National Parks South Australia

Baseline and predicted changes for the Encounter Marine Park

DEWNR Technical report 2016/25

SOUTH AUSTRALIA

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

Baseline and predicted changes for the Encounter Marine Park

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Department of Environment, Water and Natural Resources, August 2016
DEWNR Technical report 2016/25

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ISBN 978-1-925510-34-8

Preferred way to cite this publication

Bryars, S., Brook, J., Meakin, C., McSkimming, C., Eglinton, Y., Morcom, R., Wright, A. and Page, B. 2016, *Baseline and predicted changes for the Encounter Marine Park,* DEWNR Technical report 2016/25, Government of South Australia, through Department of Environment, Water and Natural Resources, Adelaide

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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 draft versions of the baseline reports (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, Gary Frost, Dr Shelley Paull, Shane Holland, Dirk Holman, Vera Hughes, Glenn Jackway, Celeste Klose, Danny Male, Dr Jane McKenzie, David Miller, Angus Mitchell, David Pearce, Jonathan Phillips, Matt Royal, Glen Scholz, Robert Sleep, Chris Thomas, Roman Urban, Patricia von Baumgarten, Dr Annelise Wiebkin and Jessica Wilson.

Thanks to Professor Michelle Waycott (University of Adelaide and DEWNR) for undertaking DEWNR's Science, Monitoring and Knowledge (SMK) Principal Advisor review and contributing to improvement of the reports. Dr Brad Page (DEWNR) provided SMK principal advisor sign-off.

External peer review was facilitated by Dr Michele Akeroyd through the Goyder Institute for Water Research and undertaken by Dr Scoresby Shepherd AO (SARDI Aquatic Sciences), Dr Bryan McDonald (Certitude Consulting), and Anthony Kosturjak and Steve Whetton (both from the South Australian Centre for Economic Studies, University of Adelaide). We thank those reviewers for their comprehensive feedback which greatly improved the quality of the reports.

The following people and organisations are thanked for assistance with sourcing of information for the reports: Jane Cooper (Bird Life Australia), Deb Clarke (South Australian Tourism Commission), Zsolt Szilassy (Viterra Ltd), Heather Bailey and Dr Julian Morison (EconSearch Pty Ltd), Claire Charlton (Curtin University), Sam Gaylard (EPA), Clinton Wilkinson (SASQAP), University of Tasmania, Reef Life Survey, PIRSA Aquaculture, PIRSA Fisheries, SARDI Aquatic Sciences, IMOS – the Integrated Marine Observing System, South Australian Centre for Economic Studies, University of Adelaide, District Council of Kangaroo Island, District Council of Victor Harbor, and District Council of Ceduna.

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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 full effect as prescribed by the *Marine Parks (Zoning) Regulations 2012*.

The Encounter Marine Park (EMP) covers 3,119 square kilometres of the Gulf St Vincent and Coorong Bioregions. It extends from southern metropolitan Adelaide waters around the Fleurieu Peninsula and past the Murray Mouth to the Coorong coast. At its western boundary, the marine park includes all waters of Backstairs Passage and the eastern shores of Kangaroo Island. There are 11 Sanctuary Zones, which cover about 9 per cent of the total park area, 7 HPZs (about 61 per cent), 7 GMUZs (about 30 per cent) and 1 RAZ (less than 1 per cent). Shoreline fishing is allowed in the Port Noarlunga Reef and the Encounter Bay Sanctuary Zones. There are 6 SPAs for harbour activities situated adjacent to Rapid Bay, Cape Jervis, Kingscote, Penneshaw, Victor Harbor and American River. An SPA for submarine cables and pipelines is situated near Cape Jervis and extends to Kangaroo Island. An SPA for Murray Mouth Dredging is situated adjacent to Mundoo Island.

The marine park management plans, including the EMP management plan, 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 for the EMP is one of a series of baseline reports completed for each of South Australia's 19 marine parks along with an overarching statewide consolidation. These baseline reports 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 drivers, socio-economic drivers, human-mediated pressures and marine park management plans. The information from this baseline report will be aggregated with equivalent information from the other 18 marine parks to inform the MER program. 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 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).

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 state-wide 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 state-wide 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, 8 marine bioregions and highlighting the Encounter Marine Park.

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 2), 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?

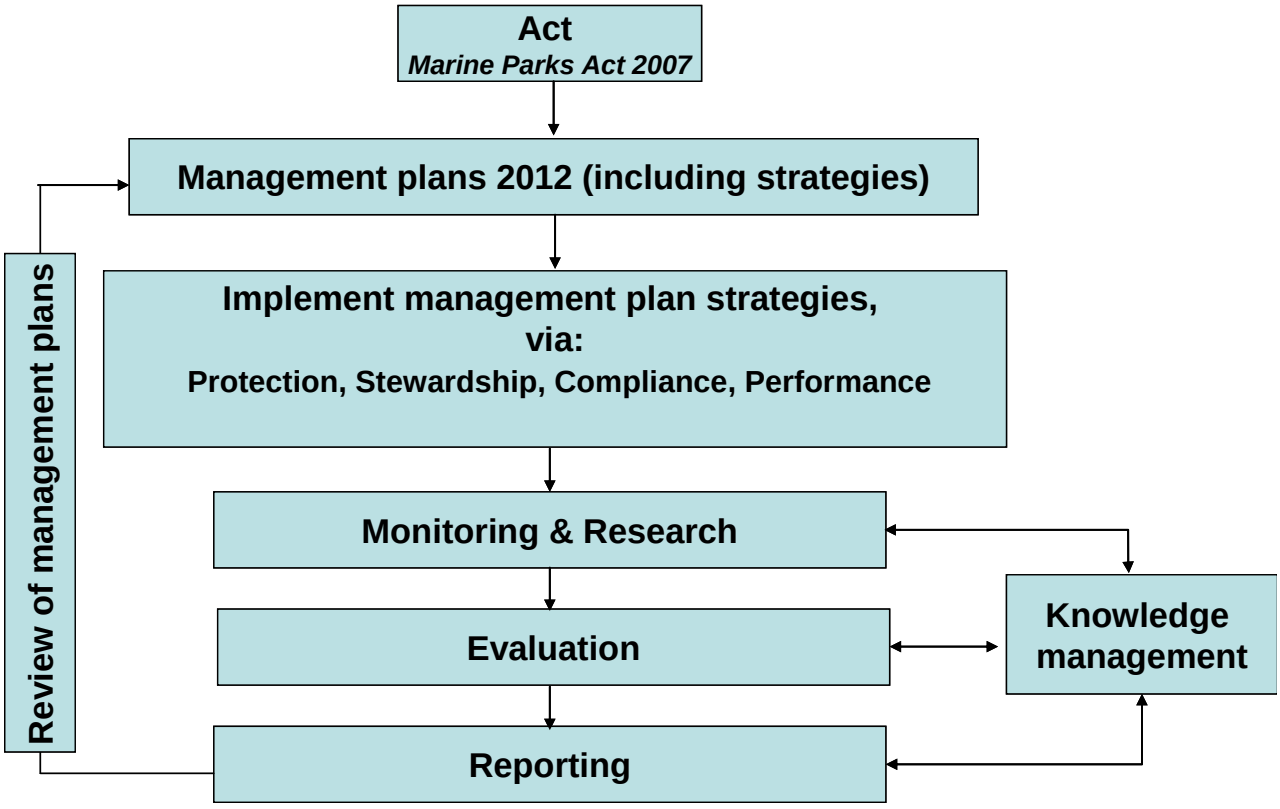


Figure 2. Adaptive management cycle for the marine parks MER program.

1.3 Structure and aims of this report

This baseline report for the Encounter Marine Park (EMP) is one of a series of baseline reports completed for each of South Australia's 19 marine parks and an overarching statewide baseline report that consolidates information at the network scale. 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 3).

The ecological and socio-economic values of the marine parks are central to the MER program (Figure 3). 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 values 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 3). Conceptual models are used in this report 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.

The information from each baseline report will be aggregated with equivalent information from the other 18 marine parks to inform the MER program. 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 comprehensiveness, adequacy and representativeness of the network of marine parks.

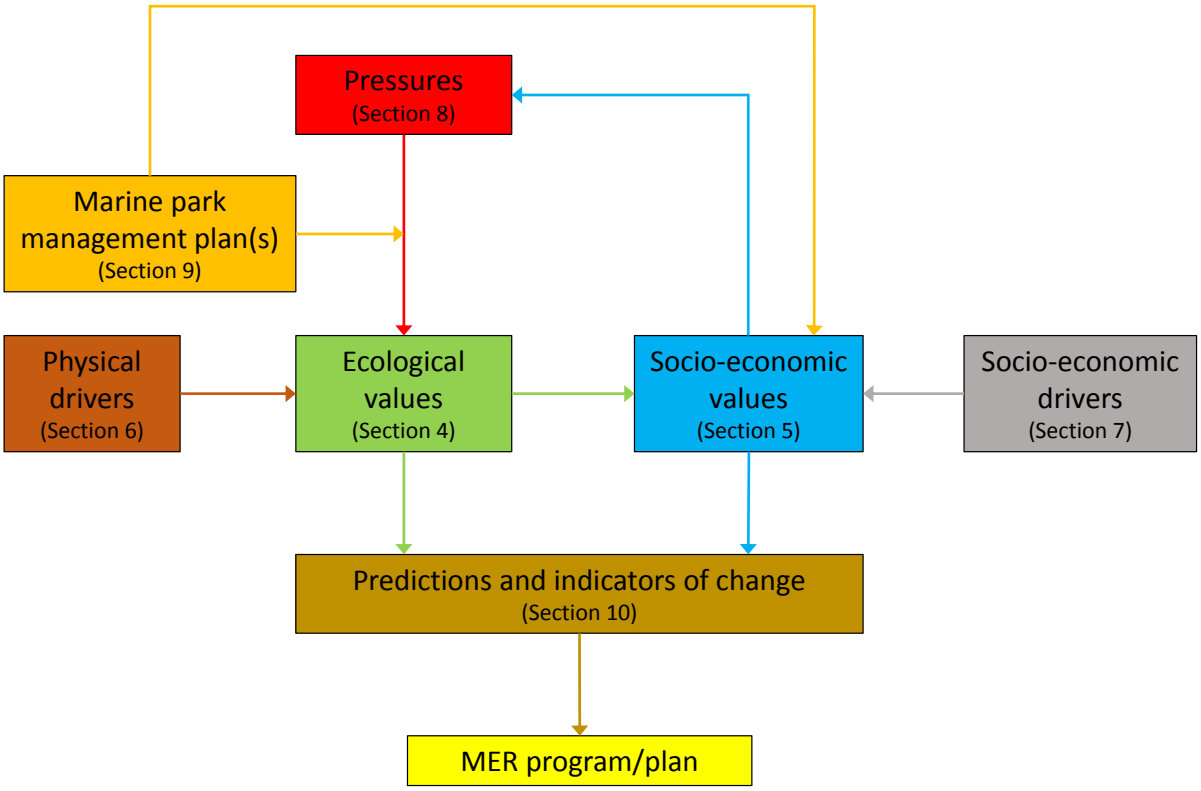


Figure 3. Framework for the baseline report that indicates how Sections 4 to 9 of this report are linked and used to inform Section 10 on predictions and indicators of change. All components of the framework will be used to inform the MER program. The direction and colour of the arrows indicates the 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 3:

1. **Section 2 – Marine park description**: Summary and accompanying map, which detail the location, dimensions, and zoning of the marine park. To reduce repetition, the statewide baseline report references the individual marine park reports.
2. **Section 3 – Conceptual model:** Diagram 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 model.
4. **Section 5 – Socio-economic values:** Description and baseline information for the values depicted on the conceptual model.
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 plan:** Outlines the zoning and strategies of the management plan and how the management plan mitigates pressures on the ecological values and also affects 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 park description

The Encounter Marine Park (EMP) covers 3,119 square kilometres of the Gulf St Vincent and Coorong Bioregions (Figure 1). It extends from southern metropolitan Adelaide waters around the Fleurieu Peninsula and past the Murray Mouth to the Coorong coast. At its western boundary, the marine park includes all waters of Backstairs Passage and the eastern shores of Kangaroo Island. There are 11 Sanctuary Zones, which cover about 9 per cent, 7 HPZs (about 61 per cent), 7 GMUZs (about 30 per cent) and 1 RAZ (less than 1 per cent, Figure 4). Shoreline fishing is allowed in the Port Noarlunga Reef and the Encounter Bay Sanctuary Zones. There are 6 SPAs for harbour activities situated adjacent to Rapid Bay, Cape Jervis, Kingscote, Penneshaw, Victor Harbor and American River. An SPA for submarine cables and pipelines is situated near Cape Jervis and extends to Kangaroo Island. An SPA for Murray Mouth Dredging is situated adjacent to Mundoo Island (Figure 4).

Land use adjacent to the EMP includes agricultural and residential. The largest population centres are Noarlunga, Aldinga and Victor Harbor. The EMP marine park overlaps or is adjacent to a number of other protected areas, including the Coorong National Park; Beatrice Islet, Busby Islet, Cape Willoughby, Deep Creek, Baudin, Lashmar, Newland Head, Pelican Lagoon, Pullen Island, West Island, Nepean Bay, Moana Sands and the Pages Islands Conservation Parks and the Granite Island and Onkaparinga River Recreation Parks (Figure 4). The Aldinga Reef and Port Noarlunga Aquatic Reserves overlap the marine park. This region experiences warm summers and cool winters (Bureau of Meteorology 2015a). The annual freshwater runoff is 760 gigalitres in the Gulf St Vincent Region and 28,850 gigalitres in the Coorong Region (National Water Commission 2007).

For further descriptive information on the EMP see DEWNR (2015a).

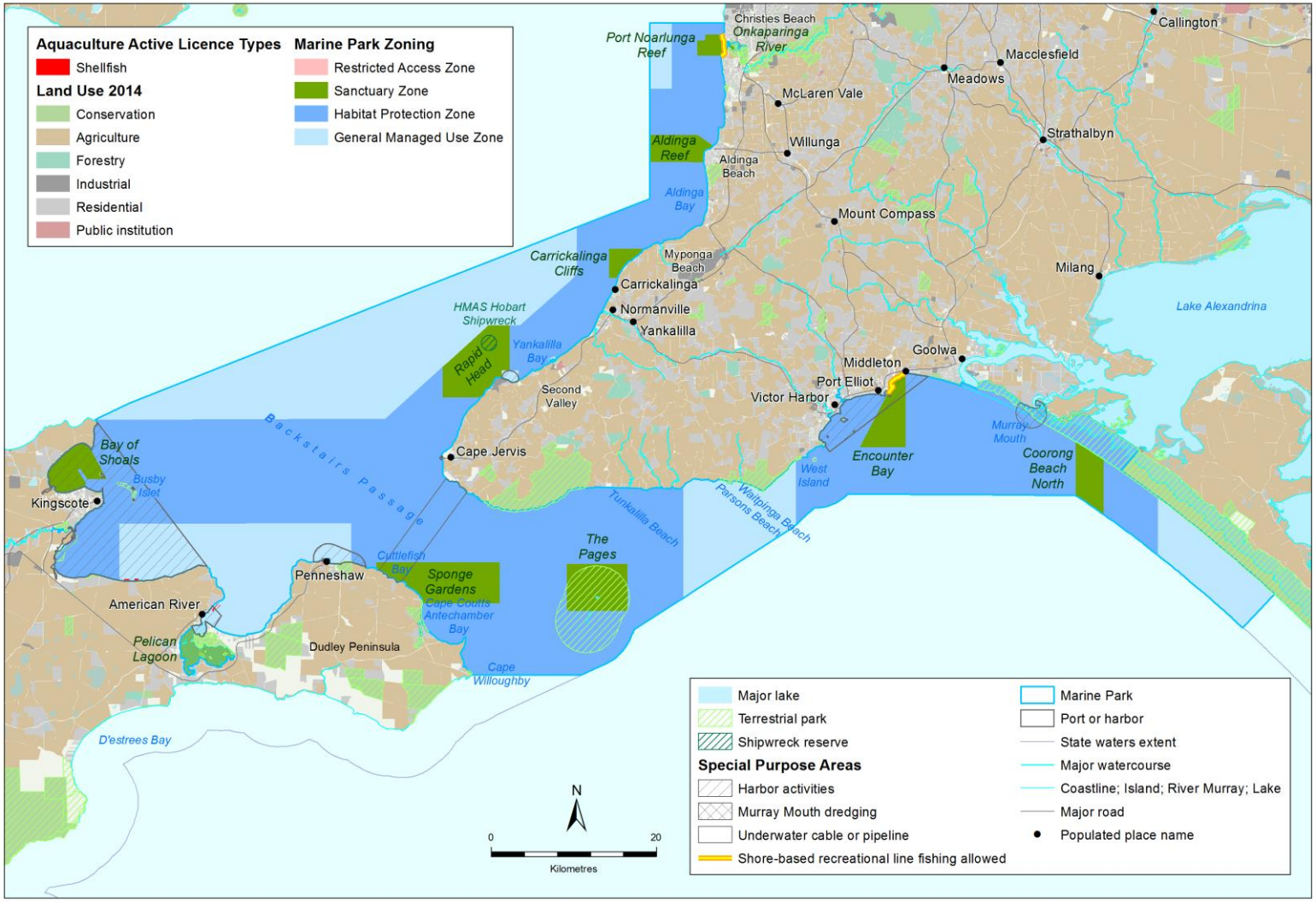


Figure 4. Map of the Encounter Marine Park showing important features of the marine park and adjacent land areas. Further information on marine and land uses is shown in Appendix C.

3 Conceptual model

The conceptual model of the EMP (Figure 5) summarises the ecological and socio-economic values, physical and socio-economic drivers, human-mediated pressures on the ecological values, the influence of the marine park on these pressures, and predictions of change (ecological and socio-economic) due to the marine park. Features depicted on the conceptual model 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 in the marine park. The physical drivers that exist in this 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 model are depicted in the baseline report framework (Figure 3). The components of the conceptual model are discussed in more detail in Sections 4 to 10.

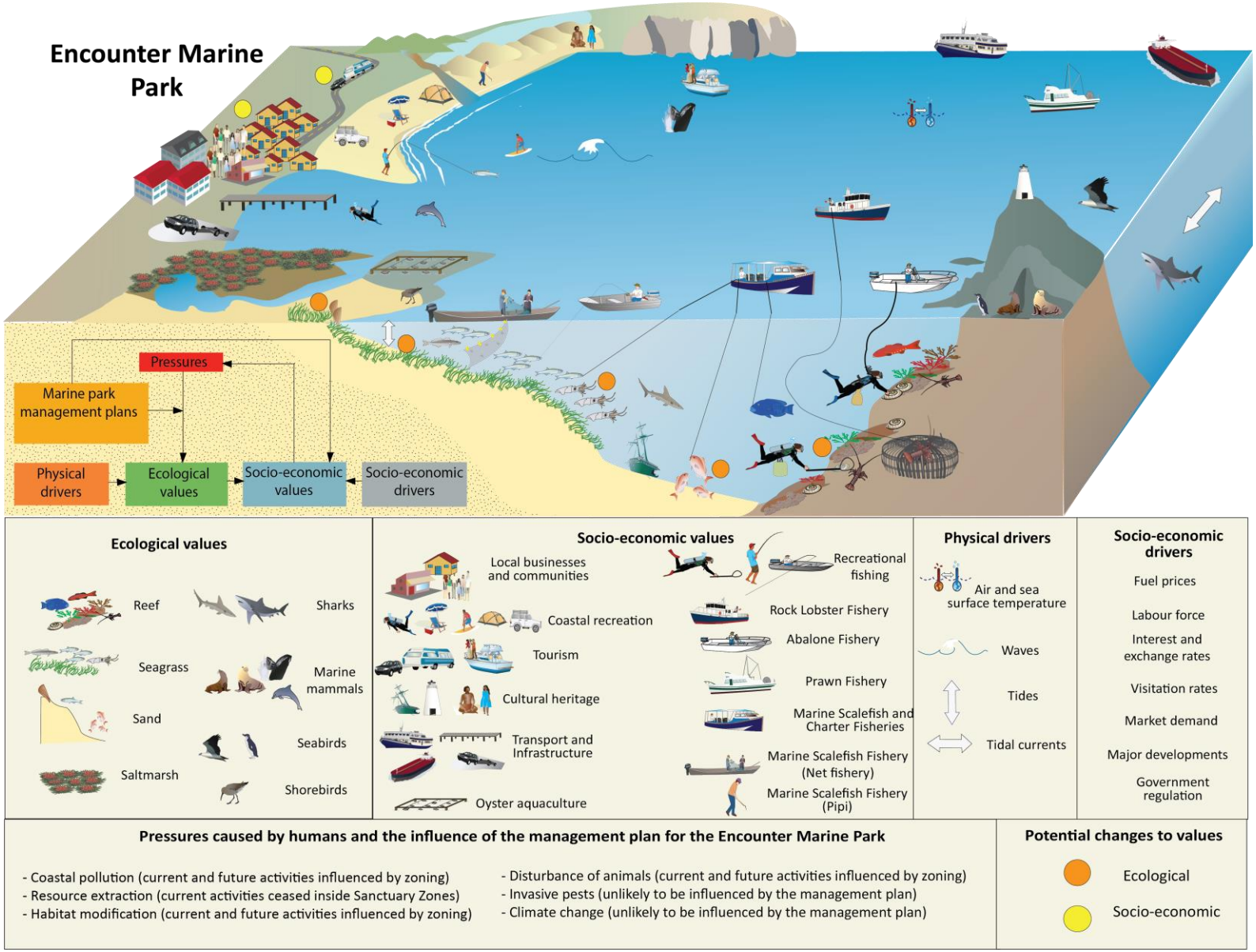


Figure 5. Conceptual model for the Encounter Marine Park.

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 5). The habitat types in the conceptual model (reef, seagrass, sand, mangrove and saltmarsh, Figure 6) 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 the EMP (DENR 2010, Bailey et al. 2012b). Additional information on the ecological values of the EMP is provided by a series of atlas maps (DEWNR 2015b).

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 (Section 10). 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 are data collected from a single point in time but which could potentially be resampled in the future.

In developing a comprehensive, adequate and representative system of marine parks, habitats were 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). About 14 per cent of the benthic habitats of the EMP 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 6). An additional 17 per cent has been mapped at a broad scale (1:100,000) using satellite imagery (DEWNR 2015e, Edyvane 1999a, b, Figure 6). The majority (70 per cent) of the subtidal habitats in the EMP are not mapped. Grid-based video drops (separated by 1 kilometre) have been conducted in 8 of the SZs to characterise the distribution of habitat types in previously unmapped areas or areas with uncertainty in current mapping (Figure 7 to Figure 14). A summary of the mapping for the 11 SZs in the EMP is provided in Table 1. The entire shoreline of the EMP 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.

Table 1. Benthic habitat mapping in SZs of the EMP. 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).

SZ	Mapping type
Onkaparinga River	Fine scale for saltmarsh areas
Port Noarlunga Reef	Fine scale for about 63 per cent (to about 2 kilometres offshore). The remainder has been mapped at a broad scale. Grid-based (1 kilometre apart) video drops have also been undertaken (Figure 7).
Aldinga Reef	Fine scale for about 19 per cent of the zone (up to 2 kilometres offshore). A further 29 per cent has been mapped at a broad scale (to about 3 kilometres offshore). Grid-based (1 kilometre apart) video drops have also been undertaken (Figure 8).
Carrickalinga Cliffs	Fine scale for about 84 per cent of the zone (up to 2 kilometres offshore). A further 5 per cent has been mapped at a broad scale. Grid-based (1 kilometre apart) video drops have also been undertaken (Figure 9).

SZ	Mapping type
Rapid Head	Fine scale for about 25 per cent of the zone (up to 4 kilometres offshore). Grid-based (1 kilometre apart) video drops have also been undertaken (Figure 10).
Encounter Bay	Fine scale for about 56 per cent of the zone (up to 6 kilometres offshore). Grid-based (1 kilometre apart) video drops have also been undertaken (Figure 11).
Coorong Beach North	Broad scale for about 61 per cent (to about 4 kilometres offshore)
Bay of Shoals	Broad scale. Grid-based (1 kilometre apart) video drops have also been conducted (Figure 12)
Pelican Lagoon	Fine scale for the entire zone
Sponge Gardens	Fine scale for about 41 per cent (offshore sponge gardens, Figure 6). A further 3 per cent has been mapped at a broad scale (up to 500 metres offshore). Grid-based (1 kilometre apart) video drops have also been undertaken (Figure 13).
The Pages	Grid-based (1 kilometre apart) video drops have been undertaken (Figure 14)

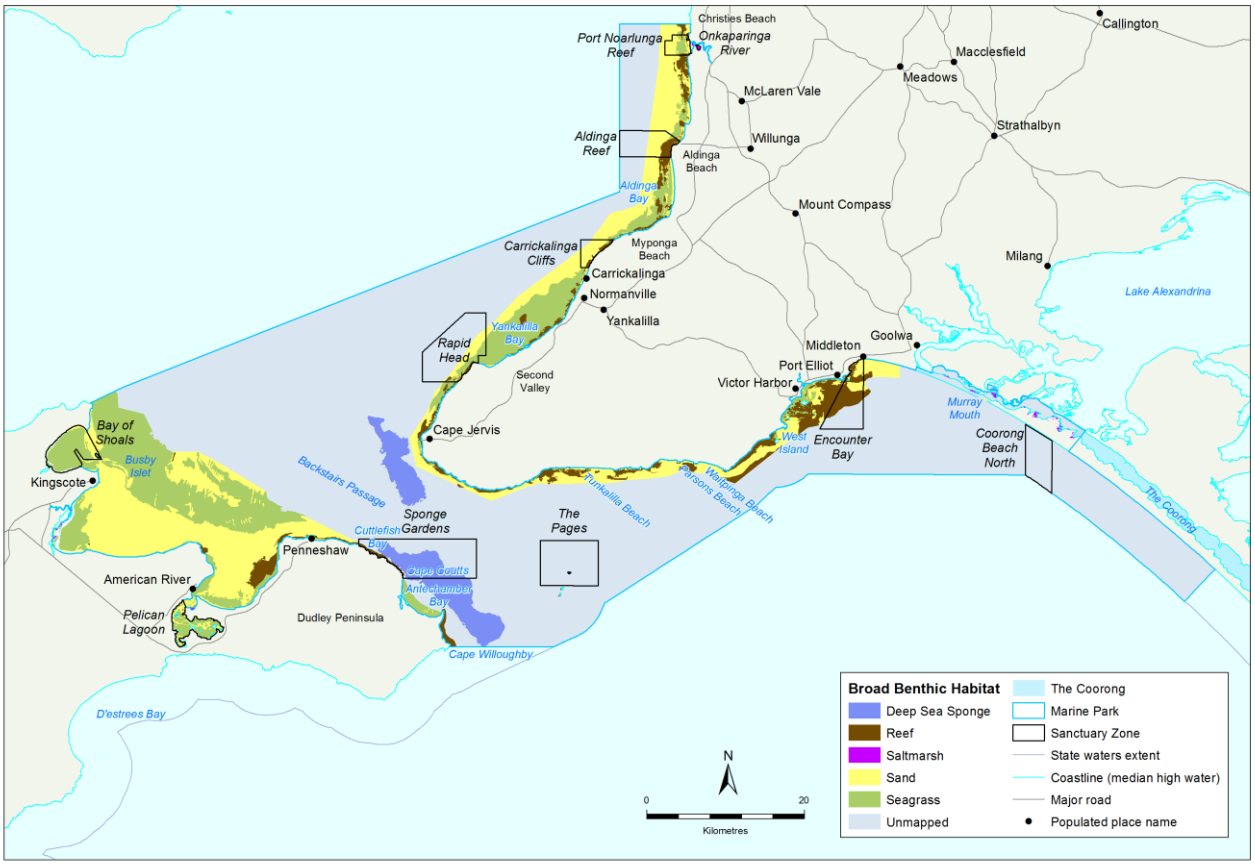


Figure 6. Benthic habitats of the Encounter Marine Park based on fine and broad scale mapping. Source: DEWNR (2015c, d, e), Miller et al. (2009), Edyvane (1999a, b).

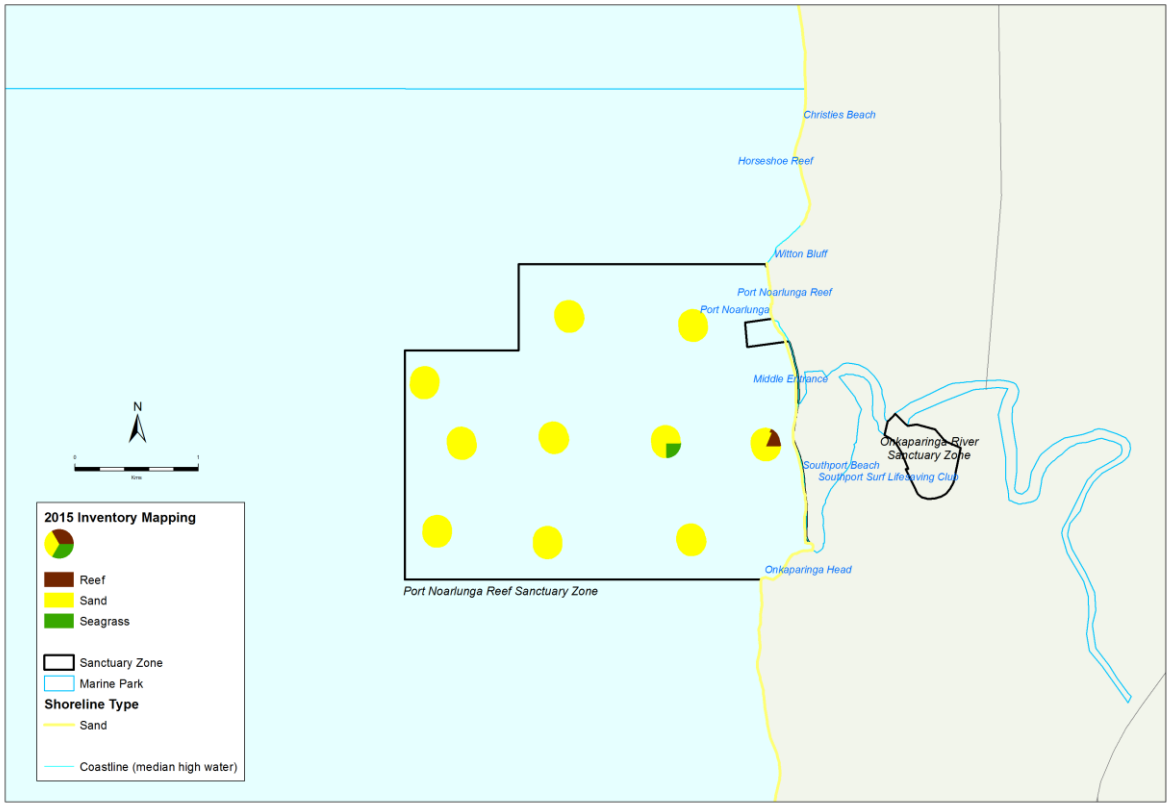


Figure 7. Benthic habitat classes recorded during video drops in the Port Noarlunga Reef Sanctuary Zone.

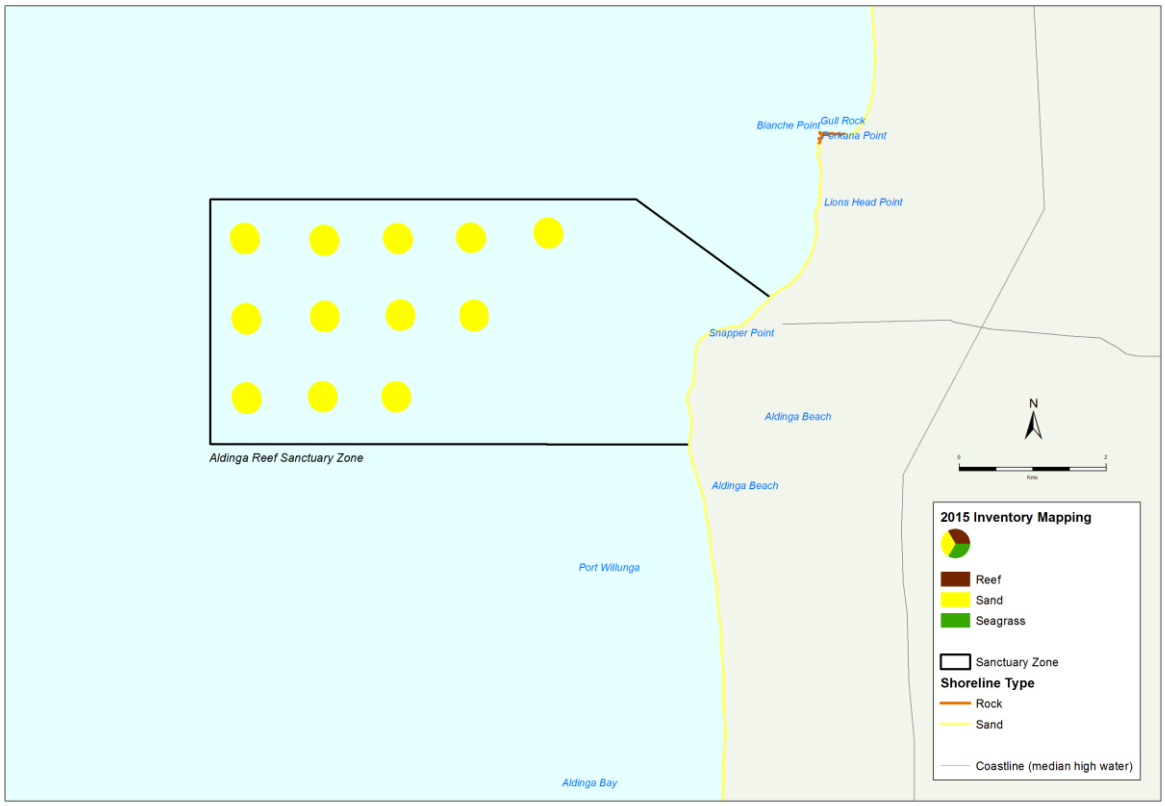


Figure 8. Benthic habitat classes recorded during video drops in the Aldinga Reef Sanctuary Zone.

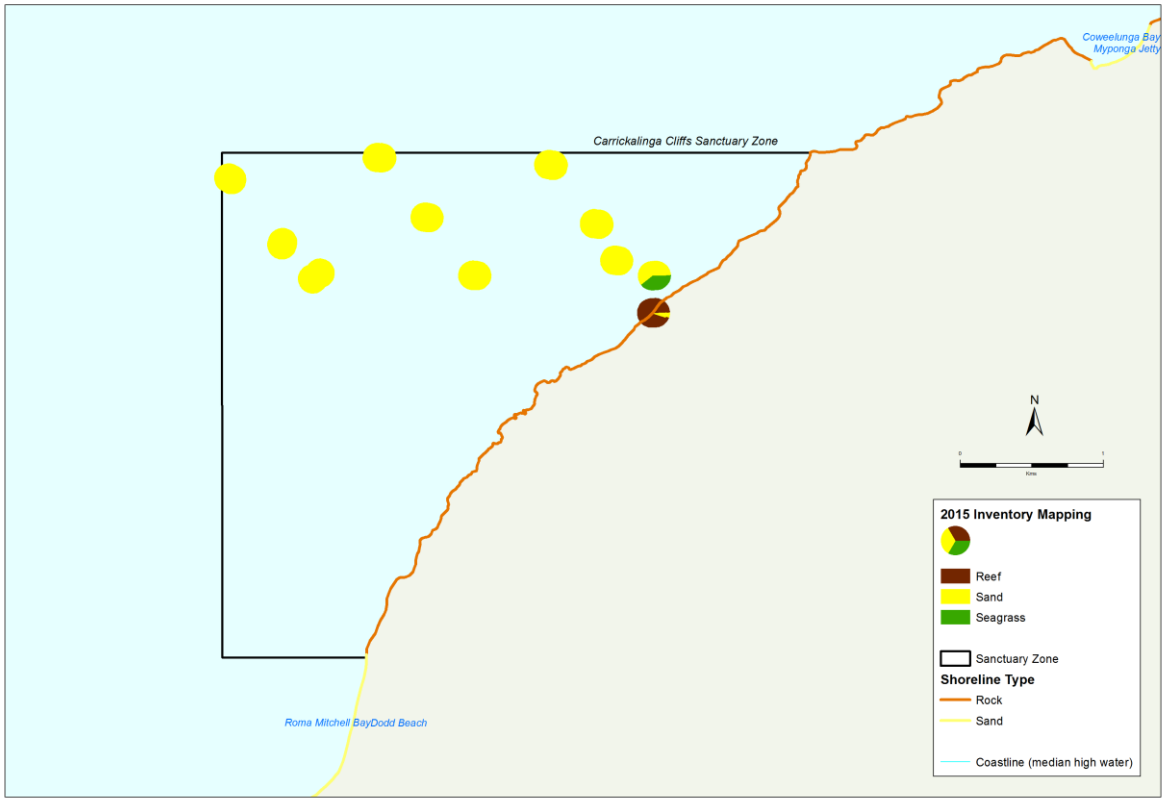


Figure 9. Benthic habitat classes recorded during video drops in the Carrickalinga Cliffs Sanctuary Zone.

