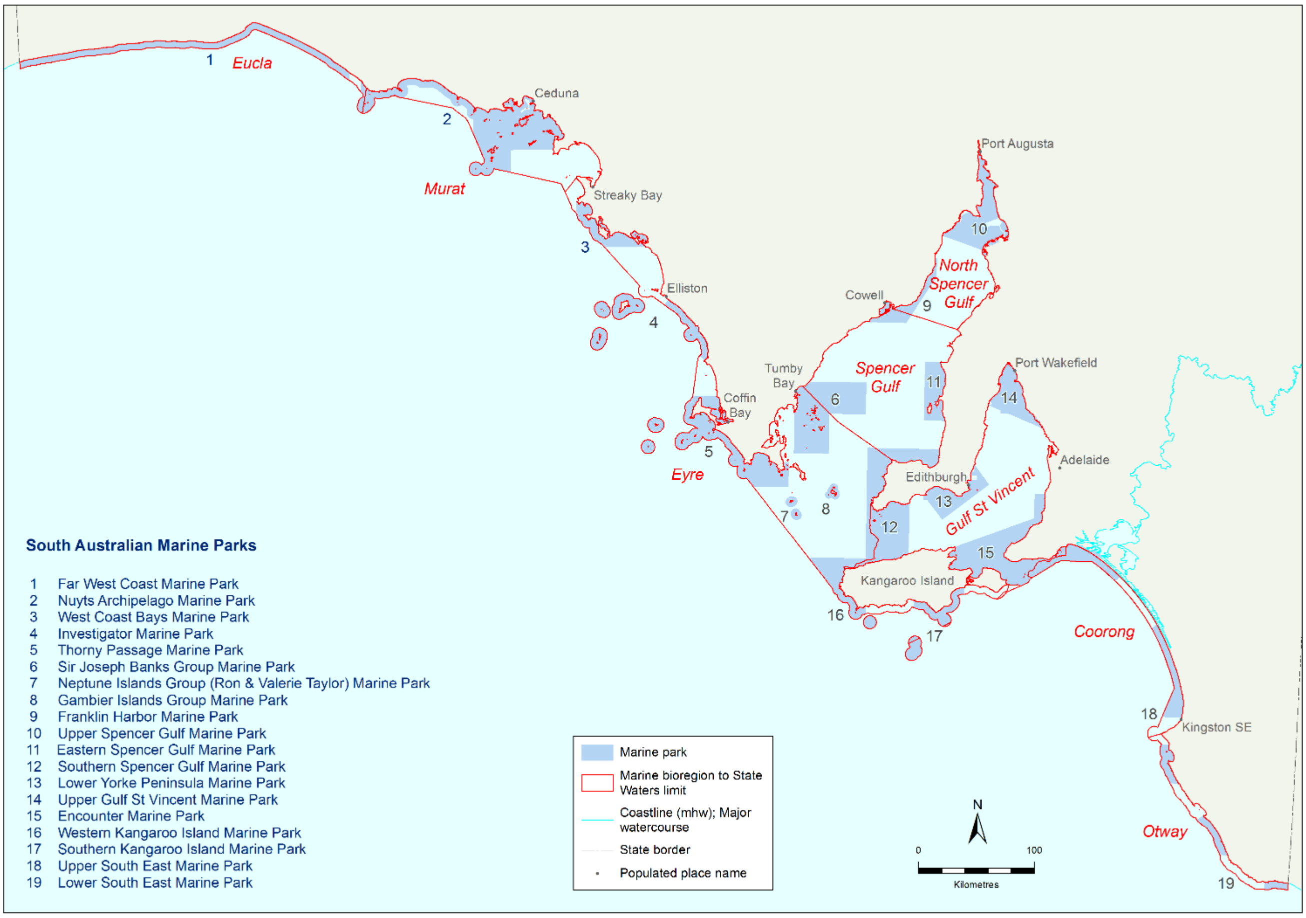


Figure 1. South Australia's network of 19 marine parks showing marine park outer boundaries and 8 marine bioregions clipped to state waters.

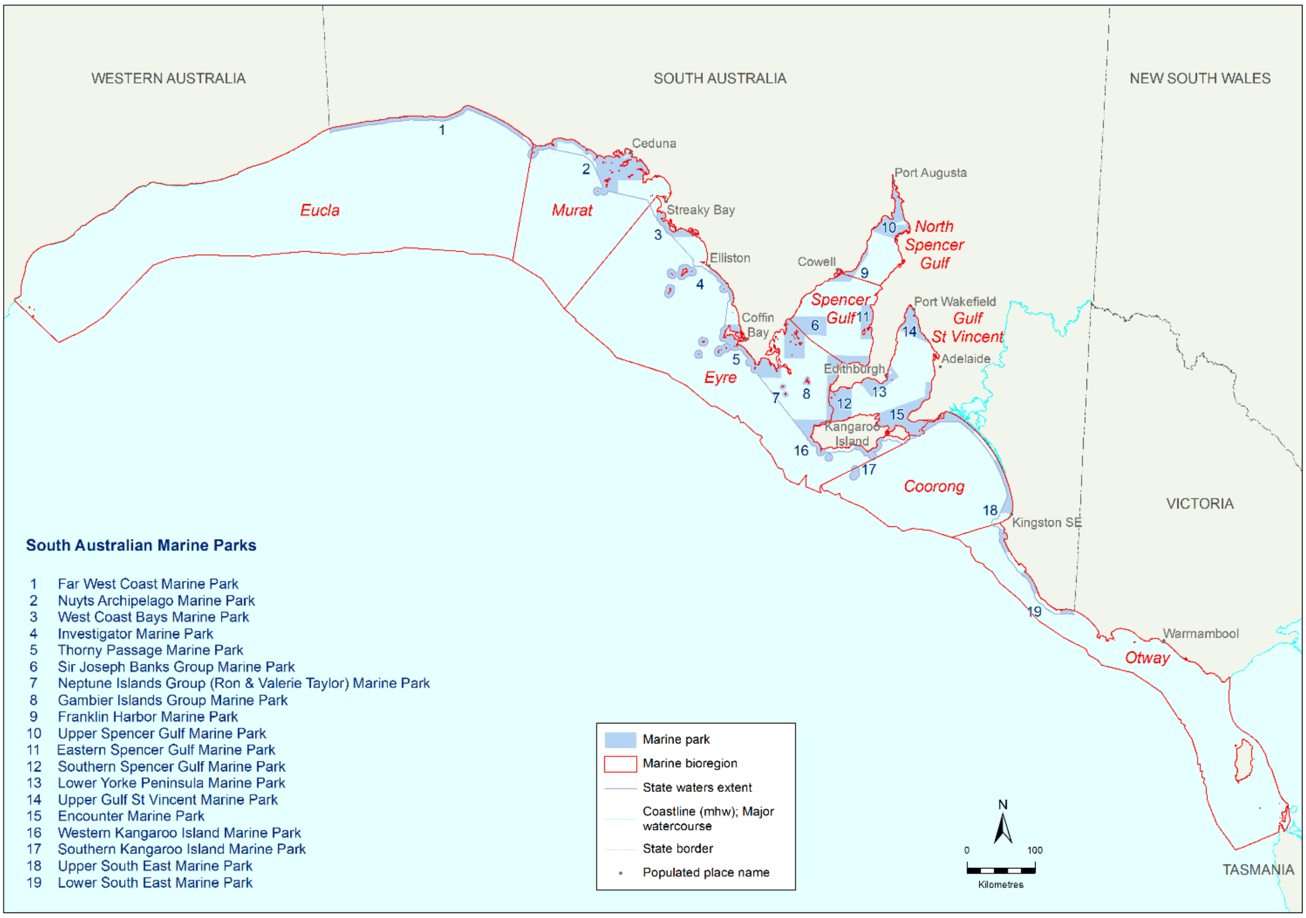


Figure 2. **South Australia's network of 19 marine parks showing marine park outer boundaries and 8 marine bioregions at their entire extent.**

1.2 Marine parks monitoring, evaluation and reporting program

The marine park management plans indicate that a monitoring, evaluation and reporting program (hereafter MER program) must be implemented to measure the effectiveness of each management plan in achieving the objects of the Marine Parks Act 2007. A review of each plan must be completed within 10 years of the plan's adoption. The MER program is guided by an adaptive management framework (Figure 3), which aims to continually improve the management of marine parks. One of the main objectives of the marine parks MER program is to assess the effectiveness of the marine parks network, by providing critical ecological, economic, social and management information to inform the future review of the management plans.

A MER program is required to target specific components of the marine parks network, based upon a variety of considerations including predicted changes, community expectations, the logistics and budget of the MER program, strategies in the marine park management plans, and the objects of the *Marine Parks Act 2007*. An important component of the MER program is the MER plan, which outlines the 'what, where, when and why' of the MER program.

The marine parks MER program is guided by 6 evaluation questions, which have been developed from the management plans and *Marine Parks Act 2007* (see Appendix A for detailed list):

1. To what extent has the legislated comprehensive, adequate, representative system protected and conserved marine biological diversity and marine habitats?
2. To what extent have marine park strategies contributed to the maintenance of ecological processes?
3. To what extent have marine park strategies contributed to enabling marine environments to adapt to impacts of climate change?
4. To what extent have the marine park strategies contributed to the ecologically sustainable development and use of the marine environment?
5. To what extent have the marine park strategies contributed to providing opportunities for public appreciation, education, understanding and enjoyment of marine environments?
6. To what extent have the marine park strategies contributed to the protection and conservation of features of natural and cultural heritage significance?

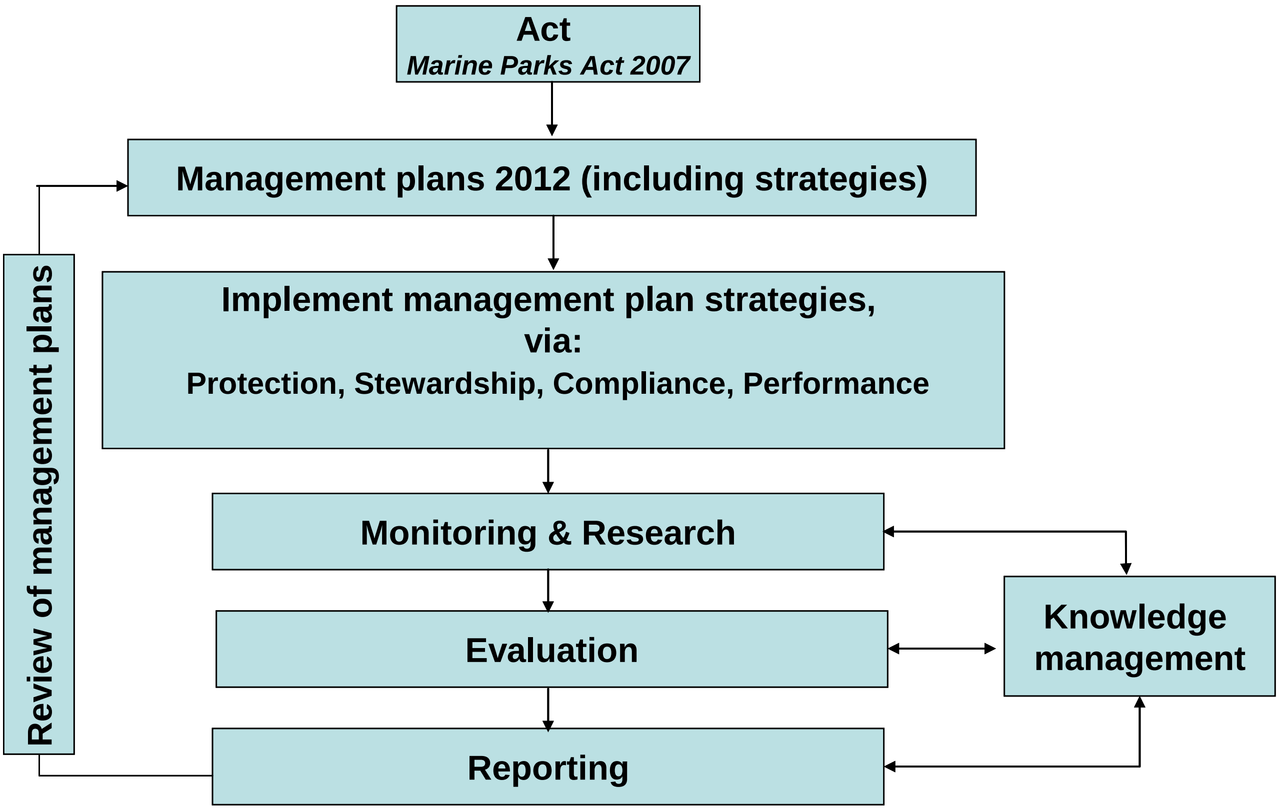


Figure 3. Adaptive management cycle for the marine parks MER program.

1.3 Structure and aims of this report

This baseline report is an overarching statewide consolidation of a series of baseline reports completed for each of South Australia's 19 marine parks. These baseline reports aim to inform the marine parks MER program by providing predictions and indicators of change based upon the relationships between 6 components: ecological values, social and economic (socio-economic) values, physical environmental drivers, socio-economic drivers, human-mediated pressures and marine park management plans (Figure 4).

The ecological and socio-economic values of the marine parks are central to the MER program (Figure 4). These values are linked because many of the socio-economic values are reliant on ecological values, and some of the socio-economic values can in turn place pressure on ecological values. The marine park management plans are designed to relieve some pressures, and to positively influence ecological and some socio-economic values. The management plans may also have neutral or negative impacts on socio-economic values. In addition to the relationship between values, pressures and the management plans, there are external physical and socio-economic drivers, which influence the ecological and socio-economic values and which are not related to the management plans (Figure 4). Conceptual models are used in these reports to show these components and the types of relationships that exist between them. The reports summarise the available baseline information and indicators for the values, drivers and pressures that are identified in the conceptual models.

A comprehensive MER program requires baseline and monitoring information on the ecological and socio-economic values, and the drivers and pressures that are not influenced by the marine park management plans. To assess the effectiveness of the management plans, the marine parks MER program will monitor a selection of the values, drivers and pressures relevant to the specific marine park whilst also being aware of the need to assess the network at a bioregional and jurisdictional scale. For example, ecological indicators may be used to measure the condition of a reef ecosystem to determine if condition of the reef changes due to the marine park management plan that has been put in place. Socio-economic indicators may measure the catch of particular fisheries or the values of residential properties in the area near the marine park to determine whether they have changed. The 'baseline date' varies between indicators depending on whether they are related to the commencement of the *Marine Parks (Zoning) Regulations 2012* in March 2013 or the commencement of fishing restrictions inside SZs under the *Marine Parks (Zoning) Regulations 2012* on 1 October 2014.

Another aim of the baseline reports is to identify knowledge gaps that can be addressed by new initiatives of the MER program. For example, there may be SZs for which seafloor (or benthic) habitat maps have not been created, or there may be a lack of biological information for some parks. The MER program will report new information and review the validity of the conceptual models. New information will also be critical for the MER program to enable it to evaluate the marine park system against its design principles, including the comprehensiveness, adequacy and representativeness of the network of marine parks.

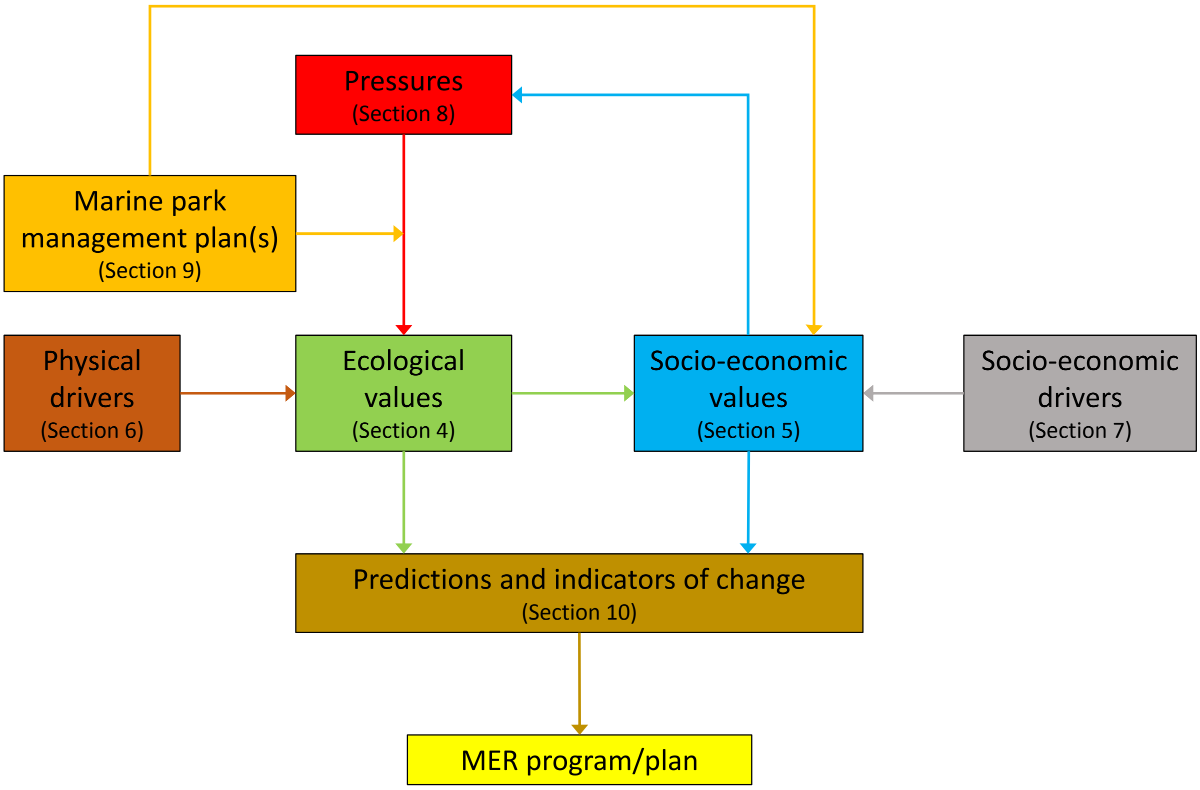


Figure 4. Framework for the baseline report that indicates how Sections 4 to 9 of this report are linked and used to inform Section 10 on predictions and indicators of change. All components of the framework will be used to inform the MER program. The direction and colour of the arrows indicates the influence of one component on another component or link. For example, the marine park management plan will directly influence socio-economic values, but it will also indirectly influence ecological values by mitigating some (but not all) of the pressures on those values.

The primary readership for the baseline reports is staff from DEWNR and other government agencies, as well as Natural Resources Management Boards, marine park stakeholders (including industries), and monitoring, research and funding partners.

Each baseline report has the following structure, which aligns with the framework shown in Figure 4:

1. **Section 2 – Marine Park Network description:** Summary and accompanying map, which detail the location, dimensions, and zoning of the marine parks. To reduce repetition, the statewide baselinereport references the individual marine park reports and presents additional information on the network structure.
2. **Section 3 – Conceptual models:** Diagrams of the most important ecological and socio-economic values, physical and socio-economic drivers, pressures, and summaries of predicted changes due to marine park management.
3. **Section 4 – Ecological values:** Description and baseline information for the values depicted on the conceptual models.
4. **Section 5 – Socio-economic values**: Description and baseline information for the values depicted on the conceptual models.
5. **Section 6 – Physical drivers:** Description and baseline information for the physical factors that drive change in ecological values.
6. **Section 7 – Socio-economic drivers:** Description and baseline information for the socio-economic factors that drive change in socio-economic values.
7. **Section 8 – Pressures:** Description and baseline information for the most important human-mediated pressures on ecological values.
8. **Section 9 – Marine park management plans:** Outlines the zoning and strategies of the management plans and how the management plans mitigate pressures on the ecological values and also affect some socio-economic values.
9. **Section 10 – Predictions and indicators of change:** Predictions of change for the ecological and socio-economic values, and potential indicators that can be used to assess changes in values, but also in drivers, pressures and management. The indicators for monitoring will be detailed in the MER plan.

2 Marine parks network description

Descriptions of each marine park can be found in the individual baseline reports (Baseline Reports). The 19 marine parks are distributed from the South Australia/Western Australia border in the west to the South Australia/Victoria border in the east and occur in all 8 marine bioregions (Figure 1). The Nuyts Archipelago Marine Park is the largest in the network at 3,932 km^2 with the Gambier Islands Marine Park being the smallest at 114 km^2 (Table 1).

There are 8 marine bioregions in South Australia; Eucla, Murat, Eyre, Spencer Gulf, North Spencer Gulf, Gulf St Vincent, Coorong and Otway (Figure 1), with the Eucla and Otway Bioregions also extending into interstate waters (Figure 2). Within South Australia, the Eucla Bioregion extends from the Western Australia border to Cape Adieu, near Fowlers Bay and covers nearly half of the total area of the Great Australian Bight (GAB). The Murat Bioregion extends from Cape Adieu, to the west of Fowlers Bay, eastward to Cape Bauer near Streaky Bay. The bioregion is characterised by a coastline made up of a series of sheltered bays bound by capes, points and headlands. Offshore, the area includes many islands comprising the Nuyts Archipelago. The Eyre Bioregion extends from Cape Bauer to Tumby Bay, then eastward across Spencer Gulf to include waters from Corny Point to West Cape, and then across to Cape Borda on Kangaroo Island and around the southern side of Kangaroo Island to Cape Willoughby. The Spencer Gulf Bioregion is bounded by Corny Point across to Tumby Bay in the south and Point Riley across to Shoalwater Point to the north. The Spencer Gulf Bioregion comprises east- and west-facing opposing shorelines. The North Spencer Gulf Bioregion includes all waters north of the line between Point Riley and Shoalwater Point; it is an area that experiences seasonal extremes. The Gulf St Vincent Bioregion extends from West Cape to Cape Borda (Kangaroo Island) and Cape Willoughby to Port Elliot. Gulf St Vincent (as with Spencer Gulf) is a confined, inverse estuary characterised by seasonally fluctuating temperatures and salinities in the upper reaches in comparison to the open sea. Stretching southeast from Port Elliot to Cape Jaffa, the Coorong Bioregion is dominated by large beach-dune systems which include the Younghusband and Sir Richard Peninsulas. Within South Australia, the Otway Bioregion extends eastwards from Cape Jaffa to the Victorian border, and supports some of the most diverse and productive waters in South Australia.

The marine parks network covers a total area of 26,937 km^2 (Table 1). Of this, 267 km^2 comprises coastal lands and islands and the remaining 26,670 km^2 covers 44% of South Australia's state waters. The network includes 83 SZs and 26 RAZs (9 in state waters and 17 on land), comprising 5% and 1% of state waters, respectively. There are 59 HPZs and 42 GMUZs comprising 25% and 14% of state waters, respectively. The network also includes 52 SPAs which allow for harbour activities, transhipment, significant economic development and shore based recreational line fishing.

The majority of Marine Parks are adjacent to remote and sparsely populated areas of the state, which are generally dominated by agricultural land, vacant land and conservation areas (Figure 5-Figure 11). Many of the marine parks lie adjacent to several of the small coastal towns around the state, from Ceduna on the West Coast to Robe in the South East. Encounter Marine Park is located adjacent to the largest population centres, that of outer metropolitan Adelaide and Victor Harbor. In contrast the Western and Southern Kangaroo Island Marine Parks are located adjacent to remote areas dominated by conservation parks. The marine parks network overlaps many of the existing Aquatic reserves and overlap or lie adjacent to many of the coastal conservation parks. South Australia experiences hot, dry summers and cool winters. The annual fresh water runoff for the areas in which marine parks are located ranges from 760 gigalitres to 28,850 gigalitres (National Water Commission 2007).

For further descriptive information on the 19 marine parks see Bryars et al. 2016a-s (Baseline Reports).

Table 1. Area and number of SZs and RAZs for the 19 individual marine parks within state waters.

Marine Park	Total Area of Marine Park (km^2)	Total Area of Marine Park in State Waters (km^2)	Area of SZ and RAZ (km^2)	No. of SZ	No. of RAZ	% of SZ and RAZ in Marine Park Area	% of MP in the Network	% of MP in State Waters
01 - Far West Coast	1690	1690	1306	3	1	77	6.3	2.8
02 - Nuyts Archipelago	3998	3932	342	9		9	14.8	6.5
03 - West Coast Bays	788	779	71	9	2	9	2.9	1.3
04 - Investigator	1184	1181	219	3		18	4.4	2.0
05 - Thorny Passage	3656	2461	98	8		3	9.2	4.1
06 - Sir Joseph Banks Group	2628	2618	172	5		7	9.8	4.3
07 - Neptune Islands Group	146	142	34	1		24	0.5	0.2
08 - Gambier Islands Group	120	114	0	0		0	0.4	0.2
09 - Franklin Harbor	635	622	70	4		11	2.4	1.0
10 - Upper Spencer Gulf	1606	1528	206	9		13	6.0	2.5
11 - Eastern Spencer Gulf	784	784	41	3		5	2.9	1.3
12 - Southern Spencer Gulf	2974	2973	146	3	3	5	11.0	4.9
13 - Lower Yorke Peninsula	855	855	72	2		8	3.2	1.4
14 - Upper Gulf St Vincent	975	959	222	4	1	23	3.6	1.6
15 - Encounter	3121	3072	282	11	1	9	11.6	5.1
16 - Western Kangaroo Island	1021	1021	219	3		21	3.8	1.7
17 - Southern Kangaroo Island	673	672	80	1	1	12	2.5	1.1
18 - Upper South East	906	906	87	3		10	3.4	1.5
19 - Lower South East	360	360	34	2		10	1.3	0.6
Total	**26937**	**26670**	**3702**	**83**	**9**	**14**	**100**	**44**

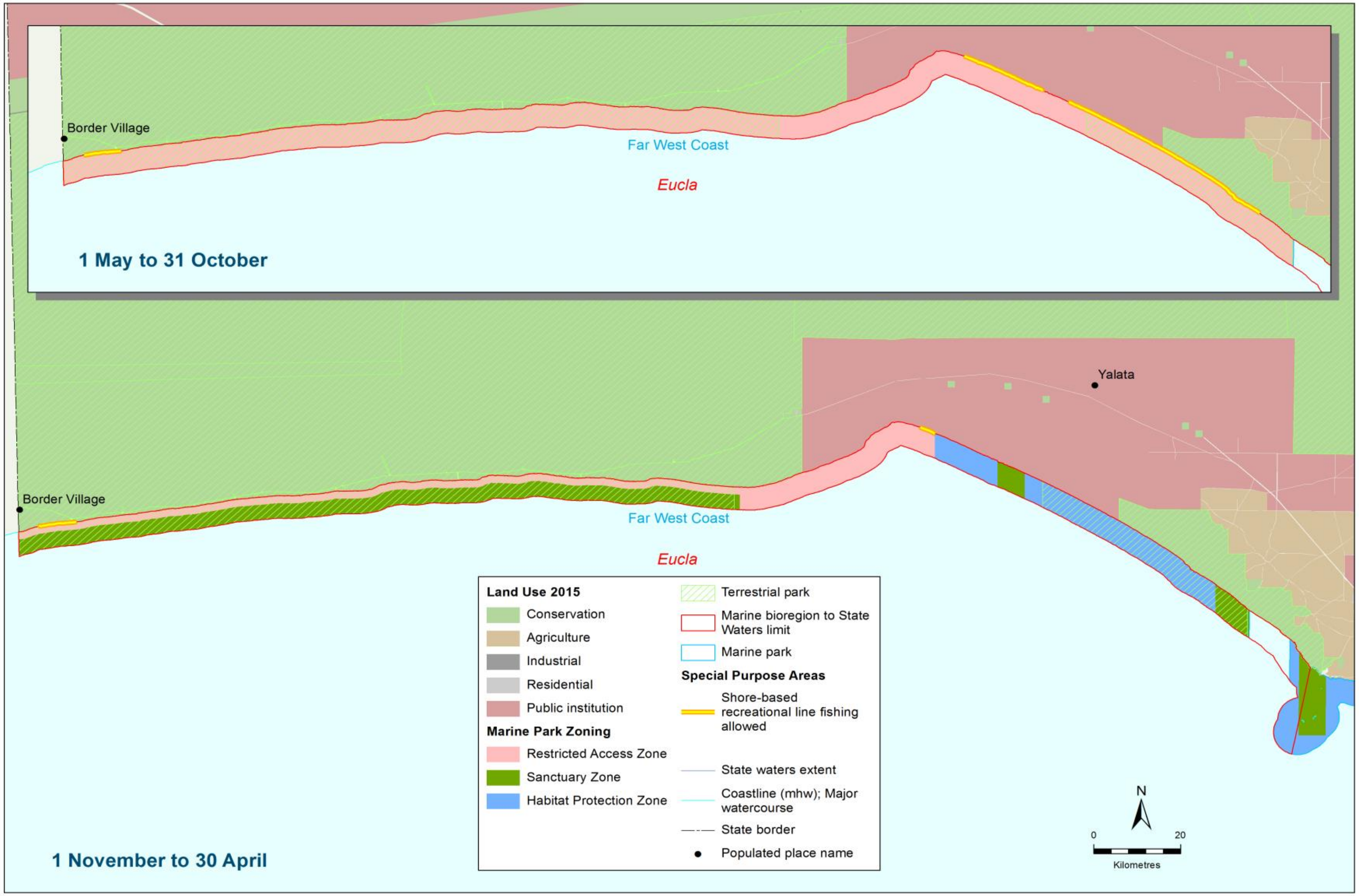


Figure 5. Map of the Eucla Bioregion showing important features and adjacent land areas. Further information on marine and land uses is shown in Appendix C.

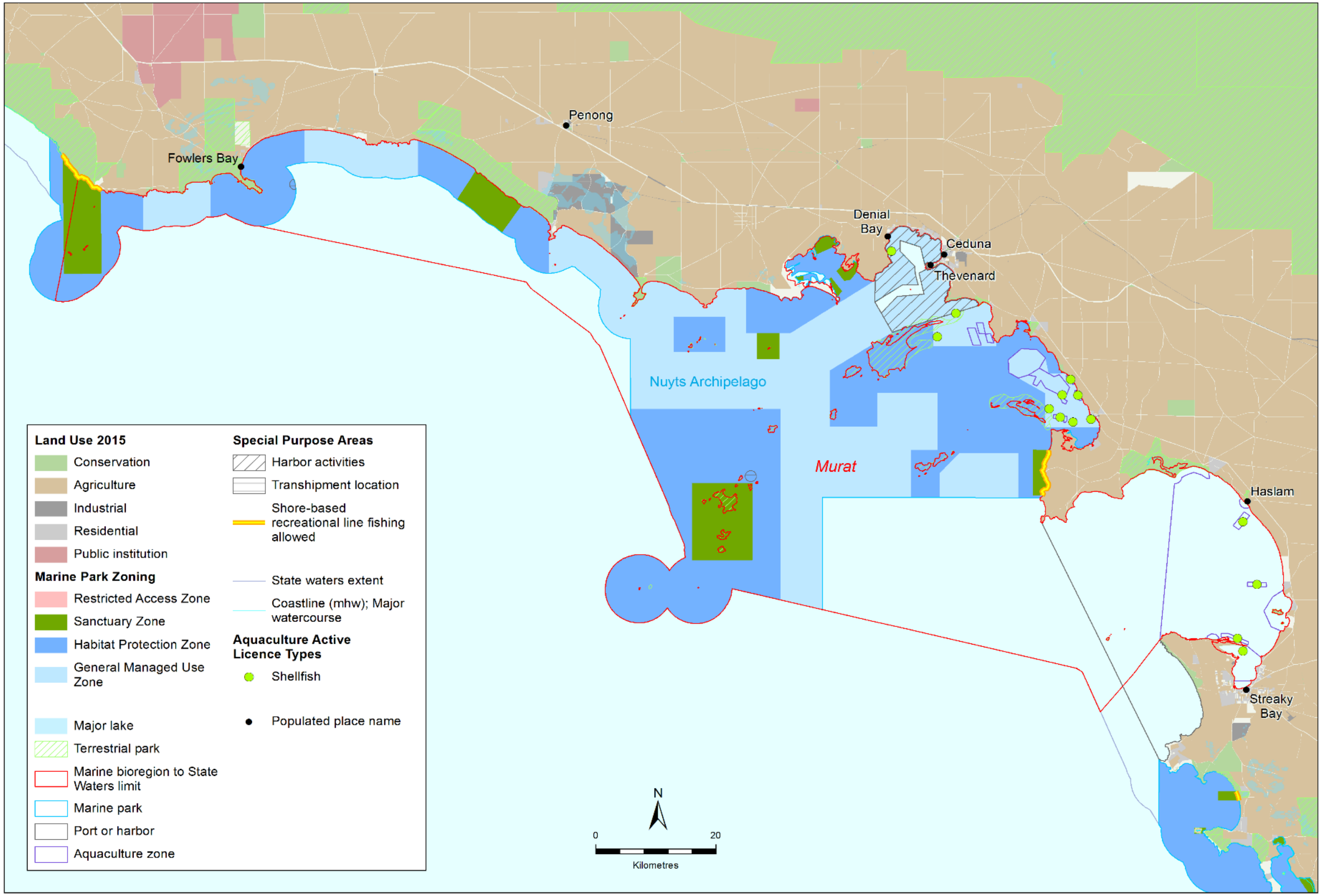


Figure 6. Map of the Murat Bioregion showing important features and adjacent land areas. Further information on marine and land uses is shown in Appendix C.

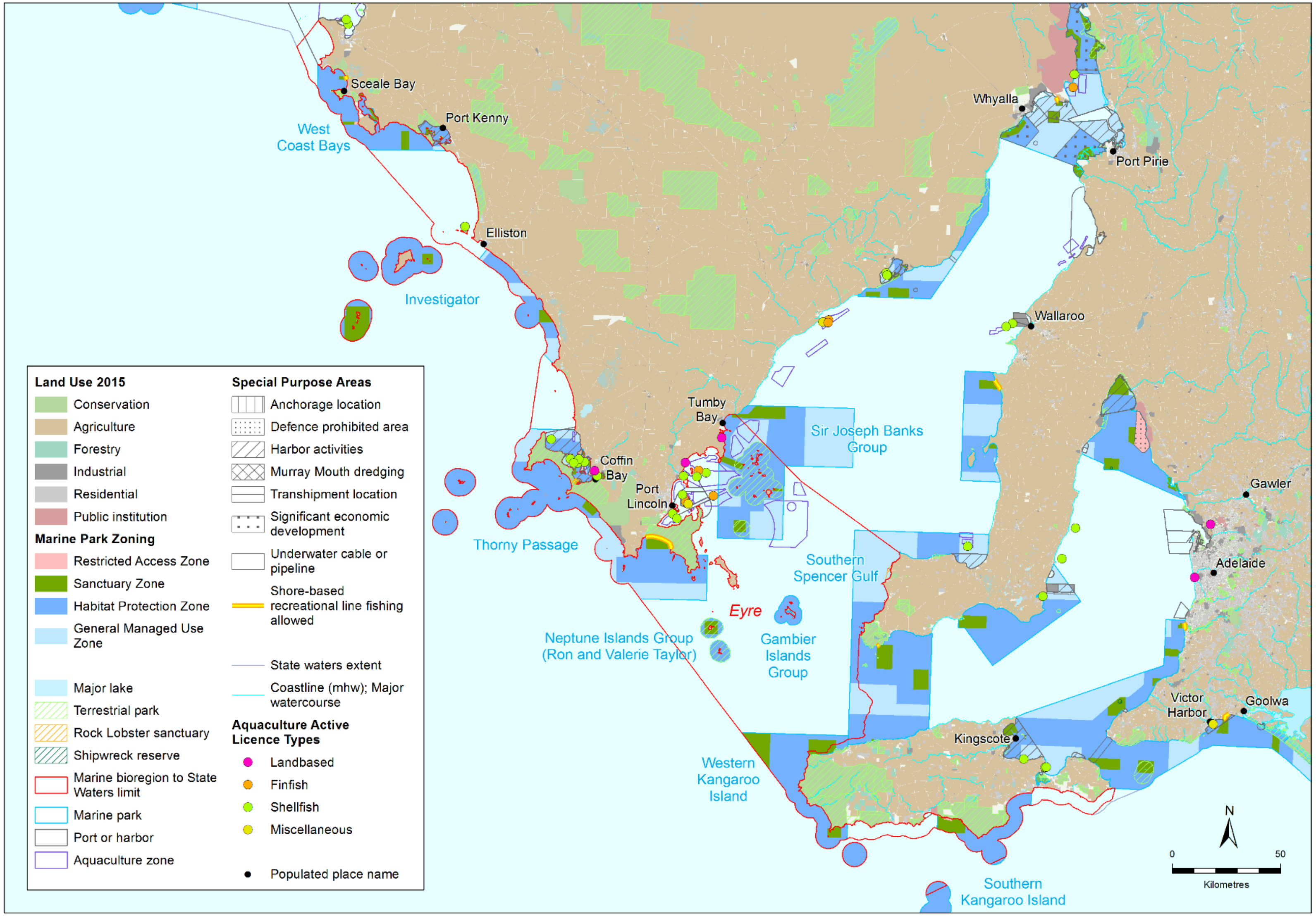


Figure 7. Map of the Eyre Bioregion showing important features and adjacent land areas. Further information on marine and land uses is shown in Appendix C.

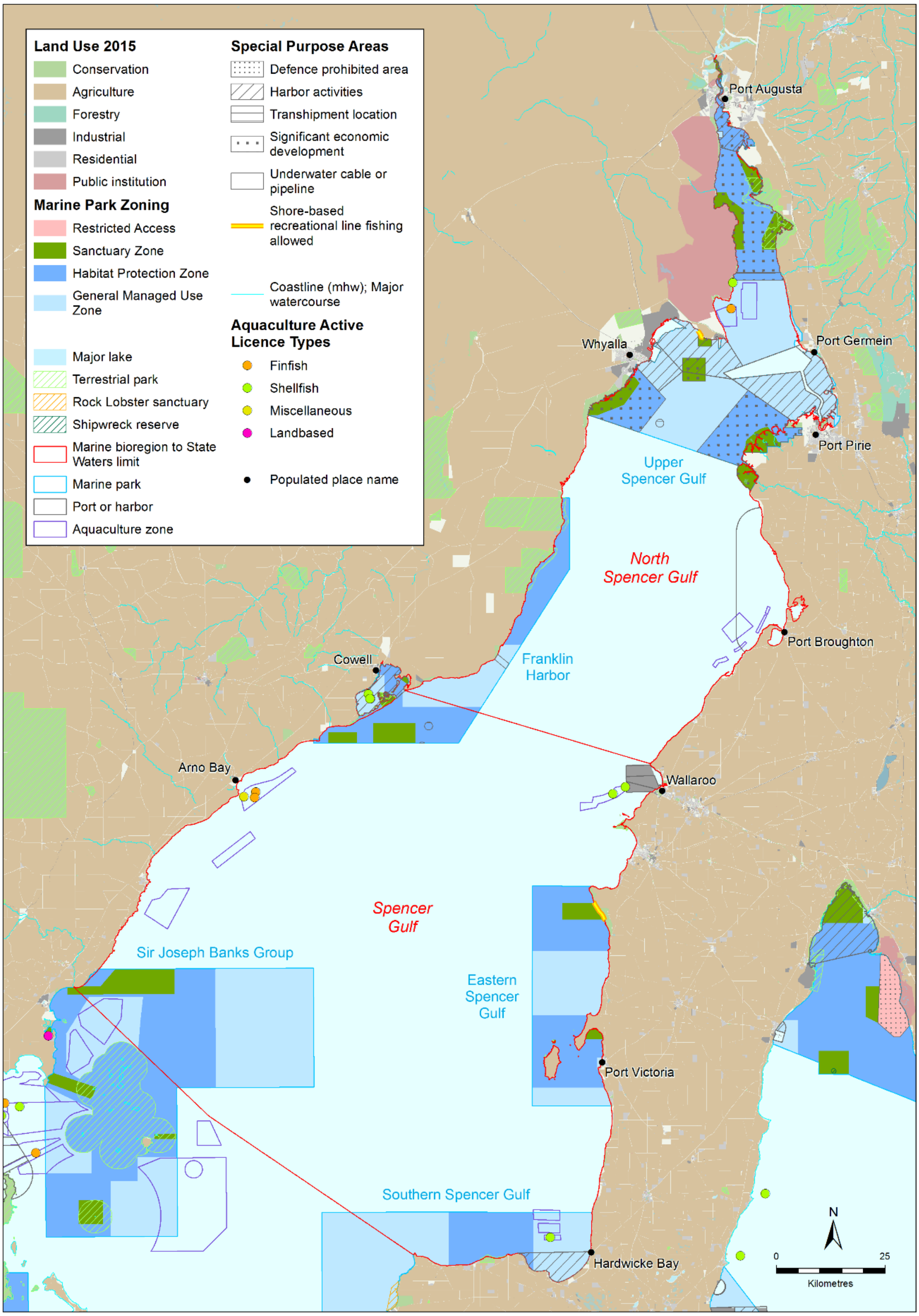


Figure 8. Map of the Spencer Gulf and North Spencer Gulf Bioregions showing important features and adjacent land areas. Further information on marine and land uses is shown in Appendix C.

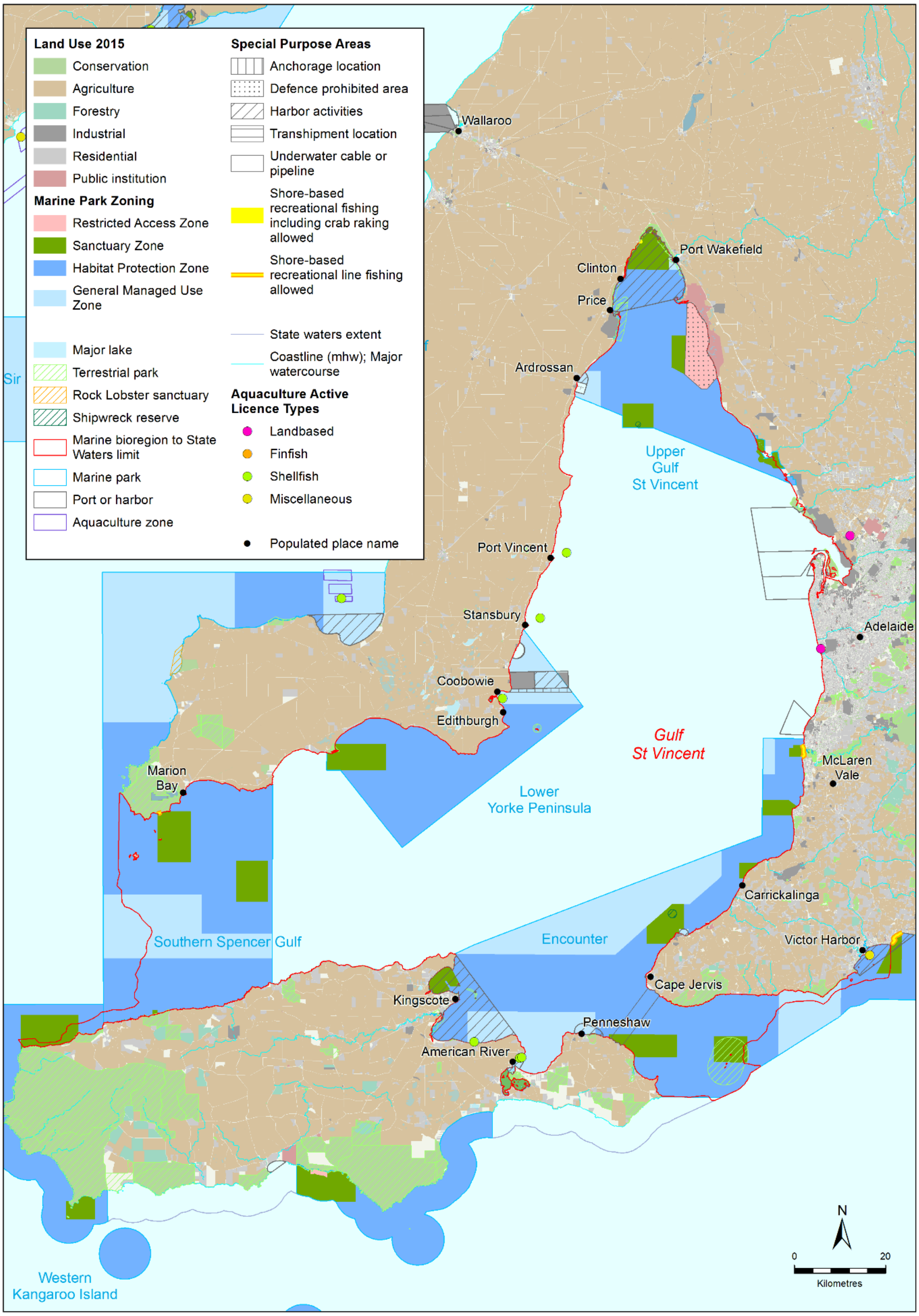


Figure 9. Map of the Gulf St Vincent Bioregion showing important features and adjacent land areas. Further information on marine and land uses is shown in Appendix C.

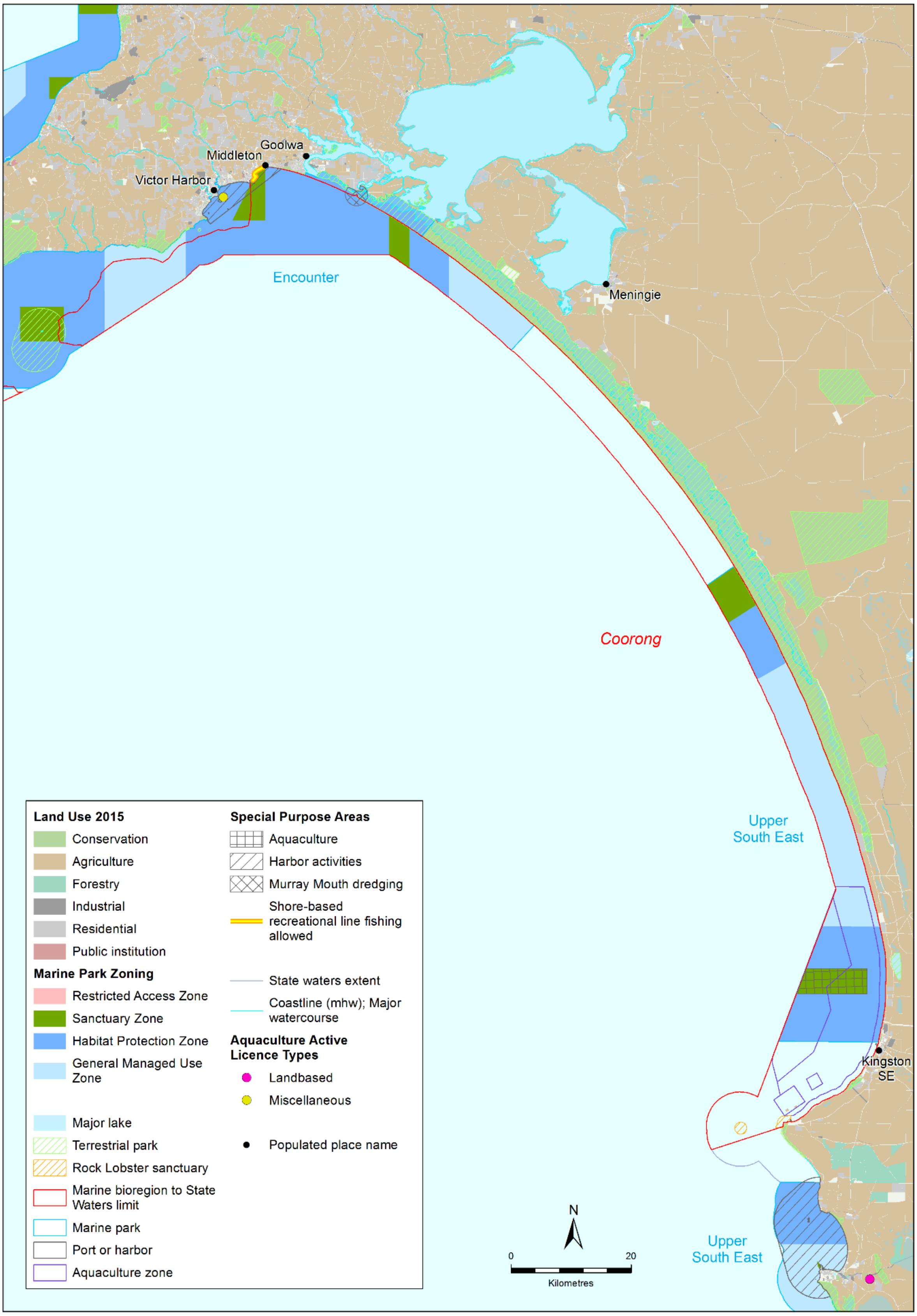


Figure 10. Map of the Coorong Bioregion showing important features and adjacent land areas. Further information on marine and land uses is shown in Appendix C.

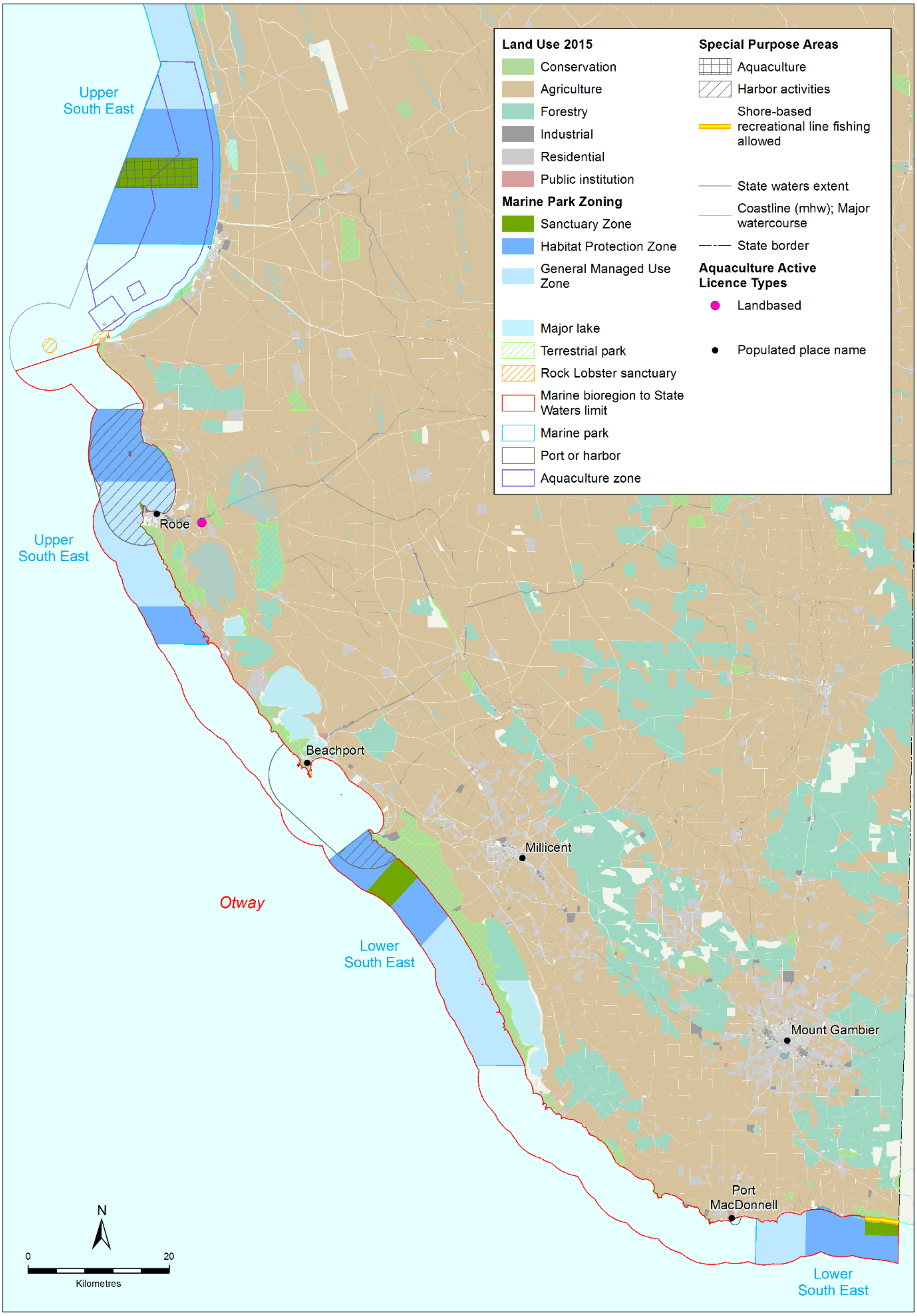


Figure 11. **Map of the Otway Bioregion showing important features and adjacent land areas. Further information on marine and land uses is shown in Appendix C.**

3 Conceptual models

The conceptual models of the 8 marine bioregions (Figure 12 to Figure 19) summarise the ecological and socio-economic values, physical and socio-economic drivers, human-mediated pressures on the ecological values, the influence of the marine parks on these pressures, and predictions of change (ecological and socio-economic) due to the marine parks. Features depicted on the conceptual models are presented and discussed in this baseline report.

Many of the socio-economic values are closely linked to the ecological values. For example, healthy seagrass ecosystems sustain the King George whiting stock (Jones et al. 2008a), which is used by commercial and recreational fishers. A stable or increasing population of southern right whales is needed to sustain whale-watching businesses. The physical drivers that exist in the area can influence the ecological and socio-economic values. Socio-economic drivers can also influence socio-economic values. The links between the various components of the conceptual models are depicted in the baseline report framework (Figure 4). The components of the conceptual models are discussed in more detail in Sections 4 to 10.

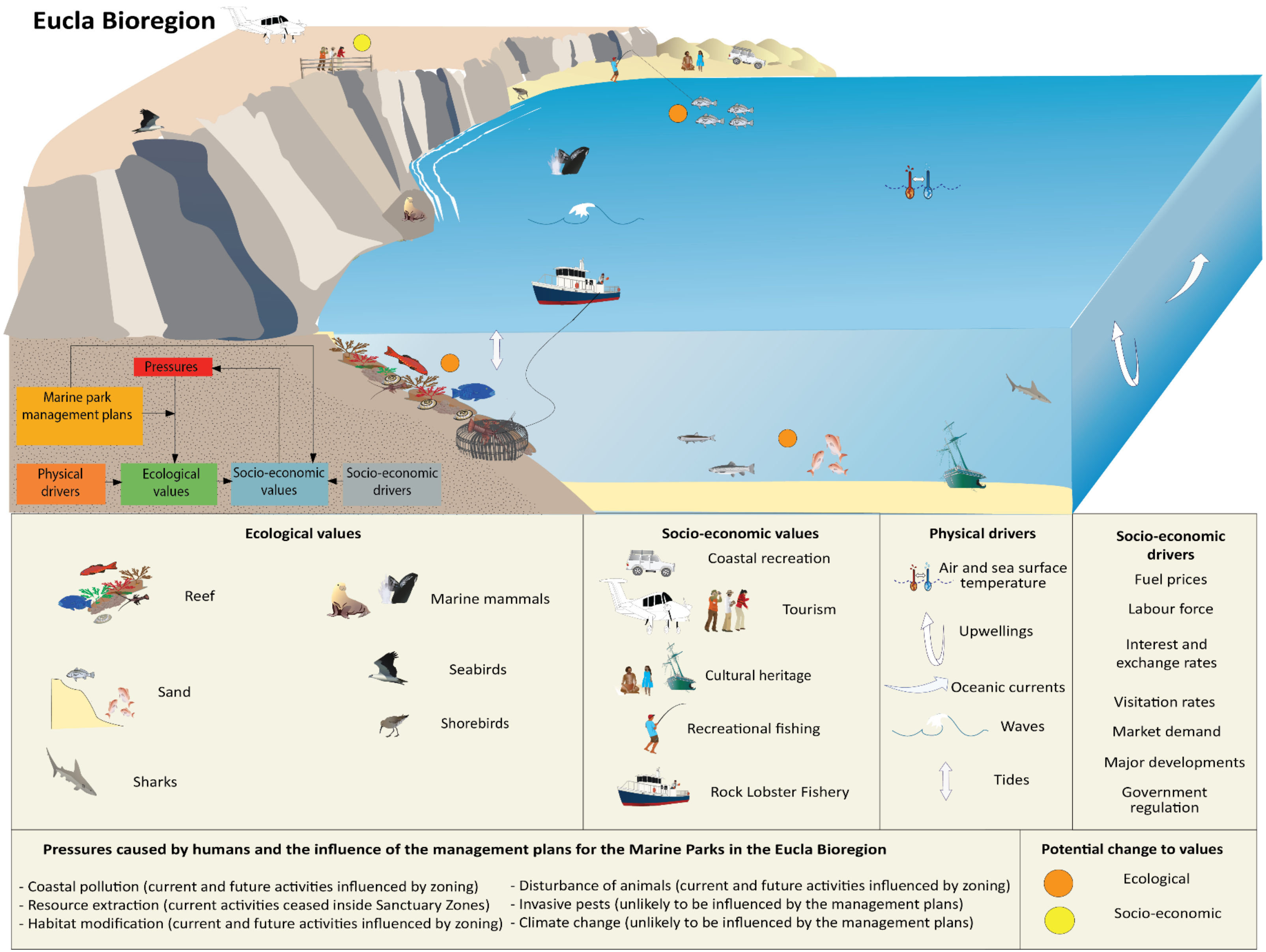


Figure 12. Conceptual model for marine parks in the Eucla Bioregion.

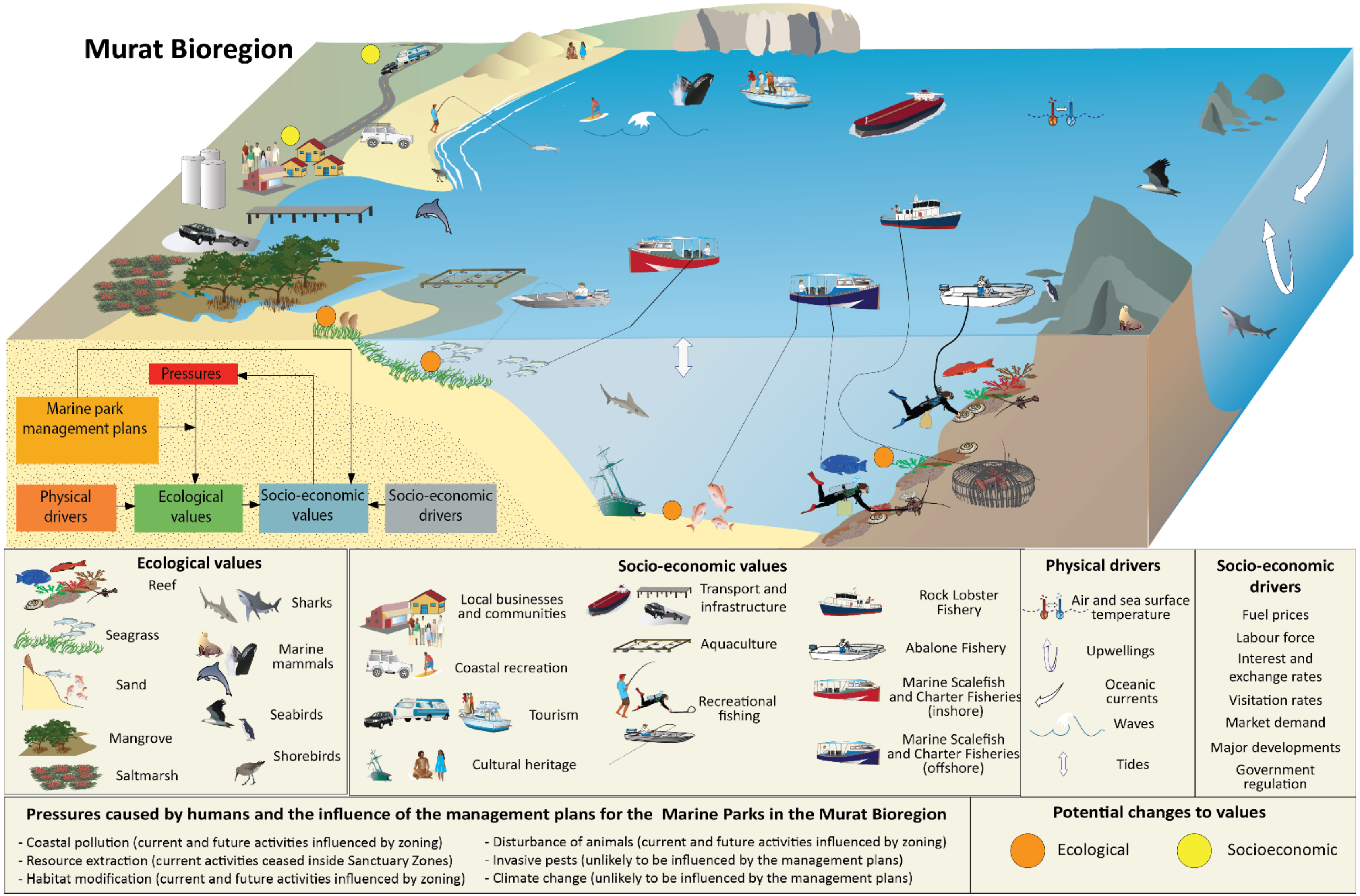


Figure 13. Conceptual model for marine parks in the Murat Bioregion.

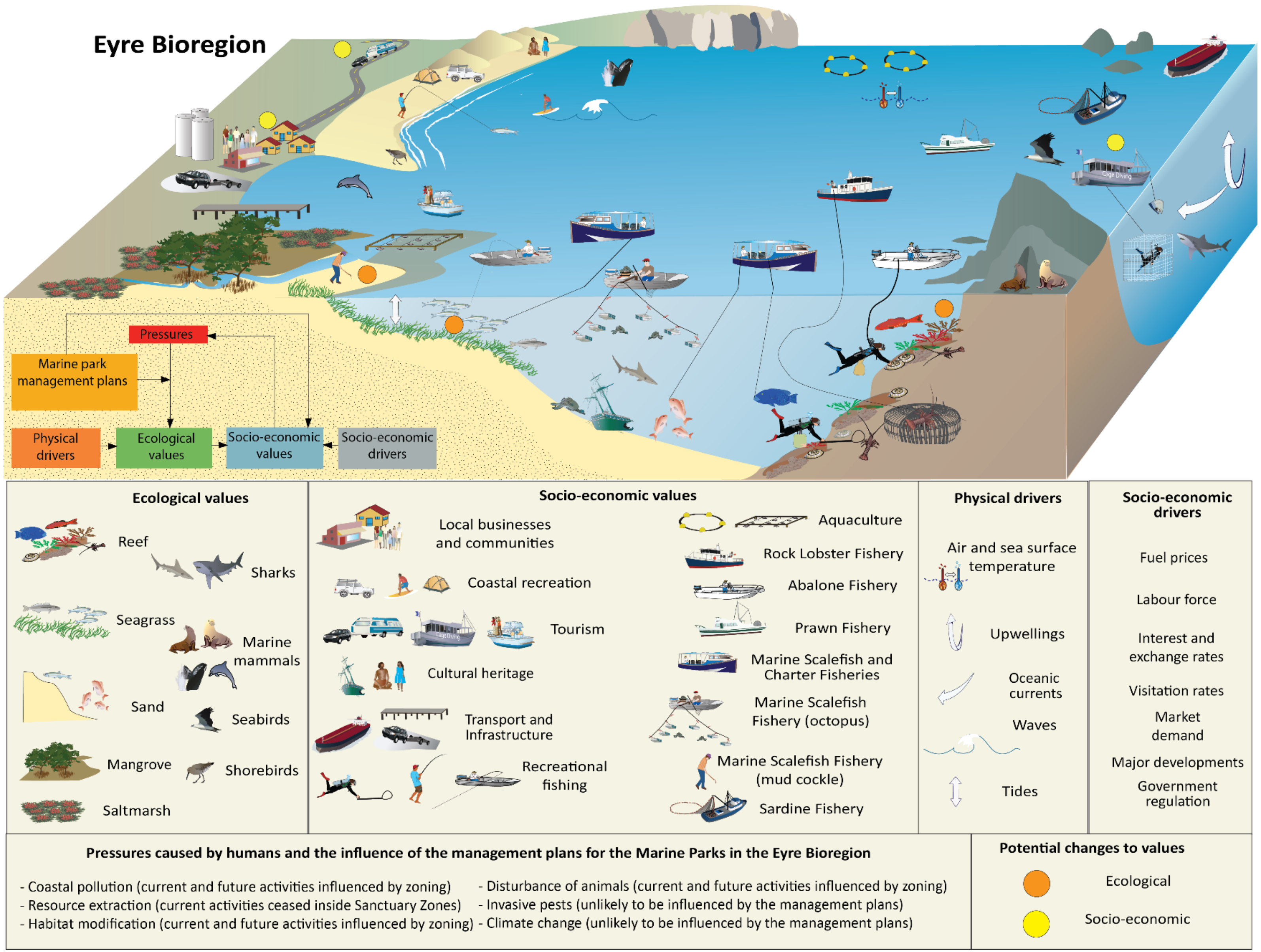


Figure 14. Conceptual model for marine parks in the Eyre Bioregion.

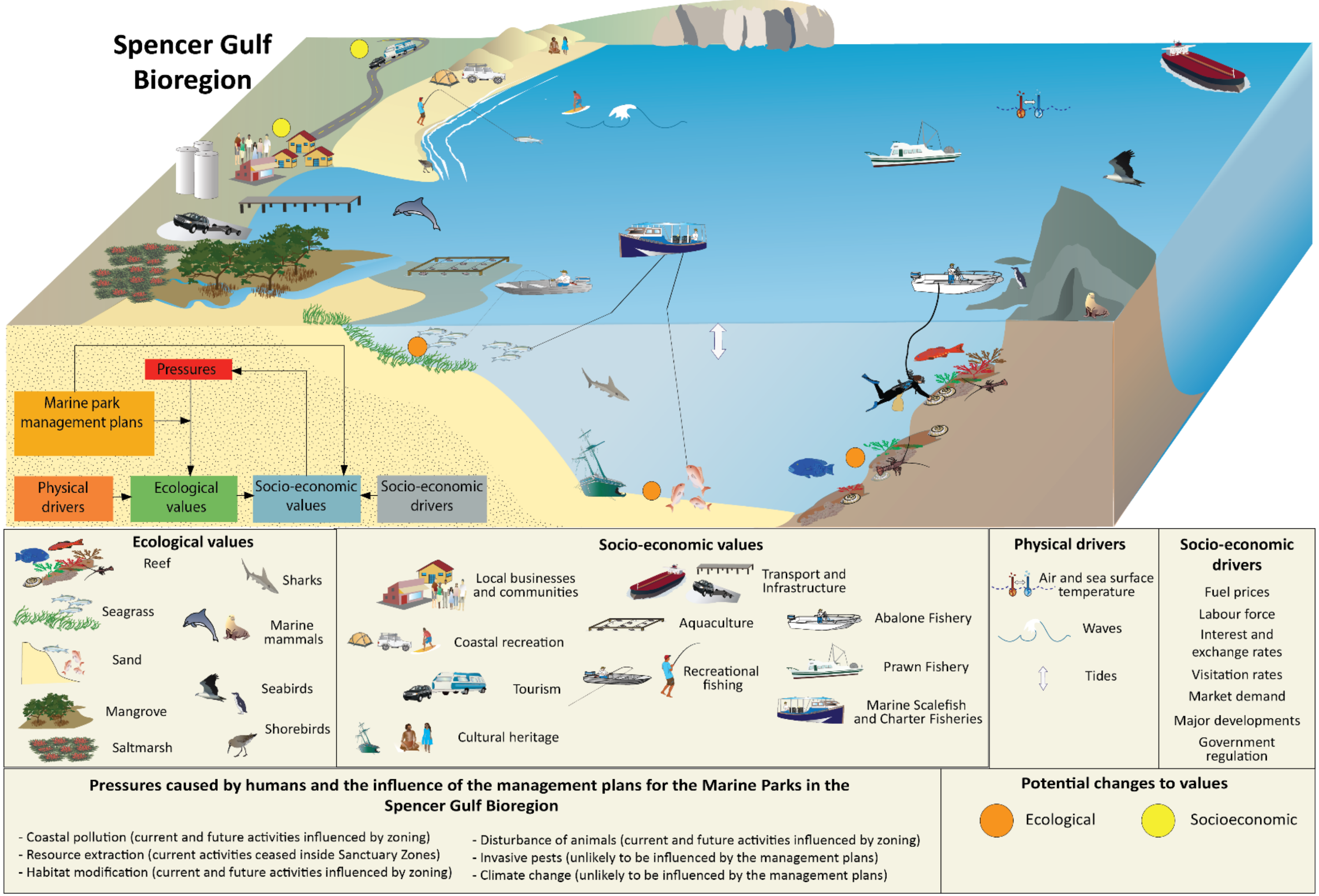


Figure 15. **Conceptual model for marine parks in the Spencer Gulf Bioregion.**

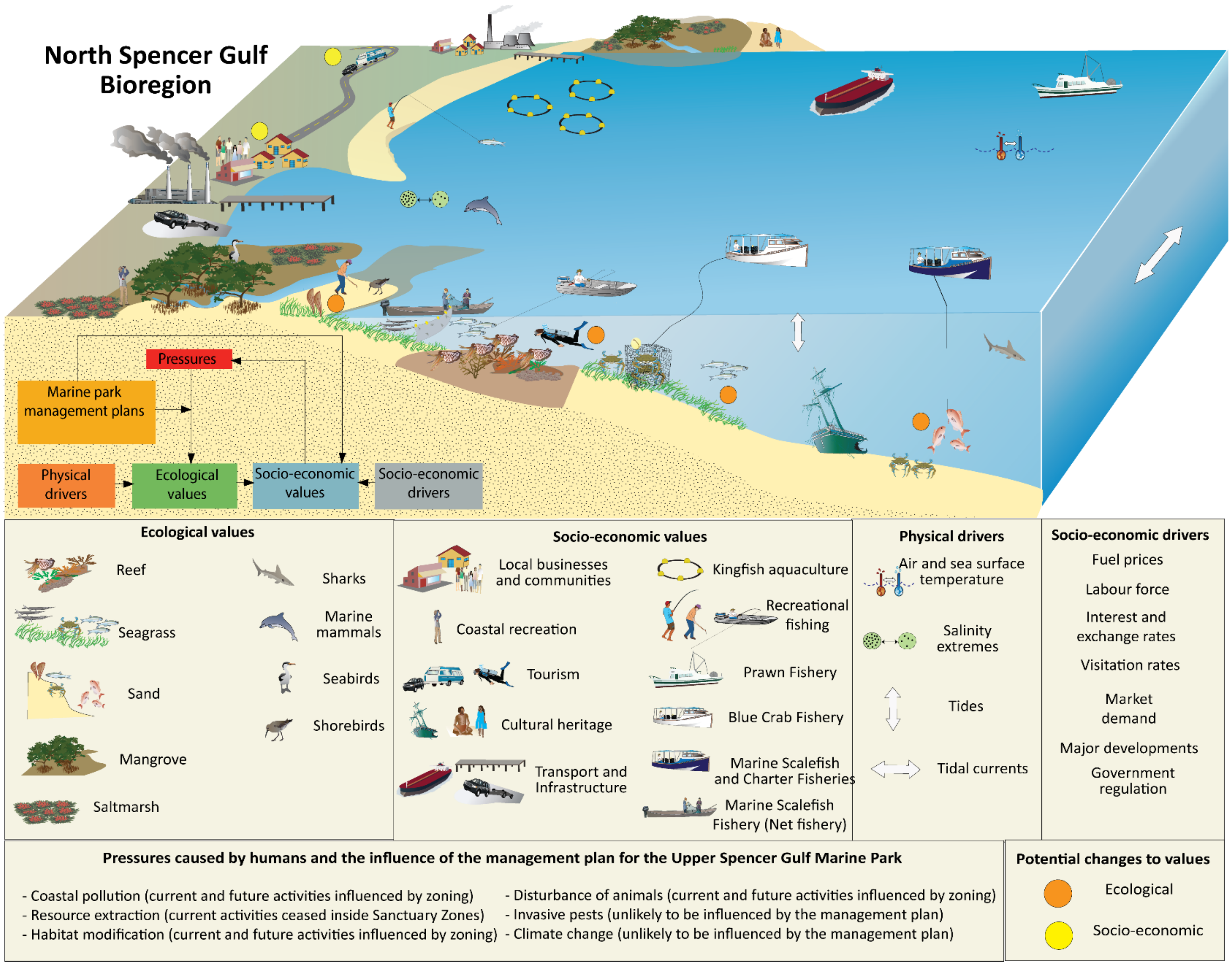


Figure 16. Conceptual model for marine parks in the North Spencer Gulf Bioregion.