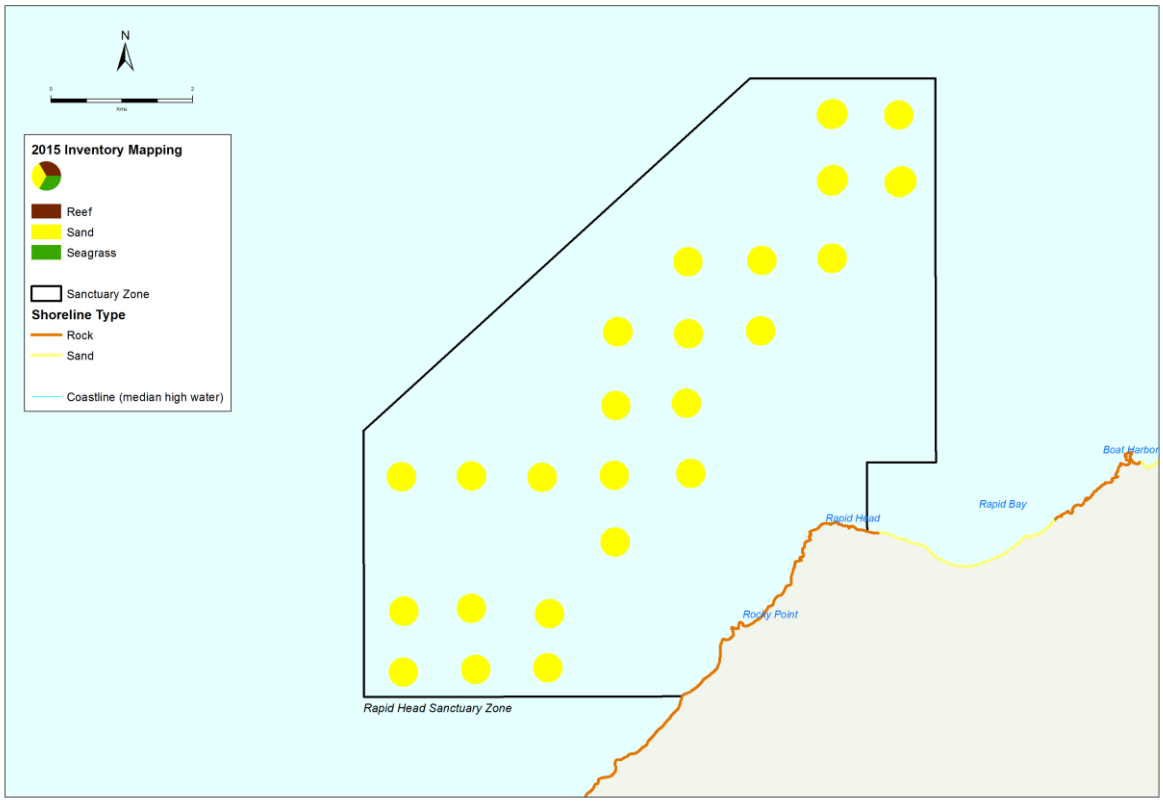


Figure 10. Benthic habitat classes recorded during video drops in the Rapid Head Sanctuary Zone.

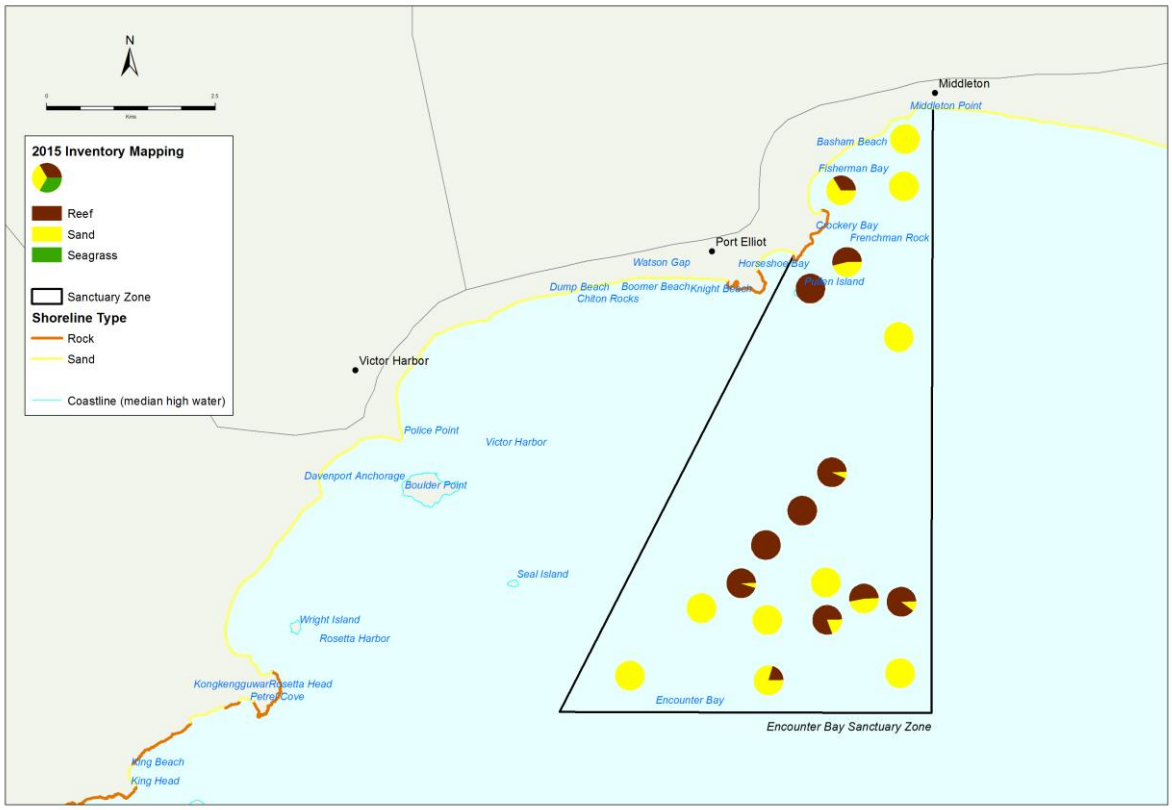


Figure 11. Benthic habitat classes recorded during video drops in the Encounter Bay Sanctuary Zone.

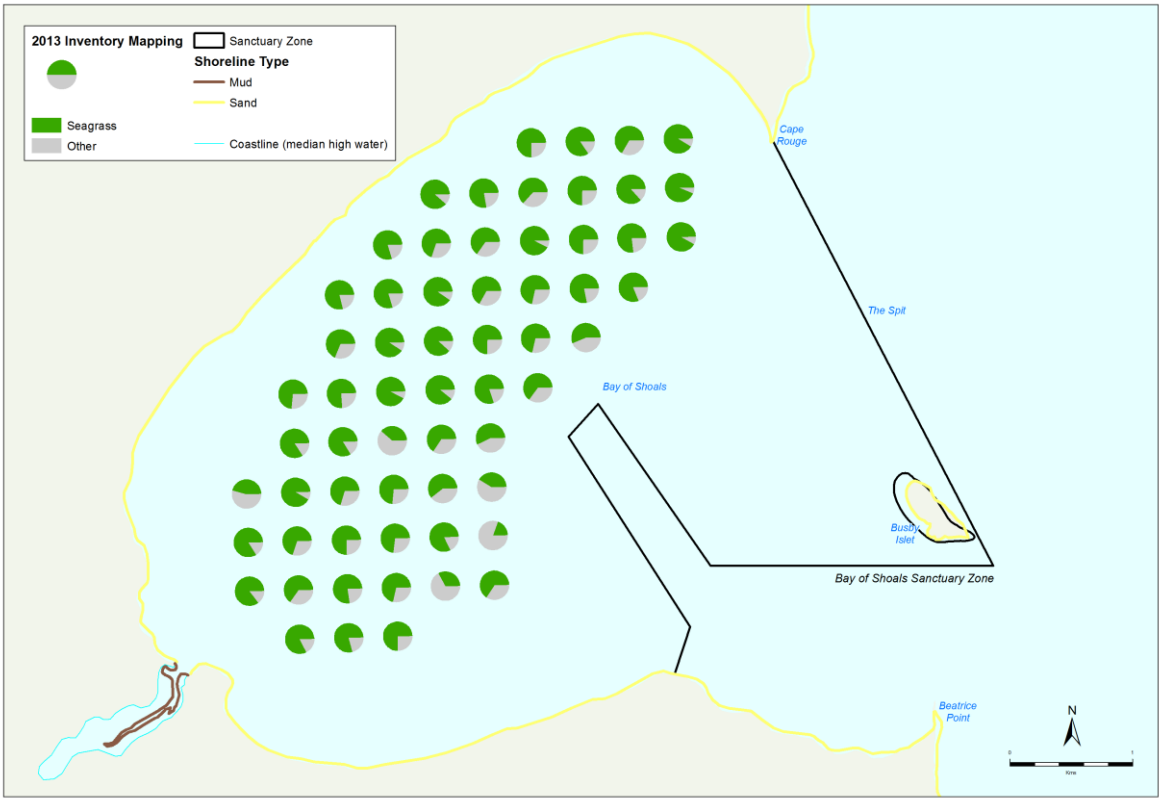


Figure 12. Benthic habitat classes recorded during video drops in the Bay of Shoals Sanctuary Zone.

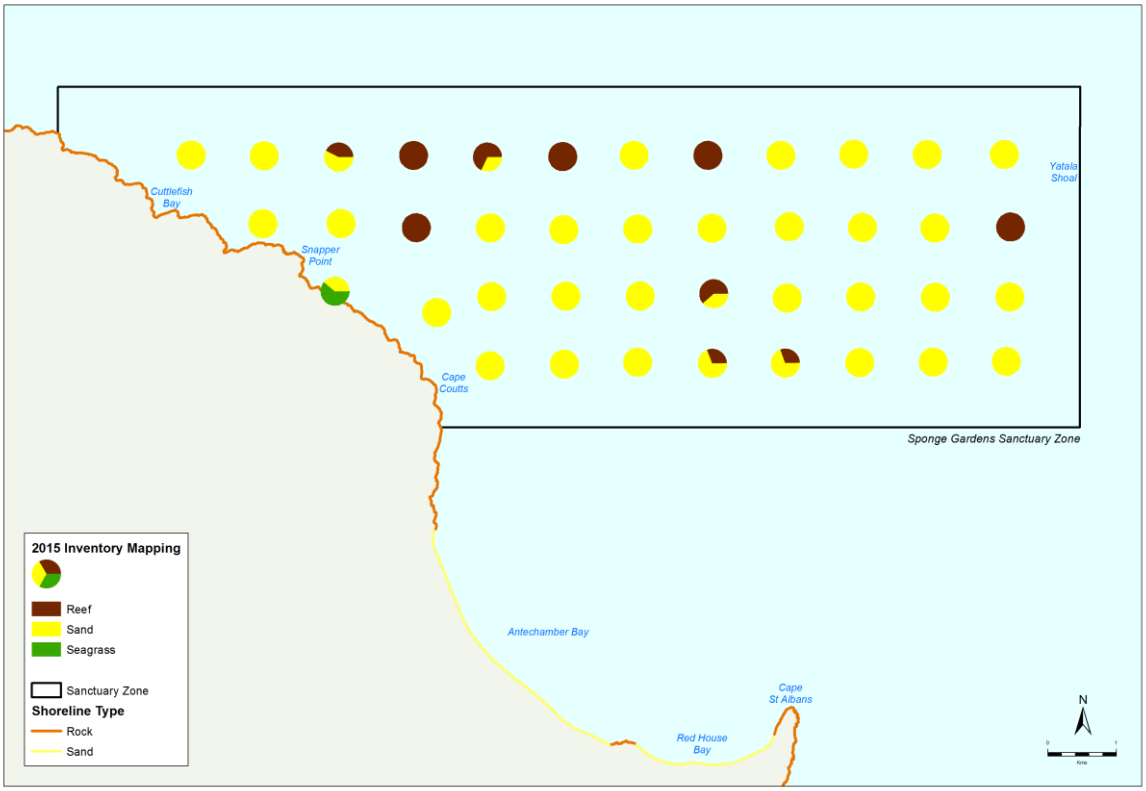


Figure 13. Benthic habitat classes recorded during video drops in the Sponge Gardens Sanctuary Zone.

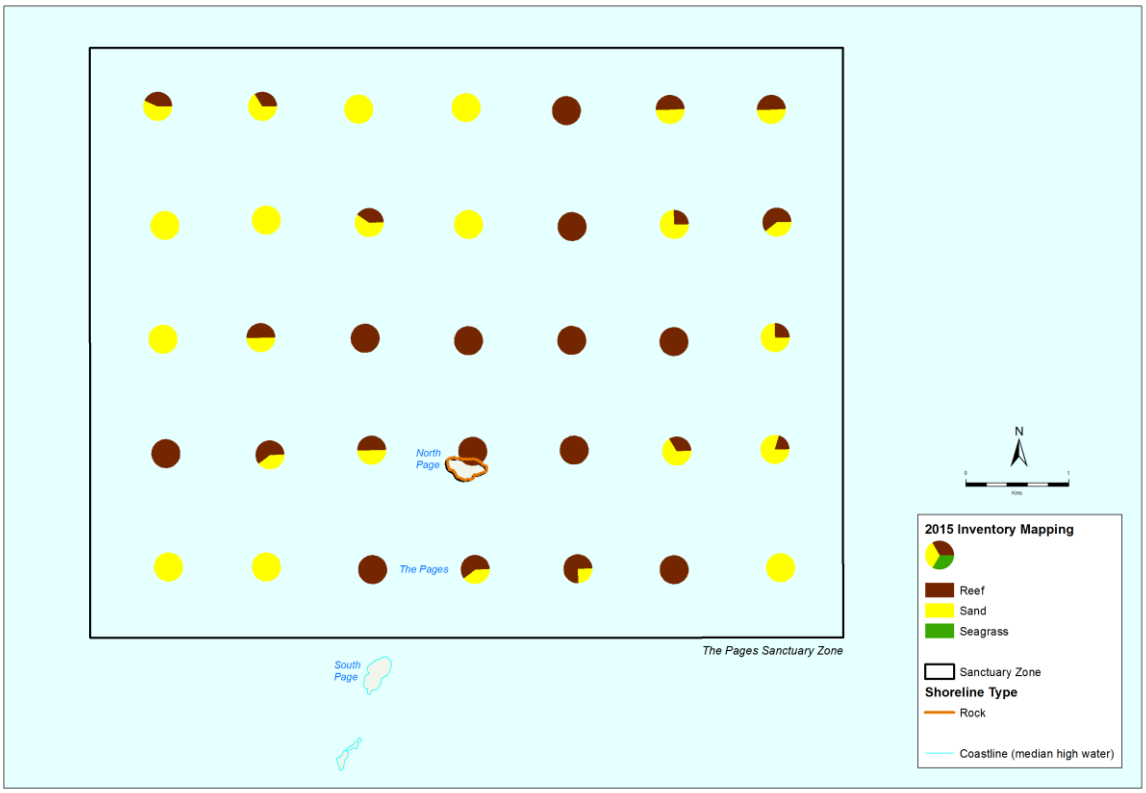
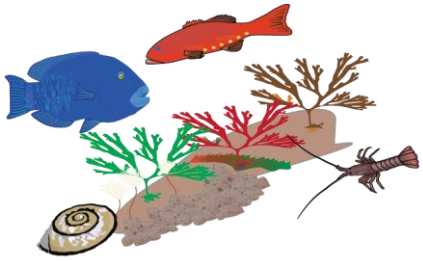


Figure 14. Benthic habitat classes recorded during video drops in The Pages Sanctuary Zone.

4.1 Reef



Subtidal reef occurs at numerous locations along the mainland coast and Dudley Peninsula. Reef is particularly prevalent at Aldinga and Encounter Bay (Figure 6). The cliffs and headlands of Dudley Peninsula and offshore Islands such as Granite, Wright, West, Seal and Pullen Island and The Pages island group are fringed by reef (DENR 2010).

Baseline information on reef relevant to the EMP includes:

Spatial extent of reef habitat

- Intertidal reefs extend along about 121 kilometres of the mainland and Kangaroo Island coastline in the EMP (see Appendix B). The shoreline extent of intertidal reefs on islands (other than Kangaroo Island) has not been mapped in the EMP.
- About 100 square kilometres of subtidal reef have been mapped in the EMP (Figure 6). About 2,159 square kilometres of seafloor in the EMP have not been mapped (see Appendix B)
- Historically, extensive oyster reefs existed within the EMP (Alleway and Connell 2015).

Size, abundance and diversity of reef communities

- Fish, invertebrate and macroalgal diversity and abundance were surveyed by divers at 48 sites at depths of 5 or 10 metres during some or all of the years 2005–2007, 2012 and 2013 (Edgar et al. 2006, DEH 2008, DEWNR and the University of Tasmania unpublished data, Figure 20). About 150 fish, 140 invertebrate and 220 macroalgal taxa were recorded during the surveys. Sites included:
  - 6 sites within the Carrickalinga Cliffs SZ (Figure 18)
  - 5 sites within the Rapid Head SZ (Figure 19)
  - 5 sites within the Sponge Gardens SZ (Figure 20)
  - 1 site within The Pages SZ (Figure 20)
- Fish and invertebrate diversity and abundance were surveyed and photos of the benthic habitat were taken by divers at 21 sites (including 9 of those surveyed by DEWNR, see above) at depths between 2 and 10 metres during some or all of the years 2008–2009 and 2011–2014 (Reef Life Survey 2016, Figure 20). Sites included:
  - 1 site within the Port Noarlunga Reef SZ (Figure 16)
  - 2 sites within the Aldinga Reef SZ (Figure 17)
  - 1 site within the Carrickalinga Cliffs SZ (Figure 18)
  - 1 site within the Rapid Head SZ (Figure 19)
  - 1 site within the Encounter Bay SZ (Figure 21)
- Fish, invertebrate and macroalgal diversity and abundance were surveyed by divers at 5 sites on the southern metropolitan coast and Fleurieu Peninsula, depths of about 5 or 10 metres during some or all of autumn 2005, 2007 and 2013 and spring 2012 and 2013 (Turner et al. 2007, Collings et al. 2008, Brook and Bryars 2014). Sites included:
  - 5 sites within the Port Noarlunga Reef SZ (Figure 16)
  - 2 sites within the Aldinga Reef SZ (Figure 17)

- 1 site within the Encounter Bay SZ (Figure 21)

- Fish diversity and abundance were surveyed by divers at 5 sites on the Fleurieu Peninsula and 2 sites on Kangaroo Island at various depths up to 20 metres during 2002, 2003 or 2005 (Shepherd and Brook 2007).
- Fish diversity and abundance were surveyed by divers and underwater video at 1 site at depths between 3 and 6 metres during summer and winter 2005/06, with 21 fish species recorded (Brock and Kinloch 2007).
- Fish and invertebrate diversity and abundance were surveyed by divers and snorkellers at 4 sites on Dudley Pensinsula, Kangaroo Island at depths up to 4 metres during February 2014. A total of 36 species were recorded (McArdle et al. 2015).
- Fish diversity and abundance were surveyed using baited remote underwater video systems (Cappo et al. 2003) at 12 sites within the vicinity of subtidal reef (6 inside the Aldinga Reef SZ)at depths between 5 and 13 metres during summer 2013 and spring 2014 (S. Whitmarsh, Flinders University, unpublished data).
- The density of leafy seadragons was surveyed by divers using photo-identification methods near West Island, with density estimated at 57 per hectare (Connolly et al. 2002).
- Macroalgae cover was surveyed at 2 subtidal reef locations (one within the Port Noarlunga Reef SZ) on the southern Adelaide metropolitan coast during October 1968 (Port Noarlunga Reef) and October 1969 and 1973 (Horseshoe Reef) at depths between 5 and 10 metres (Connell et al. 2008).
- Algae and invertebrate diversity and cover were surveyed at 13 intertidal reef locations on the Fleurieu Peninsula and Kangaroo Island (including 1 inside each of the Carrickalinga Cliffs SZ, the Aldinga Reef SZ and the Encounter SZ) between November 2006 and February 2007 (Dutton 2008).
- Algae and invertebrate diversity and cover were surveyed at 3 intertidal reef locations along the southern Adelaide metropolitan coast during 2006/07. A total of 30 invertebrate species were recorded (Dutton and Benkendorff 2008).
- Substrate type and algae and invertebrate diversity and cover were surveyed at 14 intertidal reef locations on the Fleurieu Peninsula (including 1 inside each of the Noarlunga Reef SZ, the Carrickalinga Cliffs SZ and the Encounter SZ and 2 inside the Aldinga Reef SZ) between November 2006 and March 2007. A total of 111 invertebrate species were recorded (Benkendorff and Thomas 2007).
- Algae and invertebrate diversity and abundance were surveyed at 4 intertidal reef locations on the Fleurieu Peninsula (including 1 inside the Carrickalinga Cliffs SZ) between May 2009 and January 2010 (Baring et al. 2010).
- Macroalgae, invertebrate and fish diversity and abundance were surveyed by divers at 21 subtidal reef sites along the southern Adelaide Metropolitan coast and Fleurieu Peninsula (including 5 inside the Noarlunga Reef SZ and 2 inside the Aldinga Reef 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).
- Macroalgae, invertebrate and fish diversity and abundance were surveyed by divers at 6 subtidal reef sites along the southern Adelaide metropolitan coast (including 2 inside the Noarlunga Reef SZ) seasonally in 2009 and biannually between 2010 and 2012 (Russell and Connell 2011; Cheshire 2014).
- Macroalgae, invertebrate and fish diversity and abundance were surveyed by divers at 8 subtidal reef sites on the Fleurieu Peninsula (including 1 inside the Encounter Bay 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 at 1 subtidal reef location on Kangaroo Island at depths between 3 and 6 metres during summer and winter 2005/06. A total of 21 species were recorded (Brock and Kinloch 2007).

- Fish and invertebrate diversity and abundance were surveyed by snorkellers at 4 subtidal reef locations on Kangaroo Island at depths up to 4 metres during November 2014. A total of 38 species were recorded (McArdle et al. 2015).
- Fish and invertebrate diversity and abundance were surveyed by divers and snorkelers at 3 subtidal reef locations on Kangaroo Island at depths up to 10 metres during November 2013 and February 2014. A total of 41 species were recorded (McArdle et al. 2015).
- Larval fish distribution, diversity and abundance were surveyed using towed Twin Ring nets at 2 subtidal reef sites (1 inside each of the Aldinga Reef and Carrickalinga Cliffs SZs) at a depth of 15 metres during autumn and winter 2014 (Jones 2014).
- 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. 2015, Mayfield et al. 2014, Fowler et al. 2013a, 2014a, Steer et al. 2007, 2016, 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. 2015).

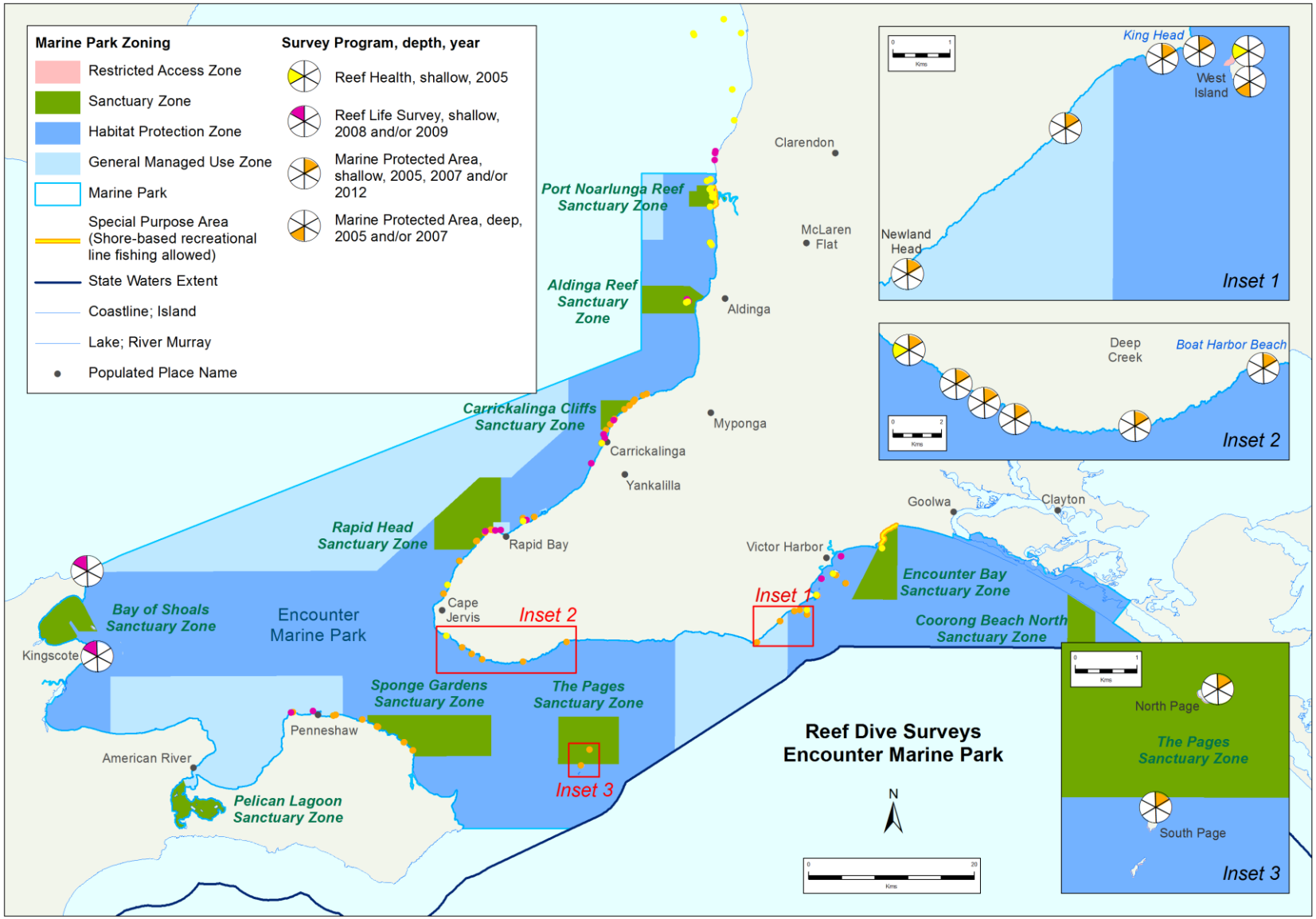


Figure 15. Map showing reef sites that have been surveyed for fishes, invertebrates and macroalgae in the Encounter Marine Park.

Figure 16. Map showing reef sites that have been surveyed for fishes, invertebrates and macroalgae inside and outside the Port Noarlunga Reef Sanctuary Zone of the Encounter Marine Park.

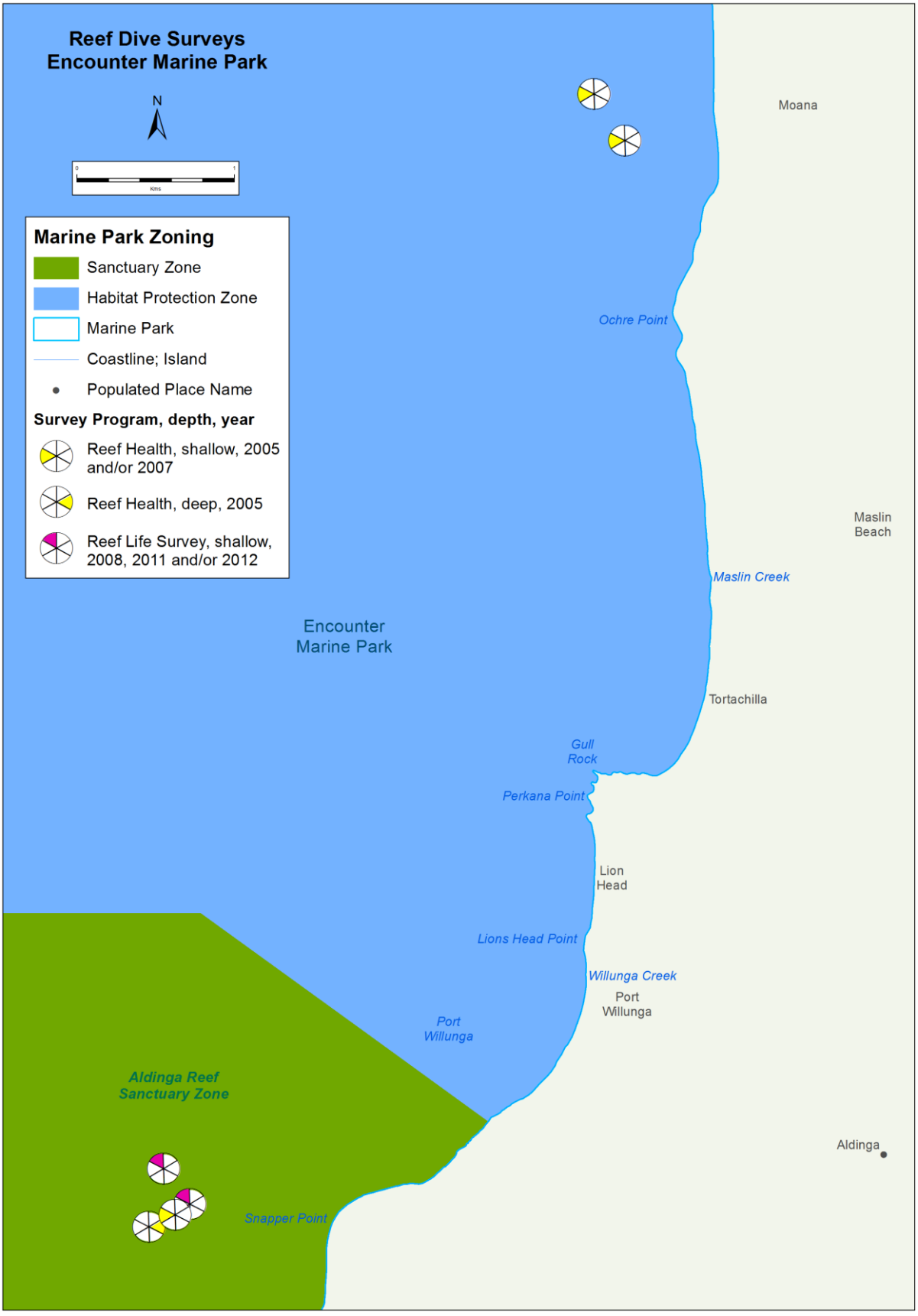


Figure 17. Map showing reef sites that have been surveyed for fishes, invertebrates and macroalgae inside the Aldinga Reef Sanctuary Zone of the Encounter Marine Park.

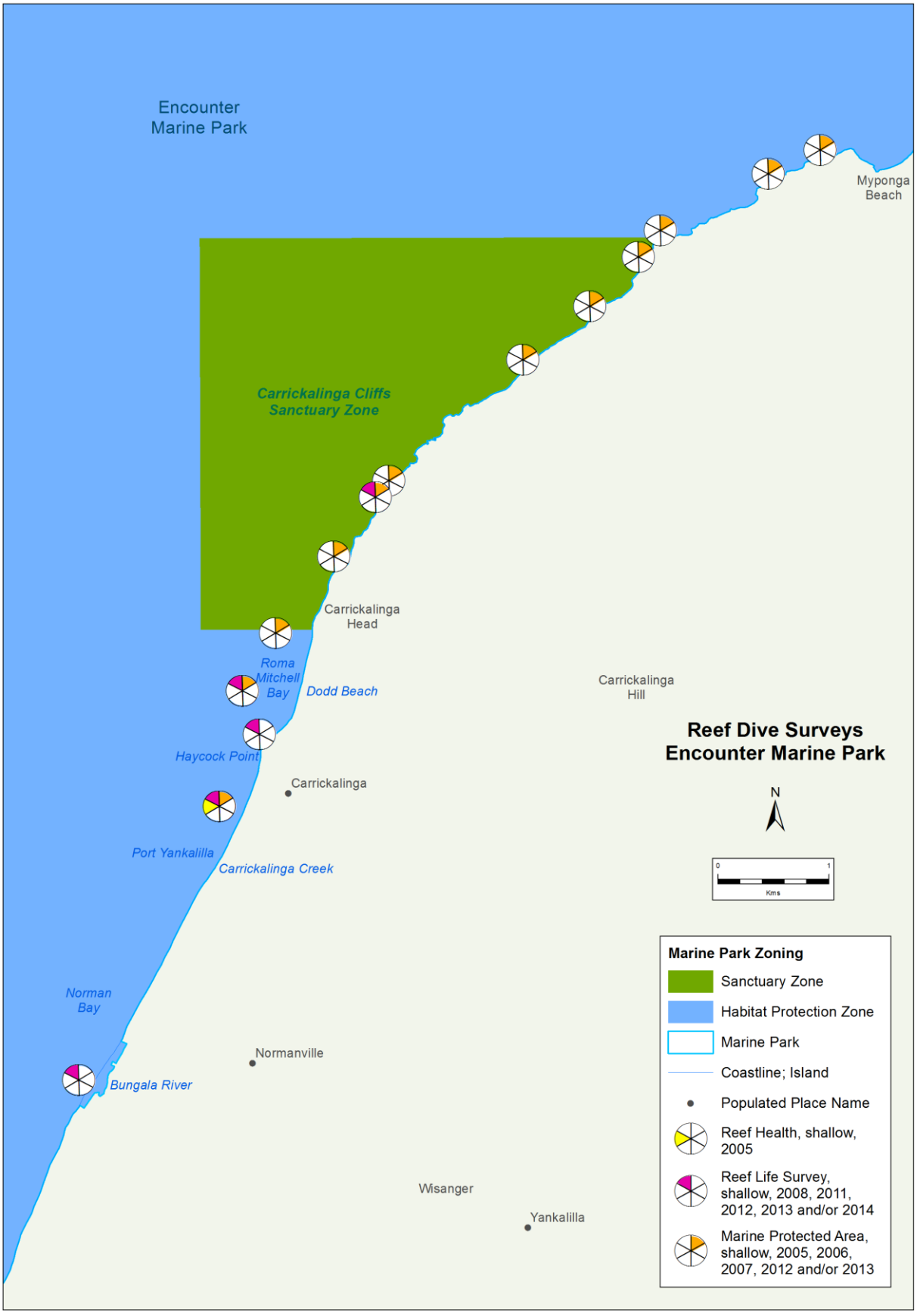


Figure 18. Map showing reef sites that have been surveyed for fishes, invertebrates and macroalgae inside and outside the Carrickalinga Cliffs Sanctuary Zone of the Encounter Marine Park.

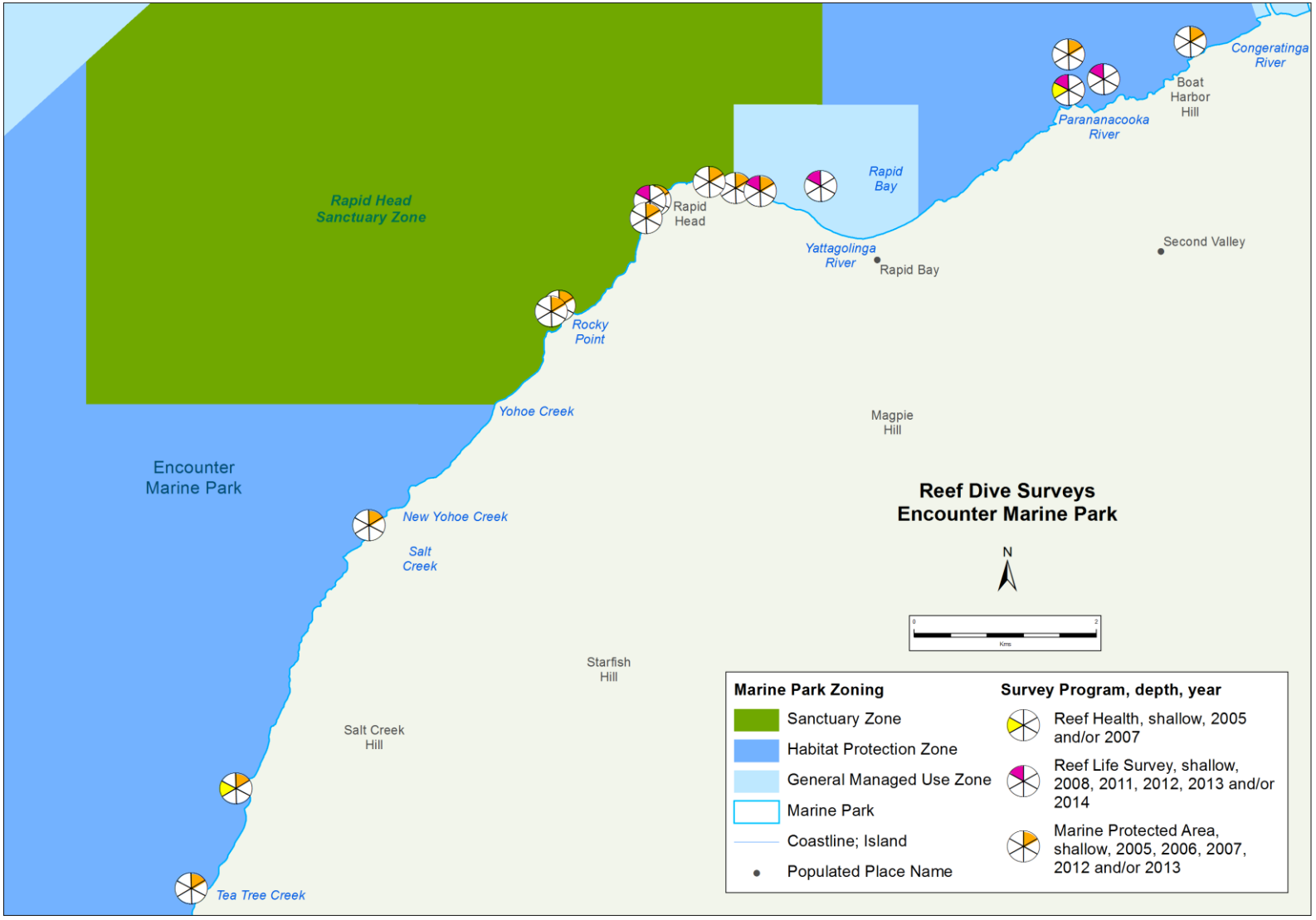


Figure 19. Map showing reef sites that have been surveyed for fishes, invertebrates and macroalgae inside and outside the Rapid Head Sanctuary Zone of the Encounter Marine Park.

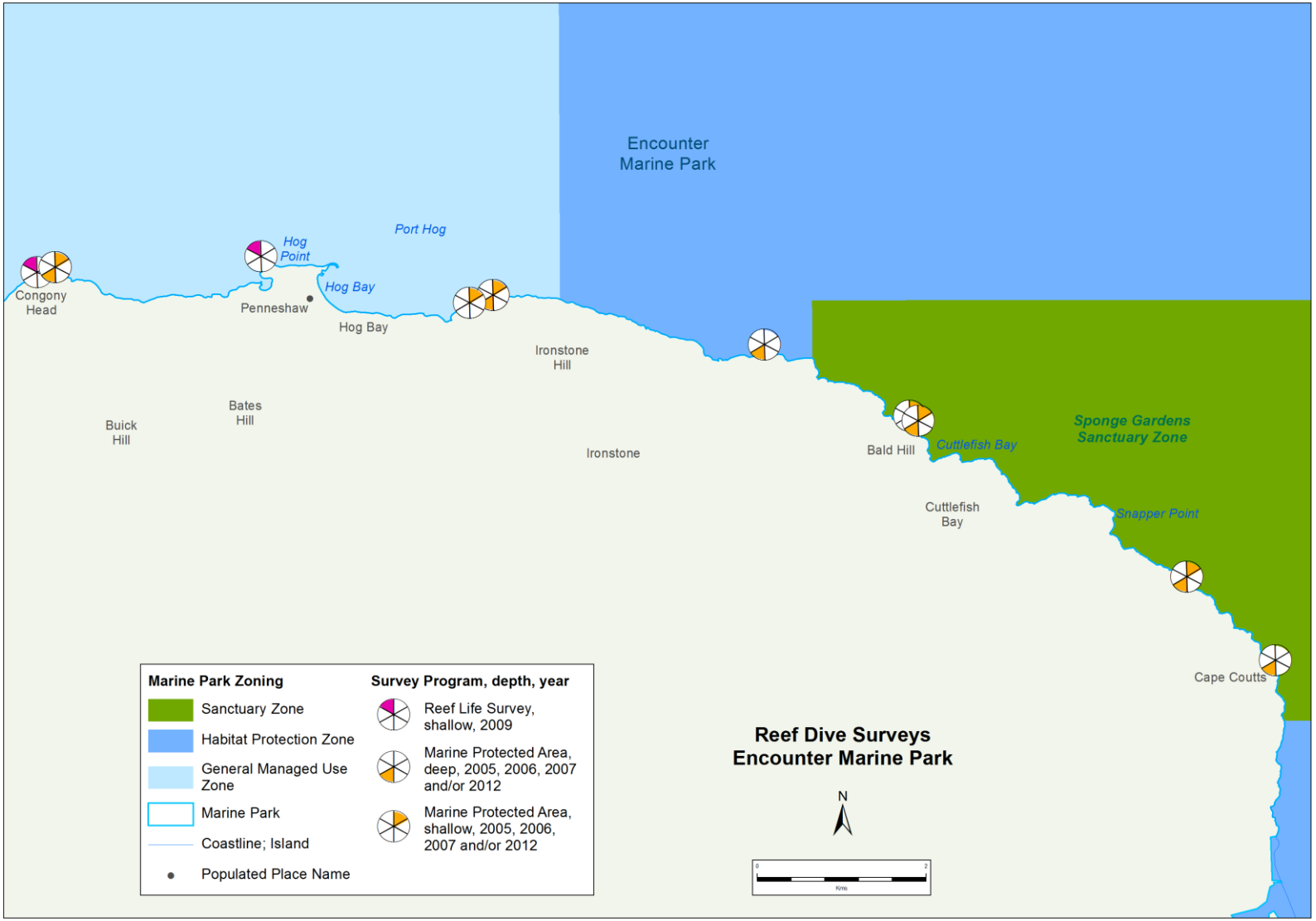


Figure 20. Map showing reef sites that have been surveyed for fishes, invertebrates and macroalgae inside and outside the Sponge Gardens Sanctuary Zone of the Encounter Marine Park.

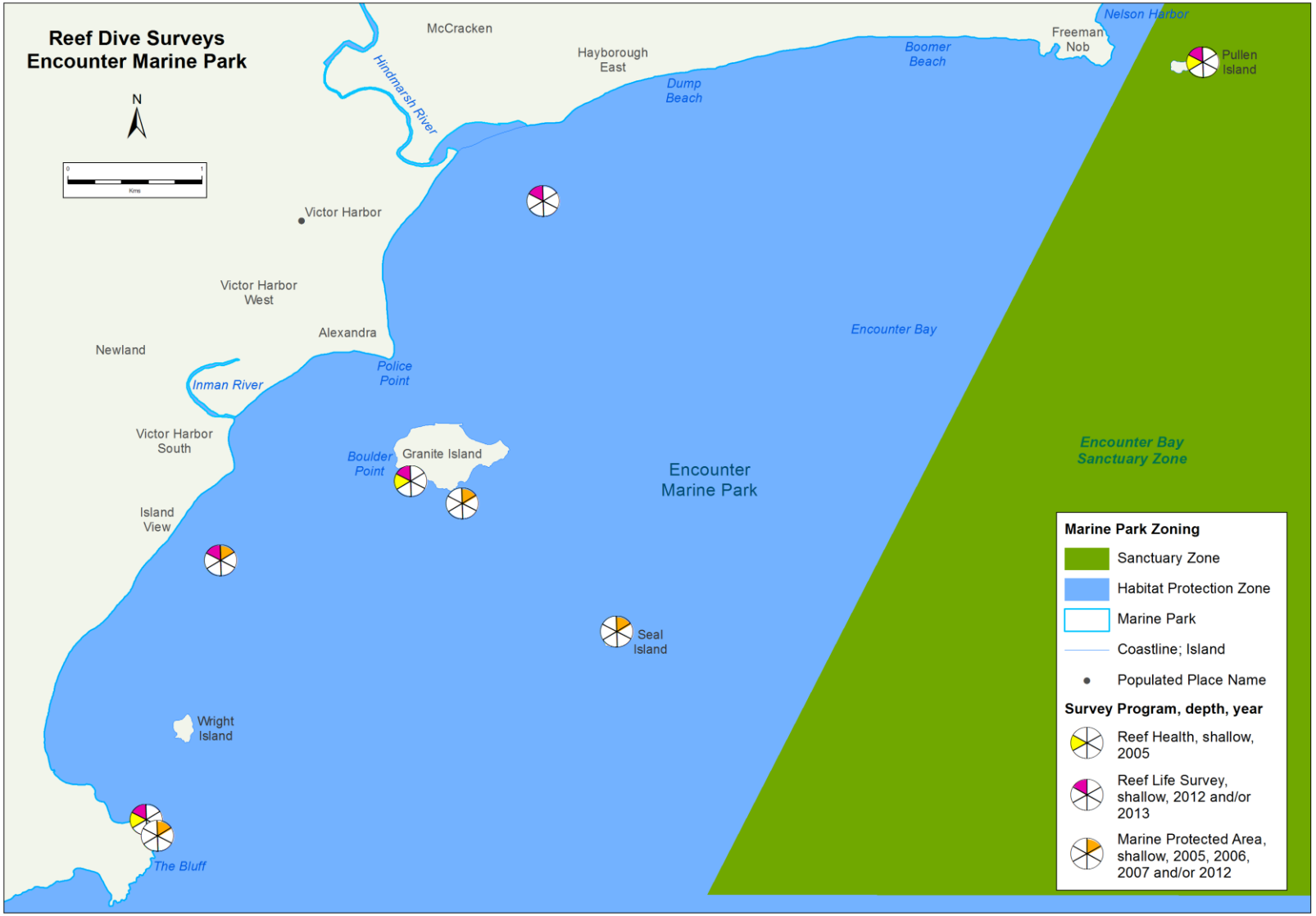


Figure 21. Map showing reef sites that have been surveyed for fishes, invertebrates and macroalgae inside and outside the Encounter Bay Sanctuary Zone of the Encounter Marine Park.

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 during some or all of the years 2005–2007, 2012 and 2013 (Edgar et al. 2006, DEH 2008, DEWNR and the University of Tasmania unpublished data, Figure 20) were used to infer condition of subtidal reefs in the EMP from canopy cover calculated using the methods of Brook and Bryars (2014). The canopy cover of reefs in the EMP was above the threshold for classification as 'good' (Figure 22) between 2005 and 2007, both inside and outside of SZs, but thereafter exceeded this threshold only in 2013 inside SZs. The set of reefs surveyed was not consistent between survey events.
- The cover of canopy algae, turf and bare substrate was used as an indicator of reef condition from surveys during autumn and spring 2011 (Gaylard et al. 2013, Nelson et al. 2013). Reef communities between Sellicks Beach and the northern boundary of the EMP were classified as being in moderate condition with an average cover of canopy algae greater than 60 per cent but moderate levels of bare substrate or turfing algae. Reefs between Baudin Beach and the western boundary of the EMP were not assessed as the reef cover was less than 10 per cent.

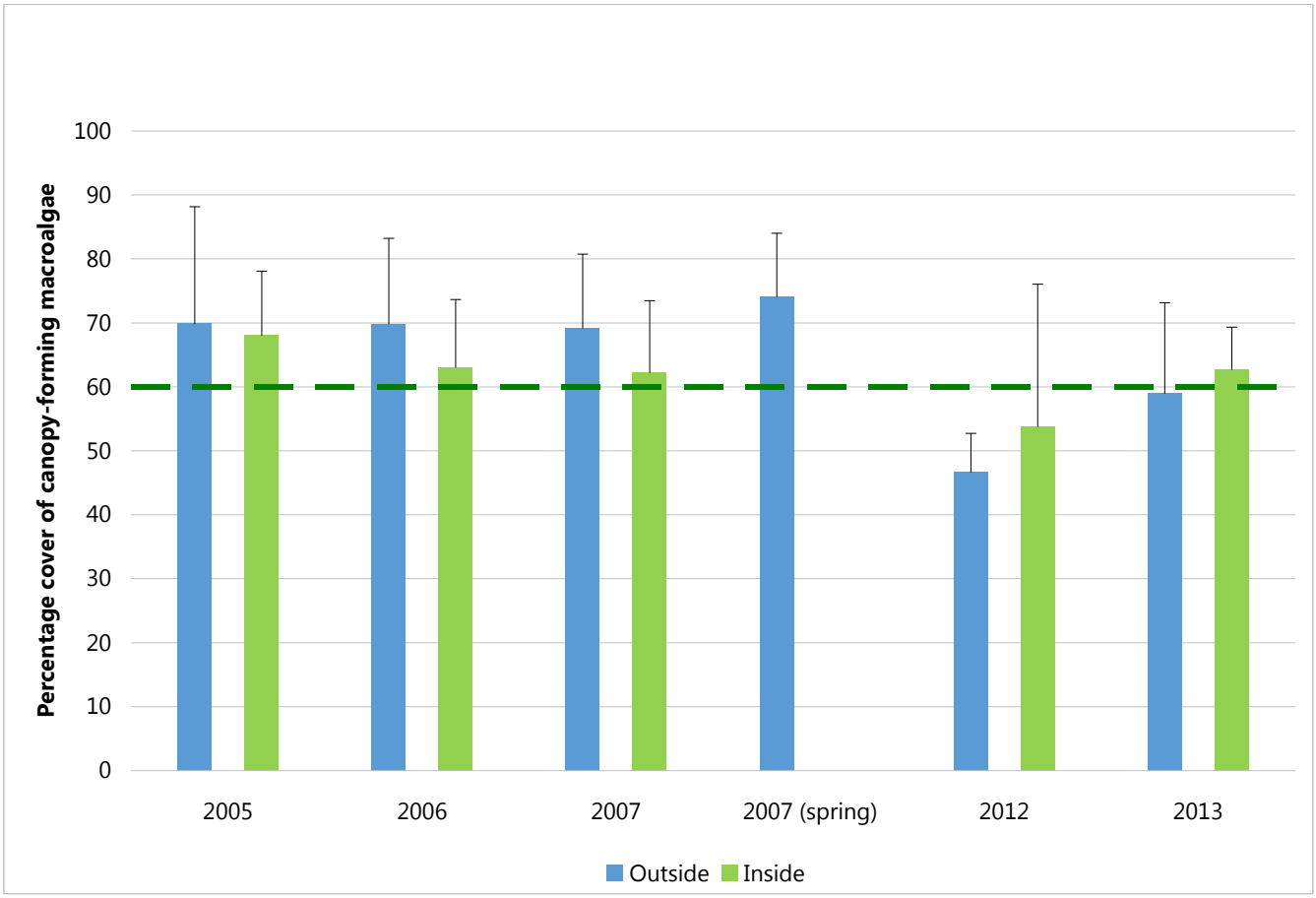
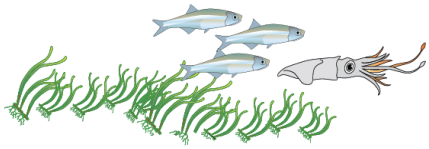


Figure 22. Percentage canopy cover of subtidal reefs surveyed during 2005–2007 and 2012–2013, inside and outside of Sanctuary Zones. Canopy cover estimates derived from unpublished DEWNR and the University of Tasmania data following the method described by Brook and Bryars (2014). Reefs with a canopy cover greater than 60 per cent (dashed line) are considered to be in 'good'condition (Turner et al. 2007, Collings et al. 2008).

4.2 Seagrass

The largest areas of seagrass in the EMP occur in Yankalilla Bay, the Bay of Shoals and Western Cove (Figure 6, DENR 2010).



Baseline information on seagrass relevant to the EMP includes:

Spatial extent of seagrass habitat

- A total of 315 square kilometres of seagrass has been mapped in the EMP (Figure 6). About 2,159 square kilometres of seafloor in the EMP have not been mapped (see Appendix B).
- Two areas of seagrass loss have been assessed using digitised aerial photographs (Environment Protection Authority 1998, Bryars 2014).
- Seagrass loss in Yankalilla Bay was assessed by underwater video and diver surveys during November/December 2013 and March 2014 (Bryars 2014).
- Seagrass loss in Western Cove, Kangaroo Island has been observed on field surveys during October 1999. The cause of loss is unknown (Bryars et al. 2003).
- Tanner (2005) found that *Zostera* seagrass mapped by Shepherd and Sprigg (1976) in Investigator Strait was no longer present in 2000/01.

Size, abundance and diversity of seagrass communities

- Seagrass distribution and density were surveyed using underwater video at 7 sites on the western Fleurieu coast (including 2 inside the Port Noarlunga Reef SZ) and 10 in Nepean Bay (including 1 inside the Bay of Shoals SZ) during autumn and spring of 2010 and 2011 (Nelson et al. 2013). Not all sites were dominated by seagrass but the habitat details for each site are not yet available.
- Seagrass diversity and cover were surveyed using underwater video at 6 subtidal seagrass locations on the north-eastern coast of Kangaroo Island (1 inside the Bay of Shoals SZ) 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 northern part of Nepean Bay (including 1 inside the Bay of Shoals 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 on the Fleurieu Peninsula (including 1 inside the Onkaparinga Wetland SZ) between April 2006 and February 2007. A total of 44 species were recorded (Gillanders et al. 2008).
- Fish and invertebrate diversity and abundance were surveyed using beam trawls at 9 subtidal seagrass locations on Kangaroo Island (including 2 inside the Pelican Lagoon SZ) at depths up to 7 metres during summer and winter 2005/2006. A total of 157 species were recorded (Kinloch et al. 2007).
- Fish diversity and abundance were surveyed using baited remote underwater video systems at 3 locations in north eastern Kangaroo Island (including 1 inside each of the Bay of Shoals and Pelican Lagoon SZs) at depths between 0.5 and 2.7 metres during January 2012. A total of 47 fish species were recorded (Whitmarsh 2012).
- Larval fish distribution, diversity and abundance were surveyed using towed Twin Ring nets at 2 subtidal seagrass sites (1 inside each of the Noarlunga Reef and Rapid Head SZs) at a depth of 15 metres during autumn and winter 2014 (Jones 2014).
- 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, 2016,

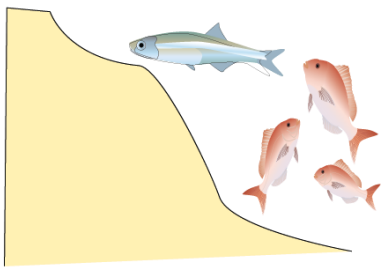
Tsolos 2013). These assessments include fishery-dependent spatial and temporal information on catch, effort, catch rate and size structure (see Sections 5.8 and 8.2.1).

Seagrass condition

- Seagrass condition was inferred from seagrass density, 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* and *Amphibolis*) 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 was inferred from seagrass density and epiphyte loads during 2010 and 2011 (Nelson et al. 2013, Gaylard et al. 2013, see above). Seagrass between Sellicks Beach and the northern boundary of the EMP was patchy, sparse or under stress with high epiphyte loads. Between Baudin Beach and the western boundary of the EMP there were dense and intact seagrass meadows while in other areas the habitats were degraded or under stress with high epiphyte loads (Nelson et al. 2013).

4.3 Sand

Sand habitat is prevalent across the EMP, with areas of beach, intertidal flats and subtidal sand plains (Figure 6, DENR 2010).



Baseline information on sand relevant to the EMP includes:

Spatial extent of sand habitat

- Sandy beaches extend along about 208 kilometres of the mainland and Kangaroo Island coastline in the EMP (Appendix B). The shoreline extent of island beaches (other than Kangaroo Island) has not been mapped in the EMP.
- About 424 square kilometres of sand have been mapped in the EMP (Figure 6). About 2,159 square kilometres of seafloor in the EMP have not been mapped (see Appendix B).
- About 93 square kilometres of deep sea sponge gardens has been mapped in the EMP (Figure 6), which lies mainly over sand habitat (Figure 13)

Size, abundance and diversity of sand communities

- Assessments were made of the physical characteristics (as surrogates for biodiversity) of 39 beaches 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 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 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 Pipi, Gulf St Vincent Prawn, Lakes and Coorong, Marine Scalefish and Charter Boat Fisheries (Ferguson 2013, Beckmann et al. 2015, Earl and Ward 2014, Fowler et al. 2014a, 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). Fisheries independent data includes prawn catch rates (Beckmann et al. 2015) and pipi biomass estimates (Ferguson 2013).

Sand habitat condition

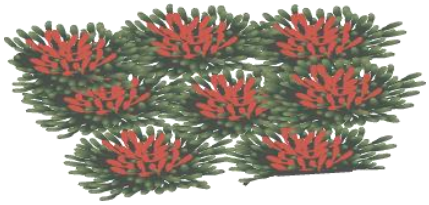
- There is no information available on the condition of sand habitat in the EMP.

4.4 Mangrove

There are no mangrove ecosystems in the EMP.

4.5 Saltmarsh

The largest areas of saltmarsh in the EMP occur near the Onkaparinga River and in Western Cove (Figure 6).



Baseline information on saltmarsh relevant to the EMP includes:

Spatial extent of saltmarsh habitat

- About 4 square kilometres of saltmarsh have been mapped in the EMP, extending along about 20 kilometres of mainland and Kangaroo Island shoreline. Current mapping captures the extent of all known saltmarsh in the EMP.

Size, abundance and diversity of saltmarsh communities

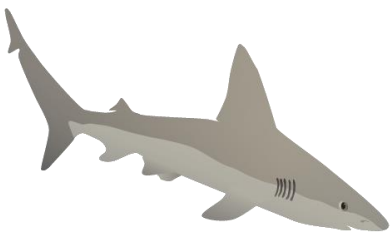
- Saltmarsh diversity and cover were quantified from field surveys at 2 sites in the Onkaparinga estuary during March and November 2008 (Cook and Coleman 2009).

Saltmarsh habitat condition

- There is currently no information available on the condition of saltmarsh in the EMP.

4.6 Sharks

The EMP is used by a number of shark species, including dusky whaler, smooth hammerhead, school shark, hammerhead shark, white shark and shortfin mako (DENR 2010).



Baseline information on sharks relevant to the EMP 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 EMP is used by a number of marine mammal species, including southern right whale, pigmy right whale, humpback whale, Australian sea lion, long-nosed fur seal (formerly New Zealand fur seal), short-nosed fur seal (formerly the 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. The Cape Jervis and Encounter Bay regions form a migratory corridor for southern right whales (Carroll et al. 2011).

Baseline information on marine mammals relevant to the EMP includes:

- The distribution and abundance of Australian sea lions has been recorded during a variable number of surveys at South Australian breeding sites (Goldsworthy and Page 2009). There are 2 Australian sea lion breeding sites in the EMP, at North and South Pages Islands, with an estimated annual pup production of 589 (Goldsworthy and Page 2009).
- Haul-out sites for the long-nosed fur seal include North Page, West and Seal Islands (Shaughnessy et al. 1994, Shaughnessy et al. 2014).
- A haul-out site for the Australian fur seal is located at North Pages Island (DEWNR 2015g).

4.8 Seabirds

The EMP is used by a number of seabird species, including white-bellied sea-eagle, osprey, black-faced cormorant, Caspian tern, crested tern, fairy tern, little penguin, Pacific gull, pied cormorant and silver gull (DENR 2010). Some of these species are resident while others are more transient, visiting the EMP to rest, breed and/or feed. Many of the islands in the EMP support seabird breeding colonies (Robinson et al. 1996). Seabirds that breed in New Zealand or Antarctica, such as albatrosses, petrels and prions also occur in the EMP (Marchant and Higgins 1990).

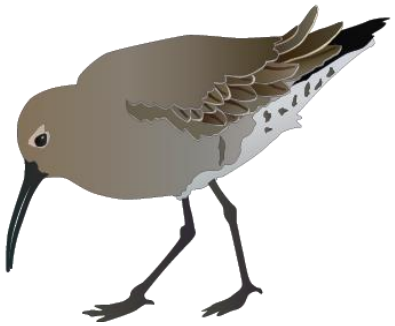
Baseline information on seabirds relevant to the EMP includes:

- The distribution and abundance of osprey and white-bellied sea-eagle breeding pairs were surveyed across South Australia over 3 breeding seasons between May 2008 and October 2010 (Dennis et al. 2011a).
- The distribution and abundance of breeding sites for 16 species of seabird have been surveyed across South Australia numerous times since 1971 (Copley 1996, DEWNR 2015h). Goldsworthy and Page (2010) reviewed the distribution and abundance of crested terns, little penguins, short-tailed shearwaters and flesh-footed shearwaters. Little penguins previously bred at 7 locations within the EMP, including estimated populations of about 2,000 and 500 pairs on West Island and Granite Island, respectively (Copley 1996). The Granite Island population is now estimated to be 32 penguins (Colombelli-Négrel 2015) and penguins are no longer present on West Island or a number of the other former breeding locations (Colombelli-Négrel and Kleindorfer 2014).

Crested terns breed at 3 locations, including estimated populations of about 1,500 pairs and 2,000 nests at West Island and South Page Island, respectively (Copley 1996). There are also breeding sites for the silver gull (The Pages, Pelican Lagoon), pied cormorant (Busby Islet) and Pacific gull (Pelican Lagoon and Busby islet, Copley 1996).

4.9 Shorebirds

The EMP is used by a number of shorebird species for breeding and feeding, including pied oystercatchers, greater sand plover, grey plover, terek sandpiper and masked lapwing (DENR 2010). Some of these species are resident and others migrate to the EMP from interstate or overseas. Shorebird habitat is provided by a number of Wetlands of National Importance, including the Onkaparinga Estuary, The Coorong, Lashmar Lagoon and Chapman River, American River Wetland system, Cygnet Estuary, and Busby and Beatrice Islet (Department of the Environment 2015).



Baseline information on shorebirds relevant to the EMP includes:

- Diversity and abundance of shorebirds were surveyed in three seasons during 2010 and 2011 in Gulf St Vincent including sites at Carrickalinga, with 1 shorebird species (masked lapwing) recorded (Purnell et al. 2011). Shorebirds were also surveyed at both Carrickalinga and Aldinga Reef in November 2008 with 1 shorebird species (red-necked stint) recorded (Purnell et al. 2009). These data are a subset of an ongoing statewide dataset that is maintained by the Shorebirds 2020 Project (BirdLife Australia 2015).
- Diversity and abundance of shorebirds have been surveyed since 1981 near the Murray Mouth and in the Coorong (Wainwright 2012). These data are a subset of an ongoing statewide dataset that is maintained by the Shorebirds 2020 Project (BirdLife Australia 2015).
- Hooded plover breeding success has been monitored by volunteers on the Fleurieu Peninsula since 2006 (Maguire and Mead 2015). This is a collaborative project between the Adelaide and Mount Lofty Ranges Natural Resources Management Board, BirdLife Australia, DEWNR, local councils and the Friends of the Hooded Plover, Fleurieu Peninsula. Red-capped plover breeding success is also being monitored at particular sites on the Fleurieu (Maguire and Mead 2015).

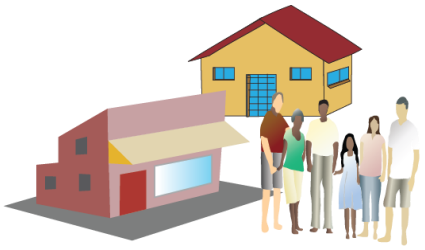
5 Socio-economic values

Monitoring the 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, transport and infrastructure, aquaculture, recreational fishing, and commercial fishing (Figure 5). 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 the EMP (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

Local businesses and communities are based within the vicinity of a number of townships including Port Noarlunga, Aldinga, Normanville, Cape Jervis, Victor Harbor, Goolwa, Penneshaw and Kingscote. Most information in this section is reported for the Aldinga, Christies Beach, Seaford, Yankalilla, Victor Harbor, Goolwa and Kangaroo Island Statistical Areas Level 2 or the Onkaparinga, Yankalilla, Alexandrina, Victor Harbor, Coorong and Kangaroo Island Local Government Areas, or the Fleurieu and Coorong Region (Bailey et al. (2012b, see Appendix C).



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).

Baseline information on human population relevant to the EMP 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. Between 2004 and 2014, the population in South Australia rose by about 10 per cent, and the estimated resident population and population growth for Local Government Areas relevant to the EMP were (ABS 2015a, Figure 23):
    - Onkaparinga: growth of about 10 per cent (16,500 persons) to 167,659 persons
    - Yankalilla: growth of about 13 per cent (582 persons) to 4,630 persons
    - Victor Harbor: growth of about 20 per cent (2,985 persons) to 14,938 persons
    - Alexandrina: growth of about 29 per cent (5,500 persons) to 24,824 persons

- The Coorong: a decrease of about 5 per cent (292 persons) to 5,585 persons
- Kangaroo Island: growth of about 6 per cent (228 persons) to 4,583 persons

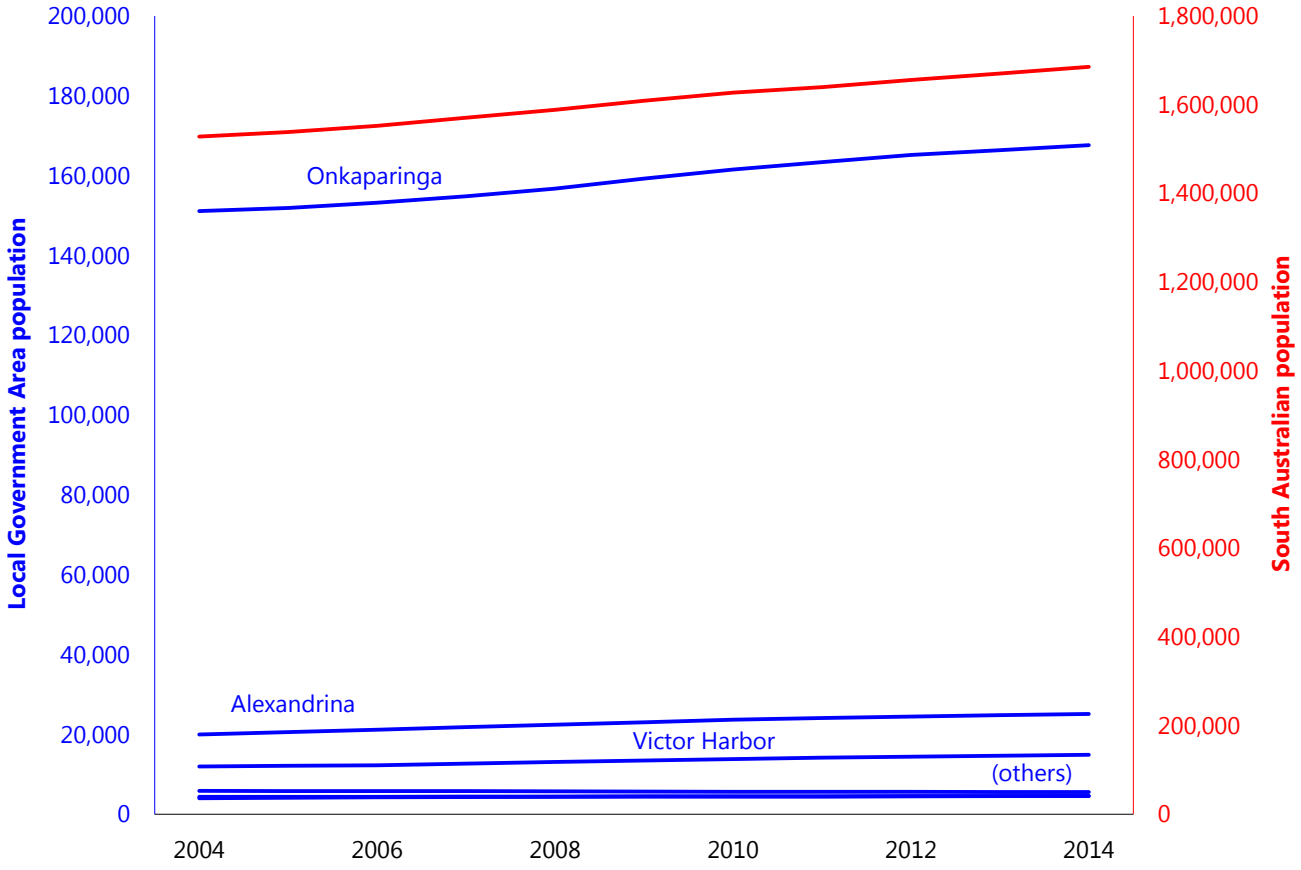


Figure 23. Population trends in the Local Government Areas relevant to the Encounter Marine Park compared with South Australia. Source: ABS (2015a).

5.1.2 Production and employment

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

Baseline information on production and employment relevant to the EMP includes:

- Gross regional product has been calculated for Local Government Areas by the National Institute of Economic and Industry Research Pty Ltd for 2010/11 and 2013/14 (National Economics and .id 2015). Gross regional products in 2013/14 for Local Government Area relevant to the EMP (see Appendix C) were (National Economics and .id 2015):
  - Onkaparinga: $4,459 million, representing about 5 per cent of gross state product in the same year (about $90 billion).
  - Yankalilla: $253 million, representing 0.28 per cent of gross state product in the same year.
  - Victor Harbor: $472 million, representing 0.52 per cent of gross state product in the same year.
  - Alexandrina: $833 million, representing 0.92 per cent of gross state product in the same year.
  - The Coorong: $293 million, representing 0.32 per cent of gross state product in the same year.

- Kangaroo Island: $228 million, representing 0.25 per cent of gross state product in the same year.

- Gross regional product for the Fleurieu and Coorong Region (see Appendix C) was about $2.5 billion in 2009/10, calculated once only by EconSearch for a specific report (Bailey et al. 2012b). The fishing, agriculture and forestry sector was the third highest contributor to gross regional product (8 per cent) and second highest contributor to exports (19 per cent) in this region (Bailey et al. 2012b). Gross regional product for the Kangaroo Island Local Government Area was $161 million in 2009/10, calculated once only by EconSearch for a specific report (Bailey et al. 2012b). The fishing, agriculture and forestry sector was the highest contributor to: gross regional product (20 per cent), jobs (22 per cent) and exports (35 per cent) in the Kangaroo Island Local Government Area in 2009/10 (Bailey et al. 2012b). Tourism contributed 29 per cent of exports from Kangaroo Island in that year (Bailey et al. 2012b). It should be noted that methodological differences may account for some of the discrepancy between the estimates by National Institute of Economic and Industry Research and EconSearch, and that estimates at this scale should be interpreted with caution.