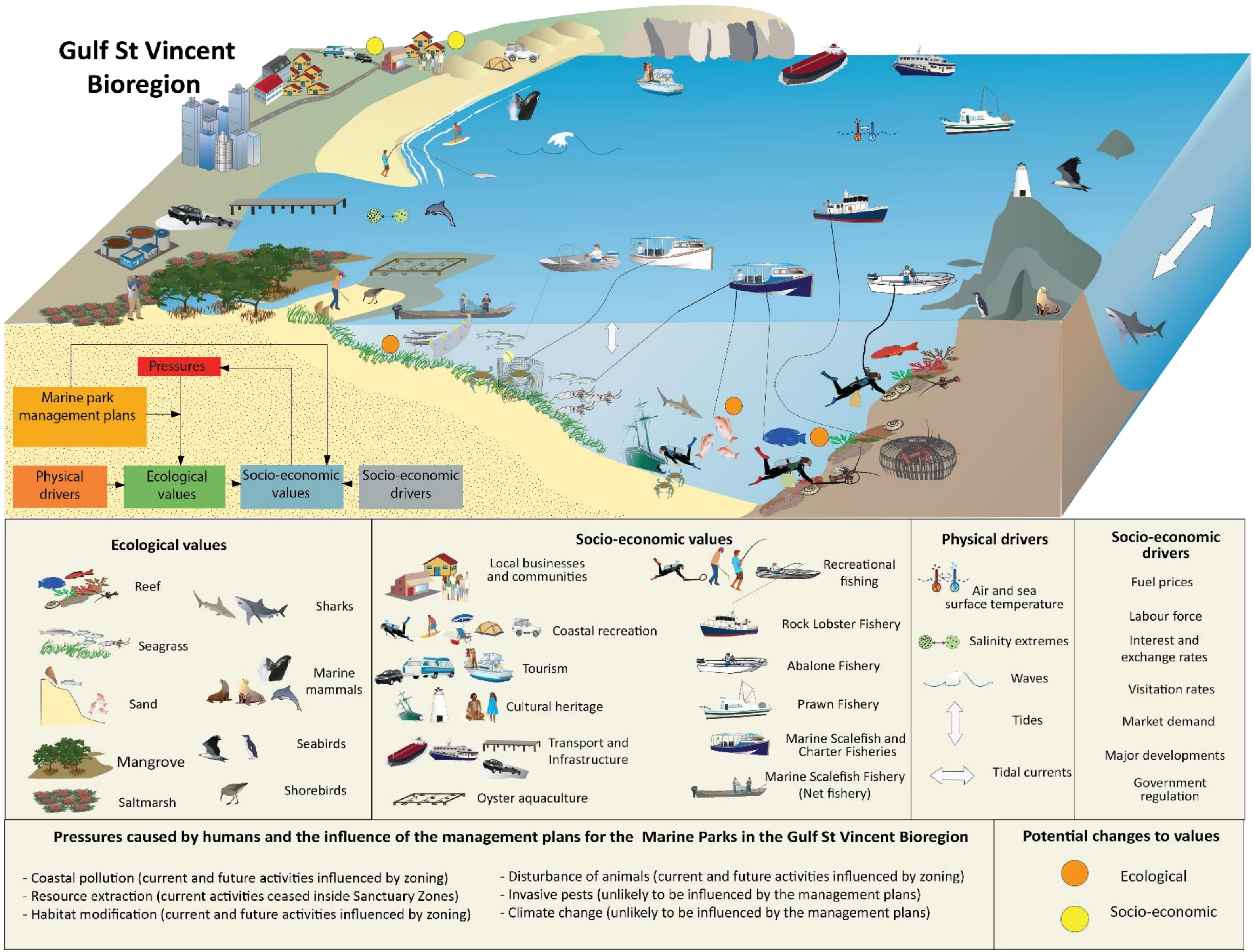


Figure 17. Conceptual model for marine parks in the Gulf St Vincent Bioregion.

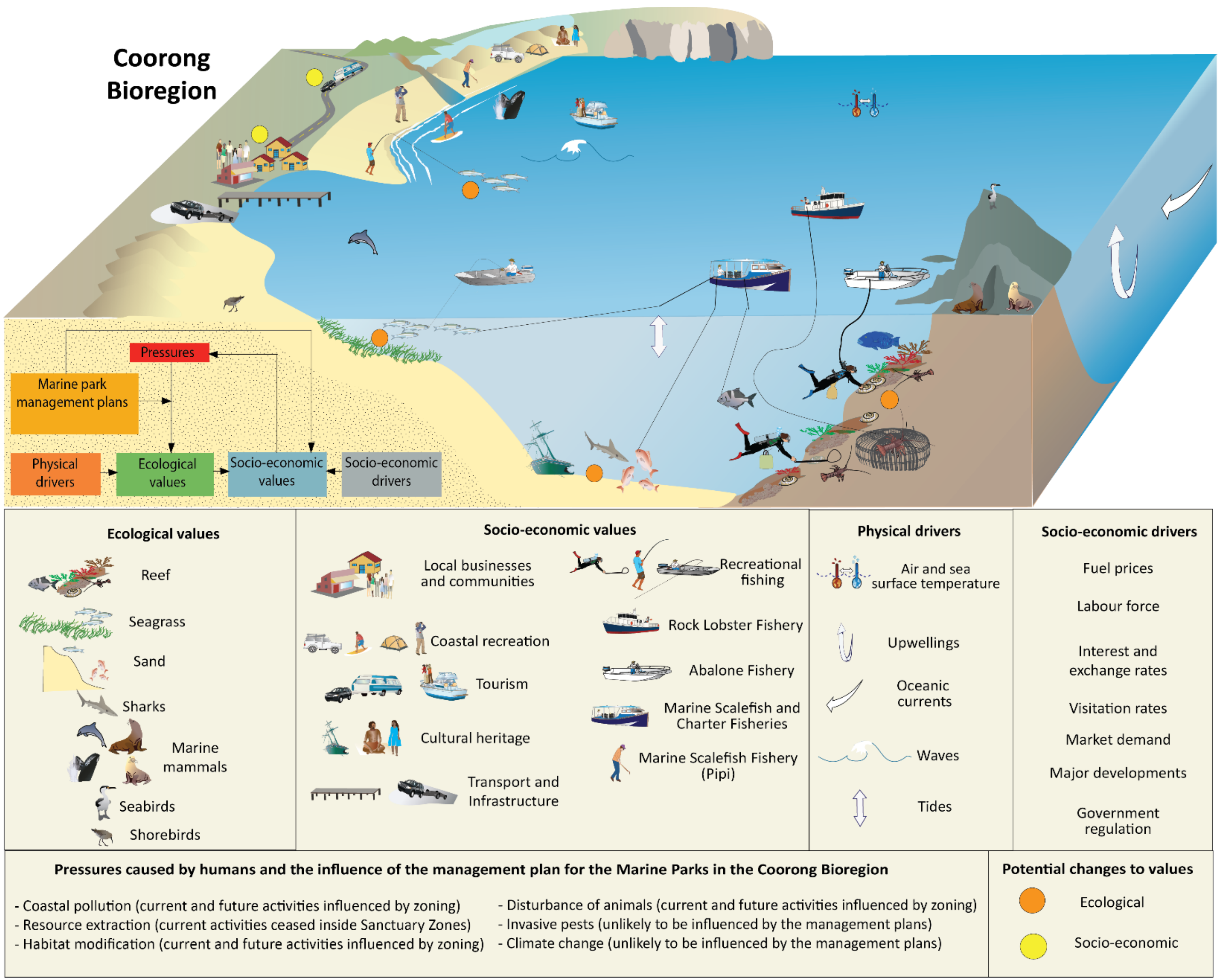


Figure 18. Conceptual model for marine parks in the Coorong Bioregion.

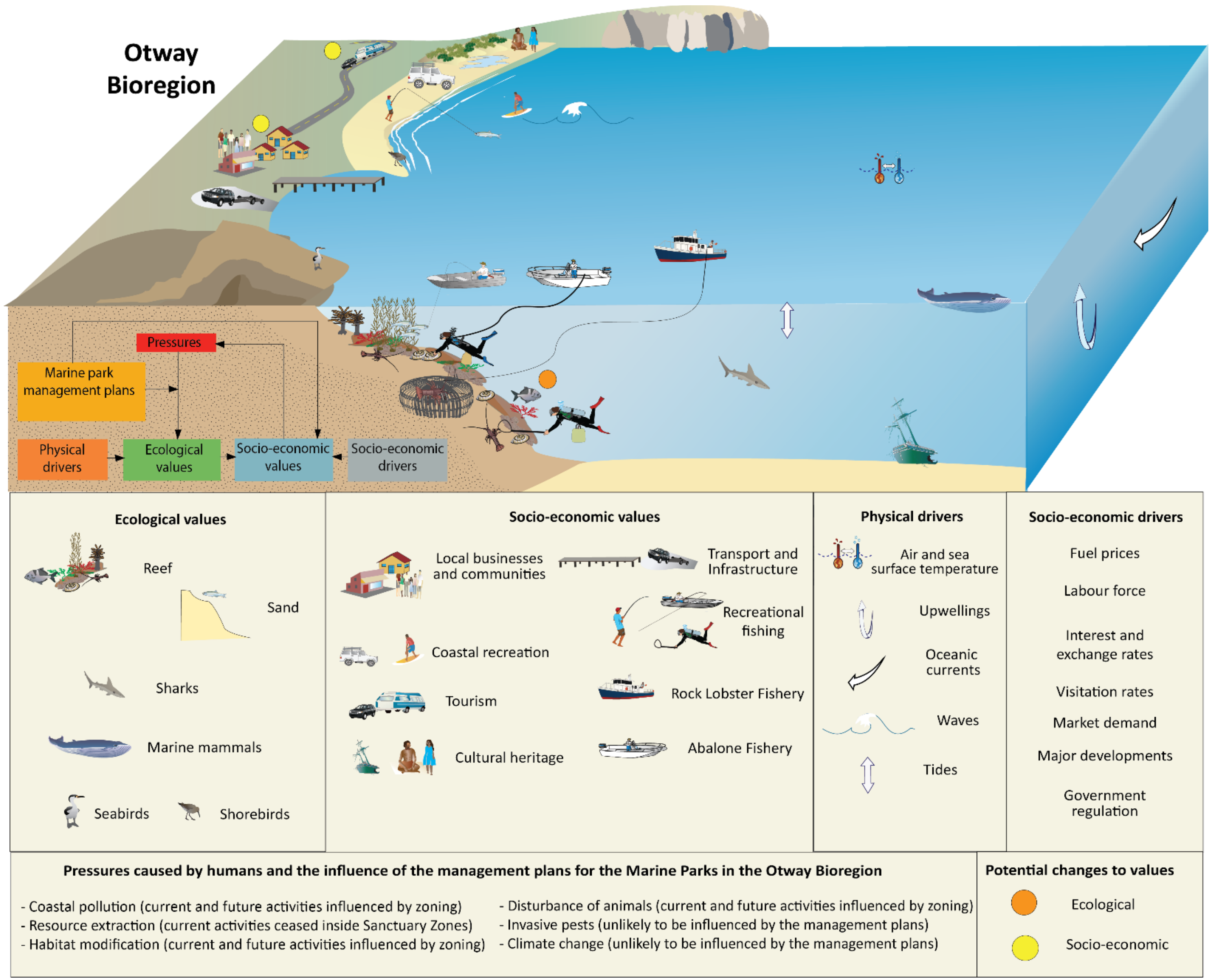


Figure 19. Conceptual model for marine parks in the Otway Bioregion.

4 Ecological values

Monitoring the ecological values will be a core component of the marine parks MER program. For the purposes of the baseline reports, ecological values are summarised according to 5 habitat types and 4 species groups (Figure 12 to Figure 19). The habitat types in the conceptual models (reef, seagrass, sand, mangrove and saltmarsh, Figure 20 to Figure 26) are based on the benthic features that were used in the design process of the marine parks network. The pelagic ecosystem was not considered as a separate habitat. The species groups (sharks, marine mammals, seabirds and shorebirds) are iconic and relatively mobile species. The ecological values of the 5 habitat types and 4 species groups are well documented (Edgar 2001, Turner et al. 2006, Connolly and Lee 2007, Bailey et al. 2012a), including in each of the 19 marine parks (DENR 2010, Bailey et al. 2012b-t). Additional information on the ecological values of the 19 marine parks is provided by a series of atlas maps (DEWNR 2016e-w).

The following sections summarise the available baseline information on the 9 ecological values. This report provides an inventory of the available information and examples of the current state of knowledge and historical trends prior to 2015. The emphasis of this section is on the nature and scale (temporal and spatial) of information and indicators that may be used in the MER program. Of particular interest is information that has been collected inside and outside SZs because they are expected to result in changes to the ecological and socio-economic values (Bailey et al. 2012a). In some cases there are time series of data available, while in other cases there is data collected from a single point in time which could potentially be resampled in the future. In addition to park-specific information that was presented in the individual baseline reports (Bryars et al. 2016a-s), this statewide report also considers information that has been collected outside of park boundaries but which may be useful in the MER program. For example, ecological information collected at sites that lie outside of park boundaries may be useful for comparative purposes in a bioregional or network assessment of the effectiveness of SZs and HPZs.

In developing a comprehensive, adequate and representative system of marine parks, habitats are used as key surrogates for broader biodiversity. Consideration was given to benthic habitat type and extent as well as shoreline habitat type and length (DEH 2009a). The habitat information for this baseline report has been reported at the bioregion level:

- About 24.1 per cent of the benthic habitats in the Eucla Bioregion have been mapped at a broad scale (1:100,000) using satellite imagery (DEWNR 2015e, Edyvane 1999a, b, Figure 20). The majority (75.9 per cent) of the subtidal habitats have not been mapped.
- About 10 per cent of the benthic habitats of the Murat Bioregion have been mapped at a fine scale (1:10,000), by digitising aerial photographs, field surveys (for mangrove and saltmarsh), acoustic mapping and towed camera surveys (DEWNR 2015c, d, Miller et al. 2009, Figure 21). An additional 15.1 per cent has been mapped at a broad scale. The majority (74.9 per cent) of the subtidal habitats in the Murat Bioregion have not been mapped.
- About 4.8 per cent of the benthic habitats in the Eyre Bioregion have been mapped at a fine scale (Figure 22). An additional 8.7 per cent have been mapped at a broad scale. The majority (86.5 per cent) of the subtidal habitats in the Eyre Bioregion have not been mapped.
- About 9.6 per cent of the benthic habitats of the Spencer Gulf Bioregion have been mapped at a fine scale (Figure 23), and an additional 7 per cent at a broad scale. The majority (83.4 per cent) of the subtidal habitats in the Spencer Gulf Bioregion have not been mapped.
- About 57.3 per cent of the benthic habitats of the Northern Spencer Gulf Bioregion have been mapped at a fine scale (1:10,000), by digitising aerial photographs, field surveys (for mangrove and saltmarsh), acoustic mapping and towed camera surveys (DEWNR 2015c, d, Miller et al. 2009, Figure 23). An additional 36.9 per cent has been mapped at a broad scale (1:100,000) using satellite imagery (DEWNR 2015e, Edyvane 1999a, b, Figure 6). Only about 5.7 per cent of the North Spencer Gulf Bioregion is not mapped.

- About 24.4 per cent of the benthic habitats in the Gulf St Vincent Bioregion have been mapped at a fine scale, along with an additional 6.8 percent at a broad scale (Figure 24). The majority (68.8 per cent) of the subtidal habitats in the Gulf St Vincent Bioregion have not been mapped.
- About 30.6 per cent of benthic habitats in the Coorong Bioregion have been mapped at a fine scale and 3.3 per cent have been mapped at a broad scale (Figure 25). The majority (66.1 per cent) have not been mapped.
- About 56.2 per cent of the benthic habitats have been mapped in the Otway Bioregion and a further 8.5 per cent have been mapped at a broad scale (Figure 26). Only 35.3 per cent of the subtidal habitats in the Otway Bioregion have not been mapped.

A summary of the mapping for the 8 bioregions is provided in Table 2. The entire shoreline of the 8 marine bioregions has been mapped (Appendix B) by digitising aerial photos (DEWNR 2015f). Each of the mapping techniques delivers a different type of estimate of 'spatial extent' and this will influence the ability to detect any potential change from the baseline condition.

Pie charts were used to visually assess the representation of each mapped benthic habitat type, comparing the proportional distribution of benthic habitats in the bioregions with the proportional distribution of habitats included in the marine parks and core zones (the combination of SZs and RAZs) (Figure 27 to Figure 34). Ideally in a comprehensive and representative marine park network, the size of the slices of the pie (proportions of each feature) should be similar when comparing the core zones with the marine parks, and with the bioregions.

A visual assessment of the bioregion pie charts (Figure 27 to Figure 34) reveals their different character in terms of the habitats present within them. For example, many of the bioregions are dominated by unmapped habitats (grey slices) whereas the North Spencer Gulf Bioregion is dominated by seagrass (green slices).

Eucla and Otway core zones are in similar proportions to the bioregion for benthic habitats. For the majority of the bioregions, the inclusion of habitats in core zones was disproportionate due to the under- or over-representation of one or more of the habitat types. For many of the bioregions, the habitats included within the marine park boundaries are in similar proportions to those available but the pattern was not repeated to the core zones.

Table 2. Number of SZs in each bioregion with benthic habitat mapping. Mapping type includes: fine scale (DEWNR 2015c, d, Miller et al. 2009); broad scale (DEWNR 2015e, Edyvane 1999a, b) and video drops (DEWNR unpublished report).

Bioregion	Mapping type	No. of SZs
Eucla	Broad scale	3
	Unmapped	1
Murat	Broad scale	4
	Fine scale	4
	Grid-based (1 kilometre apart) video drops	2
Eyre	Broad scale	13
	Fine scale	15
	Unmapped	11
	Grid-based (1 kilometre apart) video drops	1
Spencer Gulf	Fine scale	7
	Unmapped	3
North Spencer Gulf	Broad scale	1
	Fine scale	8
Gulf St Vincent	Broad scale	7
	Fine scale	15
	Unmapped	3
	Grid-based (1 kilometre apart) video drops	12
Coorong	Broad scale	3
	Fine scale	2
	Unmapped	2
	Grid-based (1 kilometre apart) video drops	1
Otway	Broad scale	2
	Fine scale	2

Figure 20. Benthic habitats of the Eucla Bioregion based on fine and broad scale mapping. Source: DEWNR (2015c, d, e), Miller et al. (2009), Edyvane (1999a, b).

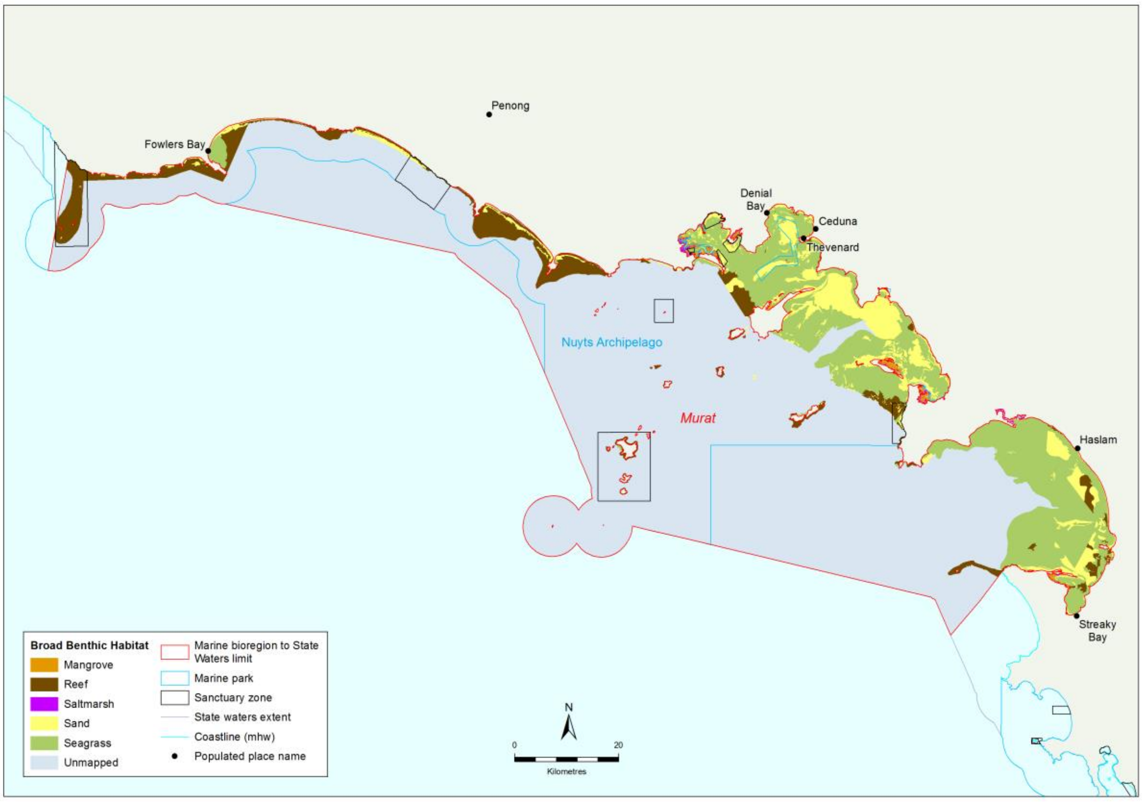


Figure 21. Benthic habitats of the Murat Bioregion based on fine and broad scale mapping. Source: DEWNR (2015c, d, e), Miller et al. (2009), Edyvane (1999a, b).

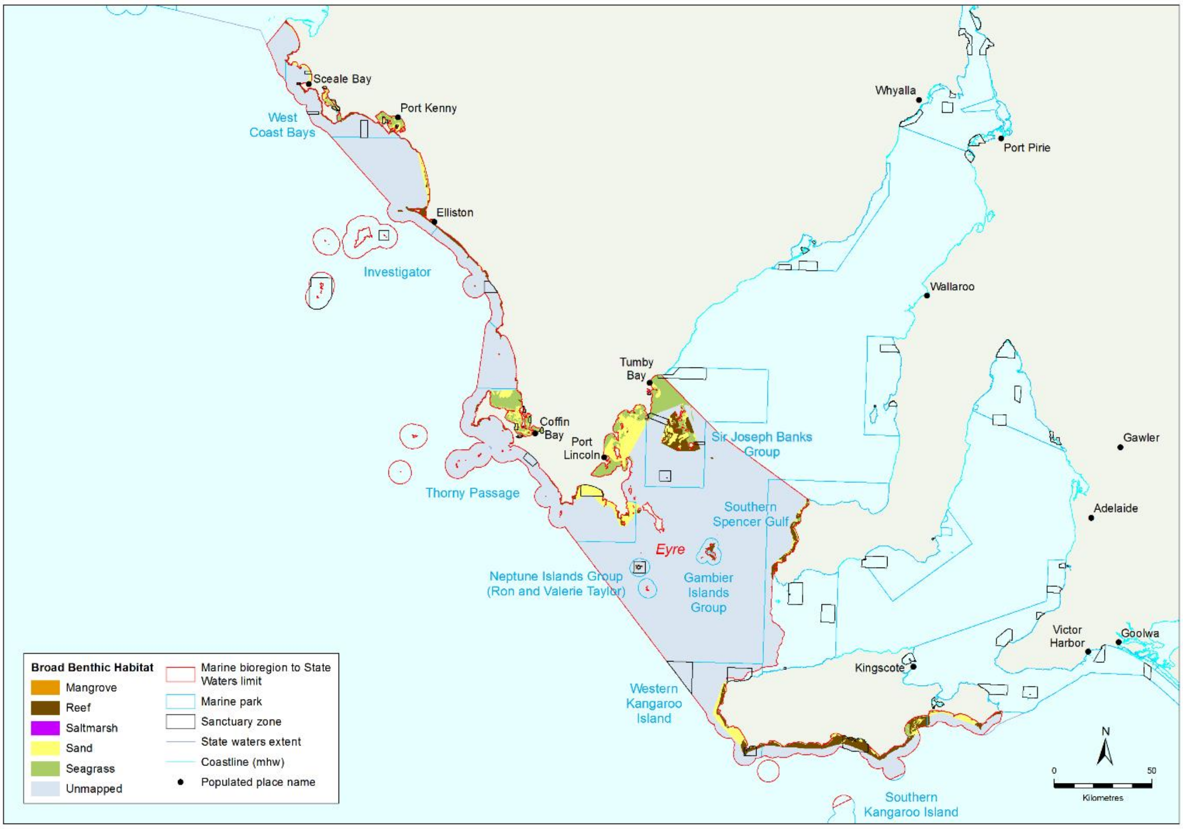


Figure 22. Benthic habitats of the Eyre Bioregion based on fine and broad scale mapping. Source: DEWNR (2015c, d, e), Miller et al. (2009), Edyvane (1999a, b).

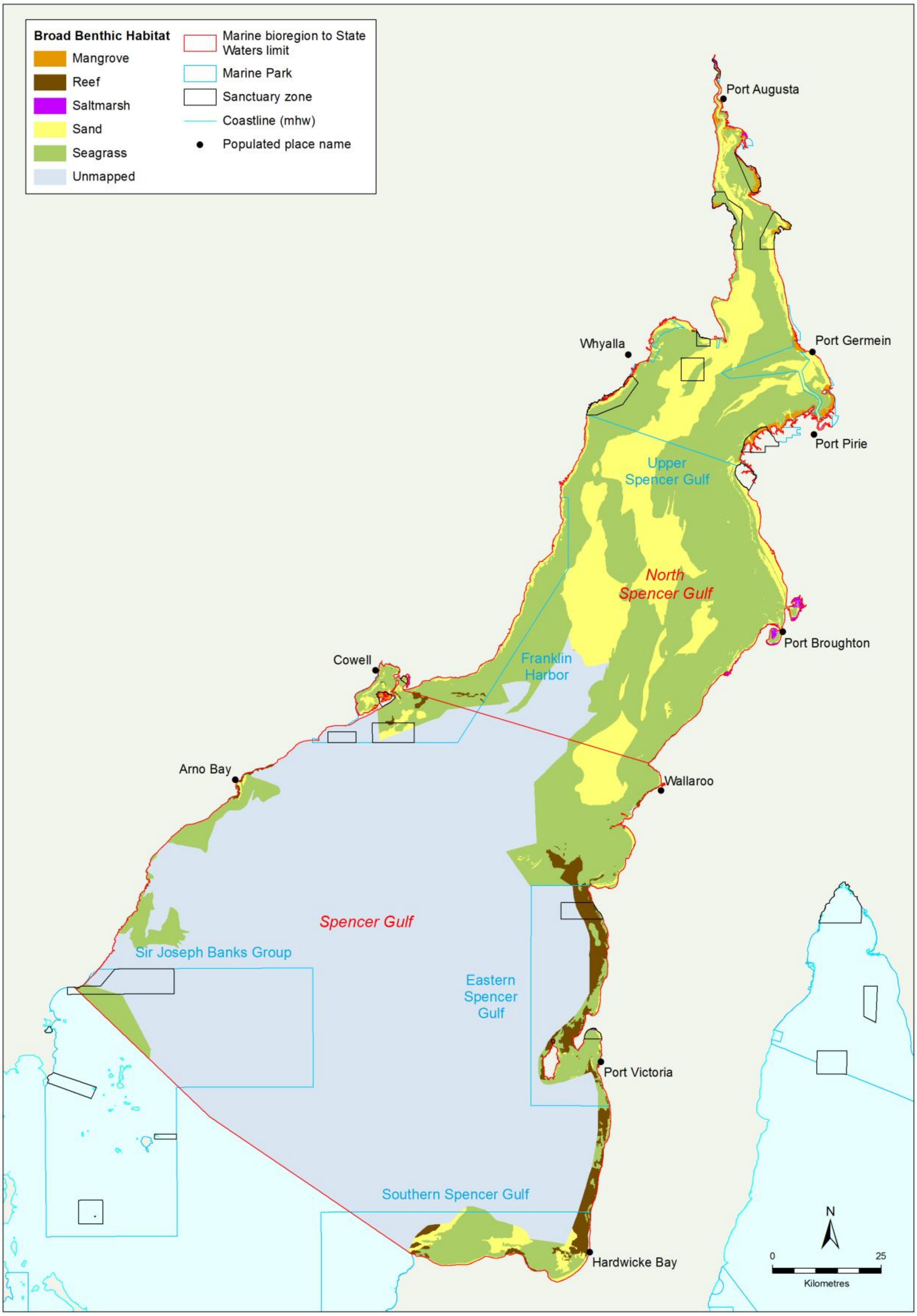


Figure 23. Benthic habitats of the Spencer Gulf and North Spencer Gulf Bioregions based on fine and broad scale mapping. Source: DEWNR (2015c, d, e), Miller et al. (2009), Edyvane (1999a, b).

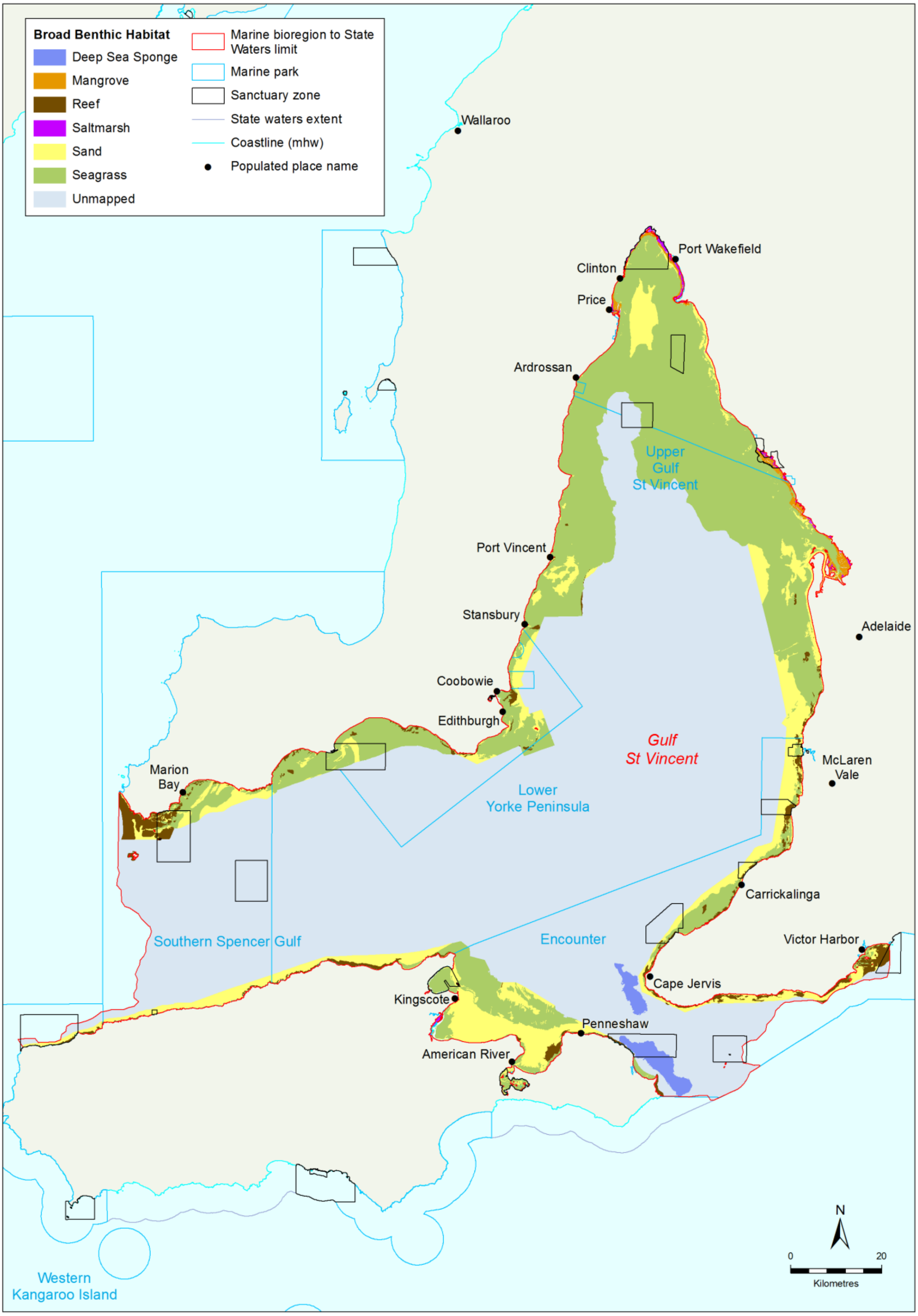


Figure 24. Benthic habitats of the Gulf St Vincent Bioregion based on fine and broad scale mapping. Source: DEWNR (2015c, d, e), Miller et al. (2009), Edyvane (1999a, b).

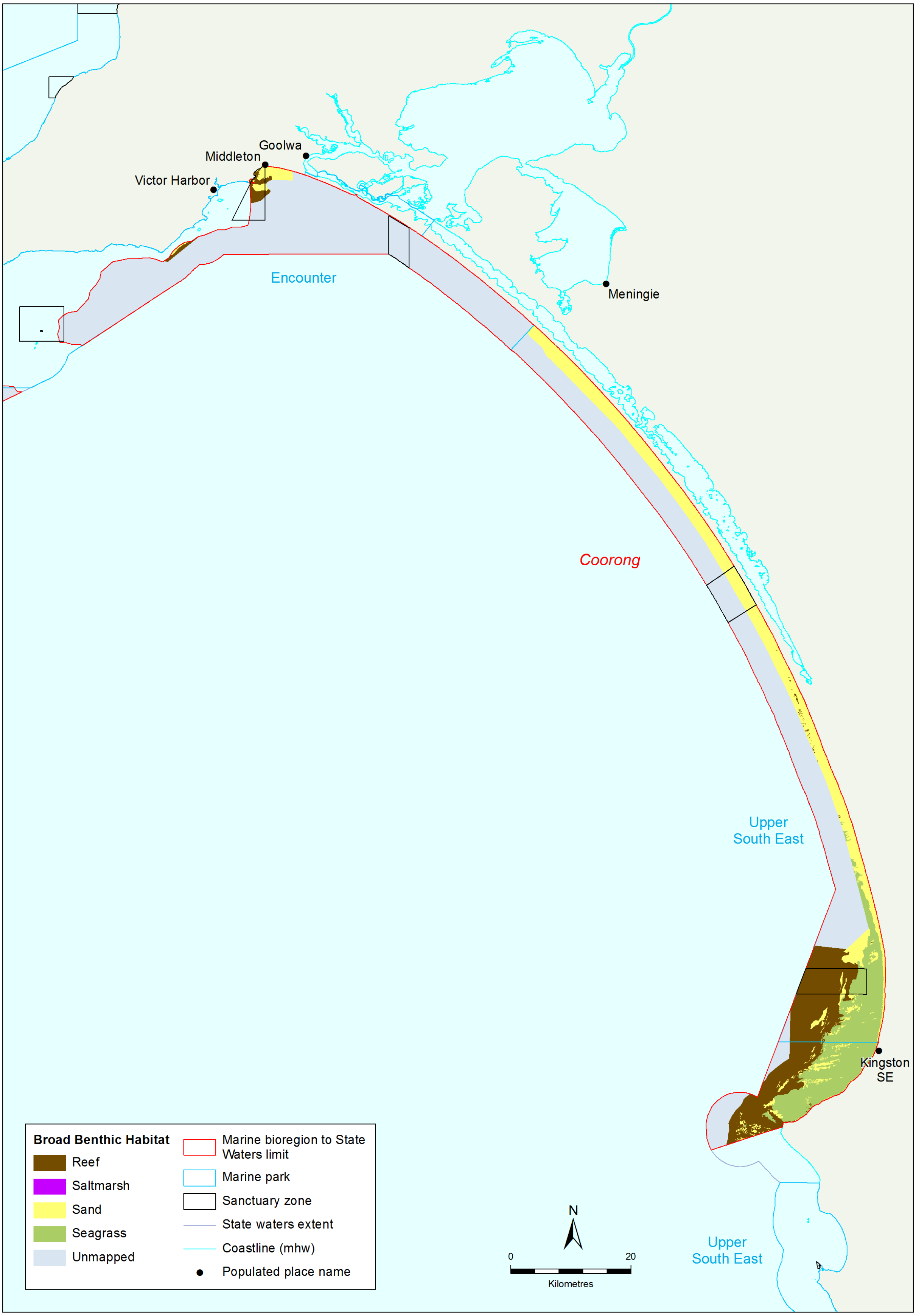


Figure 25. Benthic habitats of the Coorong Bioregion based on fine and broad scale mapping. Source: DEWNR (2015c, d, e), Miller et al. (2009), Edyvane (1999a, b).

Figure 26. Benthic habitats of the Otway Bioregion based on fine and broad scale mapping. Source: DEWNR (2015c, d, e), Miller et al. (2009), Edyvane (1999a, b).

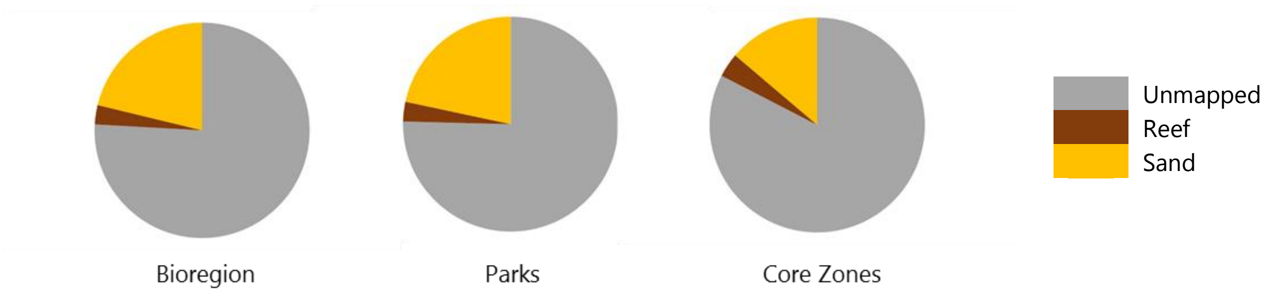


Figure 27. Pies charts showing the proportional representation of benthic habitats for the Eucla Bioregion within state waters, marine parks and core zones.

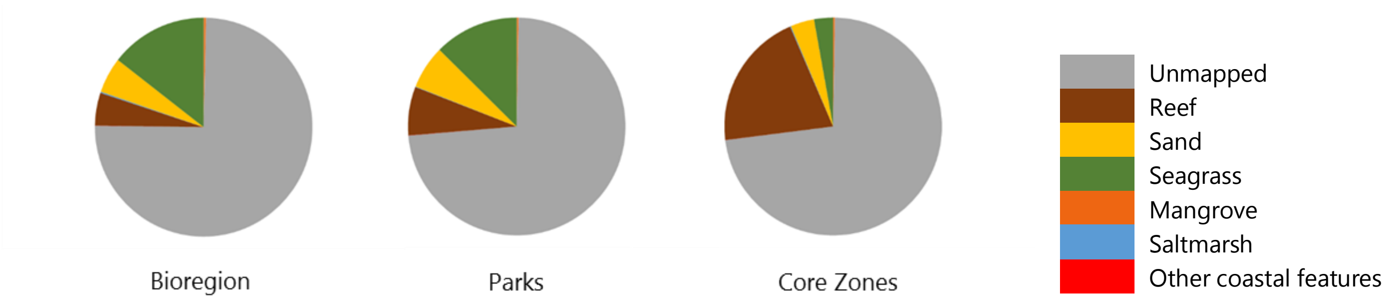


Figure 28. Pies charts showing the proportional representation of benthic habitats for the Murat Bioregion within state waters, marine parks and core zones.

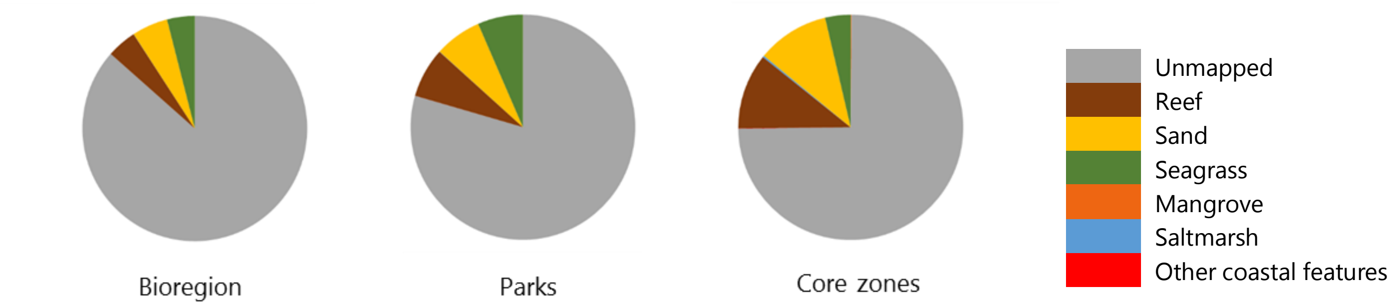


Figure 29. Pies charts showing the proportional representation of benthic habitats for the Eyre Bioregion within state waters, marine parks and core zones.

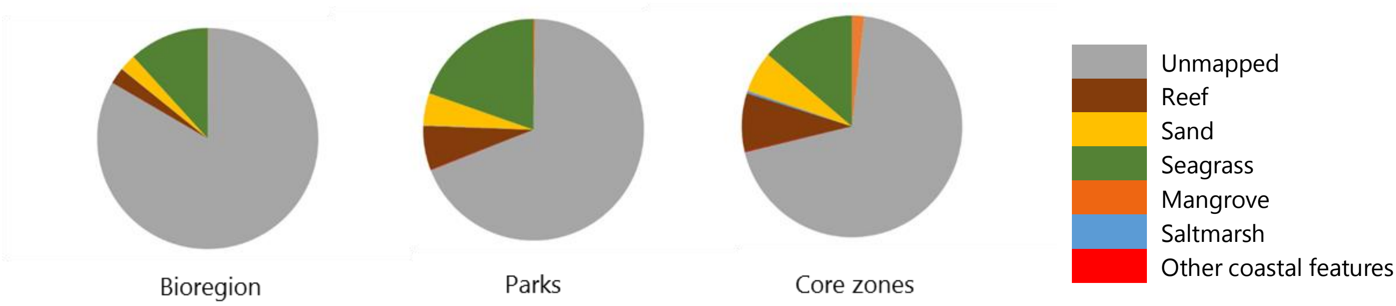


Figure 30. Pies charts showing the proportional representation of benthic habitats for the Spencer Gulf Bioregion within state waters, marine parks and core zones.

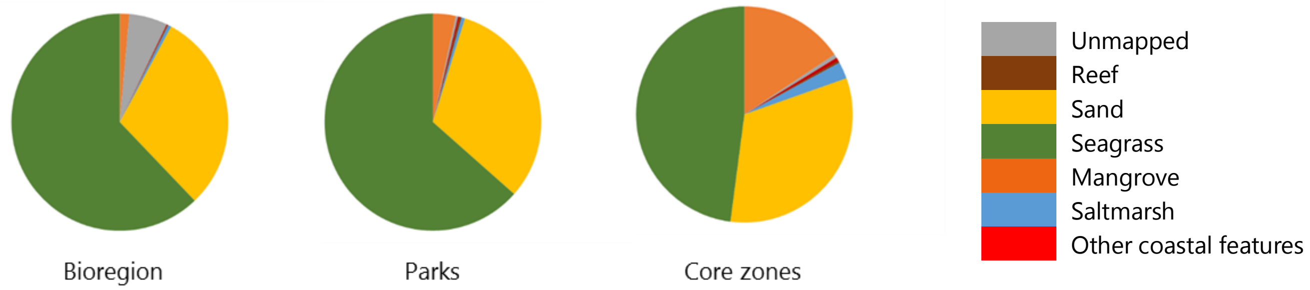


Figure 31. Pies charts showing the proportional representation of benthic habitats for the North Spencer Gulf Bioregion within state waters, marine parks and core zones.

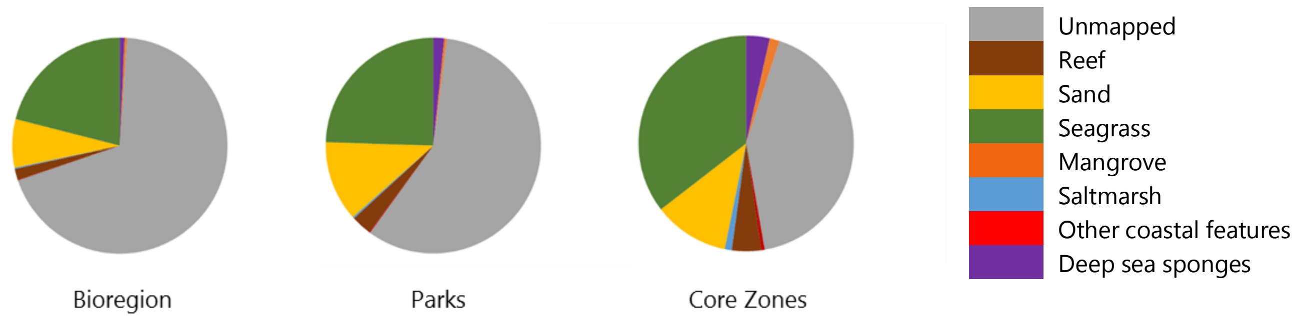


Figure 32. Pies charts showing the proportional representation of benthic habitats for the Gulf St Vincent Bioregion within state waters, marine parks and core zones.

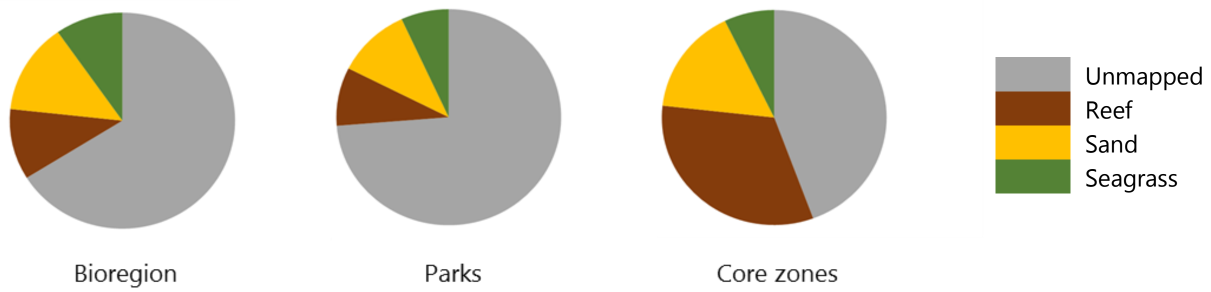


Figure 33. Pies charts showing the proportional representation of benthic habitats for the Coorong Bioregion within state waters, marine parks and core zones.

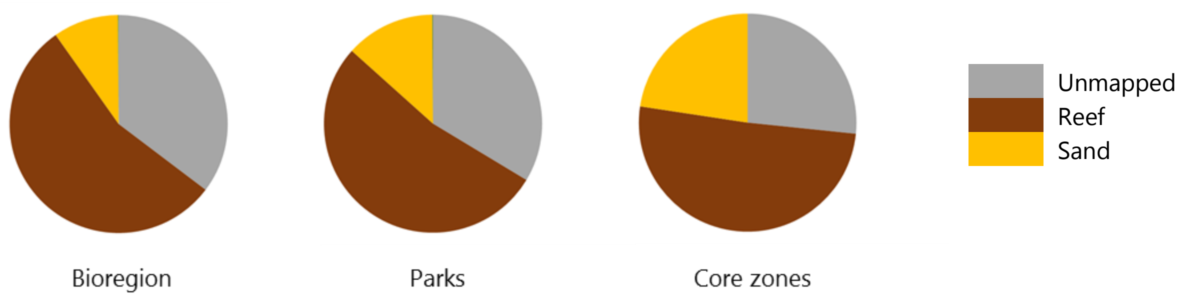
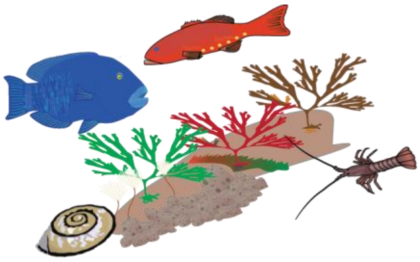


Figure 34. Pies charts showing the proportional representation of benthic habitats for the Otway Bioregion within state waters, marine parks and core zones.

4.1 Reef



Limestone and granite rocky reefs form a significant portion of the inshore marine habitats of South Australia. Reef across the state is diverse with various exposures, forms and compositions. Reef habitats occur on a large portion of South Australia's coasts except those in the Upper Gulfs where sand and seagrass is much more dominant.

High-energy, sub-tidal calcareous reefs and wave-cut platforms occur along the Eucla Bioregion coastline. One of the largest and most diverse reefs is the Nuyts reef.

In the Murat Bioregion large areas of reef occur near Point Bell and Point Sinclair. Further offshore, there are 19 rocky islands, which have fringing reefs. Most of the reefs are granitic, with some limestone or calcarenite reefs in the lee of some of the islands.

The Eyre Bioregion is the largest of the bioregions and includes 9 of the 19 marine parks. The coast of the Eyre Bioregion is large and diverse, it alternates between island and reef exposures. There is a highly diverse range of subtidal reef habitats including ledges, boulders, caves, crevasses, overhangs, cobble reefs, wave-exposed granite outcrops and reef platforms. In some parts of the Eyre Bioregion, reefs extend from intertidal wave-cut shore platforms to at least 50 metres deep.

In the Spencer Gulf Bioregion subtidal reefs occur in various forms. Mixed sand, seagrass and reef patch habitats are also common throughout the bioregion. Reefs are a dominant feature of eastern Spencer Gulf, including Wardang Island, Point Pearce, Reef Point, and other headland reefs. Many of the Islands are surrounded by reef platforms, boulders and scattered and eroded limestone reef.

In the North Spencer Gulf Bioregion the only significant reef occurs around Point Lowly.

In the Gulf St Vincent Bioregion subtidal reef occurs at numerous locations along the mainland coast and Kangaroo Island coast. Reef is particularly prevalent at Aldinga and Encounter Bay. The cliffs, headlands and offshore Islands such as Granite, Wright, West, Seal and Pullen Island and The Pages island group are fringed by reef.

In the Coorong Bioregion subtidal reef includes low platform reefs, offshore calcareous reefs to the south, and fringing granite reefs in Encounter Bay. Margaret Brock Reef, on the boundary between the Coorong and Otway Bioregion is one of the largest reef systems in the area.

In the Otway Bioregion reefs fringe the rocky headlands and extend offshore to waters more than 60 metres deep. Most of the reefs are made of limestone.

Park-specific baseline information on reef is presented in the individual baseline reports (Bryars et al. 2016a-s). Baseline information on reef relevant to South Australia includes:

Spatial extent of reef habitat

- Intertidal reefs extend along about 138 kilometres of the mainland coastline of South Australia (see Appendix B). The shoreline extent of intertidal reefs on islands has not been mapped.
- About 3,800 square kilometres of subtidal reef have been mapped in South Australia's coastal waters (Figure 20 to Figure 26). About 54 square kilometres of reef have been mapped in the Eucla Bioregion, 341 square kilometres of reef have been mapped in the Murat Bioregion, 1,025 square kilometres of reef have been mapped in the Eyre Bioregion, 736 square kilometres of reef have been mapped in the Spencer Gulf Bioregion, 300 square kilometres of reef have been mapped in the North Spencer Gulf Bioregion, 368 square kilometres of reef have been mapped in the Gulf St Vincent Bioregion, 279 square kilometres of reef have been mapped in the Coorong Bioregion, and 725 square kilometres of reef have been mapped in the Otway Bioregion.

- Historically, extensive native oyster reefs existed across many parts of South Australia (Alleway and Connell 2015)

Size, abundance and diversity of reef communities

- Fish, invertebrate and macroalgal diversity and abundance were surveyed by divers at 245 sites around South Australia at depths of 5 or 10 metres between 2004 and 2014; 16 sites in the Murat Bioregion (5 sites inside SZs), 40 sites in the Eyre Bioregion (2 sites inside SZs), 17 sites in the Spencer Gulf Bioregion (5 sites inside SZs), 8 sites in the North Spencer Gulf Bioregion (3 sites inside SZs), 147 sites in the Gulf St Vincent Bioregion (48 sites inside SZs), 11 sites in the Coorong Bioregion (4 sites inside SZs) and 6 sites in the Otway Bioregion (2 sites inside SZs) (DEWNR and University of Tasmania unpublished data, Figure 35 to Figure 40). About 443 fish taxa were recorded during the surveys across the state. About 69 fish taxa were recorded in the Murat Bioregion, 77 fish taxa were recorded in the Eyre Bioregion, 70 fish taxa were recorded in the Spencer Gulf Bioregion, 38 fish taxa were recorded in the North Spencer Gulf Bioregion, 132 fish taxa were recorded in the Gulf St Vincent Bioregion, 35 fish taxa were recorded in the Coorong Bioregion and 22 fish taxa were recorded in the Otway Bioregion. About 550 invertebrate taxa were recorded during the surveys across the state. About 64 invertebrate taxa were recorded in the Murat Bioregion, 102 invertebrate taxa were recorded in the Eyre Bioregion, 101 invertebrate taxa were recorded in the Spencer Gulf Bioregion, 51 invertebrate taxa were recorded in the North Spencer Gulf Bioregion, 142 invertebrate taxa were recorded in the Gulf St Vincent Bioregion, 55 invertebrate taxa were recorded in the Coorong Bioregion and 35 invertebrate taxa were recorded in the Otway Bioregion. About 1033 macroalgal taxa were recorded during the surveys across the state. About 125 macroalgal taxa were recorded in the Murat Bioregion, 210 macroalgal taxa were recorded in the Eyre Bioregion, 123 macroalgal taxa were recorded in the Spencer Gulf Bioregion, 63 macroalgal taxa were recorded in the North Spencer Gulf Bioregion, 255 macroalgal taxa were recorded in the Gulf St Vincent Bioregion, 137 macroalgal taxa were recorded in the Coorong Bioregion and 120 macroalgal taxa were recorded in the Otway Bioregion.
- Fish diversity and abundance were surveyed using baited remote underwater video systems (Cappo et al. 2003) at 302 sites within the vicinity of subtidal reef at various locations across South Australia between 2011 and 2015. These sites vary in number between bioregions; 53 sites within the Murat Bioregion (5 sites inside SZs), 17 sites in the Eyre Bioregion (7 sites inside SZs), 6 sites in the Spencer Gulf Bioregion (0 sites inside SZs), 181 sites in the Gulf St Vincent Bioregion (7 sites inside SZs), 3 sites in the Coorong Bioregion (0 sites inside SZs)and 15 sites in the Otway Bioregion (0 sites inside SZs) (DEWNR unpublished data).
- Macroalgal abundance and community structure were surveyed using underwater video at up to 293 sites across South Australia between 2010 and 2014, with 19 sites in the Murat Bioregion (4 sites inside SZs), 73 in the Eyre Bioregion, 13 in the Spencer Gulf Bioregion (0 sites inside SZs), 60 in the North Spencer Gulf Bioregion (0 sites inside SZs) and 128 in the Gulf St Vincent Bioregion (0 sites inside SZs) (Gaylard et al. 2013, EPA unpublished data).
- Macroalgal diversity and abundance were surveyed by divers at 4 subtidal reef locations during February 1971 at depths up to 60 m and 8 locations at depths between 5 and 20 metres during June 1992. All locations were in the Murat Bioregion inside a SZ. A total of 86 and 76 species were recorded, respectively (Baker and Edyvane 2003, Baker et al. 2008).
- Macroalgal abundance and community structure were surveyed by divers at 10 subtidal reef sites in the Murat Bioregion (all are located inside a SZ) at a depth of 5 metres during February 2002 (Turner and Cheshire 2003).
- Fish diversity and abundance were surveyed by divers at 17 subtidal reef locations in the Murat Bioregion (16 inside a SZ) at depths between 5 and 20 metres during February 2002. A total of 57 species were recorded (Shepherd and Brook 2003).
- Fish, invertebrate and macroalgal diversity and abundance were surveyed by divers at 16 subtidal reef sites in the Eyre Bioregion (8 inside the Point Labatt Aquatic Reserve and SZ) during November 2004 and March 2005 at depths up to 20 metres. About 17 fish species, 29 invertebrate species and 73 macroalgal species were recorded during this survey (Currie and Sorokin 2009).

- Fish and invertebrate diversity and abundance were surveyed and photos of the benthic habitat were taken by divers at 93 sites around South Australia between 2008 and 2015, with 10 sites in the Murat Bioregion (all 10 are located within a SZ), 26 sites in the Eyre Bioregion (6 sites inside SZs), 2 sites in the Spencer Gulf Bioregion (0 sites inside SZs), 53 sites in the Gulf St Vincent Bioregion (21 sites inside SZs), 1 site in the Coorong Bioregion (which is inside a SZ) and 1 site in the Otway Bioregion (which is not inside an SZ) (Reef Life Survey 2016).
- Fish and invertebrate diversity and abundance were surveyed and photos of the benthic habitat were taken by divers at 10 sites in the Eyre Bioregion at depths between 2 and 8 metres during 2009 (Friends of Sceale Bay 2010).
- Abundance of the sea star "little patti" (*Parvulastra parvivipara)* was recorded at 7 intertidal sites (4 in the Murat Bioregion and 3 in the Eyre Bioregion) during 2005 and 2006 (Roediger and Bolton 2008).
- Macroalgae and benthic invertebrate diversity and abundance were surveyed by divers and underwater video near Point Lowly in the North Spencer Gulf Bioregion at depths of about 6 metres during autumn and spring 2006 (BHP Billiton 2009).
- Percentage cover of macroalgae and diversity and abundance of fish and invertebrates was surveyed using divers and towed video camera at one location in the North Spencer Gulf Bioregion during February 2009 (Theil and Tanner 2009).
- Giant Australian cuttlefish abundance and biomass were surveyed by divers and underwater video at 13 subtidal reef locations in the North Spencer Gulf Bioregion at depths up to 6 metres from 1998 to 2001 (Hall and Fowler 2003), during 2005 (Steer and Hall 2005) and from 2008 to 2011 (Hall 2008, 2010, 2012). Eleven of these locations were surveyed from May to July between 2012 and 2015, with about 131,000 individuals recorded in 2015 (Steer et al. 2013, Steer 2015, Steer et al. 2016a).
- Fish, invertebrate and macroalgal diversity and abundance were surveyed by divers at a depth of about 5 metres during autumn 2005 at 7 sites in the Spencer Gulf Bioregion, with 3 of the sites inside SZs (Turner et al. 2007, Figure 9).
- Macroalgae, invertebrate and fish diversity and abundance were surveyed by divers at 46 subtidal reef sites in the GSV Bioregion (13 sites inside SZs) and 1 site in the Coorong Bioregion (which is inside an SZ) at depths of 5 metres between January and May 2005 and/or in March to June 2007 (Turner et al. 2007, Collings et al. 2008).
- Fish, invertebrate and macroalgae diversity and abundance were surveyed by divers at 6 sites in the Eyre Bioregion (2 inside SZs) at depths of 5 metres during May 2006 (Robinson et al. 2008, SARDI unpublished data, Figure 7).
- Fish diversity and abundance were surveyed by divers at 8 sites in the Gulf St Vincent Bioregion at various depths up to 20 metres during 2002 or 2004 (Shepherd and Brook 2007).
- Fish diversity and abundance were surveyed by divers at 12 sites in the Gulf St Vincent Bioregion (1 site is inside an SZ) and 1 site in the Eyre Bioregion at depths around 10 metres between 2002 and 2008 (Shepherd et al. 2009).
- Macroalgae, invertebrate and fish diversity and abundance were surveyed by divers at 7 subtidal reef sites in Gulf St Vincent Bioregion and 1 in the Coorong Bioregion (which is inside an SZ) at depths between 4 and 6 metres during autumn and spring 2012/13 (Brook and Bryars 2014).
- Fish diversity and abundance were surveyed by divers and underwater video at 5 sites in the GSV Bioregion (1 site inside an SZ) and 3 sites in the Eyre Bioregion at depths between 3 and 8 metres during summer and winter 2005/06, with 41 fish species recorded (Brock and Kinloch 2007).
- Fish and invertebrate diversity and abundance were surveyed using baited traps at 2 sites in the Eyre Bioregion and 2 sites in the Gulf St Vincent Bioregion at depths between 10 and 20 metres during November

2008. A total of 129 fish and motile invertebrates were recorded from a total of 23 species across all sites surveyed (Rowling et al. 2009a).

- Fish and invertebrate diversity and abundance were surveyed using baited fish traps at 1 site in the Coorong Bioregion and 9 sites in the Otway Bioregion during April and June 2009. A total of 22 fish and motile invertebrates were recorded from a total of 8 species (Rowling et al. 2009b).
- Fish and invertebrate diversity and abundance were surveyed using baited remote underwater video systems at 2 subtidal reef sites in the Eyre Bioregion and 2 subtidal reef sites in the Gulf St Vincent Bioregion at a depth of 10 and 20 metres during November 2008. A total of 89 species were recorded across all sites surveyed (Rowling et al. 2009a).
- Fish and invertebrate diversity and abundance were surveyed using baited remote underwater video systems at 1 subtidal reef site in the Coorong Bioregion and 8 subtidal reef sites in the Otway Bioregion at a depth of 10 and 20 metres during April and June 2009. A total of 32 species were recorded across all sites surveyed (Rowling et al. 2009b).
- Sedentary invertebrate diversity and biomass were surveyed using a benthic sled tow at 1 subtidal reef location in the Eyre Bioregion and 1 in the Gulf St Vincent Bioregion at a depth of 20 metres during November 2008. A total of 125 species were recorded across all sites surveyed (Rowling et al. 2009a).
- Algae and sedentary invertebrate diversity and biomass were surveyed using a benthic sled tow at 1 subtidal reef location in the Coorong Bioregion and 9 in the Otway Bioregion at a depth of 20 metres during April and June 2009. A total of 170 species were recorded across all sites surveyed (Rowling et al. 2009b).
- Size and abundance of Western Blue Groper were surveyed at 6 subtidal reef sites in the Eyre Bioregion, 15 sites in the Gulf St Vincent Bioregion (2 sites are inside SZs) and 2 sites in the Otway Bioregion (Bryars and Brook 2013).
- Algae and invertebrate diversity and cover were surveyed at 15 intertidal reef locations in the Gulf St Vincent Bioregion (3 sites are inside SZs), 2 locations in the Eyre Bioregion and 1 location in the Coorong Bioregion between November 2006 and February 2007 (Dutton 2008).
- Algae and invertebrate diversity and cover were surveyed at 12 intertidal reef locations along the Gulf St Vincent Bioregion coast during 2006/07. A total of 37 invertebrate species were recorded (Dutton and Benkendorff 2008).
- Substrate type and algae and invertebrate diversity and cover were surveyed at 17 intertidal reef locations in the Gulf St Vincent Bioregion (5 sites are inside SZs) between November 2006 and March 2007. A total of 112 species of molluscs, 29 echinoderms and 49 marine plants across all sites were recorded (Benkendorff and Thomas 2007).
- Algae and invertebrate diversity and abundance were surveyed at 11 intertidal reef locations in the Gulf St Vincent Bioregion (1 site is inside an SZ) between May 2009 and January 2010 (Baring et al. 2010).
- Mollusc and echinoderm diversity and abundance were surveyed at 10 intertidal reef sites in the Gulf St Vincent Bioregion during February 2004. A total of 82 and 8 species were recorded, respectively (Benkendorff 2005).
- Algae and invertebrate diversity and abundance were surveyed at 3 intertidal reef locations in the Gulf St Vincent Bioregion and 2 in the Eyre Bioregion in October 2006 (Benkendorff et al. 2007).
- Substrate type and algae and invertebrate diversity and cover were surveyed at 7 intertidal reef locations in the Gulf St Vincent Bioregion in May and October 2009 (Benkendorff et al. 2009).
- Macroalgae, invertebrate and fish diversity and abundance were surveyed by divers at 10 subtidal reef sites along the Gulf St Vincent Bioregion coast (2 sites are inside SZs), seasonally in 2009 and biannually between 2010 and 2012 (Russell and Connell 2011; Cheshire 2014).

- Giant kelp (*Macrocystis pyrifera*) distribution was inferred from the composition of wrack deposits on beaches at 7 locations in the Coorong Bioregion and 21 locations in the Otway Bioregion (2 sites are inside SZs) between June 2005 and December 2007 (Duong 2010).
- Assessments are conducted on a regular basis for a number of commercially-fished species that use reef habitat, including the Rock Lobster, Abalone, Marine Scalefish and Charter Boat Fisheries (Linnane et al. 2014a, Stobart et al. 2012, 2013, 2014a, Mayfield et al. 2014, Mayfield et al. 2015, Fowler et al. 2013a, 2014a, Steer et al. 2007, 2016b, Tsolos 2013). These assessments include fisheries-dependent spatial and temporal information on catch, effort, catch rate and size structure (see Sections 5.8 and 8.2.1). Fishery-independent data include late-stage larval lobster (puerulus) settlement rates (Linnane et al. 2014a).

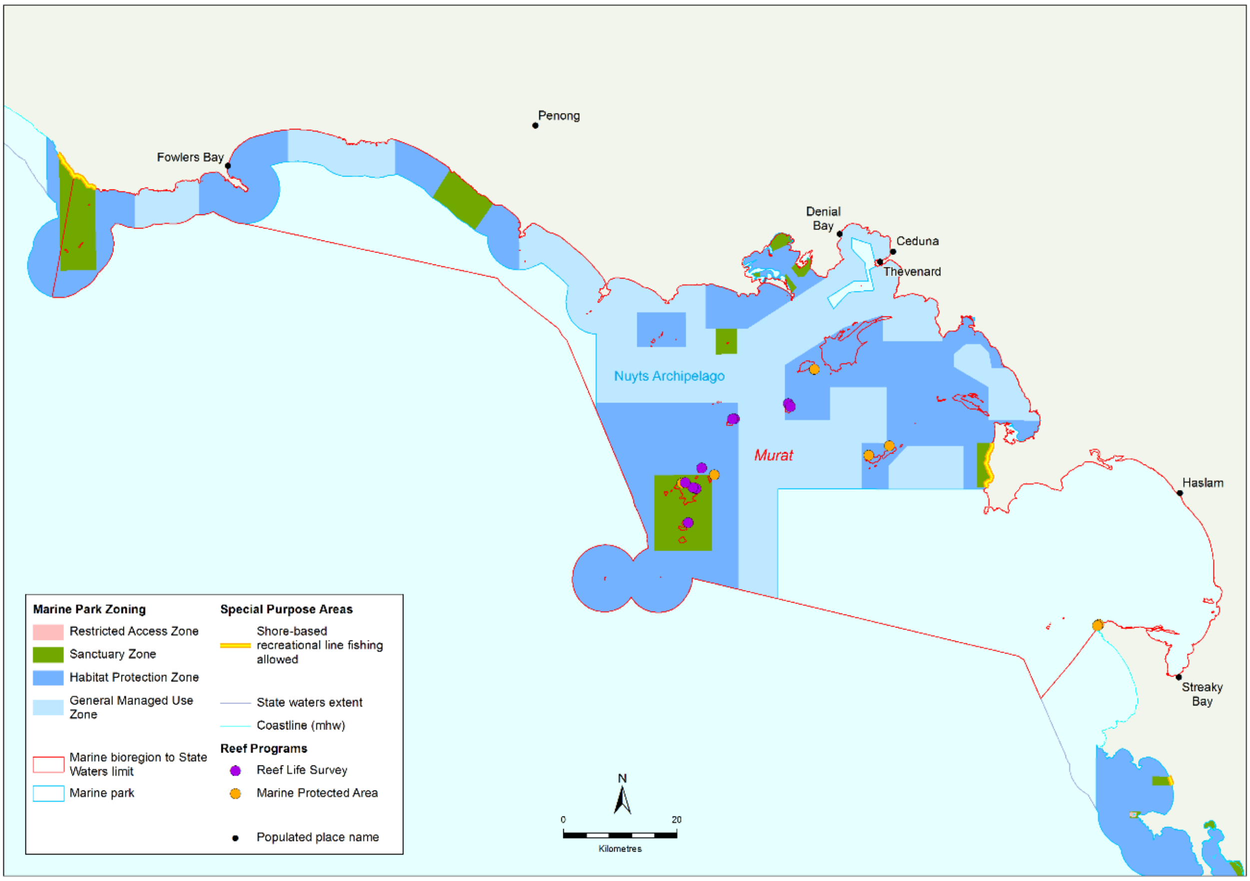


Figure 35. Map showing reef sites that have been surveyed for fishes, invertebrates and macroalgae in the Murat Bioregion.

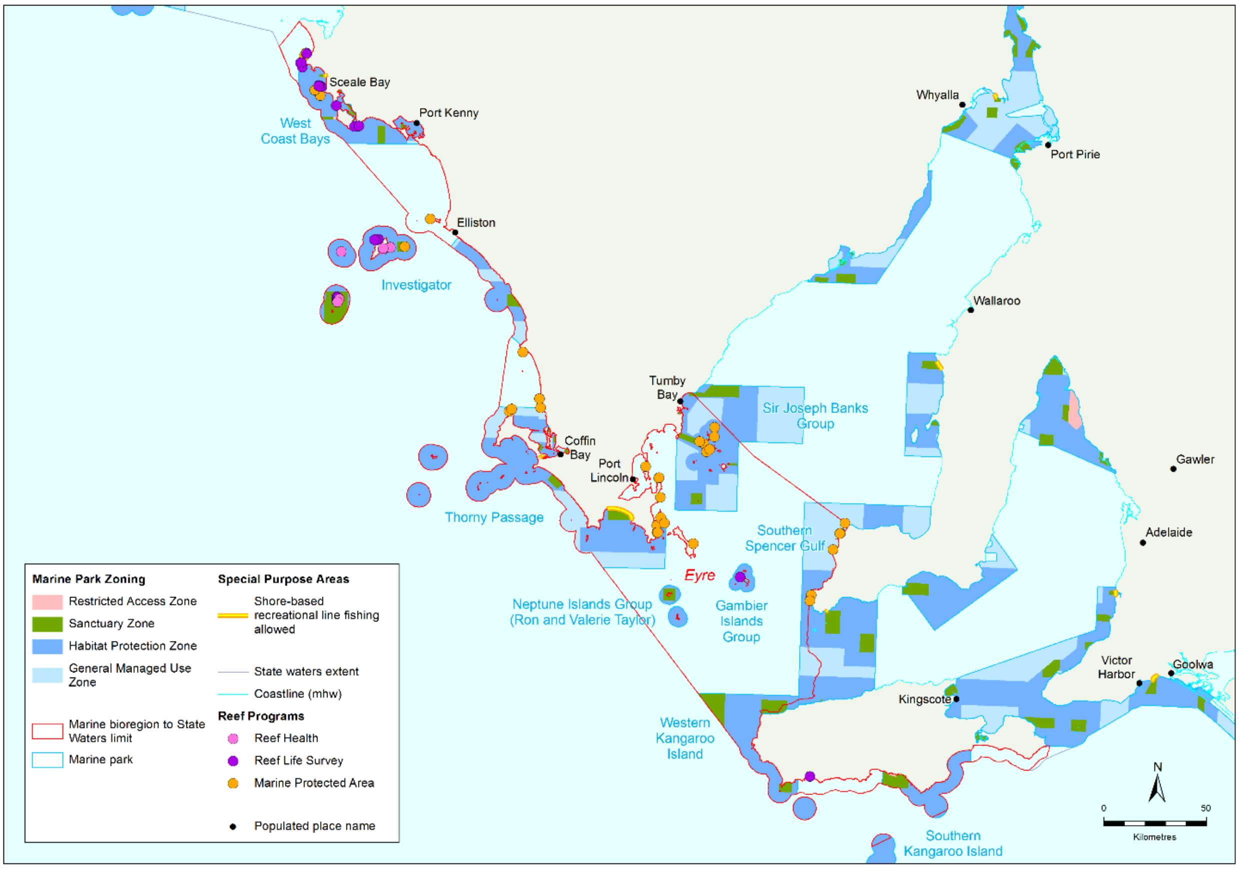


Figure 36. Map showing reef sites that have been surveyed for fishes, invertebrates and macroalgae in the Eyre Bioregion.