- 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 Statistical Areas Level 2 between 2009 and 2014 (ABS 2015b). The total number of businesses operating in June 2014 in Statistical Areas Level 2 relevant to the EMP (see Appendix C) were (ABS 2015b):

    - Christies Beach: 509, of which 4 were in the 'agriculture, forestry and fishing' sector
    - Seaford: 841, of which 23 were in the 'agriculture, forestry and fishing' sector
    - Aldinga: 637, of which 39 were in the 'agriculture, forestry and fishing' sector
    - Yankalilla: 558, of which 216 were in the 'agriculture, forestry and fishing' sector
    - Victor Harbor: 944, of which 114 were in the 'agriculture, forestry and fishing' sector
    - Goolwa: 658, of which 44 were in the 'agriculture, forestry and fishing' sector
    - The Coorong: 765, of which 440 were in the 'agriculture, forestry and fishing' sector
    - Kangaroo Island: 680, of which 293 were in the 'agriculture, forestry and fishing' sector

- The number of local jobs for Local Government Areas has been estimated by the National Institute of Economic and Industry Research Pty Ltd between 2010/11 and 2013/14 (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 2013/14, jobs in the Local Government Areas relevant to the EMP (see Appendix C) were (National Economics and .id 2015):

    - Onkaparinga: 44,040
    - Yankalilla: 1,599
    - Victor Harbor: 4,775
    - Alexandrina: 7,088
    - The Coorong: 2,347
    - Kangaroo Island: 2,213

- In 2006, 53 per cent of jobs in the Fleurieu and Coorong region (see Appendix C) and 90 percent of jobs on Kangaroo Island were held by local residents (Bailey et al. 2012b).

- The unemployment rate is available from the Australian Government Department of Employment for Local Government Areas and Statistical Areas Level 2 since 2011, and for 2003 to 2013 for Statistical Local Areas (which generally follow local government boundaries). 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 2015, Figure 24). The unemployment rates for Local Government Areas relevant to the EMP (see Appendix C) were (Department of Employment 2015, Figure 24):

  - Onkaparinga: 8.7 per cent
  - Yankalilla: 6.6 per cent
  - Victor Harbor: 7.8 per cent
  - Alexandrina: 6.0 per cent
  - The Coorong: 6.9 per cent
  - Kangaroo Island: 5.3 per cent

  The number of unemployed people and the available labour force are also available (Department of Employment 2015, Kosturjak et al. 2015).

- 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).

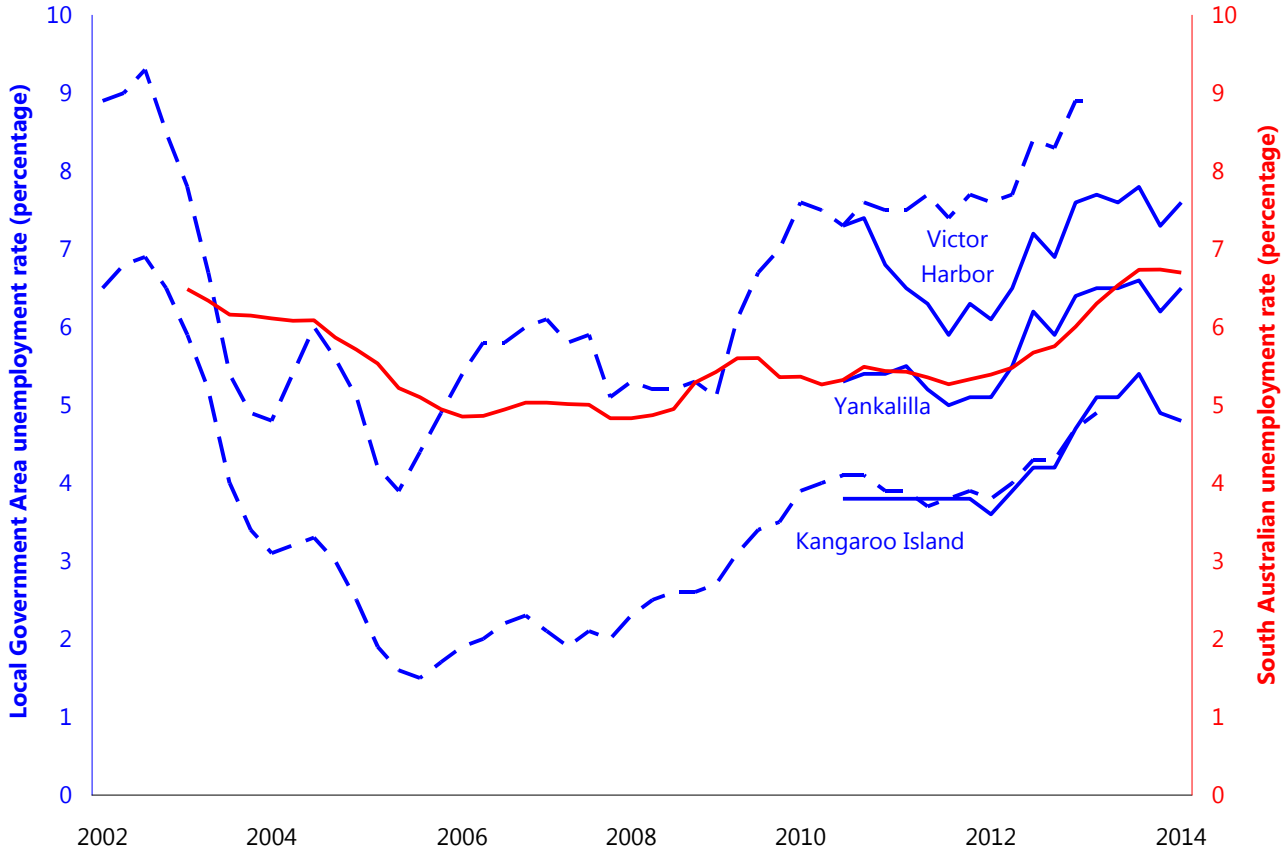


Figure 24. Unemployment rate (quarterly) in the Victor Harbor, Yankalilla and Kangaroo Island Local Government Areas compared with South Australia. Dotted blue lines show data for Statistical Local Areas which are similar to the Local Government Areas, but are no longer used for reporting. Source: Department 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, b).

Baseline information on building activity and residential property prices relevant to the EMP 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) compiled this information for the Fleurieu and Coorong region and Kangaroo Island (see Appendix C), and reported that:
  - the number of building approvals increased by 3 per cent and decreased by 55 per cent for the Fleurieu and Coorong region and Kangaroo Island, respectively, between 2001/02 and 2010/11, compared with a 3 per cent increase in South Australia.
  - the average value per approval between 2001/02 and 2010/11 increased from $102,000 to $210,000 (107 per cent) for the Fleurieu and Coorong region and from $107,000 to $255,000 (137 per cent) on Kangaroo Island, compared with $128,000 to $236,000 (85 per cent) in South Australia.

- Kosturjak et al. (2015) provided the number and value of residential building approvals, and the value of non-residential building approvals, for Kangaroo Island between 2004/05 and 2013/14.
- Bailey et al. (2012b) reported house price information sourced from RP Data Pty Ltd. The median house price between 2000/01 and 2010/11 increased from about $108,000 to $330,000 (206 per cent) in the Fleurieu and Coorong region and from about $85,000 to $235,000 (176 per cent) on Kangaroo Island, compared with $126,000 to $370,000 (194 per cent) in South Australia (Bailey et al. 2012b). 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 2015i). Comparative property price data are also available for a group of major South Australian towns (Kosturjak et al. 2015). Trends in the median house price for Local Government Areas relevant to the EMP between 1990 and 2014 were (Figure 25):
    - Onkaparinga: increased from about $68,500 to $320,000
    - Yankalilla: increased from about $61,000 to $320,000
    - Victor Harbor: increased from about $82,500 to $330,500
    - Alexandrina: increased from about $57,500 to $315,000
    - The Coorong: increased from about $28,000 to $160,000
    - Kangaroo Island: increased from about $53,000 to $239,000.

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.

Baseline information on socio-economic advantage and disadvantage includes:

- The Australian Bureau of Statistics ranks Statistical Areas Level 1 and 2 and Local Government Areas according to an index of relative ocio-economic advantage and disadvantage based on income, education, employment, occupation, housing and other information from the five-yearly census (ABS 2011a). In 2011, the Victor Harbor Local Government Area was in the lowest 40 per cent (i.e. relatively disadvantaged), the Yankalilla and Kangaroo Island Local Government Areas were in the lowest 50 percent, and the Onkaparinga and Alexandrina Local Government Areas were in the highest 40 per cent (i.e. relatively advantaged) in South Australia for the index of relative social disadvantage and advantage (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.

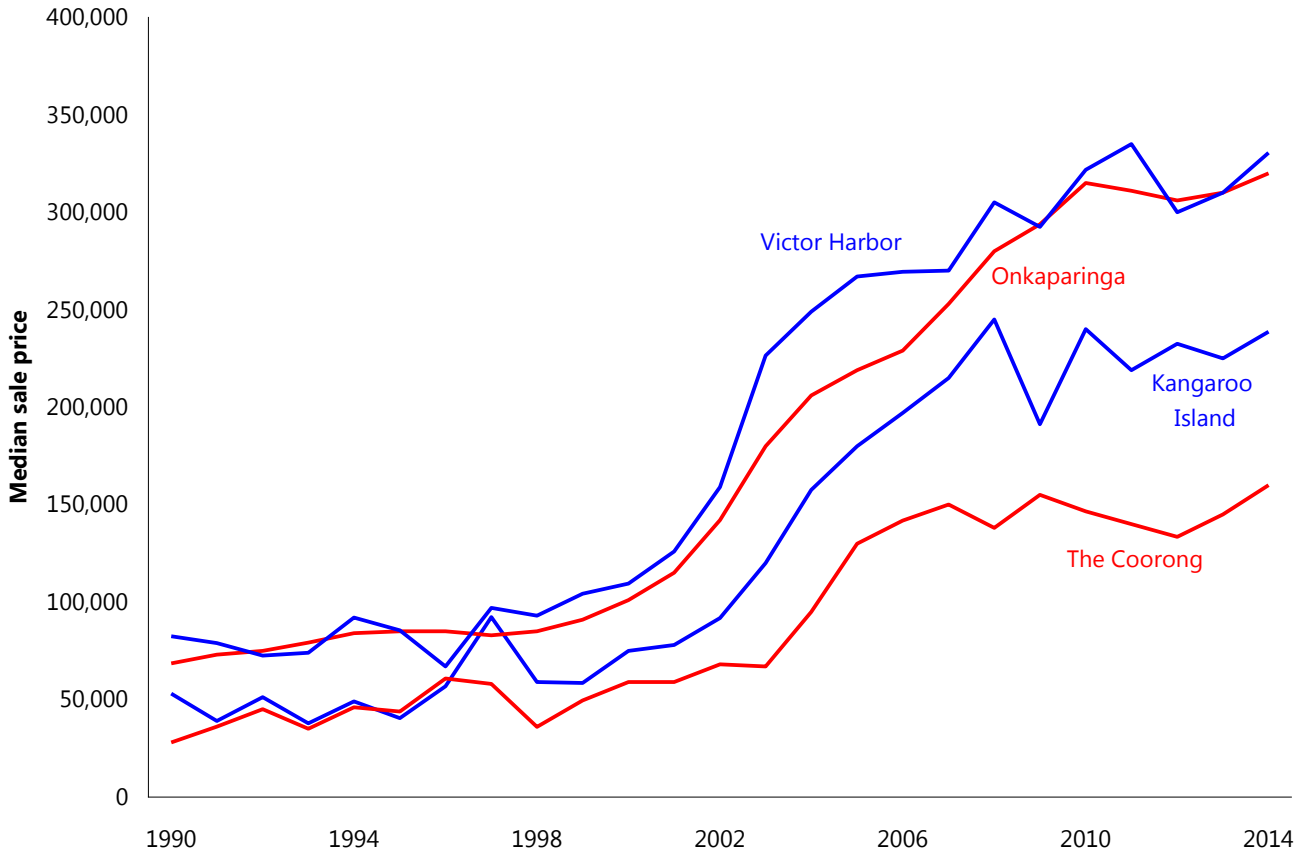


Figure 25. Median sale price for residential properties in the Victor Harbor, Onkaparinga, Kangaroo Island and The Coorong Local Government Areas. For each property, these data only include the most recent sale which is a transfer of the full value and whole of land. There is potential volatility in the median price due to random fluctuations in the quality of properties sold in particular years. Source: DEWNR (2015i).

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).

Baseline information on public appreciation, education and understanding of the marine environment and marine parks relevant to the EMP 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, i.e. protection of marine plants and animals, but less so (between 58 and 79 per cent) for marine parks in the local area of the people who were surveyed (Figure 26). In 2015, support for marine parks in general and in their local area was 91 and 77 per cent, respectively, for Fleurieu Peninsula respondents (from Cape Jervis, Victor Harbor, Goolwa, Port Elliot, Middleton, and Meningie), and 67 and 52 per cent, respectively, for Kangaroo Island respondents (Square Holes 2015).

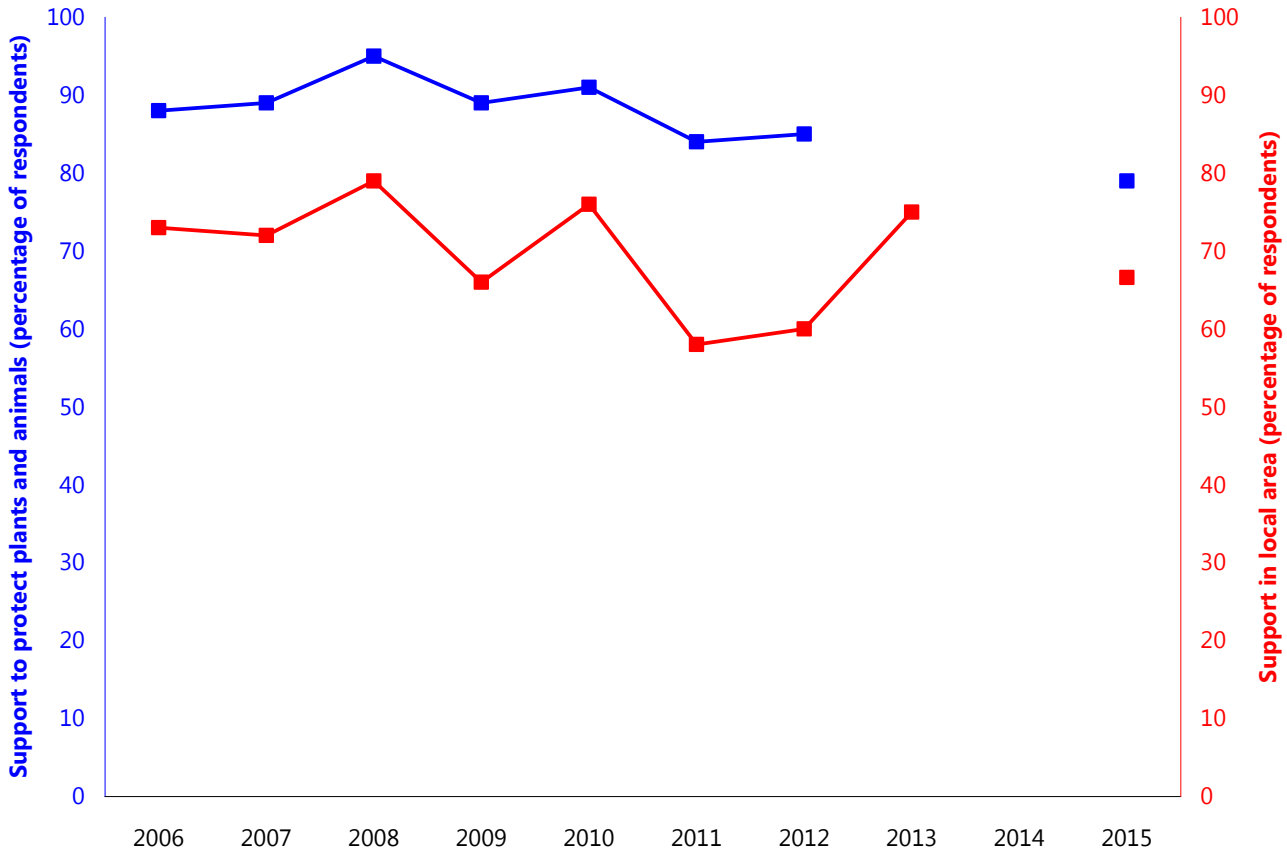


Figure 26. Results of statewide phone surveys regarding support for marine parks to protect marine plants and animals and support in local area. No data were available for 2013 (blue line) or 2014 (both lines). Source: Square Holes (2015).

5.2 Coastal recreation

The EMP 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).

Baseline information on coastal recreation relevant to the EMP 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 27). These uses declined after 2007 but have since been stable (Figure 27). In 2015, the general use, fishing and boating participation rates were 64, 23 and 26 per cent, respectively, of Fleurieu Peninsula respondents (from Cape Jervis, Victor Harbor, Goolwa, Port Elliot, Middleton, and Meningie), and 66, 45 and 37 per cent, respectively, of Kangaroo Island respondents (Square Holes 2015).
- During 2013 and 2014, 51 per cent of domestic visitors to the Fleurieu Peninsula tourism region visited the beach, 11 per cent went fishing, and 9 per cent visited national or state parks (South Australian Tourism Commission unpublished data). 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 (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 28). Boat licences varied between 5,000 and 7,000 during the same period (DPTI 2015b, Figure 29). Note that data are available from 1975 but only data from 1992 are presented in Figure 29. In 2015, the option for six-monthly registration renewals was introduced, which may result in a short-term perturbation in the time-series.
- A survey has been conducted of the scenic quality of the South Australia coastline (Lothian 2005). The coastline of the EMP was rated as having moderate to high (between 6 and 8 out of 10) scenic quality, with the exception of north-western Nepean Bay, which was rated low (Lothian 2005).

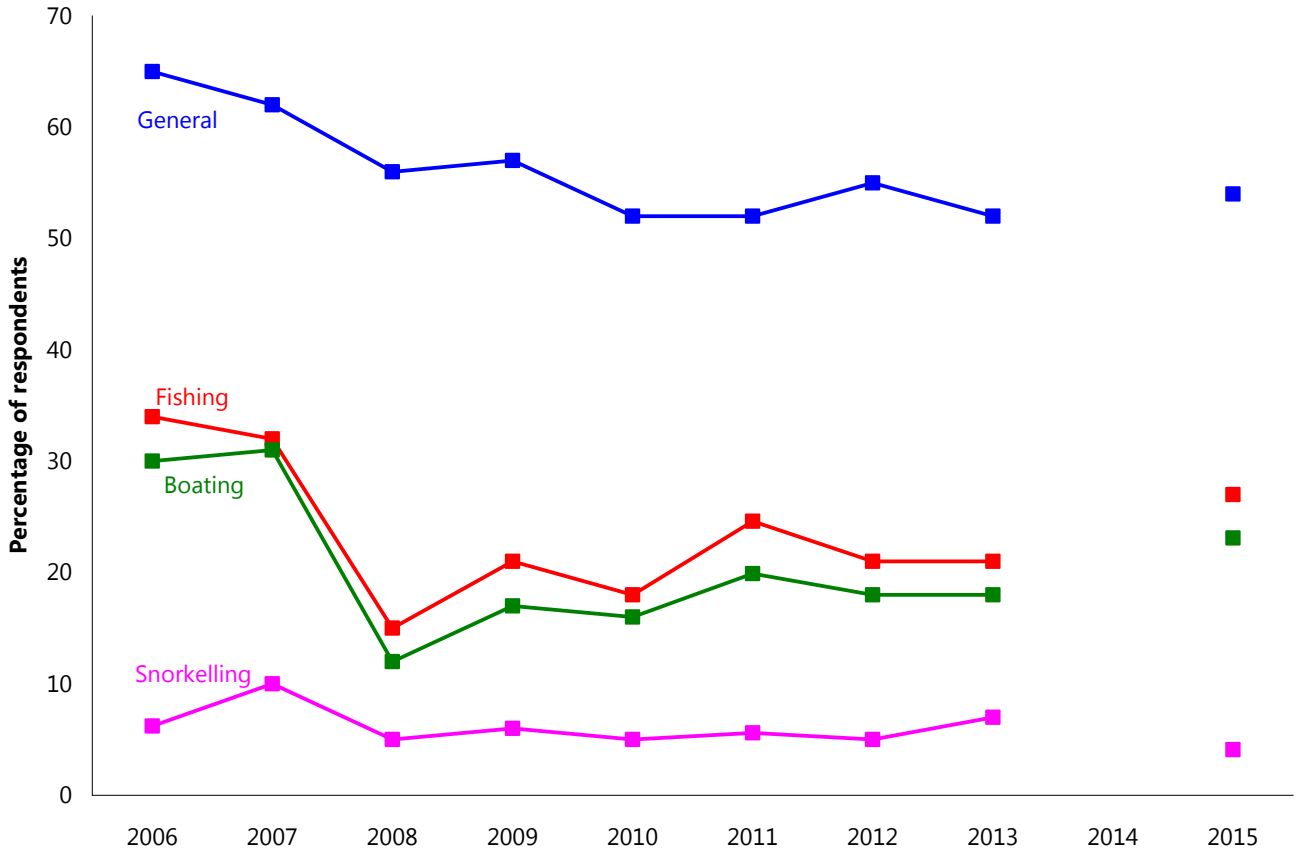


Figure 27. Percentage of statewide phone survey respondents who participate in general recreational, fishing, boating and snorkelling activities in the marine environment at least monthly. No data were available for 2014. Source: Square Holes (2015).

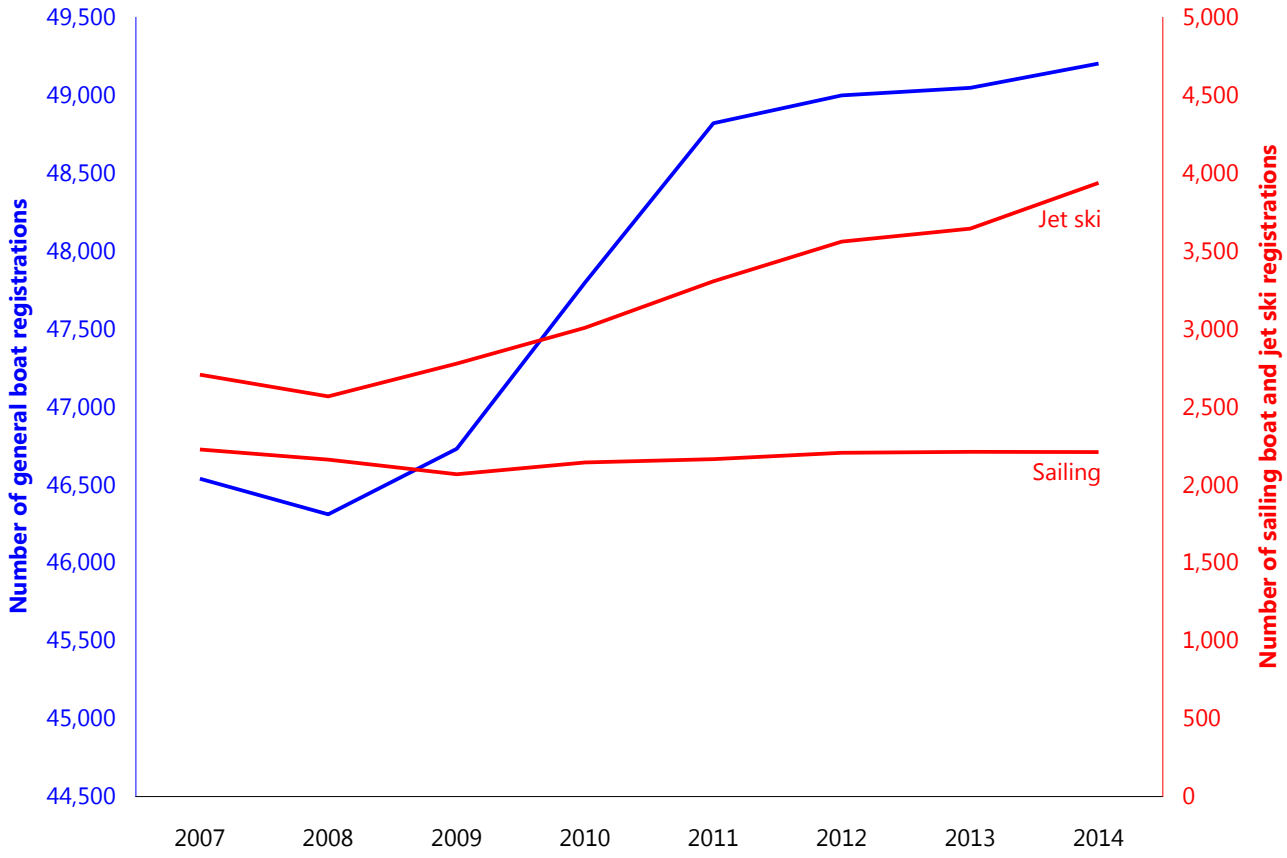


Figure 28. South Australian boat registrations for general boats, and sailing vessels and jet skis (red lines, right axis). General boat registrations include cabin cruisers, half cabins, cuddy cabins, centre consoles, inflatables, open boats and runabouts. Catamarans are grouped with sailing vessels. Source: DPTI (2015a).

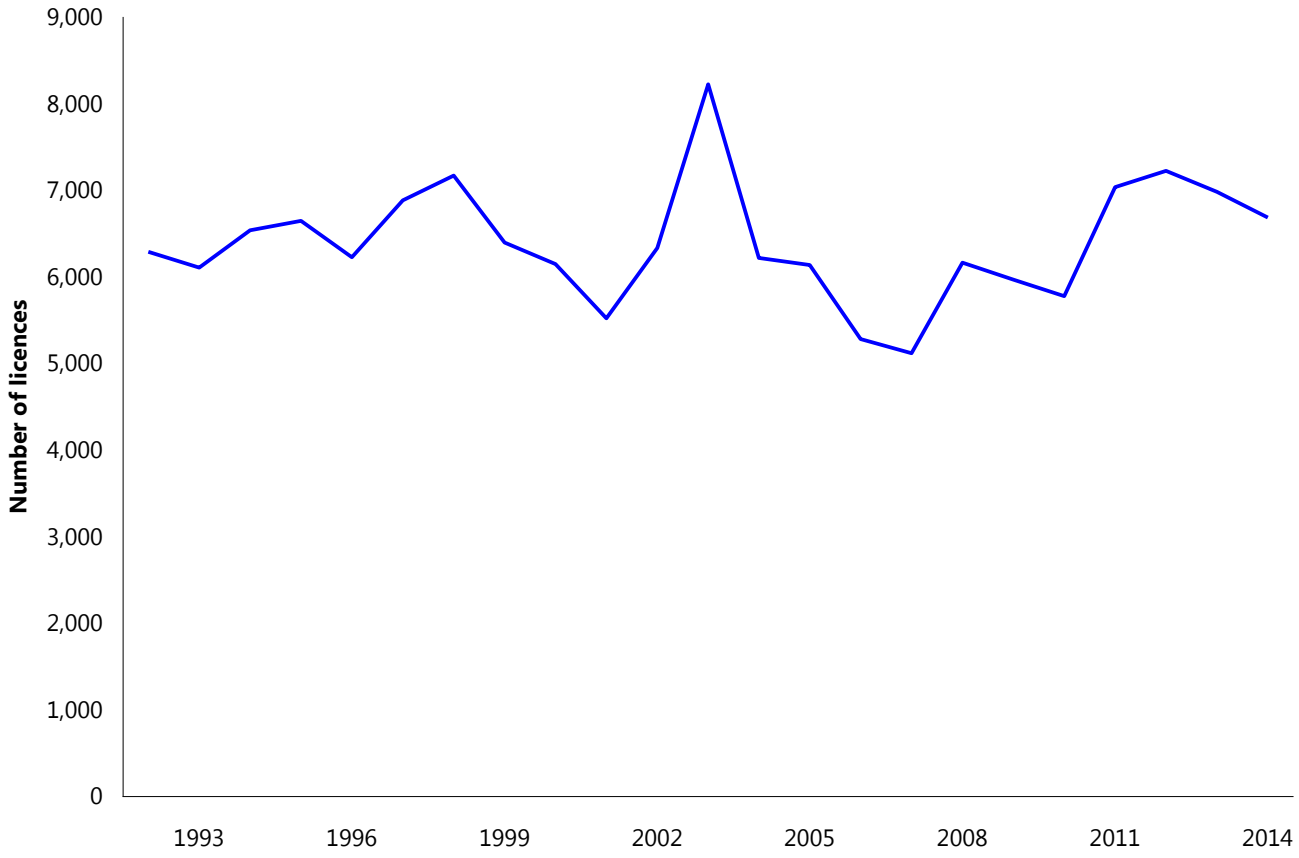


Figure 29. Number of South Australian boat licences. Source: DPTI (2015b).

5.3 Tourism

Tourism is an important economic contributor to the region. 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, b). Kangaroo Island, the Coorong National Park, and Deep Creek and Newland Head Conservation Parks are popular tourist destinations (DENR 2010).

Baseline information on tourism relevant to the EMP includes:

- Bailey et al. (2012b) provided information on expenditure by tourists for the Fleurieu and Coorong region (see Appendix C) and Kangaroo Island. Expenditure by tourists in 2009/10 in the Fleurieu and Coorong region of about $260 million contributed about 20 per cent of its total value of exports and generated about 6 per cent of its gross regional product and about 9 per cent of its jobs. Expenditure by tourists in 2009/10 on Kangaroo Island of about $121 million contributed about 57 per cent of its total value of exports, about 38 per cent of its gross regional product and about 46 per cent of its jobs.
- 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 2015, see Figure 30 and Figure 31). Expenditure by tourists in the Fleurieu and Kangaroo Island tourism regions (see Appendix C) in 2013/14 was $435 and $113 million, respectively. Data are available for previous years, but are not comparable with 2013/14 due to a change in methods (Tourism Research Australia 2015).

- 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, 51 per cent of domestic visitors to the Fleurieu Peninsula visited the beach, 11 per cent went fishing, and 9 per cent visited national or state parks (South Australian Tourism Commission unpublished data). 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 (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). In 2014, at least 18 coastal or marine tourism operators used the EMP offering a range of activities including fishing charters, swimming with dolphins, penguin viewing, kayak tours, whale watching, and/or general cruises and sight-seeing.

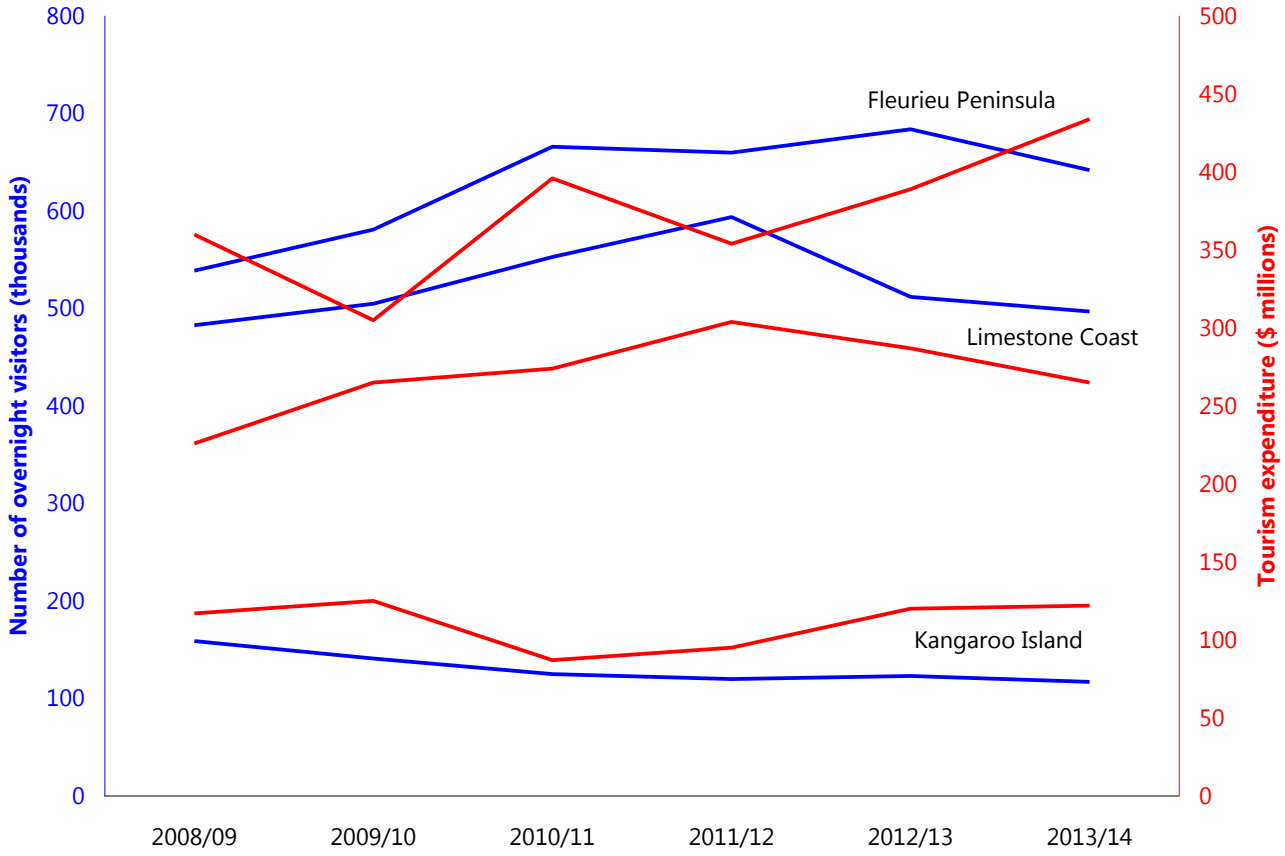


Figure 30. Number of overnight visitors and tourism expenditure for the Fleurieu Peninsula, Limestone Coast and Kangaroo Island tourism regions. Source: Tourism Research Australia (2015).