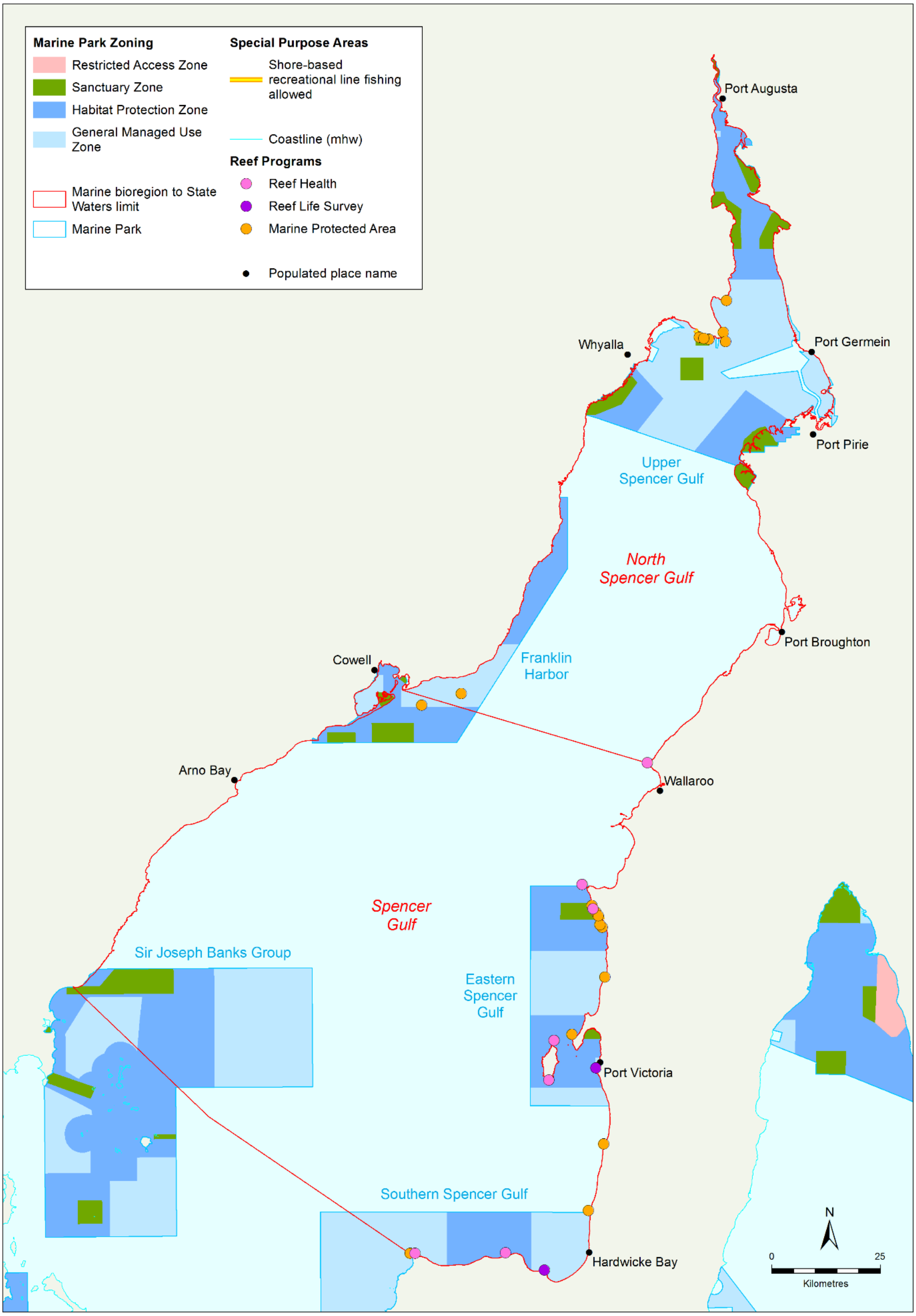


Figure 37. Map showing reef sites that have been surveyed for fishes, invertebrates and macroalgae in the Spencer Gulf and North Spencer Gulf Bioregions.

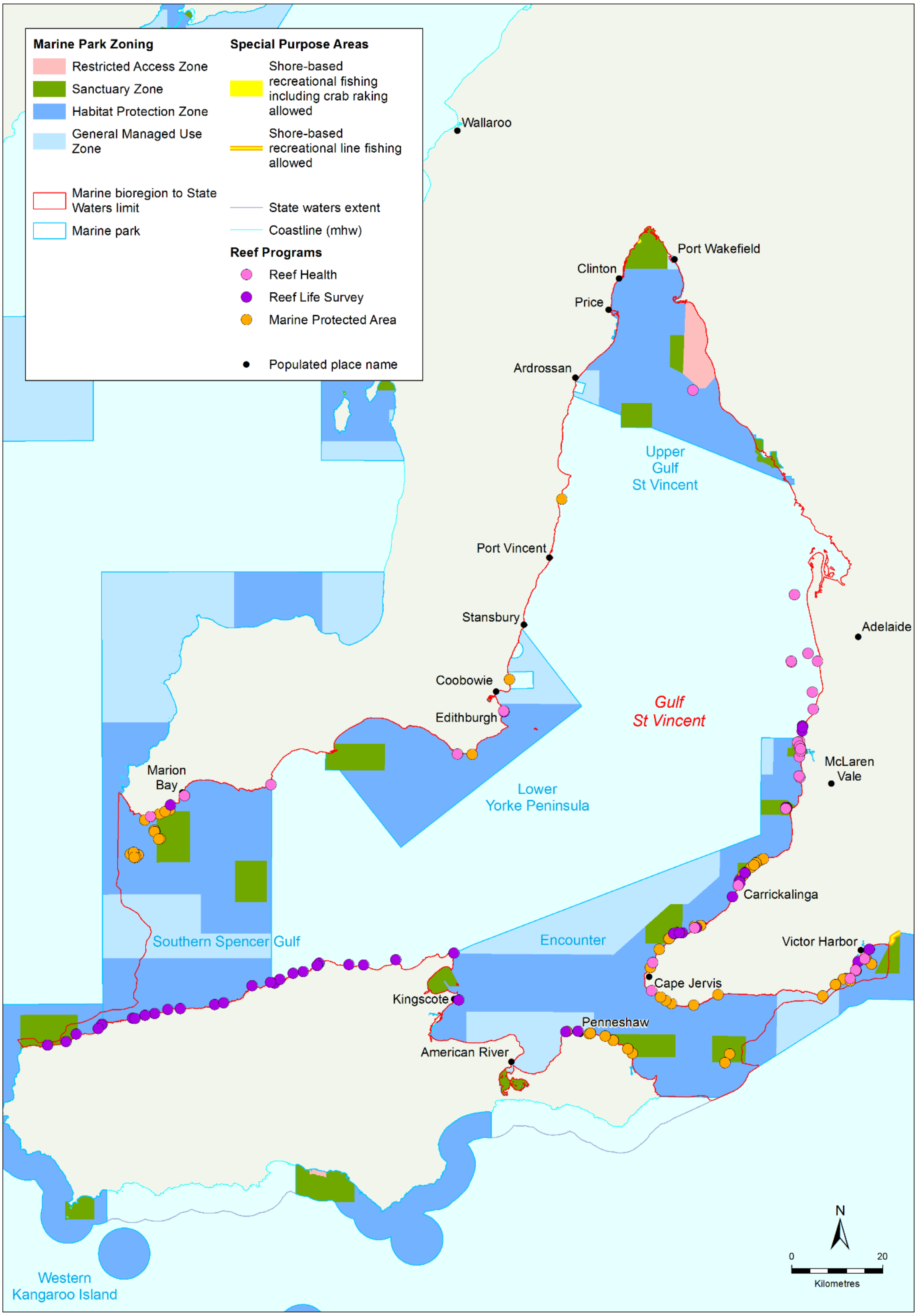


Figure 38. Map showing reef sites that have been surveyed for fishes, invertebrates and macroalgae in the Gulf St Vincent Bioregion.

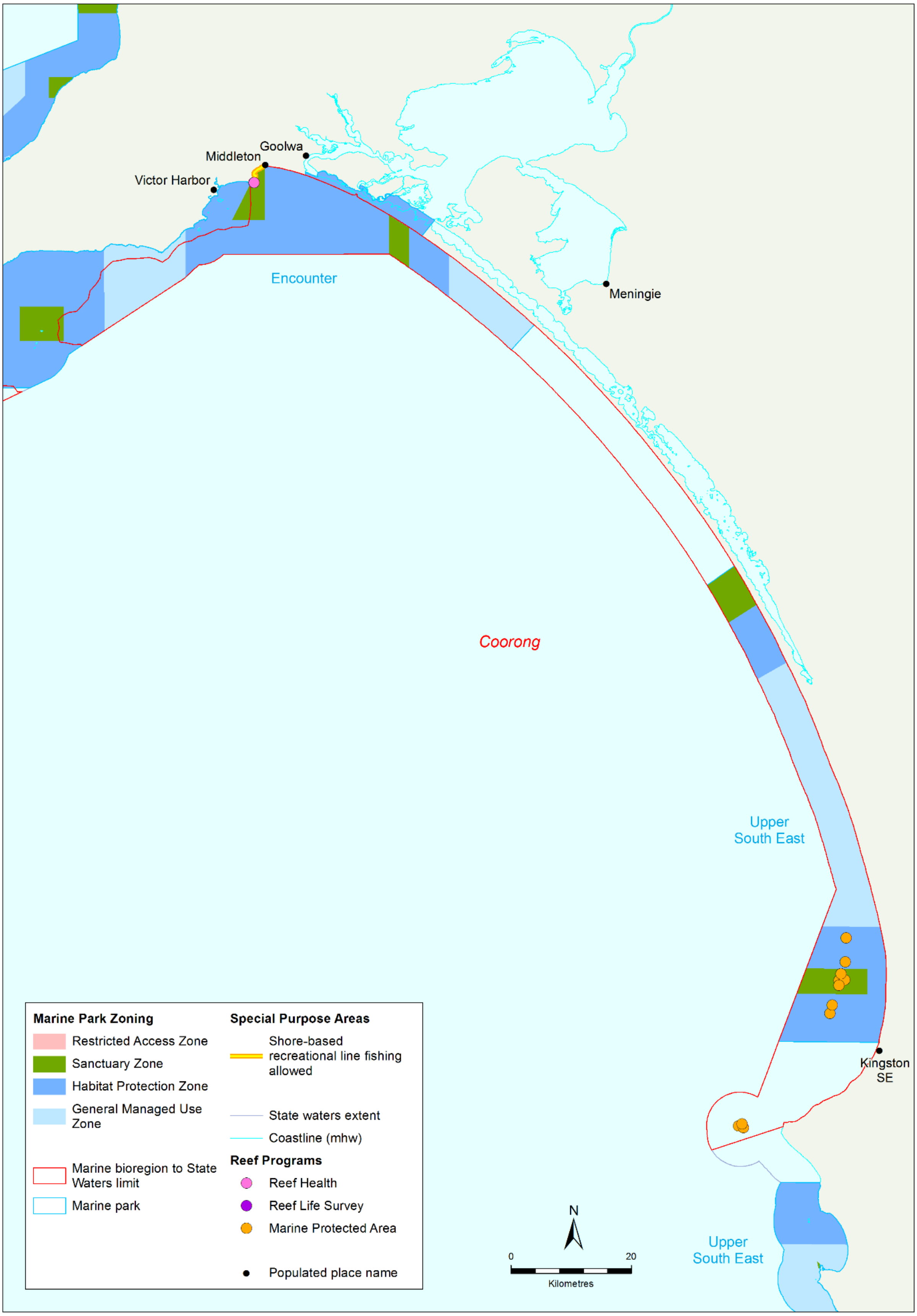


Figure 39. Map showing reef sites that have been surveyed for fishes, invertebrates and macroalgae in the Coorong Bioregion.

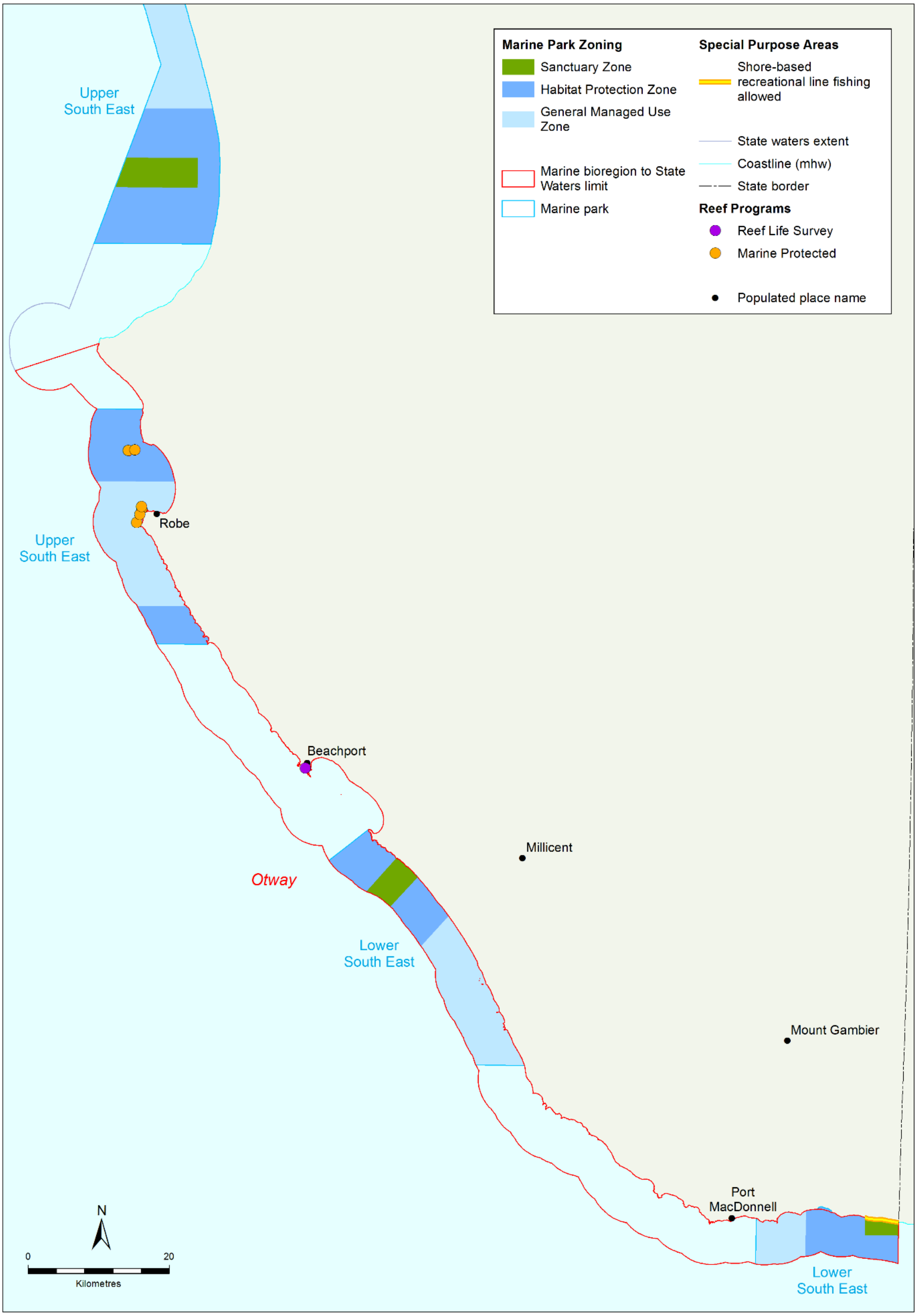
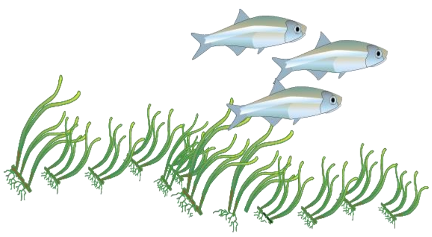


Figure 40. Map showing reef sites that have been surveyed for fishes, invertebrates and macroalgae in the Otway Bioregion.

Reef condition

- The cover of canopy-forming macroalgae is an important indicator of subtidal reef condition in South Australia (Cheshire et al. 1998, Cheshire and Westphalen 2000, Turner et al. 2007, Collings et al. 2008, Gaylard et al. 2013, Brook and Bryars 2014). The macroalgal data recorded during surveys across several years (DEWNR and University of Tasmania unpublished data) were used to infer condition of subtidal reefs in the individual parks where data existed from canopy cover calculated using the methods of Brook and Bryars (2014). See the individual marine park baseline reports for more information (Bryars et al. 2016a-s)
- The cover of canopy algae, turf and bare substrate was used as an indicator of reef condition from surveys between 2010 and 2014 (Gaylard et al. 2013, EPA unpublished data, see above).

4.2 Seagrass



Seagrasses in South Australia occur in shallow sheltered bays from Port MacDonnell near the Victorian border to Fowlers Bay in the west, with the most extensive seagrass meadows being located in the upper reaches of the two gulfs.

There are no seagrass beds currently mapped in the Eucla Bioregion.

In the Murat Bioregion the largest areas of seagrass occur in Fowlers, Tourville and Smoky Bays, offshore from Denial Bay, and near offshore islands.

The large number of sheltered sandy embayments in the Eyre Bioregion, including Baird, Venus, Waterloo, Coffin, Proper, Boston, Louth, and Peak Bays off Eyre Peninsula, and D'Estrees Bay at Kangaroo Island, boast extensive areas of seagrass meadows. The lee side of some islands in the bioregion, such as the Sir Joseph Banks and Investigator Groups, provide sheltered conditions and support dense seagrasses.

Seagrasses are not widespread in the Spencer Gulf Bioregion, they occur in the more sheltered areas, such as, Franklin Harbour in the west; Hardwicke Bay in the east; also Port Victoria and areas around the Wardang Island group, and other areas along the mid-east coast (including Balgowan). Highly productive seagrass meadows are also a feature of the Tiparra reef area. There are small stands of seagrass in the south-east of Spencer Gulf, such as off Port Minlacowie and the southern part of Hardwicke Bay.

The North Spencer Gulf Bioregion supports seagrass meadows mostly in the central and northern reaches, and form the largest seagrass meadows recorded in South Australia. The largest areas of seagrass occur near Yatala Harbour Aquatic Reserve, from Point Davis to Port Pirie and from Cowleds Landing to Point Lowly.

Seagrass meadows dominate the shallow, low energy environment at the top of Gulf St Vincent in the Gulf St Vincent Bioregion. The low wave energy environment of western Gulf St Vincent contains large seagrass meadows between Ardrossan and Troubridge Island. The northern coast of Kangaroo Island is dominated by seagrass filled embayments punctuated by rocky headlands.

In the Coorong Bioregion a dense and extensive seagrass meadow is located in the sheltered waters of Lacepede Bay.

In the Otway Bioregion the most easterly seagrass bed is found at Port MacDonnell close to the Victorian border, with other small patches near Beachport and Boatswains Point.

Park-specific baseline information on seagrass is presented in the individual baseline reports (Bryars et al. 2016a-s). Baseline information on seagrass relevant to South Australia includes:

Spatial extent of seagrass habitat

- A total of 10,162 square kilometres of seagrass has been mapped in South Australia's coastal waters (Figure 20 to Figure 26). About 1,198 square kilometres of seagrass has been mapped in the Murat Bioregion, 891 square kilometres of seagrass in the Eyre Bioregion, 1,583 square kilometres of seagrass in the Spencer Gulf Bioregion, 3,254 square kilometres of seagrass in the North Spencer Gulf Bioregion, 2,970 square kilometres of seagrass in the Gulf St Vincent Bioregion, 266 square kilometres of seagrass in the Coorong Bioregion and 1.3 square kilometres of seagrass in the Otway Bioregion (see Appendix B).

Size, abundance and diversity of seagrass communities

- Seagrass diversity and biomass were surveyed by divers at 8 locations in the Murat Bioregion, all locations were inside SZs, at depths between 5 and 20 metres during June 1992. Biomass was recorded for 5 species (Baker and Edyvane 2003, Baker et al. 2008).
- Seagrass distribution and density were surveyed using underwater video at up to 293 sites across South Australia between 2010 and 2014, with 19 in the Murat Bioregion (4 sites inside SZs), 73 in the Eyre Bioregion (4 sites inside SZs), 13 in the Spencer Gulf Bioregion, 60 in the North Spencer Gulf Bioregion (3 sites inside SZs) and 128 in the Gulf St Vincent Bioregion (3 sites inside SZs), (Gaylard et al. 2013, EPA unpublished data).
- Fish diversity and abundance were surveyed using baited remote underwater video systems at 459 sites within the vicinity of seagrass at various locations across South Australia between 2010 and 2015 These sites vary in number between Bioregions; there were 52 sites within the Murat Bioregion, 40 sites in the Eyre Bioregion (5 sites inside SZs), 3 sites in the Spencer Gulf Bioregion, 13 sites in the North Spencer Gulf Bioregion (1 site inside SZs), 330 sites in the Gulf St Vincent Bioregion (4 sites inside SZs) and 3 sites in the Coorong Bioregion (DEWNR unpublished data).
- Fish and invertebrate diversity and abundance were surveyed using baited fish traps at 2 subtidal seagrass locations in the Spencer Gulf Bioregion and 3 in the Gulf St Vincent Bioregion at a depth of 10 metres during November 2008. A total of 129 fish and motile invertebrates were recorded from a total of 23 species across all sites surveyed (Rowling et al. 2009a).
- Fish and invertebrate diversity and abundance were surveyed using baited traps at 1 subtidal seagrass location in the Coorong Bioregion at a depth of 10 metres during April and June 2009. A total of 3 species were recorded (Rowling et al. 2009b).
- Fish and invertebrate diversity and abundance were surveyed using baited remote underwater video systems at 2 subtidal seagrass locations in the Spencer Gulf Bioregion and 3 in the Gulf St Vincent Bioregion at a depth of 10 metres during November 2008. A total of 89 species were recorded across all sites surveyed (Rowling et al. 2009a).
- Fish and invertebrate diversity and abundance were surveyed using baited remote underwater video systems at 1 subtidal seagrass location in the Coorong Bioregion at a depth of 10 metres during April and June 2009 (Rowling et al. 2009). A total of 5 species were recorded (Rowling et al. 2009b).
- Fish and invertebrate diversity and abundance were surveyed using beam trawls at 2 subtidal seagrass locations in the Spencer Gulf Bioregion and 3 in the Gulf St Vincent Bioregion at a depth of 10 metres during November 2008. A total of 114 species were recorded across all sites surveyed (Rowling et al. 2009a).
- Fish and invertebrate diversity and abundance were surveyed using beam trawls at 1 subtidal seagrass location in the Coorong Bioregion at a depth of 10 metres during April and June 2009. A total of 51 species were recorded (Rowling et al. 2009b).

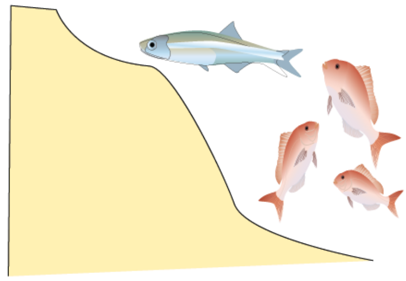
- Seagrass, algae and sedentary invertebrate diversity and biomass were surveyed using a benthic sled tow at 2 subtidal seagrass sites in the Spencer Gulf Bioregion and 3 in the Gulf St Vincent Bioregion in November 2008. A total of 22 species were recorded across all sites surveyed (Rowling et al. 2009a).
- Seagrass, algae and sedentary invertebrate diversity and biomass were surveyed using a benthic sled tow at 1 subtidal seagrass site in the Coorong Bioregion during April and June 2009. A total of 2 seagrass, 14 algae and 10 invertebrate species were recorded (Rowling et al. 2009b).
- Fish and invertebrate diversity and abundance were surveyed using beam trawls at 9 subtidal seagrass locations in the Gulf St Vincent Bioregion (including 2 inside SZs) at depths up to 7 metres during summer and winter 2005/2006. A total of 157 species were recorded (Kinloch et al. 2007).
- Seagrass diversity and cover were surveyed using underwater video at 7 subtidal seagrass locations, 6 sites in the Gulf St Vincent Bioregion (1 site inside a SZ) and 1 site in the Eyre Bioregion at depths up to 15 metres during December 2005 (Southgate 2005).
- Seagrass distribution, diversity and cover were surveyed by divers at 6 subtidal seagrass sites in the Gulf St Vincent Bioregion (including 1 inside an SZ) at depths between 5 and 8 metres during October 1999 (Bryars et al. 2003).
- Fish diversity and abundance were surveyed using seine nets in 9 estuaries in the Gulf St Vincent Bioregion (including 1 inside an SZ) between April 2006 and February 2007. A total of 44 species were recorded (Gillanders et al. 2008).
- Larval fish distribution, diversity and abundance were surveyed using towed twin ring nets at 3 subtidal seagrass sites in the Gulf St Vincent Bioregion, all of which were inside SZs at a depth of 15 metres during autumn and winter 2014 (Jones 2014).
- Seagrass distribution and diversity were surveyed by divers at 3 locations in the Eyre Bioregion (1 inside an SZ) at depths of 7 metres during May 2006. Nine species of seagrass were recorded (Bryars and Wear 2008).
- Seagrass diversity and biomass were surveyed by divers at 6 locations in the Eyre Bioregion (3 inside SZs) at depths between 5 and 20 metres during February 1993 (Baker and Edyvane 2003, Baker et al. 2008).
- Seagrass density and benthic invertebrate diversity and abundance were surveyed by divers in the North Spencer Gulf Bioregion at depths between 3 and 6 metres during autumn and spring 2006 (BHP Billiton 2009).
- Pearl oyster distribution and abundance were surveyed using underwater video in the North Spencer Gulf Bioregion during March and June 2011 (Rutherford and Miller 2011).
- Rare and endemic invertebrate distribution and abundance were surveyed from seagrass samples collected from 4 locations in the Spencer Gulf Bioregion, 1 location in the Eyre Bioregion and 14 locations in the Gulf St Vincent Bioregion at depths up to 5 metres during 2013 to 2015 (Baker et al. 2015).
- Biomass, canopy structure and epiphyte load of *Amphibolis antarctica* was inferred from samples collected at 6 locations in the Gulf St Vincent Bioregion at depths between 2 to 4 metres during February and June 2007 (Bryars 2008).
- Recruitment patterns and reproductive output of *Amphibolis antarctica* were tested at 4 locations in the Gulf St Vincent Bioregion between March and May 2009 (Irving 2009).
- Seagrass distribution and density were surveyed using underwater video at 3 locations across the Gulf St Vincent Bioregion (1 location was inside an SZ) during April 2011 (Tanner et al. 2012).
- Seagrass diversity and cover were surveyed by divers at 5 sites in the Coorong Bioregion during November 2002 (Bryars 2003).
- Leaf density, leaf area, leaf length and width and epiphyte load were inferred from samples collected at 6 locations in the Coorong Bioregion and 1 location in the Otway Bioregion (Wear et al 2006).

- Assessments are conducted on a regular basis for a number of commercially-fished species that use seagrass habitat including the Marine Scalefish and Charter Boat Fisheries (Fowler et al. 2014a, Steer et al. 2007, 2012, Tsolos 2013). These assessments include fishery-dependent spatial and temporal information on catch, effort, catch rate and size structure (see Sections 5.8 and 8.2.1).

Seagrass condition

- Seagrass condition was inferred from seagrass density and epiphyte loads surveyed between 2010 and 2014 (Gaylard et al. 2013, Nelson et al. 2013, EPA unpublished data). Seagrass was classified as being in very good or excellent condition in the Murat Bioregion with dense and continuous meadows and generally (except in Smoky Bay) few epiphytes suggesting a very low nutrient environment. The condition of seagrass within surveyed areas of the Eyre Bioregion was classified as 'good' with largely intact seagrass meadows. Seagrass condition in areas of the Spencer Gulf Bioregion was classified as 'good', with generally dense and continuous meadows, but with epiphyte loads suggesting that some areas were under stress due to nutrient enrichment. Seagrass within the North Spencer Gulf Bioregion was found to be in fair and good condition to the north and south of Point Lowly, respectively. In both areas there were sites with dense and largely intact seagrass and others with generally degraded seagrass. Almost all sites were under stress from epiphyte growth (Gaylard et al. 2013, Environment Protection Authority 2016). The condition of seagrass in some areas of the Gulf St Vincent Bioregion was assessed as 'very good', with the seagrass being largely dense and intact but initial symptoms of nutrient enrichment with moderate epiphyte loads. Whereas other areas of the Gulf St Vincent Bioregion were assessed as patchy, sparse, degraded or under stress with high epiphyte loads (Nelson et al. 2013).
- Seagrass condition was inferred from seagrass density, area, length and epiphyte loads sampled on surveys at two sites adjacent to drains in Lacepede Bay in the Coorong Bioregion during 2004/05 (Wear et al. 2006). Seagrasses at both sites were concluded to be in poor condition with reduced seagrass leaf densities and leaves of reduced stature.
- Seagrass condition was inferred from seagrass density, percentage cover and species composition observed on surveys on the Fleurieu Peninsula during March 2009 and September 2011 (Tanner et al. 2012).
- The condition of seagrass was inferred as 'good' in Antechamber Bay, and 'poor' in the Bay of Shoals, American River, Pelican Lagoon, Island Beach and offshore between Kingscote and Penneshaw from seagrass cover (mainly *Posidonia* spp and *Amphibolis* spp) and epiphyte load observed on surveys during December 2005 (Southgate 2005).
- Seagrass condition in Western Cove was inferred from seagrass cover, standing crop, leaf density and epiphyte load from samples collected on surveys during December 2000 (Bryars et al. 2003).
- *Amphibolis antarctica* condition in Yankalilla Bay was inferred from reproductive output, recruitment and growth observed on surveys between March and May 2009 (Irving 2009).
- Seagrass condition in the Investigator Islands Group was inferred to be 'healthy' from seagrass density, biomass and epiphyte load surveyed during May 2006 (Bryars and Wear 2008, see above).
- Seagrass condition in D'Estrees Bay was inferred as being 'good' from seagrass cover (mainly *Posidonia* spp and *Amphibolis* spp) and epiphyte load observed on surveys during December 2005 (Southgate 2005).

4.3 Sand



Sand habitat is prevalent across all of the 8 marine bioregions, with areas of beach, intertidal flats and subtidal sand plains.

Park-specific baseline information on sand is presented in the individual baseline reports (Bryars et al 2016a-s). Baseline information on sand relevant to South Australia includes:

Spatial extent of sand habitat

- Sandy beaches extend along about 200 kilometres of the mainland coastline (Appendix B).
- About 7,530 square kilometres of sand have been mapped in South Australia's coastal waters (Figure 20 to Figure 26). About 395 square kilometres of sand have been mapped in the Eucla Bioregion, 290 square kilometres of sand in the Murat Bioregion, 1,935 square kilometres of sand in the Eyre Bioregion, 1,540 square kilometres of sand in the Spencer Gulf Bioregion, 1,570 square kilometres of sand in the North Spencer Gulf Bioregion, 1,003 square kilometres of sand in the Gulf St Vincent Bioregion, 668 square kilometres of sand in the Coorong Bioregion and 128 square kilometres of sand in the Otway Bioregion.

Size, abundance and diversity of sand communities

- Fish diversity and abundance were surveyed using baited remote underwater video systems at 102 sites within the vicinity of sand at various locations across South Australia. These sites vary in number between bioregions, with 24 sites in the Eyre Bioregion (3 sites inside SZs), 6 sites in the Spencer Gulf Bioregion and 45 sites in the Gulf St Vincent Bioregion (1 site inside an SZ) (DEWNR unpublished data).
- Sediment types and benthic invertebrate diversity and abundance were surveyed using sediment core samples from 3 sites in the Spencer Gulf Bioregion, 4 sites in the Eyre Bioregion and 7 sites in the Gulf St Vincent Bioregion at depths between 10 and 20 metres during November 2008. A total of 169 species were recorded (Rowling et al. 2009a).
- Sediment types and benthic invertebrate diversity and abundance were surveyed using sediment core samples from 4 locations within the Coorong Bioregion and 3 locations within the Otway Bioregion at depths between 10 and 20 metres during April and June 2009. A total of 53 species were recorded (Rowling et al. 2009b).
- Fish and invertebrate diversity and abundance were surveyed using baited fish traps at 4 sites in the Spencer Gulf Bioregion, 4 sites in the Eyre Bioregion and 7 sites within the Gulf St Vincent Bioregion at depths between 10 and 30 metres during November 2008. A total of 23 species were recorded across all sites surveyed (Rowling et al. 2009a).
- Fish and invertebrate diversity and abundance were surveyed using beam trawls at 3 sites in the Spencer Gulf Bioregion, 3 sites in the Eyre Bioregion and 7 sites in the Gulf St Vincent Bioregion at depths between 10 and 30 metres during November 2008. A total of 114 species were recorded across all sites surveyed (Rowling et al. 2009b).
- Sedentary invertebrate diversity and biomass were surveyed using benthic sled tows at 4 sites in the Spencer Gulf Bioregion, 4 sites in the Eyre Bioregion and 7 sites in the Gulf St Vincent Bioregion at depths between 10 and 30 metres during November 2008, with a total of 125 species recorded across all sites surveyed (Rowling et al. 2009a).
- Fish and invertebrate diversity and abundance were surveyed using baited remote underwater video systems at 4 sites in the Spencer Gulf Bioregion, 4 sites in the Eyre Bioregion and 7 sites in the Gulf St Vincent Bioregion at depths between 10 and 30 metres during November 2008. A total of 89 species were recorded across all sites surveyed (Rowling et al. 2009b).

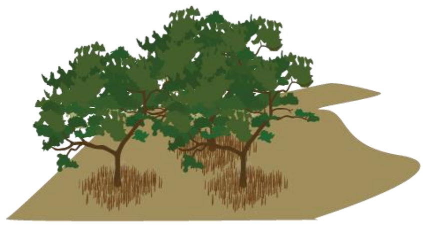
- Sediment types and benthic invertebrate diversity and abundance were surveyed using sediment core samples from 3 sites within the Coorong Bioregion during November 2009. A total of 27 species were recorded (Rowling et al. 2010).
- Fish and invertebrate diversity and abundance were surveyed using beam trawls at 3 sites within the Coorong Bioregion during November 2009. A total of 21 species were recorded across all sites surveyed (Rowling et al. 2010).
- Fish, invertebrate and macroalgae distribution, diversity and abundance were surveyed using bycatch from prawn trawling at 50 sites in the North Spencer Gulf Bioregion (1 site inside an SZ), 61 sites in the Spencer Gulf Bioregion (3 sites inside SZs) and 8 sites in the Eyre Bioregion at depths up to 30 metres during February 2007 (Currie et al. 2009). A total of 395 species were identified from 12 phyla.
- Benthic invertebrate diversity and abundance were surveyed at 9 intertidal mudflat locations in the Gulf St Vincent Bioregion (1 inside an SZ) during January 2007. A total of 40 species were recorded (Dittman 2008).
- Benthic macroinvertebrate diversity and abundance were surveyed at 4 intertidal mudflat sites in the Gulf St Vincent Bioregion during November 2011 and March 2012. A total of 90 species were recorded (Dittman et al. 2012)
- Benthic macroinvertebrate diversity and abundance were surveyed at 4 intertidal mudflat sites at Middle Beach in the Gulf St Vincent Bioregion during December 2002 (Coleman and Cook 2003).
- Larval fish distribution, diversity and abundance were surveyed using towed Twin Ring nets at 2 subtidal sand sites in the Gulf St Vincent Bioregion (1 inside a SZ) at depths between 10 and 15 metres during autumn and winter 2014 (Jones 2014).
- Sponge distribution, diversity and abundance were surveyed using bycatch from prawn trawling at 50 sites in the North Spencer Gulf Bioregion (1 site inside a SZ), 61 sites in the Spencer Gulf Bioregion (3 sites inside SZs) and 8 sites in the Eyre Bioregion at depths between 12 and 55 metres during February 2007 (Sorokin and Currie 2009).
- Sediment type and benthic invertebrate diversity and abundance were surveyed by divers near Point Lowly in the North Spencer Gulf Bioregion at depths between 6 and 29 metres during spring and autumn 2006 (BHP Billiton 2009).
- Pearl oyster distribution and abundance were surveyed using underwater video in the North Spencer Gulf Bioregion during March and June 2011 (Rutherford and Miller 2011).
- Invertebrate communities were surveyed using towed video camera on sand near Stony Point in the North Spencer Gulf Bioregion (Theil and Tanner 2009).
- Assessments were made of the physical characteristics (as surrogates for biodiversity) of 39 beaches in the Gulf St Vincent Bioregion during spring 2006, and repeated at 13 of them in summer 2007, in conjunction with samples of macrofauna (Morcom 2007).
- Macrofauna diversity and abundance, wrack cover and pipi density along the ocean beach of Younghusband Peninsula in the Coorong Bioregion, were surveyed at 4 sites during trials of a beach monitoring protocol during spring 2007 and summer 2008 (DEH 2009b).
- The size and abundance of greenback flounder, black bream and hardyheads were monitored in the Coorong between 2008 and 2014 (Ye et al. 2015).
- Samples of fish were collected from five fish passages (fishways) through the Goolwa and Tauwitchere barrages in the Coorong Bioregion between 2006/07 and 2014/15 (Bice and Zampatti 2015).
- Assessments are conducted on a regular basis for a number of commercially-fished species that use sand habitat including the Blue Crab, Prawn, Marine Scalefish, Pipi and Charter Boat Fisheries (Noell et al. 2014a, b, Beckmann et al. 2014, Dixon et al. 2012, Fowler et al. 2013a, 2014a, Earl and Ward 2014, Ferguson 2013, Tsolos

2013). These assessments include fishery-dependent spatial and temporal information on catch, effort, catch rate and size structure (see Sections 5.8 and 8.2.1). Fishery-independent data include blue crab and prawn catch rates (Beckmann et al. 2014, Noell et al. 2014a, b, Dixon et al. 2012) and mud cockle and pipi biomass estimates (Dent et al. 2014, Ferguson 2013).

Sand habitat condition

- Intertidal mudflat condition was inferred from benthic invertebrate diversity, abundance and community structure surveyed using sediment core samples at 4 locations in the Gulf St Vincent Bioregion during November 2011 and March 2012 (Dittman et al. 2012).

4.4 Mangrove



Mangroves predominantly occur in the upper reaches of the two gulfs. Pockets of mangroves are also found around Eyre Peninsula. Mangroves occur in 5 of the 8 bioregions.

In the Murat Bioregion mangroves occur in Tourville, Denial and Smoky Bays, as well as on St Peter and Eyre Islands.

In the Eyre Bioregion mangroves occur on Germein Island in Venus Bay and in Second Creek near Tumby Bay.

In the Spencer Gulf Bioregion mangroves occur in Franklin Harbour.

In the North Spencer Gulf Bioregion mangroves occur in Yatala Harbour Aquatic Reserve, between Cowleds Landing and Point Lowly and from Camp Point to the top of the Gulf.

In the Gulf St Vincent Bioregion mangroves occur at Wills Creek (near Price) and Port Clinton, at Port Wakefield, in the Light River Delta and throughout St Kilda into the Port River system.

Park-specific baseline information on mangroves is presented in the individual baseline reports (Bryars et al 2016a-s). Baseline information on mangroves relevant to South Australia includes:

Spatial extent of mangrove habitat

- About 154 square kilometres of mangrove have been mapped in South Australia (Figure 20 to Figure 26). About 24 square kilometres of mangrove have been mapped in the Murat Bioregion, 1.4 square kilometres of mangrove in the Eyre Bioregion, 8.3 square kilometres of mangrove in the Spencer Gulf Bioregion, 73.5 square kilometres of mangrove in the North Spencer Gulf Bioregion and 47 square kilometres of mangrove in the Gulf St Vincent Bioregion. This mapping captures the extent of all known mangroves in South Australia.

Size, abundance and diversity of mangrove communities

- Sediment types and benthic invertebrate diversity and abundance were surveyed in mangroves in Davenport Creek, Laura Bay and Smoky Bay in the Murat Bioregion, Tumby Bay, Franklin Harbour and Germein Point in the Spencer Gulf Bioregion, Whyalla, Blanche Harbour, Port Augusta, Chinaman Creek and Yatala Harbour in the North Spencer Gulf Bioregion and Price and Port Clinton in the Gulf St Vincent Bioregion during summer 1974/75. A total of 14 invertebrate species were recorded in the Murat and Spencer Gulf Bioregions, 10 invertebrate species recorded in the North Spencer Gulf Bioregion and 9 species recorded in the Gulf St Vincent Bioregion (Butler et al. 1977a, b).

Mangrove condition

- Field surveys across the Eyre Peninsula Natural Resources Management region during 2012 assessed the mangroves as being in good condition, with a score of 71 out of 100 (where 100 represents pristine, undisturbed condition, Wiebkin 2013).

4.5 Saltmarsh

Saltmarsh predominantly occurs in the upper reaches of the two gulfs. Pockets of saltmarsh are also found around Eyre Peninsula and Yorke Peninsula. Saltmarsh occurs in 5 of the 8 bioregions.

The largest areas of saltmarsh in the Murat Bioregion occur in Tourville, Denial and Smoky Bays, as well as on St Peter and Eyre Islands.

In the Eyre Bioregion saltmarsh occurs in Venus and Baird Bays, as well as on Germein Island, Yangie and Kellidie Bays, and along the eastern side of Horse Peninsula and Second Creek near Tumby Bay.

In the Spencer Gulf Bioregion saltmarsh occurs in Franklin Harbour, Port Victoria and Wardang Island.

In the North Spencer Gulf the largest area of saltmarsh occurs near Winninowie Conservation Park, Port Davis and from Cowleds Landing to Point Lowly.

In the Gulf St Vincent Bioregion saltmarsh occurs near Point Davenport, the Light River Delta, near Port Clinton and Price and near the Onkaparinga River and in Western Cove.

Park-specific baseline information on saltmarsh is presented in the individual baseline reports (Bryars et al. 2016a-s). Baseline information on saltmarsh relevant to South Australia includes:

Spatial extent of saltmarsh habitat

- About 87 square kilometres of saltmarsh have been mapped in South Australia (Figure 20 to Figure 26). About 15 square kilometres of saltmarsh have been mapped in the Murat Bioregion, about 7 square kilometres of saltmarsh in the Eyre Bioregion, about 5 square kilometres of saltmarsh in the Spencer Gulf Bioregion, 27 square kilometres of saltmarsh in the North Spencer Gulf Bioregion, and 26 square kilometres of saltmarsh in the Gulf St Vincent Bioregion have been mapped. Current mapping captures the extent of all known saltmarsh in South Australia.

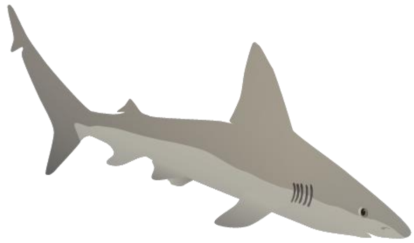
Size, abundance and diversity of saltmarsh communities

- Saltmarsh diversity and cover were quantified from field surveys at 2 sites in the Onkaparinga estuary in the Gulf St Vincent Bioregion during March and November 2008 (Cook and Coleman 2009).
- The abundance and diversity of saltmarsh communities were surveyed at Laura Bay in the Murat Bioregion in autumn 1996 (DEWNR 2015g).
- The abundance and diversity of saltmarsh communities in Franklin Harbour in the Spencer Gulf Bioregion were surveyed in 1998 (DEWNR 2015g).
- The abundance and diversity of saltmarsh communities in the upper parts of the Gulf St Vincent Bioregion were surveyed at 3 sites (2 sites overlapping SZs) in spring 2000 (DEWNR 2015f).

Saltmarsh habitat condition

There is currently no information available on the condition of saltmarsh in South Australia.

4.6 Sharks



The waters off South Australia are used by a number of shark species, including whitespotted spurdog, bronze whaler, blue shark, dusky whaler, smooth hammerhead, gummy shark, school shark and white shark (DENR 2010). Several areas around the state are relatively productive areas for gummy and whaler sharks in the South Australian Marine Scalefish Fishery (Fowler et al. 2012, 2013b, 2014b, see Section 8.2.1).

Park-specific baseline information on sharks is presented in the individual baseline reports (Bryars et al 2016a-s). Baseline information on sharks relevant to South Australia includes:

- Assessments are conducted on a regular basis for a number of species in the Marine Scalefish Fishery and the Gillnet Hook and Trap Sector of the Commonwealth Southern and Eastern Scalefish and Shark Fishery (Jones 2008, Fowler et al. 2012, 2013b, 2014b, Flood et al. 2014, Georgeson et al. 2014). These assessments include information on trends in catch, effort and catch rate (see Sections 5.8 and 8.2.1).
- Fishery independent surveys reported catch rates for school and gummy sharks, sawsharks and elephant fish (Braccini et al. 2009).

4.7 Marine mammals

The waters off South Australia are used by a number of marine mammal species, including southern right whale, Australian sea lion, long-nosed fur seal (formerly New Zealand fur seal), Australian fur seal, common dolphin and bottlenose dolphin (DENR 2010). Some of these species are resident while others are more transient, visiting to rest, breed and/or feed. Southern right whales migrate along the coastline between May and October, calving and resting in several areas including Encounter Bay and Fowlers Bay, which are considered as emerging aggregation areas (Mackay and Goldsworthy 2015).

Park-specific baseline information on marine mammals is presented in the individual baseline reports (Bryars et al. 2016a-s). Baseline information on marine mammals relevant to South Australia includes:

- The distribution and abundance of Australian sea lions have been recorded during surveys at their breeding sites (Goldsworthy and Page 2009). There are 49 Australian sea lion breeding sites in South Australia ,with an estimated annual pup production of about 3,107 (Goldsworthy and Page 2009) (Figure 41).
- There are 35 breeding sites for the long-nosed fur seal in South Australia, with an estimated pup production of 20,426 (Shaughnessy et al. 2014).
- There is a breeding site for the Australian fur seal at North Casuarina Island (Goldsworthy and Page 2009).
- There are 17 Haul-out sites for the long-nosed fur seal in South Australia (Shaughnessy et al. 2014) (Figure 42).
- The abundance of southern right whales at Fowlers Bay has been monitored between 2005 and 2013 (Charlton et al. 2014). The abundance at Fowlers Bay typically follows a cycle of triennial peaks, with an overall trend of increasing numbers between peaks (Figure 43, Charlton et al. 2014). A similar trend has been observed in the Far West Coast Marine Park, at the Head of Bight. Photo identification of individual whales indicates that there is movement of calving females and unaccompanied adults across years between Fowlers Bay and the Head of Bight (Charlton et al. 2014).
- The distribution, density, habitat use and population structure of bottlenose and common dolphins between Ceduna and Port Pirie (in Spencer Gulf) is being assessed by Flinders University (DEWNR unpublished data).

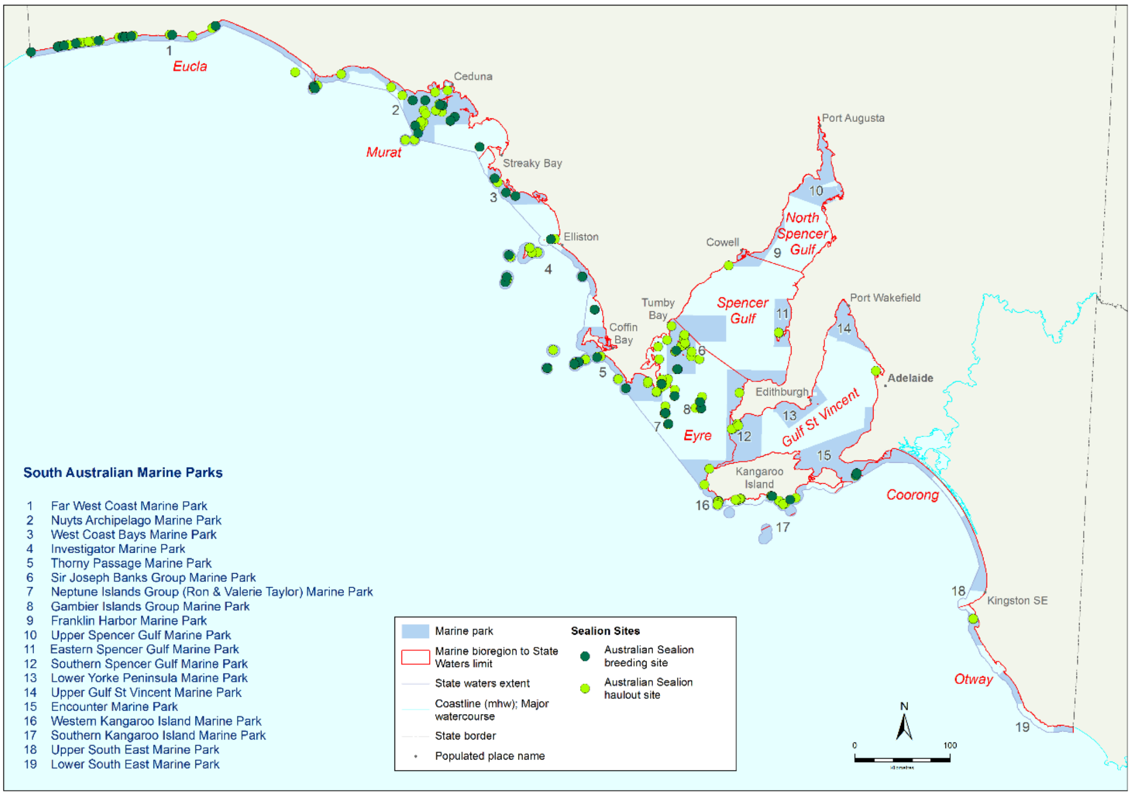


Figure 41. **Distribution of breeding and haul out sites of the Australian sea lion in South Australia.**

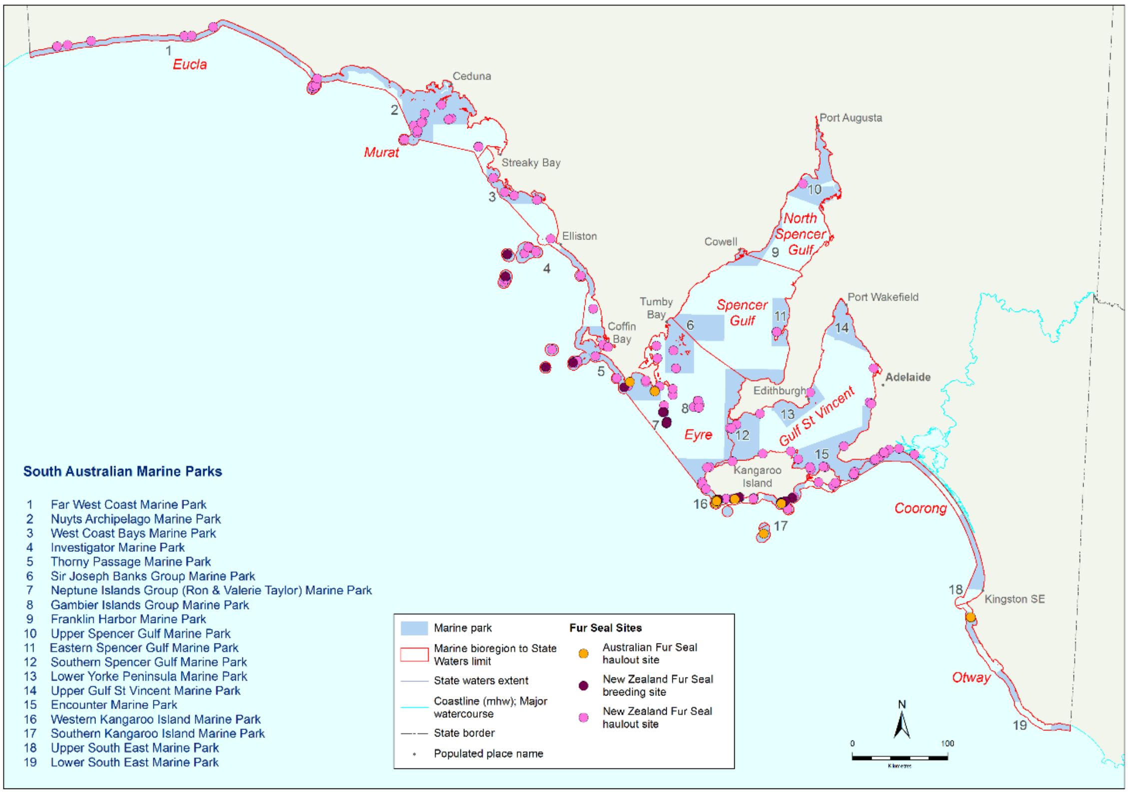


Figure 42. **Distribution of breeding and haul out sites for the Australian fur seal and the long nose fur seal in South Australia.**

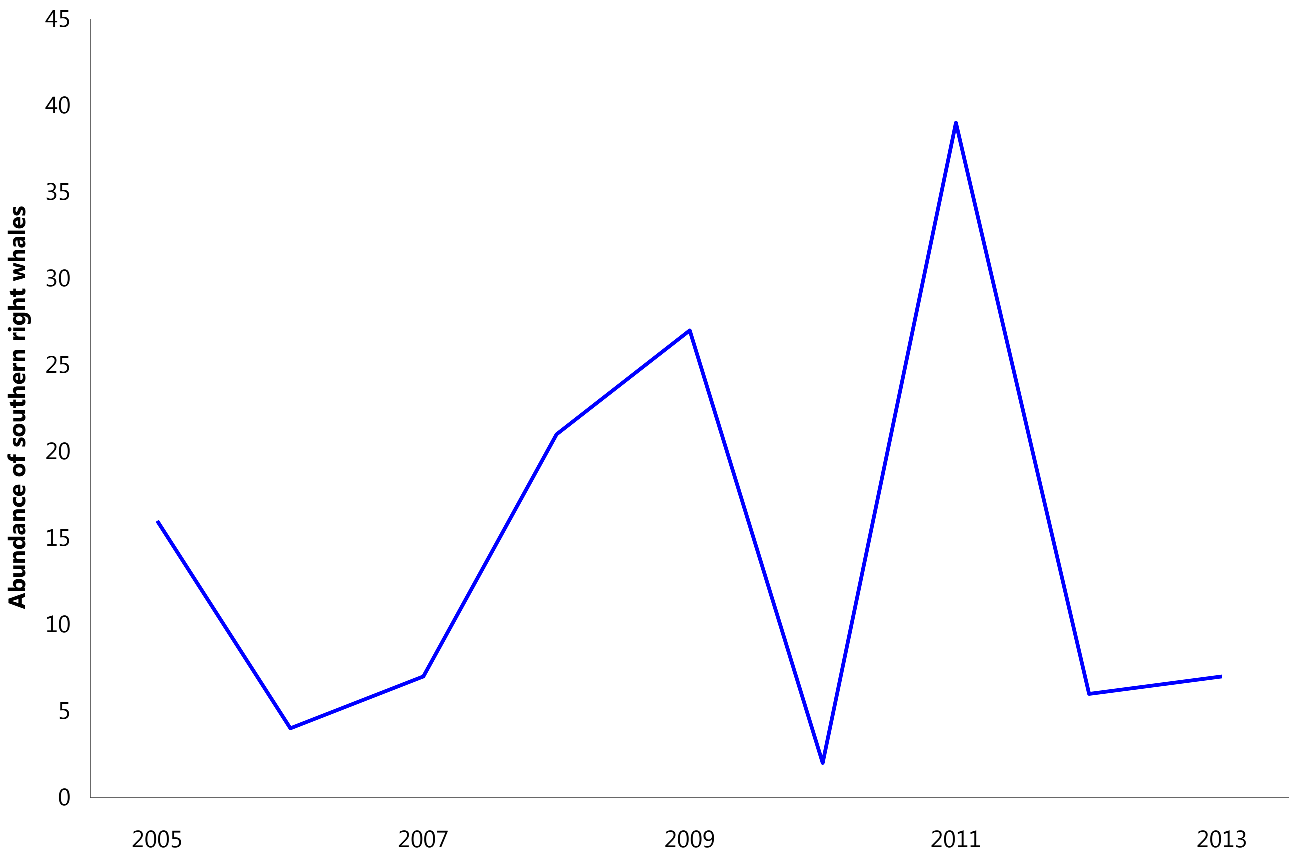
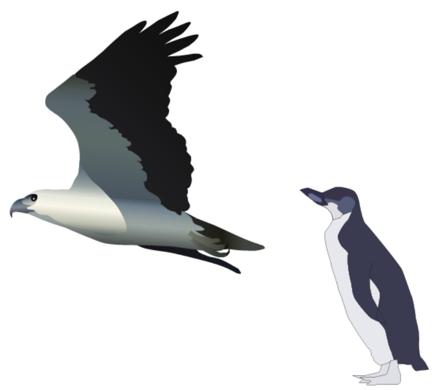


Figure 43. Abundance of southern right whales during the breeding season at Fowlers Bay. Source: Charlton et al. (2014).

4.8 Seabirds



The coastline and waters around South Australia are used by a number of seabird species, including white-bellied sea-eagle, osprey, short-tailed shearwater (mutton bird), little penguin, fairy tern, white-faced storm petrel (DENR 2010). Some of these species are resident while others are more transient, visiting South Australia to rest, breed and/or feed. Many of the islands around the state support seabird breeding colonies (Robinson et al. 1996). Seabirds that breed in New Zealand or Antarctica, such as albatrosses, petrels and prions can also be found in certain locations (Marchant and Higgins 1990).

Park-specific baseline information on seabirds is presented in the individual baseline reports (Bryars et al. 2016a-s). Baseline information on seabirds relevant to South Australia includes:

- The distribution and abundance of osprey and white-bellied sea-eagle breeding pairs were surveyed over 3 breeding seasons between May 2008 and October 2010 (Dennis et al. 2011a) (Figure 44).The distribution and abundance of breeding sites for 16 species of seabird have been surveyed numerous times since 1971 (Copley 1996, DEWNR 2015g). Goldsworthy and Page (2010) reviewed the distribution and abundance of crested terns, little penguins, short-tailed shearwaters and flesh-footed shearwaters.

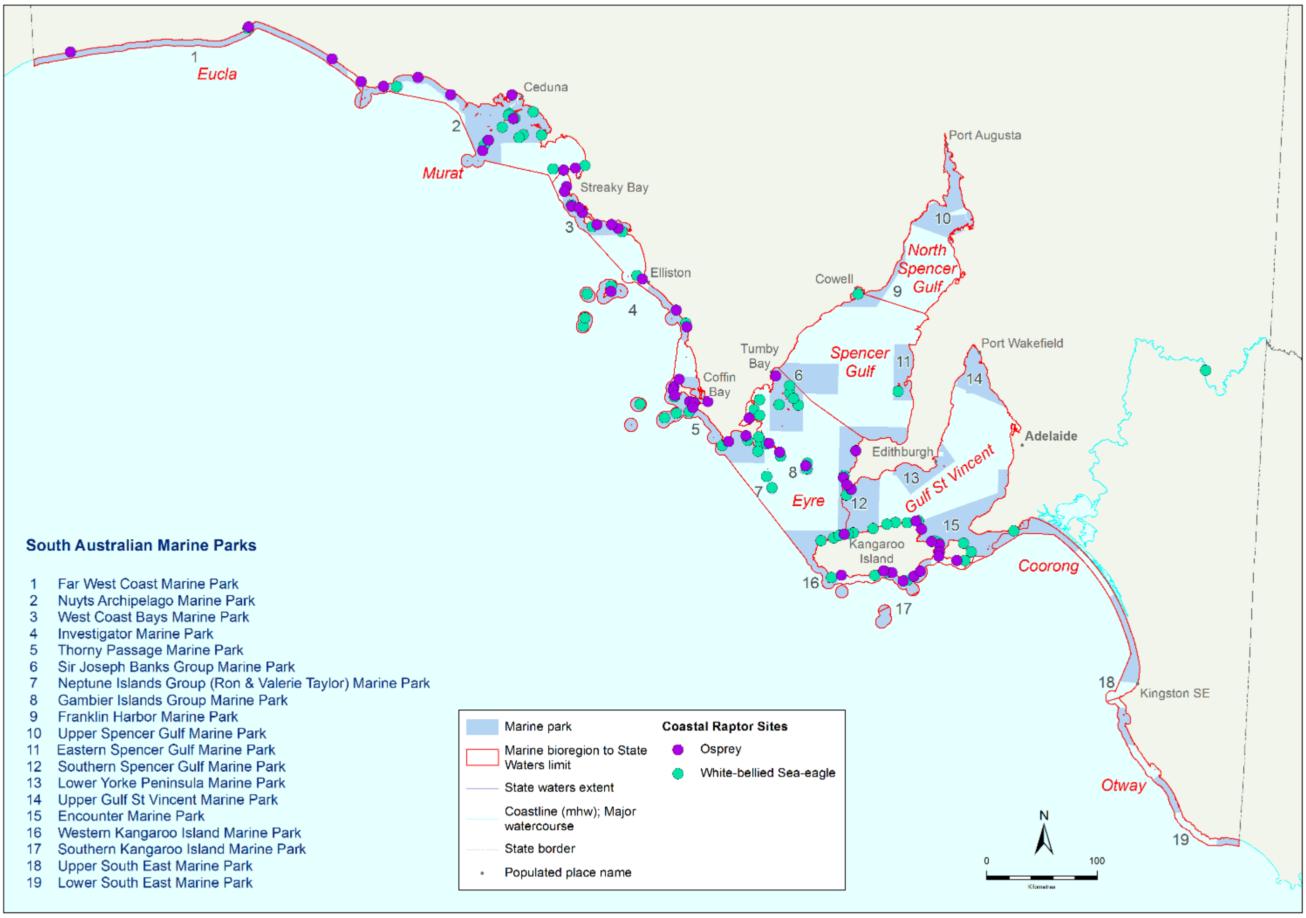
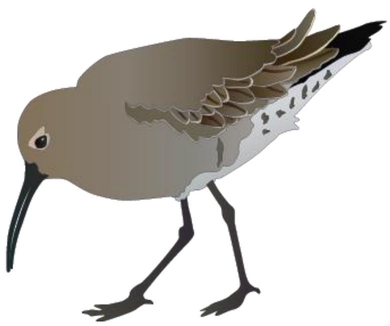


Figure 44. Distribution of osprey and white-bellied sea-eagle sites in South Australia.

4.9 Shorebirds



The coastline and waters around South Australia are used by a number of shorebird species for breeding and feeding, including pied and sooty oystercatchers, hooded plover, grey plover, common greenshank, and eastern curlew (DENR 2010). Some of these species are resident and others migrate from interstate or overseas.

Park-specific baseline information on shorebirds is presented in the individual baseline reports (Bryars et al. 2016a-s). Baseline information on shorebirds relevant to South Australia includes:

- Diversity and abundance of shorebirds have been surveyed at several locations around South Australia. These data are an ongoing statewide dataset that is maintained by the Shorebirds 2020 Project (BirdLife Australia 2015) (Figure 45).

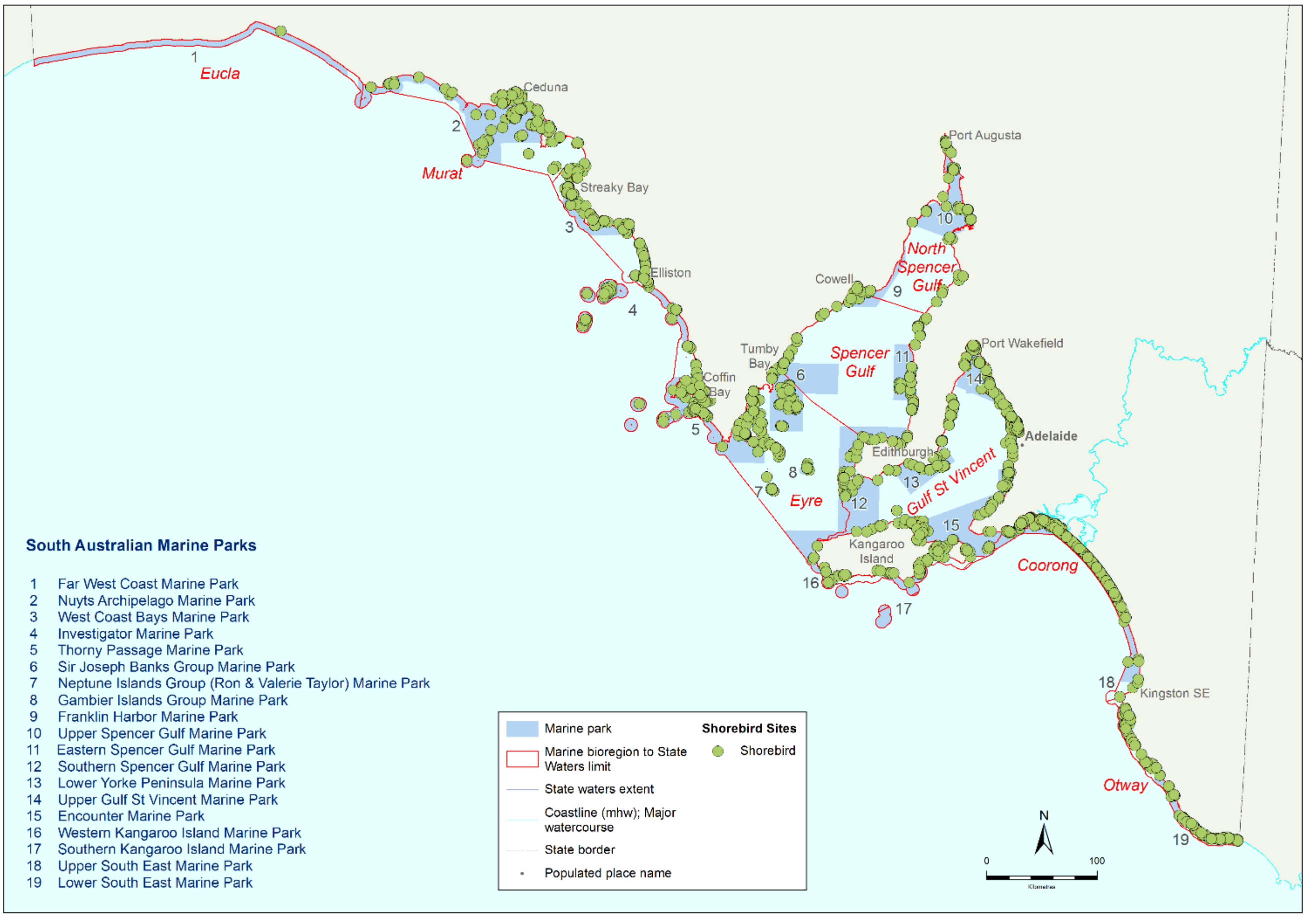


Figure 45. Distribution of shorebird sites in South Australia.

5 Socio-economic values

Monitoring socio-economic values will be a core component of the marine parks MER program. For the purpose of the baseline reports, socio-economic values are summarised according to 8 broad categories: local businesses and communities, coastal recreation, tourism, cultural heritage, shipping, aquaculture, recreational fishing, and commercial fishing (see Section 3) These categories are based on work undertaken for the marine park planning and assessment processes (DENR 2010, Bailey et al. 2012a, b). The socio-economic values of the 8 categories are well documented (DENR 2010, Bailey et al. 2012a, b), including a series of maps for all the 19 marine parks (DEWNR 2015b). Information on socio-economic values is available at a range of spatial scales, with information documented in the following sections starting from a statewide scale to the smallest available local scale. In many cases information is available only at a spatial scale that is larger than or doesn't align well with the marine park, but is nonetheless documented as it may be relevant to the marine park.

The following sections summarise the available information under the 8 categories of socio-economic values. This report provides an inventory of the available information together with examples of the current state of knowledge and historical trends prior to 2015. The emphasis of this section is on the nature and scale (temporal and spatial) of information and indicators that may be used in the MER program (Section 10). In some cases there are time series of data available, while in other cases there are data collected from a single point in time but which could potentially be resampled in the future. Kosturjak et al. (2015) used a Government of South Australian framework for assessment of the impacts of marine parks on socio-economic values and this framework will be adopted in the MER program.

5.1 Local businesses and communities

Most local businesses and communities throughout South Australia are based within the vicinity of Statistical Areas Level 2 or Local Government Areas. However for the purposes of this report information in this section will be reported at a statewide level. Park specific and Statistical Area Level 2/Local Government Area information on local businesses and communities is presented in the individual baseline reports (Bryars et al. 2016a-s)

5.1.1 Human population

Population size is a basic demographic characteristic of the region and was an area of focus for regional economic impact assessment of the marine park network (Bailey et al. 2012a).

Park-specific baseline information on human population is presented in the individual baseline reports (Bryars et al. 2016a-s). Baseline information on human population relevant to South Australia includes:

- The Australian Bureau of Statistics provides annual estimates of the resident population. This information is presented for several spatial scales including Statistical Areas Level 2 and Local Government Areas (see Appendix C) as a time-series covering the previous decade (ABS 2015a). The estimated resident population of South Australia increased by about 10 per cent between 2003 and 2014, from 1.52 million to 1.68 million (ABS 2015a, Figure 46).

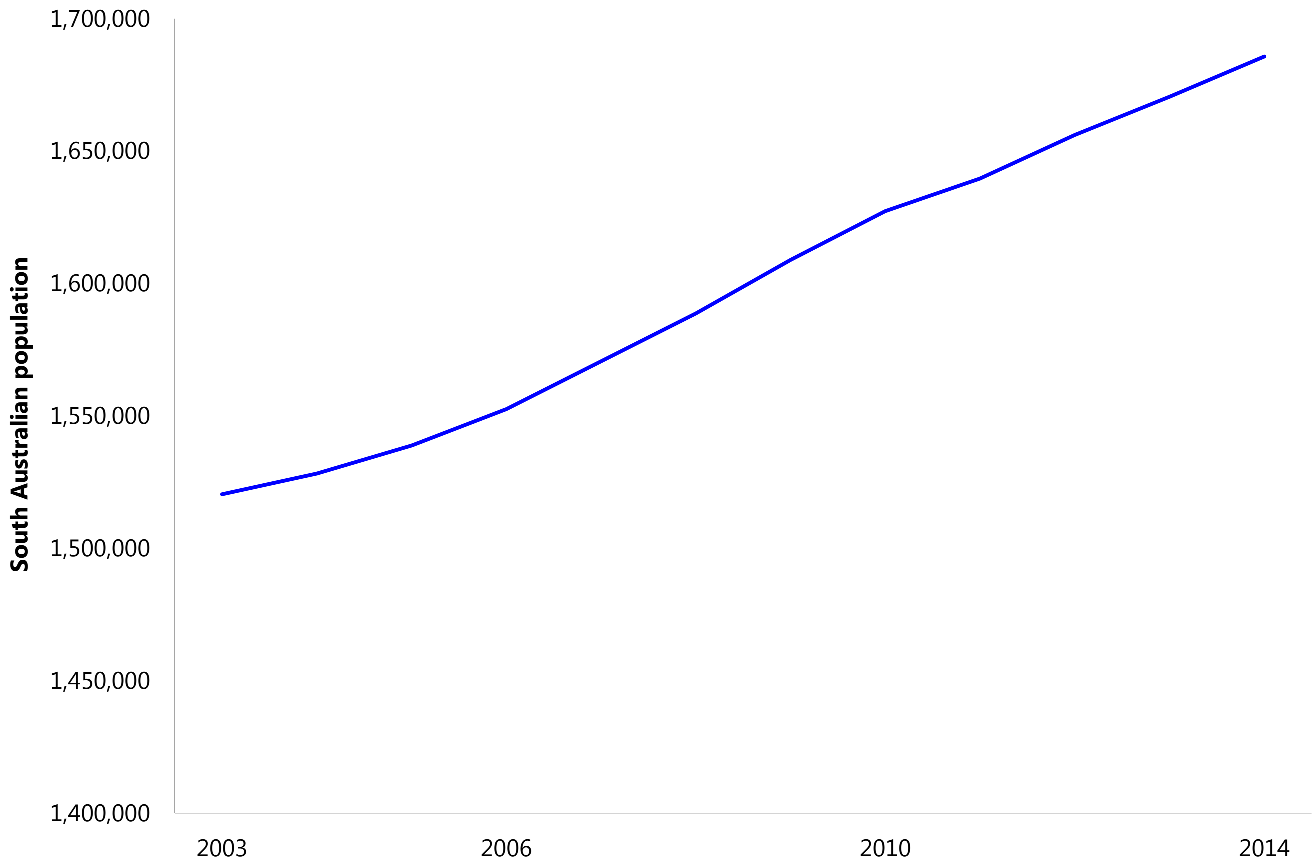


Figure 46. Population trends in South Australia. Source: ABS (2015a)

5.1.2 Production and employment

A number of businesses, industries and jobs are reliant on the ecological values of the marine environment of South Australia or use the marine environment. These include tourism (Section 5.3), shipping (Section 5.5), aquaculture (Section 5.6) and commercial fishing (Section 5.8).

Park-specific baseline information on production and employment is presented in the individual baseline reports (Bryars et al. 2016a-s). Baseline information on production and employment relevant to South Australia includes:

- Gross regional product has been calculated for the state by the National Institute of Economic and Industry Research Pty Ltd between 2010/11 and 2013/14 (National Economics and .id 2015). Gross regional product for the state was close to $88 billion for 2010/11 and $90 billion for 2013/14 (Figure 47).
- The Australian Bureau of Statistics provides annual counts of Australian businesses sourced from the Australian Bureau of Statistics Business Register (ABS 2015b). Information is available for between 2011 and 2015 (ABS 2015b). The total number of businesses operating in June 2014 in South Australia was 143,491.
- The number of local jobs for South Australia has been estimated by the National Institute of Economic and Industry Research Pty Ltd between 2010/11 and 2014/15 (National Economics and .id 2015). These data are based on modelling from a number of sources, including tax data, and are more up-to-date than census data (National Economics and .id 2015). In 2010/2011, there were 802,927 jobs in South Australia, in 2014/15, this decreased to 798,472 (National Economics and .id 2015).
- The unemployment rate is available from the Australian Government Department of Employment. These data are available on a quarterly basis, smoothed using a four quarter average (with unsmoothed data also

available), but a focus on long-term annual comparisons is recommended (Department of Employment 2015) In September 2014, the unemployment rate in South Australia was 6.7 per cent (Department of Employment 2016, Figure 48).

- The Australian Bureau of Statistics provides labour market information derived from its Census of Population and Housing (ABS 2015c). Although the census is only conducted every five years and generally underestimates employment levels, it provides high quality data at a fine spatial scale and fine level of industry classification. Available data include unemployment rate, labour force participation rate, and employment to population ratio, and personal, family and household income (ABS 2015c).
- The Australian Tax Office provides average annual salary or wage income and the number of earners by postcode (ATO 2015). The same information is available at a Local Government Area level and Statistical Area Level 2 from the *Estimates of Personal Income for Small Areas*, which also includes income earned in respect of own business (ABS 2016).
- Data on employment and remuneration in respect of payroll taxes may be available from Return to Work SA or the SA Department of Treasury and Finance (ABS 2015d).