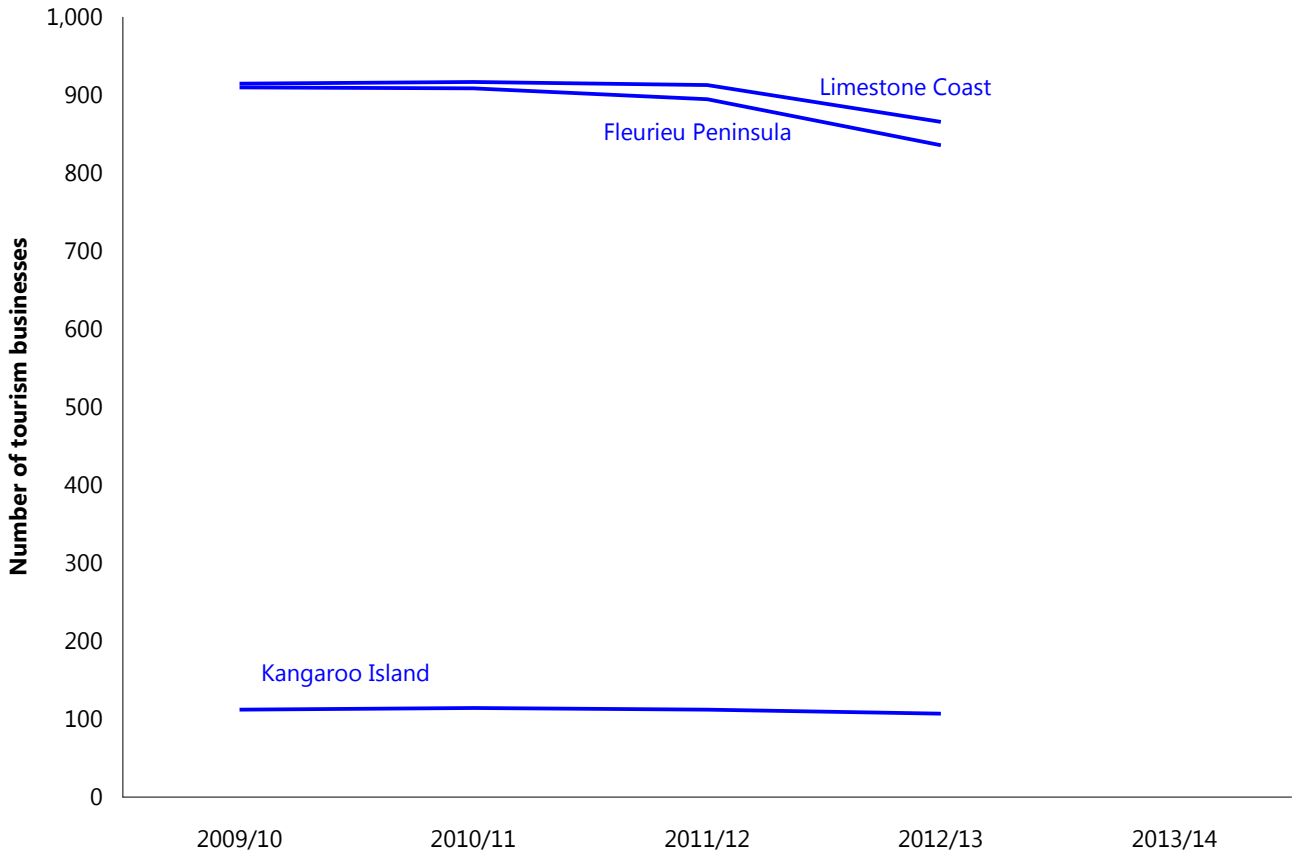
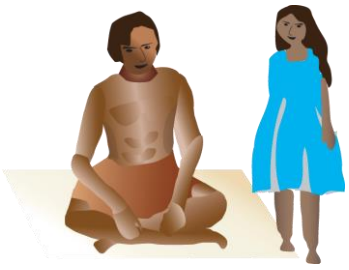


Figure 31. Number of tourism businesses in the Fleurieu Peninsula, Limestone Coast and Kanagroo Island tourism region. Source: Tourism Research Australia (2015). No data were available for 2013/14.

5.4 Cultural heritage

5.4.1 Aboriginal heritage

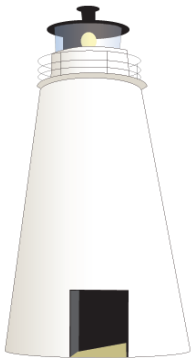


The Kaurna and Ngarrindjeri Aboriginal people are understood to have traditional associations (which may include Aboriginal traditional fishing) with areas of the EMP. Both the Kaurna and Ngarrindjeri people have lodged native title claims that include parts of the EMP (DENR 2010, National Native Title Tribunal 2015a, b).

Baseline information on Aboriginal heritage relevant to the EMP 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 Kangaroo Island is believed to contain many cultural heritage sites from the period when the island was connected to the mainland, as well as more recently from the early 19th century, when many Aboriginal women were taken to Kangaroo Island, from Kaurna, Ngarrindjeri and Tasmanian Aboriginal groups by sealers and whalers.

5.4.2 European heritage



In 1802, Matthew Flinders named Investigator Strait, Backstairs Passage and Cape Willoughby and named Encounter Bay to mark his chance meeting with the French explorer Nicolas Baudin in the waters off the Murray Mouth. The EMP is associated with some of the most significant sites of European contact and settlement in South Australia, reflecting the early history of exploration, whaling, colonisation and shipping. Many of these sites are recognised and listed as State Heritage Places.

Baseline information on European heritage relevant to the EMP 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). Entries for the EMP include a historical whaling site at Fishery Beach, the breakwater and jetty at Port Elliot and Granite Island and the Lighthouse at Cape Willoughby (DEWNR 2015j).
- 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 87 shipwrecks in the EMP (DEWNR 2015k).

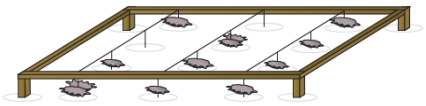
5.5 Transport and infrastructure

Transport and infrastructure provide important socio-economic activity and value in this region (DENR 2010). There are no cargo ports in the EMP, but Backstairs Passage is an important shipping route and ships pass within a few kilometres of the Noarlunga Reef, Aldinga Reef, Carrickalinga Cliffs, Rapid Bay, Bay of Shoals and Sponge Gardens SZs (AMSA 2015). A ferry service operates between Cape Jervis and Penneshaw.

Baseline information on transport and infrastructure relevant to the EMP includes:

- The South Australian Tourism Commission maintains a database of the numbers of cruise ship arrivals and cruise ship passengers/crew to locations around SA. In 2013/14, there were 7 cruise ship arrivals to Penneshaw on Kangaroo Island with a total of 6,403 passengers and crew.
- As of October 2014, coastal infrastructure in the EMP included 3 breakwaters, 18 jetties, 3 wharves, 14 moorings, 6 harbours, 1 marina and 21 boat ramps (DEWNR 2016a, b, c, d, DEWNR unpublished data).
- 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.

5.6 Aquaculture



The EMP supports an aquaculture industry based mainly on intertidal Pacific oysters (DENR 2010, Econsearch 2015a).

Baseline information on aquaculture relevant to the EMP includes:

- Primary Industries and Regions South Australia (PIRSA) Aquaculture provide a spatial public register of aquaculture leases and licences in South Australia that can be queried from

an online mapping system or exported as a GIS layer (PIRSA 2010). Within the EMP there are 6 intertidal oyster leases, and 2 subtidal mollusc leases. The majority of the oyster leases are in Nepean Bay on Kangaroo Island.

- Econsearch Pty Ltd have estimated the regional and state economic impact of aquaculture activity in South Australia in most years between 1997 and 2014. 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 2015a). The economic benefits associated with aquaculture in the Kangaroo Island region in 2013/14 include (EconSearch 2015a):
  - Direct output (business turnover) of $4.2 million with associated downstream activities of $0.3 million and flow-on output in other sectors of the regional economy of $3.4 million
  - Contribution to gross regional product (total direct and indirect economic contribution) of about $2.7 million
  - Direct employment of 27 full-time equivalent persons plus 15 from flow-on business activity
  - Personal income of $0.8 million from aquaculture and downstream activities and an additional $0.8 million of household income in other local businesses.

  A longer timeseries is available for a central region comprising Kangaroo Island, Yorke Peninsula and the Adelaide Hills (Figure 32).

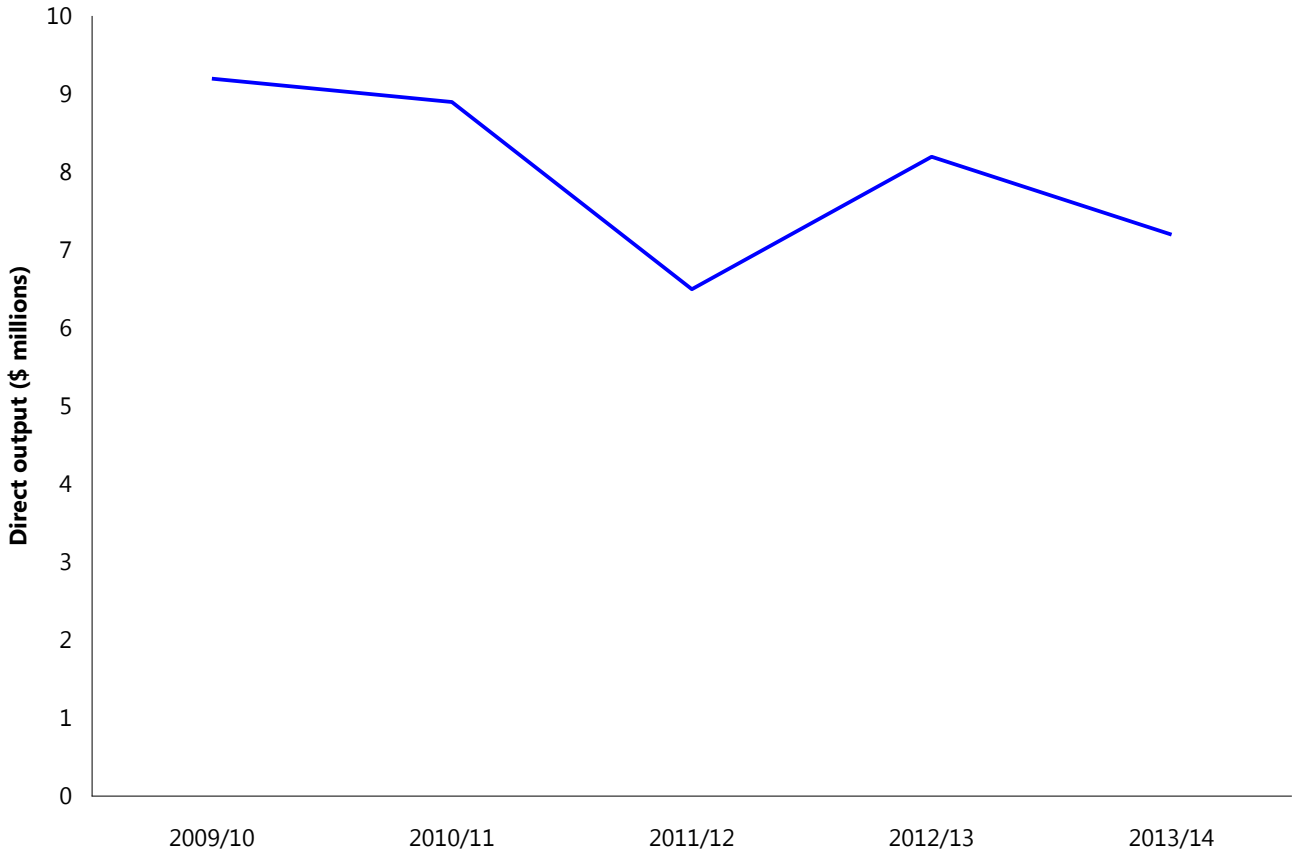


Figure 32. Direct output (business turnover) from aquaculture on Kangaroo Island, Yorke Peninsula and in the Adelaide Hills. Itemised data from 2012/13 and 2013/14 show that Kangaroo Island provided about 65 per cent of the direct output from this region. Source: Econsearch (2014a).

5.7 Recreational fishing

Recreational fishing has an important socio-economic value across South Australia including in the EMP. Recreational fishing surveys indicate that 16 and 18 percent of South Australians (aged 5 and older) 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 in the EMP include King George whiting, garfish, snapper, Australian herring, Australian salmon, and southern calamary. For these species, the statewide recreational catch is between 23 and 58 per cent of the total catch (i.e. recreational and commercial, Giri and Hall 2015).

Baseline information on recreational fishing relevant to the EMP 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 the Gulf St Vincent and Kangaroo Island areas by South Australian resident recreational fishers was about 662,000 in 2000/01, 445,000 in 2007/08 and 273,000 in 2013/14. The estimated number of days fished in the South East area (see Appendix C) by South Australian resident recreational fishers was about 172,000 in 2000/01, 78,000 in 2007/08 and 58,000 in 2013/14.
- Between 2000/01 and 2007/08, the estimated number of days fished by South Australian resident recreational fishers in recreational fishing regions overlapping the EMP (see Appendix C) decreased by 31 per cent from about 293,900 days in 2000/01 to 203,900 days in 2007/08 (Jones 2009).
- Between 2000/01 and 2007/08, the estimated number of South Australian resident recreational fishers in recreational fishing regions overlapping the EMP decreased by about 32 per cent from about 106,900 in 2000/01 to 72,300 in 2007/08 (Jones 2009).
- 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). Between 46 and 69 per cent of the respondents fished recreationally at least once each year, and between 15 and 34 per cent fished monthly (Figure 33). Recreational fishing activity declined slightly after 2007 but has since been relatively stable (Figure 33). In 2015, 22 and 46 per cent of Fleurieu Peninsula respondents (from Cape Jervis, Victor Harbor, Goolwa, Port Elliot, Middleton, and Meningie) fished at least once each month or each year, respectively, and 45 and 65 per cent of Kangaroo Island respondents fished at least once each month or each year, respectively.

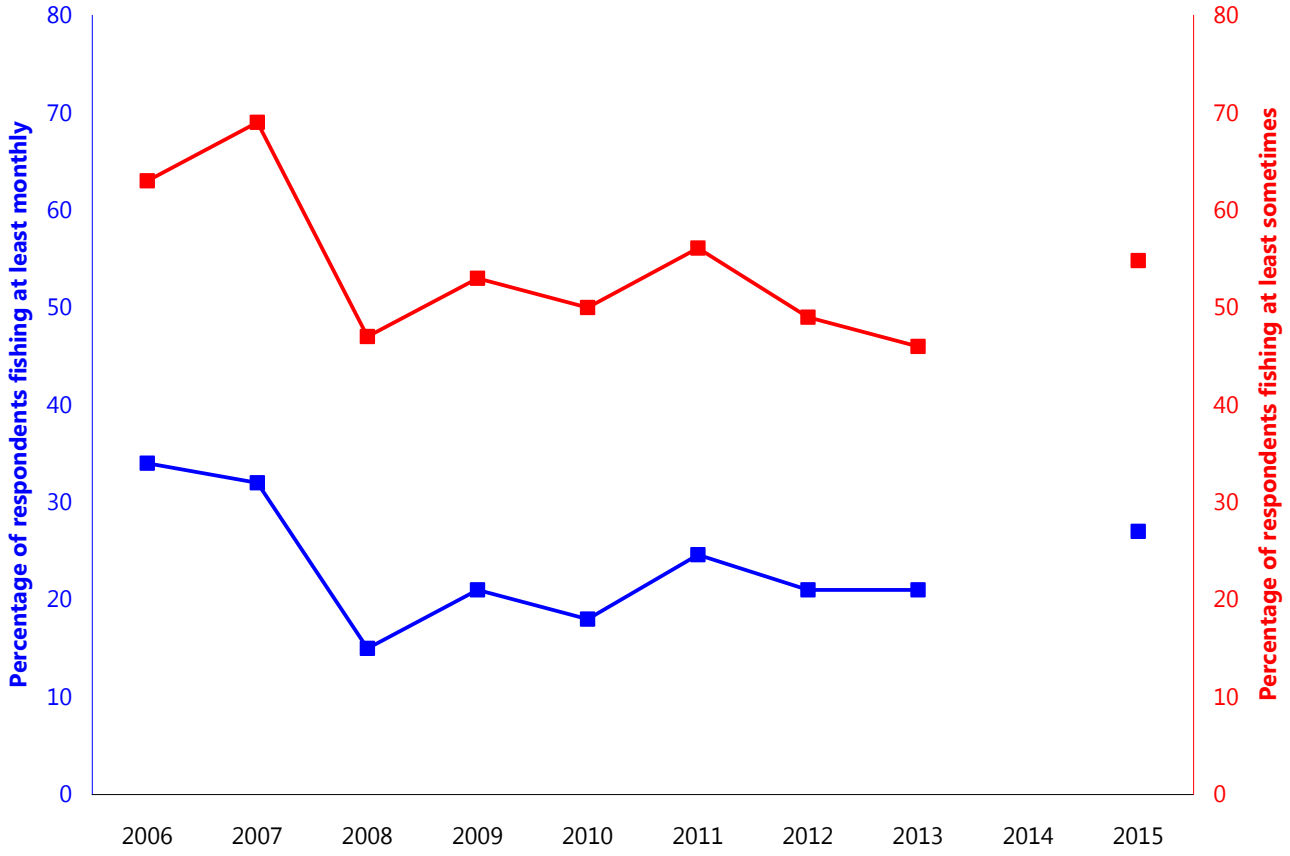


Figure 33. Percentage of statewide phone survey respondents who participate in recreational fishing. No data were available for 2014. Source: Square Holes (2015).

5.8 Commercial fishing

There are a number of commercial fisheries operating in the EMP. 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 2013/14 (EconSearch 2015b, c, d, e, f, g). A range of economic information is available, including gross value of production, costs, profit, return on investment, economic impact and exports (EconSearch 2015b, c, d, e, f, g).

This section presents selected information to demonstrate the value and extent of commercial fisheries that operate in or near the marine park, 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 park, and the current status of each of the fisheries.

5.8.1 Rock Lobster Fishery

The EMP lies within the Northern Zone of the South Australian Rock Lobster Fishery, which extends from the WA border to the Murray Mouth. 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. 2015).

Baseline information on the Rock Lobster Fishery relevant to the EMP 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 34).
- 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, 2015). Marine fishing areas 42, 43, 44, 45 and 46 overlap the EMP (see Appendix C). An average of 1.3 per cent these areas between 1993 and 2011 (Ward et al. 2012).

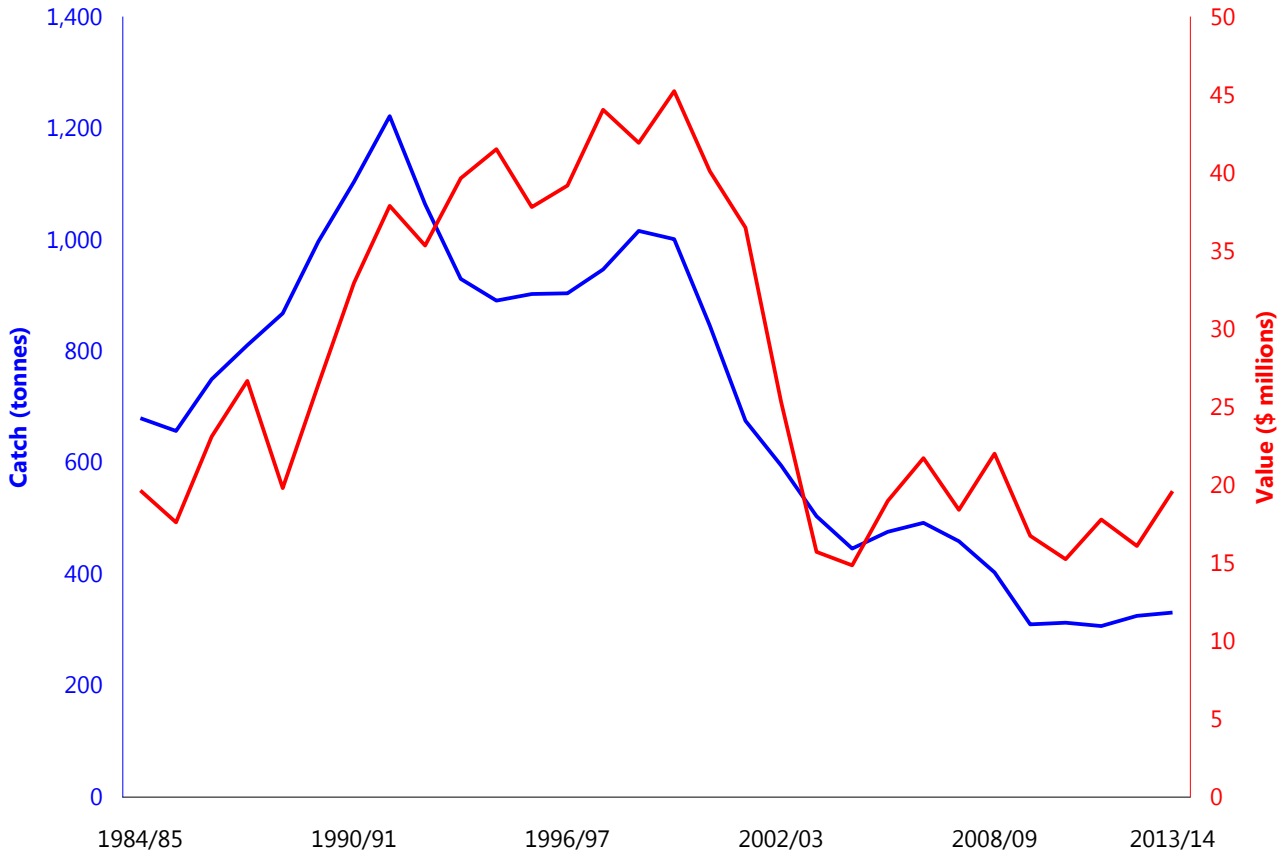


Figure 34. Catch and value of catch for the Northern Zone Rock Lobster Fishery. Value of catch has been adjusted to real terms (2013/14 dollars) using the consumer price index for Adelaide. Source: EconSearch (2015b).

5.8.2 Abalone Fishery

The EMP lies within the Central Zone of the South Australian Abalone Fishery, which extends from the Cowell to west of the Murray Mouth, and allows removal of greenlip and blacklip abalone. Fishing is conducted on subtidal reef habitat. 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).

Baseline information on the abalone fishery relevant to the EMP includes:

- The annual value of the Central Zone Abalone Fishery catch rose from about $5.4 million in 1990/91 to a peak of about $12.5 million in 2000/01, and declined to $5.6 million in 2013/14 (EconSearch 2015c, Figure 35).

- 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 (Mayfield et al. 2014, Mayfield and Ferguson 2015). The Fleurieu, North Kangaroo Island and South Kangaroo Island spatial assessment units overlap the EMP (see Appendix C). More than 12 per cent of the catch in the Central Zone Abalone Fishery between 2004 and 2013 was taken from the North and South Kangaroo Island spatial assessment units (Mayfield et al. 2014).

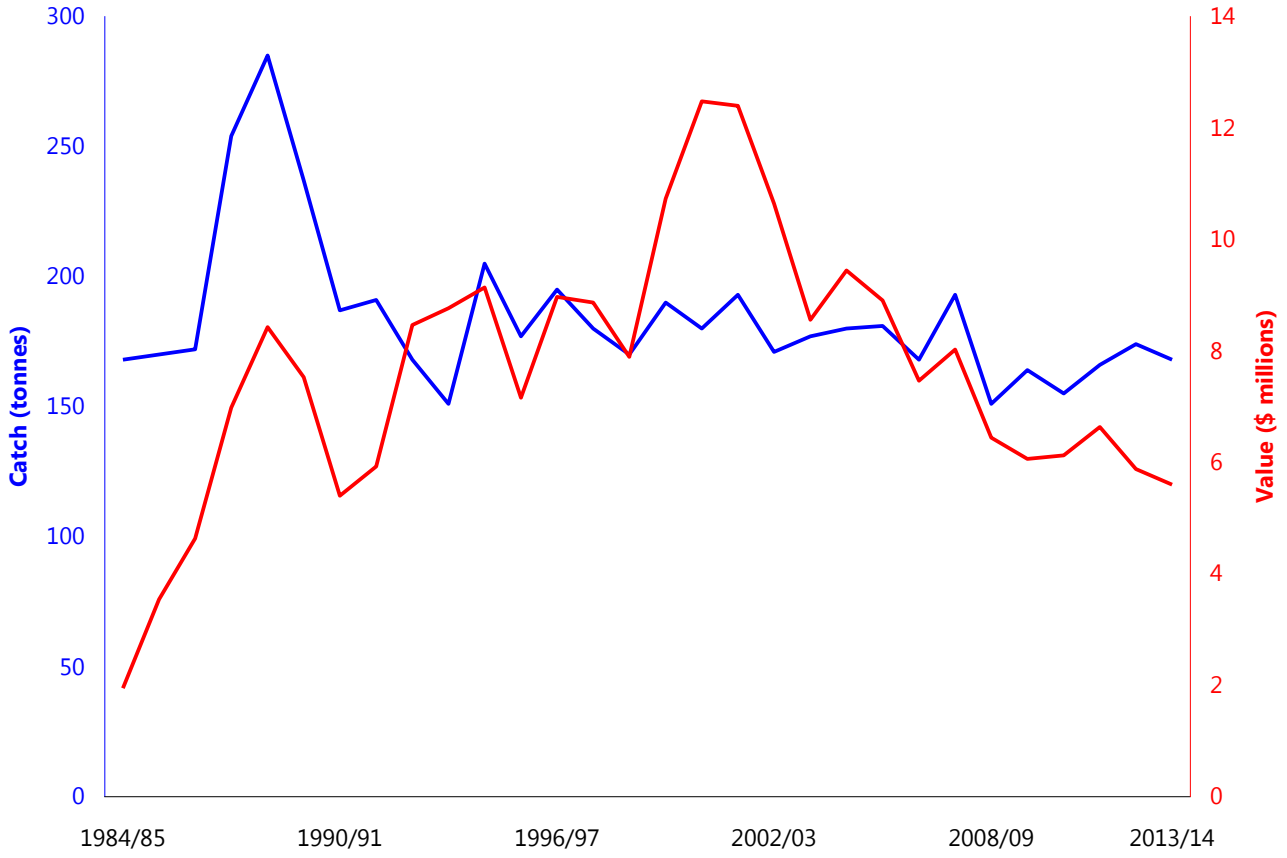


Figure 35. Catch and value of catch for the Central Zone Abalone Fishery. Value of catch has been adjusted to real terms (2013/14 dollars) using the consumer price index for Adelaide. Source: EconSearch (2015c), Knight and Tsolos (2012).

5.8.3 Prawn Fishery

The EMP overlaps region 4 (Port Noarlunga to Rapid Bay, see Appendix C) of the Gulf St Vincent Prawn Fishery, which targets western king prawn using an otter trawl. Fishing is conducted on subtidal sand habitat. There are 10 licences in the Gulf St Vincent Prawn Fishery (Beckmann et al. 2015). The Gulf St Vincent Prawn Fishery closed in December 2012 (PIRSA 2012) but reopened in November 2014.

Baseline information on the prawn fishery relevant to the EMP includes:

- The annual value of the Gulf St Vincent Prawn Fishery ranged between $2 and $11 million between 1984 and 2011 (Knight and Tsolos 2012, Figure 36).

- 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 (Dixon et al. 2012, Beckmann et al. 2015). The total annual catch for the Gulf St Vincent Prawn Fishery in 2010/11 was 178 tonnes (Dixon et al. 2012).

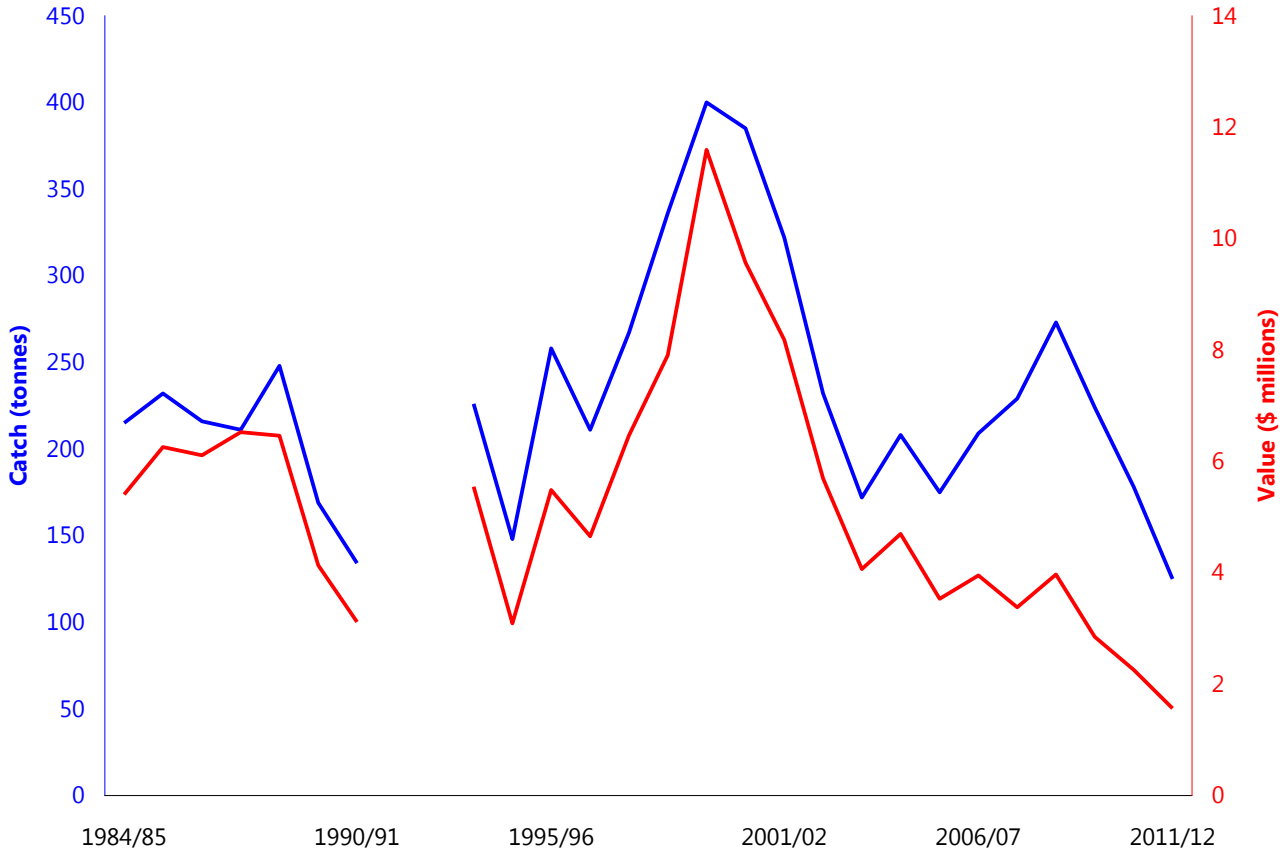


Figure 36. Catch and value of catch for the Gulf St Vincent Prawn Fishery. Value of catch has been adjusted to real terms (2013/14 dollars) using the consumer price index for Adelaide. Note that the fishery was closed in 1992/93 and 2006/07. Source: Knight and Tsolos (2012).

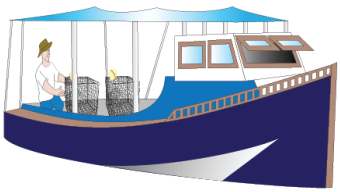
5.8.4 Blue Crab Fishery

The Blue Crab Fishery does not operate in the EMP.

5.8.5 Sardine Fishery

The Sardine Fishery does not operate in the EMP.

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, with the EMP being one of the most productive areas for southern calamary in South Australia (Fowler et al. 2014b). Two licences have quota for pipi (Ferguson 2013).

Baseline information on the Marine Scalefish Fishery relevant to the EMP 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 2015d).
- The value of the Gulf St Vincent/Kangaroo Island region (see Appendix C) of the Marine Scalefish Fishery between 2003/04 and 2013/14 ranged between $6.7 and $10.6 million and was $10.6 million in 2013/14 (EconSearch 2015d, Figure 37).
- The total annual Marine Scalefish Fishery catch of the Gulf St Vincent/Kangaroo Island region was 670 tonnes in 2003/04 and 376 tonnes in 2013/14 (EconSearch 2015d, Figure 37).
- 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, 2016, Fowler et al. 2012, 2013a, b, 2014a, b). Catches of southern calamary in marine fishing area 44 were between 51 and 75 tonnes in 2012/13 and between 26 and 50 tonnes in 2013/14 (Fowler et al. 2013b, 2014b).

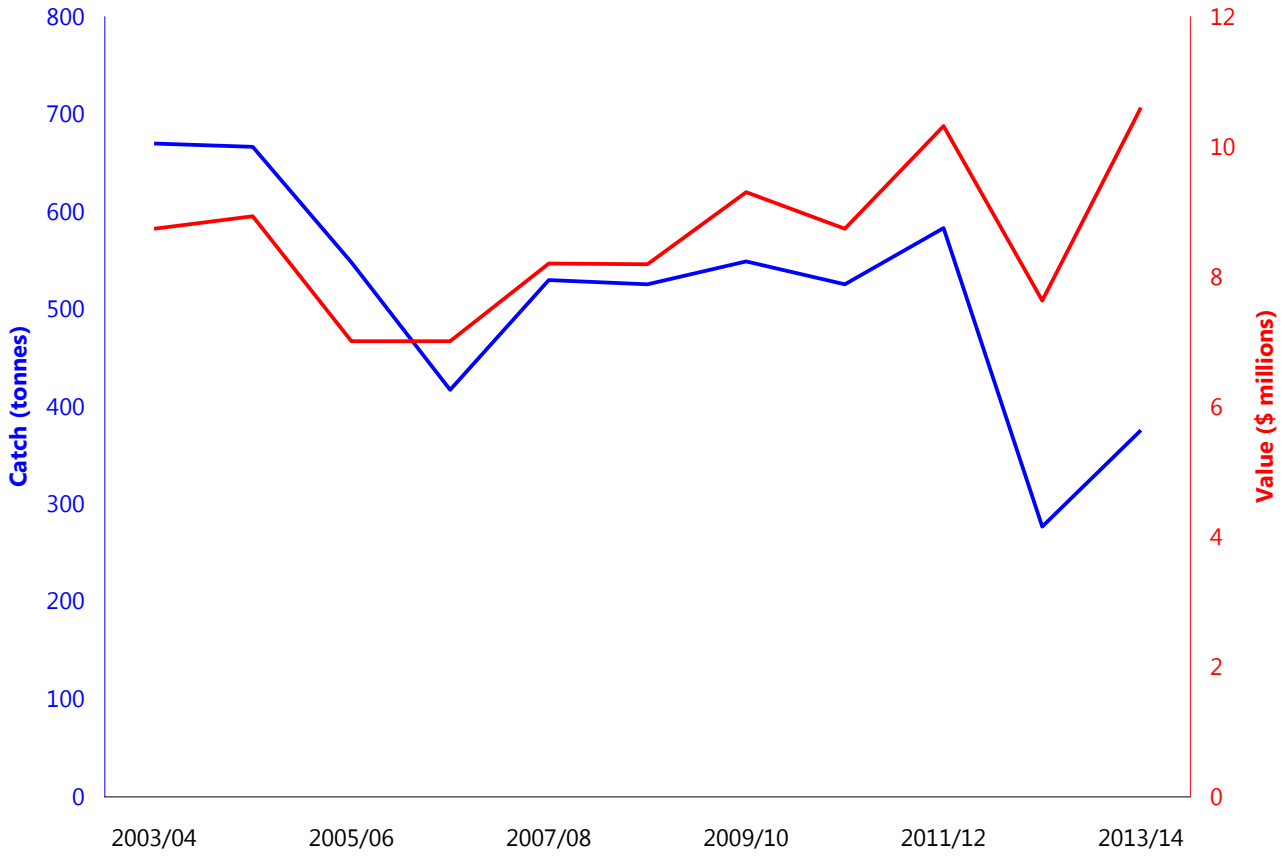
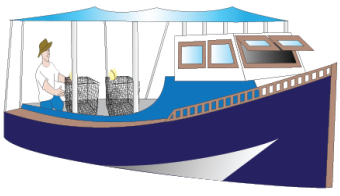


Figure 37. Catch and value of catch for the Gulf St Vincent/Kangaroo Island region of the Marine Scalefish Fishery. Value of catch has been adjusted to real terms (2013/14 dollars) using the consumer price index for Adelaide. Source: EconSearch (2015d) and earlier reports.

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. Nine operators used Cape Jervis as their port of departure, 5 operators used Wirrina, 3 operators used American River, 1 operator used Penneshaw and 1 operator used Kingscote (Tsolos 2013).

Baseline information on the Charter Boat Fishery relevant to the EMP 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 38).
- 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). The catch in the Gulf St Vincent/Kangaroo Island region (see Appendix C) accounted for between 54 and 61 per cent of the statewide catch between 2009/10 and 2011/12 (Tsolos 2013). During this period, the number of fish harvested varied between 78,000 and 90,000, and the proportion of King George whiting varied between 26 and 37 per cent (Tsolos 2013).

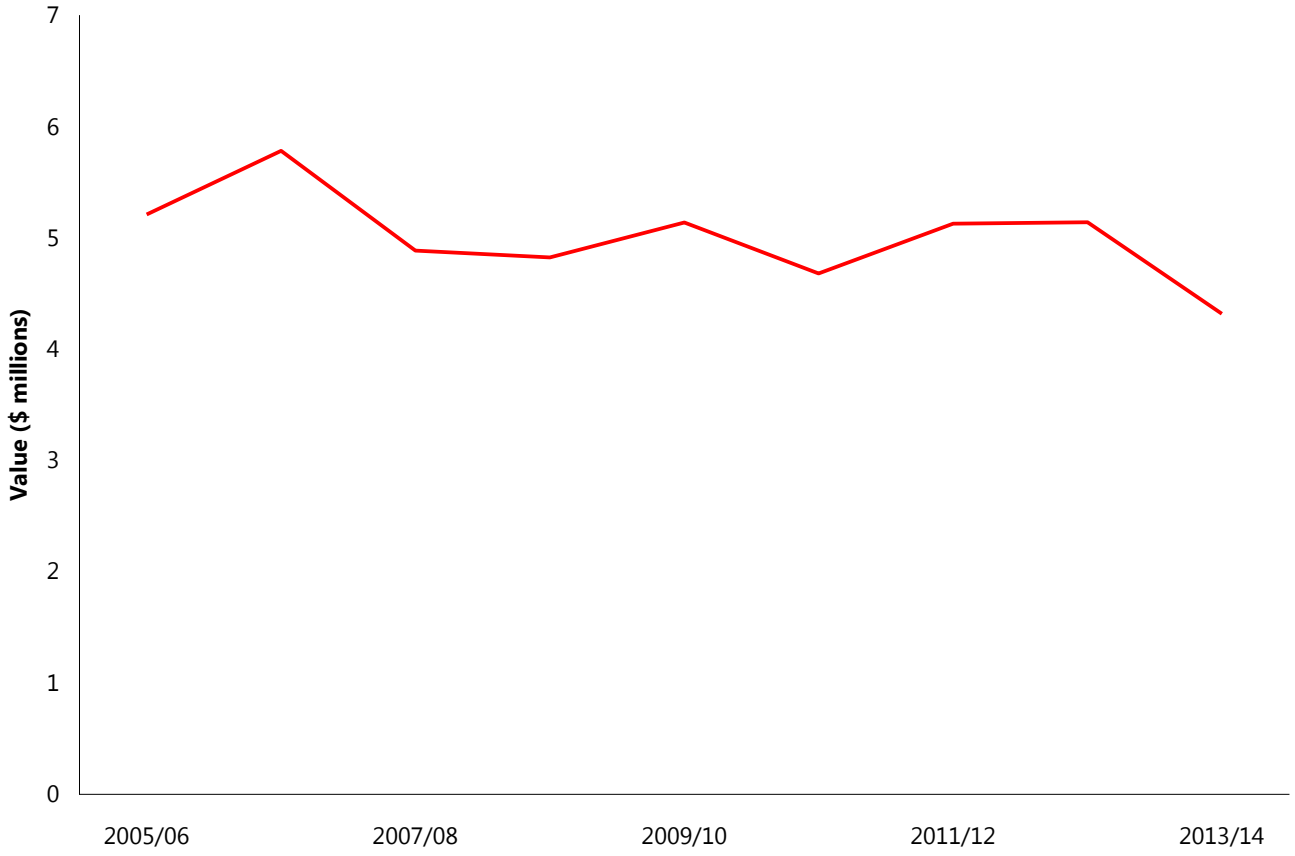


Figure 38. Total statewide revenue for the Charter Boat Fishery. Revenue has been adjusted to real terms (2013/14 dollars) using the consumer price index for Adelaide. Revenue was calculated from the total number of clients and an average price per person. Source: EconSearch (2015e).

5.8.8 Other South Australian managed fisheries

Lakes and Coorong Fishery

The Lakes and Coorong Fishery is a multi-gear fishery that overlaps the EMP in two of its three ecosystem components, namely the northern lagoon of the Coorong and the coastal waters along the Sir Richard and Younghusband Peninsulas (PIRSA 2011c). The main target species within the EMP are pipi, mulloway, yelloweye mullet, greenback flounder and black bream. Fishing within the EMP is conducted on subtidal or intertidal (for pipis) sand and seagrass (*Ruppia*). There are currently 36 licences (Econsearch 2015f).

Baseline information on the Lakes and Coorong Fishery relevant to the EMP includes:

- The annual value of the Lakes and Coorong Fishery was between $7 and $12 million between 1998/99 and 2013/14 (EconSearch 2015f, Figure 39).
- The total Lakes and Coorong Fishery catch peaked at about 2,400 tonnes in 2005/06 and was 1,852 tonnes in 2013/14 (EconSearch 2015f, Figure 37).
- SARDI collates monthly fishery logbook data and provides summaries of catch, effort and catch rates for the most important species every few years in fishery assessment reports (Earl and Ward 2014).

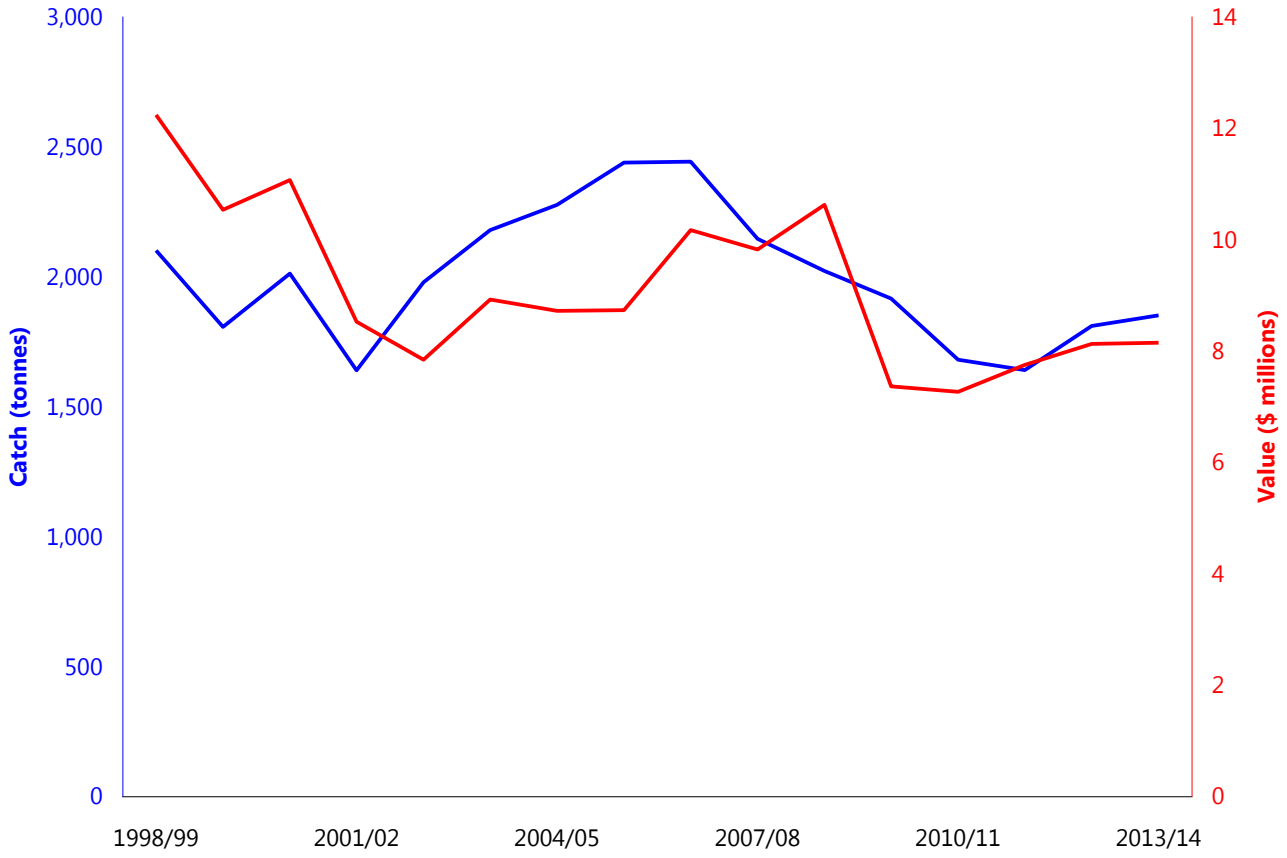


Figure 39. Catch and value of catch for the Lakes and Coorong Fishery. Value of catch has been adjusted to real terms (2013/14 dollars) using the consumer price index for Adelaide. Source: EconSearch (2015f).

5.8.9 Commonwealth gillnet 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, including the EMP. 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 32 tonnes of gummy shark caught off northern Kangaroo Island (from near Cape Borda to Cape Willoughby) 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 relevant to the EMP 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 (Figure 40, Georgeson et al. 2014).

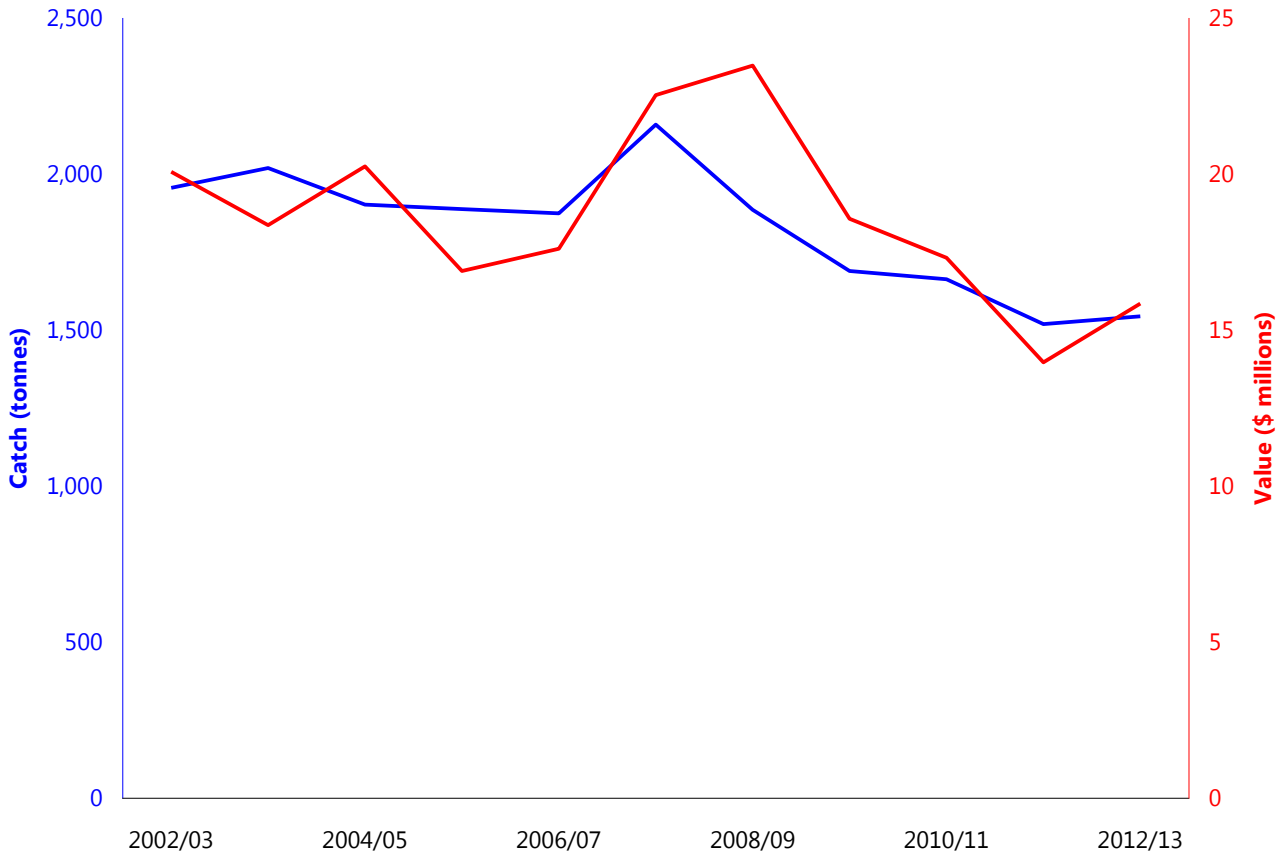


Figure 40. Catch and value of catch for the Shark Gillnet and Shark Hook sectors. Value of catch has been adjusted to real terms (2012/13 dollars). Source: Georgeson et al. 2014.

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 41).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 42).

- EconSearch (2015d, 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).

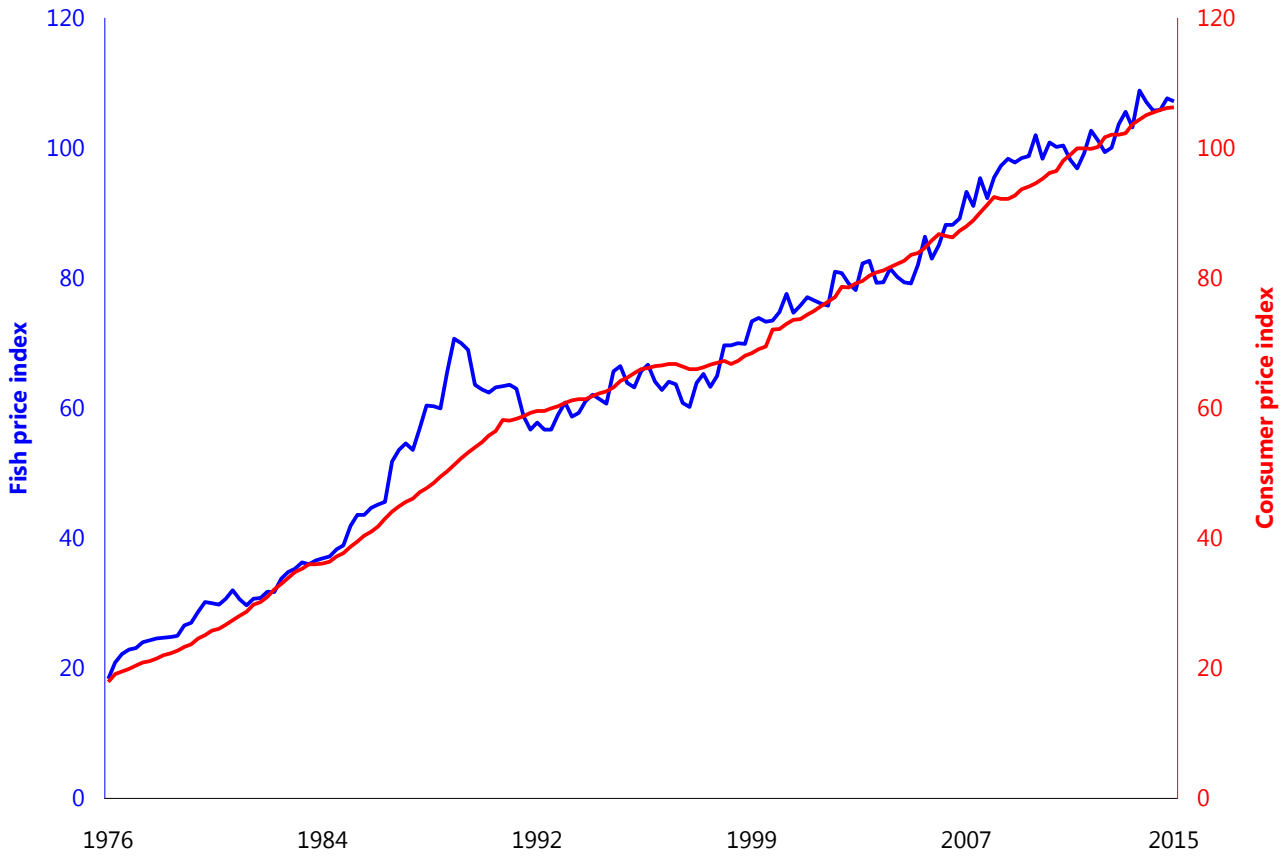


Figure 41. Fish and other seafood price index for Adelaide, compared with Consumer Price Index. Source: ABS (2015f).

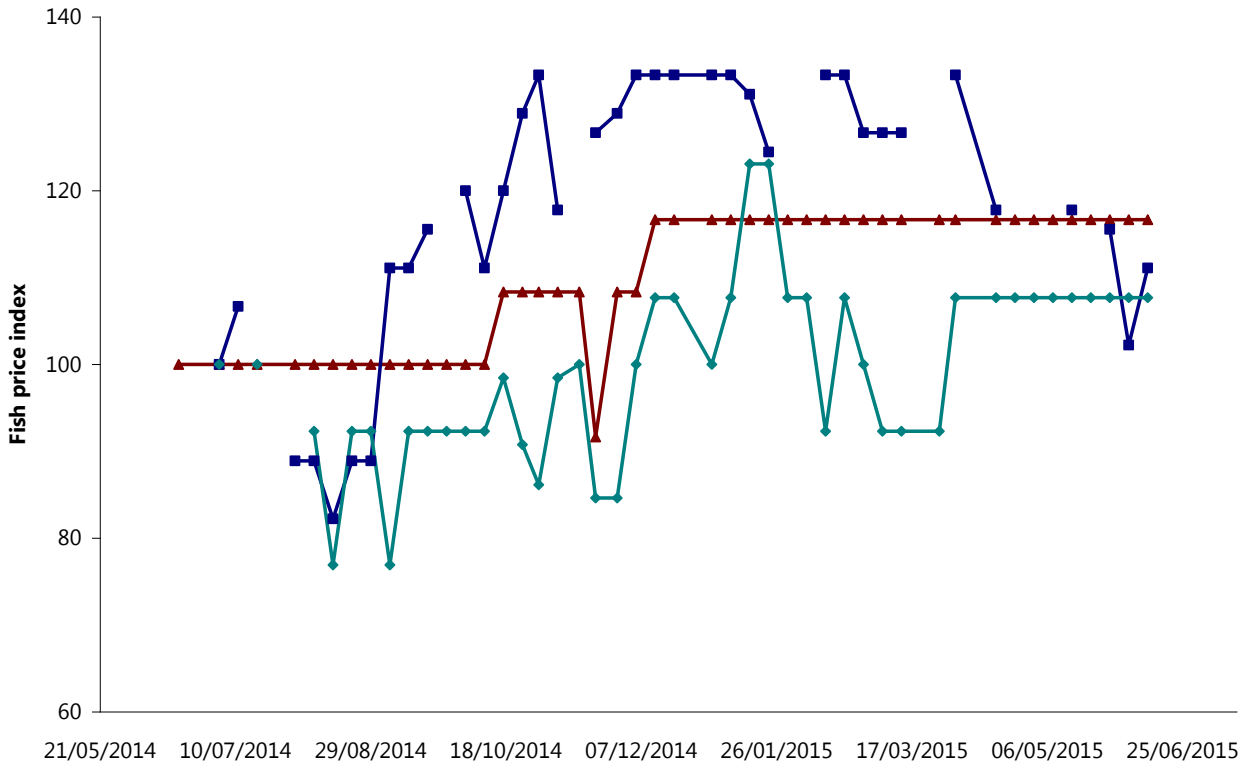


Figure 42. Changes in King George whiting prices at 3 Adelaide stores, with a different colour for each, between June 2014 and June 2015. Price is indexed to a value of 100 on 19/06/2014. Source: DEWNR unpublished data.

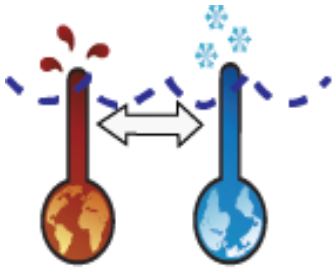
6 Physical drivers

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 of the EMP, such as oyster 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 2015), which is a collaboration of 8 institutions, including SARDI, led by the University of Tasmania. 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 within the EMP range from 11 °C in winter to 26 °C in summer (DENR 2010), and in Gulf St Vincent and the bays of Kangaroo Island follows a seasonal pattern related to air temperature (Bureau of Meteorology 2015b, Figure 43). Sea surface temperatures may be influenced by cooler water conveyed from south-eastern Australia by the Flinders Current (Middleton and Bye 2007).



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 the EMP 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).
- 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 (Beckmann et al. 2014, Carrick 2008).

Baseline information on sea surface temperature relevant to the EMP 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 Integrated Marine Observing System, the Australian Bureau of Meteorology produce 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 Port Stanvac (Bureau of Meteorology 2015b, Figure 43).
- Temperature 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)

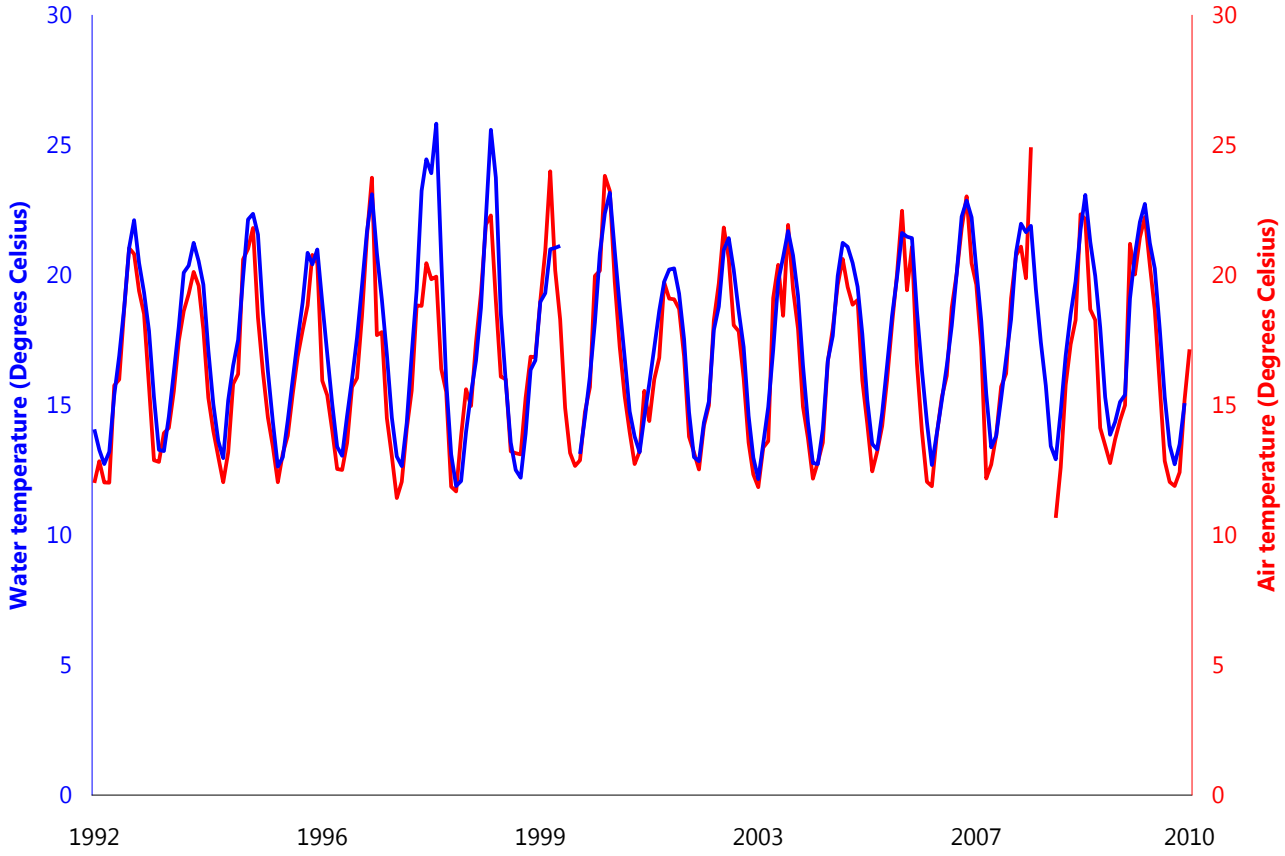
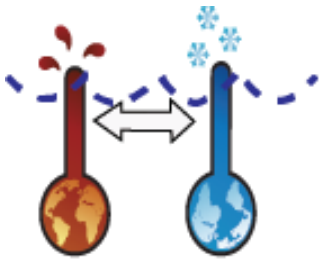


Figure 43. Air and water temperature at the Port Stanvac station of the Australian Baseline Sea Level Monitoring Project. Source: Bureau of Meteorology (2015b).

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 (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 the EMP 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 Port Stanvac (Bureau of Meteorology 2015b). Parameters measured include air temperature (Figure 43).

6.3 Salinity extremes

As the park lies towards or beyond the mouth of Gulf St Vincent, water is oceanic in nature and salinity would generally vary little (Millero et al. 2008), Towards the north of the park, salinity varies seasonally up to 2 parts per thousand higher than oceanic water (SA Water 2008) but this change in salinity is not considered to be an important physical influence within the EMP.

Seasonal salinities at a point just north of the EMP were measured at between 36.43 and 36.52 (Harris and O'Brien 1998, Bye and Kämpf 2008). As such, change in salinity is not considered to be an important physical influence on the ocean components of the EMP.

There are a number of creeks and rivers around Fleurieu Peninsula and Kangaroo Island (Figure 4) that periodically discharge freshwater to the sea. There would be localised decreases in salinity when this occurs but data are lacking. The major discharge in the EMP is from the River Murray.

6.4 Upwellings

Upwellings are not considered to be a key feature of the EMP but could potentially have a peripheral influence in the southern margins of the EMP.

6.5 Waves

The energy of breaking waves varies throughout the EMP. High energy waves shape the exposed cliffs, dunes, beaches and headlands from Cape Jervis to the Murray Mouth (DENR 2010, Edyvane 1999b). 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 wave energy will be required to interpret changes in ecological and socio-economic indicators. For example, storms and inter-annual variations in wave energy within the EMP 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 the EMP includes:

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

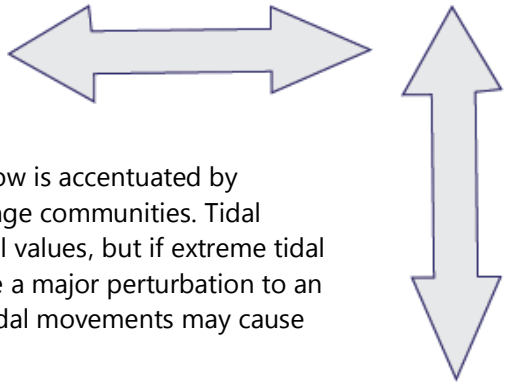
6.6 Oceanic currents

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 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 may be required to interpret changes in ecological and socio-economic indicators. For example, cooler water associated with the Flinders Current could increase catch rates of rock lobster (Feenstra et al. 2014), while the two boundary currents likely influence larval/propagule dispersal and genetic connectivity across southern Australia (Coleman et al. 2013).

No baseline information or indicators have currently been identified for the two boundary currents in the EMP.

6.7 Tides and tidal currents



The EMP is classified as having a microtidal to mesotidal tidal range (1.2 metres or less near the Coorong and between 1.2 and 3.3 metres in Gulf St Vincent; 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 currents in Backstairs Passage support deep sea sponge communities. 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 the EMP includes:

- The Australian Baseline Sea Level Monitoring Project records sea level each hour at an array of stations, including Port Stanvac (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 plan. 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, 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 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.

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 2015g).

Baseline information on interest rates includes:

- The Reserve Bank of Australia (2016a) provides a monthly cash rate target (Figure 44). 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 also provides data on the lending rate for small business (EconSearch 2015g).

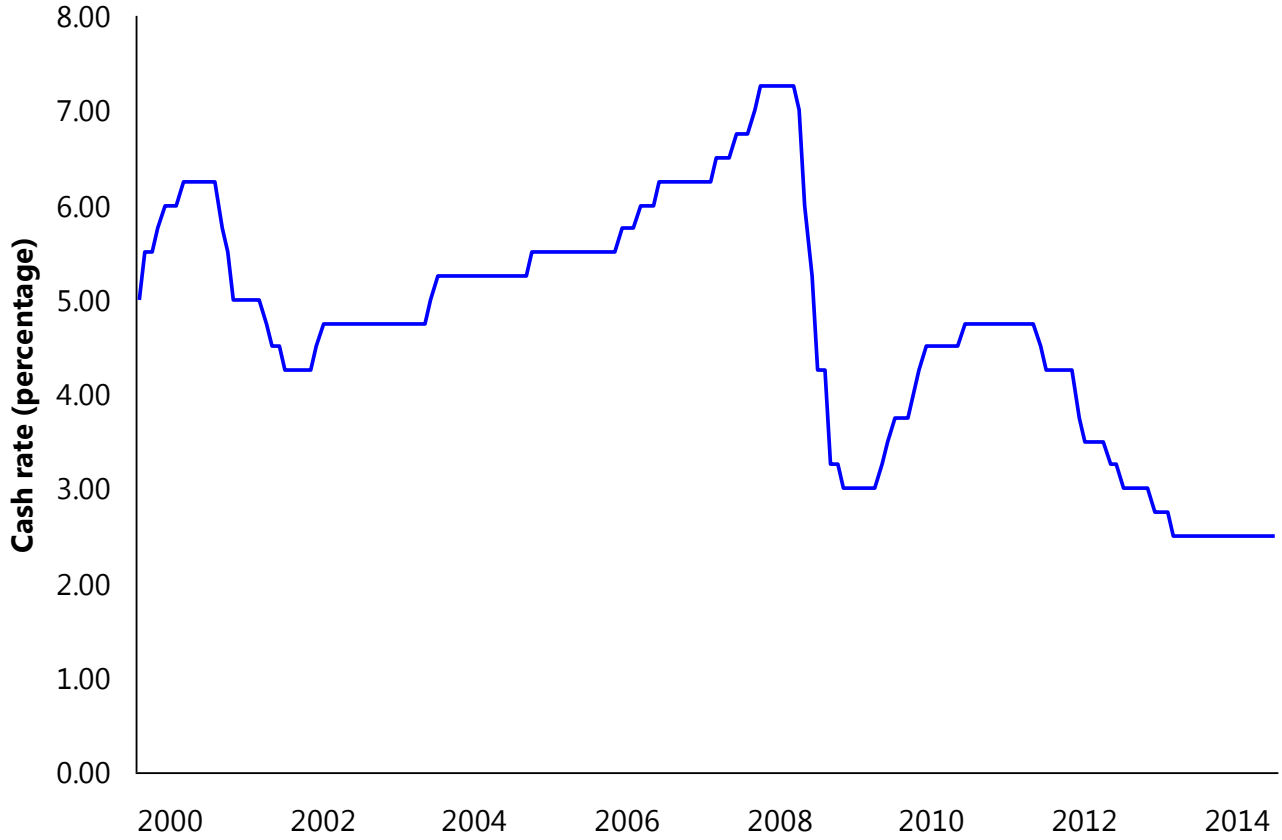


Figure 44. The Australian Target Cash Rate. Source: Reserve Bank of Australia (2016a).

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 140 in 2008 and was 85 at the end of 2014 (Figure 45).

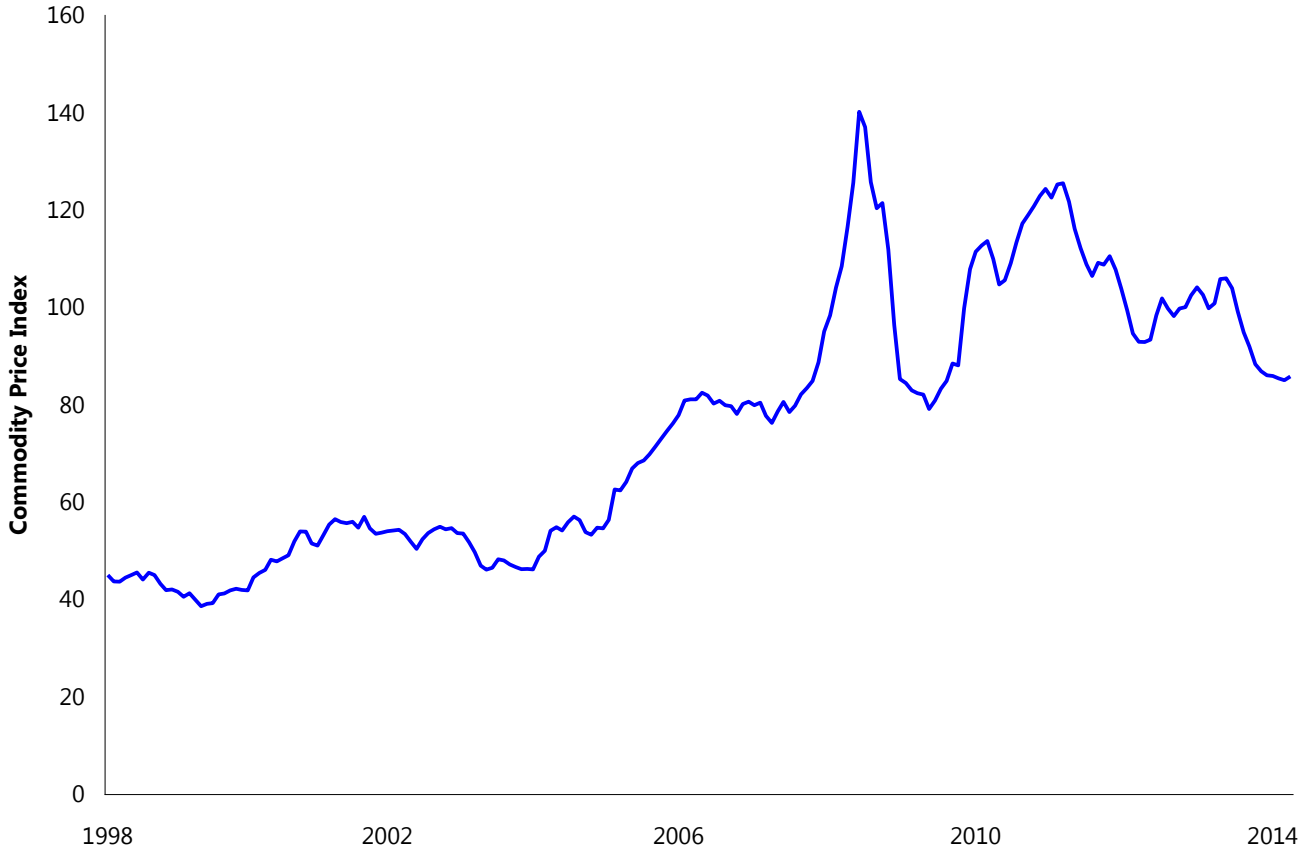


Figure 45. Monthly Commodity Price Index. Source: Reserve Bank of Australia (2016b).

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 2015g).

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 2015h).
- 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 46), 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.