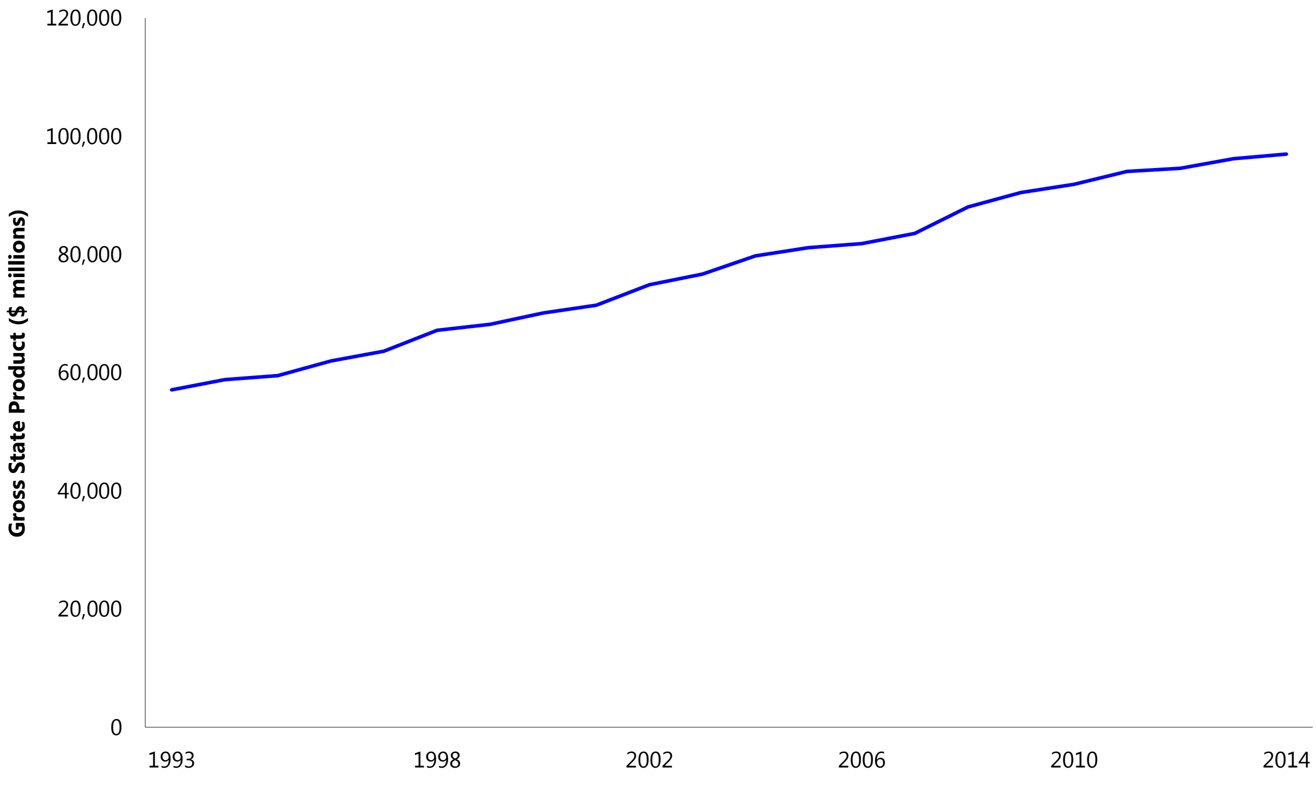


Figure 47. Gross State Product. Source: National Economics and .id (2015).

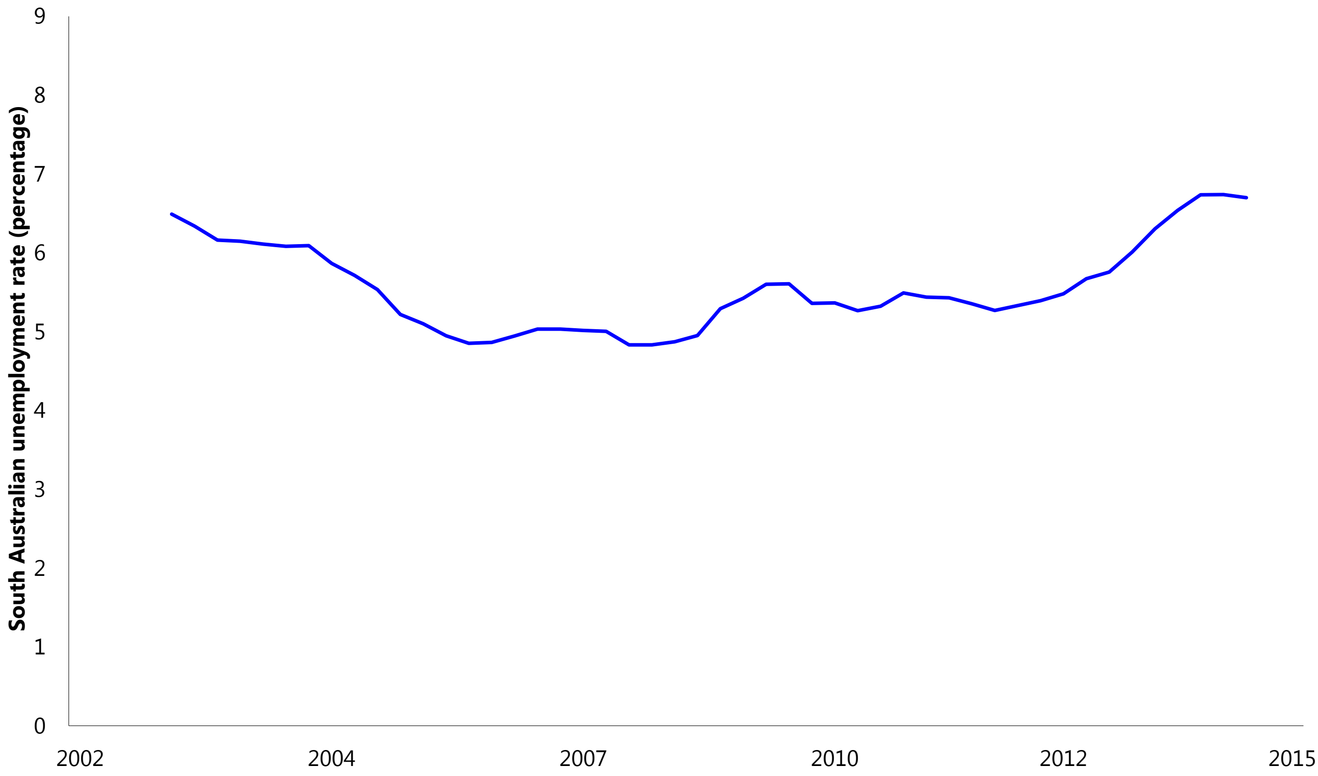


Figure 48. Unemployment rate (quarterly) in South Australia.. Source: Department of Employment (2015).

5.1.3 Building and property

Information on buildings and properties is an economic indicator for regional communities and was an area of focus for previous regional economic impact assessment of the marine park network (Bailey et al. 2012a-t).

Park-specific baseline information on building and property is presented in the individual baseline reports (Bryars et al. 2016a-s). Baseline information on building activity and residential property prices relevant to South Australia includes:

- Building approvals data, are considered to be one of the higher quality sources of information about regional economic activity (Kosturjak et al. 2015). The Australian Bureau of Statistics provides monthly updates and annual summaries of the number and value of residential building approvals (ABS 2015e). This information is available for Statistical Areas Level 2 since 2011/12, for Local Government Areas since 2012/13 and for Statistical Local Areas (similar to Local Government Areas) between 2002/03 and 2011/12. Bailey et al. (2012b-t) compiled this information and reported that:

– the number of building approvals increased by 3 per cent between 2001/02 and 2010/11 in South Australia.

– the average value per approval increased from$128,000 to $236,000 (85 per cent) between 2001/02 and 2010/11 in South Australia.

- Bailey et al. (2012b) reported house price information sourced from RP Data Pty Ltd. The median house price in South Australia increased from $126,000 to $370,000 (194 per cent) between 2000/01 and 2010/11, (Bailey et al. 2012b-t). Other commercial organisations providing property sales data for a fee include CoreLogic and Australian Property Monitors.

  The Department of Planning, Transport and Infrastructure maintains a database of properties which includes the most recent sales price and valuations by the Valuer-General (DEWNR 2015h). The median house price for all Local Government Areas adjacent Marine Parks increased from about $81,000 to $333,000 between 1990 and 2013, and was $356,000 in 2014 (Figure 49). Comparative property price data are also available for a group of major South Australian towns (Kosturjak et al. 2015).

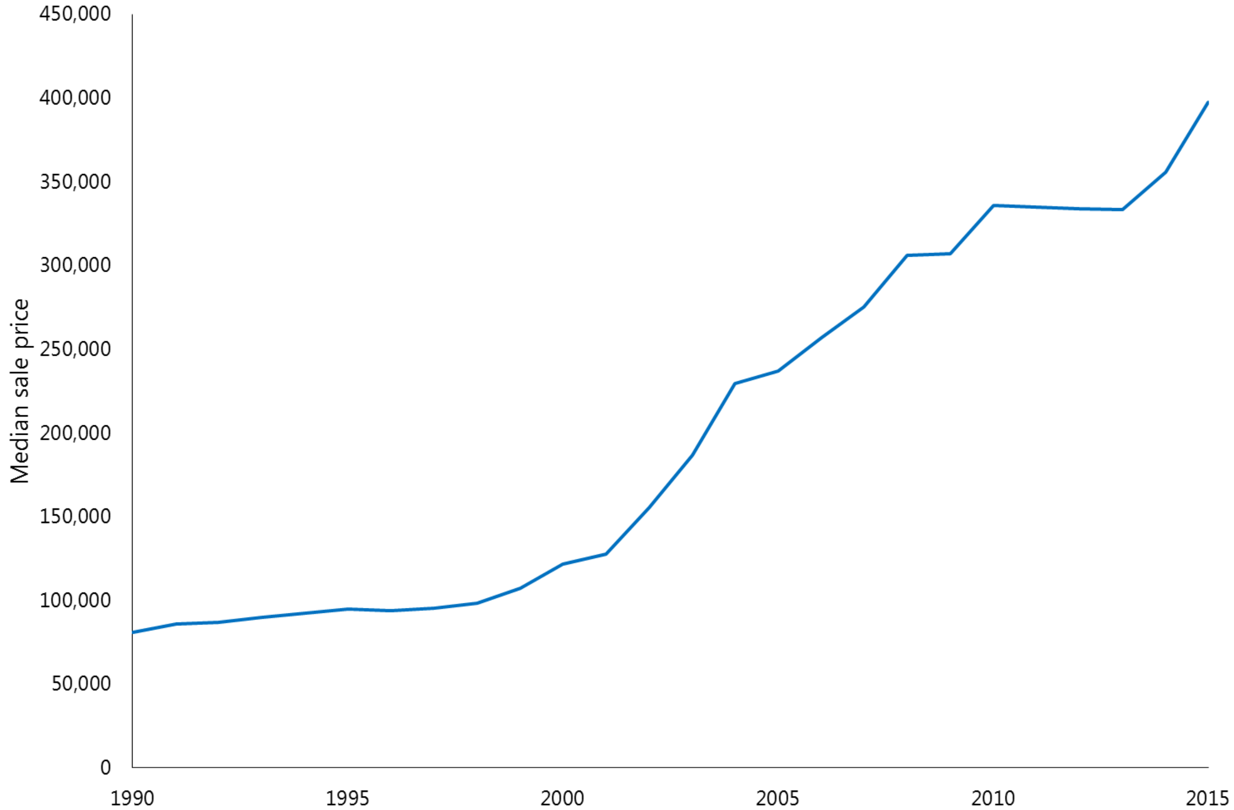


Figure 49. Median sale price for residential properties combined for Local Government Areas adjacent to Marine Parks. For each property, these data only include the most recent sale which is a transfer of the full value and whole of land. There is potential volatility in the median price due to random fluctuations in the quality of properties sold in particular years. Source: DEWNR (2015h).

5.1.4 Socio-economic advantage and disadvantage

'Socio-economic advantage and disadvantage' can be defined in terms of the access that people have to resources (material and social) and their ability to participate in society (ABS 2011a). This integrated indicator has not been used in previous impact assessments of marine parks in SA, but it could be used to track the socio-economic condition of regional communities.

Park-specific baseline information on socio-economic advantage and disadvantage is presented in the individual baseline reports (Bryars et al. 2016a-s). Baseline information on socio-economic advantage and disadvantage relevant to South Australia includes:

- The Australian Bureau of Statistics ranks Statistical Areas Level 1 and 2 and Local Government Areas according to an index of relative socio-economic advantage and disadvantage based on income, education, employment, occupation, housing and other information from the five-yearly census (ABS 2011a). While household income is taken into account in calculating this index, it may also be worth reporting personal, family and household income separately.

5.1.5 Public appreciation, education and understanding

Information on public appreciation, education and understanding of the marine environment and marine parks provides useful social indicators for regional (and city-based) communities and was used in social impact analyses of the marine park network (Bailey et al. 2012a, b, Square Holes 2015).

Park-specific baseline information on public appreciation, education and understanding of the marine environment and marine parks is presented in the individual baseline reports (Bryars et al. 2016a-s). Baseline information on public appreciation, education and understanding of the marine environment and marine parks relevant to South Australia includes:

- Regular (about annual) phone surveys of the general public have been commissioned by DEWNR to gauge community support and perceptions on a range of factors related to the marine environment and marine parks in South Australia (e.g. Square Holes 2015). Community attitudes towards marine parks in South Australia indicated between 79 and 95 per cent support for marine parks (Figure 50). Support for marine parks in the local area of the people who were surveyed has typically been lower (between 58 and 79 per cent, Figure 50). In 2015, support for marine parks in general versus those in their local area was 79 and 67 per cent, respectively, for all respondents (Square Holes 2015).

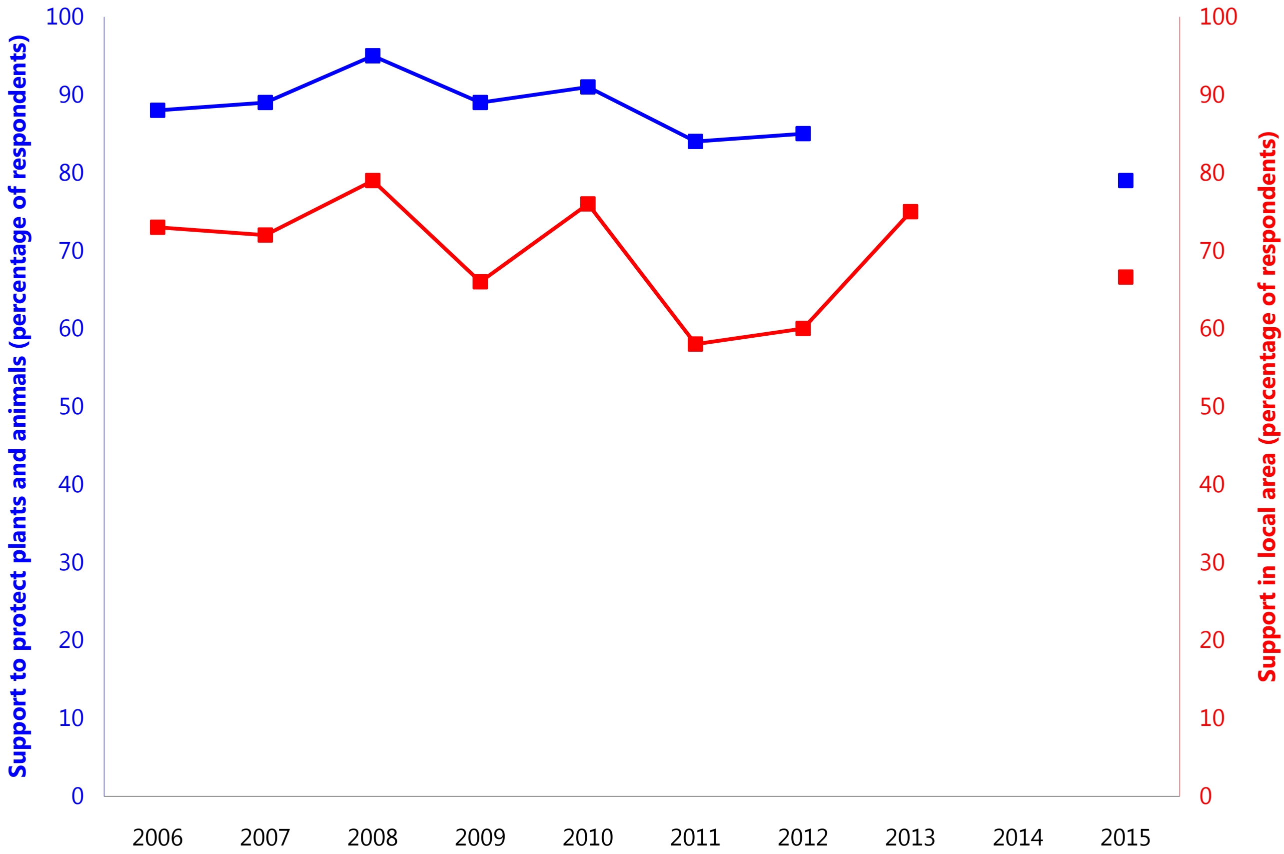


Figure 50. Results of statewide phone surveys regarding support for marine parks to protect marine plants and animals and support in local area. No data were available for 2013 (blue line) or 2014 (both lines). Source: Square Holes (2015).

5.2 Coastal recreation

The marine environment is used for a range of coastal recreation activities including fishing (Section 5.7), boating, snorkelling, scuba diving, swimming, surfing, camping and sightseeing (DENR 2010).

Park-specific baseline information on coastal recreation is presented in the individual baseline reports (Bryars et al. 2016a-s). Baseline information on coastal recreation relevant to South Australia includes:

- Regular (about annual) phone surveys of the general public since 2006 have been commissioned by DEWNR to gauge community use of the marine environment and marine parks in South Australia (e.g. Square Holes 2015). Between 52 and 65 per cent of the statewide respondents made general recreational use of the marine environment at least monthly, between 15 and 34 per cent participated in fishing (see also Section 5.7), and between 12 and 31 per cent participated in boating (Figure 51). These uses declined after 2007 but have since been stable (Figure 51).
- During 2013 and 2014, 31 per cent of domestic visitors to the Eyre Peninsula tourism region (from Whyalla to the Western Australian border, see Appendix C) visited the beach, 22 per cent went fishing, and 15 per cent visited national or state parks. On Yorke Peninsula, 52 per cent of domestic visitors visited the beach, 38 per cent went fishing and 9 per cent visited national or state parks. On Kangaroo Island, 53 per cent of domestic visitors visited the beach, 24 per cent went fishing and 43 per cent visited national or state parks. On the Fleurieu Peninsula, 51 per cent of domestic visitors visited the beach, 11 per cent went fishing, and 9 per cent visited national or state parks. Down the Limestone Coast, 20 per cent of domestic visitors to the visited the beach, 9 per cent went fishing, and 15 per cent visited national or state parks (South Australian Tourism Commission unpublished data, see Section 5.3).
- The Department of Planning, Transport and Infrastructure publishes annual statewide statistics on boat registrations and licences (DPTI 2015a, b). General boat and jet ski registrations increased by about 6 and 45 per cent, respectively, between 2007 and 2014 (DPTI 2015a, Figure 52). Boat licences varied between 5,000 and 7,000 during the same period (DPTI 2015b, Figure 53). Note that data are available from 1975 but only data from 1992 are presented in Figure 53. In 2015, the option for six-monthly registration renewals was introduced, which may result in a short-term perturbation in the time-series.

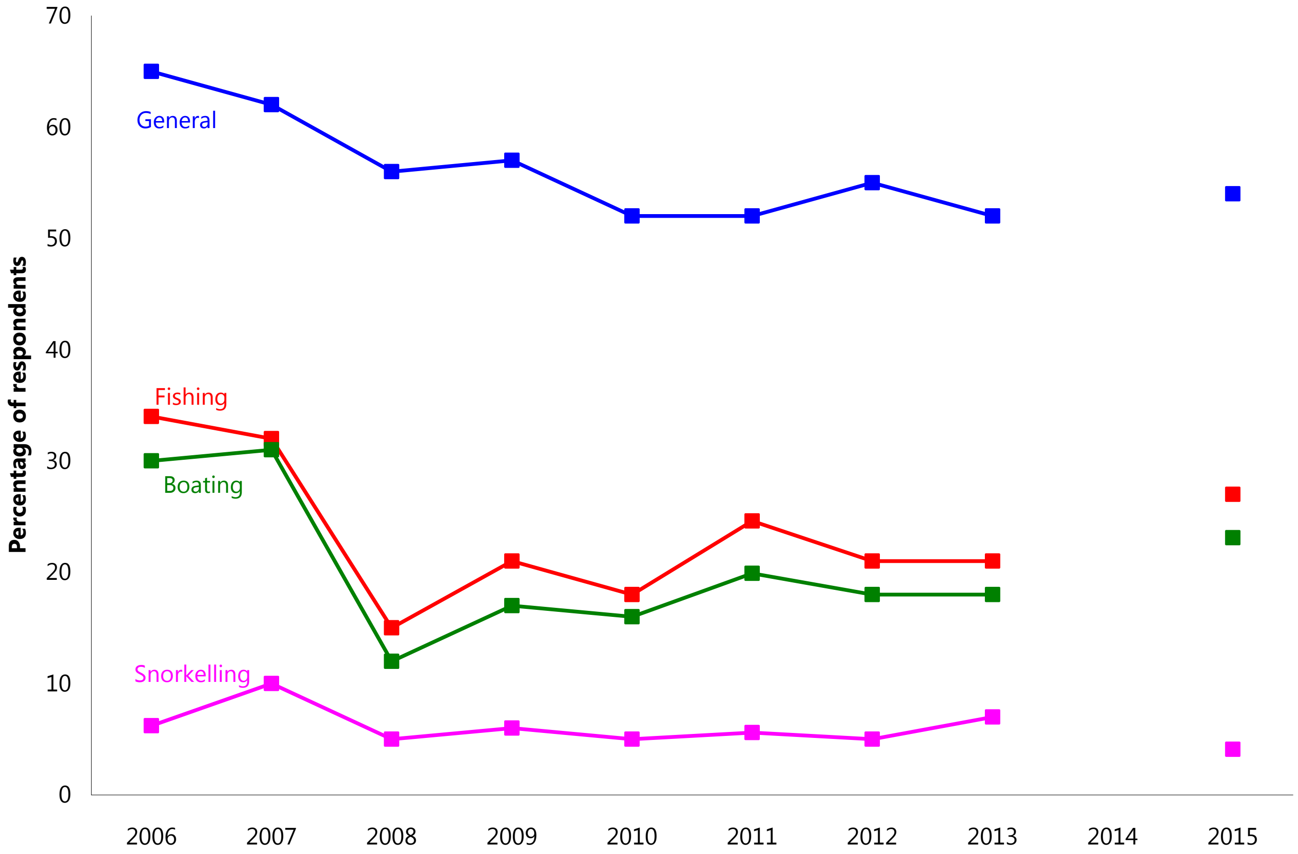


Figure 51. Percentage of statewide phone survey respondents who participate in general recreational, fishing, boating and snorkelling activities in the marine environment at least monthly. No data were available for 2014. Source: Square Holes (2015).

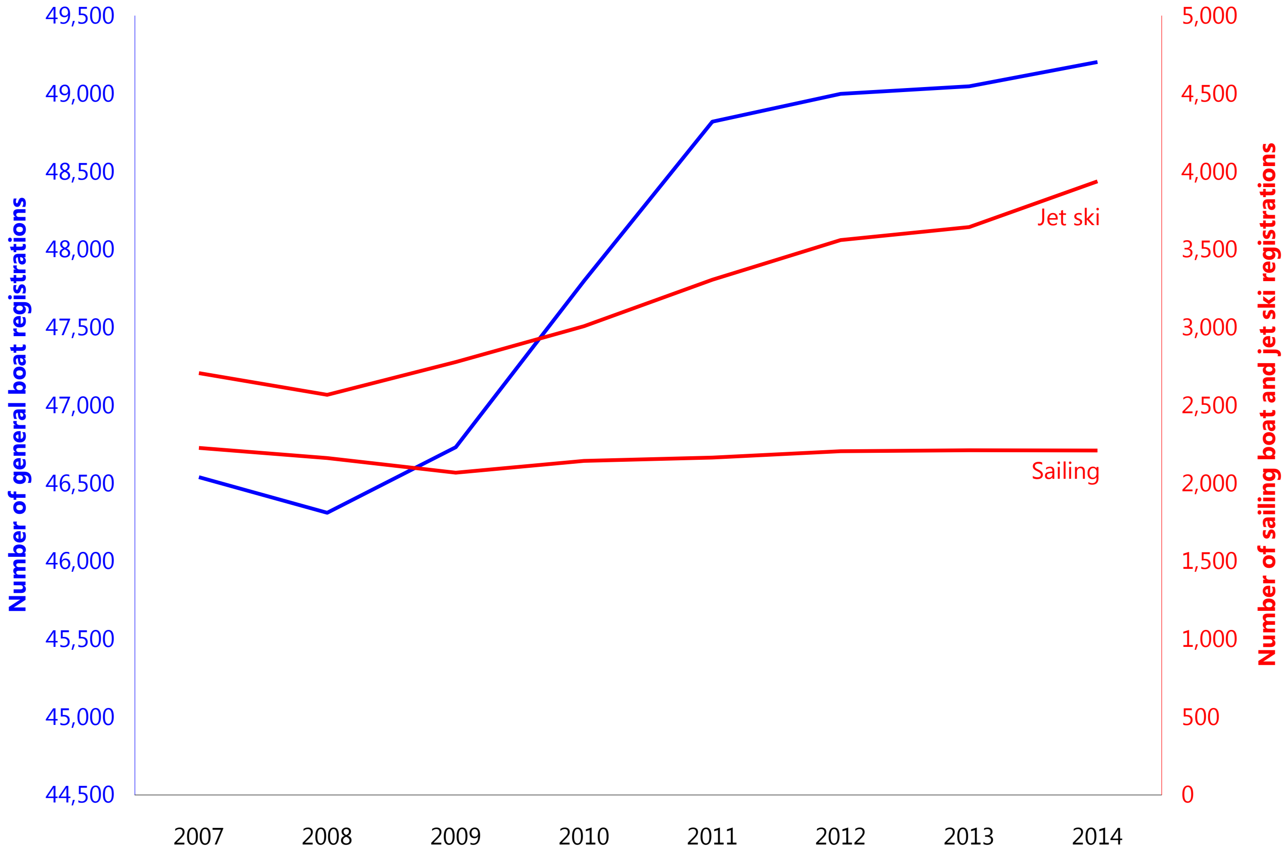


Figure 52. South Australian boat registrations for general boats, and sailing vessels and jet skis. General boat registrations include cabin cruisers, half cabins, cuddy cabins, centre consoles, inflatables, open boats and runabouts. Catamarans are grouped with sailing vessels. Source: DPTI (2015a).

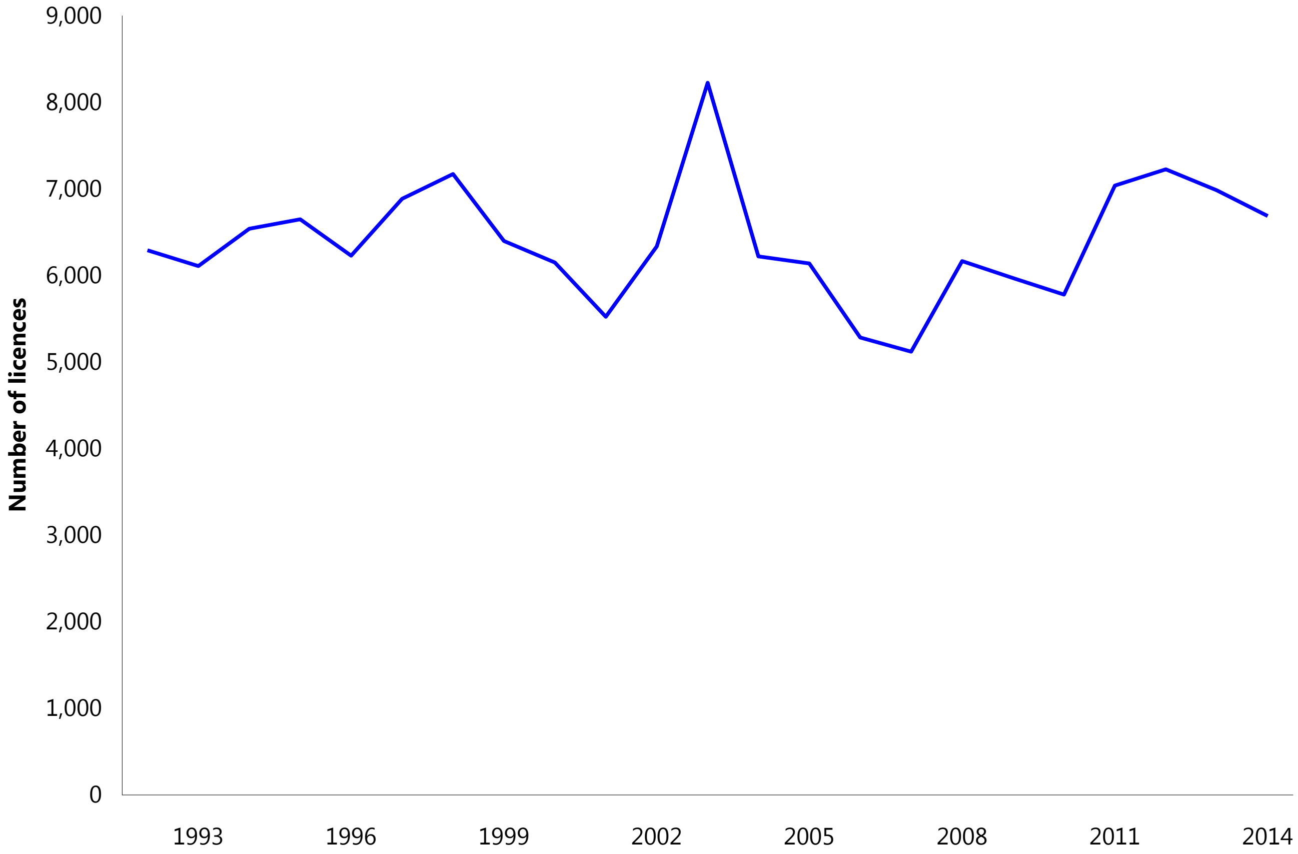


Figure 53. Number of South Australian boat licences. Source: DPTI (2015b).

5.3 Tourism

Tourism is an important economic contributor to South Australia. Coastal and marine recreational opportunities include general recreation (Section 5.2), recreational and charter fishing (Sections 5.7 and 5.8.7), whale watching, scenic cruises and four-wheel driving (DENR 2010; South Australian Tourism Commission 2015a-e).

Park-specific baseline information on Tourism is presented in the individual baseline reports (Bryars et al. 2016a-s). Baseline information on Tourism relevant to South Australia includes:

- Tourism Research Australia provides time series of international and domestic tourism numbers and expenditure, and the number of tourism businesses, for South Australia's tourism regions (Tourism Research Australia 2015a-e, see Figure 54 and Figure 55). Expenditure by tourists in the coastal regions of South Australia (including Eyre Peninsula, Yorke Peninsula, Fleurieu Peninsula, Kangaroo Island and the Limestone Coast) in 2013/14 was close to $4.6 billion. Data are available for previous years, but are not comparable with 2013/14 due to a change in methods (Tourism Research Australia 2015a-e).
- The South Australian Tourism Commission prepares regional tourism profiles using information from international and national visitor surveys conducted by Tourism Research Australia. During 2013 and 2014, 31 per cent of domestic visitors to Eyre Peninsula (from Whyalla to the Western Australian border, see Appendix C) visited the beach, 22 per cent went fishing, and 15 per cent visited national or state parks.

On Yorke Peninsula, 52 per cent of domestic visitors visited the beach, 38 per cent went fishing and 9 per cent visited national or state parks. On the Fleurieu Peninsula domestic visitors visited the beach, 11 per cent went fishing, and 9 per cent visited national or state parks. On Kangaroo Island, 53 per cent of domestic visitors visited the beach, 24 per cent went fishing and 43 per cent visited national or state parks. Down the Limestone Coast, 20 per cent of domestic visitors visited the beach, 9 per cent went fishing, and 15 per cent visited national or state parks (South Australian Tourism Commission unpublished data).

- A report by BDA Marketing Planning for Tourism Australia (Australia Consumer Demand Research) based on a survey of international visitors found that beaches were the top Australian attraction, appealing to 53 per cent of visitors, and viewing aquatic wildlife was the top experience, appealing to 50 per cent of visitors (Tourism Australia, undated a).
- DEWNR maintains a database of coastal and marine tourism operators in South Australia (DEWNR unpublished data). Several coastal or marine tourism operators use the marine environment, and offer a range of activities including but not limited to fishing charters, swimming with dolphins, penguin viewing, kayak tours, whale watching, and/or general cruises and sight-seeing.

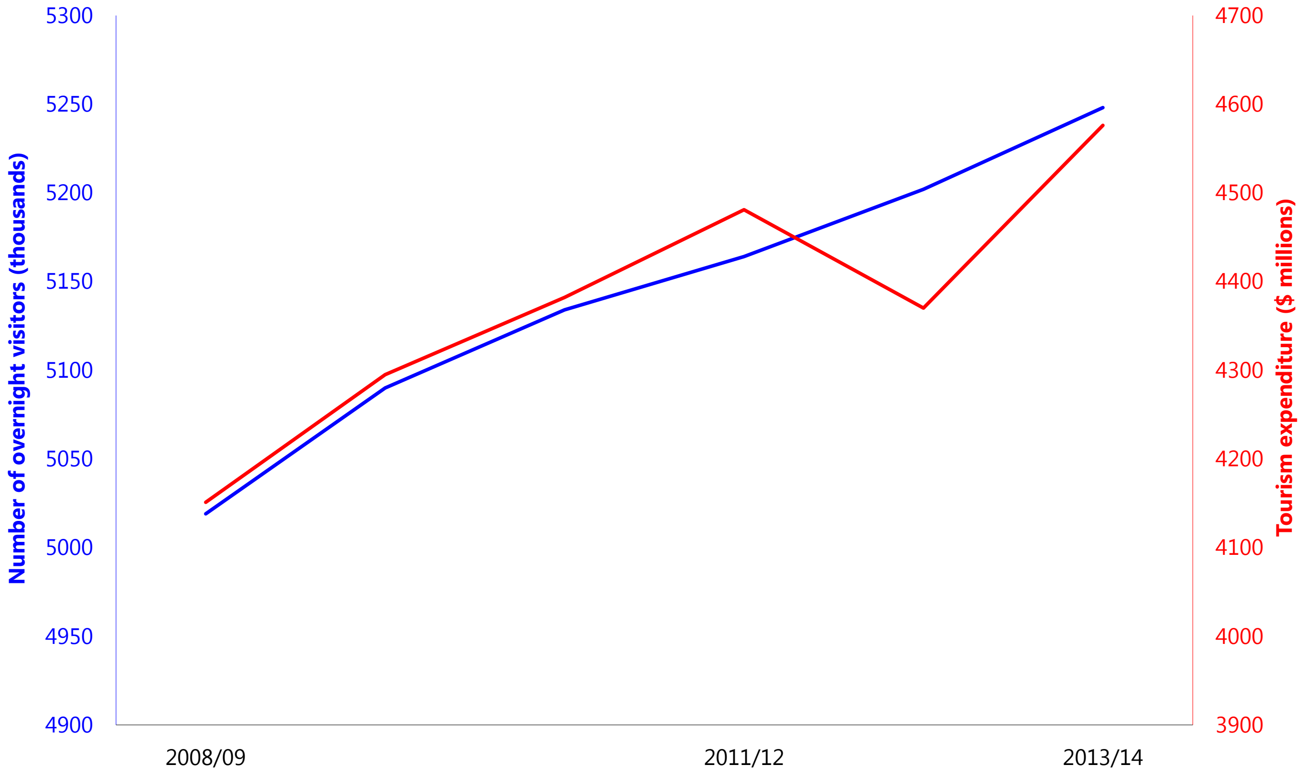


Figure 54. Number of overnight visitors and tourism expenditure for South Australia's coastal tourism regions. Source: Tourism Research Australia (2015).

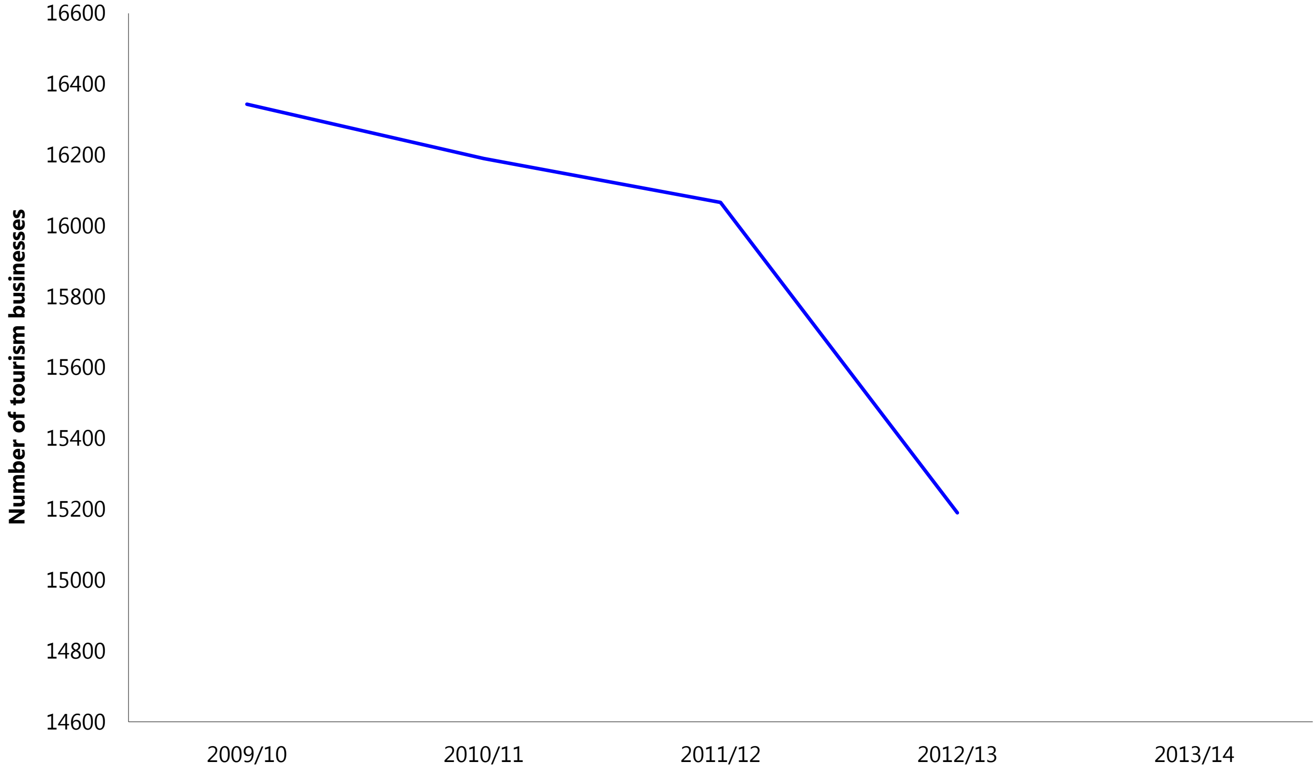
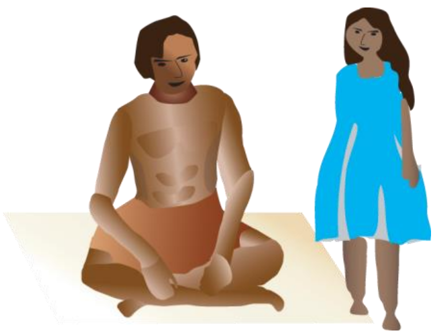


Figure 55. Number of tourism businesses in South Australia's coastal tourism regions. Source: Tourism Research Australia (2015). No data were available for 2013/14.

5.4 Cultural heritage

5.4.1 Aboriginal heritage



Aboriginal people have traditional associations (which may include Aboriginal traditional fishing) with the coastal and marine environment across South Australia. There are native title claims in many coastal areas across the state.

Park-specific baseline information on Aboriginal heritage is presented in the individual baseline reports (Bryars et al. 2016a-s). Baseline information on Aboriginal heritage relevant to South Australia includes:

- The Central Archive, including the Register of Aboriginal Sites and Objects, is maintained by the Aboriginal Affairs and Reconciliation Division of the South Australian Department of State Development. Information on the site register is confidential and is only released with the permission of the traditional owners.
- DENR (2010) noted that unique Aboriginal heritage sites such as constructed fish traps are still visible along sections of South Australia's coastline.

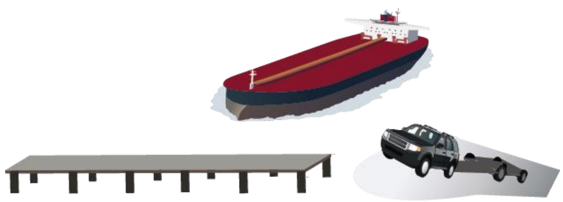
5.4.2 European heritage

South Australia has a diverse maritime history which includes exploration, whaling, sealing, lighthouses, pastoralism, trade and shipping. Remaining sites, structures and objects now provide a tangible link with the past and encourages an understanding of the activities, people and values that have shaped our European history and environment.

Park-specific baseline information on European heritage is presented in the individual baseline reports (Bryars et al. 2016a-s). Baseline information on European heritage relevant to South Australia includes:

- The South Australian Heritage Register contains descriptions of local, national and world heritage places in South Australia which are protected under legislation. The Register and associated spatial data can be accessed via the Heritage Places Database (DPTI 2015c).
- DEWNR maintains the South Australian Shipwrecks Database, which includes all known shipwrecks located in South Australian waters. It incorporates the Register of Historic Shipwrecks and the Register of Historic Relics as required under the (Commonwealth) *Historic Shipwrecks Act 1976* and the (South Australian) *Historic Shipwrecks Act 1981*, and includes shipwrecks that have not been declared under either of these Acts. There are more than 800 shipwrecks in South Australia (DEWNR 2015i).

5.5 Transport and infrastructure



Transport and infrastructure provide important socio-economic activity and value in South Australia (DENR 2010). The ports around South Australia are important for the export of a variety of commodities including grain, limestone, iron ore, cement, gypsum, mineral sands and salt.

Park-specific baseline information on transport and infrastructure is presented in the individual baseline reports (Bryars et al. 2016a-s). Baseline information on transport and infrastructure relevant to South Australia includes:

- Flinders Ports provide an annual summary report which includes bulk cargo import and export, and the number of vessel calls (visits). Approximately 13 million tonnes of cargo were exported from South Australia in 2014 (no imports) with 1745 vessel calls (Figure 56, Flinders Ports 2014).
- The Australian Bureau of Statistics international merchandise trade data include the volume and value of international exports and imports of goods for individual South Australian ports, including by commodity or industry. These data would require a customised request and may be limited by confidentiality restrictions.
- As of October 2014, there were 76 breakwaters, 173 jetties, 34 slipways, 165 moorings, and 182 boat ramps in South Australia (DEWNR 2016a, b, c, d, DEWNR unpublished data).
- The District Council of Ceduna maintains records of the annual fees paid by boat ramp users (including commercial and recreational fishers). Between 2007/08 and 2013/14, the total boat ramp fees were between $25,000 and $37,000 and were $30,000 in 2013/14 (Kosturjak et al. 2015).
- The Kangaroo Island Council maintains records of the number of boat ramp permit holders. In 2013/14, 113 annual recreational boat ramp permits were issued.

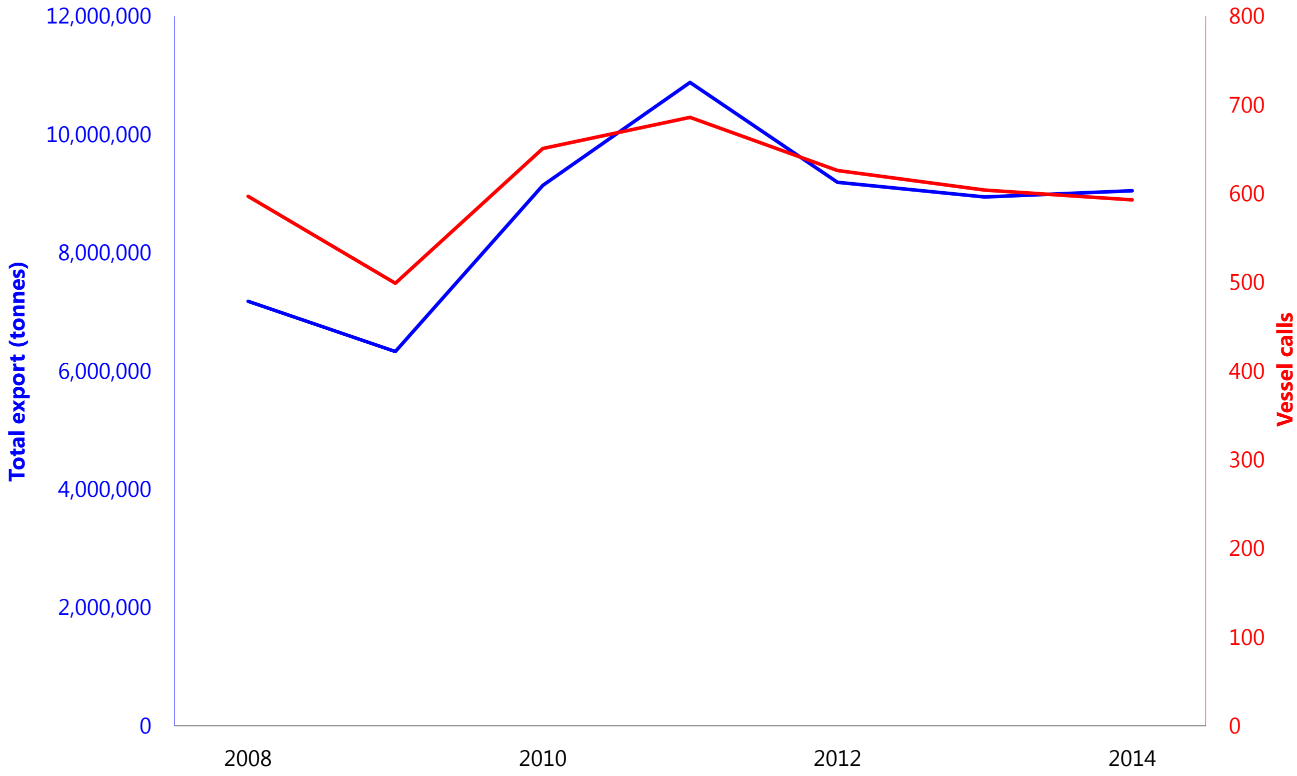
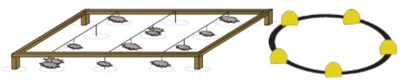


Figure 56. Annual cargo exports and vessel calls for South Australia, excluding Whyalla and Port Bonython, between 2008 and 2014. Source: Flinders Ports (2014).

5.6 Aquaculture



The South Australian marine environment supports an aquaculture industry based mainly on intertidal Pacific oysters, and sea cage grow-out of southern bluefin tuna and yellow-tail kingfish (PIRSA 2007, DENR 2010, Econsearch 2014a).

Park-specific baseline information on aquaculture is presented in the individual baseline reports (Bryars et al. 2016a-s). Baseline information on aquaculture relevant to South Australia includes:

- Primary Industries and Regions South Australia (PIRSA) Aquaculture provide a register of aquaculture leases and licences that can be queried from an online mapping system or exported as a GIS layer (DEWNR 2015k). Within South Australia there are 292 intertidal oyster leases, 40 finfish leases (including tuna), 38 subtidal mussel leases, and 32 other leases (including abalone, subtidal and miscellaneous).
- Econsearch Pty Ltd estimated the regional and state economic impact of aquaculture activity in South Australia in most years between 1997 and 2013. Estimates since 2003 consider the farm gate value of production, the net value of local processing, the net value of local retail and food service trade, and the value of local transport services at all stages of the marketing chain (EconSearch 2014a). The economic benefits associated with aquaculture in South Australia's marine environment in 2013/14 include (EconSearch 2014a):
  - Direct output (business turnover) of about $239 million (Figure 57) with associated downstream activities of $56 million and flow-on output in other sectors of the regional economy of $278 million
  - Contribution to gross regional product (total direct and indirect economic contribution) of about $252 million

– Direct employment of 830 full-time equivalent persons plus 1,035 from flow-on business activity

– Personal income of $40 million from aquaculture and downstream activities and an additional $77 million of household income in other local businesses.

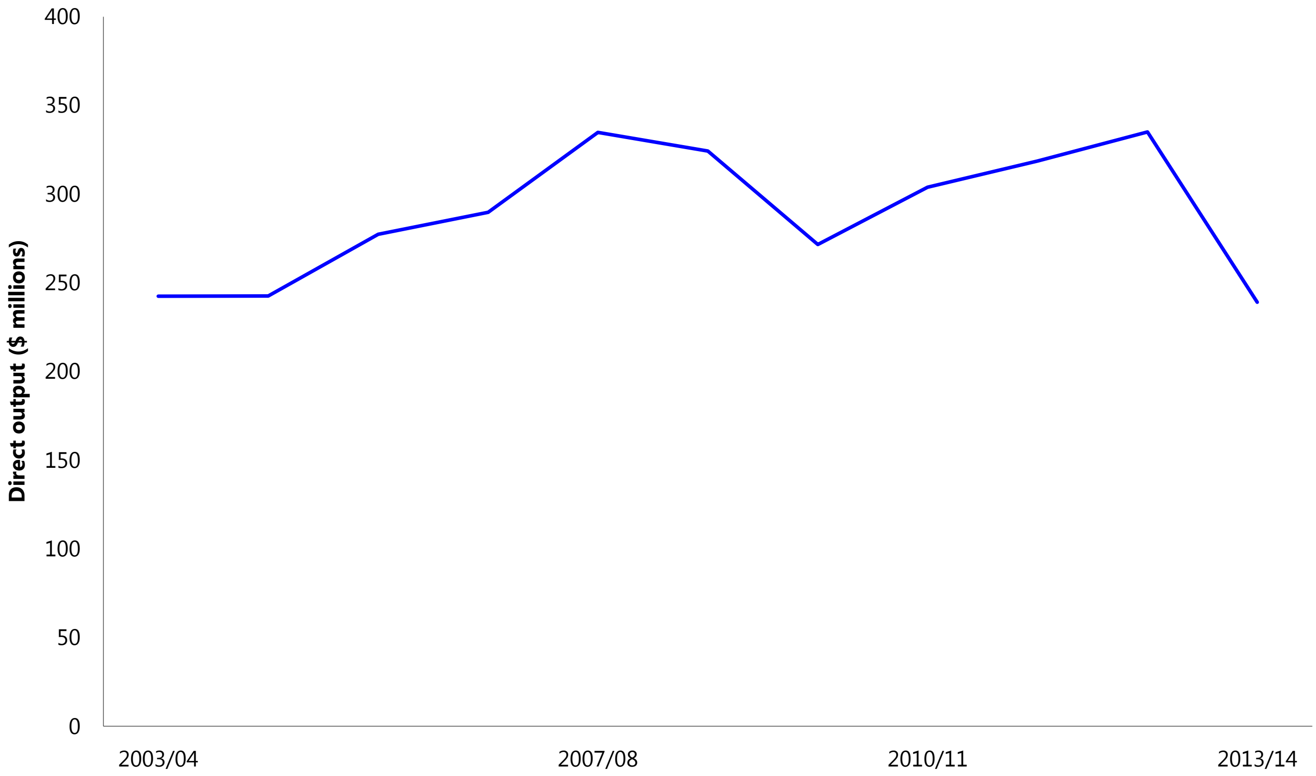
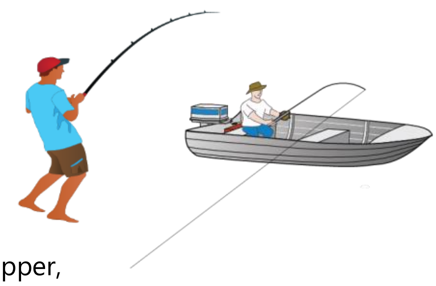


Figure 57. Direct output (business turnover) from aquaculture in South Australia. Source: Econsearch (2014a).

5.7 Recreational fishing



Recreational fishing has an important socio-economic value across South Australia. A recreational fishing survey conducted by PIRSA indicate that 16 and 18 percent of South Australians went fishing in 2007 and 2013, respectively (Jones 2009, Giri and Hall 2015). Collectively, they fished for about 1 million days. Recreational fishing is conducted in all habitat types except saltmarsh. Species targeted by recreational fishers include King George whiting, garfish, snapper, Australian herring, Australian salmon, southern calamary and blue swimmer crab. For these species, the statewide recreational catch is between 19 and 50 per cent of the total catch (i.e. recreational and commercial, Giri and Hall 2015).

Park-specific baseline information on recreational fishing is presented in the individual baseline reports (Bryars et al. 2016a-s). Baseline information on recreational fishing relevant to South Australia includes:

- Three statewide recreational fishing surveys have been undertaken in South Australia – in 2000/01 (The National Recreational and Indigenous Fishing Survey, Henry and Lyle 2003, Jones and Doonan 2005), in 2007/08 (Jones 2009), and in 2013/14 (Giri and Hall 2015). The estimated number of days fished in South Australia (see Appendix C) by South Australian resident recreational fishers was about 1,861,637 in 2000/01, 1,054,200 in 2007/08 and 965,561 in 2013/14.

- Between 2000/01 and 2007/08, the estimated number of days fished by South Australian resident recreational fishers (see Appendix C) decreased by 43 per cent and between 2007/08 and 2013/14 decreased by 8 per cent (Jones and Doonan 2005, Jones 2009, Giri and Hall 2015).
- Between 2000/01 and 2007/08, the estimated number of South Australian resident recreational fishers in South Australia decreased by about 28 per cent from about 328,228 in 2000/01 to 236,463 in 2007/08 (Jones 2009). Between 2007/08 and 2013/14, the estimated number of South Australian resident recreational fishers in South Australia increased by about 17 per cent from about 236,463 in 2007/08 to 277,027 in 2013/14 (Giri and Hall 2015). An economic report was produced in conjunction with the National Recreational and Indigenous Fishing Survey, which estimated that total expenditure attributable to recreational fishing in South Australia in 2000/01 was $148 million (Campbell and Murphy 2005).
- Regular (about annual) phone surveys of the general public since 2006 have been commissioned by DEWNR to gauge community use of the marine environment and marine parks in South Australia (e.g. Square Holes 2015). Over the 9-year period, between 46 and 69 per cent of the respondents fished recreationally at least once each year, and between 15 and 34 per cent fished at least monthly (Figure 58). Recreational fishing activity declined slightly after 2007 but has since been relatively stable (Figure 58). In 2015, 28 and 55 per cent of respondents fished at least once per month or per year, respectively.

Figure 58. Percentage of statewide phone survey respondents who participate in recreational fishing. No data were available for 2014. Source: Square Holes (2015).

5.8 Commercial fishing

There are a number of commercial fisheries operating in South Australia. Historical data are available on the volume and value of production from South Australian commercial fisheries between 1984/85 and 2010/11 (Knight and Tsolos 2012) and between 1990/91 and 2012/13 (EconSearch 2014b, c, d, e, f). A range of economic information is available, including gross value of production, costs, profit, return on investment, economic impact and exports (EconSearch 2014b, c, d, e, f). This section presents selected information to demonstrate the value and extent of commercial fisheries that operate in South Australia, while Section 8.2.1 (fishing as a pressure) provides detail on the catch that has historically been extracted from within or near the marine parks, and the current status of each of the fisheries.

5.8.1 Rock Lobster Fishery

There are two zones that form the South Australian Rock Lobster Fishery; the Northern Zone, which extends from the WA border to the Murray Mouth and the Southern Zone which extends from the Murray Mouth to the Victorian border. The fishery allows potting for rock lobster, and various by-product species including Maori octopus. Fishing is conducted on subtidal reef habitat. There are 68 licences in the Northern Zone Rock Lobster Fishery, with the majority of vessels based at Port Lincoln (Linnane et al. 2015a). There are 181 licences in the Southern Zone Rock Lobster Fishery, with the majority of vessels fishing from Robe and Port MacDonnell (Linnane et al. 2015b).

Park-specific baseline information on the Rock Lobster Fishery is presented in the individual baseline reports (Bryars et al. 2016a-s). Baseline information on the Rock Lobster Fishery relevant to South Australia includes:

- The annual value of the Northern Zone Rock Lobster Fishery between 2003/04 (when quota system was introduced) and 2013/14 ranged between $15 and $22 million (EconSearch 2015b, Figure 59).
- The annual value of the Southern Zone Rock Lobster Fishery between 2003/04 (when quota system was introduced) and 2013/14 ranged between $65 and $95 million (EconSearch 2015b, Figure 60).
- The South Australian Research and Development Institute (SARDI) collates monthly fishery logbook data for individual marine fishing areas, validates it using catch disposal records (Vainickis 2010), and provides summaries of catch, effort and catch rates in annual stock assessment and stock status reports (Linnane et al. 2014, 2015a,b).

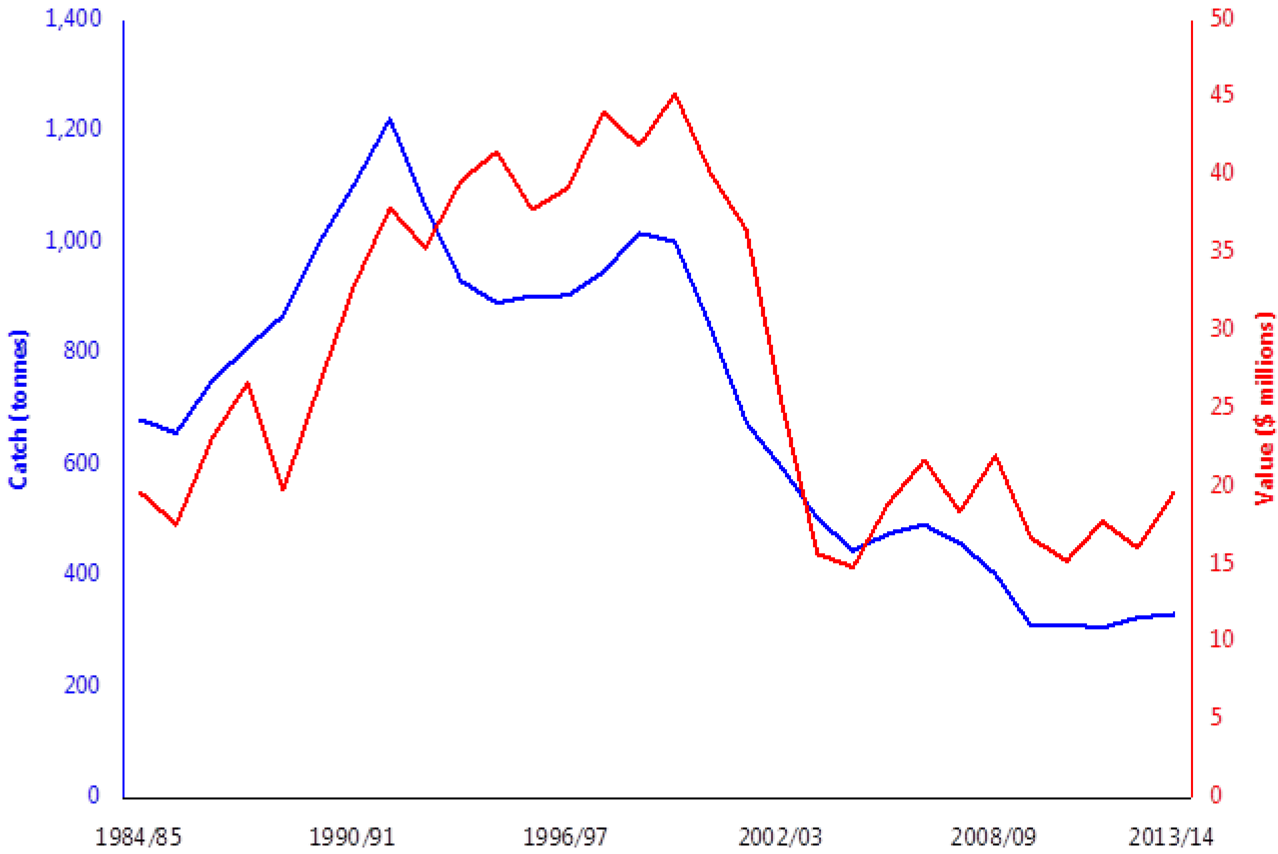


Figure 59. Catch and value of catch for the Northern Zone Rock Lobster Fishery. Value of catch has been adjusted to real terms (2013/14 dollars) using the consumer price index for Adelaide. Source: EconSearch (2015b).

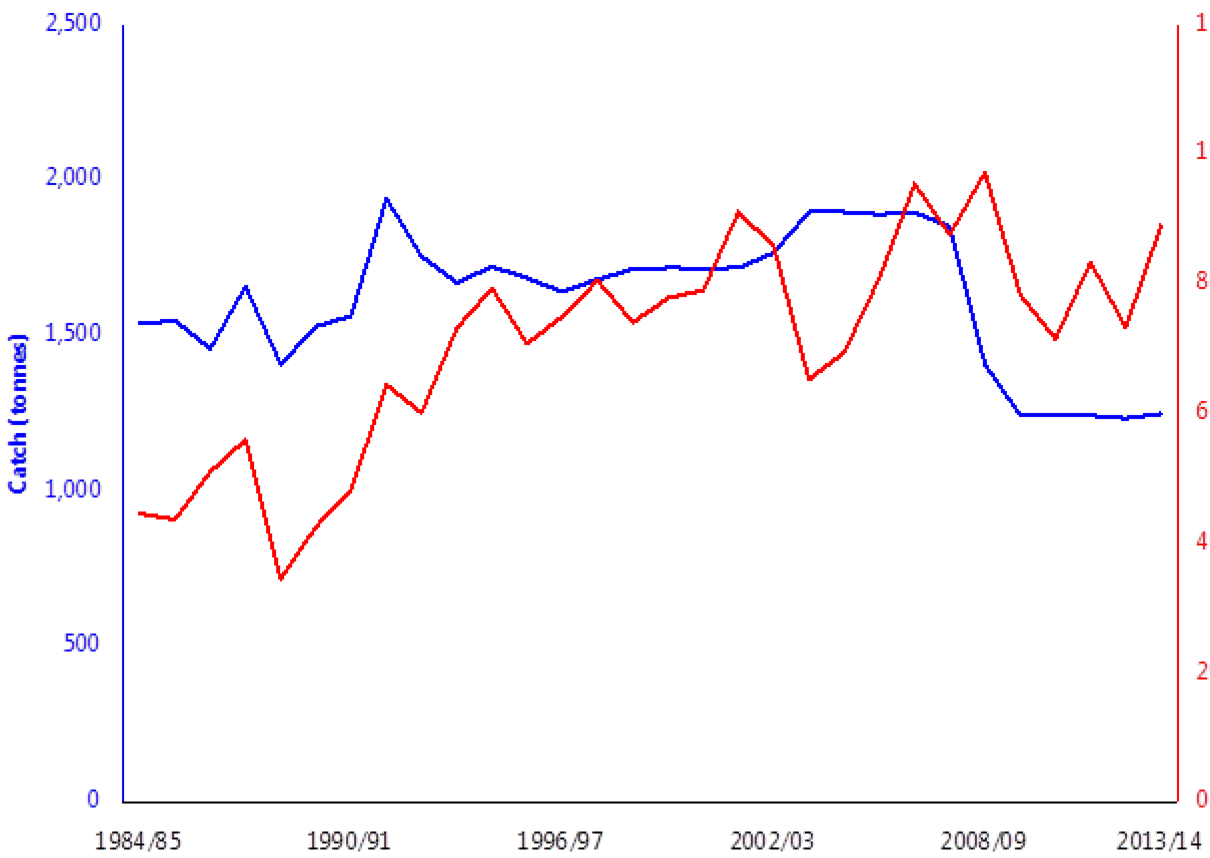
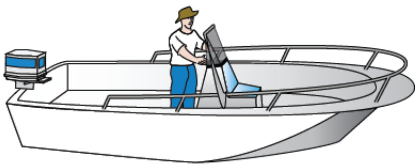


Figure 60. Catch and value of catch for the Southern Zone Rock Lobster Fishery. Value of catch has been adjusted to real terms (2013/14 dollars) using the consumer price index for Adelaide. Source: EconSearch (2014b).

5.8.2 Abalone Fishery



Three zones form the South Australian Abalone Fishery; the Western Zone, which extends from the WA border to near Arno Bay on Eyre Peninsula, the Central Zone, which extends from Cowell to west of the Murray Mouth, and the Southern Zone, which extends from Cape Jaffa to the Victorian Border. The South Australian Abalone Fishery allows removal of greenlip and blacklip abalone. Fishing is conducted on subtidal reef habitat. There are 22 licences in the Western Zone (Stobart et al. 2015a). The main regional areas associated with the fishery are Port Lincoln, Streaky Bay and Elliston (PIRSA 2009). There are 6 licences in the Central Zone (Mayfield et al. 2014). The main regional areas associated with the fishery are Port Hughes and Kangaroo Island (PIRSA 2009). There are 6 licences in the Southern Zone (PIRSA 2015a). The main regional area associated with the fishery is Mount Gambier (PIRSA 2009).

Park-specific baseline information on the Abalone Fishery is presented in the individual baseline reports (Bryars et al. 2016a-s). Baseline information on the Abalone Fishery relevant to South Australia includes:

- The annual value of the Western Zone Abalone Fishery catch rose from about $16 million in 1990/91 to a peak of about $33 million in 2000/01, and has since been between $18 and $27 million (EconSearch 2015c, Figure 61).
- The annual value of the Central Zone Abalone Fishery catch rose from $5.2 million in 1990/91 to a peak of $12.1 million in 2000/01, and has since ranged between $5.7 and $10.3 million (EconSearch 2015c, Figure 62).

- The annual value of the Southern Zone Abalone Fishery catch rose from about $3.5 million in 1990/91 to a peak of about $10 million in 2000/01, and was about $3.4 million in 2013/14 (EconSearch 2015c, Figure 63).
- SARDI collates monthly fishery logbook data for individual map codes and spatial assessment units (see Appendix C), validates it using catch disposal records (Vainickis 2010), and provides summaries of catch, effort and catch rates in annual stock assessment and stock status reports (Stobart et al. 2014, 2015a, b, Mayfield et al. 2014, Mayfield and Ferguson 2015, Mayfield et al. 2015).

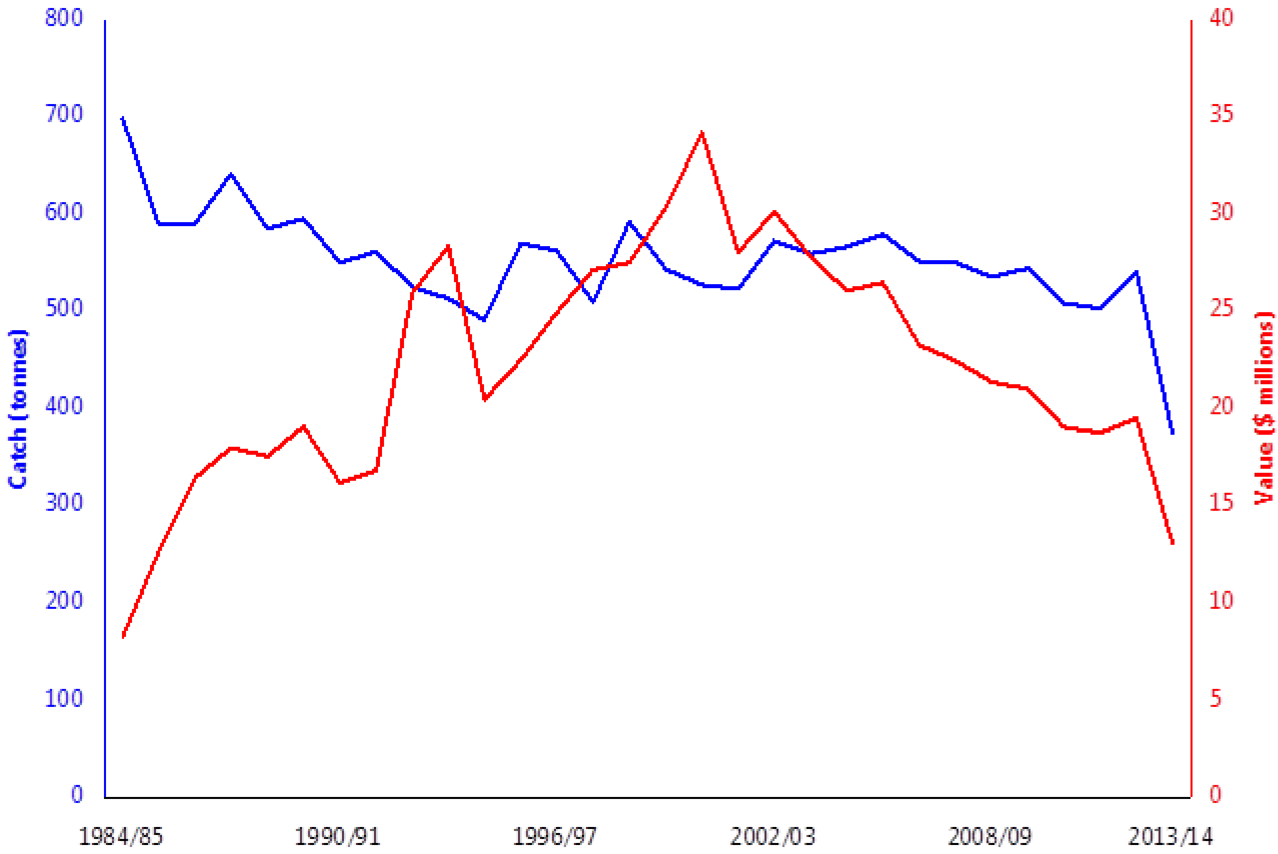


Figure 61. Catch and value of catch for the Western Zone Abalone Fishery. Value of catch has been adjusted to real terms (2013/14 dollars) using the consumer price index for Adelaide. Source: EconSearch (2015c), Knight and Tsolos (2012).

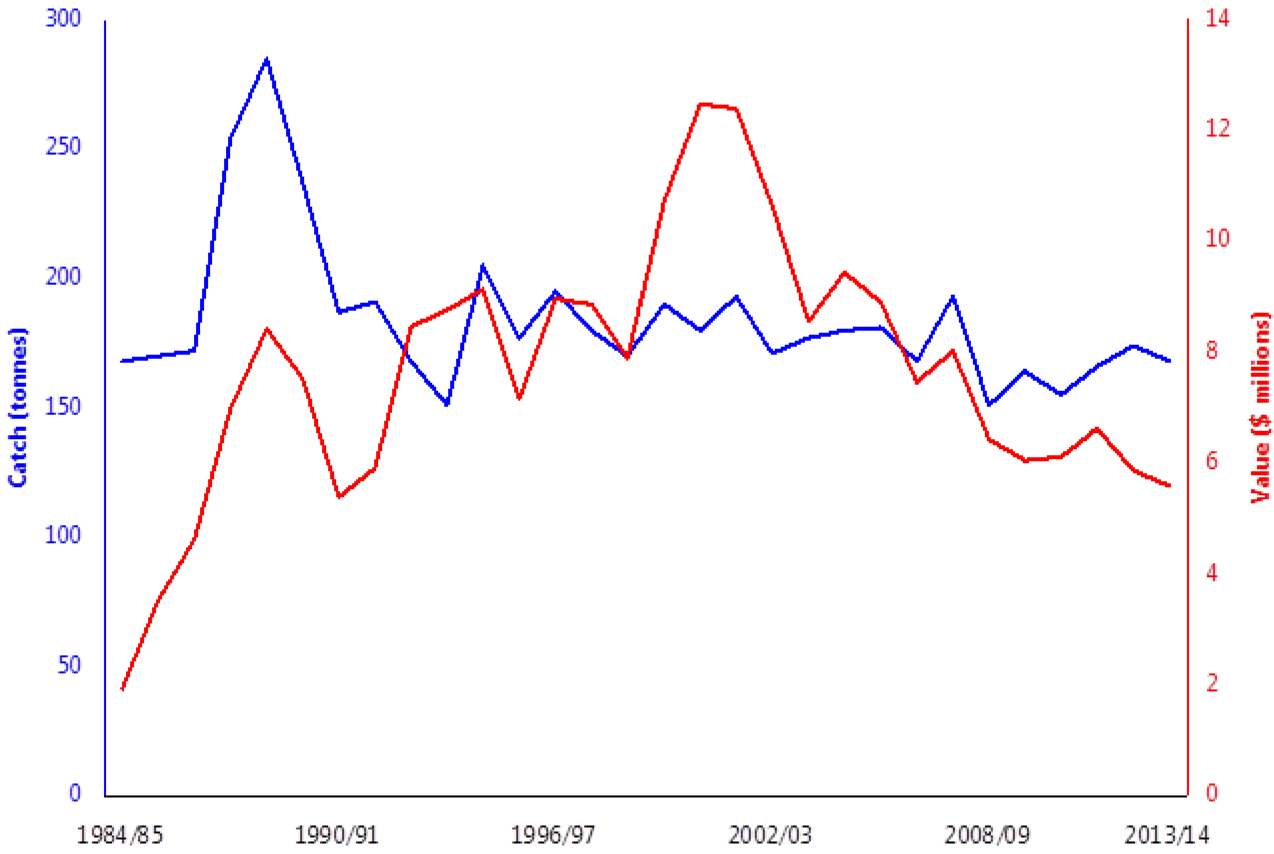


Figure 62. Catch and value of catch for the Central Zone Abalone Fishery. Value of catch has been adjusted to real terms (2013/14 dollars) using the consumer price index for Adelaide. Source: EconSearch (2015c), Knight and Tsolos (2012).

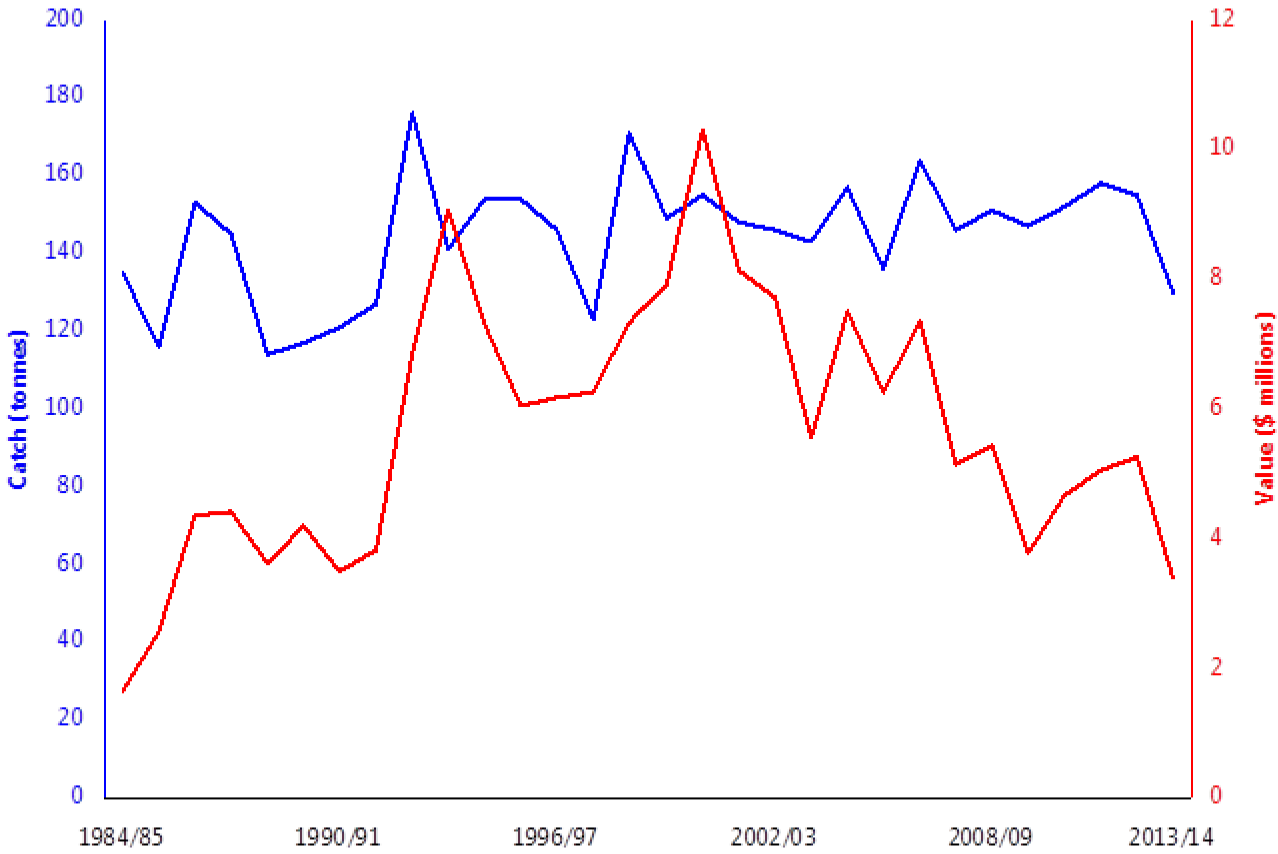


Figure 63. Catch and value of catch for the Southern Zone Abalone Fishery. Value of catch has been adjusted to real terms (2013/14 dollars) using the consumer price index for Adelaide. Source: EconSearch (2015c), Knight and Tsolos (2012).

5.8.3 Prawn Fishery

There are three sectors of the South Australian Prawn Fishery which targets western king prawn using an otter trawl; the West Coast Prawn Fishery, the Spencer Gulf Prawn Fishery and the Gulf St Vincent Prawn Fishery. Fishing is conducted on subtidal sand habitat. In the West Coast Prawn Fishery there are currently 3 licences. Fishing has not occurred in the region since 2009 but could recommence (Beckmann and Hooper 2015a). There are currently 39 licences in the Spencer Gulf Prawn Fishery (Noell and Hooper 2015). There were 10 licences in 2009/10 in the Gulf St Vincent Prawn Fishery (Beckmann et al. 2015) which then closed in December 2012 (PIRSA 2012) but reopened in November 2014.

Park-specific baseline information on the Prawn Fishery is presented in the individual baseline reports (Bryars et al. 2016a-s). Baseline information on the Prawn Fishery relevant to South Australia includes:

- The annual value of the West Coast Prawn Fishery ranged between $0.3 and $3.7 million between 1984/85 and 2010/11 and was $1.8 million in 2010/11 (Knight and Tsolos 2012, Figure 64).
- The annual value of the Spencer Gulf Prawn Fishery was between $25 and $64 million between 1984/85 and 2013/14 (EconSearch 2015c, Figure 65).

- The annual value of the Gulf St Vincent Prawn Fishery ranged between about $2 and $11 million between 1984 and 2011 (Knight and Tsolos 2012, Figure 66).
- SARDI collates monthly fishery logbook data for individual fishing blocks (see Appendix C) and provides summaries of catch, effort and catch rates every few years in fishery assessment reports (Beckmann et al. 2014, Beckmann and Hooper 2015a, Noell et al. 2014b, Noell and Hooper 2015, Dixon et al. 2012, Beckmann et al. 2015).

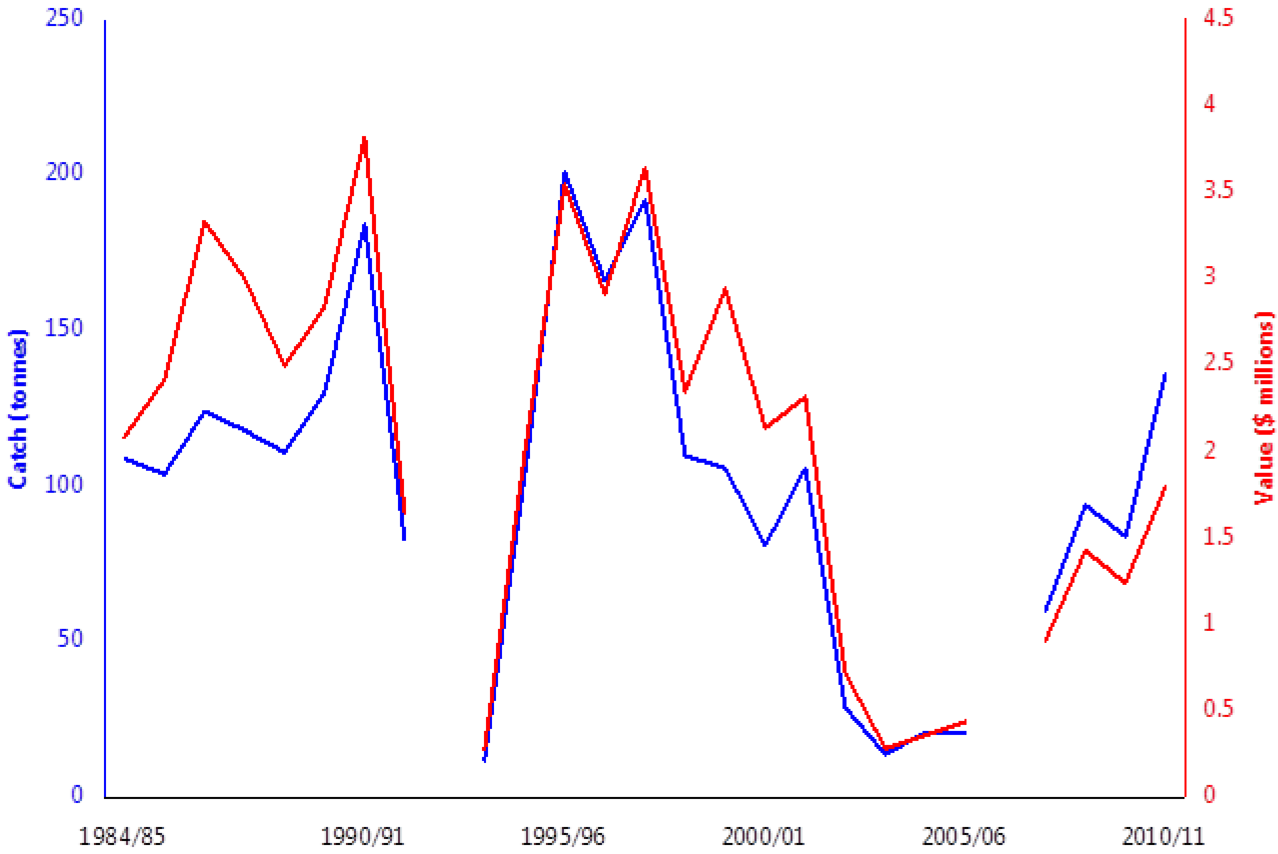


Figure 64. Catch and value of catch for the West Coast Prawn Fishery. Value of catch has been adjusted to real terms (2013/14 dollars) using the consumer price index for Adelaide. Note that the fishery was closed in 1992/93 and 2006/07. Source: Knight and Tsolos (2012).

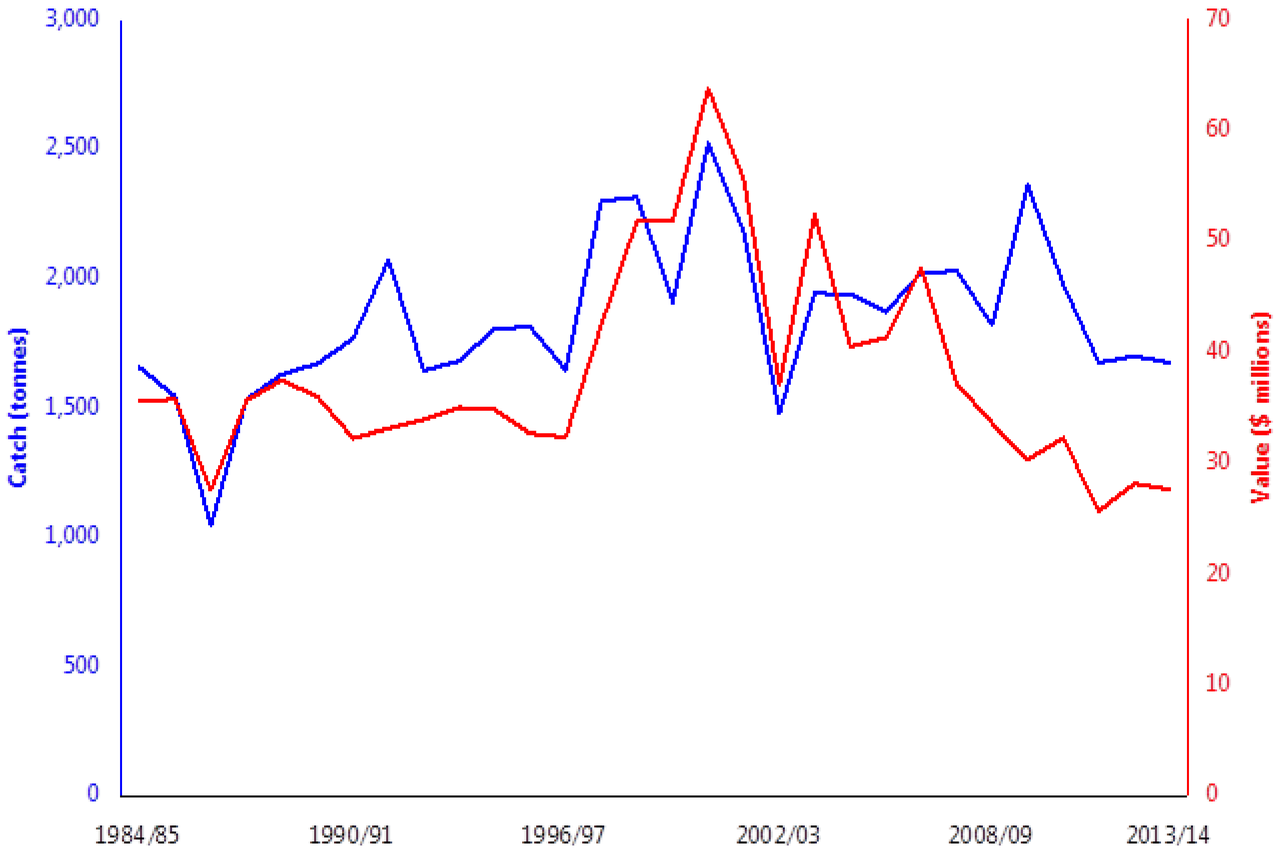


Figure 65. Catch and value of catch for the Spencer Gulf Prawn Fishery. Value of catch has been adjusted to real terms (2013/14 dollars) using the consumer price index for Adelaide. Source: Knight and Tsolos (2012).

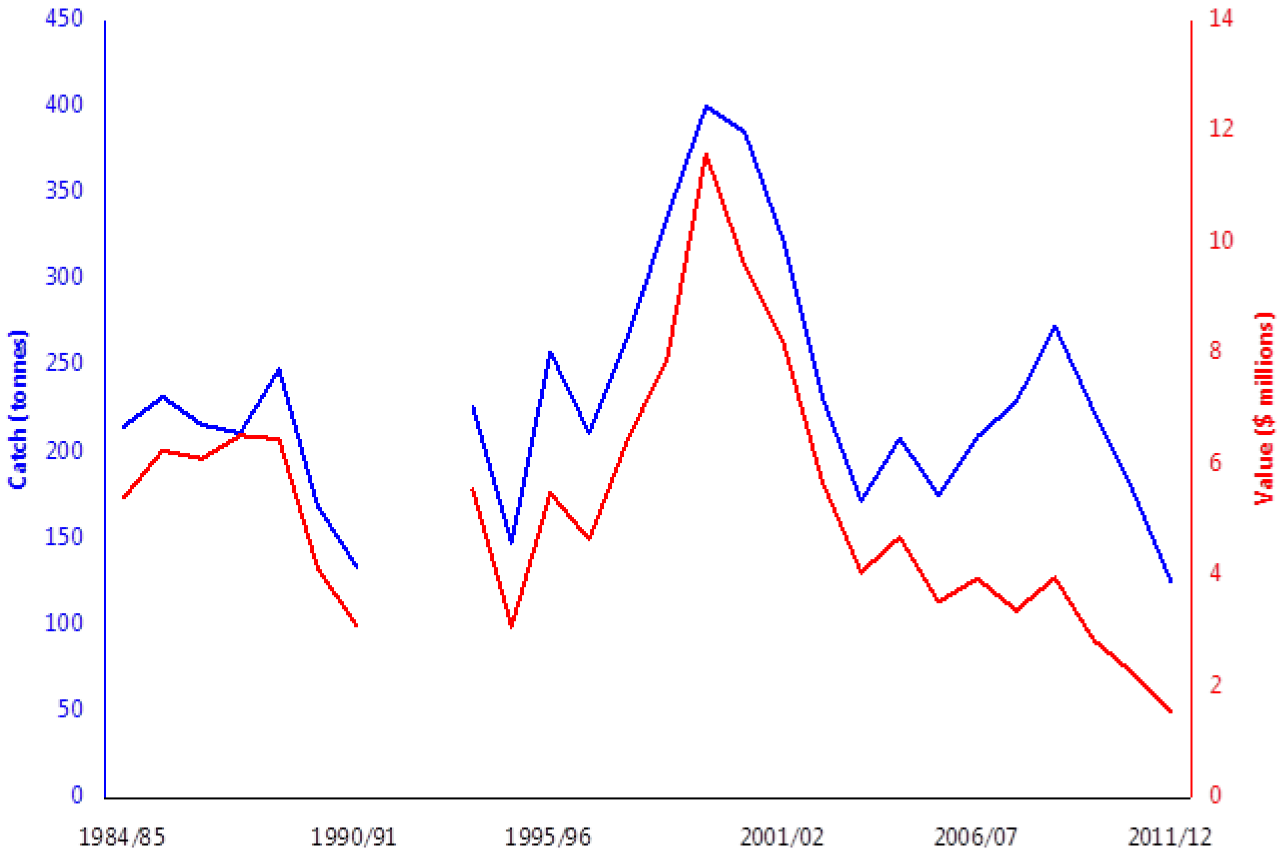
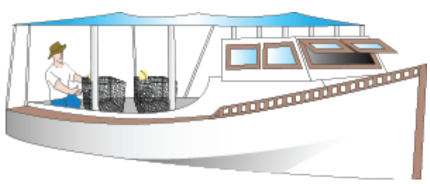


Figure 66. Catch and value of catch for the Gulf St Vincent Prawn Fishery. Value of catch has been adjusted to real terms (2013/14 dollars) using the consumer price index for Adelaide. Note that the fishery was closed in 1992/93 and 2006/07. Source: Knight and Tsolos (2012).

5.8.4 Blue Crab Fishery



The South Australian Blue Crab Fishery is divided into two zones, the Spencer Gulf fishing zone and the Gulf St Vincent fishing zone. This fishery uses specifically designed pots to target blue swimmer crab, although other crab species may also be landed (Beckmann and Hooper 2015b). Fishing is conducted on subtidal reef, seagrass and sand habitats. There are 5 Blue Crab Fishery licences for the Spencer Gulf sector which take about half of the statewide catch, and there are 4 Blue Crab Fishery licences for the Gulf St Vincent sector which take about half of the statewide catch. There are also 3 Marine Scalefish Fishery licences with blue crab quota entitlements, which take only about 1 per cent of the statewide catch (Beckmann and Hooper 2015b). Most of the commercial catch is sold at the Sydney and Melbourne fish markets.

Park-specific baseline information on the Blue Crab Fishery is presented in the individual baseline reports (Bryars et al. 2016a-s). Baseline information on the Blue Crab Fishery relevant to South Australia includes:

- The annual statewide value of the Blue Crab Fishery was between $3.2 and $6.4 million between 1996/97 and 2012/13 (Knight and Tsolos 2012, EconSearch 2014e, Figure 67).
- SARDI collates monthly fishery logbook data for individual fishing blocks (see Appendix C) and provides summaries of catch, effort and catch rates in fishery assessment reports (Noell et al. 2014a).
- The total annual catch of the Blue Crab Fishery was about 464 tonnes in 1996/97 (when quota was introduced) and about 569 tonnes in 2012/13 (EconSearch 2014e, Figure 67).

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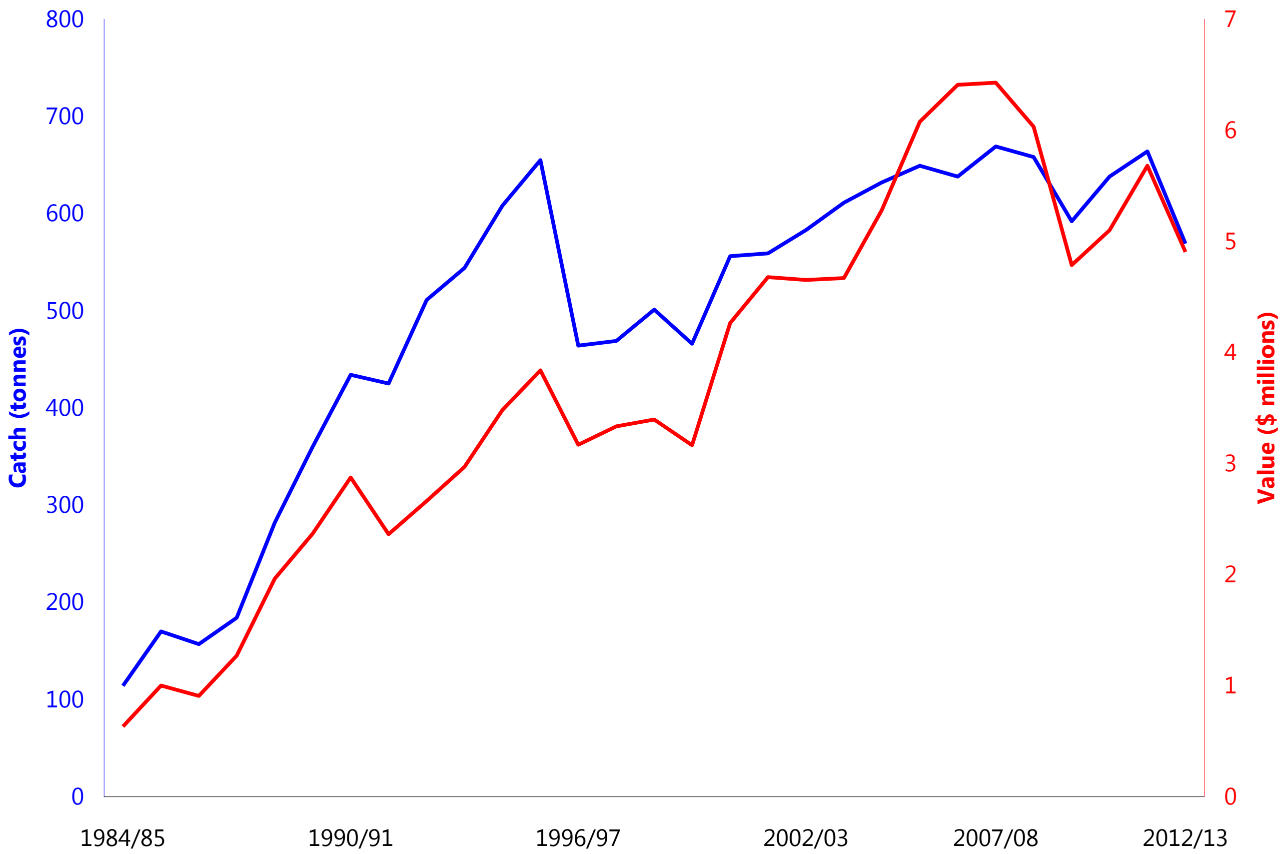
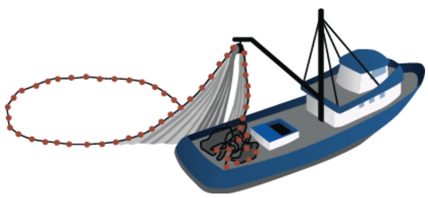


Figure 67. Catch and value of catch for the Blue Crab Fishery. Value of catch has been adjusted to real terms (2012/13 dollars) using the consumer price index for Adelaide. Source: EconSearch (2014e).

5.8.5 Sardine Fishery

The South Australian Sardine Fishery targets Australian Sardine using a purse seine net, and is also permitted to take Australian Anchovy (PIRSA 2014c). Fishing is conducted in the pelagic environment over benthic habitats. There are 14 licences, with fishing activity concentrated at the southern end of Spencer Gulf but some fishing near Western Eyre Peninsula (including near Flinders and Cap Islands), in Investigator Strait and to the west of Kangaroo Island (PIRSA 2014c, Ward et al. 2015).



Park-specific baseline information on the Sardine Fishery is presented in the individual baseline reports (Bryars et al 2016a-s). Baseline information on the Sardine Fishery relevant to South Australia includes:

- The statewide value of the Sardine Fishery was between $18 and $30 million between 2002/03 and 2013/14, and was $19 million in 2013/14 (EconSearch 2015d, Figure 68).
- SARDI collates trip logbook data for individual marine fishing areas (see Appendix C) and provides summaries of retained catches in a fishery assessment report (Ward et al. 2015). Most fishing occurs in the Spencer Gulf region (see Appendix C, Ward et al. 2015). The annual catch between 2003/04 and 2013/14 ranged between 25,000 and 47,000 tonnes (Ward et al. 2015).

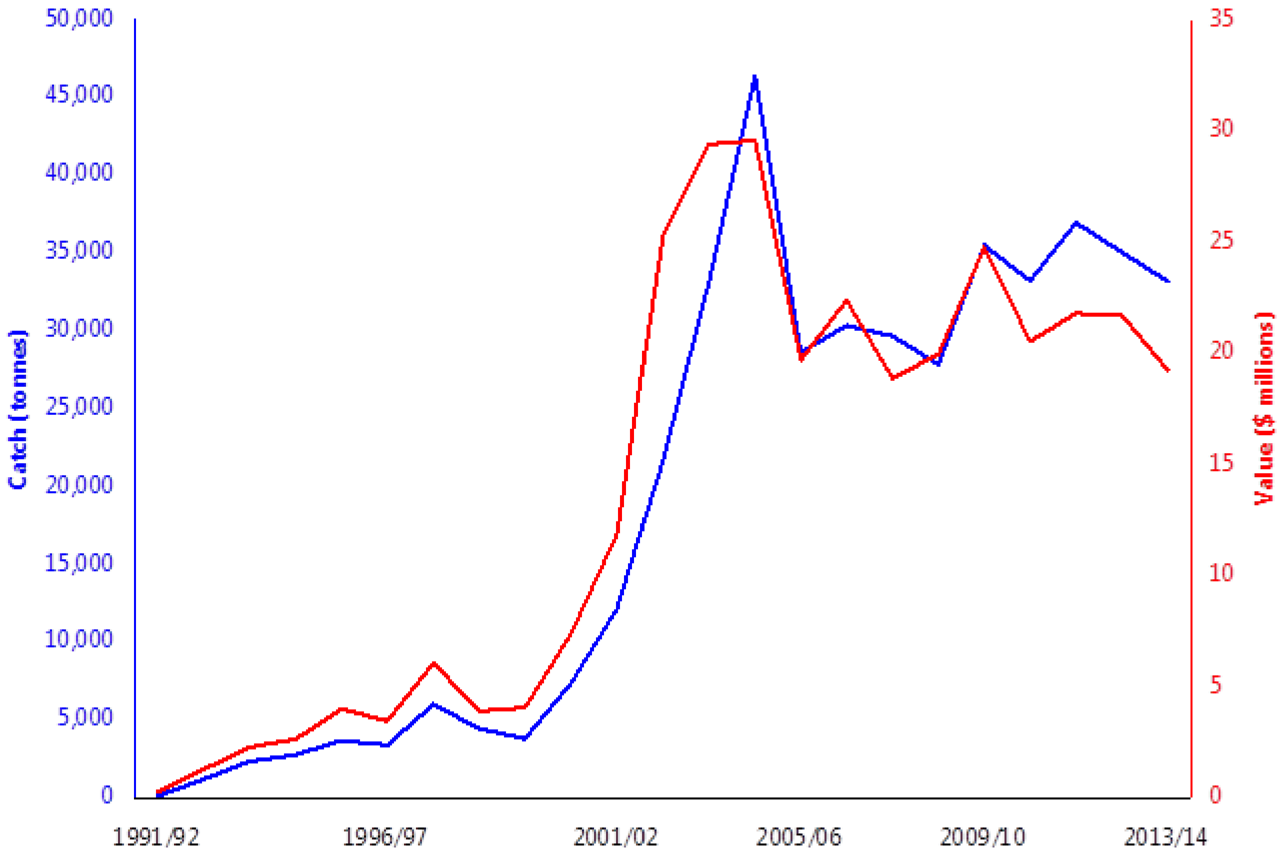
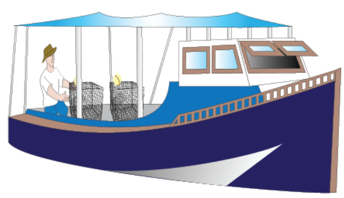


Figure 68. Catch and value of catch for the Sardine Fishery. Value of catch has been adjusted to real terms (2013/14 dollars) using the consumer price index for Adelaide. Source: EconSearch (2014e).

5.8.6 Marine Scalefish Fishery



The Marine Scalefish Fishery is a statewide, multi-gear fishery that targets more than 50 species, of which the 4 most important are King George whiting, snapper, southern calamary and southern sea garfish (PIRSA 2013b). Fishing is conducted mainly on subtidal reef, seagrass and sand habitats. There are 309 Marine Scalefish and 12 Restricted Marine Scalefish Fishery licences (PIRSA 2015a). Most fishing effort is concentrated in Spencer Gulf and Gulf St Vincent. Razorfish and mud cockles are also targeted by some Marine Scalefish licence holders.

Park-specific baseline information on the Marine Scalefish Fishery is presented in the individual baseline reports (Bryars et al. 2016a-s). Baseline information on the Marine Scalefish Fishery relevant to South Australia includes:

- The annual statewide value of the Marine Scalefish Fishery was between $21 and $40 million between 1987/88 and 2013/14 (Knight and Tsolos 2012, EconSearch 2015e).
- SARDI collates monthly fishery logbook data for individual marine fishing areas (see Appendix C) and provides summaries of catch, effort and catch rates for the most important species every few years in fishery assessment reports (Steer et al. 2007, 2012, Fowler et al. 2012, 2013a, b, 2014a, b). The total annual statewide catch of the Marine Scalefish Fishery was about 3,000 tonnes in 2008/09 and about 2,300 tonnes in 2013/14 (EconSearch 2014e, Figure 69).

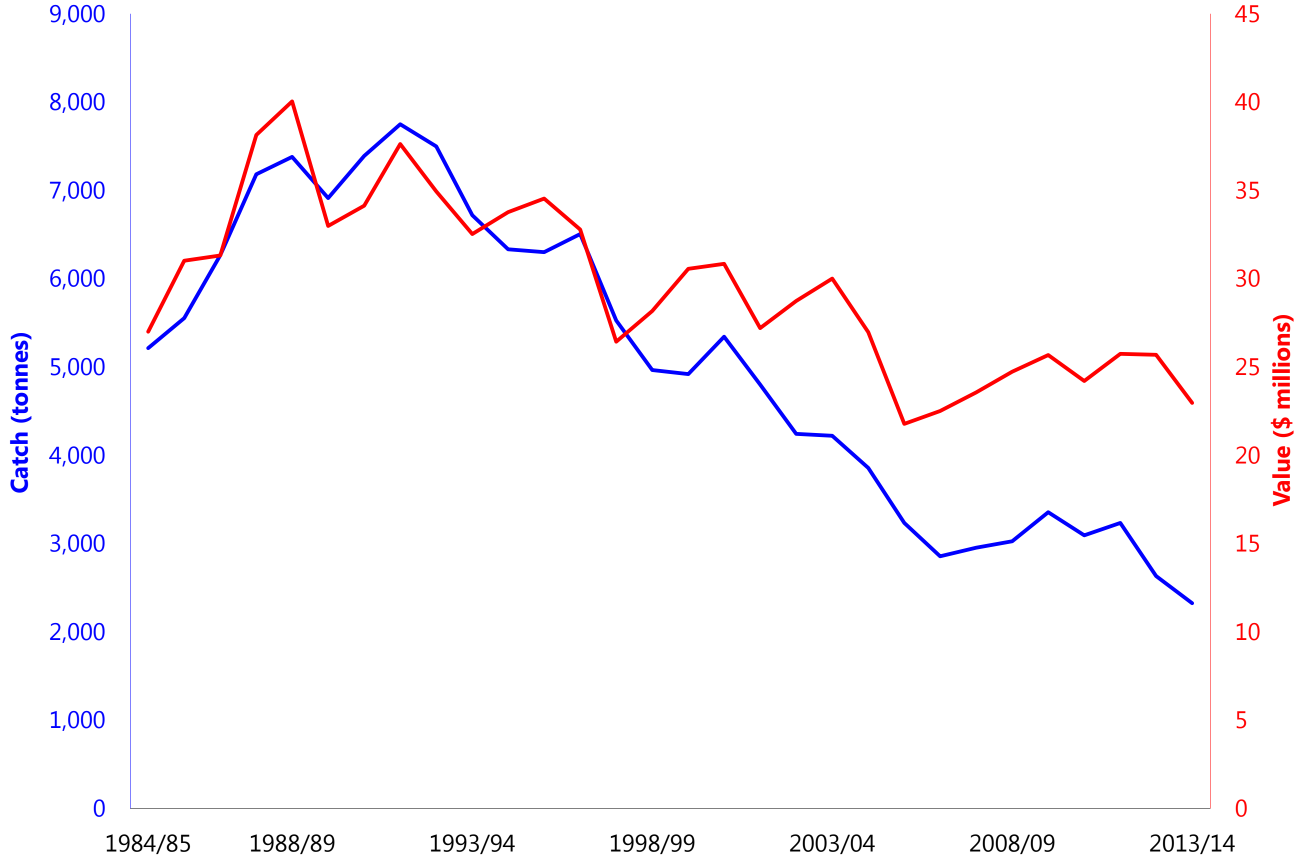
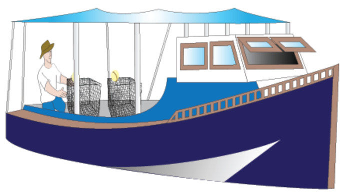


Figure 69. Catch and value of catch for the Marine Scalefish Fishery. Value of catch has been adjusted to real terms (2013/14 dollars) using the consumer price index for Adelaide. Source: EconSearch (2014e).

5.8.7 Charter Boat Fishery



The Charter Boat Fishery (Tsolos 2013) is a statewide multi-gear fishery that typically targets King George whiting, snapper, bight redfish and southern sea garfish. Fishing is conducted mainly on subtidal reef, seagrass and sand habitats. There are 109 licences (77 are active) and 148 registered vessels (80 are active) across the state (Tsolos 2013).

Park-specific baseline information on the Charter Boat Fishery is presented in the individual baseline reports (Bryars et al. 2016a-s). Baseline information on the Charter Boat Fishery relevant to South Australia includes:

- The total statewide revenue of the Charter Boat Fishery was between $4.3 and $5.7 million between 2006/07 and 2013/14, and was about $4.3 million in 2013/14 (EconSearch 2015e, Figure 70).
- SARDI collated trip logbook data for individual marine fishing areas (see Appendix C) and provided summaries of retained catches in a fishery assessment report (Tsolos 2013). (Tsolos 2013). During 2009/10 and 2011/12, there was a decline in the number of fish harvested from about 4,200 to 3,100, a reduction in the proportion of bight redfish in the harvest from 37 to 12 per cent, and an increase in the proportion of King George whiting from 16 to 37 per cent (Tsolos 2013).

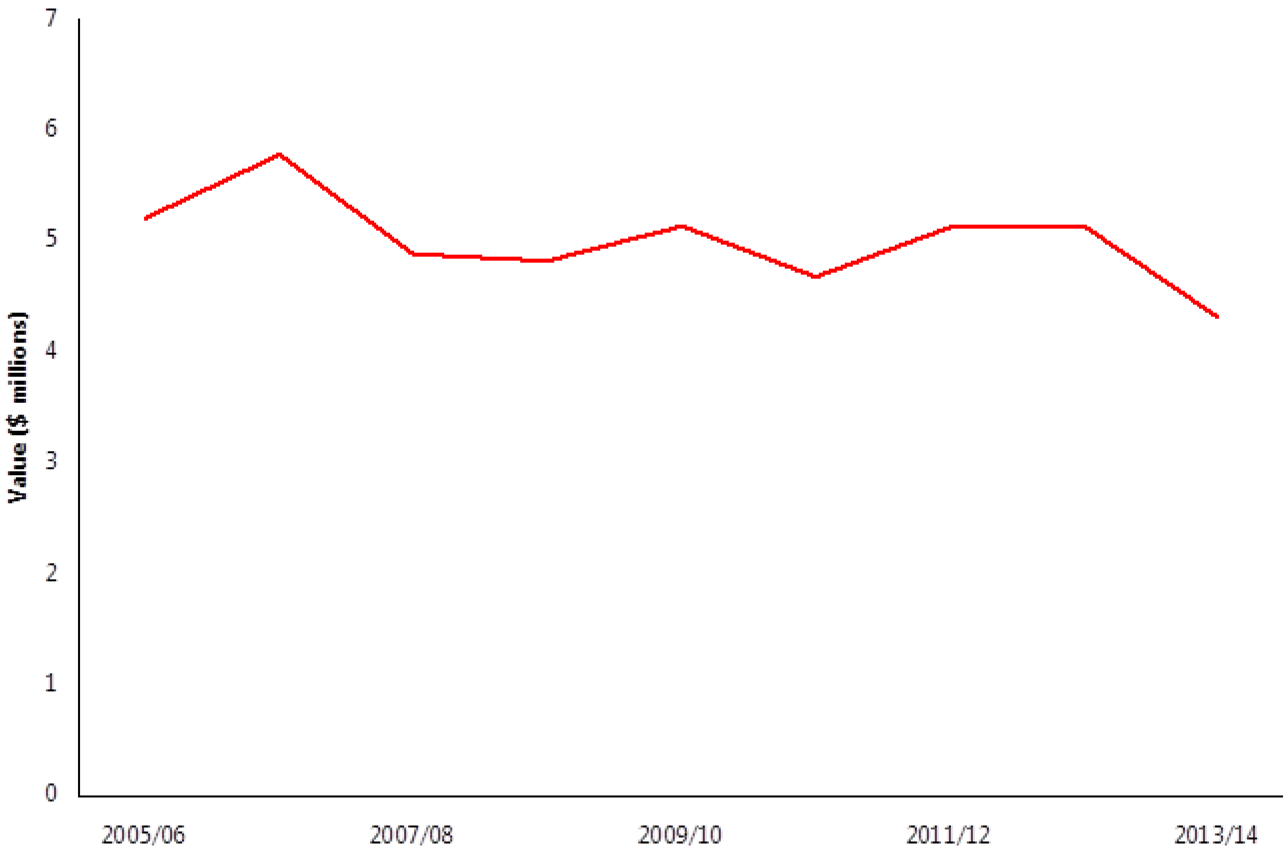


Figure 70. Total statewide revenue for the Charter Boat Fishery. Revenue of catch has been adjusted to real terms (2013/14 dollars) using the consumer price index for Adelaide. Revenue was calculated from the total number of clients and an average price per person. Source: EconSearch (2014f).

5.8.8 Other South Australian managed fisheries

A Miscellaneous Fishery exists for South Australia. The Miscellaneous fishery includes: species that are not in management arrangements of existing commercial fisheries, specialised fisheries and multiple types of fishing gear (PIRSA 2016).

Many of the fisheries included are low production, low value, or both. Biological information on most of the miscellaneous species is limited (PIRSA 2016).

5.8.9 Commonwealth Shark Fishery

The Gillnet, Hook and Trap Sector of the Southern and Eastern Scalefish and Shark Fishery operates in waters offshore from Victoria, Tasmania and South Australia. The fishery is managed by the Australian Government but a permit from the Government of South Australia is required to fish in South Australian coastal waters (AFMA 2014). The sector has historically targeted gummy and school shark using hooks or gillnets, but in recent years the sector has been managed to rebuild the school shark stock. Byproduct species include elephant fish and sawsharks (Georgeson et al. 2014). Fishing is conducted mainly on subtidal reef and sand habitats. There are currently 61 tradeable shark gillnet statutory fishing rights, of which 40 are active (Georgeson et al. 2014). Primary ports include Adelaide and Port Lincoln. There were about 638 tonnes of gummy shark caught off western Eyre Peninsula (from Kangaroo Island to Point Fowler) between 2006 and 2008 (Goldsworthy et al. 2010), but fishing effort is now concentrated off Victoria as a result of spatial closures to reduce the bycatch of Australian sea lions and common dolphins (Georgeson et al. 2014). The primary markets for the fishery are in Sydney and Melbourne (Georgeson et al. 2014).

Baseline information on the Commonwealth Shark Fishery includes:

- The Australian Bureau of Agricultural and Resource Economics and Sciences produces annual reports on the catch, value and status of Commonwealth fisheries (Georgeson et al. 2014). The catch and value of the Gillnet, Hook and Trap Sector between 2002/03 and 2012/13 were between 1500 and 2200 tonnes and between $14 million and $23 million, respectively (Figure 71, Georgeson et al. 2014).

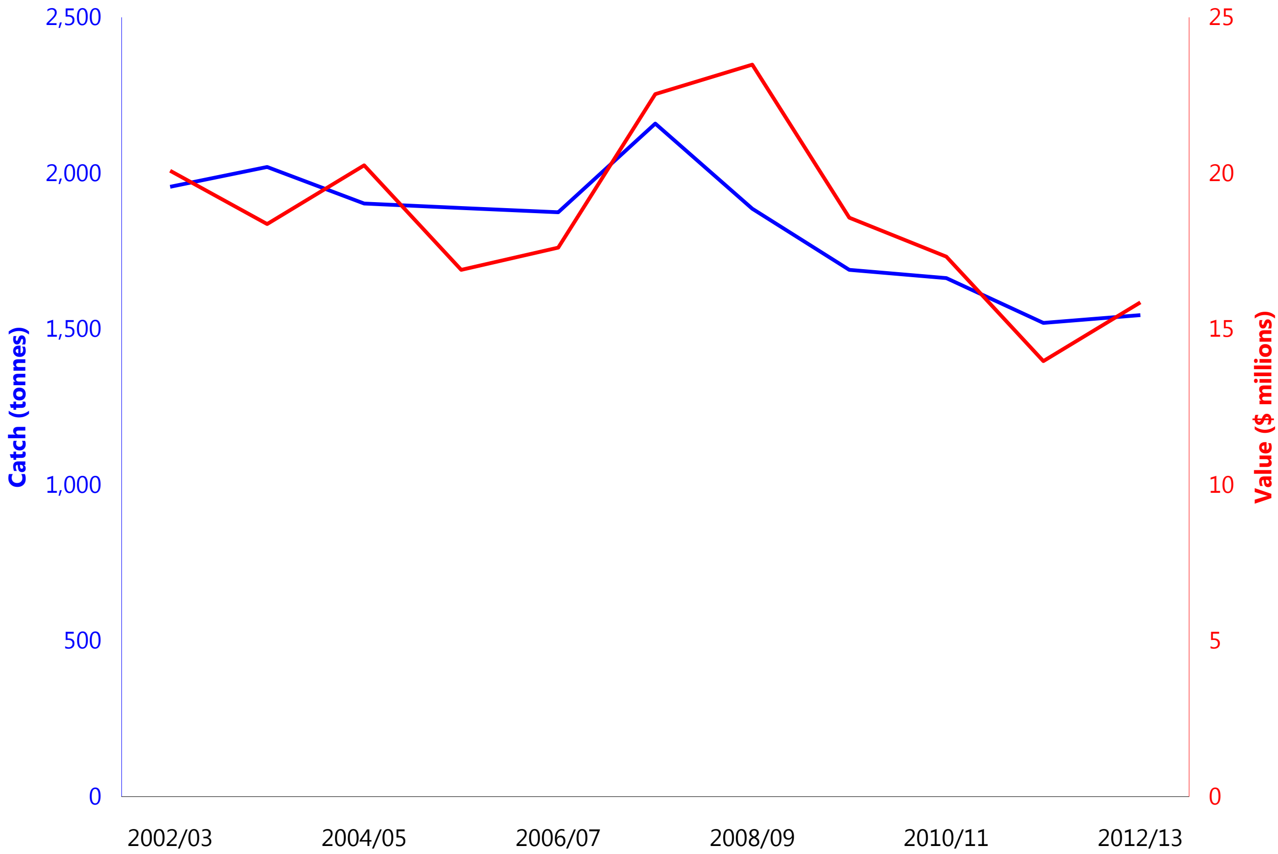


Figure 71. Catch and value of catch for the Shark Gillnet and Shark Hook sectors. Value of catch has been adjusted to real terms (2012/13 dollars). Source: Georgeson et al. 2014.

5.8.10 Fish prices

The value of catch presented in the above sections reflects the beach price for each commercial fishery. Market prices for fish are also important because they highlight the economic benefit to businesses involved in the supply chain, and the availability of seafood to the South Australian community and for export to Sydney and Melbourne.

Baseline information on South Australian fish prices includes:

- The Australian Bureau of Statistics produces a quarterly update of the Consumer Price Index (ABS 2015f). One component of this index is the 'Fish and other seafood' index. The price of seafood in Adelaide has fluctuated seasonally but risen on an annual basis over the past 40 years. Prices rose by about 33 per cent between 2004 and 2014 (ABS 2015f, Figure 72). . The index includes prices of products imported from both interstate and overseas, therefore changes in the index may reflect a broad range of factors, not just impacts relating to local production activity.

- DEWNR has recorded the retail prices for the 4 main Marine Scalefish Fishery species and 2 additional species (silver whiting and snook) at 3 Adelaide retail outlets from June 2014 to the present (DEWNR unpublished data). The price data are expressed as an index of change relative to the price in June 2014. For example, the index varied between 77 and 133 across the 3 stores over the year for King George whiting (Figure 73).
- EconSearch (2015e, and previous reports) published data on average annual beach prices (incorporating interstate markets, where relevant) for 19 species, and average monthly beach prices for 8 species (based on prices paid by a single fish processor).

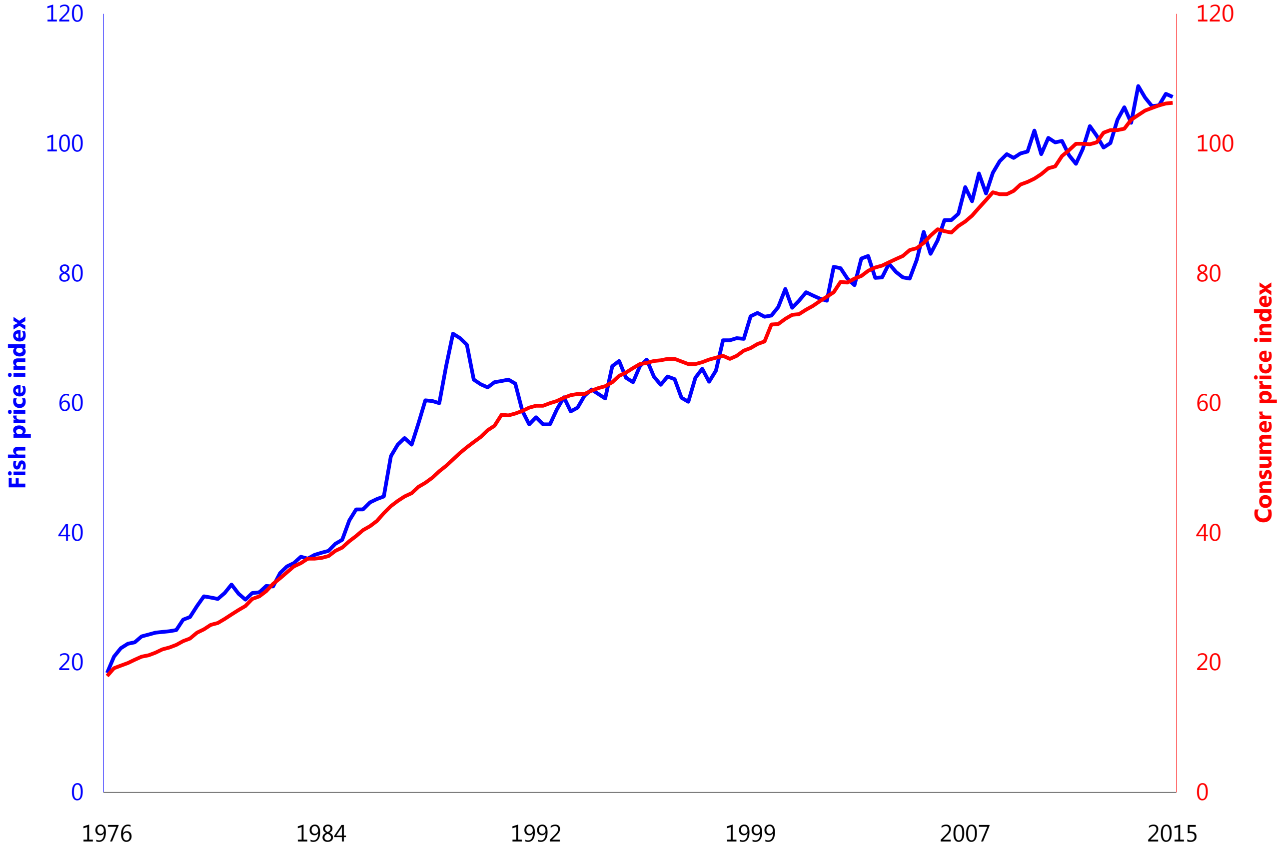


Figure 72. Fish and other seafood price index for Adelaide, compared with Consumer Price Index. Source: ABS (2015f).

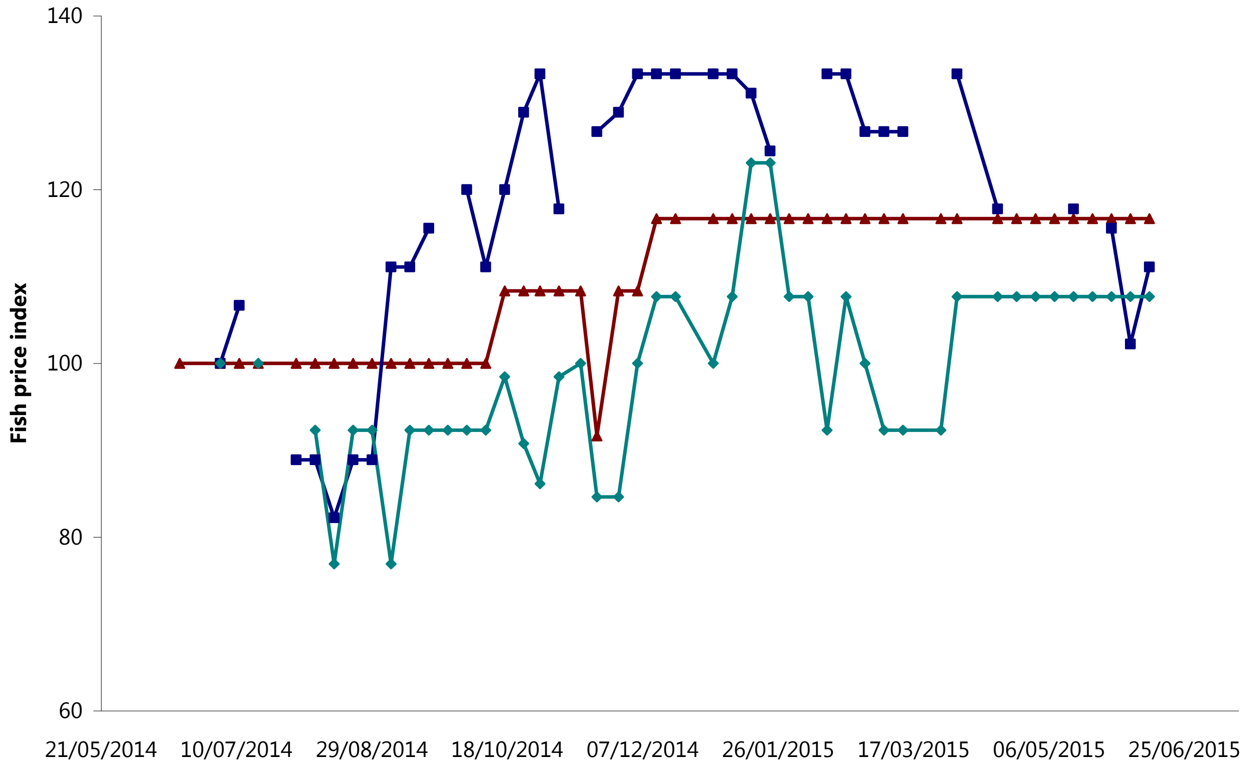


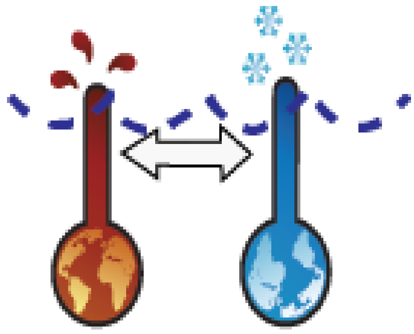
Figure 73. Changes in King George whiting prices at 3 Adelaide stores, with a different colour for each, between June 2014 and June 2015. Price is indexed to a value of 100 on 19 June 2014. Source: DEWNR unpublished data.

6 Physical drivers

To interpret monitoring data on ecological and socio-economic values in the marine parks MER program, it is necessary to include information on physical drivers. Physical drivers of change to ecological values include temporal variations in sea and air temperatures, salinity, upwellings, oceanic currents, waves and tides. These physical drivers can also influence socio-economic values, such as aquaculture and fisheries productivity (see below). Physical drivers may also be related to climate change, and other human-mediated pressure (Section 8.6). Other physical factors that shape ecosystems, but which do not drive temporal change, such as depth, bathymetry, topography and geology, are not considered here as the intent of each baseline report is to describe the key components of marine parks that should always be considered when monitoring for, and interpreting, change. More detailed consideration of other drivers is not precluded *a priori* from consideration and the MER framework provides for expansion beyond the minimum set of values and drivers listed here.

Data on physical oceanographic drivers are available through the Integrated Marine Observing System (IMOS), which is a collaboration of 8 institutions, including SARDI, led by the University of Tasmania (IMOS 2015). The IMOS marine monitoring infrastructure is designed to provide oceanographic information that is relevant at both ocean-basin and regional scales. In South Australia, most of the IMOS infrastructure is centred in the area to the south of Spencer Gulf and west of Kangaroo Island, an area with high primary and fisheries productivity.

6.1 Sea surface temperature



Sea surface temperatures in state waters generally range from 11–12 °C in winter and 18–20 °C in summer. In the gulf waters sea surface temperatures in summer can get a lot higher; in the upper reaches of Spencer Gulf it can reach 29 °C (DENR 2010). Sea surface temperatures generally follow a seasonal pattern related to air temperature (Bureau of Meteorology 2015b, Figure 74). Areas offshore may be influenced by upwellings of cold water and the input of warmer and cooler water via the Leeuwin and Flinders Currents, respectively (see Sections 6.4 and 6.5).

Information on sea surface temperature will be required to interpret changes in ecological and socio-economic indicators. For example, inter-annual variations in the amplitude and timing of temperature changes within South Australia may influence the following species:

- Australian herring growth rate increases with warmer temperature (Smith et al. 2013).
- Southern calamary growth, survival and hence recruitment increase with warmer temperatures (Steer et al. 2007).
- At Seal Bay on Kangaroo Island, Australian sea lion gestation periods increase and recruitment decreases with warmer temperatures (Goldsworthy et al. 2004, McIntosh et al. 2013).
- King George whiting grow most rapidly in late summer and autumn, when temperatures are highest (Fowler et al. 2014a).
- Snapper growth rates vary with water temperature (Fowler et al. 2013a), with slower growth apparent when water temperature in summer is low (Fowler and Jennings 2003).
- Rock lobster growth rates were highest in areas with higher water temperature (and/or lower density, Linnane et al. 2010, 2014).

- Abalone larval durations are influenced by temperature, and temperature is one of several factors that influence growth rates (Mayfield et al. 2014). Greenlip abalone recruitment increases with warmer temperatures (Shepherd and Edgar 2013).
- Blue swimmer crab hatching, larval survival and hence recruitment increases with warmer temperatures (Bryars 1997).
- Western king prawn have longer larval periods and hence decreased survival with cooler temperatures (Carrick 2008, Beckmann et al. 2014).

Baseline information on sea surface temperature relevant to South Australia includes:

- Geoscience Australia provides sea surface temperature data derived from the (United States Government) National Aeronautics and Space Administration's satellite-based Moderate-resolution Imaging Spectroradiometer images and image processing software. The data cover the entire Australian EEZ and surrounding waters (including the Southern Ocean). The data comprise monthly summaries from between 2002 and 2012, at a spatial resolution of 0.01 degrees (Huang 2013).
- As part of the IMOS, the Australian Bureau of Meteorology produces high-resolution sea surface temperature data from Advanced Very High Resolution Radiometer sensors on the National Oceanic and Atmospheric Administration satellites and drifting buoy sea surface temperature observations (IMOS 2015).
- The Australian Baseline Sea Level Monitoring Project monitors sea level and meteorological data, including water temperature, at an array of stations, including Thevenard, Port Stanvac and Portland (in Victoria) (Bureau of Meteorology 2015b, Figure 74).
- Temperature data recorded by surface drifters are available from the international Drifting Buoy Data Assembly Center (NOAA 2015a).
- The International Comprehensive Ocean Atmosphere Data Set consists of digital dataset DSI-1173, archived at the (United States Government) National Climatic Data Center. It is the world's largest collection of marine surface in situ observations, with a total of about 185 million records for years between 1784 and 2015 (NOAA 2015b).
- The Extended Reconstructed Sea Surface Temperature dataset is derived from the International Comprehensive Ocean–Atmosphere Data Set (NOAA 2015c, Huang et al. 2015). It is produced on a 2 degree by 2 degree grid and is available as monthly averages extending back to 1854 (NOAA 2015c).
- The COBE SST2 dataset is a global monthly sea surface temperature dataset derived from the International Comprehensive Ocean–Atmosphere Data Set (NOAA 2015d, Hirahara et al. 2014). It is produced on a 1 degree by 1 degree grid and is available as monthly averages extending back to 1854. It can be queried to obtain time series for a particular point and date range (NOAA 2015d).
- The Bureau of Meteorology (2015c) provides sea surface temperature anomaly data (departure from the average of 15.3 degrees between 1961 and 1990) for southern Australia. This dataset is based on an earlier version of the NOAA Extended Reconstructed Sea Surface Temperature (Smith and Reynolds 2004)

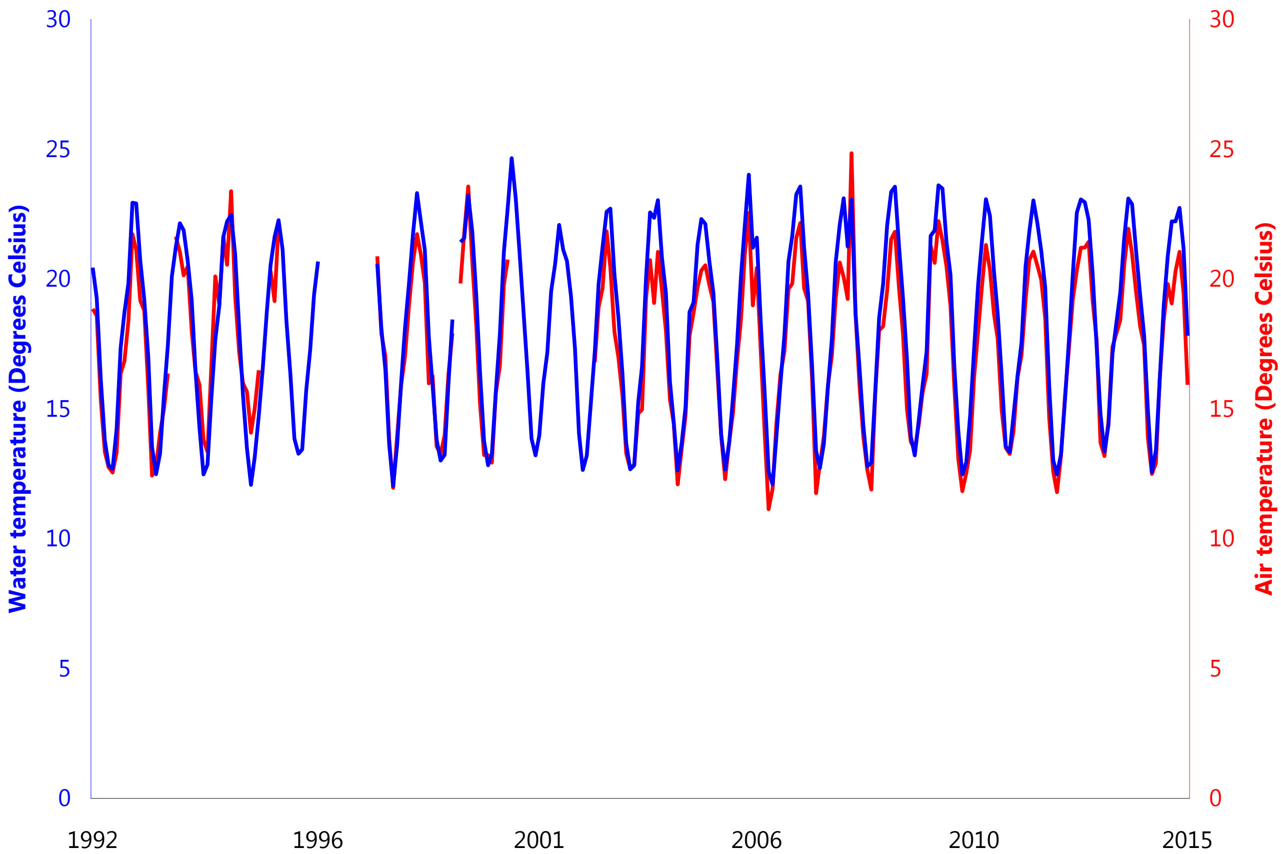
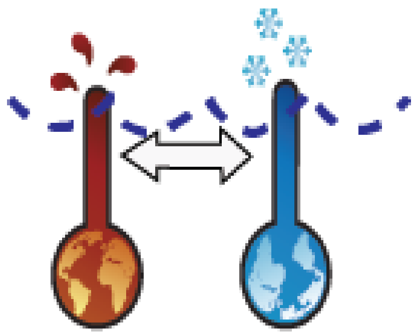


Figure 74. Air and water temperature at the Thevenard station of the Australian Baseline Sea Level Monitoring Project. Source: Bureau of Meteorology (2015b).

6.2 Air temperature



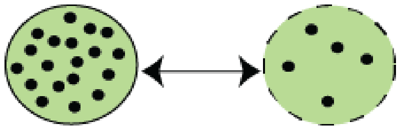
Information on air temperature may be required to interpret changes in ecological indicators because extreme temperatures can result in loss of biota, for example:

- High temperatures (in conjunction with low tides) caused seagrass loss in parts of Spencer Gulf (Seddon et al. 2000)
- Intertidal reef organisms are likely to be highly sensitive to increases in sea and air temperatures and increases in extreme temperature events (Bellgrove et al. 2013)
- Extreme heat can cause deaths in seabird chicks (Chambers et al. 2009).

Baseline information on air temperature relevant to South Australia includes:

- The Bureau of Meteorology provides time series of South Australian temperatures from 1910 to the present, as anomalies from the 1961–90 average. Separate time series are available for maximum and minimum temperatures (Bureau of Meteorology 2015d).
- The Australian Baseline Sea Level Monitoring Project monitors sea level and meteorological data at an array of stations, including Thevenard, Port Stanvac and Portland (in Victoria) (Bureau of Meteorology 2015b). Parameters measured include air temperature (Figure 74).

6.3 Salinity extremes



The majority of South Australia's state waters are considered oceanic where the salinity varies little (Millero et al. 2008) and would therefore not be influential on the values.

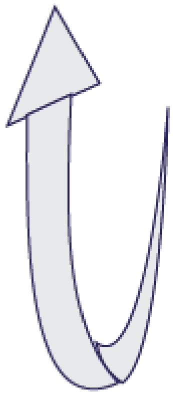
Spencer Gulf and Gulf St Vincent are classified as inverse estuaries in which salinity is higher at the top of the estuary than the bottom, i.e. salinity increases with distance from the mouth of the gulf. Salinities vary seasonally, with Spencer Gulf ranging from 39–48 parts per thousand (Nunes and Lennon 1986) and Gulf St Vincent ranging from 39–42 parts per thousand (de Silva Samarasinghe and Lennon 1987).

Information on salinity will be required to interpret changes in ecological and socio-economic indicators. For example, inter-annual variations in salinity could influence the growth, reproduction and survival of a number of species (BHP Billiton 2009).

Park-specific baseline information on salinity is presented in the individual baseline reports (Bryars et al. 2016a-s). Baseline information on salinity relevant to South Australia includes:

- The Hybrid Coordinate Ocean Model (HYCOM) is an operational global ocean model which assimilates data from satellites and the Argo global array of 3,000 free-drifting profiling floats that measures the temperature and salinity of the upper 2,000 m of the ocean (HYCOM Consortium 2015).

6.4 Upwellings



Upwellings of cold (11–12 °C), nutrient-rich water occurs in summer between Portland in Victoria and the Eastern Great Australian Bight (Herzfeld and Tomczak 1999). These upwellings are driven by strong south-easterly winds that push surface water away from the coast and encourage deep, nutrient rich, water to flow to the surface (Middleton and Platov 2003, Middleton and Bye 2007). El Niño–Southern Oscillation events are characteristically associated with stronger, more persistent south-easterly winds during summer and can enhance upwellings (Middleton and Bye 2007). Upwellings near Kangaroo Island draws from a pool of cold water (the "Kangaroo Island Pool") that originates from the Murray Canyons south of the island (McClatchie et al. 2006). The Bonney Upwelling brings cold (11–12 °C), nutrient-rich water in summer across the relatively narrow continental shelf between Portland and Robe (Butler et al. 2002). This upwelling is driven by strong south-easterly winds (Middleton and Platov 2003, Middleton and Bye 2007).

Information on upwellings will be required to interpret changes in ecological and socio-economic indicators. For example, inter-annual variations in the strength of upwellings within South Australia could influence the following species:

- Growth rates in a range of species are influenced by water temperature (see Section 6.1).
- Rock lobster densities may increase due to increased phytoplankton productivity associated with upwellings (Linnane et al. 2015). Catch rates were found to increase in response to decreases in bottom temperature associated with upwellings (Feenstra et al 2014).
- Small pelagic fish including Australian sardines and anchovies benefit from increased phytoplankton production and associated enhancement of zooplankton (Ward et al. 2006). Predators of sardines and anchovies including long-nosed fur seals and southern bluefin tuna may also benefit (Ward et al. 2006, Goldsworthy et al. 2011).

Baseline information on upwellings relevant to South Australia includes:

- An index of upwelling based on wind stress has been developed (following the methods of van Ruth et al. 2010, Figure 75).

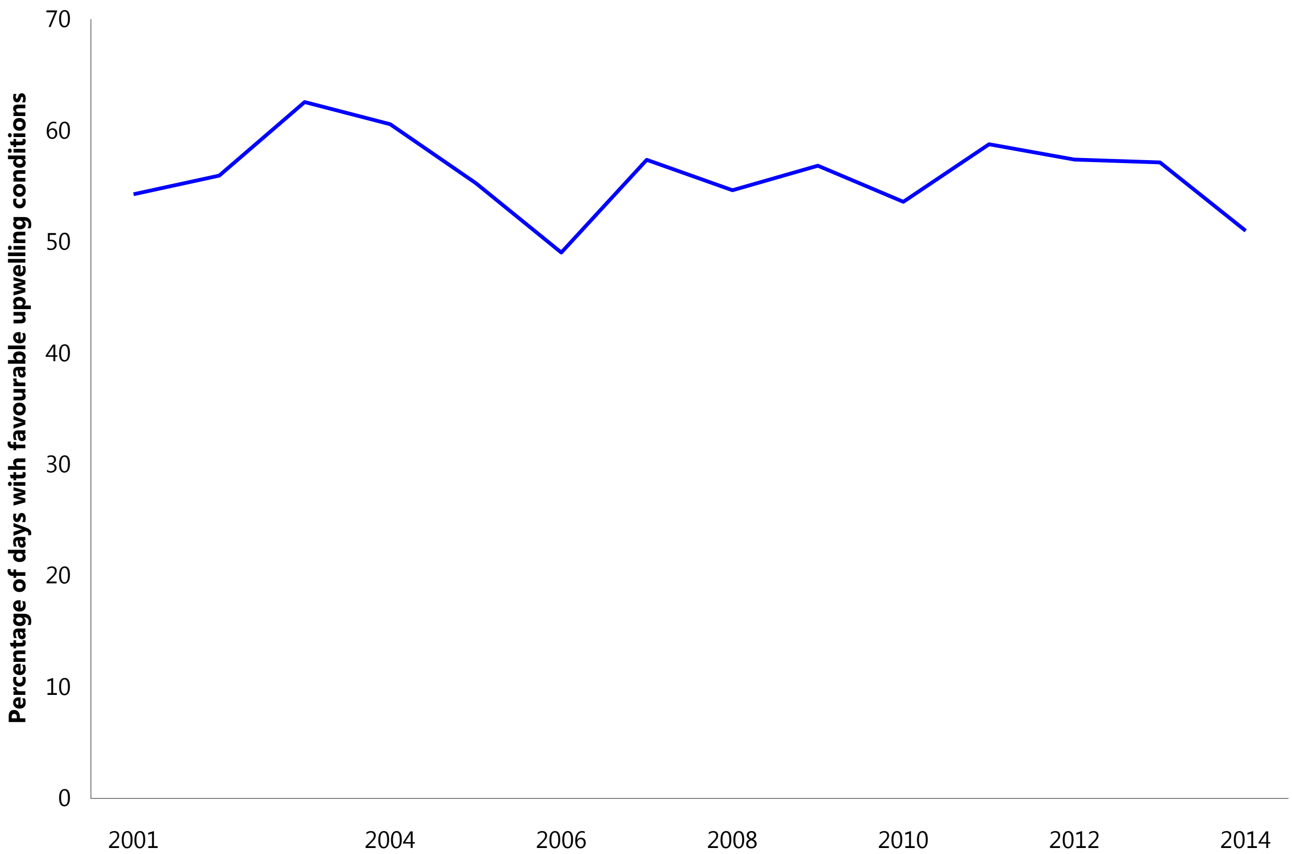
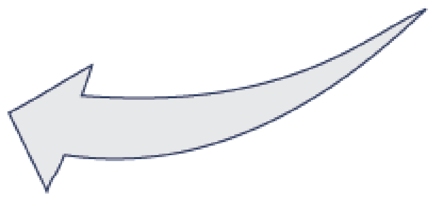


Figure 75. Percentage of days per year with favourable upwelling conditions, using an index of upwelling based on wind stress (following the methods of van Ruth et al. 2010). Data are missing for about 4 weeks in each year between 2000 and 2003 and about 1 week in 2010. Data were sourced from the Integrated Marine Observing System (IMOS) - IMOS is a national collaborative research infrastructure, supported by the Australian Government.

6.5 Oceanic currents

The Leeuwin Current brings relatively warm and low nutrient waters into the Eastern Great Australian Bight in winter (Middleton and Bye 2007). It is driven by the influx of tropical Pacific Ocean water into the Indian Ocean via the Indonesian throughflow. The strength of the Leeuwin Current is weaker during El Niño–Southern Oscillation events (Feng et al. 2003).



Two major boundary currents influence the South East coast of South Australia; the Flinders Current and the South Australian Current. The Flinders Current is a deep south-east to west flowing current which brings cooler water from the west Tasmanian shelf (Middleton and Bye 2007). Seasonally the South Australian Current flows eastward along the southern shelf (Middleton and Bye 2007).

Information on oceanic currents will be required to interpret changes in ecological and socio-economic indicators. For example, inter-annual variation in the strength of currents within South Australia could influence the following species:

- Australian herring recruitment in South Australia is higher during years of stronger Leeuwin Current (Smith et al. 2013).
- Western blue groper spawn during winter and larvae advected into South Australian waters by the Leeuwin Current may supplement local spawning (Shepherd and Brook 2007).

- Western king prawn recruitment in the West Coast Prawn Fishery may be affected by reduced larval supply to nurseries associated with a weaker Leeuwin Current (Carrick 2008, Beckmann et al. 2014).

Park-specific baseline information on oceanic currents is presented in the individual baseline reports (Bryars et al. 2016a-s). Baseline information on oceanic currents relevant to South Australia includes:

- The sea level at Fremantle is used as an index of the strength of the Leeuwin Current (Feng et al. 2003). Monthly sea levels from the Fremantle tide gauge are available (Bureau of Meteorology 2015e, Figure 76).