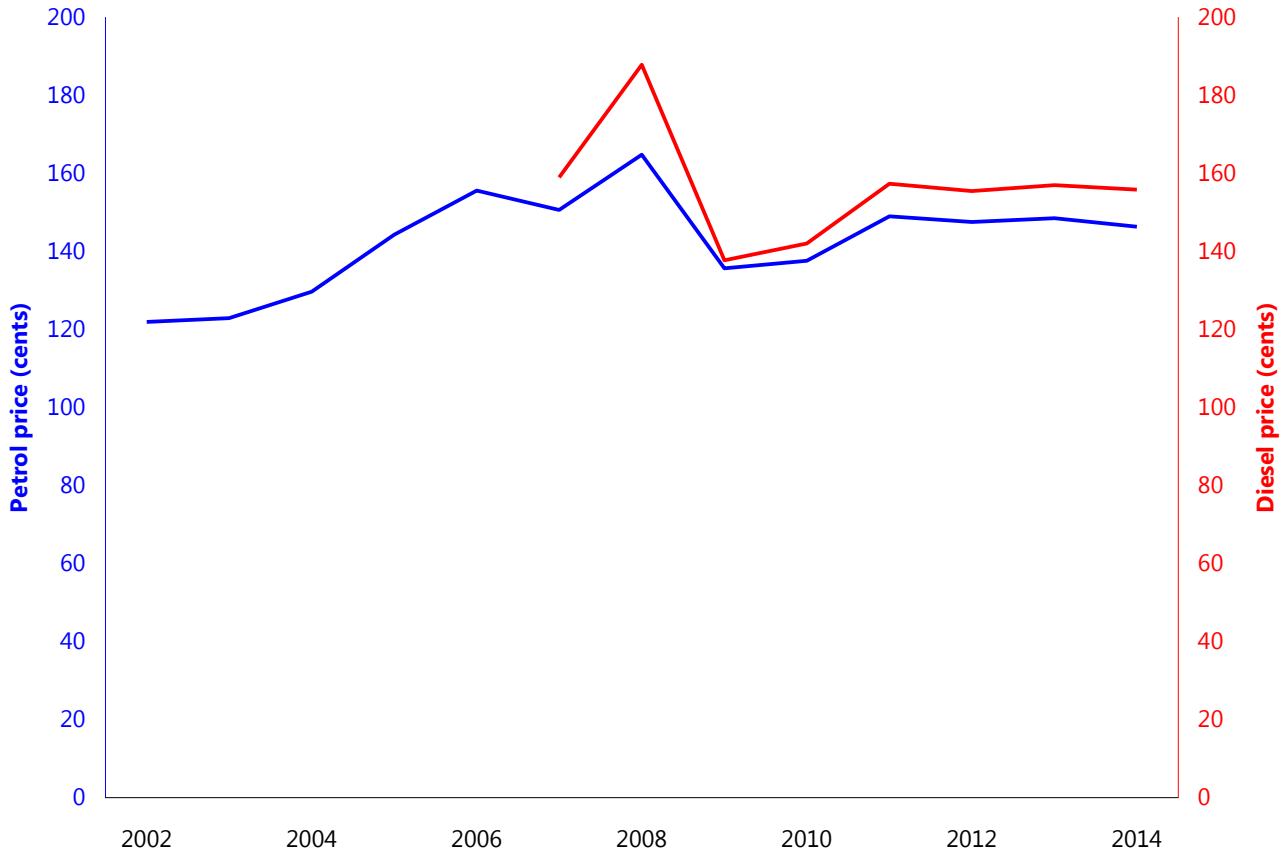


Figure 46. Statewide average retail price (including GST) for diesel and unleaded petrol. Source: Australian Institute of Petroleum (2015).

7.4 Labour force

Wages are a significant cost for most marine-based businesses, including commercial fisheries (EconSearch 2015g). 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 47). The wage price index increased from about 70 in 1998/99 to about 120 in 2013/14 (EconSearch 2015g).
- Employment and unemployment data (see Section 5.1.2)

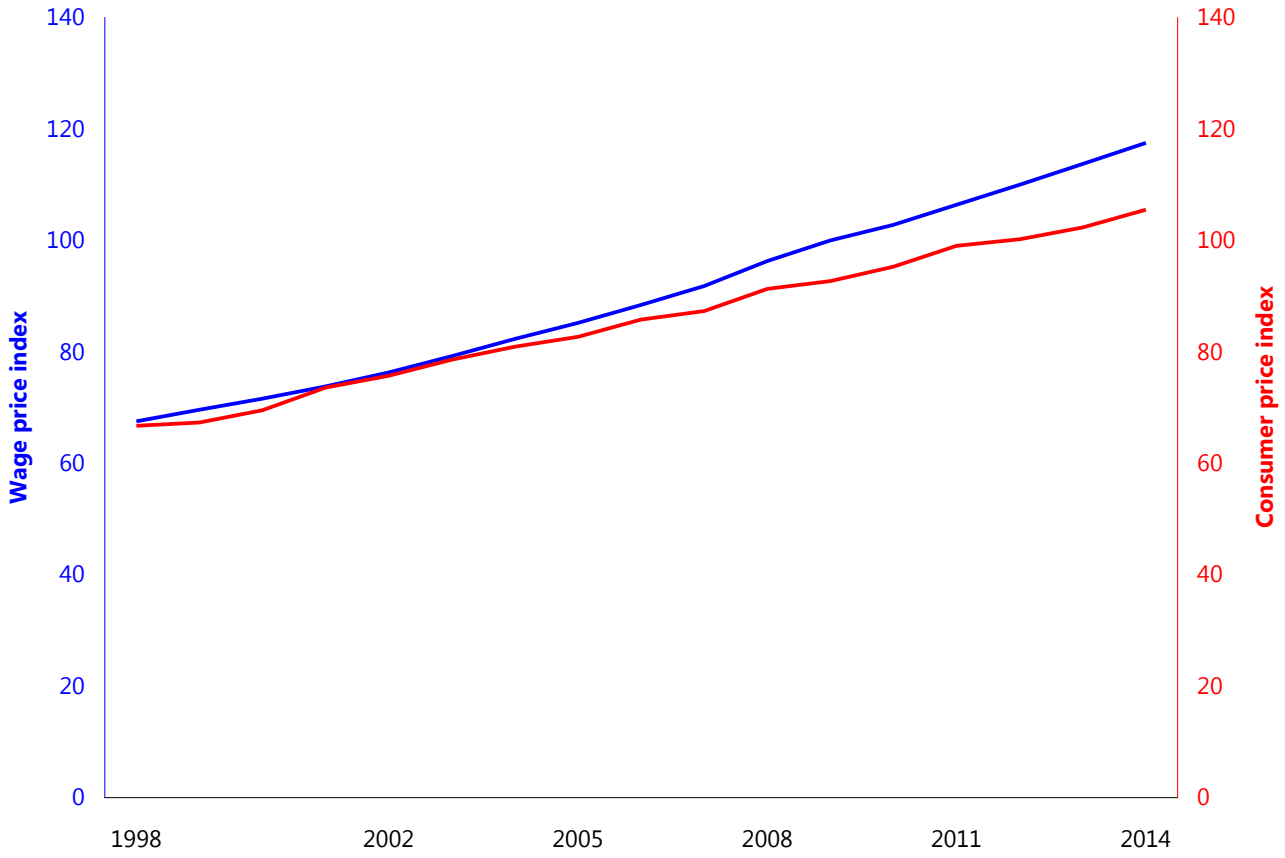


Figure 47. Wage Price Index (June quarter) compared with Consumer Price Index. Source: ABS (2015f, h).

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 2015g). 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 2015g).

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 aried between 0.6 and 1.1, and was about 0.8 in April 2015 (Reserve Bank of Australia 2015, Figure 48). 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 48, Reserve Bank of Australia 2015).

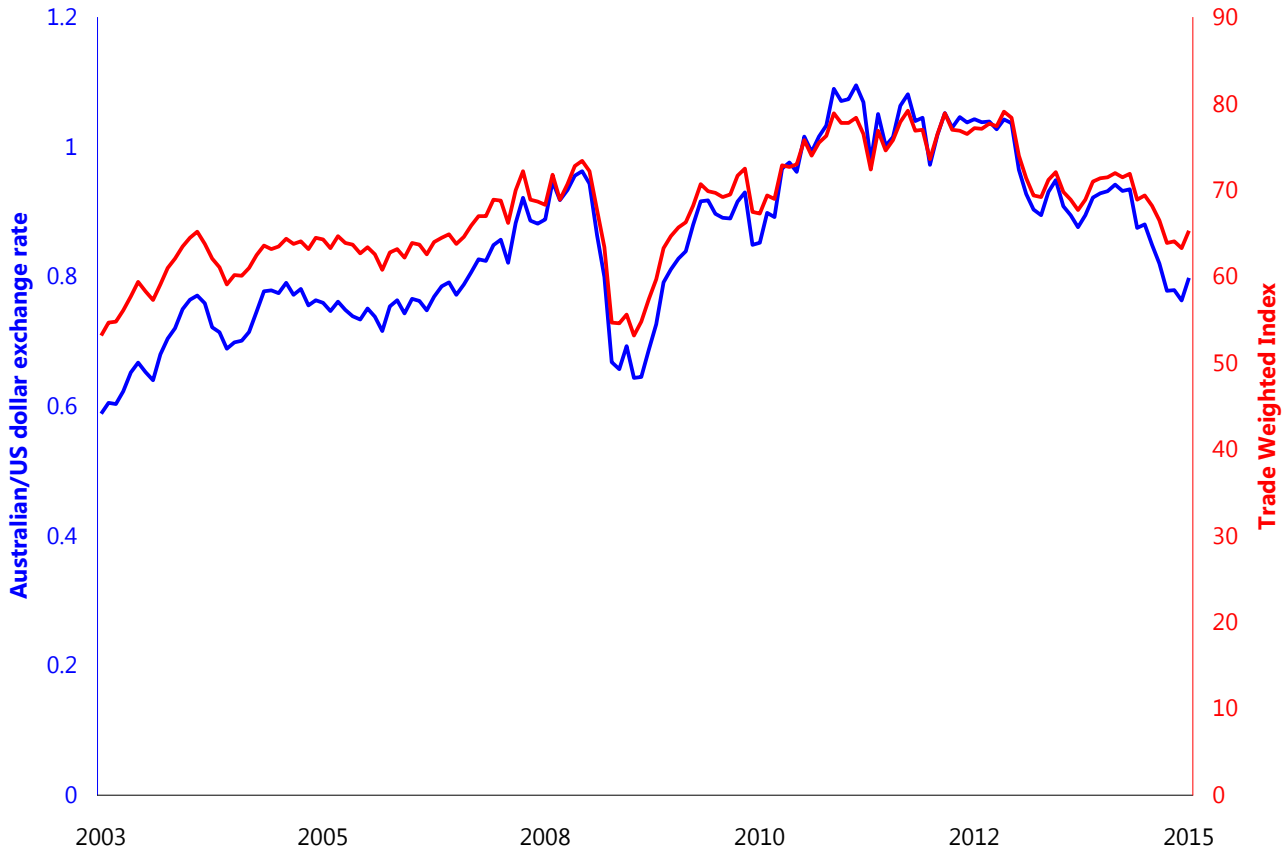


Figure 48. Australian dollar to US dollar exchange rate and Trade-weighted Index. Source: Reserve Bank of Australia (2015).

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 relevant to the EMP includes:

- Tourism Research Australia provides regional profiles of international and domestic tourism (Tourism Research Australia 2015). Total number of visitors to the Fleurieu and Kangaroo Island tourism regions (see Appendix C) in 2013/14 were about 3.1 million and about 117,000, respectively. Data are available for previous years, but are not compatible with 2013/14 due to a change in methods (Tourism Research Australia 2015).
- 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 to the EMP.

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 the EMP 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 relevant to the EMP include:

- The introduction in 2012 of possession limits for recreational fishers (PIRSA 2011d), 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 EMP.

8 Pressures

To enable predictions of change due to the marine park management plan (Section 9), an understanding of pressures on the ecological values of the EMP 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. This section summarises human-mediated pressures on the ecological values of the marine park 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 EMP 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, Caton et al. 2009). Because sections of the EMP lie adjacent to the southern suburbs of Adelaide and regional centres with relatively high populations such as Victor Harbor and Kingscote, seagrass loss, reef degradation or 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). Potential water quality issues have been identified with discharges from the Hindmarsh and Inman River estuaries into Encounter Bay, discharges from the Yankalilla, Bungala and Carrickalinga catchments into Yankalilla Bay, discharge from the Onkaparinga River into Southport Beach and wastewater outfall from Christies Beach, and high nutrient runoff from the Cygnet River into Western Cove (Nelson et al. 2013, Sinclair Knight Merz, 2010a, b, Bryars 2014). Septic overflow may influence American River, Island Beach and Penneshaw (Nelson et al. 2013). Stormwater runoff from Kingscote may enter Nepean Bay, and desalination waste is discharged at Penneshaw (Nelson et al. 2013).

Baseline information on coastal pollution relevant to the EMP includes:

- The *Australian Water Resources 2005 Report* provides estimates of freshwater runoff for drainage divisions in Australia. There is very little freshwater runoff (<1,000 Gigalitres) in the Gulf St Vincent Bioregion and moderate amounts (<10,000 to 50,000 Gigalitres) in the Coorong Bioregion (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). The Onkaparinga Local Government Area population is the highest of Local Government Areas within the EMP.
- PIRSA Aquaculture collates information on aquaculture zoning, and the number and type of active lease types. There is no finfish aquaculture or land-based aquaculture with discharge to the sea in the EMP.
- The Environment Protection Authority surveyed water quality at 7 sites on the western Fleurieu coast (2 inside the Port Noarlunga Reef SZ) and 10 in Nepean Bay (1 inside the Bay of Shoals SZ) during autumn and spring of 2010 and 2011 (Nelson et al. 2013).
- Several published studies indicate that water quality parameters such as turbidity (sediment loads) and chlorophyll concentrations of near-shore waters can be monitored using remotely sensed data from Landsat and/or the NASA MODIS-Aqua sensor (Ritchie et al. 2003).
- Marine debris can cause injury and fatality to vertebrate marine life through ingestion of, or entanglement in, harmful marine debris and was listed as a key threatening process under the *Environment Protection and Biodiversity Conservation Act 1999*. Surveys of marine debris were undertaken at 38 beaches in Gulf St Vincent, including 8 sites within the EMP. Willunga Beach had a relatively high litter abundance (Peters and Flaherty 2011).

8.2 Resource extraction

8.2.1 Fishing

Six commercial fisheries operate within the marine park, as well as recreational fishing (Section 5). The Blue Crab and Sardine Fisheries do not operate in the EMP. 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. 2014, Mayfield et al. 2014). 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 34). 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. 2015).
- The historic average annual catch of rock lobster is available for the 5 reporting areas that overlap the EMP (marine fishing areas 42, 43, 44, 45 and 46 – see Appendix C). Between 1993 and 2011 the average annual catch was about 1.4, 0.06, 5.1, 1.7 and zero tonnes, respectively (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 Zone Rock Lobster Fishery is currently classified as *sustainable* (Linnane et al. 2015).

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 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 and catch rates of greenlip abalone since 1979 varied between years and between the North Kangaroo Island, South Kangaroo Island and Fleurieu spatial assessment units (Appendix C). Between 2004 and 2014 annual catches were between 0.1 and 1.3 tonnes for North Kangaroo Island, between 1 and 6 tonnes for South Kangaroo Island, and less than 0.25 tonnes for the Fleurieu spatial assessment unit. In 2014, the annual catches were about 1.3, 3 and 0.1 tonnes for the North Kangaroo Island, South Kangaroo Island and Fleurieu spatial assessment units, respectively (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 and catch rates of blacklip abalone since 1979 varied between years and between the North Kangaroo Island, South Kangaroo Island and Fleurieu spatial assessment units (see Appendix C). Between 2004 and 2014, annual catches were inconsistent and less than 0.6 tonnes for North Kangaroo Island, between 0.5 and 3 tonnes in South Kangaroo Island, and inconsistent and less than 1 tonne for the Fleurieu spatial assessment unit. In 2014, the annual catches were about 0.1 tonnes for North Kangaroo Island, about 1 tonne for South Kangaroo Island and about 0.5 tonnes for the Fleurieu spatial assessment unit (Mayfield and Ferguson 2015).

The Central Zone greenlip and blacklip abalone stocks have been classified as *transitional-depleting* (Mayfield and Ferguson 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 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 Gulf St Vincent Prawn Fishery is classified as *transitional-depleting* (Beckmann et al. 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 at a range of scales 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 pipi, for which the Coorong Beach is one of the more productive areas in the Marine Scalefish Fishery:

- 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.
- Annual catches from the Gulf St Vincent/Kangaroo Island whiting stock (see Appendix C) have been consistently lower than the Spencer Gulf and West Coast stocks. Since the peak catch in 1992 of about 147 tonnes, the annual catch of this stock declined to its lowest catch of 45 tonnes in 2013 (Fowler et al. 2014a).
- Annual catches of whiting within the marine fishing areas overlapping with the EMP (see Appendix C) in 2013/14 ranged between 16 and 30 tonnes in area 42, between 1 and 5 tonnes in area 44, were confidential in areas 43 and 45, and zero (not fished) in area 46 (Fowler et al. 2014b)
- 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).
- Annual longline catches of the Southern Gulf St Vincent snapper stock (see Appendix C) peaked in 2011 at about 29 tonnes then declined to 17 tonnes in 2012. Handline catches in the mid-1980s to the early 1990s were greater than 30 tonnes before dropping to their lowest level of 5 tonnes in 1995. Handline catches between 1995 and 2012 were less than 20 tonnes per year (Fowler et al. 2013a).
- Annual snapper catches within the marine fishing areas that overlap the EMP (see Appendix C) in 2013/14 were between 11 and 25 tonnes in each of areas 44, 45 and 46, were confidential in area 43 and zero (not fished) in area 42 (Fowler et al. 2014b).
- 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).
- Annual catches of the Southern Gulf St Vincent garfish stock (see Appendix C) peaked in 1992/1993 at 70 tonnes then declined to less than 10 tonnes in 2014, taken mainly by the dab net sector (Steer et al. 2016).
- Annual catches of garfish within marine fishing areas overlapping with the EMP (see Appendix C) in 2013/14 were confidential for areas 42, 43, 44 and 45 and zero (not fished) in area 46 (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).

- Annual catches of southern calamary within the South Central Gulf St Vincent region (see Appendix C) peaked at about 135 tonnes in 2004. The annual catch was about 80 tonnes in 2006 (Steer et al. 2007). Annual catches in the Kangaroo Island region (see Appendix C) were typically less than 10 tonnes, with about 2.5 tonnes of calamary caught in 2006 (Steer et al. 2007).
- Annual catches of southern calamary within marine fishing areas that overlap the EMP (see Appendix C) in 2013/14 were between 1 and 5, 6 and 25 and 26 and 50 tonnes in areas 42, 43 and 44 respectively, confidential in area 45 and zero (not fished) in area 46 (Fowler et al. 2014b).
- 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).
- Annual catches of sharks within the marine fishing area overlapping the EMP (Areas 42, 43, 45 and 46, see Appendix C) in 2013/14 were between 1 and 5 tonnes and 6 and 10 tonnes for gummy sharks in areas 42 and 45 respectively, and confidential in areas 43 and 46. Catches of whaler sharks were between 1 and 13 tonnes in area 45, confidential in areas 42 and 46 and zero (not fished) in area 43 (Fowler et al. 2014b).
- 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).
- Annual catches of pipi from the EMP have been historically highest 20–40 kilometres from the Murray mouth. Annual catch from this region was about 200 tonnes in 2011/12. Catch in the area less than 20 kilometres from the Murray mouth was about 20 tonnes in 2011/12 (Ferguson 2013).

The Gulf St Vincent/Kangaroo Island King George whiting stock is classified as *transitional-depleting* (Fowler et al. 2014a). The Southern Gulf St Vincent snapper stock is classified as *transitional-depleting* (Fowler et al. 2013a). The Southern Gulf St Vincent garfish stock is classified as *sustainable* (Steer et al. 2012, 2014). The statewide calamary fishery is classified as *sustainable* (Lyle et al. 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' 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).
- The annual retained catch in the Gulf St Vincent/Kangaroo Island region (see Appendix C) was between 83,000 and 90,000 'fish' between 2009/10 and 2011/12 and reduced from 61 to 54 per cent of the statewide charter boat harvest. Throughout this period, King George whiting remained the most frequently caught fish, followed by bight redfish and snapper (Tsolos 2013).
- The annual retained catch in the Victor Harbor/South East region (see Appendix C) decreased from about 3,700 to 3,300 'fish' between 2009/10 to 2011/12 but remained at about 2 per cent of the statewide charter boat harvest. Throughout this period, snapper remained the most frequently caught fish, followed by King George whiting, tuna and bight redfish (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).

Regional information is available for some fisheries:

- The recreational greenlip and blacklip abalone catch in the Central Zone were estimated to be about 0.38 (181 kilograms) and 0.21 (17 kilograms) per cent of the total allowable commercial catch, respectively (Mayfield et al. 2014).
- The recreational rock lobster catch in the Northern Zone in 2013/14 was about 5 tonnes, equating to about 1.5 per cent of the total allowable commercial catch (Linnane et al. 2015).
- The recreational King George whiting, snapper, garfish and calamary catches for the Gulf St Vincent/Kangaroo Island region in 2006/07 were about 112, 68, 29 and 94 tonnes respectively (Jones 2009).

Illegal fishing

Illegal fishing is a recognised issue for fisheries management in South Australia (PIRSA 2009, 2011a, 2011b). Illegal fishing in the Central Zone Abalone Fishery was estimated to account for 4.8 per cent of the total allowable commercial catch in 2013 (Mayfield et al. 2014). 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).

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 occurs in the EMP in Nepean Bay (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 the EMP includes:

- PIRSA Aquaculture collates information on aquaculture zoning, and the number and type of active lease types (DEWNR 2015l). Currently there are 108 active leases within the EMP (DEWNR 2015l).

- Production values may provide an indication of resource extraction levels. EconSearch (2015a, 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 the EMP have not been modified since European settlement (Bailey et al. 2012b), but some activities have modified habitats.

Baseline information on habitat modification relevant to the EMP includes:

- Coastal structures, including jetties and oyster racks, have replaced natural habitat and disrupted coastal processes (Bryars 2003, DEWNR 2016a).
- Prawn trawling impacts sand habitats (Tanner 2005) but the impacts are not quantified in the EMP. Data on historical prawn trawl effort are available (Section 8.2.1).
- Vehicles can impact beaches through erosion, sand compaction, disturbance of wrack deposits and damage to macrofauna (Brown and McLachlan 2002, Ramsdale 2010) but the impacts are not quantified in the EMP.
- Native oyster beds formerly present on the north-east Coast of Kangaroo Island 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 in the EMP.
- Fishing equipment and anchors may damage shipwrecks (DEWNR unpublished data) but these pressures have not been quantified in the EMP.

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 relevant to the EMP 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 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.
- Threats to shorebirds on the Fleurieu Pensinsula, including humans, dogs and vehicles, have been recorded since 2006 (Maguire and Mead 2015).
- 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 in the EMP. 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 become established. Feral populations of Pacific Oyster have established in Western Cove on Kangaroo Island (Wiltshire et al. 2010).

Baseline information on invasive marine pests relevant to the EMP includes:

- A number of invasive marine pests have been recorded inside the EMP, including crustacean, algal, worm, mollusc and bryozoan species (Wiltshire et al. 2010, Figure 49). The impacts of these pests on ecological values are not known.

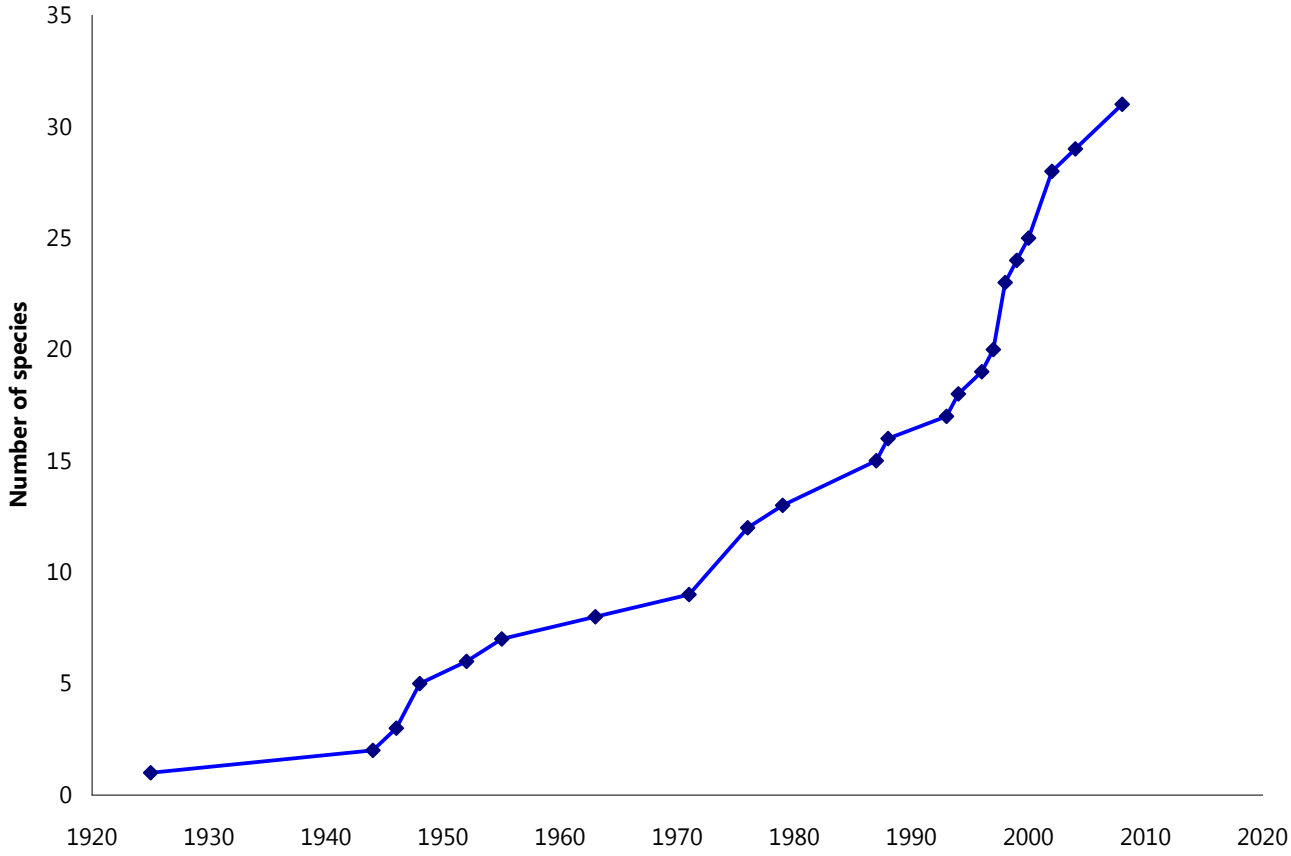


Figure 49. Cumulative count of invasive marine pest species recorded in the Encounter Marine Park over time. Note that pest surveys have not been standardised between years or locations within the park and records are typically recorded opportunistically. Source: Wiltshire et al. (2010).

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 (Gaughen 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 the EMP include foxes, cats and rodents (West 2008, Caughley et al. 1998). Introduced land pests cause vegetation degradation, compete for habitat and food sources, and prey on native species including shorebirds and lizards (West 2008).

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 (West 2008, Caughley et al. 1998) and are present on Granite Island (DEH 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 for space. A number of coastal weed species have been observed in the EMP including bridal creeper, bridal vein, pyp grass, gazania, western coastal wattle, African boxthorn, gorse, boneseed, lavatory creeper, coast tea-tree, myrtle-leaf milkwort, sea spurge, coastal galenia, New Zealand mirror-bush, false caper, white weeping broom and blowfly bush (Caton et al. 2007, Caton et al. 2009, NRKI 2015).

8.6 Climate change

Climate change may place pressure on ecological values of the EMP 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 Port Adelaide of 0.3–0.9 °C by 2030 and 0.4–3.5 °C by 2090 (Hope 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 6.3).
- Changes (increases or decreases) in sea surface salinity at Port Adelaide of -0.19–0.14 by 2030 and -0.71–0.39 by 2090 as a result of changes in rainfall (Hope et al. 2015, CSIRO and Bureau of Meteorology 2015). Changes in salinity directly 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 Port Adelaide of 0.07–0.17 metres by 2030 and 0.23–0.83 metres by 2090 (Hope 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 prevent inland migration (Scientific Working Group 2011, Fotheringham and Coleman 2008). Sea level rise may also exacerbate loss of habitat for 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 Port Adelaide of 0.6–0.8 by 2030 and 0.6–0.33 by 2090 (Hope et al. 2015), which may affect the process by which marine animals, e.g. molluscs, make shells and plates (Secretariat CBD 2009, Brierley & Kingsford 2009, The Royal Society 2005, Hobday et al. 2006, Kleypas et al. 2006).
- 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 that exceed 40 °C increasing from about 4 days up to 7 days by 2030 and 22 days by 2090 (Hope 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 plan

This section outlines the strategies of the marine park management plans and how the EMP management plan influences pressures (Section 8) on the ecological values (Section 4) and also affects 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 RAZs, 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 park, 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.

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 EMP management plan

9.2.1 Coastal pollution

The only current activity generating coastal pollution that would be influenced by the management plan 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.

Habitats within the EMP 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 plan does 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 plan, fishing was allowed throughout the EMP 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*:

- the Port Noarlunga, Aldinga, West Island and American River Aquatic Reserves (PIRSA 2015b)
- general netting closures around Kingscote spit, in Eastern Cove, north of Aldinga, in Encounter Bay and near the Murray Mouth, and a seasonal net closure (January to March) in the Bay of Shoals (DEWNR 2015m).
- intertidal reef areas to a depth of 2 metres
- 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)
- 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.
- spatial closures in the Commonwealth demersal gill net Shark Fishery in Backstairs Passage and around The Pages (AFMA 2014).

The management plan 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. (2012) and EconSearch (2014) 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 fisheries (PIRSA 2011e).

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 EMP:

- About 37 tonnes of rock lobster catch from SZs within the bounds of the Northern Zone Rock Lobster Fishery, including about 5 tonnes from the EMP (Ward et al. 2012).
- About 1.7 and 3.8 tonnes of greenlip and blacklip abalone catch, respectively, from SZs within the bounds of the Central Zone Abalone Fishery, including about 0.27 and 0.13 tonnes, respectively, from the EMP (Ward et al. 2012).
- About 1.1 tonnes of prawn catch from SZs and HPZs within the Gulf St Vincent Prawn Fishery (Ward et al. 2012).
- About 863, 701, 225 and 672 days of handline, haulnet, longline and other 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 2014). This included about 274, 0, 29 and 32 days of handline, haulnet, longline and other fishing effort, respectively, from the EMP (Ward et al. 2012).
- About 1,136 person -days of Charter Boat effort was estimated to have been displaced from SZs statewide, including about 19 person-days from the EMP (Ward et al. 2012).
- About 0.25 and 1 tonnes of shark hook and gillnet catch, respectively, from SZs within the EMP (Bailey et al. 2012b). There are now a number of closures within the park to protect Australian sea lions, bronze whalers, snapper and mulloway (AFMA 2014), and fishing effort is now concentrated off Victoria (Georgeson et al. 2014).

Aquaculture

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

9.2.3 Habitat modification

It can be expected that compliance operations within the marine park 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 2015k). Prevention of fishing and possible reduced boating activity within SZs may reduce the potential for damage of shipwrecks.

Habitats within the EMP 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 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 plan does 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 plan 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 the EMP (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 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 RAZ.

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 plan is not likely to reduce the number of marine pest species that are introduced to the EMP.

Monitoring programs within the EMP 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 plan is 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 EMP management plan

The marine park management plan is designed to influence some pressures on ecological values and result in direct ecological and indirect socio-economic positive outcomes, but it may also result in direct changes (positive and negative) to some socio-economic values (Figure 3). 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 EMP management plan. Predictions and indicators of change have been informed by previous impact assessments (Bailey et al. 2012a, b, EconSearch 2014, Kosturjak et al. 2015), expert workshops (DEWNR unpublished data) and published reports (Bryars 2013b). The indicators and predictions are summarised in the conceptual model (Figure 5). Predictions and indicators of change are summarised in Table 2. 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 to 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). 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). Rock lobster, greenlip abalone, blacklip abalone, Bight redfish, bluethroat wrasse, harlequin fish, King George whiting, snapper, swallowtail, sweep and/or western blue groper, when each considered in isolation, were predicted to increase in size and abundance over the next 20 years inside the Sponge Gardens, The Pages, Carrickalinga Cliffs, Port Noarlunga Reef, Rapid Head and/or Encounter Bay SZs of the EMP (Bailey et al. 2012a). Southern calamary were predicted to temporarily increase in size and abundance while spawning inside the Carrickalinga Head, Rapid Head, Sponge Gardens and Encounter Bay SZs (Bailey et al. 2012a). 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, is predicted to increase in size and abundance over the next 20 years inside the Bay of Shoals SZ of the EMP (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). King George whiting and southern garfish are predicted to temporarily increase in abundance while inside the Bay of Shoals SZ of the EMP (Bailey et al. 2012a). King George whiting, when considered in isolation, are predicted to increase in size and abundance over the next 20 years inside the Rapid Head SZ of the EMP (Bailey et al. 2012a). Southern calamary are predicted to temporarily increase in size and abundance while spawning inside the Rapid Head and Bay of Shoals SZs of the EMP (Bailey et al. 2012a). 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, were predicted by Bailey et al. (2012b) to increase in size and abundance over the next 20 years inside the Bay of Shoals SZ of the EMP. 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 near shore 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 (2013b) did make predictions for some beach fishes. No predictions are available for

beach ecosystems in the EMP. Given that there is minimal displacement of recreational shore-based line fishing from beaches in the EMP (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). King George whiting and snapper, when each considered in isolation, are predicted to increase in size and abundance over the next 20 years inside the Sponge Gardens, The Pages, Carrickalinga Cliffs, Port Noarlunga Reef, Aldinga Reef, Rapid Head and/or Encounter Bay SZs of the EMP (Bailey et al. 2012a). While uncertainty remains around whether prawn trawling has previously occurred in these locations, it is predicted that western king prawn will temporarily increase in size and abundance inside some sections of HPZs 1, 5 and 6 that overlap with prawn fishing grounds (Bailey et al. 2012a). 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

There are no mangroves in the EMP.

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, 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). 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). 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). 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). 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.

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 about 90 per cent of the park (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 Kangaroo Island region and concluded that regional impacts due to sanctuary zones were not occurring but that some local impacts on marine scalefish fishers were apparent due to the Bay of Shoals SZ.

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. Recreational boating is accommodated by the management plans with some minor spatial displacement likely for boat fishing and water sports due to some of the SZs. Recreational fishing continues to be accommodated within the EMP (see Section 10.2.7).

Some recreational activities such as scuba diving may be enhanced inside SZs (due to larger and more abundant fish). The SZs suitable for diving on subtidal reef and where changes are predicted to occur within the EMP include Port Noarlunga Reef (southern section of reef, see Bailey et al. 2012), Carrickalinga Cliffs, Rapid Head, Sponge Gardens and Encounter Bay. 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, 43 and 9 per cent of domestic visitors to Kangaroo Island and the Fleurieu Peninsula, respectively, visited terrestrial parks (South Australian Tourism Commission unpublished data). Possible benefits of the EMP 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 provided by zoning restrictions.

10.2.4 Cultural heritage

There is an expectation that the management plan 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 2014) 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 in the EMP 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

Change in the fishery due to the EMP 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).
- The 4 Marine Fishing Areas (42, 43, 44 and 45) that overlap with the EMP are not included in the 10 main fishing areas for the fishery (Linnane et al. 2015), i.e. the EMP is not a significant rock lobster fishing region.
- Some traditional fishing grounds were lost due to the Sponge Gardens, The Pages, Rapid Head and Encounter Bay SZs. However, relatively little reef habitat suitable for rock lobster occurs in the Sponge Gardens, The Pages and Rapid Head SZs.

- The estimated displaced catch was 0.11 per cent of the total average annual catch in the Northern Zone Rock Lobster Fishery (EconSearch 2014).

Abalone Fishery

Change in the fishery due to the EMP 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 due to the Sponge Gardens, The Pages, Rapid Head and Encounter Bay SZs. However, the area of mapped reef habitat suitable for abalone inside these SZs is relatively small compared to the area still available for fishing outside of SZs across the EMP.
- The estimated displaced catch was 0.21 per cent of the total average annual catch in the fishery (EconSearch 2014).

Prawn Fishery

Change in the fishery due to the EMP 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 0.56 per cent of the total average annual catch in the fishery (EconSearch 2014).

Blue Crab Fishery

Change in the fishery due to the EMP 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 main fishing areas lie in upper Gulf St Vincent outside of the EMP.
- The EMP lies at the southern limits of the natural distribution of the blue swimmer crab in Gulf St Vincent and only the Port Noarlunga and Aldinga SZs are likely to overlap with traditional fishing grounds.

Sardine Fishery

The Sardine Fishery does not operate within the EMP.

Marine Scalefish Fishery

Change in the fishery due to the EMP 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 the Bay of Shoals SZ in the Kangaroo Island region (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
- Fishers are mobile and can generally adapt to spatial closures.