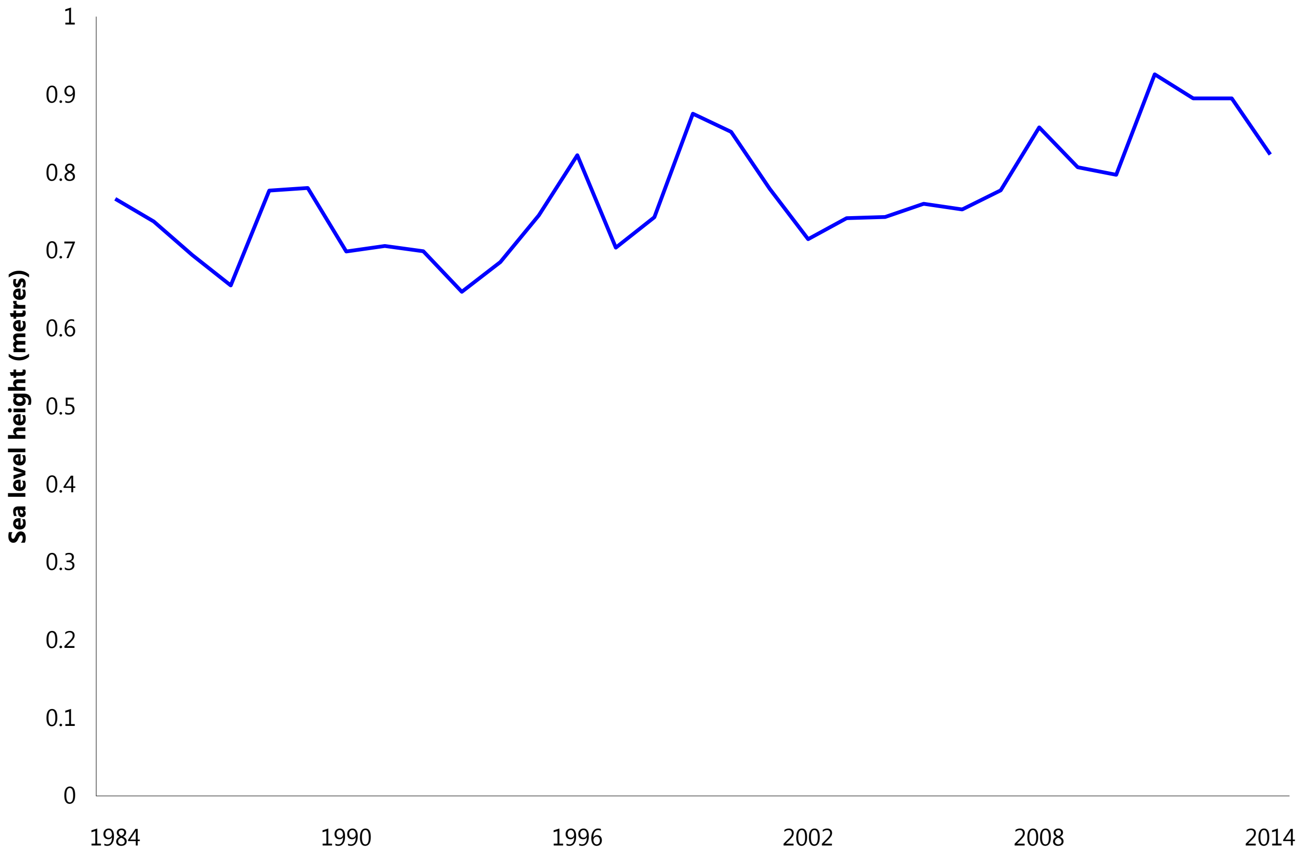
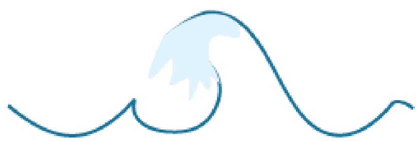


Figure 76. Annual maximum of monthly average sea levels at Fremantle, as an index of Leeuwin Current strength Source: Bureau of Meteorology (2015e).

6.6 Waves



The energy of breaking waves varies considerably throughout South Australia. High energy waves shape exposed cliffs, beaches, dunes, offshore islands such as the Isles of St Francis, Investigator Islands, Kangaroo island, and headlands. Semi-protected areas are characterised by moderate wave energy. Low wave energy is found in protected embayments and in the gulf environments (DENR 2010). The ecological values found in these different environments are influenced by their adaptations to wave energy. For example, the macroalga, *Cystophora moniliformis*, will grow in exposed reef environments but is absent from sheltered reef environments (Shepherd and Edgar 2013). Extreme variations in wave energy (e.g. a severe storm) can cause major perturbations to marine ecosystems. The intensity and frequency of storms are predicted to increase due to climate change (Section 8.6).

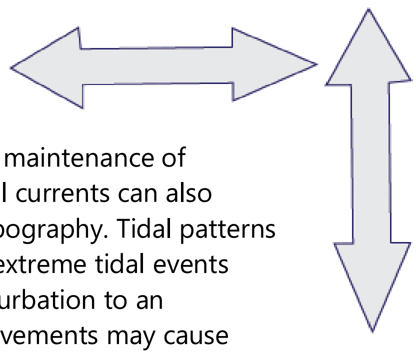
Information on waves will be required to interpret changes in ecological and socio-economic indicators. For example, storms and inter-annual variations in wave energy within South Australia could influence the following species:

- Rock lobster catch rates were found to increase with lower same-day wave heights, but decrease with lower wave heights averaged over the previous 3 days (Feenstra et al. 2014).
- Harlequin fish were found to temporarily migrate from their home territory during a storm (Bryars et al. 2012).
- Seagrass composition was changed by storms in Waterloo Bay during 1974, with climax species being replaced by successional species (Shepherd and Womersley 1981).
- Red algal biomass was found to be significantly correlated with an index of swell height (Shepherd 1979, 1981), and up to 30 per cent of the understorey algae could be torn out by storms each year (Baker et al. 2008).

Baseline information on waves relevant to South Australia includes:

- The Australian Baseline Sea Level Monitoring Project monitors sea level and meteorological data at an array of stations. Parameters measured include wind direction and speed (Bureau of Meteorology 2015b).
- The Bureau of Meteorology has a Waverider™ buoy that is 4 nautical miles west of Cape du Couedic off south-west Kangaroo Island (Bureau of Meteorology 2015f).

6.7 Tides and tidal currents



The Eucla, Murat, Eyre, Spencer Gulf, Coorong and Otway Bioregions are classified as having a micro-tidal tidal range (1.2 metres or less). The North Spencer Gulf and Gulf St Vincent Bioregions are classified as having a micro to mesotidal tidal range (between 1.8 and 3.6 metres or less, IMCRA Technical Group 1998). Inundation by regular tidal movement is critical to the maintenance of saltmarsh, mangrove and intertidal seagrass/sand ecosystems. Longshore tidal currents can also shape the biota of reef and sand ecosystems where flow is accentuated by topography. Tidal patterns are predictable and do not generally drive change in ecological values, but if extreme tidal events occur in conjunction with another physical factor, they can cause a major perturbation to an ecosystem. In addition, sea level rise (Section 8.6) in conjunction with tidal movements may cause major changes to intertidal ecosystems.

Information on tides will be required to interpret changes in ecological and socio-economic indicators. For example, low tides combined with extremely hot air temperatures and strong northerly winds were linked to large-scale seagrass diebacks in Spencer Gulf (Seddon et al. 2000), and it is possible that extreme weather and tidal conditions caused a mass mortality of mud cockles in Streaky Bay in 2013 (Dent et al. 2014).

Baseline information on tides relevant to South Australia includes:

- The Australian Baseline Sea Level Monitoring Project records sea level each hour at an array of stations (Bureau of Meteorology 2015b).

7 Socio-economic drivers

To interpret monitoring data on socio-economic values in the marine parks MER program, it will be necessary to include information on socio-economic drivers that can drive changes independent of the marine park management plans. A number of socio-economic drivers for the commercial fishing industry have been identified through risk and economic assessments (PIRSA 2009, 2010, 2011a, b, 2014a, Econsearch 2014b, c, d, e, f, g). Drivers include fuel prices, market forces (e.g. exchange rates, demand and product value), market access (e.g. trade agreements, marketing strategies and trade routes), interest rates on loans, and labour force (e.g. availability, cost). Many of these drivers were assessed as a high risk to the viability of commercial fisheries and must therefore be accounted for when assessing potential impacts of marine parks on commercial fisheries. The implementation of new fisheries management arrangements (outside of marine park management arrangements) can also impact commercial and recreational fisheries, with subsequent flow-on effects to other socio-economic values such as local businesses and tourism.

For local businesses and communities, external socio-economic drivers have been identified through risk assessments and socio-economic evaluation (Gardner et al. 2006). Drivers include, economic growth (demand for local produce, agricultural/mineral), exchange rate (value of Australian dollar impacting the cost of international travel, imported and exported goods), population dynamics (local migration of youth to or from rural areas), labour market constraints (availability of skilled or unskilled labour), resource constraints (public and private investment in business and infrastructure), interest rates, and government policies (infrastructure development, environmental policy restricting development) (Gardner et al. 2006). The expenditure associated with tourism can contribute to national and regional economies, and plays an important role in many local businesses and communities.

In Australia, tourism made a direct contribution to the economy of $43 billion total gross domestic product in 2013 (ABS 2015g). Tourism accounted for 4.7 per cent of total employment in 2012/13. Tourist spending contributes to a variety of sectors and is therefore subject to a number of socio-economic drivers such as interest rates on loans (e.g. for accommodation), fuel prices (e.g. to access remote locations and for long distance transport), and market forces (e.g. exchange rates, demand, product value, food prices).

This section presents baseline information on socio-economic drivers that may be relevant to the marine parks MER program. Some of these drivers have indicators that can be quantitatively tracked, but other drivers are qualitative. Information on socio-economic values is available at a range of spatial scales, with information documented in the following sections from a statewide scale.

7.1 Interest rates

Interest payments are relevant to marine-based local businesses that have loans on capital expenditures. For example, commercial fishing businesses may borrow money to finance the purchase of fishing licences, quota, vessels, gear and equipment (EconSearch 2014g).

Baseline information on interest rates includes:

- The Reserve Bank of Australia (2016a) provides a monthly cash rate target (Figure 77). Between 2008 and 2015, interest rates changed 25 times with 7 increases and 18 decreases, with an overall decrease from 7 per cent to 2 per cent. The Reserve Bank of Australia also provides data on the lending rate for small business (EconSearch 2014g).

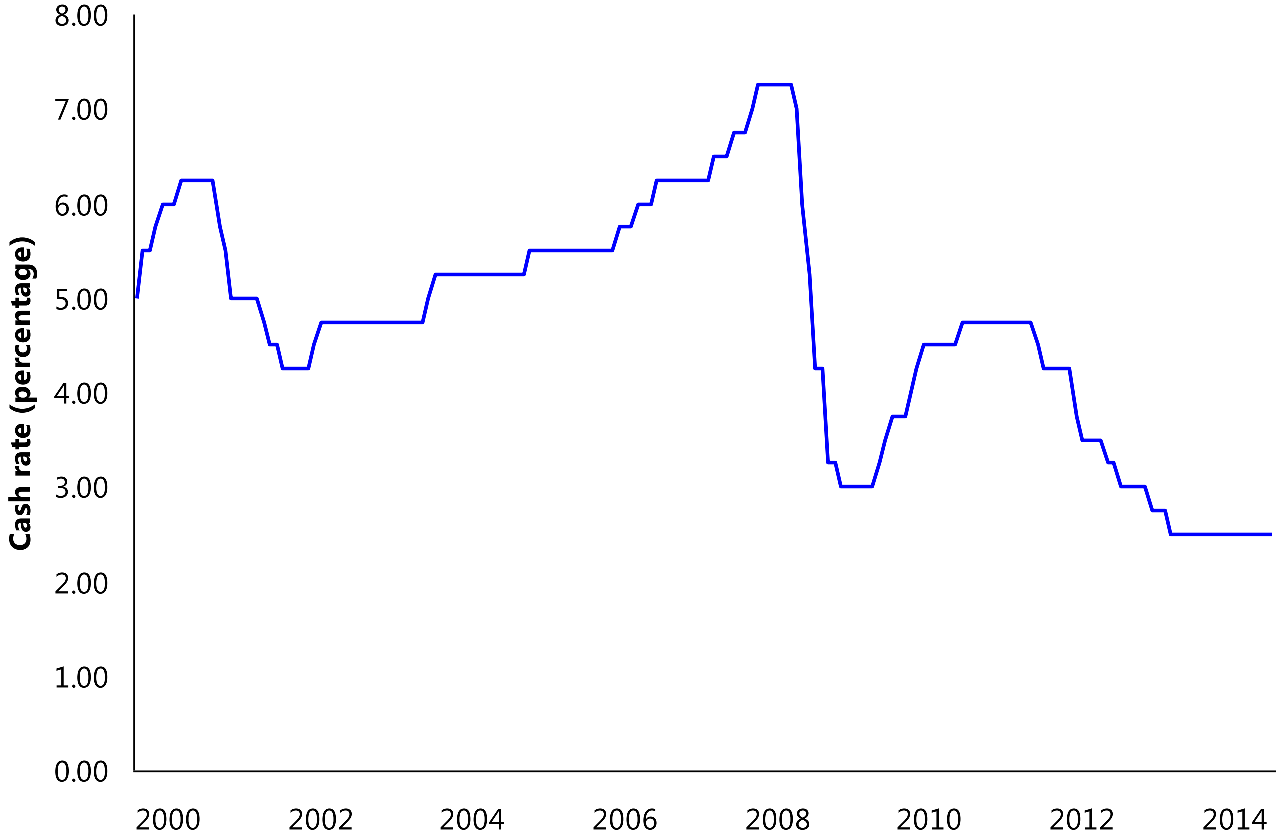


Figure 77. The Australian Target Cash Rate. Source: Reserve Bank of Australia (2016a).

7.2 Commodity prices

Commodity prices are likely to have a significant impact on regional areas given the importance of agricultural and mining production to regional communities.

Baseline information on commodity prices includes:

- The Reserve Bank of Australia (2016b) provides an overall commodity price index as well as indices for rural and non-rural commodities. The commodity price index increased from about 45 in 1998 to a peak of 120 140 in 2011 2008 and was 100 85 at the end of in 2014 (Figure 78).

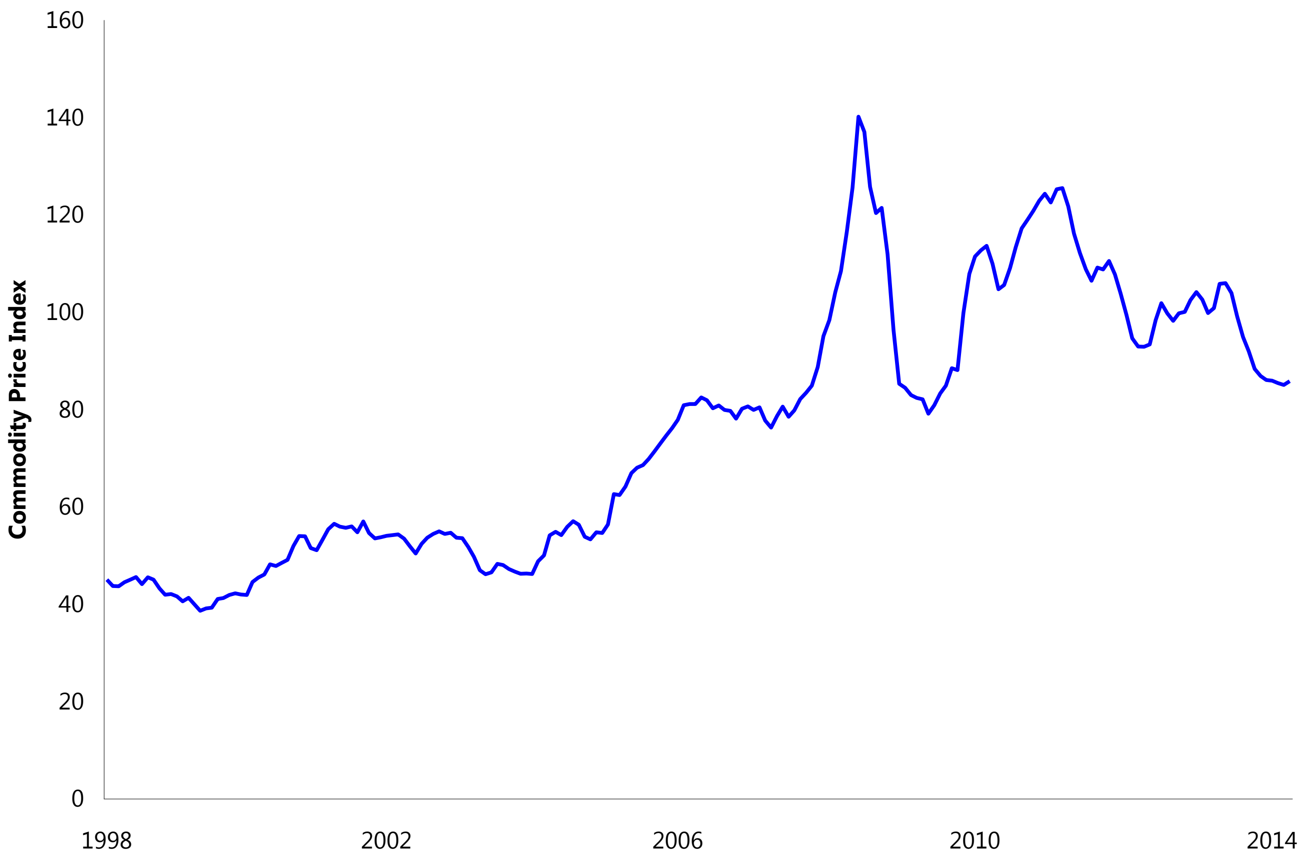


Figure 78. Monthly Commodity Price Index. Source: Reserve Bank of Australia (2016b).

7.3 Fuel prices

Fuel is a significant cost for a number of marine-based local businesses, including commercial fisheries, and its price influences their profitability (EconSearch 2014g).

Baseline information on fuel prices includes:

- The Australian Bureau of Statistics produces a quarterly update of the Consumer Price Index (ABS 2015f). One component of this index is the transport index, which provides a good proxy for the cost of fuel. The average cost of transport (largely determined by fuel) increased by 43 per cent between 1998/99 and 2013/14 (EconSearch 2015g).
- Calendar and financial year average retail data for petrol and diesel are available from the Australian Institute of Petroleum (2015). Between 2004 and 2014, unleaded fuel prices increased from about 80 cents to $1.40 (Figure 79), and diesel prices varied between $1.20 and $1.60.
- The Australian Automobile Association (2016) publishes a time series of average monthly prices since 1998 for select regional centres including Ceduna, Port Lincoln, Whyalla, Port Augusta, Port Pirie, Victor Harbor and Mount Gambier.

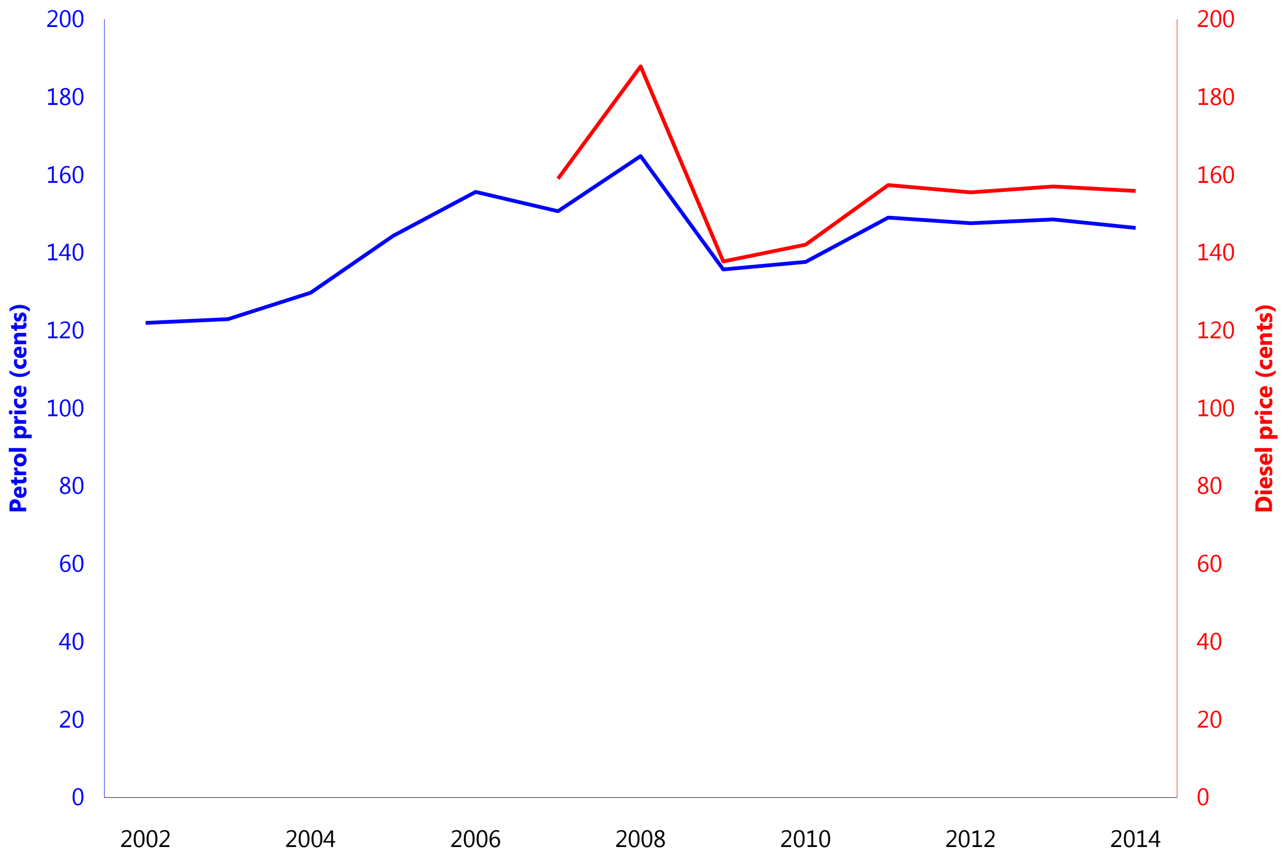


Figure 79. Statewide average retail price (including GST) for diesel and unleaded petrol. Source: Australian Institute of Petroleum (2015).

7.4 Labour force

Wages are a significant cost for most marine-based businesses, including commercial fisheries (EconSearch 2014g). In order to attract employees to the industry, the wages need to be competitive with industries such as mining.

Baseline information on wages includes:

- The Australian Bureau of Statistics produces a quarterly update of the wage price index (ABS 2015h, Figure 80). The wage price index increased from about 70 in 1998/99 to about 120 in 2013/14 (EconSearch 2014g).
- Employment and unemployment data (see Section 5.1.2).

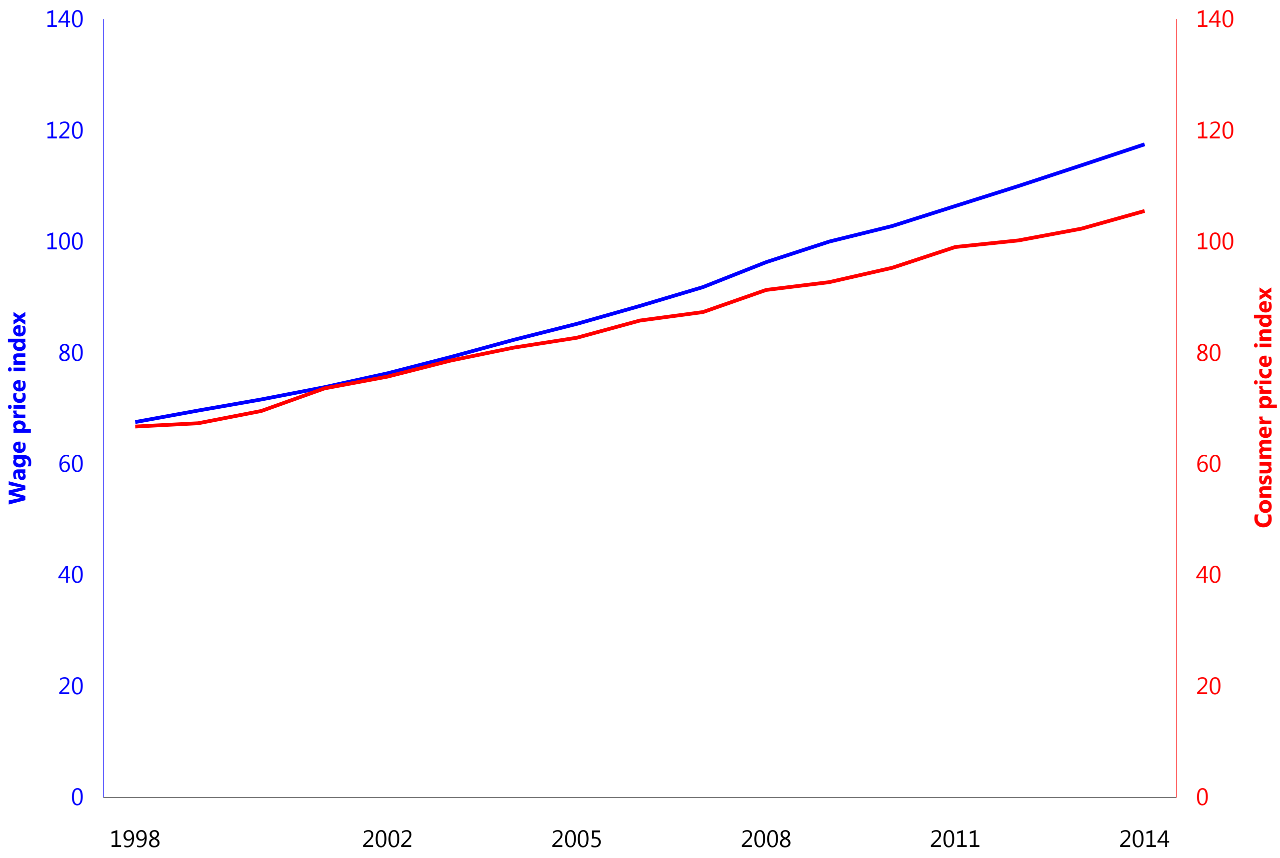


Figure 80. Wage Price Index (June quarter) compared with Consumer Price Index. Source: ABS (2015f, h).

7.5 Exchange rates

The price received for exported catch, the price for competing with imported products and the cost of purchasing imported inputs are influenced by the value of the Australian dollar relative to the currency of trading partners (EconSearch 2014g). An appreciation of the Australian dollar impacts export orientated fisheries, such as the Abalone, Rock Lobster and Prawn Fisheries by affecting price received, and in the latter case, by reducing the price of competing imported aquaculture products. Conversely, appreciation of the Australian dollar may reduce costs associated with imported goods used for fishing activity, e.g. boat engines and equipment (EconSearch 2014g).

Exchange rates impact expenditure and visitation by international and domestic tourism, but the influence on visitation is moderate compared with other factors (e.g. overall economic growth of the country of origin). Exchange rates impact the number of Australians who travel overseas (Tourism Australia, undated b).

Baseline information on exchange rates includes:

- The Reserve Bank of Australia (2015) provides monthly updates of exchange rates with 13 currencies. Between 2003 and 2015, the Australian dollar to US dollar exchange rate ratio varied between 0.6 and 1.1, and was about 0.8 in April 2015 (Reserve Bank of Australia 2015, Figure 81). The Reserve Bank also calculate a Trade-weighted Index which measures the average value of the Australian dollar against the currencies of Australia's trading partners (Figure 81, Reserve Bank of Australia 2015).

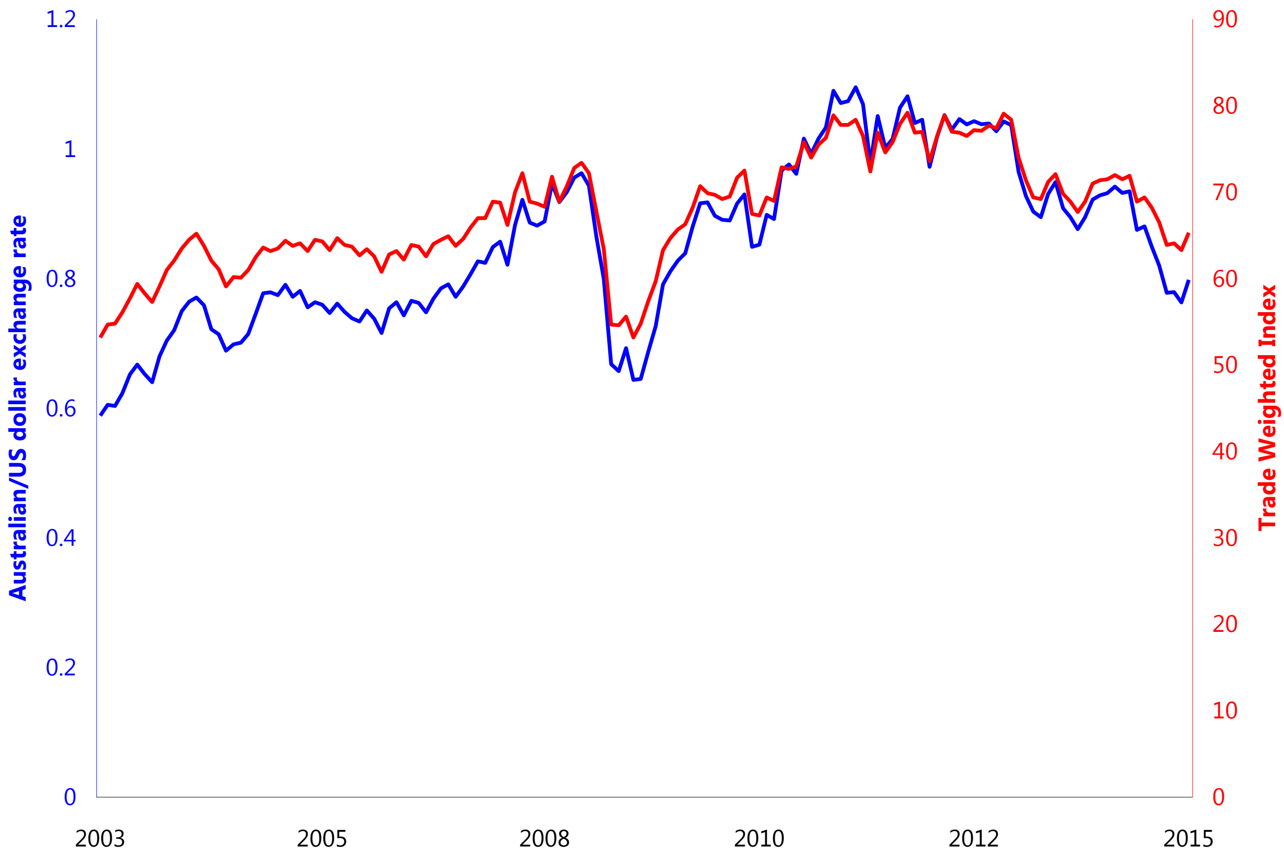


Figure 81. Australian dollar to US dollar exchange rate ratio and Trade Weighted Index. Source: Reserve Bank of Australia (2015).

7.6 Visitation rates

Visitation rates can influence some local businesses. For example, visiting commercial abalone fishers spend money on local accommodation, fuel and food, and local caravan parks are largely reliant on tourists visiting the region.

Baseline information on visitation rates includes:

- Tourism Research Australia provides regional profiles of international and domestic tourism (Tourism Research Australia 2015a-e). Total number of visitors to the coastal regions of South Australia (including Eyre Peninsula, Yorke Peninsula, Fleurieu Peninsula, Kangaroo Island and the Limestone Coast) in 2013/14 was 5.95 million. Total number of visitors to the Eyre tourism region (between Whyalla and the Western Australian border, see Appendix C) in 2013/14 was 703,000. The total number of visitors to the Yorke Peninsula tourism region in 2013/14 was 981,000. Total number of visitors to the Fleurieu tourism region in 2013/14 was about 3.1 million. Total number of visitors to Kangaroo Island in 2013/14 was 117,000. Total number of visitors to the Limestone Coast tourism region in 2013/14 was 1,058,000. Data are available for previous years, but are not compatible with 2013/14 due to a change in methods (Tourism Research Australia 2015a-e).
- PIRSA collates catch disposal records that document daily port of landings for the Abalone and Rock Lobster Fisheries. These data could be used to track visitation by abalone and rock lobster fishers across the marine parks network.

7.7 Market demand

Market demand can influence businesses such as tourism, aquaculture and commercial fishing. These drivers are qualitative and difficult to monitor, but examples of market demand that are of relevance to marine parks include:

- Prices for local seafood such as King George whiting and garfish are influenced by seasonal availability (see Section 5.8.10).
- There is greater export demand for greenlip abalone than blacklip abalone.
- Export demand for different sized or coloured rock lobster varies and as a result fishers may target particular areas. For example, the west coast of SA (e.g. marine fishing areas 7 and 8) traditionally yields large lobster, and there is a market preference for darker red coloured lobsters found in shallower water (Linnane et al. 2013). The timing of the Chinese New Year has a significant impact on rock lobster export price (Norman-Lopez et al. 2014).

7.8 Major developments

Major industry developments in regional areas can impact socio-economic values of regional coastal townships (e.g. Regional Development Australia Whyalla and Eyre Peninsula 2014). New mining operations can inflate property and rental prices and closures of large businesses can increase unemployment or decrease the population by emigration from a town. For example, the closure of a power plant at Port Augusta, the closure of the Raptis fish processing facility at Ceduna and the establishment of a helicopter base at Ceduna may impact those regional centres. Major developments can provide contextual information for assessing regional impacts of marine parks on socio-economic values.

7.9 Government regulation

Changes to government regulations (other than those related to marine parks) can impact on marine-related industries such as commercial fishing, aquaculture and tourism. Examples of relatively recent changes in government regulation that are relevant to marine parks include:

- The introduction in 2012 of possession limits for recreational fishers (PIRSA 2011c), which were designed to prevent visiting recreational fishers from stock-piling large amounts of fish. This change may affect the visitation rates of recreational fishers.
- The introduction in 2012/13 of spatial closures to manage interactions with Australian sea lions in the demersal gill net Shark Fishery (AFMA 2014, Georgeson et al. 2014), which reduced the available area for fishing in South Australia. This change has reduced the visitation rate of commercial shark fishers to the South Australia.
- The amalgamation in 2014 of management regions A and B for the Western Zone Abalone Fishery (Stobart et al. 2014), which enables fishers more freedom to obtain their annual quota in coastal waters from the Western Australian border to just north of Arno Bay in Spencer Gulf. This change may affect the visitation rates of commercial abalone fishers to marine parks.
- An application is currently underway to change the aquaculture zoning regulations in the Nuyts Archipelago Marine Park. The proposed changes could impact both the aquaculture industry and the Marine Scalefish Fishery in the Nuyts Archipelago Marine Park.
- An application is currently underway to change the aquaculture zoning regulations in the FWCMP. The proposed changes could impact both the aquaculture industry and the Marine Scalefish Fishery in the FWCMP.

- An application is currently underway to change the aquaculture zoning regulations in the SJBGMP. The proposed changes could impact both the aquaculture industry and the Marine Scalefish Fishery in the SJBGMP.
- A review of the white shark cage-diving tourism policy was undertaken in 2011, resulting in limits on the number of days per year that cage-diving activities could be undertaken (DEWNR unpublished data) and included a re-assessment and re-allocation of the licenses to undertake cage-diving activities.
- The introduction in 2013/14 of additional seasonal spatial closures for snapper in Spencer Gulf and Gulf St Vincent (Fowler and McGarvey 2014) which were introduced to prevent fishers from accessing five known aggregation sites during December/January.
- In 2013, new spatial management arrangements were introduced for the Southern Zone Abalone Fishery (Mayfield et al. 2013).

8 Pressures

To enable predictions of change due to the marine park management plan (Section 0), an understanding of pressures on the ecological values of the marine parks network is required. In addition, to interpret monitoring data on ecological and socio-economic values in the marine parks MER program, it will be necessary to include information on pressures from both within and outside of the marine parks network. This section summarises human-mediated pressures on the ecological values of the marine parks under the following categories: coastal pollution, resource extraction, habitat modification, disturbance of animals, pest species and climate change.

The categories are based on the pressure rather than on the activity, and as such some activities may relate to more than one category. In addition, these pressures may apply to one or more of the ecological values identified in Section 4. Resource extraction relates to living resources and includes fishing methods that are non-destructive to habitats, and aquaculture that involves filter-feeding organisms. Coastal pollution includes activities that result in discharge or accidental spillage of wastes into the marine environment such as shipping, offshore mining, stormwater drains, wastewater outfalls and finfish aquaculture. Habitat modification includes activities that damage benthic habitats, such as prawn trawling and coastal developments. Disturbance of animals includes activities such as shipping and motorised water sports. Pest species include a range of marine and land species. Climate change includes predicted changes to the physical drivers of the system (Section 6).

This section presents baseline information on pressures that may be relevant to the marine parks MER program. Some of these pressures have indicators that can be quantitatively tracked, but other pressures are qualitative.

8.1 Coastal pollution

Across many parts of South Australia, seagrass and reef ecosystems are threatened by declining water quality due to increases in nutrients, pollutants, sediment loads and turbidity associated with freshwater inputs from stormwater, treated sewage, seepage and agricultural runoff or industrial discharges or aquaculture (Walker and McComb 1992, Gorgula and Connell 2004, Tanner 2005, Ralph et al. 2006, Fox et al. 2007, Turner et al. 2007, Collings et al. 2008, Connell et al. 2008, Bryars and Rowling 2009, Gorman et al. 2009). Shipping and offshore mining represent a potential threat to coastal habitats due to ship discharge and accidental petrochemical spills such as the Era incident off Port Bonython in Upper Spencer Gulf in 1992 (AMSA 2005).

Coastal pollution entering the marine parks network is minor in areas with a relatively low level of urban development along the coast but is potentially substantial in areas with significant urban development and large populations (Bailey et al. 2012b-t, Caton et al. 2009). Sections of the Encounter Marine Park lie adjacent to the southern suburbs of Adelaide and regional centres with relatively high populations such as Victor Harbor and Kingscote, due to this proximity, seagrass loss, reef degradation and specific pressures e.g. effluent discharge, agricultural run-off, have been documented (e.g. Bryars 2003, Bryars et al. 2003, Connell et al. 2008, Shepherd et al. 2008, Bryars 2013a). Similarly coastal pollution entering the Upper Spencer Gulf Marine Park is relatively high because of the level of urban and industrial development along the coastline and the number of industrial discharges. The remainder of the marine parks are located in areas of the coast where towns and populations are relatively small, therefore potential impacts on seagrasses are considered to be minor (Bailey et al. 2012b-t).

Baseline information on coastal pollution relevant to South Australia includes:

- The *Australian Water Resources 2005 Report* provides estimates of freshwater runoff for drainage divisions in Australia. Fresh water runoff ranges from 760 gigalitres to 28,850 gigalitres across South Australia (National Water Commission 2007).
- Human population size could be used as a proxy for stormwater (see Section 5.1.1 for indicator of human population).
- PIRSA Aquaculture collates information on aquaculture zoning, and the number and type of active lease types.

- The Environment Protection Authority have surveyed water quality at 293 sites with 19 in the Murat Bioregion, 73 in the Eyre Bioregion, 13 in the Spencer Gulf Bioregion, 60 in the North Spencer Gulf Bioregion and 128 in the Gulf St Vincent Bioregion between 2010 and 2014 (Gaylard et al. 2013, EPA unpublished data).
- Several published studies indicate that water quality parameters such as turbidity (sediment loads) and chlorophyll concentrations of nearshore waters can be monitored using remotely sensed data from Landsat and/or the NASA MODIS-Aqua sensor (Ritchie et al. 2003).

8.2 Resource extraction

8.2.1 Fishing

Eight commercial fisheries operate within South Australia, as well as recreational fishing (Section 5). Commercial and recreational fisheries in South Australia are managed under a framework of Ecologically Sustainable Development. A range of management controls (e.g. quota, size limits) are used to manage fisheries. PIRSA has adopted the nationally endorsed classification scheme to assess fish stocks as stocks as one of the following (Flood et al. 2014):

- *sustainable*: future levels of recruitment are adequate to maintain the stock
- *overfished*: recruitment levels are significantly reduced
- *transitional-recovering*: the stock is overfished, but management measures are in place to promote stock recovery, and recovery is occurring.
- *transitional-depleting*: the stock is not yet overfished, but fishing pressure is too high and moving the stock in the direction of becoming overfished
- *environmentally limited*: recruitment levels are significantly reduced due to substantial environmental changes and management has responded appropriately to the environmental change in productivity
- *undefined*: insufficient information exists to determine stock status.

Even under an Ecologically Sustainable Development framework, fishing can have a number of negative impacts on ecological values (Marine Biodiversity Decline Working Group 2008). Illegal fishing also occurs in some areas of the state (Stobart et al. 2014a). Baseline information on fishing pressure such as catch and catch rates is available for each of the commercial fisheries based on data from fishers' logbooks (Section 5.8). A brief summary of the most recent published fisheries information is presented below, however, in some cases the 2014 information had not been published at the time of writing. The emphasis of Section 8.2.1 is to provide some indication of the level of pressure due to fisheries extraction; it is not intended to provide commentary on the sustainability of the fisheries.

Commercial Rock Lobster Fishery

The Rock Lobster Fishery applies pressure on reef biodiversity and ecosystems through the removal of southern rock lobster and Maori octopus. Baseline information at a range of scales is available on catch and/or catch rate:

- Rock lobster catch for the Northern Zone Rock Lobster Fishery was just over 1,000 tonnes in 1998/99 but annual catches declined until the implementation of a quota system in 2003/04 (Linnane et al. 2015, Figure 59). The total allowable commercial catch was progressively reduced from 625 tonnes to 310 tonnes in 2009/10 then increased to 345 tonnes in 2012/13. The total allowable commercial catch was only caught when it was 310 tonnes (Linnane et al. 2014, 2015). The catch in 2013/14 was 331 tonnes from a total allowable commercial catch of 345 tonnes (Linnane et al. 2015a).

- Rock lobster catch for the Southern Zone Rock Lobster Fishery was just over 2,000 tonnes in 1980 but annual catches declined until the implementation of a quota system in 1994. Annual catches gradually increased until 2006 following which the total allowable commercial catch was progressively reduced from 1900 tonnes to 1250 tonnes in 2009/10 which has been largely (>99 per cent) caught for the four subsequent years (Linnane et al. 2015b).
- The historic average annual catch of rock lobster is available for reporting areas around South Australia (Ward et al. 2012).
- The catch of octopus (mainly Maori octopus) from the Northern and Southern Zone Rock Lobster Fisheries was about 138 tonnes in 2010/11 (Knight and Tsolos 2012). Octopus catch rates in the Northern Zone declined by an order of magnitude from a peak of 0.022 per pot lift in 1998 to 0.003 in 2013/14 (Linnane et al. 2015).

The Northern and Southern Zone Rock Lobster Fisheries are currently classified as *sustainable* (Linnane et al. 2015a,b).

Commercial Abalone Fishery

The Abalone Fishery applies direct pressure on reef biodiversity and ecosystems through the removal of greenlip and blacklip abalone. Baseline information at a range of scales is available on abalone catch and/or catch rate:

- Annual catches of greenlip abalone for the Western Zone Abalone Fishery were stable between 1989 and 2009, after which there was a 12 per cent decrease in catch over the 4 years to about 72 tonnes in 2013 (Stobart et al. 2014a).
- Annual catches of blacklip abalone for the Western Zone Abalone Fishery were stable between 1997 and 2009, then decreased to 82 tonnes in 2014 (Stobart et al. 2015a). Catch rates declined from 2006 and, in 2014, were at the lowest level since 1996.
- Annual catches of greenlip abalone for the Central Zone Abalone Fishery have been stable at about 47 tonnes per year since the total allowable commercial catch of about 48 tonnes was set in 1994. Prior to 1990, the average annual catch was about 44 tonnes, which includes the maximum recorded catch of about 84 tonnes in 1989 (Mayfield and Ferguson 2015).
- Annual catches of blacklip abalone for the Central Zone Abalone Fishery have been stable at about 8 tonnes per year since 2006 but are at their lowest levels since 1986. The total allowable commercial catch for blacklip abalone has been sequentially reduced from 14.1 tonnes in 2004 to 9.9 tonnes in 2005 and 8.1 tonnes from 2006 (40 per cent reduction). Catch rates have decreased since 2009 and in 2014 the catch rate was 13 per cent below the average value from 1990 to 2009 (Mayfield and Ferguson 2015).
- Annual catches of greenlip abalone for the Southern Zone Abalone Fishery were about 3 tonnes between 2000/01 and 2004/05, then increased to about 5 tonnes, but catch rates dropped. The catch declined to about 3.5 tonnes in 2013/14 (Mayfield et al. 2015).
- Annual catches of blacklip abalone for the Southern Zone Abalone Fishery peaked in 1992 at around 180 tonnes then remained stable with an average of about 144 tonnes between 1993/04 and 2012/13. In 2013/14, the catch dropped to 126 tonnes, which was 83 per cent of the total allowable commercial catch, and catch rates were at their lowest level since 2001/02 (Mayfield et al. 2015).
- Annual catches and catch rates of greenlip and blacklip abalone since 1979 have varied between years and between spatial assessment units (Stobart et al. 2014a, Stobart et al. 2014b, Appendix C).

The Western Zone greenlip and blacklip abalone stocks have been classified as *transitional-depleting* (Stobart et al. 2015a, b). The Central Zone greenlip and blacklip abalone stocks have been classified as *transitional-depleting* (Mayfield and Ferguson 2015). The Southern Zone greenlip and blacklip abalone stocks have also been classified as *transitional-depleting* (Mayfield et al. 2015).

Commercial Prawn Fishery

The Prawn Fishery applies pressure on sand biodiversity and ecosystems through the removal of western king prawn and various bycatch species. Baseline information at a range of scales is available on prawn catch:

- Annual catches for the West Coast Prawn Fishery since 1968 have experienced several cycles between low (< 50 tonnes) and high (> 80 tonnes). The most recent period of stock depletion was between 2002 and 2007, and catch was about 146 tonnes in 2014 (Beckmann and Hooper 2015, Figure 64).
- Annual catches for the Spencer Gulf Prawn Fishery historically ranged between 1,000 and 2,500 tonnes. The lowest catch in ten years was recorded in 2011/12 at 1,675 tonnes and was similar in 2012/13 and 2013/14 (Noell and Hooper 2015). The catch rate in 2013/14 was the lowest in 10 years (Noell and Hooper 2015).
- Annual catches for the Gulf St Vincent Prawn Fishery peaked at about 620 tonnes in 1975/76. Catches decreased to about 120 tonnes in 1990/91 and the fishery was closed for the following two years. Catches increased from 187 tonnes in 2005/06 to 288 tonnes in 2008/09 then decreased to 125 tonnes in 2011/12 (Beckmann et al. 2015).

The West Coast Prawn Fishery is classified as *sustainable* (Beckmann and Hooper 2015). The Spencer Gulf Prawn Fishery is currently classified as *sustainable* (Noell and Hooper 2015). The Gulf St Vincent Prawn Fishery is classified as *transitional-depleting* (Beckmann et al. 2015).

Commercial Blue Crab Fishery

The Blue Crab Fishery applies direct pressure on sand biodiversity and ecosystems through the removal of blue swimmer crabs. Baseline information at a range of scales is available on blue swimmer crab catch:

- Statewide annual catches of blue swimmer crabs ranged between 464 and 629 tonnes between 1996/97 (when a quota management system was introduced) and 2013/14 (Beckmann and Hooper 2015).
- Annual catches within the Spencer Gulf sector of the Blue Crab Fishery since 2003/04 have consistently been close to the total allowable commercial catch for this sector (381.7 tonnes, Noell et al 2014a). In 2013/14, catch was about 380 tonnes (Beckmann and Hooper 2015).
- Annual catches within the Gulf St Vincent sector of the Blue Crab Fishery ranged between 130 and 240 tonnes between 1996/97 and 2013/14 (Beckmann and Hooper 2015).

The Spencer Gulf sector of the Blue Crab Fishery has been classified as *sustainable*. The Gulf St Vincent sector of the Blue Crab Fishery has also been classified as *sustainable*, but there is evidence that the stock is still in a rebuilding phase (Beckmann and Hooper 2015).

Commercial Marine Scalefish Fishery

The Marine Scalefish Fishery applies pressure on reef, seagrass and sand biodiversity and ecosystems through the removal of various species. Baseline information is available on catches of the 4 most important species across SA (King George whiting, snapper, garfish and calamary) and some locally important species, including sharks.

Baseline information at a range of scales is available on catch:

- Statewide annual catches of King George whiting have declined since 1984 to the lowest recorded annual catch of 293 tonnes in 2013 (Fowler et al. 2014a). Catches are predominantly by handline.
- Statewide annual catches of snapper have shown cyclical variation since the mid-1980s. Between 2003 and 2011, annual catches generally increased with a peak of 1032 tonnes in 2010, but have since declined to 642 tonnes in 2012. Historically, handline catch was the dominant component of catch, but since 2008, longline has become the dominant gear type (Fowler et al. 2013a).

- Statewide annual catches of garfish were stable between 1983/84 and 2001/02 and peaked in 2000/01 at over 500 tonnes. Catches have decreased since 2001/02 to their lowest level in 2012/13 of around 250 tonnes (Fowler et al. 2014b).
- Statewide annual catches of southern calamary were about 200 tonnes between 1984 and 1990. An increasing trend in catch was recorded between 1991 and 2001 when the catch peaked at 460 tonnes. In 2006, catches declined below 300 tonnes for the first time since 1990. In 2013, catch was around 400 tonnes (Steer et al. 2007, Lyle et al. 2014).
- Statewide catches of mud cockle increased between 1993/94 and 2005/06 to 385 tonnes. Catches then reduced to 70 tonnes by 2011/12 and remained stable until 2013/14 (Dent et al. 2014).
- Statewide annual catches of pipi peaked in 2008/09 at about 1250 tonnes but then dropped to 470 tonnes by 2008/09. Annual catches in 2009/10, 2010/11 and 2011/12 were limited by total allowable commercial catches of 300, 330 and 400 tonnes respectively (Ferguson 2013).
- Statewide annual catches of bronze and dusky whalers averaged about 80 tonnes since around 1990. Peak catch occurred in 2009/10 at about 150 tonnes, and the 2013/14 catch was about 60 tonnes. Statewide annual catches of gummy shark exceeded 600 tonnes between 1983 and 1997. Since then, catches have decreased and since 2008/09 have averaged about 150 tonnes (Fowler et al. 2014b).

The West Coast King George whiting stock has been classified as *sustainable*, and with increasing biomass. Spencer Gulf and GSV/KI King George whiting stocks have been classified as *transitional-depleting*. (Fowler et al. 2014a). The West Coast snapper stock has been classified as *undefined* due to a poor understanding of the population demography in the region. The Northern and Southern Spencer Gulf snapper stocks have been classified as *transitional-depleting*. The Northern GSV snapper stock has been classified as *sustainably fished*. The Southern GSV snapper stock has been classified as *transitional-depleting*. The South East snapper stock has also been classified as *transitional-depleting* (Fowler et al. 2013a). The statewide calamary fishery has been classified as *sustainable* (Lyle et al. 2014). The West Coast garfish stock has been classified as *undefined* because the catch is too small (rarely exceeding 2 per cent of the state total) and therefore insufficient information is available. The Southern Spencer Gulf, Southern GSV and South East garfish stocks have been classified as *undefined*. The Northern Spencer Gulf and Northern GSV garfish stocks have been classified as *transitional-depleting* (Steer et al. 2012, 2014).

Charter Boat Fishery

The Charter Boat Fishery applies pressure on reef, seagrass and sand biodiversity and ecosystems through the removal of various species including sharks. Baseline information at a range of scales is available on the harvest of selected species:

- The annual statewide retained catch of the Charter Boat Fishery increased from about 110,000 fish or invertebrates in 2006/07 to about 148,000 in 2009/10 and then increased to about 154,000 in 2011/12. King George whiting, snapper and bight redfish were most frequently targeted but at least 70 different marine species were taken, including finfish, rays and skates, sharks, crustaceans, and molluscs (Tsolos 2013).

Commonwealth Shark Fishery

The Commonwealth Shark Fishery applies pressure on shark populations. Baseline information is available on catches of selected shark species (Section 5).

Recreational fishing

The Recreational Fishery applies pressure on reef, seagrass and sand biodiversity and ecosystems through the removal of various species including sharks. Baseline information is available on catches of selected species (Section 5).

The most recent information on recreational fishing harvest was collected during the 2013/14 South Australian Recreational Fishing Survey (Giri and Hall 2015). Recreational fishers accounted for about 20 per cent of the statewide harvest for garfish, between 30 and 40 per cent for southern calamary, snapper and blue crabs, about 50 per cent for mulloway, Australian salmon and Australian herring, and about 60 per cent for King George whiting, (Giri and Hall 2015).

Illegal fishing

Illegal fishing is a recognised issue for fisheries management in South Australia (PIRSA 2009, 2011a, 2011b). Illegal fishing in the Western Zone Abalone Fishery was estimated to account for 5 per cent of the total allowable commercial catch in 2014 (Stobart et al. 2015a). Illegal fishing is a recognised risk to the Rock Lobster Fishery, and PIRSA manage this issue through compliance (PIRSA 2011b). Illegal fishing impacts the economics of the Marine Scalefish fishery, particularly in regional communities (PIRSA 2011a).

Stockpiling of fish became an increasing problem during the summer months on the west coast of South Australia (PIRSA 2011c), prompting the introduction of possession limits in 2012.

Indigenous fishing

Aboriginal traditional fishing does occur in some parts of South Australia. While catch is unquantified, due to the relatively small size and number of coastal communities, the amount of catch is likely to be insignificant in comparison to commercial and recreational fishing.

8.2.2 Aquaculture

Aquaculture of oysters and other bivalves occurs in several areas of South Australia (Section 5.6) over sand and seagrass. Aquaculture is managed under an Ecologically Sustainable Development framework through the *Aquaculture Act 2001*. Bivalve aquaculture can decrease nutrient levels in surrounding waters, reducing food availability for native filter-feeders. Limits on bivalve aquaculture expansion are set in different regions based on its carrying capacity (Wear et al. 2004, PIRSA 2007, 2014b).

Baseline information on aquaculture relevant to South Australia includes:

- PIRSA Aquaculture collates information on aquaculture zoning, and the number and type of active lease types (DEWNR 2015j). Currently there are 402 active leases within South Australia (DEWNR 2015j).
- Production values may provide an indication of resource extraction levels. EconSearch (2014a, and earlier reports) provide data on the production of aquaculture by sector and region.

8.3 Habitat modification

Since European settlement, habitat modification has occurred in various locations across South Australia due to pollution (see Section 8.1), prawn trawling, dredging and dredge spoil dumping, off-road vehicle use, invasive pest species, vessel moorings, land reclamation, and placement of coastal structures such as breakwaters, oyster racks, jetties and marinas (Bryars 2003, Shepherd et al. 2008, Bryars 2013a, Shepherd et al. 2014).

Most of the habitats in South Australia’s marine environment have not been modified since European settlement (Bailey et al. 2012b-t), but some activities have modified habitats.

Baseline information on habitat modification relevant to South Australia includes:

- Coastal structures, including jetties and oyster racks, have replaced natural habitat and disrupted coastal processes (Bryars 2003, DEWNR 2016a).

- Prawn trawling impacts benthic habitats in the area of operation (Tanner 2005). Data on historical prawn trawl effort are available (Section 8.2.1).
- Off-road vehicle use, stock grazing and illegal rubbish dumping in saltmarsh communities (Bryars 2003, Caton et al. 2011a, b).
- Vehicles can impact beaches through erosion, sand compaction, disturbance of wrack deposits and damage to macrofauna (Brown and McLachlan 2002, Ramsdale 2010).
- Native oyster beds formerly present in sheltered bays around the state were extirpated by a commercial fishery before the mid-1900s (Alleway and Connell 2015).
- Disturbance by boat moorings and dredging impacts seagrass in South Australia (Gaylard et al. 2013, Irving 2014), but these pressures have not been quantified.
- Fishing equipment and anchors may damage shipwrecks (DEWNR unpublished data) but these pressures have not been quantified.

8.4 Disturbance of animals

Disturbance of animals can put pressure on ecological values. Disturbance can be caused by shipping, tourists, recreational and commercial fishing, motorboats, jet skis, walkers, dogs, off-road vehicles, berleying and sounds used to attract fish, feeding, discarding of fisheries bycatch, seismic testing, mining, drilling, dredging, construction, and aquaculture operations (Kemper and Ling 1991, McCauley et al. 2000, Mattson et al. 2005, Svane 2005, Baker-Gabb and Weston 2006, Jones 2008, Bruce and Bradford 2011, Dennis et al. 2011b, Newsome and Rodger 2013, IWC 2015).

Baseline information on disturbance includes:

- Human population size (see Section 5.1.1) could be used as an indicator of level of disturbance.
- Information on coastal recreation (see Section 5.2) and tourism activity (see Section 5.3) could be used as an indicator of potential disturbance.
- Information on shipping activity (see Section 5.5) could be used as a measure of potential disturbance.
- Information on the extent of exploration leases and seismic exploration activity could be used as an indicator of potential disturbance.
- Information on aquaculture (see Section 5.6) could be used as an indicator of potential disturbance.
- Information on recreational and commercial fishing activity (see Sections 5.7 and 5.8) could be used as an indicator of potential disturbance.
- SARDI collates logbook information on interactions between commercial fisheries and threatened, endangered and protected species (McLeay et al. 2015).

8.5 Pest species

Marine and land pest species may put pressure on ecological values. Pest species are defined as invasive marine pests, disease outbreaks, and introduced terrestrial species.

8.5.1 Invasive marine pests

Biofouling is considered the principal method of marine pest introductions (Hewitt and Campbell 2010). Possible vectors include ship or boat hulls or fishing equipment. Ballast water is also recognised as a mechanism for pest introductions (Hewitt and Campbell 2010).

Wear et al. (2004) considered that there was a moderate risk of introduction of pest species or disease through aquaculture, with the most likely vector being the translocation of oyster spat from Tasmania, where pests including the Asian kelp *Undaria pinnatifida* and the northern Pacific seastar *Asterias amurensis* have established. Populations of Pacific Oyster have established in some areas in South Australia (Wiltshire et al. 2010).

Baseline information on invasive marine pests includes:

- A number of invasive marine pests have been recorded in South Australia, including mollusc, ascidian, worm, algae, cnidarian, crustacean and bryozoan species (Wiltshire et al. 2010, Figure 82). The impacts of these pests on ecological values are not known.

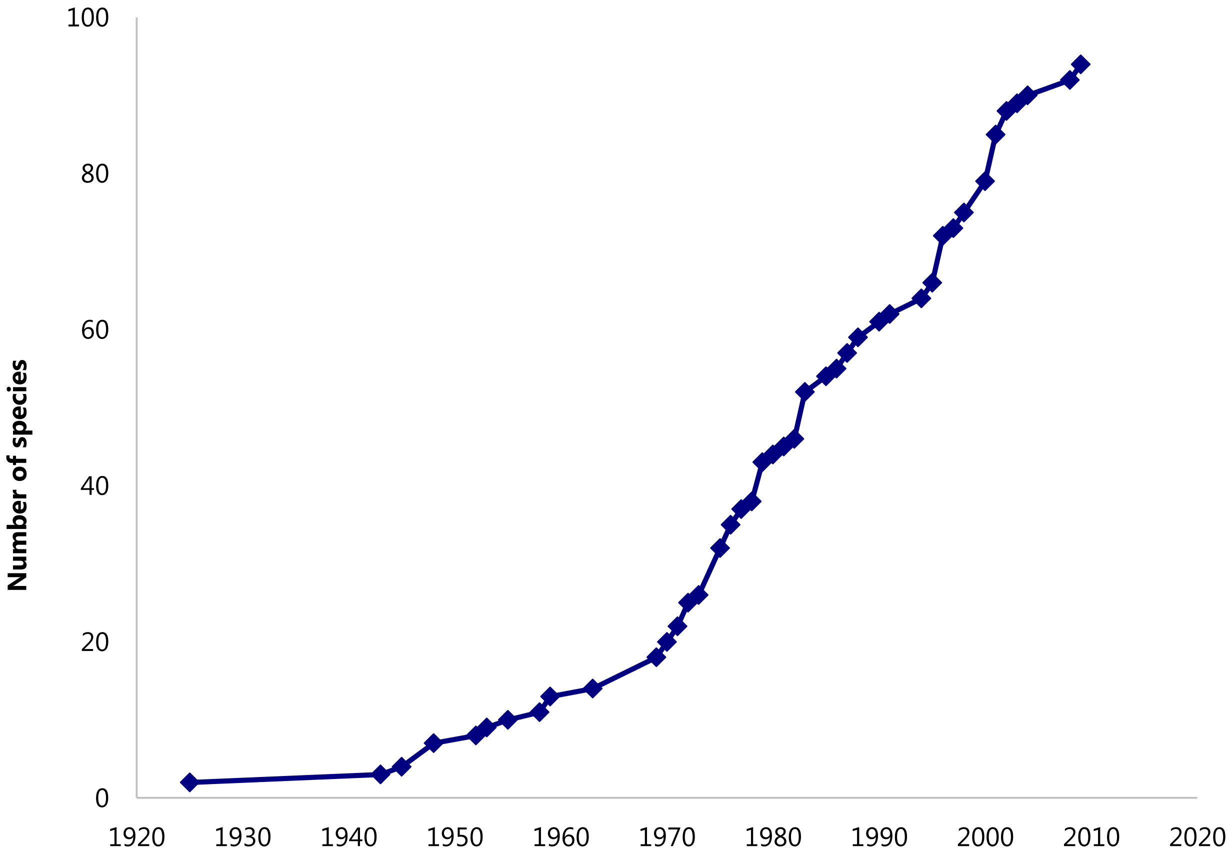


Figure 82. Cumulative count of invasive marine pest species recorded in South Australia over time. Note that pest surveys have not been standardised between years or locations and records are typically recorded opportunistically. Source: Wiltshire et al. (2010).

8.5.2 Disease outbreaks

A number of disease outbreaks have occurred in South Australian or interstate waters with negative impacts on ecological and socio-economic values.

Perkinsus olseni is a native parasite found in abalone (wild and farmed), clams, mussels and pearl oysters (PIRSA 2009). This parasite reduces the market value of abalone and can increase mortality. Abalone are more susceptible to *Perkinsus* at higher temperatures, and outbreaks are therefore more prevalent in the Western Zone Abalone Fishery and may be exacerbated by climate change (PIRSA 2009).

Abalone viral ganglioneuritis is a disease that causes mass mortalities of abalone (PIRSA 2009). The 2006/07 outbreak in Victoria resulted in severe economic loss with large areas of the Victorian fishery temporarily closed and a catch reduction of more than 50 per cent. The disease has been recorded within 40 kilometres of the South Australian border and there is a risk that it may spread into South Australia. Likely vectors for the spread of abalone viral ganglioneuritis include translocation of stock, discharge from aquaculture facilities, launch and retrieval of anchors or pots, abalone fishing and the use of abalone as berley or bait (PIRSA 2009).

A herpesvirus was deemed responsible for both the 1995 and 1998 mass mortalities of sardines in South Australia, and was believed to have been caused by an exotic pathogen (Gaughan et al. 2000). Potential vectors for the pathogen include ballast water, seabirds and imported baitfish used as feed in aquaculture (Whittington et al. 1997). It is now believed that this herpesvirus is endemic to Australian waters (Whittington et al. 2008).

Translocation of oyster spat and abalone in the region has the potential to spread diseases and parasites that can impact shellfish (Theil et al. 2004, PIRSA 2009).

8.5.3 Introduced land pests

Introduced animals recorded in South Australia include foxes, cats and rodents (Caughley et al. 1998, West 2008). Introduced land pests cause vegetation degradation, compete for habitat and food sources, and prey on native species including shorebirds and lizards (West 2008, Caton et al. 2011a, b).

Foxes are opportunistic predators and present a significant threat to native animals (Saunders and McLeod 2007). Fox predation on eggs and chicks reduces the breeding success and recruitment of shorebirds. A study in NSW reported that foxes have been responsible for 100 per cent mortality in shorebird eggs and chicks and that the breeding success of terns improves in areas where fox control is implemented (West 2008).

Feral cats and rodents have become established in almost every significant habitat type throughout Australia, including coastal dune systems and offshore islands (Caughley et al. 1998, West 2008). Feral cats and rodents prey on chicks, adults and eggs, and reduce populations of seabirds and shorebirds (Hughes et al. 2008, Jones et al. 2008b).

Salt tolerant weeds can invade saltmarsh and dune environments and compete with native vegetation. A number of coastal weed species have been observed along the coast of South Australia including but not limited to, beach daisy, sea spurge, sea-lavender, common iceplant, African boxthorn, pimpernel, marguerite daisy, western coastal wattle, Ward's weed, wild turnip and red brome (Caton et al. 2011a, b).

8.6 Climate change

Climate change may place pressure on ecological values by changing the physical drivers. Under a range of carbon emission scenarios, climate change predictions for south-western Australia include:

- Increases in sea surface temperature at Thevernard of 0.3–0.9 °C by 2030 and 0.5–3.4 °C by 2090, at Port Adelaide of 0.3–0.9 °C by 2030 and 0.4–3.5 °C by 2090 (Hope et al. 2015), at Victor Harbor of 0.3–0.8 °C by 2030 and 0.3–3.4 °C by 2090, and at Portland (in western Victoria) of 0.2–0.8 °C by 2030 and 0.3–3.4 °C by 2090 (Timbal et al. 2015). Sea surface temperature rose by about 0.6 °C over the past century (Suppiah et al. 2006). Increased water temperature is likely to have a positive effect on western king prawn and blue swimmer crab growth, and there has been a southerly extension of the range of blue swimmer crabs (Dixon et al. 2011a, b). Warmer temperatures associated with El Niño–Southern Oscillation events may increase in frequency due to climate change (Cai et al. 2014), resulting in the enhanced upwellings of cold, nutrient rich water (Middleton and Bye 2007). The increase in nutrients is expected to benefit pelagic species such as Australian sardines and anchovies, which benefit higher order predators. Conversely, cold water from upwellings may have negative impacts on species that are more successful in warmer water temperatures (see Section 6.1).
- Changes (increases or decreases) in sea surface salinity at Thevernard of -0.23–0.11 by 2030 and -0.46–0.43 by 2090, at Port Adelaide of -0.19–0.14 by 2030 and -0.71–0.39 by 2090, at Victor Harbor of -0.15–0.15 by 2030

and -1.12–0.37 by 2090, and at Portland of 0.11–0.13 by 2030 and -0.32–0.38 by 2090 as a result of changes in rainfall (Hope et al. 2015, Timbal et al. 2015, CSIRO and Bureau of Meteorology 2015). Changes in salinity affect species by altering the energy expenditure required for osmoregulation (maintaining internal salt balance) as well as the development of larvae. The impacts of salinity change are species and age-specific (BHP Billiton 2009).

- Sea level rise at Thevernard of 0.07–0.17 metres by 2030 and 0.22–0.82 metres by 2090, at Port Adelaide of 0.07–0.17 metres by 2030 and 0.23–0.83 metres by 2090, at Victor Harbor of 0.07–0.17 metres by 2030 and 0.23–0.83 metres by 2090, and at Portland of 0.07–0.17 metres by 2030 and 0.23–0.83 metres by 2090 (Hope et al. 2015, Timbal et al. 2015). This poses a threat to intertidal mangrove and saltmarsh habitats across South Australia because existing land use (e.g. farming, roads) or lack of suitable low-lying topography prevents inland migration (Scientific Working Group 2011, Fotheringham and Coleman 2008). Sea level rise may also exacerbate the loss of habitat used by migratory shorebirds both locally, e.g. hooded plover (Garnett et al. 2013), and in South East Asia (Nicol et al. 2015).
- Decreases in ocean pH (increased acidity) at Thevernard of 0.06–0.07 by 2030 and 0.06–0.32 by 2090, at Port Adelaide of 0.6–0.8 by 2030 and 0.6–0.33 by 2090, at Victor Harbor of 0.06–0.08 by 2030 and 0.06–0.33 by 2090, at Portland of 0.06–0.09 by 2030 and 0.06–0.33 by 2090 (Hope et al. 2015, Timbal et al. 2015), which may affect the process by which marine animals, e.g. phytoplankton and molluscs, make shells and plates (Secretariat CBD 2009, Brierley and Kingsford 2009, The Royal Society 2005, Hobday et al. 2006, Kleypas et al. 2006).
- The Leeuwin Current is expected to weaken (Feng et al. 2009), which may affect recruitment of some species that rely on currents to transport larvae to favourable habitats, or species for which recruitment success is correlated with stronger current (section 6.5).
- Upwellings of cold, nutrient rich water may increase, which may impact prawn recruitment (Dixon et al. 2011b, Beckmann et al. 2014).
- Upwellings may increase in future, which may increase lobster catch rates (Feenstra et al 2014).
- Increased frequency of extreme weather events, including an increase in the average number of days per year that exceed 40 °C increasing from about 4 days up to 7 days by 2030 and 22 days by 2090, and in the south east 0.3 days up to 0.8 days by 2030 and 7.5 days by 2090 (Hope et al. 2015, Timbal et al. 2015). An example of the potential impact of extreme weather events is the large-scale seagrass diebacks in Spencer Gulf during low tides combined with extremely hot air temperatures and strong northerly winds (Seddon et al. 2000).

Baseline information on physical drivers which may be influenced by climate change is presented in Section 6.

9 Marine park management plans

This section outlines the strategies of the marine park management plans and how the 19 management plans influence pressures (Section 8) on the ecological values (Section 4) and also affect socio-economic values (Section 5). To interpret monitoring data on ecological and socio-economic values in the marine parks, the MER program will include information on the effectiveness of delivering the strategies of the management plans. For example, if illegal fishing occurs in SZs because compliance is poor, then predicted ecological changes (Section 10) may not occur, or if educational activities are not undertaken then predicted changes to community perceptions may not eventuate.

9.1 The management plan

The management plans (e.g. DEWNR 2012a) set out a zoning scheme and management strategies (see Appendix D). The zoning scheme uses 4 zone types, for which any prohibitions or restrictions on activities and uses are defined in zoning tables (DEWNR 2012b). In addition, the management plans define the boundaries and set out the activities that will be permitted in Special Purpose Areas.

In most cases, the SZs and HPZs were located to minimise impacts on existing developments and activities, including recreational and commercial fishing and other recreational activities. RAZs were mostly located over areas with existing restrictions under other legislation and therefore had negligible impact. Within the SZs and HPZs, the activities that are restricted by the management plans are fishing, motorised water sports, discharge of wastewater from vessels, feeding or berleying animals and access by domestic animals.

Additional measures to mitigate some threats may be prescribed in the management plans for the marine parks. For example, measures for responding to an oil spill, establishing mooring buoys or reducing coastal erosion may be implemented, and perhaps be preferentially assigned to areas of high conservation significance (e.g. SZs).

In addition to current uses, the zoning can influence harmful future uses, e.g. land-based discharges, dredging, aquaculture, and mining that do not currently occur inside the marine parks, but may occur in the future. Many such activities are managed in other areas according to the principles of Ecologically Sustainable Development, but they have been deemed incompatible within RAZs, SZs and HPZs from a biodiversity and conservation perspective.

The zoning could reduce the cumulative impact of existing and future pressures, and/or improve resilience to pressures that are not addressed by zoning. For example, Ling et al. (2009) showed that commercial fishing of large predatory lobsters reduced the resilience of Tasmanian kelp beds against the climate-driven threat of the sea urchin and thus increased the risk of a fundamental phase shift to widespread sea urchin barrens.

In summary, zoning can influence the marine environment within the managed area by:

- removing or limiting existing pressures
- preventing or limiting future pressures
- building resilience to some pressures by limiting the influence of others
- highlighting areas of conservation value to inform impact assessment and focus management.

9.2 Pressures influenced by the management plans

9.2.1 Coastal pollution

The only current activity generating coastal pollution that would be influenced by the management plans is the discharge of black water (associated with human waste and/or toilets) from motor vessels. Black water can be discharged outside of marinas and harbours or beyond a buffer of 3 nautical miles from aquaculture or a person in the water (DEWNR 2012b, Environment Protection Authority 2003). Some of the SZs meet these criteria and provide additional areas from which black water cannot be discharged. The offshore SZs which are beyond 3 nautical miles from the shoreline will also prevent concentrated black water from being discharged.

Habitats within marine parks will also be protected by (DEWNR 2012b):

- the prevention of future discharges of industrial waste or sewage within SZs
- the requirement for all reasonable and practicable measures within HPZs to ensure no harm to habitats or the functioning of ecosystems
- all discharges managed under the *Environment Protection Act 1993* will be required to have regard to the objects of the *Marine Parks Act 2007*.

The management plans do not directly address issues associated with septic tank overflows, agricultural run-off or pollution associated with shipping. Nonetheless, the management plans (and associated Act) are designed to influence land-based activities through NRM planning.

9.2.2 Resource extraction

Fishing

Prior to the restrictions associated with the management plans, fishing was allowed throughout the 19 marine parks with the exception of the following spatial and temporal restrictions, which are managed under the *Fisheries Management Act 2007* (PIRSA 2015b) or (for Commonwealth fisheries) the *Fisheries Management Act 1991*:

- netting closures which include:
  - inshore from a line between Point Bell and Point Brown
  - general netting closures around Kingscote spit, in Eastern Cove, north of Aldinga, in Encounter Bay and near the Murray Mouth
  - general netting closures in Coffin Bay south of a line between Point Sir Isaac and Frenchman Bluff
  - a general fish net closure in Tumby Bay
  - a haulnet closure in the north-western corner of the Sir Joseph Banks Group Marine Park, extending offshore for a distance of between 4 and 12 kilometres
  - a haulnet closure covering most of the West Coast Bays Marine Park southwards from just north of Cape Blanche
  - a general netting closure in Baird Bay and the eastern half of Venus Bay
  - an inshore gill, purse seine or other haulnet closure west of Loch Well Beach
  - a general netting closure within Franklin Harbor
  - a large mesh net closure in the southern part of the Franklin Harbor Marine Park
  - a seasonal net closure (January to March) in the Bay of Shoals

- netting closures northwards from Blanche Harbor and in Germein Bay
- a gill net or other haulnet closure throughout the Eastern Spencer Gulf Marine Park
- a large mesh net closure within the triangle defined by Reef Point, Goose Island and Port Victoria
- netting closures encompassing the Yorke Peninsula section of the Souther Spencer Gulf Marine Park (north of and including the Chinamans Hat SZ)
- a haulnet closure covering all but the southern corner of the Yorke Peninsula Marine Park
- a large mesh net closure offshore from the Salt Swamp Creek SZ
- a netting closure of about 11 square kilometres near Price
- the Brown Bay general fish net closure (water <5 metres) between Danger Point and Green Point, extending about 300 metres offshore (State and Commonwealth fisheries, DEWNR 2015l).

- intertidal reef areas to a depth of 2 metres
- Aquatic Reserves (PIRSA 2015b)
- a closed area for blue groper in the gulfs and Investigator Strait
- a closed area for pipi on the Younghusband Peninsula between the Murray Mouth and 28 Mile Crossing and a closed season in all areas from June to October, inclusive.
- prawn trawling in all waters less than 10 metres deep
- seasonal closure for the Rock Lobster Fishery (June to October, inclusive)
- seasonal closure for snapper (1 November to 15 December, Fowler and McGarvey 2014)
- spatial closures around Australian sea lion colonies in the demersal gill net shark fishery (AFMA 2014).

The management plans stopped commercial and recreational fishing within SZs and prevented trawling in HPZs. Commercial collection of beach wrack is deemed to constitute 'fishing (other than trawling)' and is therefore prevented inside SZs but not inside HPZs. While Aboriginal traditional fishing is still allowed within SZs, it is likely to be insignificant compared to commercial and recreational fishing (see Section 8.2.1). By preventing commercial and recreational fishing, a range of benefits for species and ecosystems may occur, including but not limited to: elimination of direct fishing mortality and post-release mortality; more natural age, size structure and sex ratio of populations, age and size at maturity and fish behaviour; and reduced incidence of disease (Bailey et al. 2012a).

The cessation of fishing within SZs could spatially redistribute catch/effort and increase pressure in the remaining fishing areas. For some commercial fisheries, this has been mitigated by removal of catch (quota)/effort from the relevant fishery through the Commercial Fisheries Voluntary Catch/Effort Reduction Program (PIRSA 2013a, Kosturjak et al. 2015). Estimates of displaced catch from SZs were provided by Ward et al. (2012a) and EconSearch (2014h) to inform the program. The targeted reductions in catch/effort were based on proportional reductions of the current catch/effort rather than reductions based on absolute values. For example, the total allowable commercial catch for the Northern Zone Rock Lobster Fishery was reduced by 23 tonnes from 345 tonnes in 2013/14 to 322 tonnes in 2014/15 in accordance with the percentage of catch removed through the Commercial Fisheries Voluntary Catch/Effort Reduction Program for this fishery. As for all other fisheries included in this Program, the reduction exceeded the estimated annual historic catch/effort within SZs (Kosturjak et al. 2015). For the Prawn, Blue Crab, Sardine and Recreational Fisheries, PIRSA indicated that catch and effort which was previously associated with the closed zones could be redistributed without impacting on the sustainability of those fisheries (PIRSA 2011d).

Estimates of annual displaced catch/effort provide an indication of the level of historical fishing pressure that previously occurred inside SZs across the state and in the 19 marine parks:

- About 43 tonnes of rock lobster annual catch from SZs, comprising about 37 tonnes within the bounds of the Northern Zone Rock Lobster Fishery, and 5.5 tonnes within the bounds of the Southern Zone Rock Lobster Fishery (Ward et al. 2012a).
- About 23 tonnes of abalone annual catch from SZs, comprising 17 tonnes within the bounds of the Western Zone Abalone Fishery, 5.5 tonnes within the bounds of the Central Zone Abalone Fishery and 303 kg within the bounds of the Southern Zone Abalone Fishery (Ward et al. 2012a).
- About 863, 701, 225 and 672 days of handline, haulnet, longline and other annual fishing effort, respectively, from SZs statewide (Ward et al. 2012), equating to a combined total of about 75 tonnes of King George whiting, snapper, southern sea garfish and southern calamary (Econsearch 2014h, Ward et al. 2012a).
- About 1,136 person-days of Charter Boat annual effort was estimated to have been displaced from SZs statewide (Ward et al. 2012a).
- About 1.29 and 6.84 tonnes of shark hook and gillnet annual catch, respectively, from SZs within the marine parks network (Bailey et al. 2012b-t). There are now a number of closures to protect Australian sea lions, bronze whalers, snapper and mulloway (AFMA 2014), and fishing effort is now concentrated off Victoria (Georgeson et al. 2014).
- About 3 tonnes of prawn catch was estimated to have been displaced from SZs statewide. (Econsearch 2014h). (Ward et al. 2012a).
- About 449 tonnes of sardine annual catch from SZs statewide (Ward et al. 2012, EconSearch 2014).

Aquaculture

Existing aquaculture operations that extract resources (e.g. oyster farming) will not be affected by the management plans, but if future expansion were proposed then it could be influenced.

9.2.3 Habitat modification

The only current habitat modifying activity that would be influenced by the management plans is the collection of wood (e.g. for fires) within mangrove forests; although it is unlikely that this is a widespread activity.

It can be expected that compliance operations within the marine parks would result in reduced illegal rubbish dumping.

The majority of shipwrecks are not within exclusion zones under the *Historic Shipwrecks Act 1976* or *Historic Shipwrecks Act 1981* (DEWNR 2015j). Prevention of fishing and possible reduced boating activity within SZs may reduce the potential for damage of shipwrecks.

Habitats within marine parks will also be protected by (DEWNR 2012b):

- the prevention of future development of marinas, breakwalls, pontoons, jetties, pipelines and other marine infrastructure within SZs
- management of coastal developments and infrastructure in HPZs under the *Development Act 1993* to ensure no harm to habitats or the functioning of ecosystems
- consideration of all coastal developments under the *Development Act 1993* to ensure the achievement of the objects of the *Marine Parks Act 2007*

Impacts associated with aquaculture inside HPZs and GMUZs will be managed under the *Aquaculture Act 2001* to ensure that all reasonable and practicable measures are taken to ensure "no harm to habitats or the functioning of ecosystems" (DEWNR 2012b).

The management plans do not address the issues associated with off-road driving, including on beaches.

Protection of habitats from future threats inside SZs and HPZs will have varying benefits for a range of species depending on their level of residency within these zones. For migratory species such as southern right whales and shorebirds, the marine park management plans will increase protection of critical habitats including breeding and feeding areas along their migratory routes.

The management plans will not influence habitat modification that occurs outside of the marine parks network. For example, loss of intertidal habitats in South East Asia is believed to be a threat to some migratory shorebirds that visit some of the marine parks (Kirby et al. 2008, Murray et al. 2014, 2015).

9.2.4 Disturbance of animals

Many of the activities that can result in disturbance to animals are regulated through existing legislation. Nonetheless, the marine park management plans will have further influence over some activities inside HPZs, SZs and RAZs (see DEWNR 2012b).

Interactions between marine mammals and vessels and tourism operations are regulated through the *National Parks and Wildlife (Protected Animals – Marine Mammals) Regulations 2010*. Restriction of fishing activities inside SZs and RAZs may reduce disturbance by visiting fishers on marine mammals (and seabirds and shorebirds). Tourism operators are not allowed inside RAZs.

Motorised water sports, such as jet skiing and water skiing, are limited to speeds of 4 knots in some areas under the *Harbors and Navigation Regulations 2009*. Under the marine park management plans, motorised water sports are prohibited inside SZs and RAZs, providing additional areas where animals are not disturbed by these activities.

Berleying using blood, bone, meat, offal or skin of an animal is regulated under the *Fisheries Management Act 2007* to areas at least 2 nautical miles from shore, islands or emergent reefs. Under the marine park management plans, berleying (as well as feeding/baiting of aquatic and terrestrial animals) is prohibited inside SZs and RAZs and will therefore provide additional areas where animals are not disturbed by these activities. Berleying may be permitted inside SZs under other legislation, e.g. *Fisheries Management Act 2007* at Neptune Islands Group (Ron and Valerie Taylor) Marine Park.

Domestic animals in coastal environments (particularly on beaches) are managed through council by-laws or excluded (within conservation parks) by the *National Parks and Wildlife Act 1972*. Under the marine park management plans, domestic animals are prohibited from RAZs and when inside SZs, dogs must be in a vehicle or on a lead, unless local council by-laws override this, in which case they must be under the control of the person with them. The disturbance of nesting seabirds and shorebirds by walkers and off-road vehicles is reduced inside RAZs.

Coastal developments and infrastructure, harbours, navigation and transport, or resource extraction and production that cause disturbance to animals (e.g. dredging, drilling and active surveying) are restricted or limited inside HPZs, SZs and/or RAZs.

9.2.5 Invasive pest species

Protection of the ecosystems within SZs from other impacts, e.g. fishing, may make them more resilient to pest introductions (Bailey et al. 2012a), but the management plans are not likely to reduce the number of marine pest species that are introduced to marine parks.

Monitoring programs within the marine parks network may improve the detection of invasive species. For example, marine park reef surveys in Tasmania detect and monitor the southward migration of the hollow-spined urchin *Centrostephanus rodgersii,* which is facilitated by climate change and increasing water temperatures (Ling et al. 2009, see next section).

9.2.6 Climate change

Protection of the ecosystems within SZs from other impacts, e.g. fishing, may make them more resilient to pest introductions associated with climate change and range extensions (Bailey et al. 2012a), but the management plans are not likely to reduce pressures associated with climate change. The marine parks were designed to provide scope for saltmarsh and mangrove habitats to migrate inland under a scenario of sea level rise (DEH 2009a).

9.3 Socio-economic values influenced by the management plans

The marine park management plans are designed to influence some pressures on ecological values and result in direct ecological and indirect socio-economic positive outcomes, but they may also result in direct changes (positive and negative) to some socio-economic values (Figure 4). Various activities are restricted by the management plans and there is potential for negative impacts on important socio-economic values such as recreational fishing. Conversely, there is an expectation that there will be positive impacts on some socio-economic values, such as tourism, education and appreciation for the marine environment (SACES 2014).

10 Predictions and indicators of change

This section provides predictions and indicators of change to the ecological and socio-economic values due to the management plans. Predictions and indicators of change have been informed by previous impact assessments (Bailey et al. 2012a, b, EconSearch 2014h, Kosturjak et al. 2015), expert workshops (DEWNR unpublished data) and published reports (Bryars 2013b). The indicators and predictions are summarised in the conceptual models in Section 3. Predictions and indicators of change are summarised in Table 3. The 'baseline date' varies between indicators depending on whether they are related to the commencement of the *Marine Parks (Zoning) Regulations 2012* in March 2013 or the commencement of fishing restrictions inside SZs under the *Marine Parks (Zoning) Regulations 2012* on 1 October 2014.

10.1 Potential ecological changes

Bailey et al. (2012b) predicted the response of a number of fished species to protection within the proposed SZs. The predictions included changes in abundance and/or size, and spillover of adults or export of larvae. Bailey et al. (2012a, b) discussed potential changes based upon the benthic habitat types of reef (intertidal and subtidal), seagrass (intertidal and subtidal), sand (intertidal and subtidal), mangrove and saltmarsh. The predicted responses need to be considered in conjunction with predator-prey interactions, which occur at an ecosystem scale. There may also be unpredictable changes in which non-fished species are affected by changes to fished species (e.g. seabirds that feed on a commercially-fished species) and in situations where changes to fished species in one ecosystem then manifest in changes to a linked ecosystem (e.g. a commercially-fished species that spends different parts of its life cycle in different habitats/ecosystems). In addition to possible responses to protection from fishing, many fished (and unfished) species may benefit from the protection of the habitats that they use (Bailey et al. 2012a, b). The theory of ecological change is detailed by Bailey et al. (2012a, see Section 3.1 and Appendices 1–7 of that report).

The following sections are focused on how the ecological values (see Section 4) may respond to the cessation of activities that occurred prior to the implementation of the management plan. Further differentiation between habitats and ecosystems inside and outside of particular zones may also occur when future activities are limited to the areas outside zones. It is not possible to predict such changes without knowing the nature and extent of future developments, but examples include coastal developments outside SZs, and increased fishing pressure outside SZs. Due to increased levels of protection, habitats inside SZs and HPZs are predicted to maintain their spatial extent while those outside may be maintained or degraded.

10.1.1 Reef ecosystems

Intertidal reef

Intertidal reef animals were fully protected in South Australia before the implementation of the marine park management plans (Bailey et al. 2012b-t). Nonetheless, there could potentially be some change inside zones if illegal fishing is reduced due to increased compliance, signage and education or if visitation rates are increased as part of the overall marine parks program. However, evidence from South Australia (Benkendorff and Thomas 2007, Baring et al. 2010) suggests that only RAZs are effective in protecting intertidal communities from illegal fishing (and there are no new RAZs in the network) and that SZs may lead to increased trampling and disturbance by humans. If changes occur in adjacent subtidal reef communities (see next section), there could be flow-on effects for intertidal communities, but the changes that are attributable to the management plan are unlikely to be detectable. Potential indicators for monitoring intertidal reef ecosystems include size/abundance/diversity of fish, invertebrate and reef communities, and reef extent.

Subtidal reef

A number of fished species use subtidal reef ecosystems in South Australia (Bryars 2003). Some of these species are expected to change in size and/or abundance following protection from fishing and this may in turn drive ecosystem changes (Bailey et al. 2012b-t). Rock lobster, greenlip abalone, blacklip abalone and/or snapper, when each considered in isolation, are predicted to increase in size and abundance over the next 20 years inside some of the SZs (Bailey et al. 2012a). Inside some of the SZs, western blue groper, bight redfish, swallowtail, bluethroat wrasse, harlequin fish and/or sea sweep are predicted to maintain size and abundance over the next 20 years Experience from Tasmania and New Zealand suggests that some species may increase in size and/or abundance within SZs, but others may decrease in abundance (Shears and Babcock 2003, Barrett et al. 2007, 2009, Edgar et al. 2007, 2009, Babcock et al. 2010) and other unforeseen ecosystem shifts may occur (Freeman and MacDiarmid 2009, Edgar et al. 2007, Buxton et al. 2006, Langlois and Ballantine 2005). Potential indicators for monitoring subtidal reef ecosystems include size/abundance/diversity of fish, invertebrate and reef communities, and reef extent.

10.1.2 Seagrass ecosystems

Intertidal seagrass

A number of fished species reside on intertidal seagrass flats or use them at high tide (Bryars 2003). Razorfish, when considered in isolation, are predicted to increase in size and abundance over the next 20 years inside SZs that contain intertidal seagrass (Bailey et al. 2012a). Little is known about the possible response of other intertidal seagrass species and ecosystem changes following protection. Potential indicators for monitoring intertidal seagrass ecosystems include size/abundance/diversity of fish, invertebrate and seagrass communities, and seagrass extent.

Subtidal seagrass

A number of fished species use subtidal seagrass in South Australia (Bryars 2003). Due to uncertainties around fished species' responses in these ecosystems, predictions of change are limited compared to subtidal reef species (Bailey et al. 2012b-t). Blue swimmer crab, King George whiting, southern garfish and southern calamary are predicted to temporarily increase in size and/or abundance inside some of the SZs. However in SZs where there is likely to be minimal displacement of inshore fishing over subtidal seagrass (Section 9.2.2), there is limited potential for a response of fished species in seagrass. Potential indicators for monitoring subtidal seagrass ecosystems include size/abundance/diversity of fish, invertebrate and seagrass communities, and seagrass extent.

10.1.3 Sand ecosystems

Intertidal sand

A number of fished species reside on intertidal sand flats or use them at high tide (Bryars 2003). Razorfish and mud cockle, when considered in isolation, are predicted to increase in size and abundance over the next 20 years inside SZs containing intertidal sand ((Bailey et al. 2012a). Little is known about the possible response of other intertidal sand species and ecosystem changes following protection. Potential indicators for monitoring intertidal sand ecosystems include size/abundance/diversity of fish and invertebrate communities, and sand extent.

A number of fished species use nearshore beach habitats in South Australia (Bryars 2003). Due to uncertainties around fished species' responses in these ecosystems, predictions of change are generally lacking across the park network, although Bryars (2013) did make predictions for some beach fishes. Given that there is likely to be minimal displacement of recreational shore-based line fishing from beaches (Section 10.2.7), there is limited potential for a response of fished beach species.

Subtidal sand

A number of fished species use subtidal sand plains in South Australia (Bryars 2003). Snapper, King George whiting, blue swimmer crab, and yellowfin whiting when considered in isolation, are predicted to increase in size and abundance over the next 20 years inside some of the SZs (Bailey et al. 2012a). Western king prawn may temporarily increase in size and abundance inside HPZs that overlap with prawn fishing grounds. Little is known about the possible response of other subtidal sand species and ecosystem changes following protection. Potential indicators for monitoring subtidal sand ecosystems include size/abundance/diversity of fish and invertebrate communities, and sand extent.

10.1.4 Mangrove ecosystems

It is unlikely that ecosystem changes will occur in mangrove ecosystems as a result of the management plan and the cessation of existing activities (Bailey et al. 2012b-t, unpublished information from expert workshops in 2013). Potential indicators for monitoring include size/abundance/diversity of fish and invertebrate communities, and mangrove extent.

10.1.5 Saltmarsh ecosystems

It is unlikely that ecosystem changes will occur in saltmarsh ecosystems as a result of the management plans and the cessation of existing activities (Bailey et al. 2012b-t, unpublished information from expert workshops in 2013). Potential indicators for monitoring include size/abundance/diversity of fish and invertebrate communities, and saltmarsh diversity and extent.

10.1.6 Sharks

It is unlikely that measurable changes will occur to populations of sharks as a result of the management plans and the cessation of existing activities (Bailey et al. 2012b-t). Potential indicators for monitoring include size/abundance of some shark species.

10.1.7 Marine mammals

It is unlikely that measurable changes will occur to populations of marine mammals as a result of the management plans and the cessation of existing activities given that these species have already been afforded protection via other regulatory processes (Bailey et al. 2012b-t). Potential indicators for monitoring include species population counts.

10.1.8 Seabirds

It is unlikely that measurable changes will occur to populations of seabirds as a result of the management plans and the cessation of existing activities (Bailey et al. 2012b-t). Potential indicators for monitoring include species population counts.

10.1.9 Shorebirds

It is unlikely that measurable changes will occur to populations of shorebirds as a result of the management plan and the cessation of existing activities (Bailey et al. 2012b-t). Potential indicators for monitoring include shorebird population counts.

10.2 Potential socio-economic changes

The following sections are focused on predicted changes to the socio-economic values identified in Section 5 that may be linked to the management plan. Potential changes could be either negative (e.g. loss of fishing grounds for some fishers) or positive (e.g. increased appreciation of the marine environment). When predicting potential socio-economic changes due to the management plans, the analysis must also consider mediating factors such as the Commercial Fisheries Voluntary Catch/Effort Reduction Program and the zoning planning process which aimed to minimise negative impacts on commercial and recreational fisheries. It should also be noted that the spatial scale at which socio-economic data are collected rarely aligns with marine park boundaries (see Section 5) and this influences the ability to make predictions of change that may be attributable to marine park management plans.

10.2.1 Local businesses and communities

Bailey et al. (2012b) concluded that residential property values were not likely to be negatively affected by marine parks, but the MER program will monitor property values and housing approvals to test this prediction (see Section 5.1.3). There is evidence that local housing can benefit from protected area acquisition in the terrestrial environment in south-eastern Australia (Heagney et al. 2015) and it is possible that this may occur for the marine environment.

Coastal developments can occur within HPZs and GMUZs (Section 9.2.3), which collectively account for nearly 90 per cent of the network (DEWNR 2012a).

Bailey et al. (2012b) predicted some job losses in the fishing industry, but that these losses would not have a major impact on regional communities. Kosturjak et al. (2015) conducted a regional impact assessment in the Ceduna, Port Wakefield and Kangaroo Island regions and concluded that regional impacts due to sanctuary zones were not occurring. Additional information relevant to the impact of reduced fishing effort on local communities includes:

It is not expected that indicators such as unemployment rate or population will detect impacts on local communities, but the MER program will test these predictions (see Section 5.1).

There is an expectation that public appreciation, education and understanding of the marine environment and marine parks will improve over time (Bailey et al. 2012a, b, see Section 5.1).

10.2.2 Coastal recreation

The marine park zoning accommodates most forms of coastal recreation. Motorised water sports are not allowed in SZs, but the location and size of the SZs in the marine parks network should result in negligible impacts on these activities. Recreational fishing continues to be accommodated within the marine parks network (see Section 10.2.7).

Some recreational activities such as scuba diving may be enhanced inside SZs (due to larger and more abundant fish). There are a number of SZs suitable for diving on subtidal reef within the marine parks network. Indicators of recreational use include participation rates and the numbers of boat registrations/licences.

10.2.3 Tourism

Changes to fishery-based tourism are likely to be minimal (see Section 10.2.7). During 2013 and 2014, 15 per cent of domestic visitors to Eyre Peninsula (from Whyalla to the Western Australian border), 9 per cent of domestic visitors to Yorke Peninsula, 9 per cent of domestic visitors to the Fleurieu Peninsula, 43 per cent of domestic visitors to Kangaroo Island and 15 per cent of domestic visitors to the Limestone Coast visited terrestrial parks (South Australian Tourism Commission unpublished data). Possible benefits for tourism include (Bailey et al. 2012a, b):

- more natural ecosystems, including greater size and abundance of some fish within SZs

- less boating traffic due to the absence of fishing boats within SZs
- greater investment certainty for tourism operators due to protection to ecosystems.

10.2.4 Cultural heritage

There is an expectation that the management plans will contribute to the protection and conservation of features of natural and cultural heritage significance across the park network. Potential indicators include the level of protection for registered heritage sites and the level of engagement, partnerships and educational activities with Aboriginal communities.

10.2.5 Transport and infrastructure

Bailey et al. (2012a) predicted no loss of economic activity generated by ports as a result of the marine parks. The MER program will monitor shipping traffic as a vector for invasive pest incursions and a source of disturbance to animals. Potential indicators include ports and shipping activity.

10.2.6 Aquaculture

The marine park zoning accommodated aquaculture to ensure that there would be no negative impact on the industry, and to allow for expansion of the aquaculture industry. Bailey et al. (2012b) stated that no known current or potential impacts are expected from the marine parks on current or future aquaculture enterprises in marine parks. The MER program may monitor indicators of aquaculture activity.

10.2.7 Fishing

Previous assessments of socio-economic changes (Bailey et al. 2012a, b, EconSearch 2014h) focused on the direct and indirect effects of fishing being prohibited inside SZs and the Commercial Fisheries Voluntary Catch/Effort Reduction Program. Previous assessments of fishing-related impacts were limited by several factors:

- They did not consider spatial differences in fishing patterns for species within the marine scalefish sector.
- The assessments did not consider from where the fishing fleet originated, where the catch was landed, or where the fishers resided.
- The assessments used average fishing catch and effort over multi-year timescales (up to 20 years for abalone) but did not consider more recent and more relevant patterns of catch and effort.
- The Commercial Fisheries Voluntary Catch/Effort Reduction Program has now been completed.

When the above factors are considered, changes to commercial and recreational fisheries are likely to be minimal (see following sections), but the MER program will monitor indicators such as commercial catch and recreational participation to test these predictions (see Sections 5.7 and 5.8).

Rock Lobster Fishery

The estimated displaced catch was 6.3 per cent of the total average annual catch in the Northern Zone Rock Lobster Fishery and 0.3 per cent of the total average annual catch in the Southern Zone Rock Lobster Fishery. (EconSearch 2014h), but change in the fishery is predicted to be minimal because:

- More than the estimated displaced catch has been removed from the fishery through the Commercial Fisheries Voluntary Catch/Effort Reduction Program, such that the remaining fishers now have greater relative access to the available biomass. This assumes that historical catch rates in this fishery were the same inside versus outside SZs, which based upon historical catch rate data appears to be the case (see Kosturjak et al. 2015).

- Some traditional fishing grounds were lost but there are numerous other fishing grounds still available (see Bryars et al. 2016a-s).
- Fishers were given a 2 year period to adjust their spatial fishing behaviour prior to the full implementation of SZs on 1 October 2014.

Abalone Fishery

The estimated displaced catch was 2.7 per cent of the total average annual catch in the fishery (EconSearch 2014h), but change in the fishery is predicted to be minimal because:

- More than the estimated displaced catch has been removed from the fishery through the Commercial Fisheries Voluntary Catch/Effort Reduction Program, such that the remaining fishers now have greater relative access to the available biomass. This assumes that historical catch rates in this fishery were the same inside versus outside SZs—no data have been published to confirm or reject this assumption.
- Some traditional fishing grounds were lost but there are numerous other fishing grounds still available (see Bryars et al. 2016a-s).
- Fishers were given a 2 year period to adjust their spatial fishing behaviour prior to the full implementation of SZs on 1 October 2014.

Prawn Fishery

Change in the fishery is predicted to be minimal because:

- The marine park zoning accommodated prawn fishing to ensure that there would be minimal impact on the industry.
- No displaced catch or effort was deemed necessary for removal through the Commercial Fisheries Voluntary Catch/Effort Reduction Program.

Blue Crab Fishery

Change in the fishery is predicted to be minimal because:

- The marine park zoning accommodated blue crab fishing to ensure that there would be minimal impact on the industry.
- No displaced catch or effort was deemed necessary for removal through the Commercial Fisheries Voluntary Catch/Effort Reduction Program

Sardine Fishery

Change in the Sardine Fishery is predicted to be minimal because:

- No displaced catch or effort was deemed necessary for removal through the Commercial Fisheries Voluntary Catch/Effort Reduction Program.
- The estimated displaced catch was zero (EconSearch 2014h).

Marine Scalefish Fishery

The estimated displaced effort was 4.69 per cent of the total average annual catch in the fishery (EconSearch 2014h), but change in the fishery is predicted to be minimal because:

- More than the estimated displaced catch has been removed from the fishery through the Commercial Fisheries Voluntary Catch/Effort Reduction Program, such that the remaining fishers now have greater relative access to the available biomass. This assumes that historical catch rates in this fishery were the same inside versus outside SZs. It is possible that this assumption is false for some regions (see Kosturjak et al. 2015) because insufficient effort was removed in some localised areas. No data have been published to confirm or reject these assumptions.
- Some traditional fishing grounds were lost but there are numerous other fishing grounds still available (see Bryars et al. 2016a-s).
- Marine scalefish fishers are highly mobile and should be able to adapt to the spatial restrictions.
- Fishers were given a 2 year period to adjust their spatial fishing behaviour prior to the full implementation of SZs on 1 October 2014.

Charter Boat Fishery

The estimated displaced effort was 5.77 per cent of the total effort in the fishery (EconSearch 2014h), but change in the fishery is predicted to be minimal because:

- More than the estimated displaced catch has been removed from the fishery through the Commercial Fisheries Voluntary Catch/Effort Reduction Program, such that the remaining fishers now have greater relative access to the available biomass. This assumes that historical catch rates in this fishery were the same inside versus outside SZs—no data have been published to confirm or reject this assumption.
- Some traditional fishing grounds were lost but there are numerous other fishing grounds still available (see Bryars et al. 2016a-s).
- Charter fishers are generally highly mobile and should be able to adapt to the spatial restrictions.
- Fishers were given a 2 year period to adjust their spatial fishing behaviour prior to the full implementation of SZs on 1 October 2014.

Recreational shore fishing

Change for recreational shore fishing is predicted to be minimal because:

- Recreational fishing was mostly accommodated, and there are numerous locations still available for shore-based fishing.
- Areas that are readily accessible by shore or that were popular fishing locations have not been lost to recreational fishers.
- Shore-based line fishing is still allowed in many of the SZs.
- Some traditional fishing grounds were lost but there are numerous other fishing grounds still available (see Bryars et al. 2016a-s).
- Fishers were given a 2 year period to adjust their spatial fishing behaviour prior to the full implementation of SZs on 1 October 2014.

Recreational boat fishing

Change for recreational boat fishing is predicted to be minimal because:

- Recreational fishing was mostly accommodated, and there are numerous locations still available for boat fishing.
- Fishers are mobile and will be able to adapt to spatial restrictions.

- Fishers were given a 2 year period to adjust their spatial fishing behaviour prior to the full implementation of SZs on 1 October 2014.

Commonwealth Shark Fishery

As there is now little fishing within South Australia due to fisheries management arrangements, there will be virtually no displaced catch due to SZs.

10.3 Assumptions and interpretation of change

Predictions of change to ecological and socio-economic values (Sections 10.1 and 10.2) were based on the interaction between the four components of pressures, the marine park management plans, physical drivers and socio-economic drivers; these predictions had a number of assumptions (Section 10.3.1). In order to interpret monitoring data related to the predictions on ecological and socio-economic values, it will also be necessary to have information on pressures, the marine park management plans, physical drivers and socio-economic drivers (Sections 10.3.2–10.3.5).

10.3.1 Assumptions

The predictions are based on the assumption that the strategies in the marine park management plans will achieve the objects of the marine parks legislation, in particular the protection and conservation of marine biodiversity and habitats as part of the establishment of a zoning scheme to deliver a comprehensive, adequate and representative system of marine protected areas. It is assumed that activities undertaken to address the strategies of the management plans will result in measurable changes to ecological and socio-economic values. It is also important to consider that despite the fact that the same restrictions apply to the same zone-type across the network, the expected outcomes vary depending on the zone and previous uses of each zone.

Ecological change in response to protection from fishing inside SZs is influenced by a number of factors including success of enforcement (compliance), time since protection, and size and location of the SZ (Edgar et al. 2014). Predictions presented in Section 10 have a number of underlying assumptions related to these factors, including:

- there will be adequate compliance inside SZs
- responses will not be seen for several to many years (depending on individual species life history traits)
- SZs are of an adequate size and placed in appropriate locations.

It is assumed that neither external physical drivers (Section 10.3.2) nor government regulations (Section 10.3.3) will change. It is also assumed that pressures outside of the control of the management plan (Section 10.3.4) will either maintain current trends or increase under a scenario of increasing human population, climate change, coastal development, and resource use (Environment Protection Authority 2013).

Predictions of socio-economic change depend on:

- accuracy of predicted ecological changes
- effectiveness of the management plans
- effectiveness of the Commercial Fisheries Voluntary Catch/Effort Reduction Program
- current status or trends in external physical and socio-economic drivers not changing (Sections 10.3.2 and 10.3.3).

In order to assess the socio-economic performance of a region adjacent to a marine park it will be important to not only monitor how the region performs in an absolute sense, but also relative to other regions.

10.3.2 Indicators of physical drivers

A number of physical forces drive the ecology of the marine parks and these forces are not influenced by the marine park management plans. Changes to these drivers could have a bigger impact on ecological and socio-economic values than the marine park management plans. For example, long-term change in the East Australian Current has warmed coastal waters off eastern Tasmania and resulted in ecosystem shifts from kelp forests to urchin barrens (Ling et al. 2009). To interpret monitoring data on ecological and socio-economic values in the MER program, it will be necessary to include some information on physical drivers. Potential indicators include air temperature, sea surface temperature, index of upwelling, sea level, wind direction and wind speed.

10.3.3 Indicators of socio-economic drivers

There are a number of socio-economic drivers that are required to interpret changes in the socio-economic values of the marine parks. These drivers, which usuallly operate at a State, National or global scale, are not influenced by the marine park management plans. Changes in these drivers could have a bigger impact than the marine park management plans. For example, the cost of fuel for fishing vessels and changes to spatial management arrangements in fisheries influence the distribution of fishing effort. It will be necessary for the MER program to monitor information on socio-economic drivers. Potential indicators include interest rates, exchange rates, fuel prices, wage price index, sea food prices, and various qualitative measures for major developments and government regulation.

10.3.4 Indicators of pressures

There are a number of pressures on the ecological values of the marine parks. Despite the broad spectrum of pressures that are potentially influenced by zoning and the management plans, other than fishing which is the most widespread use which has been restricted, relatively few existing pressures have been affected by the marine parks. The MER program will monitor indicators that are related to the management plans (Section 10.3.5) and a range of existing (and potential future) pressures including, but not restricted to, fishing.

Changes in pressures will influence the predicted changes and could have a greater impact than the marine park management plans. For example, if illegal fishing occurs inside an SZ, it may nullify an ecological response to the management plans. Pressures on marine resources that are outside SZs may increase and this may increase the contrast between SZs and other areas. For example, coastal development, shipping activity or fishing activity may increase outside an SZ. Some of the socio-economic values which are predicted to change due to the management plans may in turn present an increased pressure on the ecological values that they rely upon. For example, increased recreation and tourism activities may cause an increase in disturbance to animals such as marine mammals and seabirds. Multiple pressures may also occur in some areas and understanding the cumulative impact of these on ecological values may present a challenge. To interpret monitoring data on ecological and socio-economic values in the MER program, it will be necessary to monitor information on pressures. A range of potential indicators for pressures is available (Table 3).

10.3.5 Indicators of marine park management plan activities

There are a range of management activities that will be undertaken to deliver the strategies of the management plans. In order to interpret changes in ecological and socio-economic values, the MER program will need to monitor a range of indicators related to management activities including numbers and types of marine parks permitting/approvals, level of compliance, and numbers and types of educational activities.

11 Conclusion

The present report provides a comprehensive inventory of available information that is relevant to monitoring of the statewide network of 19 marine parks. The report provides information and descriptions for the 6 inter-related components that are considered necessary for a robust MER program on South Australia's marine parks network; ecological values, socio-economic values, physical drivers, socio-economic drivers, pressures on ecological values, and the marine park management plan. Conceptual models have been prepared that synthesise the important aspects of each of these components for the 8 marine bioregions. The report also outlines predictions of change to ecological and socio-economic values that may occur due to the marine park management plans, and also presents a range of potential indicators that could be used in a MER program.

This report was not designed to provide a definitive list of indicators (or to present all associated information) that must be used in the MER program but rather to provide a selection of potential indicators, document sources of information, and provide some examples. In some cases, it is evident that baseline ecological information is lacking and the report highlights these knowledge gaps. In many cases, it is evident that socio-economic information is unavailable at a spatial scale that matches the marine parks boundaries, and this will present a challenge when interpreting changes in indicators that may be related to the marine parks management plans. In some cases there are time-series of data available, while in other cases there are data collected from a single point in time but which could potentially be resampled in the future. Nonetheless, the report does provide an invaluable 'snapshot' of available information that is relevant to South Australia prior to the full implementation of the marine parks network in October 2014, and this information forms the baseline against which future changes can be measured. The conceptual models also provide useful visual mechanisms for documenting the important features and complexity of the marine park bioregions. Whilst the MER program may be constrained in scope, to ensure it remains relevant it will integrate with the conceptual models.

This report and others in the 'baseline series' for the 19 marine parks have been used to inform the development of South Australia's marine parks MER plan and to guide ongoing monitoring activities of the DEWNR MER program.

Table 3. Summary of marine park components and indicators for the marine parks MER program, the prediction to 2022, and the related Evaluation Questions (EQs, refer Appendix A).

Component	Potential indicator	Spatial unit available for assessment	Directly influenced by management plans	Measurable change predicted due to management plans	Prediction to 2022	Comments	Marine parks relevant to prediction	EQs
ECOLOGICAL VALUES								
Intertidal reef	Size/abundance /diversity of reef communities	Sanctuary Zone	Yes	No	Maintain current status	Intertidal reef organisms are protected from removal in SA under the *Fisheries Management Act 2007*. Illegal fishing is known to occur in some areas. Reefs inside SZs could receive a higher level of protection from illegal fishing if there is increased education, signage and compliance. In contrast, increased human usage inside intertidal SZs could negatively impact communities. It is predicted that the current status will be maintained inside SZs.	1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 15, 16, 17, 18, 19	1, 2, 3
	Size/abundance /diversity of reef communities	Habitat Protection Zone, General Managed Use Zone	No	No	Maintain or degrade current status	Intertidal reef organisms are protected from removal in SA under the *Fisheries Management Act 2007*. Illegal fishing may continue in some areas.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19	1, 2, 3

Component	Potential indicator	Spatial unit available for assessment	Directly influenced by management plans	Measurable change predicted due to management plans	Prediction to 2022	Comments	Marine parks relevant to prediction	EQs
	Spatial extent	Sanctuary Zone, Habitat Protection Zone	Yes	No	Maintain current status	Increased level of protection for habitats should maintain current status. Spatial extent should be maintained inside these zones but could potentially decline outside zones.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19	1, 2, 3
	Spatial extent	General Managed Use Zone	Yes	No	Maintain or degrade current status	Some increased level of protection from future coastal developments. Spatial extent may be maintained or could potentially decline.	1, 2, 3, 4, 5, 6, 9, 10, 11, 12, 13, 15, 18, 19	1, 2, 3
Subtidal reef	Size/abundance /diversity of reef communities	Sanctuary Zone	Yes	Yes	Maintain or enhance current status	Some fished species are predicted to maintain or enhance current status in response to protection from fishing.	1, 2, 3, 4, 6, 7, 9, 10, 11, 12, 15, 16, 17, 18, 19	1, 2, 3
	Size/abundance /diversity of reef communities	Habitat Protection Zone, General Managed Use Zone	No	No	Maintain or degrade current status	Fished species have no increased protection.	1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19	1, 2, 3
	Spatial extent	Sanctuary Zone, Habitat Protection Zone	Yes	No	Maintain current status	Increased level of protection for habitats should maintain current status.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19	1, 2, 3

Component	**Potential indicator**	**Spatial unit available for assessment**	**Directly influenced by management plans**	**Measurable change predicted due to management plans**	**Prediction to 2022**	**Comments**	**Marine parks relevant to prediction**	**EQs**
	Spatial extent	General Managed Use Zone	Yes	No	Maintain or degrade current status	Some increased level of protection from future coastal developments. Spatial extent may be maintained or could potentially decline.	1, 2, 3, 4, 5, 6, 9, 10, 11, 12, 13, 15, 18, 19	1, 2, 3
Intertidal seagrass	Size/abundance /diversity of seagrass communities	Sanctuary Zone	Yes	Yes	Maintain or enhance current status	Some fished species are predicted to maintain or enhance current status in response to protection from fishing.	2, 5, 6, 10, 11, 14, 15	1, 2, 3
	Size/abundance /diversity of seagrass communities	Habitat Protection Zone, General Managed Use Zone	No	No	Maintain or degrade current status	Fished species have no increased protection.	2, 3, 5, 6, 9, 10, 11, 13, 14, 15	1, 2, 3
	Spatial extent	Sanctuary Zone, Habitat Protection Zone	Yes	No	Maintain current status	Increased level of protection for habitats should maintain current status.	2, 3, 5, 6, 9, 10, 11, 13, 14, 15	1, 2, 3
	Spatial extent	General Managed Use Zone	Yes	No	Maintain or degrade current status	Some increased level of protection from future coastal developments. Spatial extent may be maintained or could potentially decline.	2, 3, 5, 6, 9, 10, 11, 12, 13, 14, 15	1, 2, 3

Component	Potential indicator	Spatial unit available for assessment	Directly influenced by management plans	Measurable change predicted due to management plans	Prediction to 2022	Comments	Marine parks relevant to prediction	EQs
Subtidal seagrass	Size/abundance /diversity of seagrass communities	Sanctuary Zone	Yes	Yes	Maintain current status	Some fished species are predicted to maintain or enhance current status in response to protection from fishing.	2, 3, 5, 6, 9, 10, 11, 12, 13, 14, 15	1, 2, 3
	Size/abundance /diversity of seagrass communities	Habitat Protection Zone, General Managed Use Zone	No	No	Maintain or degrade current status	Fished species have no increased protection.	2, 3, 4, 5, 6, 9, 10, 11, 12, 13, 14, 15, 17, 18	1, 2, 3
	Spatial extent	Sanctuary Zone, Habitat Protection Zone	Yes	No	Maintain current status	Increased level of protection for habitats should maintain current status.	2, 3, 4, 5, 6, 9, 10, 11, 12, 13, 14, 15, 17, 18	1, 2, 3
	Spatial extent	General Managed Use Zone	Yes	No	Maintain or degrade current status	Some increased level of protection from future coastal developments. Spatial extent may be maintained or could potentially decline.	2, 5, 6, 9, 10, 11, 12, 13, 14, 15, 18	1, 2, 3
Intertidal sand	Size/abundance /diversity of sand communities	Sanctuary Zone	Yes	Yes	Maintain or enhance current status	Some fished species are predicted to maintain or enhance current status in response to protection from fishing.	2, 5, 6, 9, 10, 11, 14, 15, 18	1, 2, 3

Component	Potential indicator	Spatial unit available for assessment	Directly influenced by management plans	Measurable change predicted due to management plans	Prediction to 2022	Comments	Marine parks relevant to prediction	EQs
	Size/abundance /diversity of sand communities	Habitat Protection Zone, General Managed Use Zone	No	No	Maintain or degrade current status	Fished species have no increased protection.	1, 2, 3, 4, 5, 6, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19	1, 2, 3
	Spatial extent	Sanctuary Zone, Habitat Protection Zone	Yes	No	Maintain current status	Increased level of protection for habitats should maintain current status.	1, 2, 3, 4, 5, 6, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19	1, 2, 3
	Spatial extent	General Managed Use Zone	Yes	No	Maintain or degrade current status	Some increased level of protection from future coastal developments. Spatial extent may be maintained or could potentially decline.	2, 4, 5, 6, 9, 10, 11, 12, 13, 14, 15, 18, 19	1, 2, 3
Subtidal sand	Size/abundance /diversity of sand communities	Sanctuary Zone	Yes	Yes	Maintain or enhance current status	Some fished species are predicted to maintain or enhance current status in response to protection from fishing.	2, 6, 9, 10, 11, 12, 13, 14, 15, 18	1, 2, 3

Component	Potential indicator	Spatial unit available for assessment	Directly influenced by management plans	Measurable change predicted due to management plans	Prediction to 2022	Comments	Marine parks relevant to prediction	EQs
	Size/abundance /diversity of sand communities	Habitat Protection Zone	Yes	No	Maintain or degrade current status	Benthic trawling not allowed in HPZ. There are no HPZs where trawling previously known to have occurred. Trawled communities should be maintained inside HPZs but could potentially change outside HPZs (and SZs). Non-trawled communities can still be exploited by other forms of fishing.	1, 2, 3, 4, 5, 6, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19	1, 2, 3
	Size/abundance /diversity of sand communities	General Managed Use Zone	No	No	Maintain or degrade current status	Prawn trawling and other forms of fishing still allowed in GMUZs.	2, 4, 5, 6, 9, 10, 11, 12, 13, 14, 15, 18, 19	1, 2, 3
	Spatial extent	Sanctuary Zone, Habitat Protection Zone	Yes	No	Maintain current status	Increased level of protection for habitats should maintain current status.	1, 2, 3, 4, 5, 6, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19	1, 2, 3
	Spatial extent	General Managed Use Zone	Yes	No	Maintain or degrade current status	Some increased level of protection from future coastal developments. Spatial extent may be maintained or could potentially decline.	2, 4, 5, 6, 9, 10, 11, 12, 13, 14, 15, 18, 19	1, 2, 3

Component	Potential indicator	Spatial unit available for assessment	Directly influenced by management plans	Measurable change predicted due to management plans	Prediction to 2022	Comments	Marine parks relevant to prediction	EQs
Mangrove	Size/abundance /diversity of mangrove communities	Sanctuary Zone, Habitat Protection Zone, General Managed Use Zone	No	No	Maintain or degrade current status	Zoning is unlikely to directly affect mangrove communities as fishing activity is minimal or non-existent within mangrove forests where SZs occur.	2, 3, 6, 9, 10, 14	1, 2, 3
	Spatial extent	Sanctuary Zone, Habitat Protection Zone	Yes	No	Maintain current status	Increased level of protection for habitats should maintain current status.	2, 3, 6, 9, 10, 14	1, 2, 3
	Spatial extent	General Managed Use Zone	Yes	No	Maintain or degrade current status	Some increased level of protection from future coastal developments. Spatial extent may be maintained or could potentially decline.	2, 3, 6, 9, 10, 14	1, 2, 3
Saltmarsh	Size/abundance /diversity of saltmarsh communities	Sanctuary Zone, Habitat Protection Zone, General Managed Use Zone	No	No	Maintain or degrade current status	Zoning is unlikely to directly affect saltmarsh communities as fishing does not occur within saltmarshes.	2, 3, 5, 6, 9, 10, 11, 13, 14, 15	1, 2, 3

Component	Potential indicator	Spatial unit available for assessment	Directly influenced by management plans	Measurable change predicted due to management plans	Prediction to 2022	Comments	Marine parks relevant to prediction	EQs
	Spatial extent	Sanctuary Zone, Habitat Protection Zone	Yes	No	Maintain current status	Increased level of protection for habitats should maintain current status.	2, 3, 5, 6, 9, 10, 11, 13, 14, 15	1, 2, 3
	Spatial extent	General Managed Use Zone	Yes	No	Maintain or degrade current status	Some increased level of protection from future coastal developments. Spatial extent may be maintained or could potentially decline.	2, 3, 5, 6, 9, 10, 11, 13, 14, 15	1, 2, 3
Sharks	Size/abundance of some species	Sanctuary Zone	Yes	No	Maintain current status	Sharks are protected from fishing while residing inside SZs but transient and migratory nature of most species will likely negate a population change. Detectable population change due to management plans not predicted	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19	1, 2, 3

Component	Potential indicator	Spatial unit available for assessment	Directly influenced by management plans	Measurable change predicted due to management plans	Prediction to 2022	Comments	Marine parks relevant to prediction	EQs
	Residence times of white shark	North Neptune Islands Sanctuary Zone	Yes	No	Maintain current trend	White shark is fully protected. Illegal and incidental capture does occur. Population protected from incidental capture only while inside North Neptune Islands SZ and other SZs. Detectable population change due to management plans not predicted.	7	1, 2, 3
Marine mammals	Population counts of Australian sea lion	Breeding locations	Yes	No	Maintain current trend	Habitats at breeding locations should have increased protection inside SZs. Changes in fish/invertebrate populations inside SZs adjacent to breeding locations could potentially have a positive influence. Detectable population change due to management plans not predicted.	1, 2, 3, 4, 5, 6, 7, 8, 15, 17	1, 2, 3

Component	Potential indicator	Spatial unit available for assessment	Directly influenced by management plans	Measurable change predicted due to management plans	Prediction to 2022	Comments	Marine parks relevant to prediction	EQs
	Population counts of long-nosed fur seal	Breeding locations	Yes	No	Maintain current trend	Habitats at breeding locations should have increased protection inside SZs. Changes in fish/invertebrate populations inside SZs adjacent to breeding locations could potentially have a positive influence. Detectable population change due to management plans not predicted.	3, 4, 5, 7, 12 16, 17, 18	1, 2, 3
	Population counts of Australian fur seal	Breeding locations	Yes	No	Maintain current trend	Habitats at breeding locations should have increased protection inside SZs. Changes in fish/invertebrate populations inside SZs adjacent to breeding locations could potentially have a positive influence. Detectable population change due to management plans not predicted.	16	1, 2, 3
	Population counts of southern right whale	Calving locations	Yes	No	Maintain current trend	Habitats at calving locations should have increased protection inside SZs and HPZs. Detectable population change due to management plans not predicted.	1, 2, 15	1, 2, 3

Component	Potential indicator	Spatial unit available for assessment	Directly influenced by management plans	Measurable change predicted due to management plans	Prediction to 2022	Comments	Marine parks relevant to prediction	EQs
Seabirds	Population counts of various species	Specific locations	Yes	No	Maintain current trend	Habitats at nesting locations should have increased protection inside SZs and HPZs. Changes in fish populations inside SZs at these locations could potentially have a positive influence on chicks during rearing. Detectable population change due to management plans not predicted.	All parks	1, 2, 3
	Population counts of white-bellied sea-eagle and osprey	Nesting locations	Yes	No	Maintain current trend	Habitats at nesting locations should have increased protection inside SZs and HPZs. Changes in fish/invertebrate populations inside SZs at these locations could potentially have a positive influence on chicks during rearing. Detectable population change due to management plans not predicted.	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 15, 17	1, 2, 3

Component	Potential indicator	Spatial unit available for assessment	Directly influenced by management plans	Measurable change predicted due to management plans	Prediction to 2022	Comments	Marine parks relevant to prediction	EQs
Shorebirds	Population counts of various species	Specific locations	Yes	No	Maintain current trend	Habitats at breeding and feeding locations should have increased protection inside SZs and HPZs. Changes in fish/invertebrate populations inside SZs at these locations could potentially have a positive influence. Protection of beach wrack inside SZs could potentially have a positive influence on populations. Detectable population change due to management plans not predicted.	1, 2, 3, 4, 5, 6, 9, 10, 11, 12, 13, 14, 15, 18, 19	1, 2, 3
SOCIO-ECONOMIC VALUES								
Local businesses and communities	Human population	Local Government Area	No	No	Maintain current trend	Due to the scale of data available for assessment and other external factors, any changes in this indicator are unlikely to be attributable to the management plans. No change to the current trend is predicted due to the management plans.	All parks	4

Component	Potential indicator	Spatial unit available for assessment	Directly influenced by management plans	Measurable change predicted due to management plans	Prediction to 2022	Comments	Marine parks relevant to prediction	EQs
	Gross regional product	Local Government Area	No	No	Maintain current trend	Due to the scale of data available for assessment and other external factors, any changes in this indicator are unlikely to be attributable to the management plans. No change to the current trend is predicted due to the management plans.	All parks	4
	Business counts	Statistical Area Level 2	No	No	Maintain current trend	Due to the scale of data available for assessment and other external factors, any changes in this indicator are unlikely to be attributable to the management plans. No change to the current trend is predicted due to the management plans.	All parks	4
	Number of local jobs	Local Government Area	No	No	Maintain current trend	A small number of local job losses may have occurred due to the Commercial Fisheries Voluntary Catch/Effort Reduction Program but are not predicted to occur due to the management plans.	All parks	4

Component	Potential indicator	Spatial unit available for assessment	Directly influenced by management plans	Measurable change predicted due to management plans	Prediction to 2022	Comments	Marine parks relevant to prediction	EQs
	Unemployment rate	Local Government Area	No	No	Maintain current trend	Due to the scale of data available for assessment and other external factors, any changes in this indicator are unlikely to be attributable to the management plans. No change to the current trend is predicted due to the management plans.	All parks	4
	Number of Newstart allowance recipients	Local Government Area	No	No	Maintain current trend	Due to the scale of data available for assessment and other external factors, any changes in this indicator are unlikely to be attributable to the management plans. No change to the current trend is predicted due to the management plans.	All parks	4
	Annual individual salary or wage income	Postcode	No	No	Maintain current trend	Due to the scale of data available for assessment and other external factors, any changes in this indicator are unlikely to be attributable to the management plans. No change to the current trend is predicted due to the management plans.	All parks	4

Component	Potential indicator	Spatial unit available for assessment	Directly influenced by management plans	Measurable change predicted due to management plans	Prediction to 2022	Comments	Marine parks relevant to prediction	EQs
	Number and value of residential building approvals	Local Government Area	No	No	Maintain current trend	Due to other external factors, any changes in this indicator are unlikely to be attributable to the management plans. No change to the current trend is predicted due to the management plans.	All parks	4
	House sale prices	Local Government Area	No	No	Maintain current trend	Due to other external factors, any changes in this indicator are unlikely to be attributable to the management plans. No change to the current trend is predicted due to the management plans.	All parks	4
	Index of socio-economic advantage and disadvantage	Local Government Area	No	No	Maintain current trend	Due to the scale of data available for assessment and other external factors, any changes in this indicator are unlikely to be attributable to the management plans. No change to the current trend is predicted due to the management plans.	All parks	4

Component	Potential indicator	Spatial unit available for assessment	Directly influenced by management plans	Measurable change predicted due to management plans	Prediction to 2022	Comments	Marine parks relevant to prediction	EQs
	Level of community support for and perceptions on marine parks	Postcode, Local Government Area, Statewide	Yes	Yes	Maintain or improve current trend	Education activities as part of the management plans are aimed at this indicator. It is predicted that the current trend will improve.	All parks	5
Coastal recreation	Participation rates	Post code, Local Government Area, Statewide	Yes	No	Maintain current trend	Education activities as part of the management plans are aimed at this indicator. It is unlikely that the current trend will improve or that any change from the current trend can be attributable to these activities.	All parks	5
	Boat registrations/ licences	Statewide	No	No	Maintain current trend	Recreational boating is accommodated by the management plans with some minor spatial displacement for fishing and water sports due to SZs. It is unlikely that there will be any change from the current trend due to these restrictions.	All parks	5

Component	Potential indicator	Spatial unit available for assessment	Directly influenced by management plans	Measurable change predicted due to management plans	Prediction to 2022	Comments	Marine parks relevant to prediction	EQs
Tourism	Tourist operator numbers	Marine Park	Yes	Yes	Maintain or improve current trend	Ecotourism opportunities as part of the management plans are aimed at this indicator. It is predicted that the current trend will improve.	All parks	4,5
	Tourist expenditure	Tourism regions	Yes	Yes	Maintain current trend	Ecotourism opportunities as part of the management plans are aimed at this indicator. It is predicted that the current trend will improve.	All parks	4,5
Aboriginal heritage	Level of protection for registered heritage sites	Marine Park	Yes	Yes	Maintain or improve current status	Strategies of the management plan are aimed at improving the current status of this indicator. It is predicted that the current status will improve.	All parks	6
	Level of engagement, partnerships, educational activities	Marine Park	Yes	Yes	Improve current status	Strategies of the management plan are aimed at improving the current status of this indicator. It is predicted that the current status will improve.	All parks	6

Component	Potential indicator	Spatial unit available for assessment	Directly influenced by management plans	Measurable change predicted due to management plans	Prediction to 2022	Comments	Marine parks relevant to prediction	EQs
European heritage	Level of protection for registered heritage sites	Marine Park	Yes	Yes	Maintain or improve current status	Strategies of the management plan are aimed at improving the current status of this indicator. It is predicted that the current status will improve.	All parks	6
Shipping	Number vessel calls	Individual ports	No	No	Maintain current trend	Shipping is accommodated by the management plans.	2, 10, 13, 14	4
	Cargo exports/imports	Individual ports	No	No	Maintain current trend	Shipping is accommodated by the management plans.	2, 10, 13, 14	4
Aquaculture	Number active licences	Aquaculture zone	No	No	Maintain current trend	Current and future aquaculture is accommodated by the management plans.	2, 5, 6, 9, 10, 12, 13, 15	4
	Direct output	Aquaculture zone	No	No	Maintain current trend	Current and future aquaculture is accommodated by the management plans.	2, 5, 6, 9, 10, 12, 13, 15	4

Component	Potential indicator	Spatial unit available for assessment	Directly influenced by management plans	Measurable change predicted due to management plans	Prediction to 2022	Comments	Marine parks relevant to prediction	EQs
Recreational fishing	Participation rate	Recreational Fishing Survey Region, Post code, Statewide	Yes	No	Maintain current trend	Recreational fishing is accommodated by the management plans with some minor spatial displacement possible. A number of government initiatives associated with marine parks implementation have been instigated to enhance recreational fishing, including reef restoration and reservoir fishing. Spatial behaviour may change at scale of SZ vs non-SZ but not at scale available for assessment.	All parks	5
Rock Lobster Fishery	Catch, catch value, catch rate, and fishing behaviour	Marine Fishing Area, Rock Lobster Fishery Zones	Yes	No	Maintain current trend	Spatial behaviour may change at scale of SZ vs non-SZ but not at scale available for assessment. Commercial Fisheries Voluntary Catch/Effort Reduction Program has removed any displaced effort such that catches and catch rates should be maintained.	1, 2, 3, 4, 5, 6, 7, 12, 15, 16, 17, 18, 19	4

Component	Potential indicator	Spatial unit available for assessment	Directly influenced by management plans	Measurable change predicted due to management plans	Prediction to 2022	Comments	Marine parks relevant to prediction	EQs
Abalone Fishery	Catch, catch value and fishing behaviour	Spatial Assessment Unit, Abalone Fishery Zones	Yes	No	Maintain current trend	Spatial behaviour may change at scale of SZ vs non-SZ but not at scale available for assessment. Commercial Fisheries Voluntary Catch/Effort Reduction Program has removed any displaced effort such that catches should be maintained.	2, 3, 4, 5, 6, 7, 9, 11, 12, 13, 15, 16, 17, 18, 19	4
Prawn Fishery	Catch, catch value, catch rate, and fishing behaviour	Fishery Assessment Regions, Prawn Fishery Zones	Yes	No	Maintain current trend	Trawling banned in SZs and HPZs but prawn trawling accommodated in zoning arrangements and no pre-trawled areas included in zoning. Catches should be maintained.	2, 5, 6, 9, 10, 11, 12, 15	4
Blue Crab Fishery	Catch, catch value, catch rate, and fishing behaviour	Marine Fishing Area, Blue Crab Fishery Zones	Yes	No	Maintain current trend	Spatial behaviour may change at scale of SZ vs non-SZ but not at scale available for assessment. Estimated displaced historical catches from sanctuary zones were low and catches should be maintained.	9, 10, 11, 13, 14, 15	4
Sardine Fishery	Catch, catch value, catch rate, and fishing behaviour	Statewide	Yes	No	Maintain current trend	Estimated displaced historical catches from sanctuary zones were low, and sardines are highly mobile, so catches should be maintained.	4, 5, 6, 11, 12, 16	4

Component	Potential indicator	Spatial unit available for assessment	Directly influenced by management plans	Measurable change predicted due to management plans	Prediction to 2022	Comments	Marine parks relevant to prediction	EQs
Marine Scalefish Fishery	Catch, catch value, catch rate, and fishing behaviour	Marine Fishing Area, Statewide	Yes	No	Maintain current trend	Commercial Fisheries Voluntary Catch/Effort Reduction Program has removed any displaced effort such that catches should be maintained in areas outside of SZs. Spatial fishing behaviour may change at scale of SZ vs non-SZ but not at scale available for assessment.	All parks	4
Charter Boat Fishery	Catch, catch rate, and fishing behaviour	Marine Fishing Area, Statewide	Yes	No	Maintain current trend	Spatial behaviour may change at scale of SZ vs non-SZ but not at scale available for assessment. Commercial Fisheries Voluntary Catch/Effort Reduction Program has removed any displaced effort such that catches should be maintained.	All parks	4
C'wealth Southern and Eastern Scalefish and Shark Fishery (Gillnet Hook and Trap Sector)	Catch, catch value, catch rate, and fishing behaviour	Statewide	Yes	No	Maintain current trend	Minimal or no displacement of existing fishing grounds.	1, 2, 3, 4, 5, 7, 8, 12, 13, 15, 16, 17	4
PHYSICAL DRIVERS								

Component	Potential indicator	Spatial unit available for assessment	Directly influenced by management plans	Measurable change predicted due to management plans	Prediction to 2022	Comments	Marine parks relevant to prediction	EQs
Air temperature	Air temperature	Specific locations	No	Not applicable	Maintain current trend	Indicator is external to influence of management plans.	All parks	1, 2, 3, 4
Sea surface temperature	Sea surface temperature	Specific locations	No	Not applicable	Maintain current trend	Indicator is external to influence of management plans.	All parks	1, 2, 3, 4
Upwellings	Index of upwelling	Specific locations	No	Not applicable	Maintain current trend	Indicator is external to influence of management plans.	2, 3, 4, 5, 7, 8, 12, 16, 19	1, 2, 3, 4
Currents	Index of Leeuwin current	Specific locations	No	Not applicable	Maintain current trend	Indicator is external to influence of management plans.	1, 2, 3, 4, 5	1, 2, 3, 4
Tides	Sea level	Specific locations	No	Not applicable	Maintain current trend	Indicator is external to influence of management plans.	All parks	1, 2, 3, 4
Waves	Wind direction, wind speed, Waverider™ buoy	Specific locations	No	Not applicable	Maintain current trend	Indicator is external to influence of management plans.	All parks	1, 2, 3, 4
SOCIO-ECONOMIC DRIVERS								
Interest rates	Interest rates	National	No	Not applicable	Maintain current trend	Indicator is external to influence of management plans.	All parks	4
Exchange rates	Exchange rates	Global	No	Not applicable	Maintain current trend	Indicator is external to influence of management plans.	All parks	4

Component	Potential indicator	Spatial unit available for assessment	Directly influenced by management plans	Measurable change predicted due to management plans	Prediction to 2022	Comments	Marine parks relevant to prediction	EQs
Fuel prices	Price of diesel and unleaded petrol	State	No	Not applicable	Maintain current trend	Indicator is external to influence of management plans.	All parks	4
Labour force	Wage price index	National	No	Not applicable	Maintain current trend	Indicator is external to influence of management plans.	All parks	4
Market demand	Price of seafood	State	No	Not applicable	Maintain current trend	Loss of product from Commercial Fisheries Voluntary Catch/Effort Reduction Program is minimal and product will likely be replaced from other sources.	All parks	4
	Various qualitative measures	State, National, Global	No	Not applicable	Maintain current status	Indicator is external to influence of management plans.	All parks	4
Major developments	Various qualitative measures	Marine park, State	No	Not applicable	Maintain current status	Indicator is external to influence of management plans.	All parks	4
Government regulation	Various qualitative measures	Marine park, State, National	No	Not applicable	Maintain current status or trend	Indicator is external to influence of management plans.	All parks	4
PRESSURES								

Component	Potential indicator	Spatial unit available for assessment	Directly influenced by management plans	Measurable change predicted due to management plans	Prediction to 2022	Comments	Marine parks relevant to prediction	EQs
Coastal pollution	Runoff volume	Marine park	Yes	Yes	Improve or maintain current trend	Current and future polluting activities inside marine parks should be influenced by the management plans.	All parks	1, 2, 3, 4
	Number of point sources of pollution	Marine park	Yes	Yes	Improve or maintain current status	Current and future polluting activities inside marine parks should be influenced by the management plans.	All parks	1, 2, 3, 4
	Water quality	Marine park	Yes	Yes	Improve or maintain current trend	Current and future polluting activities inside marine parks should be influenced by the management plans.	All parks	1, 2, 3, 4
Fishing	Various indicators of compliance and incidence of illegal fishing	Sanctuary Zone	Yes	Yes	Decline of illegal fishing inside SZs	Management plans mandate the removal of all forms of fishing pressure from SZs (and prawn trawling from HPZs). Some illegal fishing is expected to occur. Compliance activities are part of management plans and are expected to be effective.	All parks	1, 2, 3, 4

Component	Potential indicator	Spatial unit available for assessment	Directly influenced by management plans	Measurable change predicted due to management plans	Prediction to 2022	Comments	Marine parks relevant to prediction	EQs
	See various fisheries in *SOCIO-ECONOMIC VALUES*	Various units that exclude Sanctuary Zones – See various fisheries in *SOCIO-ECONOMIC VALUES*	No	No	Maintain current trends outside of SZs	Fisheries are managed by PIRSA Fisheries (but taking into account areas that are restricted under the marine park management plans). Trends of fishing pressure outside of SZs could influence comparisons of ecological values between sites inside and outside of SZs.	All parks	1, 2, 3, 4
Habitat modification	Number and nature of new coastal developments	Marine park	Yes	Yes	Increased consideration given to marine park zoning	Future coastal developments inside marine parks should be influenced by the management plans.	All parks	1, 2, 3, 4
	Prawn trawl effort	Marine Fishing Area	Yes	No	Maintain current trend	Trawling banned in SZs and HPZs but prawn trawling accommodated in zoning arrangements and no pre-trawled areas included in zoning.	2, 5, 6, 9, 10, 11, 12, 15	1, 2, 3, 4

Component	Potential indicator	Spatial unit available for assessment	Directly influenced by management plans	Measurable change predicted due to management plans	Prediction to 2022	Comments	Marine parks relevant to prediction	EQs
Disturbance of animals	Various indicators of compliance and incidence of illegal fishing, recreation and tourism activities	Habitat Protection Zone, Sanctuary Zone, Restricted Access Zone	Yes	Yes	Decline of illegal activities	Management plans restrict some activities in HPZs, SZs and RAZs that will reduce disturbance of animals. Some illegal activities are expected to occur. Compliance activities are part of management plans and are expected to be effective.	All parks	1, 2, 3, 4
	Recreational fishing, coastal recreation and tourism activities	Marine park	Yes	Yes	Maintain or increase current trend	Strategies of the management plan are aimed at increasing recreational fishing (outside of SZs and RAZs), recreation, and sustainable tourism activities – see *SOCIO-ECONOMIC VALUES* These socio-economic values may present an increased pressure to ecological values through disturbance of animals.	All parks	1, 2, 3, 4
	Shipping activity - see *SOCIO-ECONOMIC VALUES*	Marine park	No	No	Maintain current trend	Shipping is accommodated by the management plans. There will be no change to disturbance from this pressure.	2, 4, 5, 6, 7, 8, 10, 12, 13, 14, 15, 16, 17, 19	1, 2, 3, 4

Component	Potential indicator	Spatial unit available for assessment	Directly influenced by management plans	Measurable change predicted due to management plans	Prediction to 2022	Comments	Marine parks relevant to prediction	EQs
	Aquaculture activity - see *SOCIO-ECONOMIC VALUES*	Aquaculture zone	No	No	Maintain current trend	Current and future aquaculture is accommodated by the management plans. There will be no change to disturbance from this pressure.	2, 5, 6, 9, 10, 12, 13, 15	4
Invasive pest species	Number of new invasive marine pests and disease outbreaks	Sanctuary Zone, Marine park	No	No	Maintain current trend	Shipping is accommodated by the management plans. There will be no change to this vector for invasive pest incursions. It is possible that communities inside SZs will become more resilient to invasive pest incursions.	All parks	1, 2, 3, 4
Climate change	See *PHYSICAL DRIVERS*	Marine park	No	No	Maintain current trend	Indicator is external to influence of management plans.	All parks	1, 2, 3, 4

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13 Appendices

A. Evaluation questions

The purpose of setting evaluation questions is to provide direction to monitoring and evaluation activities. The evaluation questions will be the basis of the evaluation of the marine park management plans. This evaluation will inform the statutory review in 2022. Each evaluation question addresses specific outcomes and strategies in the context of effectiveness, impact, appropriateness and efficiency of the management plans.

Evaluation question 1

To what extent has the legislated comprehensive, adequate, representative (CAR) system protected and conserved marine biological diversity and marine habitats?

Outcome 1

Increased understanding of which components or elements of the existing legislated CAR marine park system are successfully contributing to the protection and conservation of marine environments.

Strategies include:

Develop and implement a monitoring, evaluation and reporting (MER) program that measures the effectiveness of each marine park management plan and its contribution to South Australia's marine parks network (2011 baseline); that sets out targets and indicators linked to strategies and outcomes for monitoring, which include ecological, socio-economic, environmental and management elements; and that assesses the effectiveness of compliance activities.

Ensure outcomes of the MER Program and research outcomes are made publicly available and inform decision making and periodic review of management plans.

Conduct priority research and foster research partnerships to assess the integrity of knowledge frameworks that underpin the predicted outcomes.

Evaluation questions 2 and 3

To what extent have marine parks strategies contributed to the maintenance of ecological processes?

To what extent have marine parks strategies contributed to enabling marine environments to adapt to impacts of climate change?

Outcome 2

Threats to the marine biodiversity and marine habitats are reduced.

Outcome 3

Protection and conservation of marine biodiversity and habitats are increased.

Outcome 4

Ecosystem status, functions and resilience are enhanced or maintained.

Strategies include:

Manage activities and uses in marine parks in accordance with zoning and special purpose area provisions.

Actively influence activities and uses within and adjacent to marine parks to help mitigate threats to marine biodiversity and marine habitats.

Consider additional protections and/or temporary restrictions where necessary in circumstances of urgency—

(a) to protect a listed species[1] of plant or animal, or threatened ecological community

(b) to protect a feature of natural or cultural heritage significance

(c) to protect public safety.

Develop and implement a compliance strategy that:

- is cost-efficient
- is focussed on SZs and other conservation priorities
- complements existing compliance efforts
- maximises voluntary compliance
- includes measures to address serious or repeat non-compliance.

Evaluation question 4

To what extent have the marine parks strategies contributed to the ecologically sustainable development and use of the marine environment?

Outcome 5

Ecological sustainable development and management of shipping, mining, aquaculture and fishing industries are appropriately accommodated within marine parks.

Outcome 6

Increased opportunities for research and sustainable nature-based tourism within marine parks.

Strategies include:

Manage activities and uses in marine parks in accordance with zoning and special purpose area provisions

Introduce a permitting system to provide for the following activities (where not otherwise authorised):

- scientific research in a sanctuary or restricted access zone
- tourism operations in an SZ
- competitions and organised events in an SZ
- commercial film-making (including sound recording and photography) in an SZ
- Installation of vessel moorings in an SZ

[1] "listed species" and "threatened ecological community" refers to species or ecological communities of conservation concern listed under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth), the *National Parks and Wildlife Act 1972* or the *Fisheries Management Act 2007*.

Create and promote opportunities for sustainable nature-based tourism in marine parks.

Evaluation question 5

To what extent have the marine parks strategies contributed to providing opportunities for public appreciation, education, understanding and enjoyment of marine environments?

Outcome 7

Increased stewardship of marine parks and marine environments.

Outcome 8

Marine Parks valued by more people.

Strategies include:

Provide for public appreciation, understanding and enjoyment of marine parks.

Provide education to support the implementation of marine parks.

Seek to involve local communities and stakeholders in the day-to-day management and monitoring of marine parks.

Foster partnerships to support the implementation of the MER Program incorporating opportunities for community and stakeholder involvement.

Evaluation question 6

To what extent have the marine park strategies contributed to the protection and conservation of features of natural and cultural heritage significance?

Outcome 9

Traditional Aboriginal knowledge is preserved and shared when appropriate.

Outcome 10

Impacts on the significant features of natural and cultural heritage are reduced

Strategies include:

Consider additional protections and/or temporary restrictions where necessary in circumstances of urgency— to protect a feature of natural or cultural heritage significance

Work cooperatively with Aboriginal communities to conserve country, plants, animals and culture.

Encourage Aboriginal people, local communities and stakeholders to preserve traditional and historic knowledge and, where appropriate, share this knowledge with others.

B. Summary of habitats in each zone type

Summary of habitats in the marine parks network. Total area of benthic habitats excludes land, including islands and includes coastal waters only. Bracketed numbers for shoreline habitats show length of coastline where shoreline fishing is allowed within Sanctuary Zones. Shoreline habitats are not available for islands.

Zones / Habitats	General Managed Use	Habitat Protection	Sanctuary	Restricted Access	Total Network
Benthic habitats (square kilometres)					
Reef	455.4	1009	265.7	37	1714
Seagrass	1312.9	2556.9	324	72.1	4265.9
Sand	971.9	1436.6	278.2	166.9	2466.2
Mangrove	22.1	39.1	40.5	0.5	102.2
Saltmarsh	4.4	13.7	14.3	0.06	32.5
Not mapped	5413.5	9729.8	1981.9	412	16187.6
Shoreline habitats (kilometres of coastline)					
Reef	257.7	653.4	112.4 (21.2)	208.7	1232.5
Seagrass	70.7	53.1	67.6		191.3
Sand	406.3	819.3	120.7 (38.4)	48.7 (12.5)	1416.6
Mangroves	150.2	267.4	260.9	2.1	680.5
Saltmarsh	26.4	71.7	54.5		152.6

C. Spatial reporting units relevant to the South Australian Marine Parks Monitoring, Evaluation and Reporting Program

C1. Recreational fishing

Marine park boundaries and the overlap with survey areas/regions for the Recreational Fishery

C2. Rock lobster fishing

Marine park boundaries and the overlap with marine fishing areas for the Northern Zone and Southern Zone Rock Lobster Fisheries

C3. Abalone fishing (Western Zone)

Marine park boundaries and the overlap with map codes and spatial assessment units for part of the Western Zone Abalone Fishery off the far-west coast of South Australia

C4. Abalone fishing (Western Zone)

Marine park boundaries and the overlap with map codes and spatial assessment units for part of the Western Zone Abalone Fishery off south-west Eyre Peninsula

C5. Abalone fishing (Western Zone)

Marine park boundaries and the overlap with map codes and spatial assessment units for part of the Western Zone Abalone Fishery off south-east Eyre Peninsula

C6. Abalone fishing (Central Zone)

Marine park boundaries and the overlap with map codes and spatial assessment units for the Central Zone Abalone Fishery

C7. Abalone fishing (Southern Zone)

Marine park boundaries and the overlap with map codes and spatial assessment units for the Southern Zone Abalone Fishery

C8. Prawn fishing

Marine park boundaries and the overlap with fishing blocks for the West Coast, Spencer Gulf, and Gulf St Vincent Prawn Fisheries

C9. Blue crab fishing

Marine park boundaries and the overlap with fishing blocks for the Spencer Gulf and Gulf St Vincent zones of the Blue Crab Fishery

C10. Sardine fishing

Marine park boundaries and the overlap with marine fishing areas and fishery assessment regions for the Sardine Fishery

C11. Marine Scalefish fishing

Marine park boundaries and the overlap with marine fishing areas for the Marine Scalefish Fishery

C12. Marine Scalefish fishing (King George whiting)

Marine park boundaries and the overlap with marine fishing areas and fishery stock assessment regions for King George whiting in the Marine Scalefish Fishery

C13. Marine Scalefish fishing (snapper)

Marine park boundaries and the overlap with marine fishing areas and fishery stock assessment regions for snapper in the Marine Scalefish Fishery

C14. Marine Scalefish fishing (garfish)

Marine park boundaries and the overlap with marine fishing areas and fishery stock assessment regions for garfish in the Marine Scalefish Fishery

C15. Marine Scalefish fishing (calamary)

Marine park boundaries and the overlap with marine fishing areas and fishery stock assessment regions for calamary in the Marine Scalefish Fishery

C16. Charter boat fishing

Marine park boundaries and the overlap with marine fishing areas and fishery assessment regions for the Charter Boat Fishery

C17. Local Government Areas

Marine park boundaries and the overlap with selected local government areas of South Australia that lie adjacent or near to the coast. Note that the numerous local government areas in the Adelaide region are not shown.

C18. Statistical Areas Level 2

Marine park boundaries and the overlap with selected Statistical Areas Level 2 (SA2s), as defined by the Australian Bureau of Statistics (ABS) as part of its Australian Statistical Geography Standard (ABS 2011b), that lie adjacent or near to the coast.

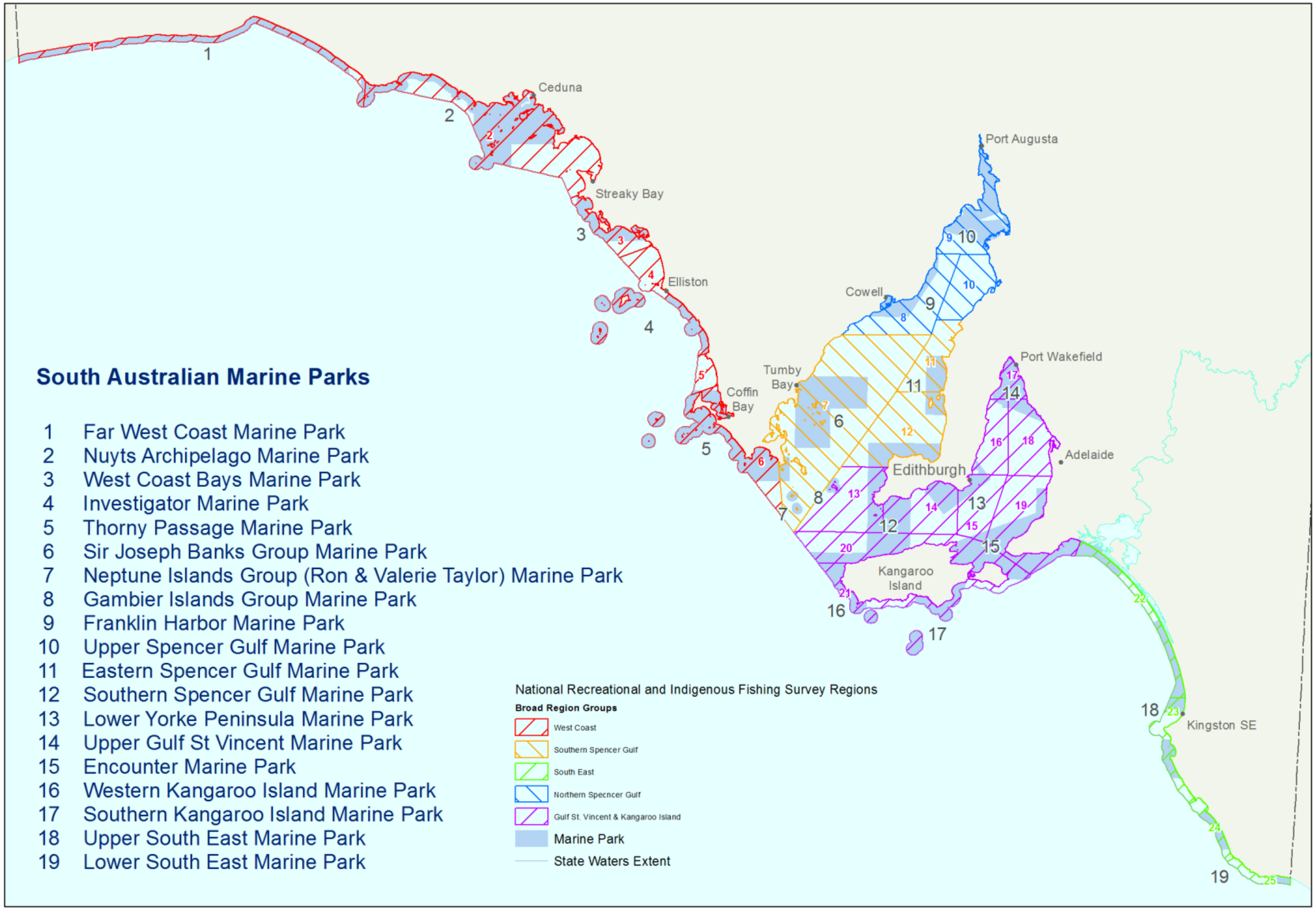
C19. EconSearch regions

Marine park boundaries and the overlap with EconSearch regions, as defined for Regional Impact Assessments (Bailey et al. 2012a, b)

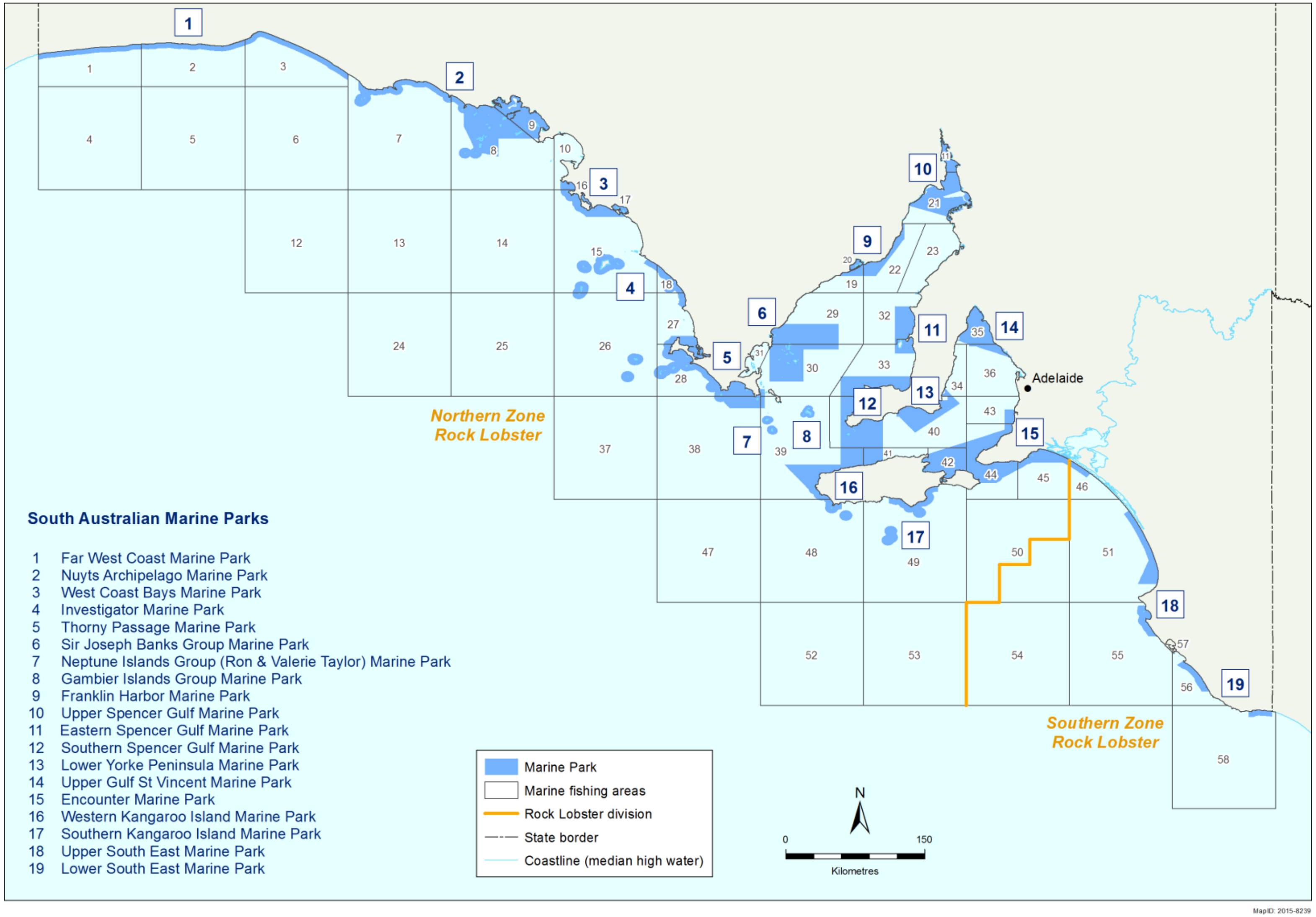
C20. Tourism regions

Marine park boundaries and the overlap with tourism regions, as defined by the Australian Bureau of Statistics (ABS)

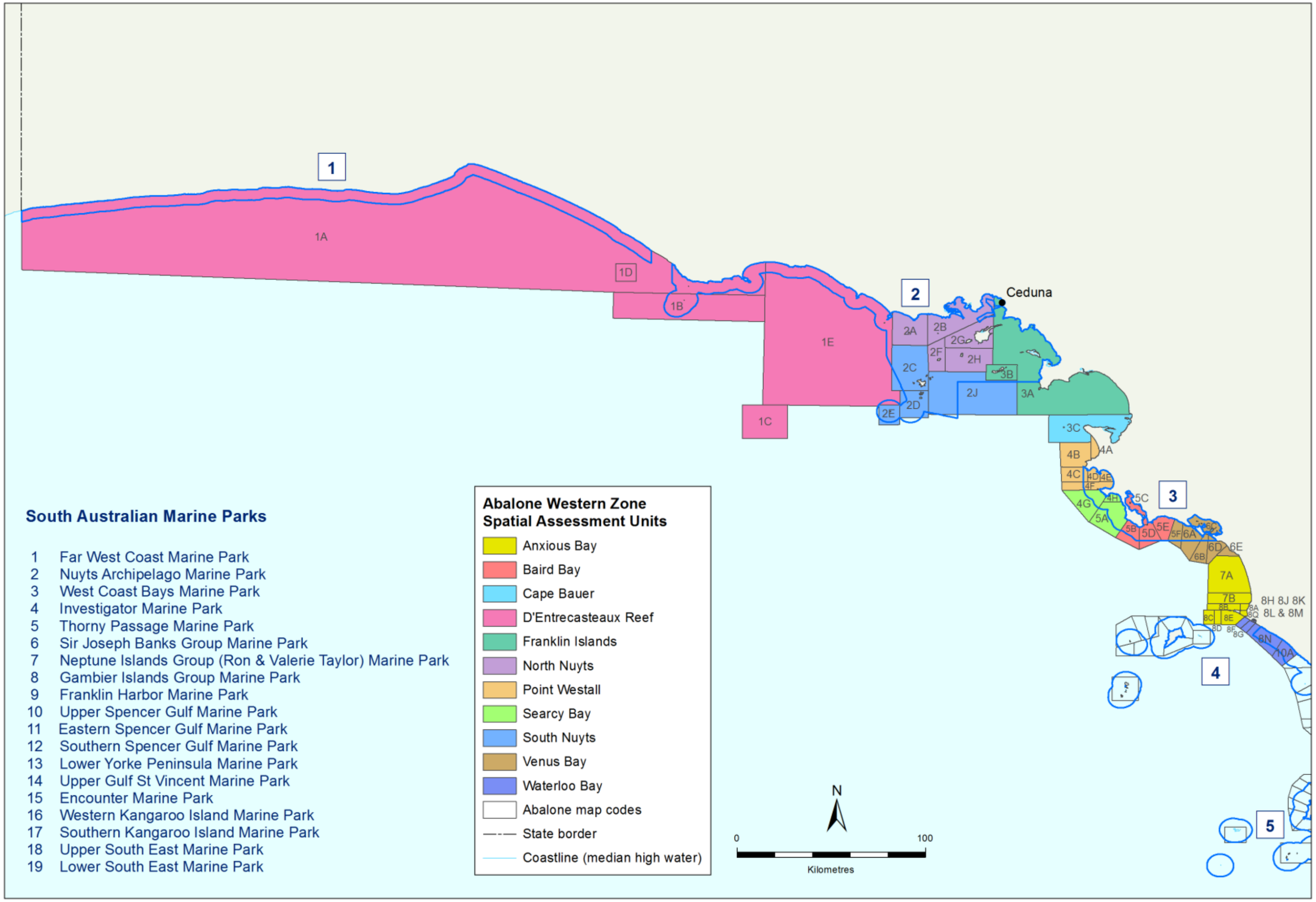
C1. Recreational fishing Marine park boundaries and the overlap with survey areas/regions for the Recreational Fishery



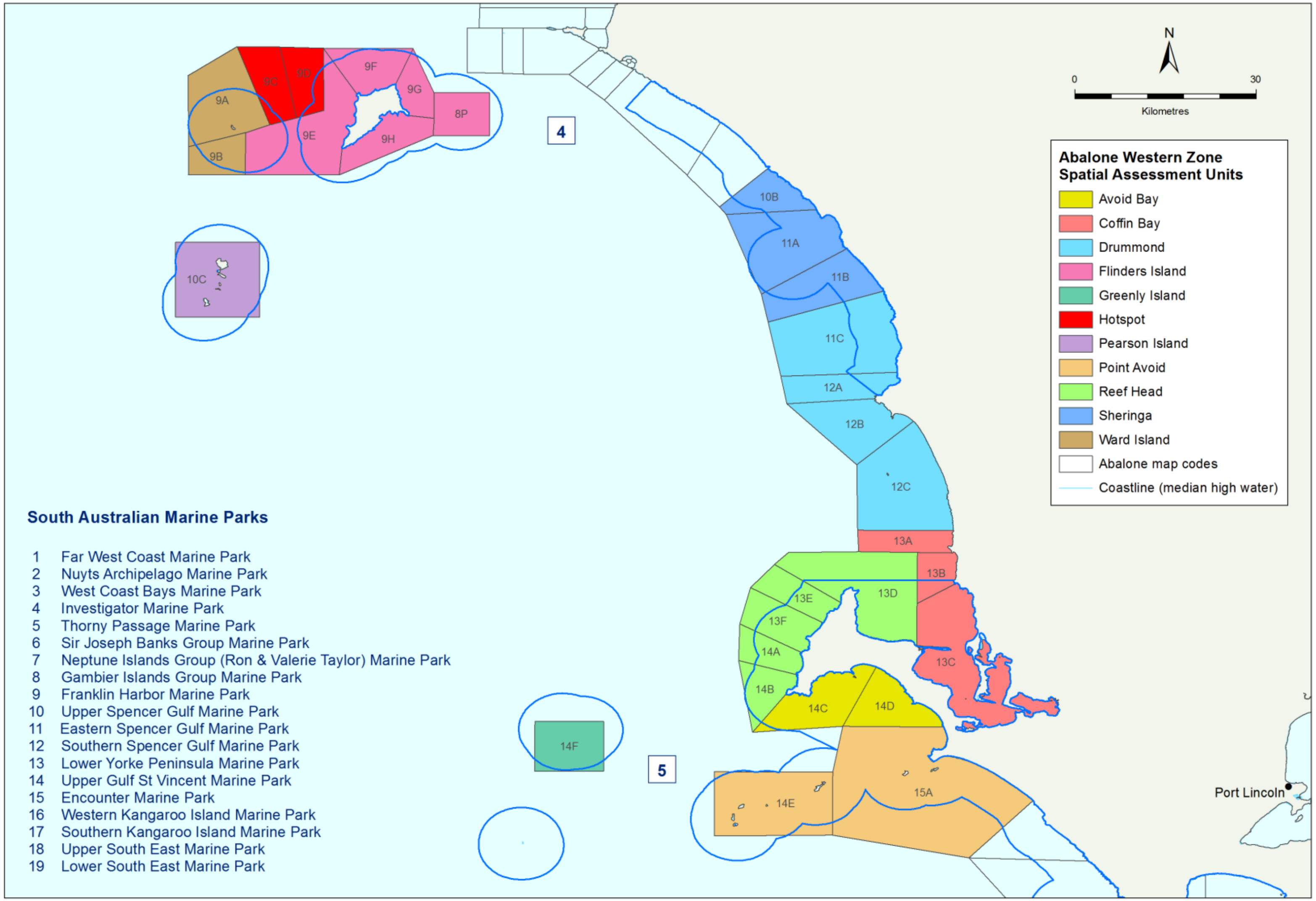
C2. Rock lobster fishing Marine park boundaries and the overlap with marine fishing areas for the Northern Zone and Southern Zone Rock Lobster Fisheries



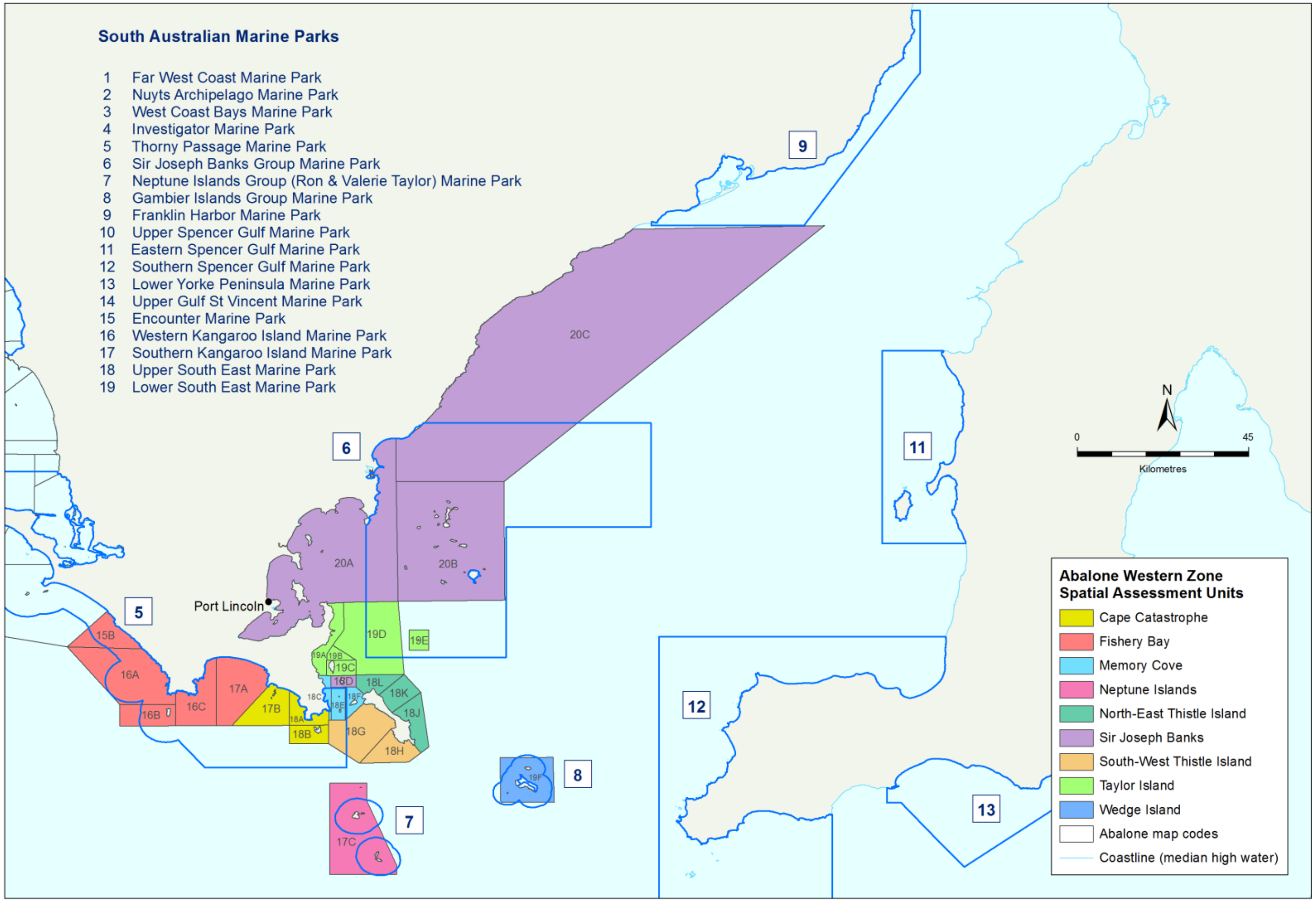
C3. Abalone fishing (Western Zone) Marine park boundaries and the overlap with map codes and spatial assessment units for part of the Western Zone Abalone Fishery off the far-west coast of South Australia



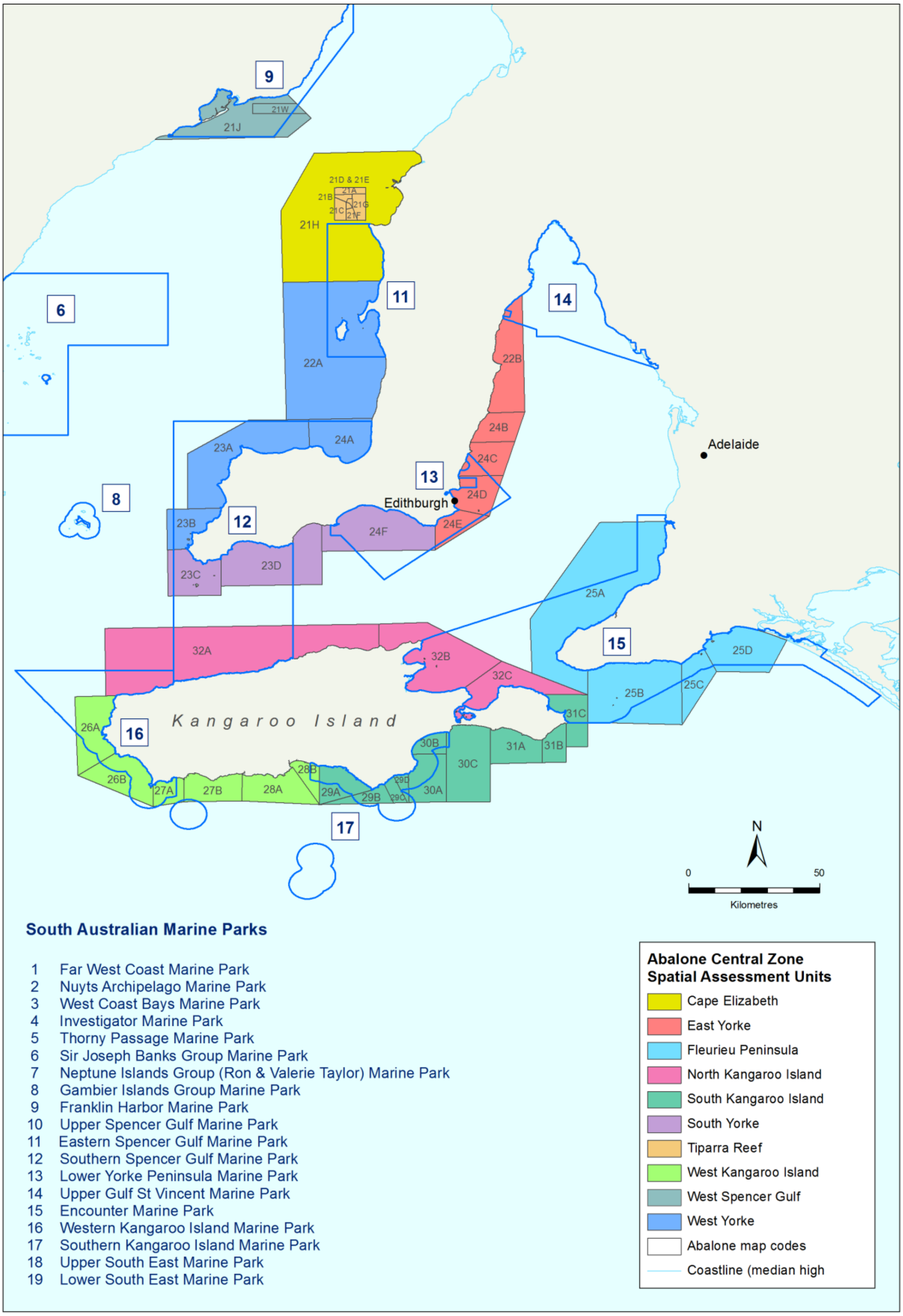
C4. Abalone fishing (Western Zone) Marine park boundaries and the overlap with map codes and spatial assessment units for part of the Western Zone Abalone Fishery off south-west Eyre Peninsula



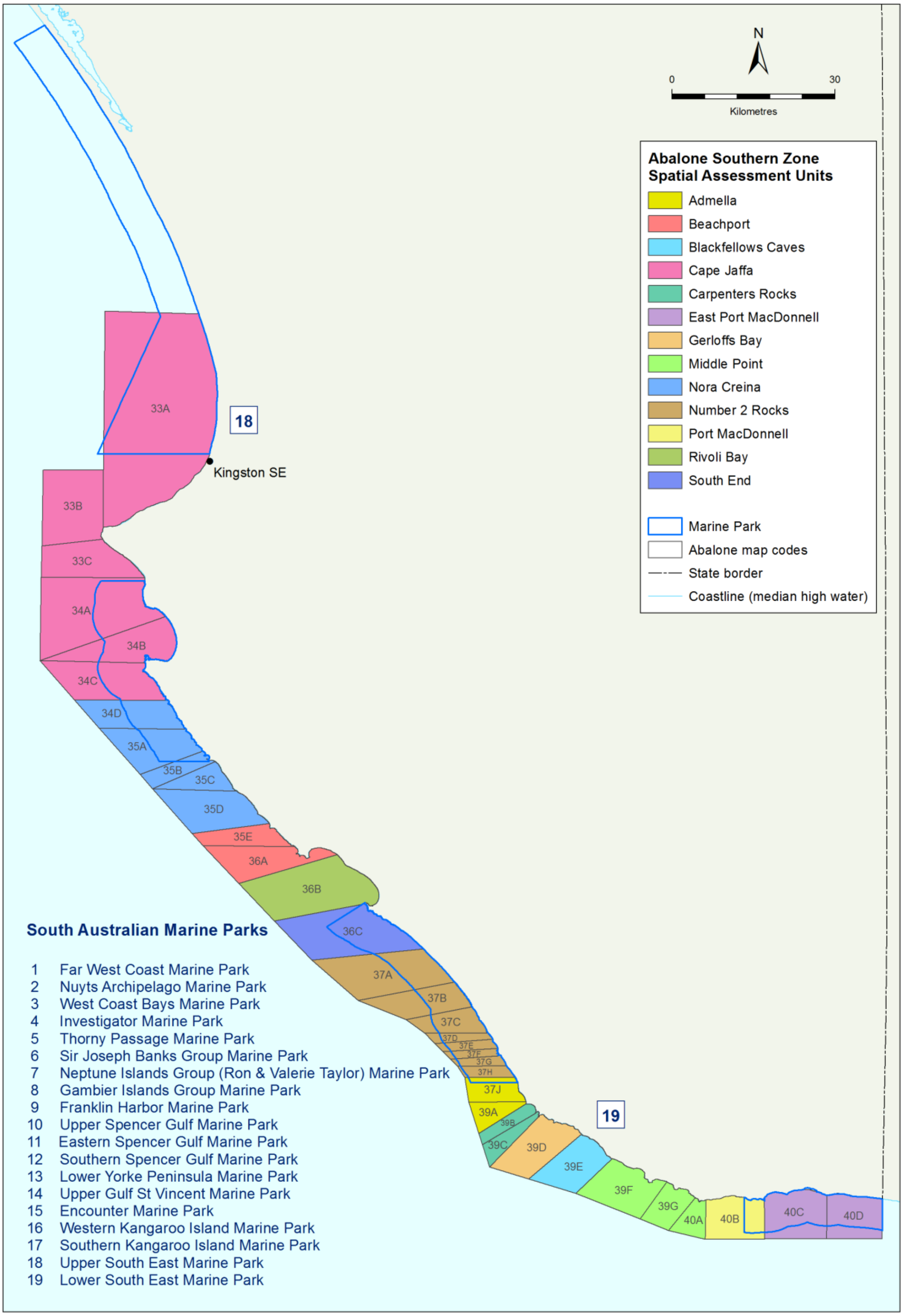
C5. Abalone fishing (Western Zone) Marine park boundaries and the overlap with map codes and spatial assessment units for part of the Western Zone Abalone Fishery off south-east Eyre Peninsula



C6. Abalone fishing (Central Zone) Marine park boundaries and the overlap with map codes and spatial assessment units for the Central Zone Abalone Fishery

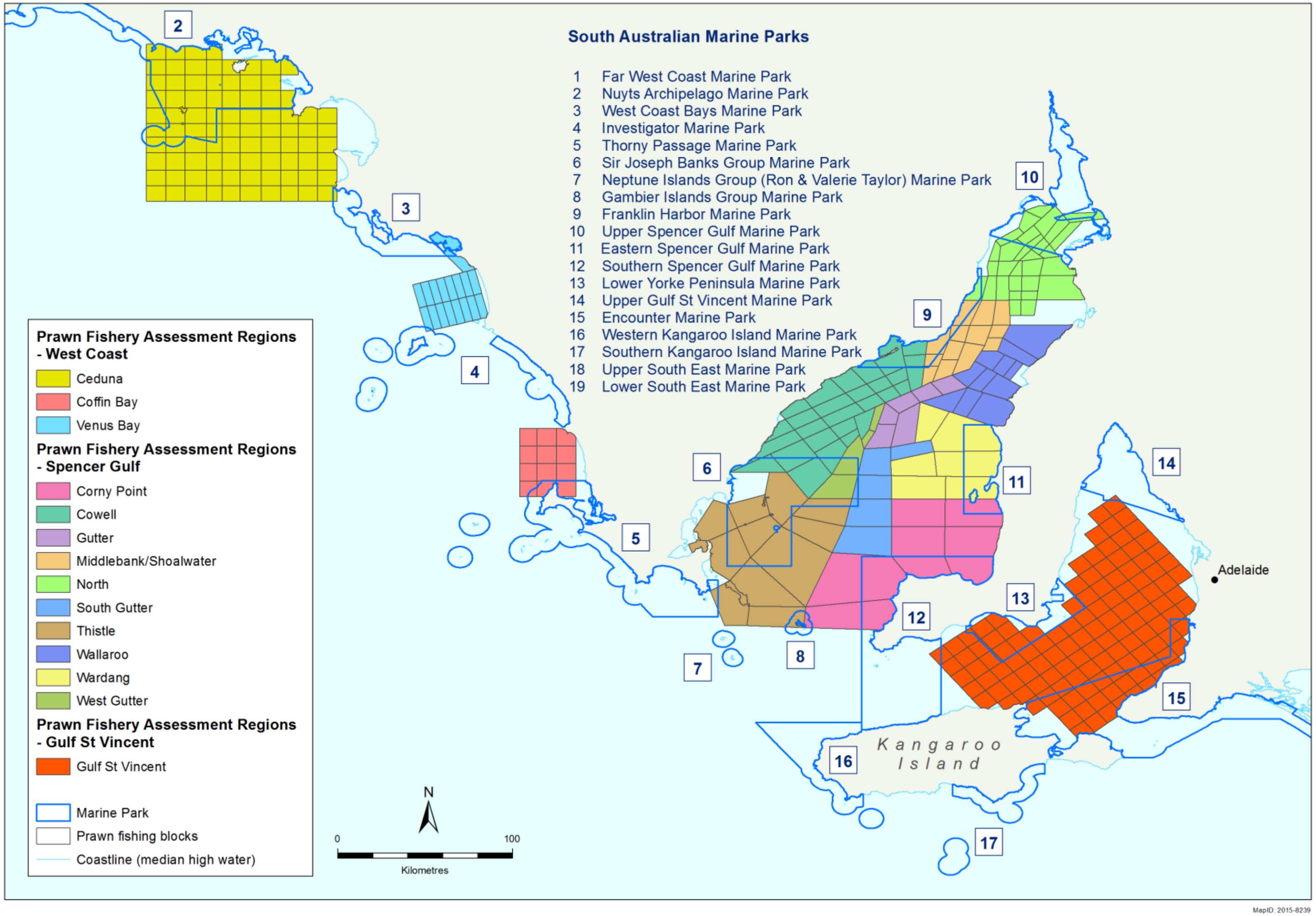


C7. Abalone fishing (Southern Zone) Marine park boundaries and the overlap with map codes and spatial assessment units for the Southern Zone Abalone Fishery

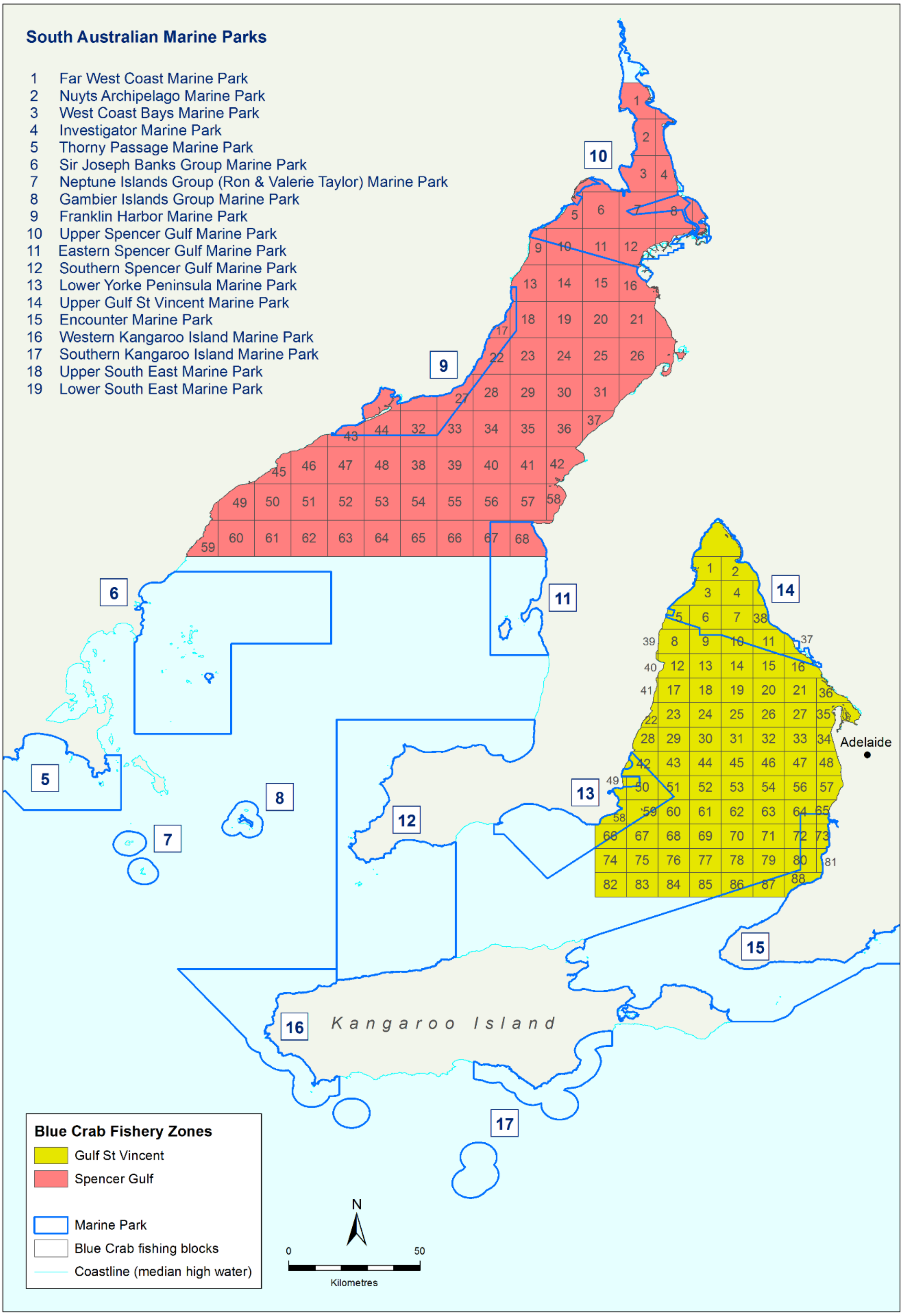


MapID: 2015-8260

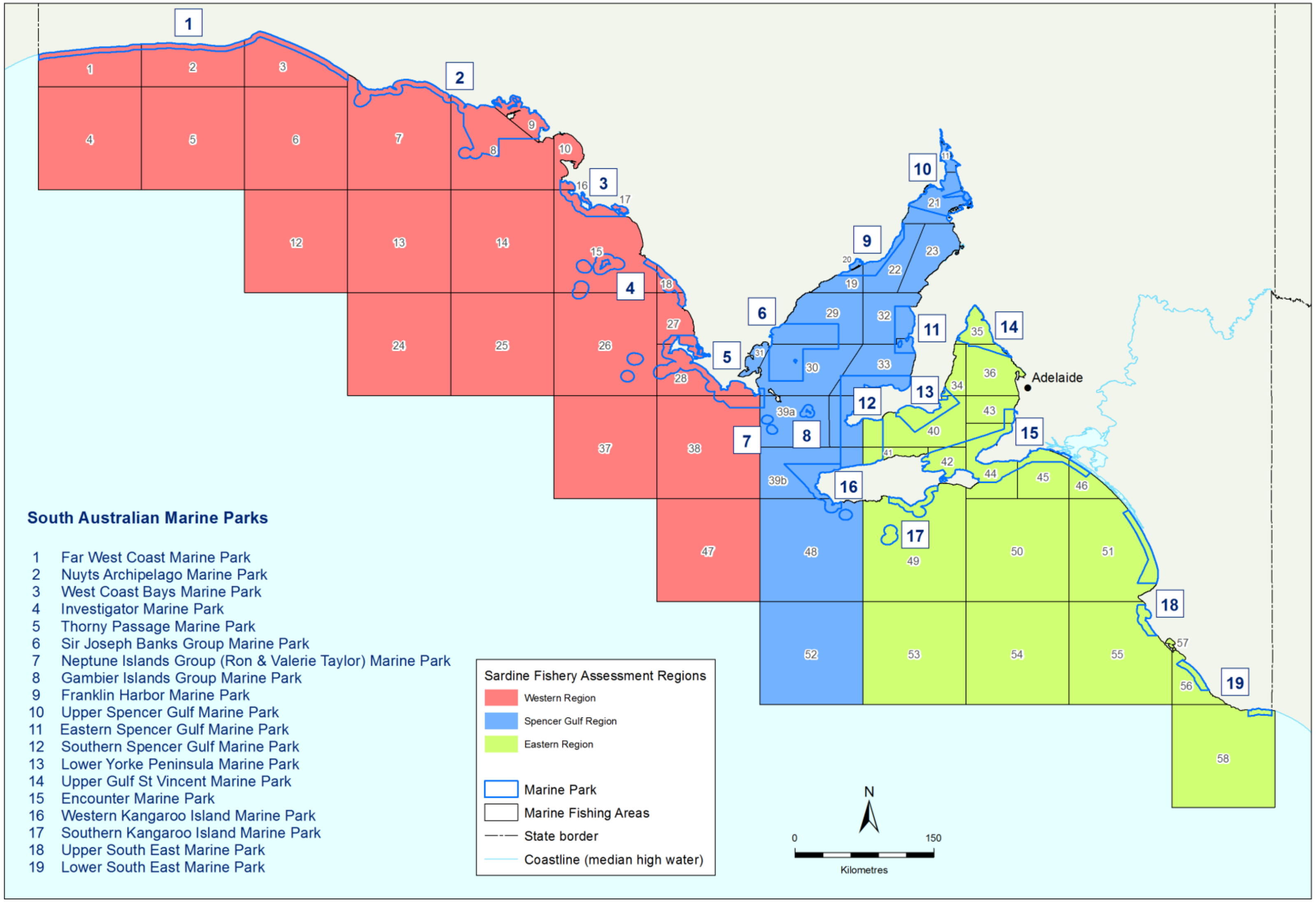
C8. Prawn fishing Marine park boundaries and the overlap with fishing blocks for the West Coast, Spencer Gulf, and Gulf St Vincent Prawn Fisheries



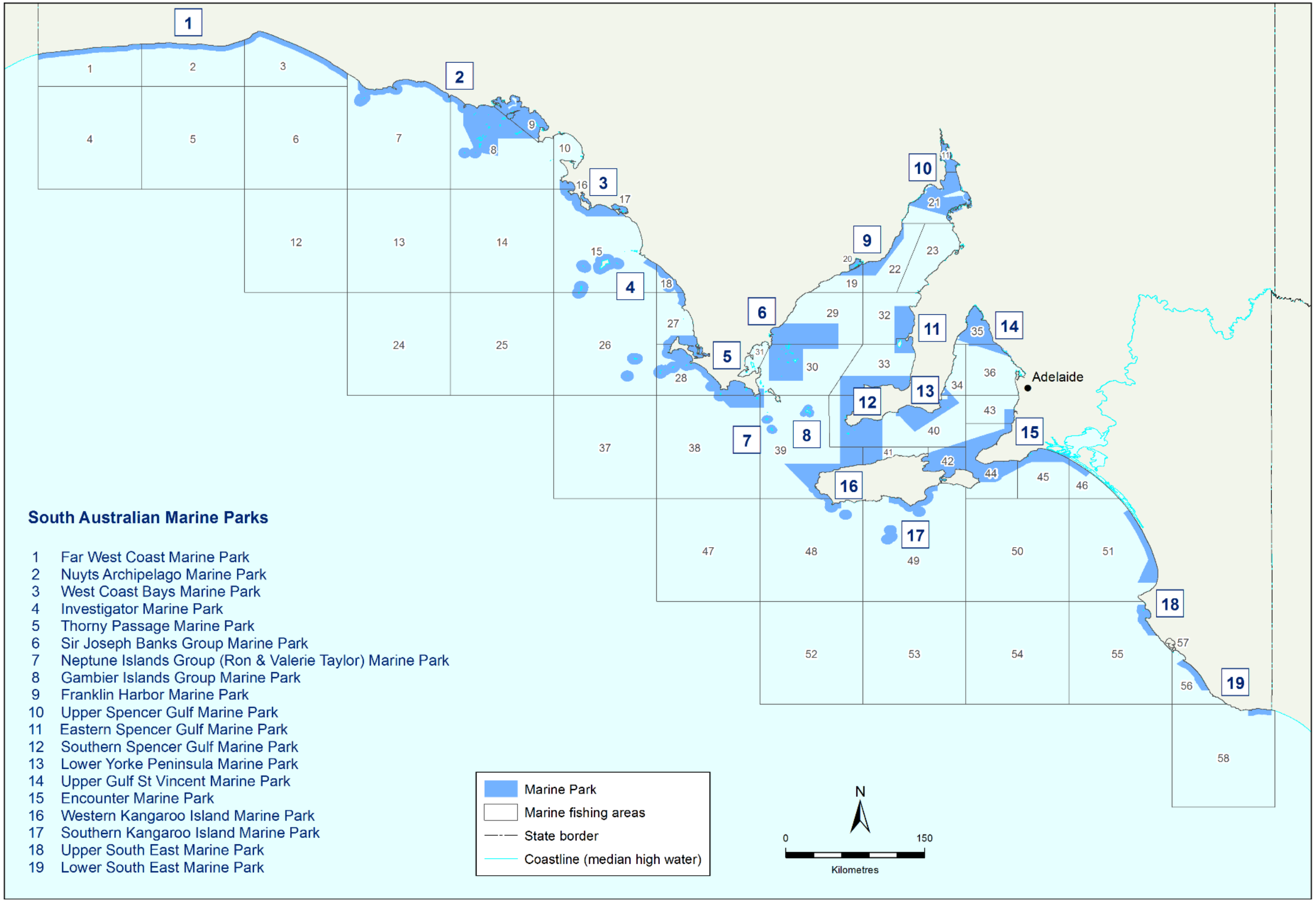
C9. Blue crab fishing Marine park boundaries and the overlap with fishing blocks for the Spencer Gulf and Gulf St Vincent zones of the Blue Crab Fishery



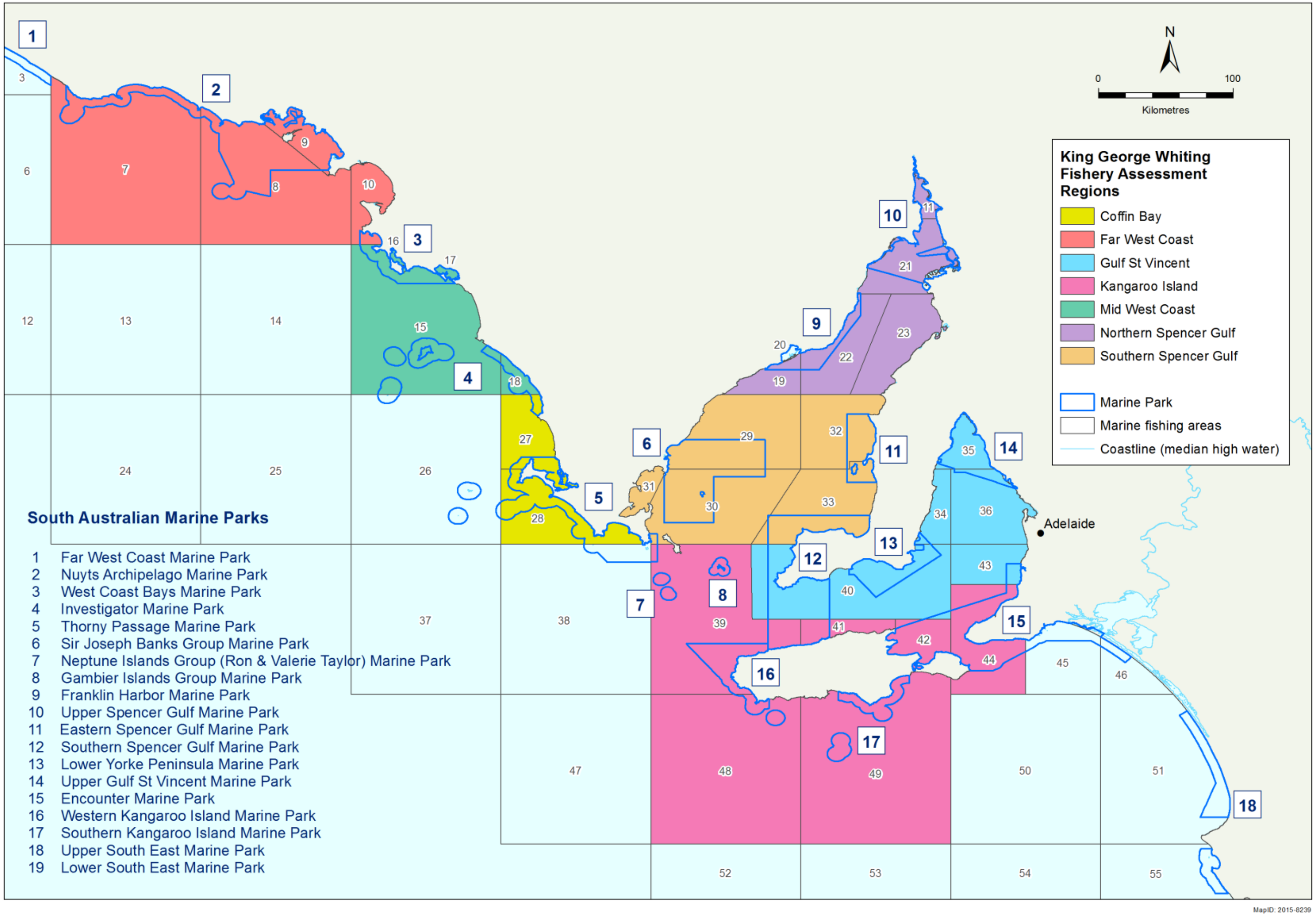
C10. Sardine fishing Marine park boundaries and the overlap with marine fishing areas and fishery assessment regions for the Sardine Fishery



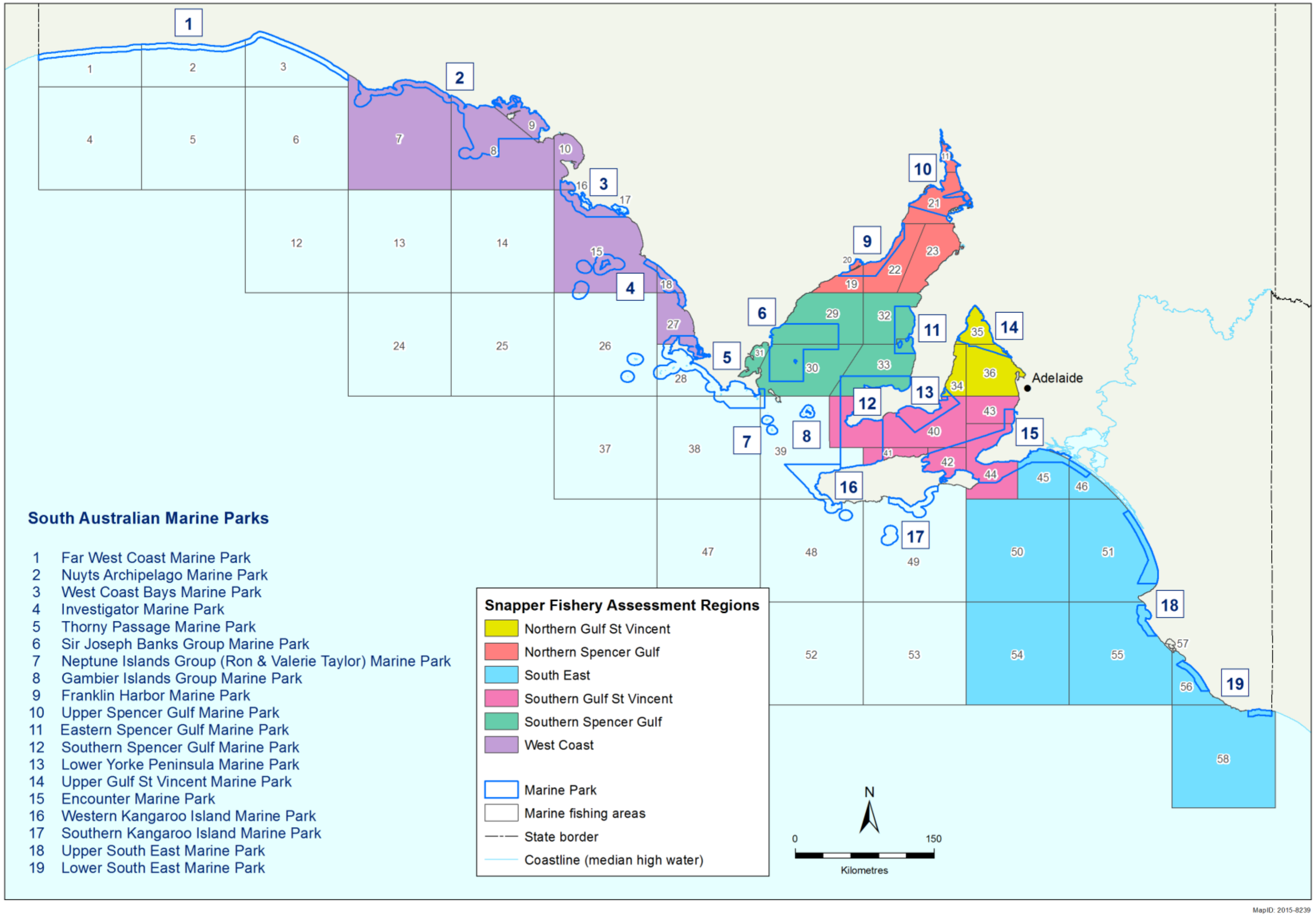
C11. Marine Scalefish fishing Marine park boundaries and the overlap with marine fishing areas for the Marine Scalefish Fishery



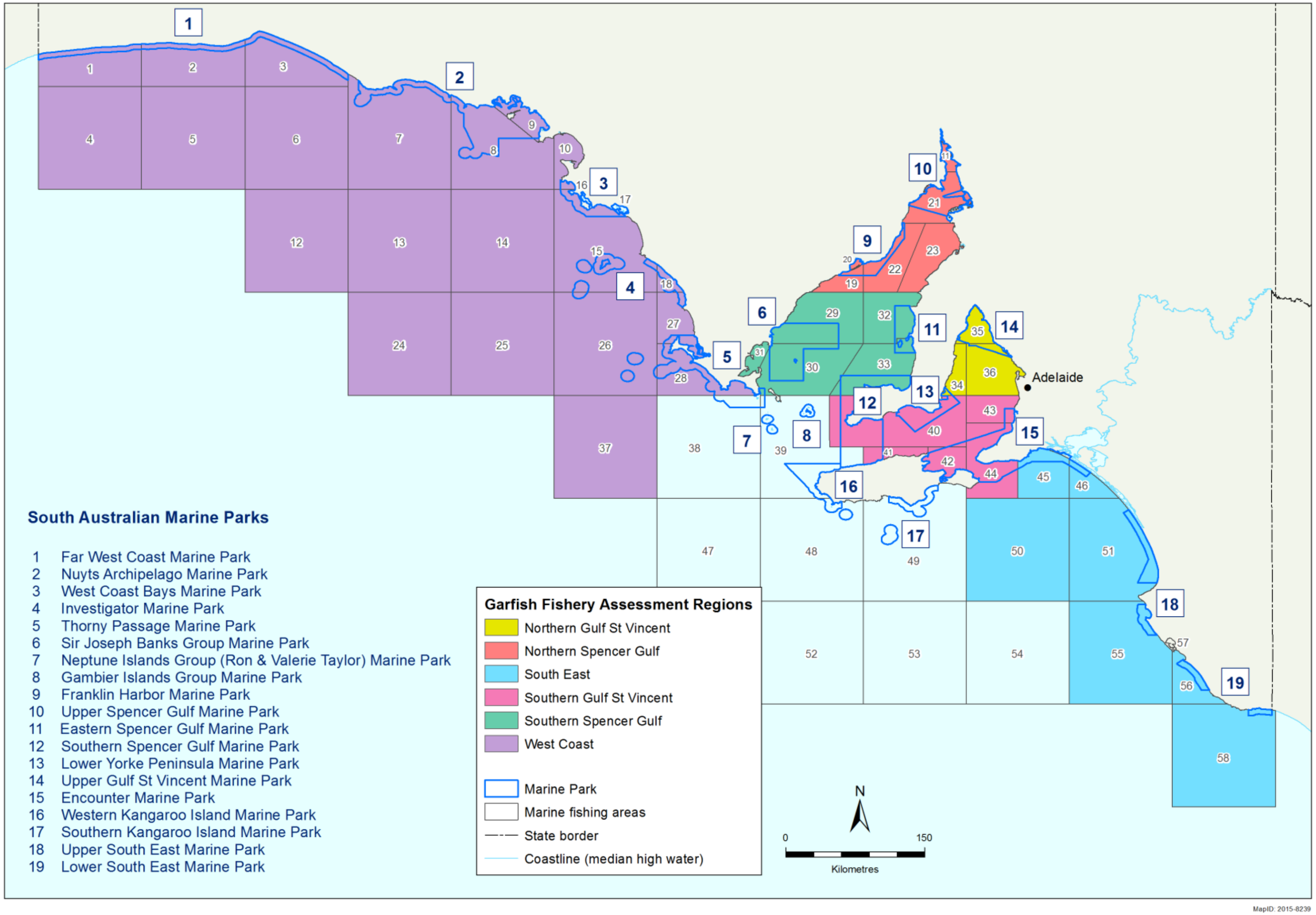
C12. Marine Scalefish fishing (King George whiting) Marine park boundaries and the overlap with marine fishing areas and fishery stock assessment regions for King George whiting in the Marine Scalefish Fishery



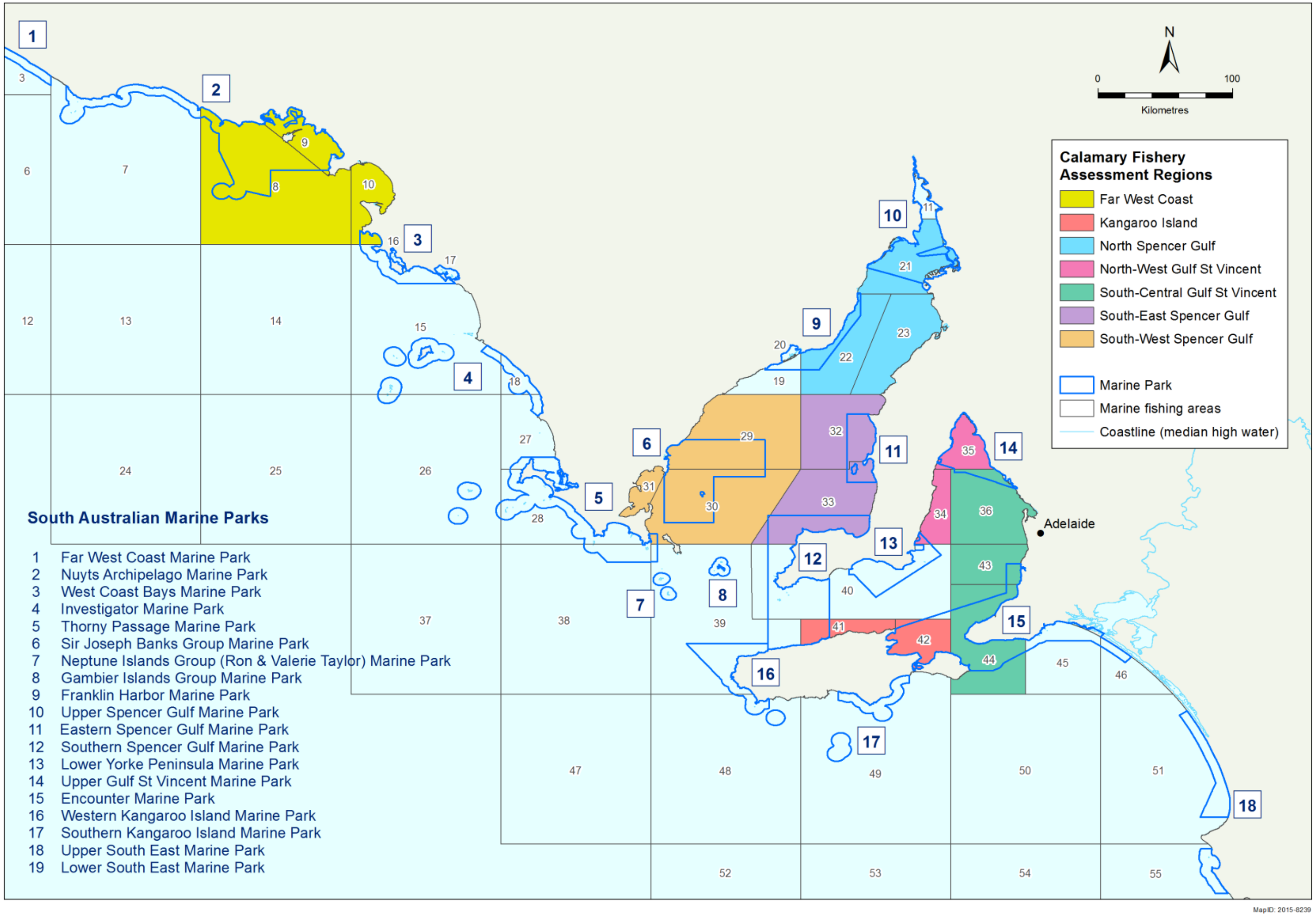
C13. Marine Scalefish fishing (snapper) Marine park boundaries and the overlap with marine fishing areas and fishery stock assessment regions for snapper in the Marine Scalefish Fishery



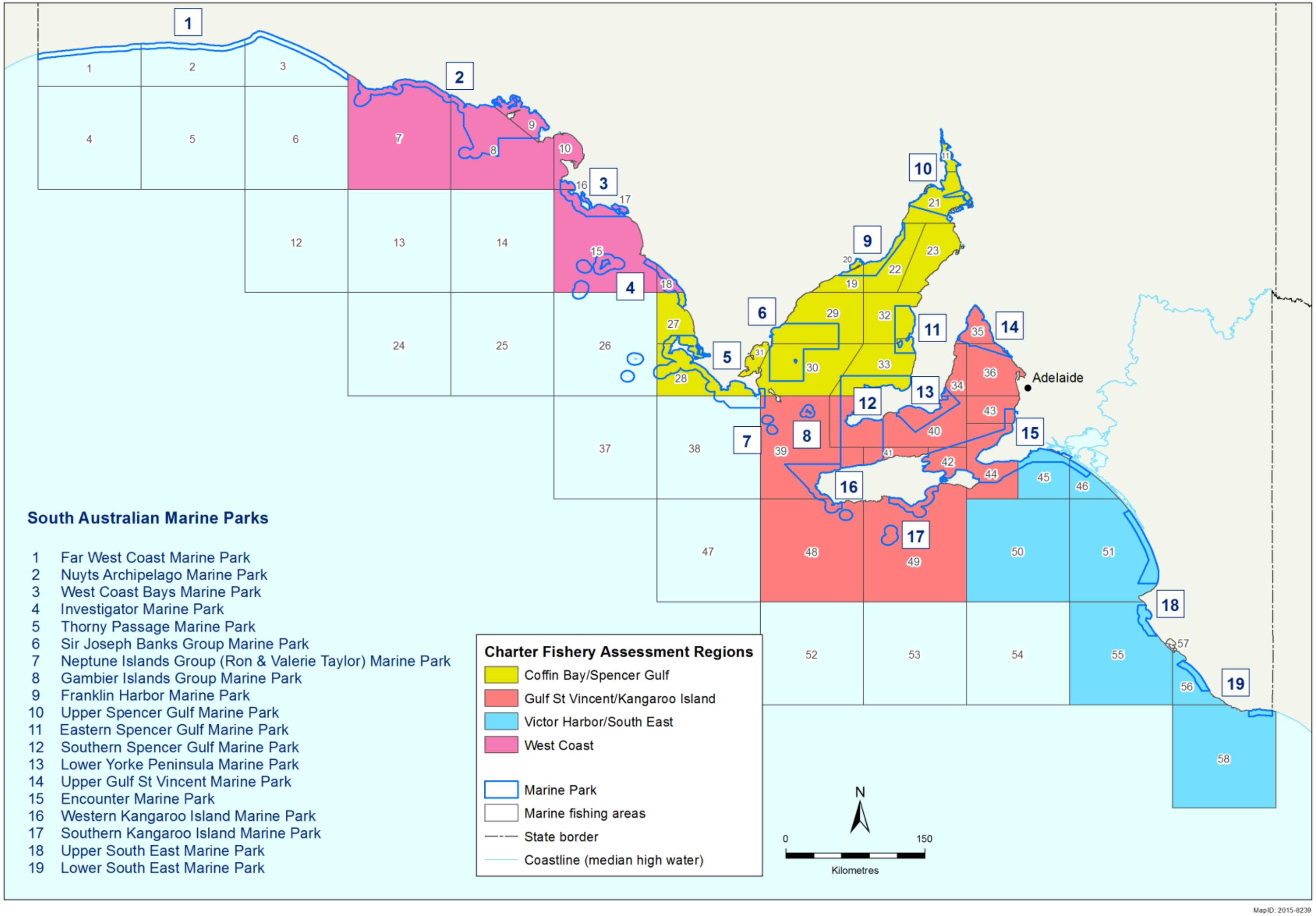
C14. Marine Scalefish fishing (garfish) Marine park boundaries and the overlap with marine fishing areas and fishery stock assessment regions for garfish in the Marine Scalefish Fishery



C15. Marine Scalefish fishing (calamary) Marine park boundaries and the overlap with marine fishing areas and fishery stock assessment regions for calamary in the Marine Scalefish Fishery

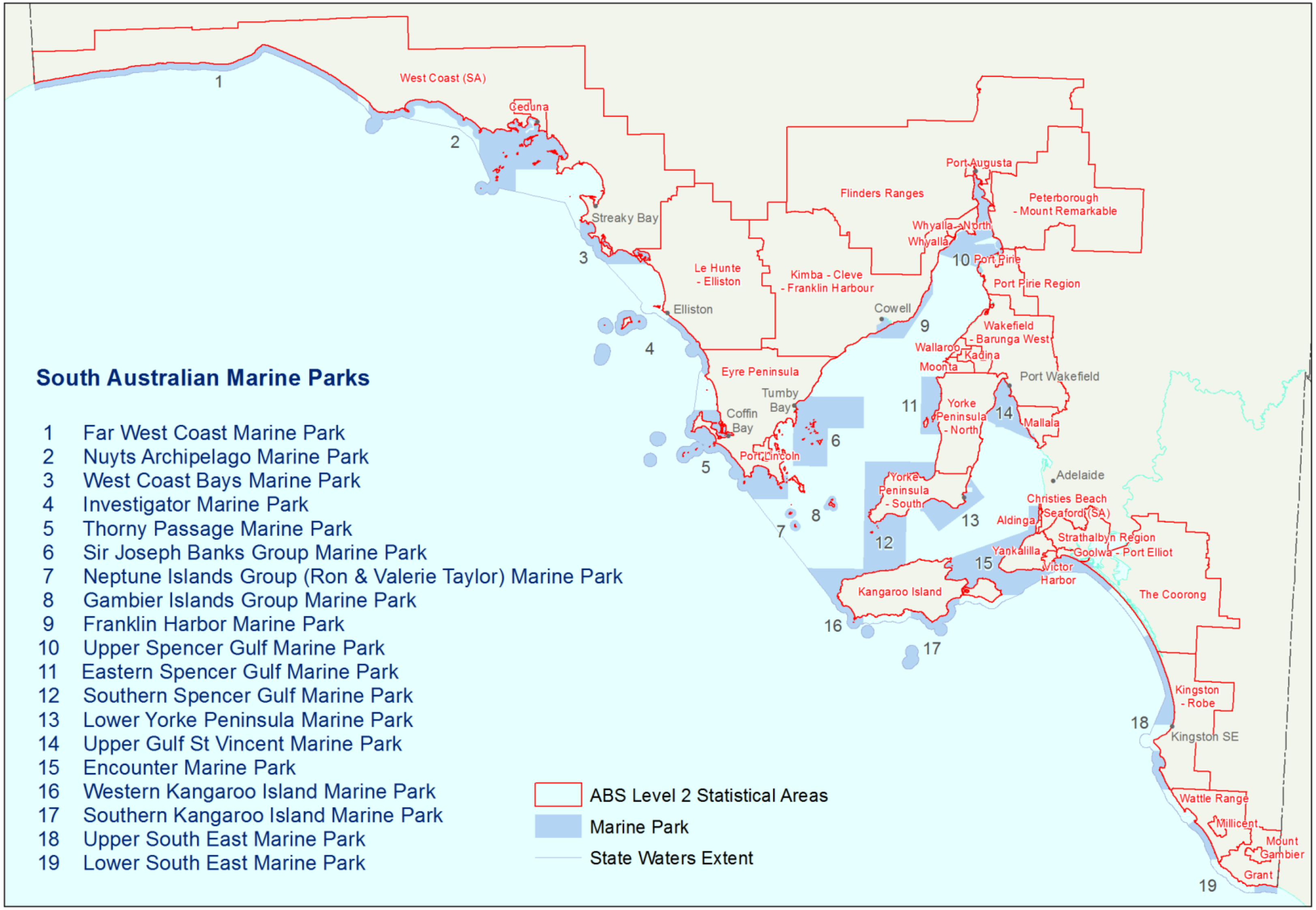


C16. Charter boat fishing Marine park boundaries and the overlap with marine fishing areas and fishery assessment regions for the Charter Boat Fishery



C17. Local Government Areas Marine park boundaries and the overlap with selected local government areas of South Australia that lie adjacent or near to the coast. Note that the numerous local government areas in the Adelaide region are not shown.

C18. Statistical Areas Level 2 Marine park boundaries and the overlap with selected Statistical Areas Level 2 (SA2s), as defined by the Australian Bureau of Statistics (ABS) as part of its Australian Statistical Geography Standard (ABS 2011b), that lie adjacent or near to the coast



C19. EconSearch regions Marine park boundaries and the overlap with EconSearch regions, as defined for Regional Impact Assessments (Bailey et al. 2012a,b)

C20. Tourism regions Marine park boundaries and the overlap with tourism regions, as defined by the Australian Bureau of Statistics (ABS)

D. Management priorities and strategies of a management plan

Management objectives for South Australia's marine parks are set out in the objects of the *Marine Parks Act 2007*. The Act requires management plans to set out strategies for achieving those objects in relation to the marine park.

Management plans for South Australia's marine parks have been developed around four management priorities with associated strategies, to directly support the achievement of the objects of the *Marine Parks Act 2007*. The strategies will guide marine park managers and inform the development of an implementation plan for each marine park, which will include more specific actions for day-to-day management.

Protection

Marine park zones are the principal tool under the *Marine Parks Act 2007* for managing both current and future activities that take place in marine parks. Management activities will be integrated to achieve multiple-use outcomes, in accordance with the objects and the four types of zones established by the Act.

Strategies

1. Manage activities and uses in the marine park in accordance with zoning and special purpose area provisions.
2. Actively influence activities and uses within and adjacent to the marine park to help mitigate threats to marine biodiversity and marine habitats.
3. Consider additional protections and/or temporary restrictions where necessary in circumstances of urgency:

   (a) to protect a listed species[2] of plant or animal, or threatened ecological community

   (b) to protect a feature of natural or cultural heritage significance

   (c) to protect public safety.
4. Introduce a permitting system to provide for the following activities (where not otherwise authorised):
   - scientific research in a sanctuary or restricted access zone
   - tourism operations in a sanctuary zone
   - competitions and organised events in a sanctuary zone
   - commercial film-making (including sound recording and photography) in a sanctuary zone
   - installation of vessel moorings in a sanctuary zone.

[2] "listed species" and "threatened ecological community" refers to species or ecological communities of conservation concern listed under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth), the *National Parks and Wildlife Act 1972* or the *Fisheries Management Act 2007*.

Stewardship through community involvement

Providing opportunities for public appreciation, involvement, education, understanding and enjoyment of marine environments is central to the success of South Australia's marine parks network, and is integral to the implementation of marine park management plans.

Strategies

5. Provide for public appreciation, understanding and enjoyment of the marine park.
6. Create and promote opportunities for sustainable nature-based tourism in the marine park.
7. Provide education to support the implementation of the marine park.
8. Seek to involve local communities and stakeholders in the day-to-day management and monitoring of the marine park.
9. Work cooperatively with Aboriginal communities to conserve country, plants, animals and culture.

Performance assessment, knowledge and review

A monitoring, evaluation and reporting (MER) program will be implemented to assess the effectiveness of this plan in achieving the objects of the *Marine Parks Act 2007*. Under the Act, the Minister is required to review marine park management plans within a 10 year period. The MER Program will provide critical environmental, economic and social information to inform management plan review. The marine environment is complex and challenging to study. It also supports a range of uses that fill diverse community needs. Good marine park management decisions are informed by an in-depth understanding of the environment and the impacts of the activities that take place within it.

Strategies

10. Develop and implement a monitoring, evaluation and reporting (MER) program that measures the effectiveness of this marine park management plan and its contribution to South Australia's marine parks network (2011 baseline), and that:
    - is designed to measure the effectiveness of the management plan in delivering the predicted outcomes to inform adaptive management
    - Includes linkages to relevant state, national and international monitoring, evaluation and reporting frameworks
    - Sets out targets and indicators linked to strategies and outcomes for monitoring, which include ecological, socio-economic, environmental and management elements
    - Monitors the delivery of education, research and governance mechanisms
    - Assesses the effectiveness of compliance activities.

11. Foster partnerships to support the implementation of the MER Program incorporating opportunities for community and stakeholder involvement.
12. Ensure outcomes of the MER Program and research outcomes are made publicly available and inform decision making and periodic review of this management plan.
13. Conduct priority research and foster research partnerships to assess the integrity of knowledge frameworks that underpin the predicted outcomes.
14. Encourage Aboriginal people, local communities and stakeholders to preserve traditional and historic knowledge and, where appropriate, share this knowledge with others.

Compliance

The *Marine Parks Act 2007* provides for a range of regulatory instruments to support the achievement of the Act's objects. Compliance with these instruments is vital to the success of the marine parks program.

Three guiding principles underpin marine park compliance:

Voluntary compliance is maximised through education initiatives

Across Government collaboration supports compliance

Operational improvement is achieved through monitoring and review of compliance activity.

Strategies

15. Develop and implement a compliance strategy for the marine park that:
    - is cost-efficient
    - is focussed on sanctuary zones and other conservation priorities
    - complements existing compliance efforts
    - maximises voluntary compliance
    - includes measures to address serious or repeat non-compliance.

14 Glossary

GMUZ — General Managed Use Zone

HPZ — Habitat Protection Zone

LGA — Local Government Area

MER — monitoring, evaluation and reporting program

RAZ — Restricted Access Zone

SPA — Special Purpose Area

SZ — Sanctuary Zone

Government of South Australia

National Parks South Australia