- The Sponge Gardens SZ has displaced some long-line fishing effort but there are numerous other locations within the EMP available for this form of fishing.
- The Rapid Head SZ has displaced some jig fishing for southern calamary but there are numerous other locations within the EMP available for this form of fishing.
- The Bay of Shoals SZ has displaced some net fishing effort and it is currently unclear if this effort can be relocated to other locations within or outside of the EMP.
- The estimated displaced effort was 0.59 per cent of the total average annual effort in the fishery (EconSearch 2014).

Charter Boat Fishery

The estimated displaced effort was 2.71 per cent of the total average annual effort in the fishery (EconSearch 2014), but change in the fishery due to the EMP 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.
- Removal of effort was targeted at the Cape Jervis region as part of the Commercial Fisheries Voluntary Catch/Effort Reduction Program.
- Charter fishers are generally highly mobile and should be able to adapt to the spatial restrictions.
- The Sponge Gardens and The Pages SZs were recognised charter fishing grounds and will cause some modification of fishing behaviour based around prevailing wind and weather conditions. However, there are numerous other locations that remain available for fishing both in and out of the EMP.

Lakes and Coorong Fishery

Change in the fishery due to the EMP is predicted to be minimal because:

- There are no SZs inside the Coorong Lagoons where most of the fishing effort occurs.
- The Coorong Beach North SZ extends offshore from a distance of about 100 m from the mean high water level and still allows the harvest of pipi from the beach.
- Net fishing on the oceanic beach generally occurs closer to the Murray Mouth.

Commonwealth Shark Fishery

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

Recreational shore fishing

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

- Recreational fishing was mostly accommodated and there are numerous locations still available for shore-based fishing within the EMP.
- 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 the Port Noarlunga Reef and Encounter Bay SZs and effectively in the Coorong Beach North SZ where the nearshore boundary commences 20m seaward of the low water mark.
- Shore-based fishing was already prohibited in the Aldinga Reef SZ prior to the EMP.
- Shore-based line fishing is now prohibited in the Carrickalinga Cliffs, Rapid Head and Sponge Gardens SZs, but these areas are difficult to access from shore and previous recreational fishing effort was probably negligible.
- Shore-based line fishing is now prohibited in The Pages SZ but this lies offshore and is unlikely to have been fished from the shore prior to the EMP.
- Shore-based line fishing is now prohibited in the Bay of Shoals SZ but the shoreline around the SZ is intertidal and mostly unsuitable for shore-based fishing.

Recreational boat fishing

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

- Recreational fishing was mostly accommodated and there are numerous locations still available for boat fishing within the EMP.
- Most of the effort is targeted at inshore areas in Aldinga Bay, Yankalilla Bay, Encounter Bay and Nepean Bay where there is minor overlap with SZs.
- Fishers are mobile and will be able to adapt to spatial restrictions.

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 plan, 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 the pressures, the marine park management plan, 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 parks 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 plan 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 plan
- 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 park and these forces are not influenced by the marine park management plan. Changes to these drivers could have a bigger impact on ecological and socio-economic values than the marine park management plan. 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 park. These drivers are not influenced by the marine park management plan. Changes in these drivers could have a bigger impact than the marine park management plan. 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 park. Despite the broad spectrum of pressures that are potentially influenced by zoning and the management plan, other than fishing which is the most widespread use which has been restricted, relatively few existing pressures have been affected by the marine park. The MER program will monitor indicators that are related to the management plan (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 plan. For example, if illegal fishing occurs inside an SZ, it may nullify an ecological response to the management plan. 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 pressureon 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 2).

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 State-wide 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. A conceptual model has been prepared that synthesises the important aspects of each of these components for the marine park. The report also outlines predictions of change to ecological and socio-economic values that may occur due to the marine park management plan, 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 park boundaries, and this will present a challenge when interpreting changes in indicators that may be related to the marine park management plan. 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 the marine park prior to its full implementation in October 2014, and this information forms the baseline against which future changes can be measured. The conceptual model also provides a useful visual mechanism for documenting the important features and complexity of the marine park. Whilst the MER program may be constrained in scope, to ensure it remains relevant it will integrate with the conceptual model.

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 2. 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
Transport and infrastructure	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
	Numbers coastal infrastructure	Marine Park	No	No	Maintain current trend	Coastal infrastructure is accommodated by the management plans.	All parks	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
- Create and promote opportunities for sustainable nature-based tourism in marine parks.

[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*.

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 park. Total area of benthic habitats excludes 25.3 square kilometres of land, including islands. 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
Benthic habitats (square kilometres)					
Deep sea sponges		69.1	24.3		93.4
Reef	19.0	61.7	19.7	0.0	100.4
Seagrass	63.7	213.8	37.4	0.0	314.9
Sand	154.7	232.0	37.1	0.1	423.8
Mangrove					
Saltmarsh	0.2	3.3	0.6		4.1
Not mapped	703.4	1295.0	160.5	0.0	2159.0
Shoreline habitats (kilometres of coastline)					
Reef	33.0	76.9	11.0 (1.2)		120.9
Seagrass	1.8		30.1		31.8
Sand	55.9	125.8	26.2 (5.9)		207.9
Mangroves					
Saltmarsh	1.9	3.3	0.3		5.5

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.

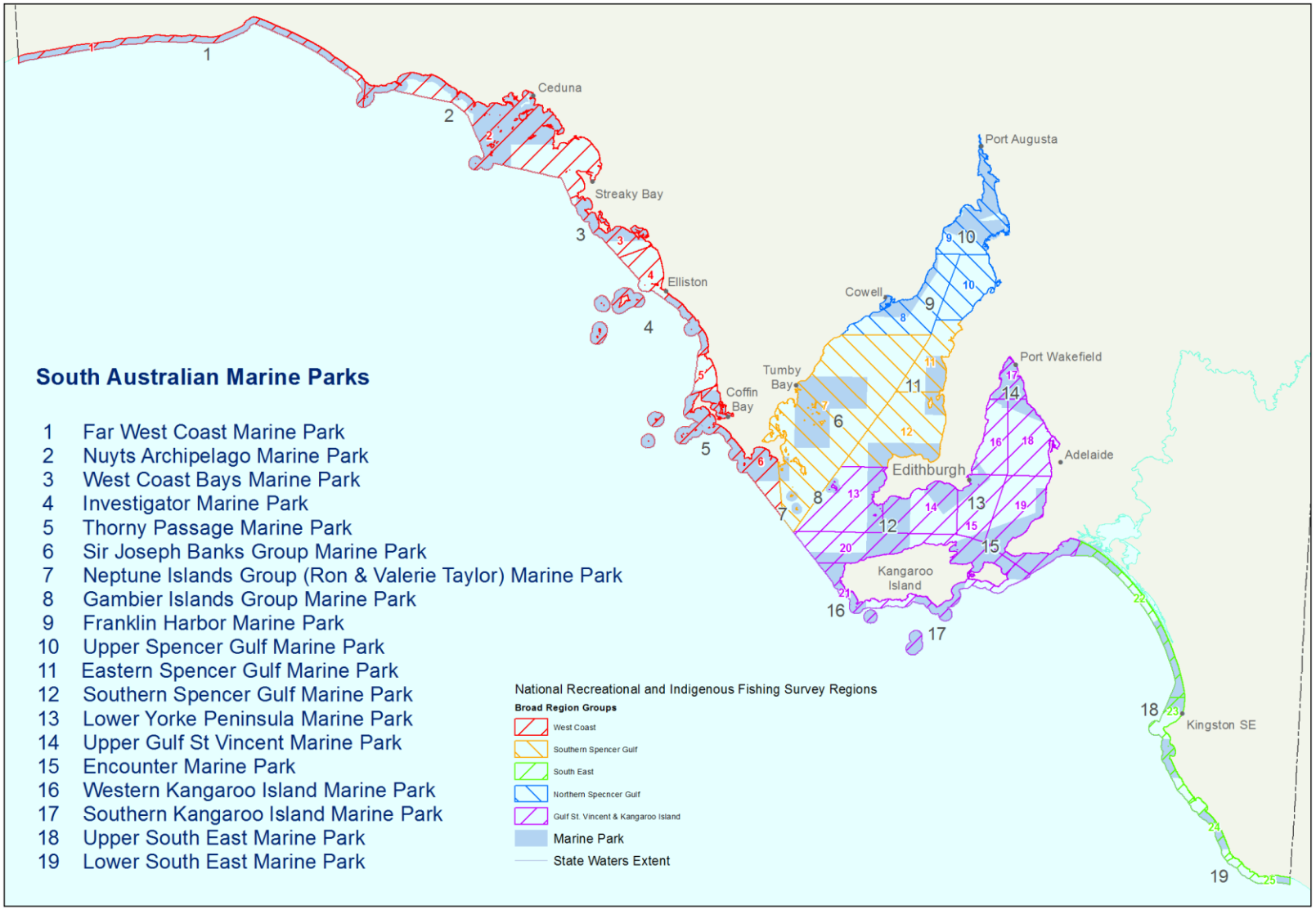
C19. EconSearch regions

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

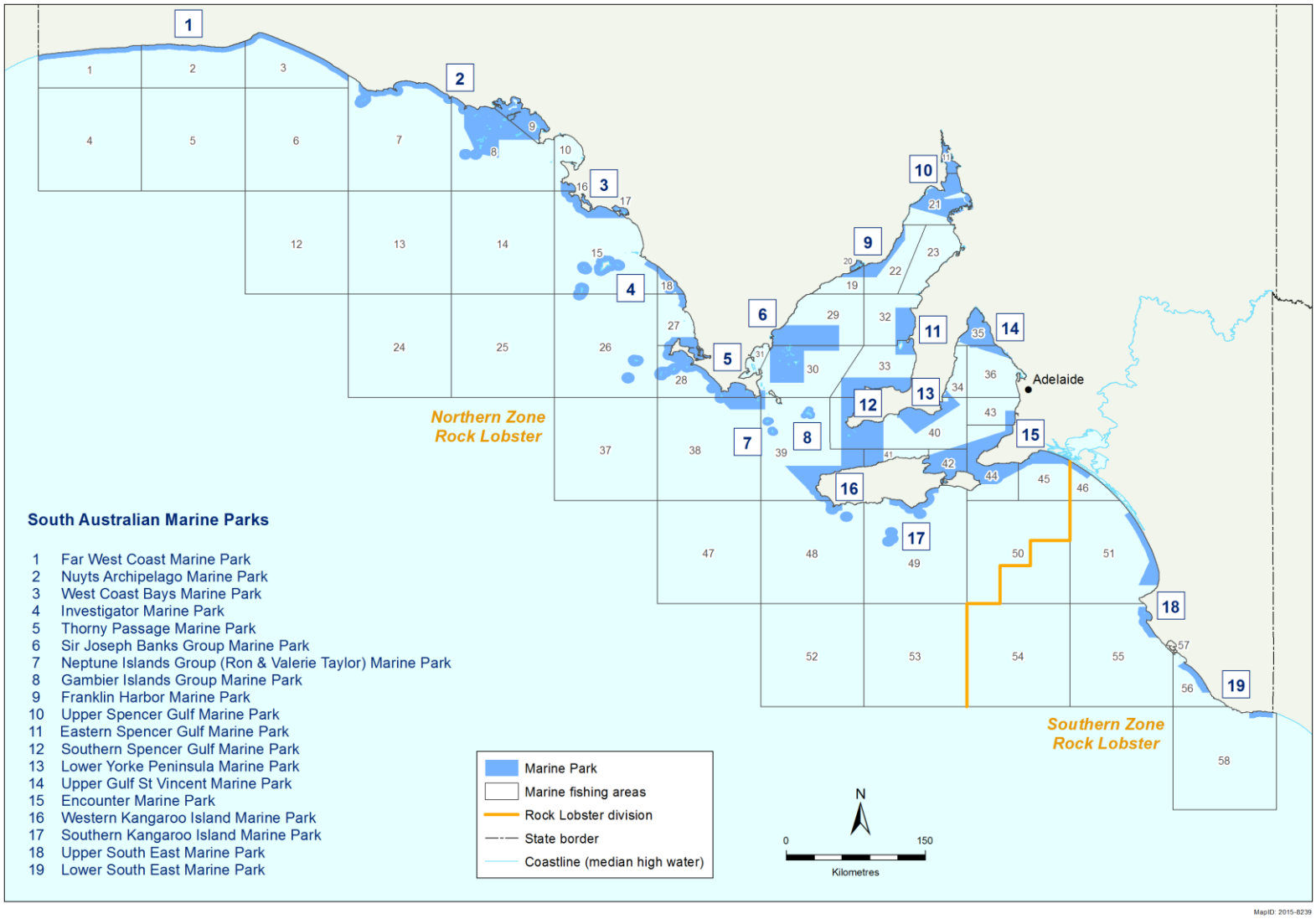
C20. Tourism regions

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

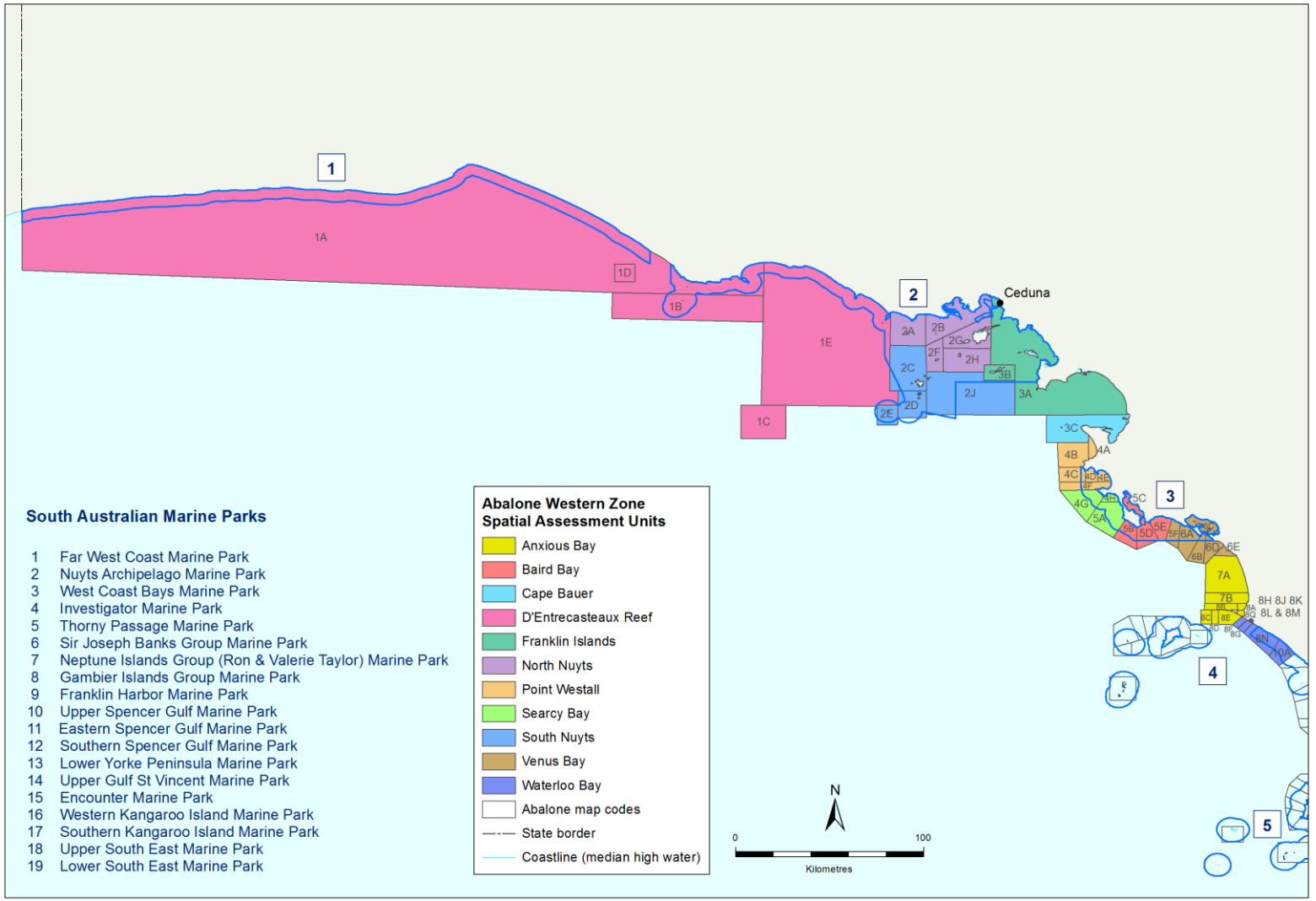
C1. Recreational fishing Marine park boundaries and the overlap with survey areas/regions for the Recreational Fishery



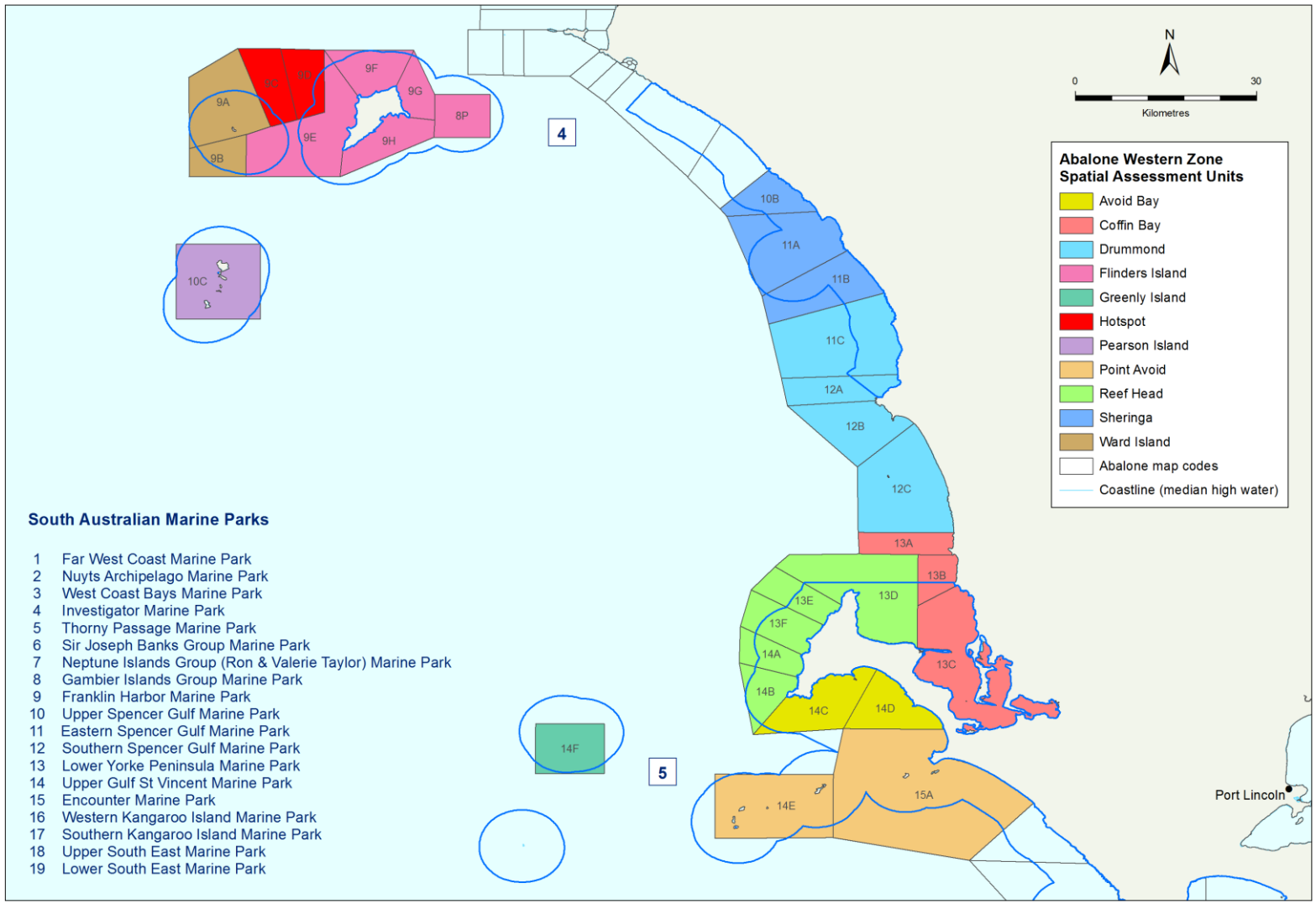
C2. Rock lobster fishing Marine park boundaries and the overlap with marine fishing areas for the Northern Zone and Southern Zone Rock Lobster Fisheries



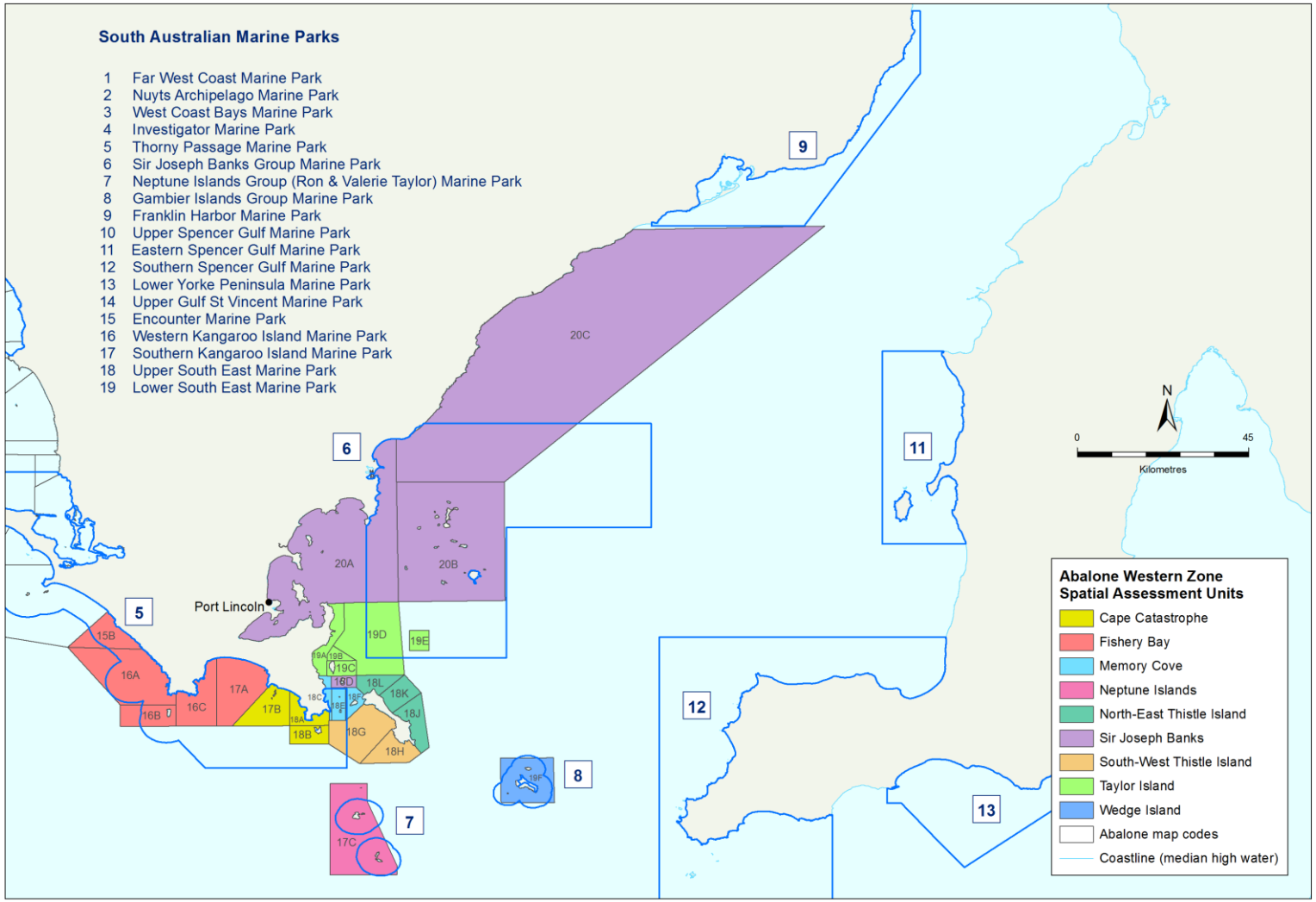
C3. Abalone fishing (Western Zone) Marine park boundaries and the overlap with map codes and spatial assessment units for part of the Western Zone Abalone Fishery off the far-west coast of South Australia



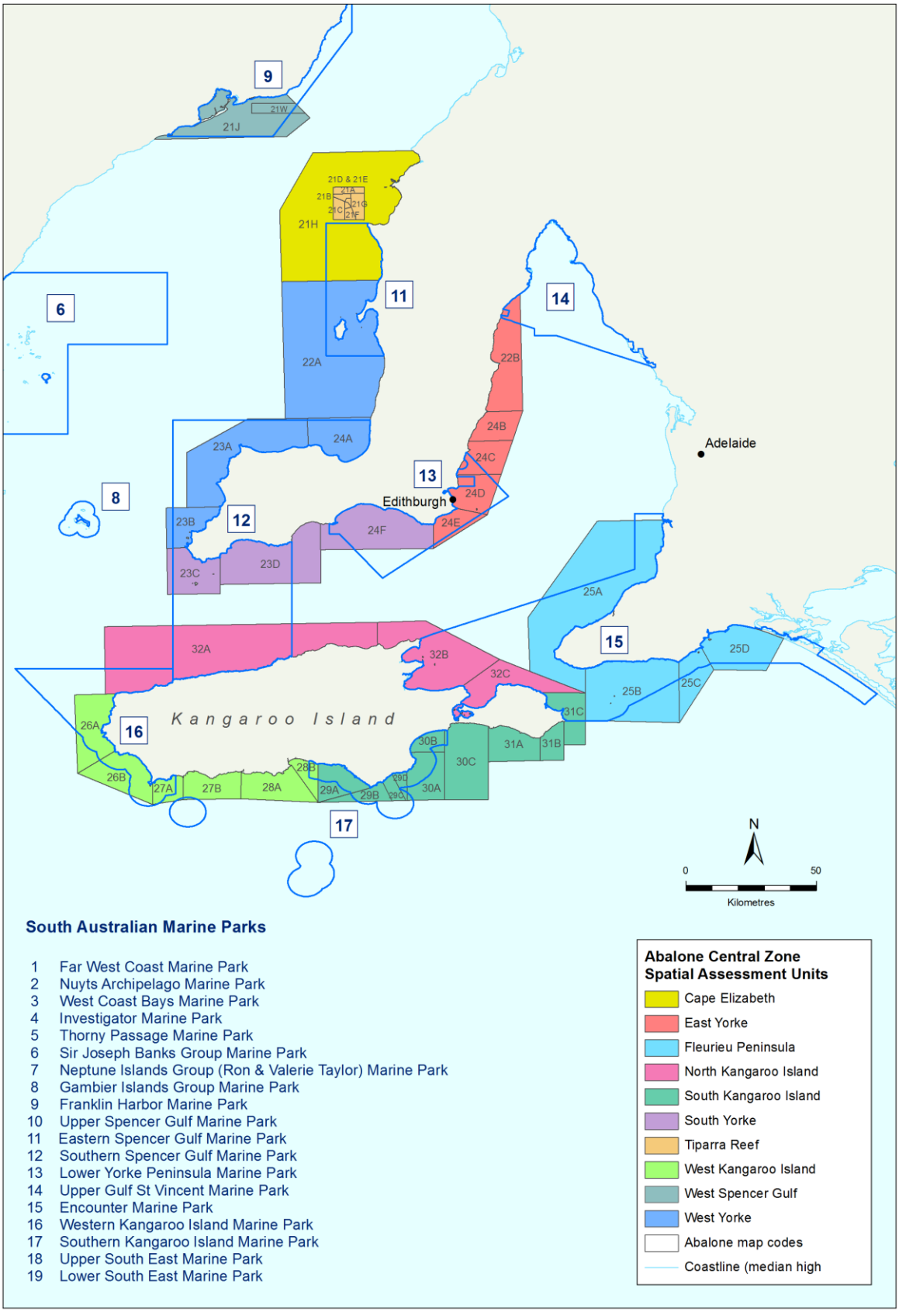
C4. Abalone fishing (Western Zone) Marine park boundaries and the overlap with map codes and spatial assessment units for part of the Western Zone Abalone Fishery off south-west Eyre Peninsula



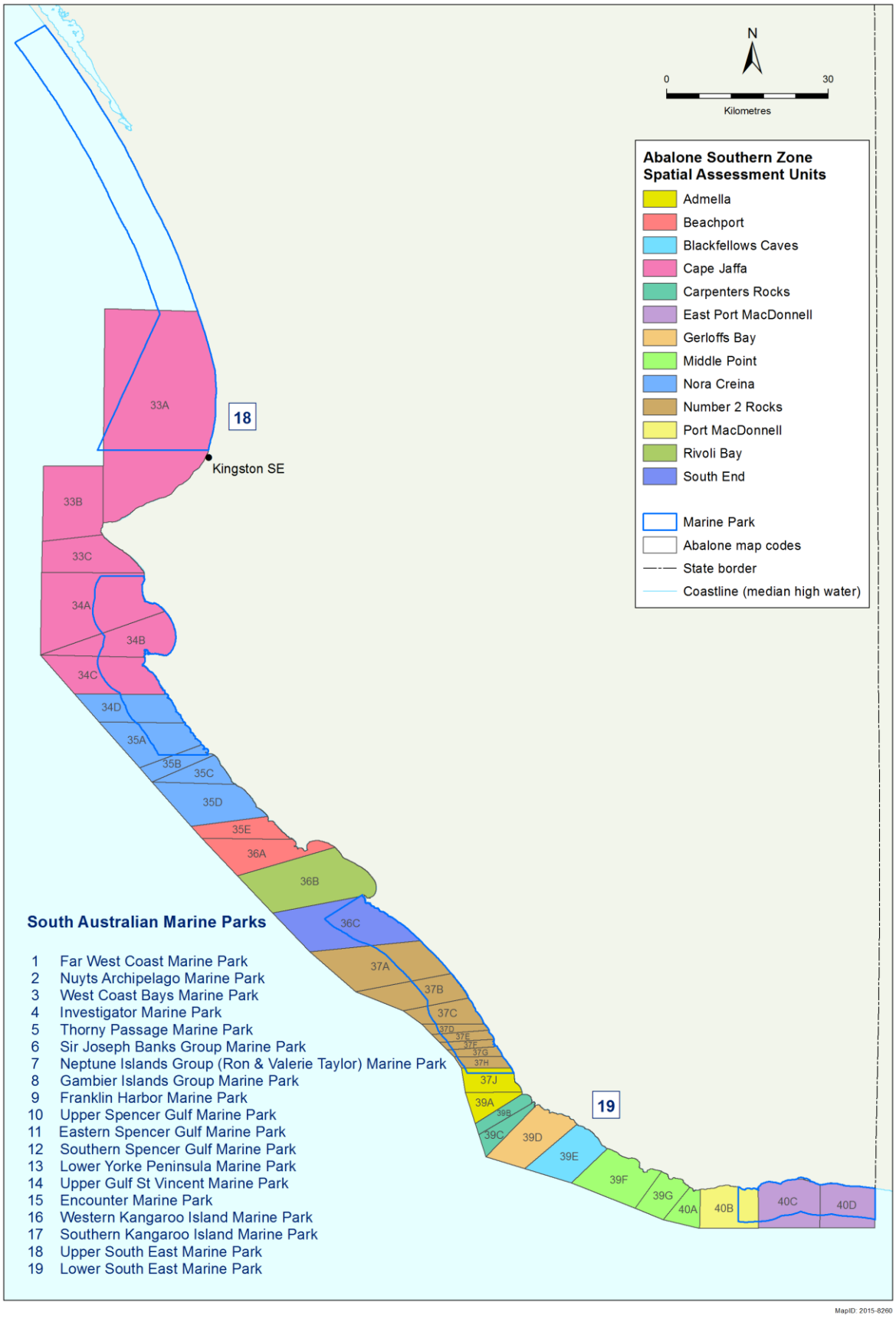
C5. Abalone fishing (Western Zone) Marine park boundaries and the overlap with map codes and spatial assessment units for part of the Western Zone Abalone Fishery off south-east Eyre Peninsula



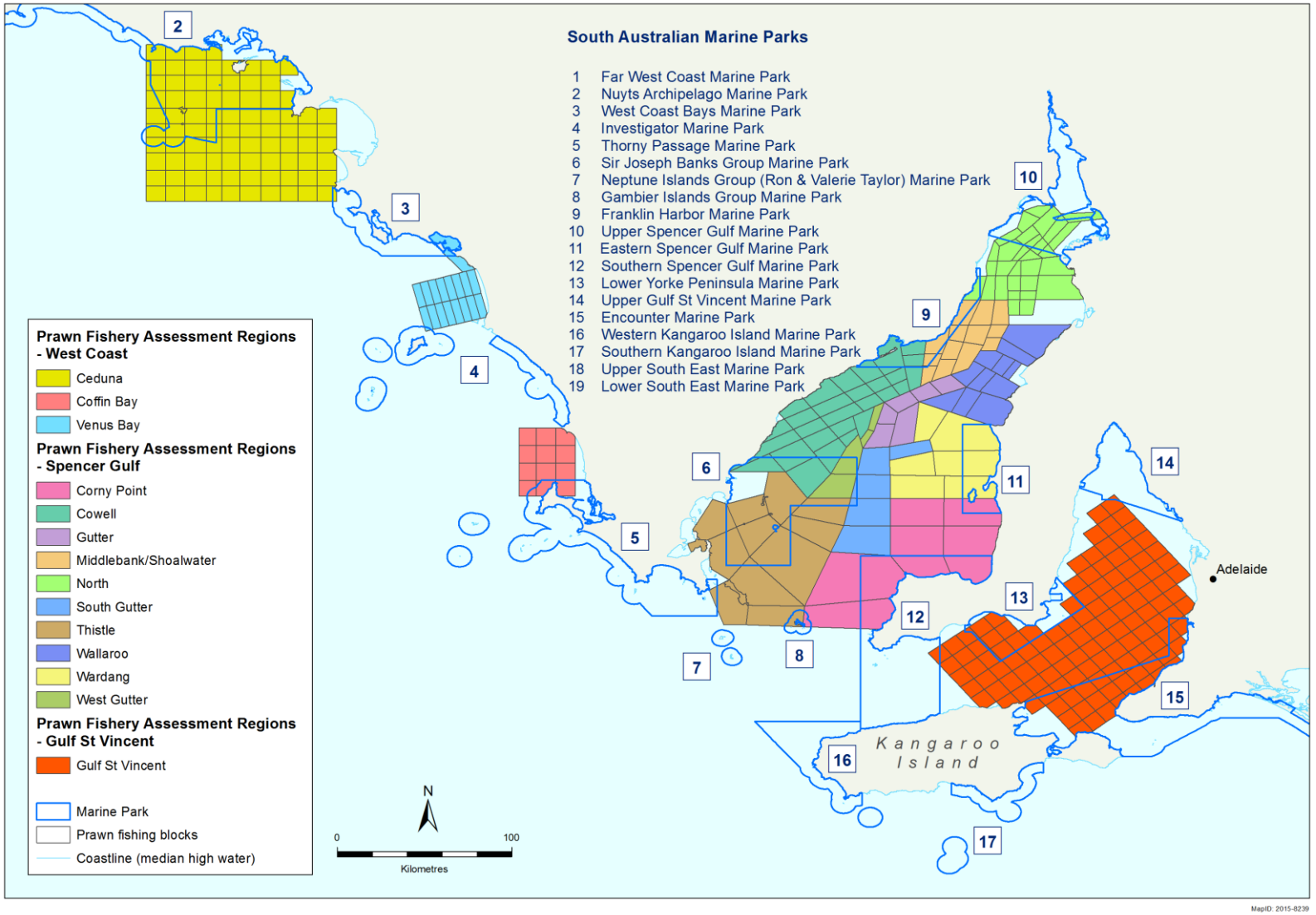
C6. Abalone fishing (Central Zone) Marine park boundaries and the overlap with map codes and spatial assessment units for the Central Zone Abalone Fishery



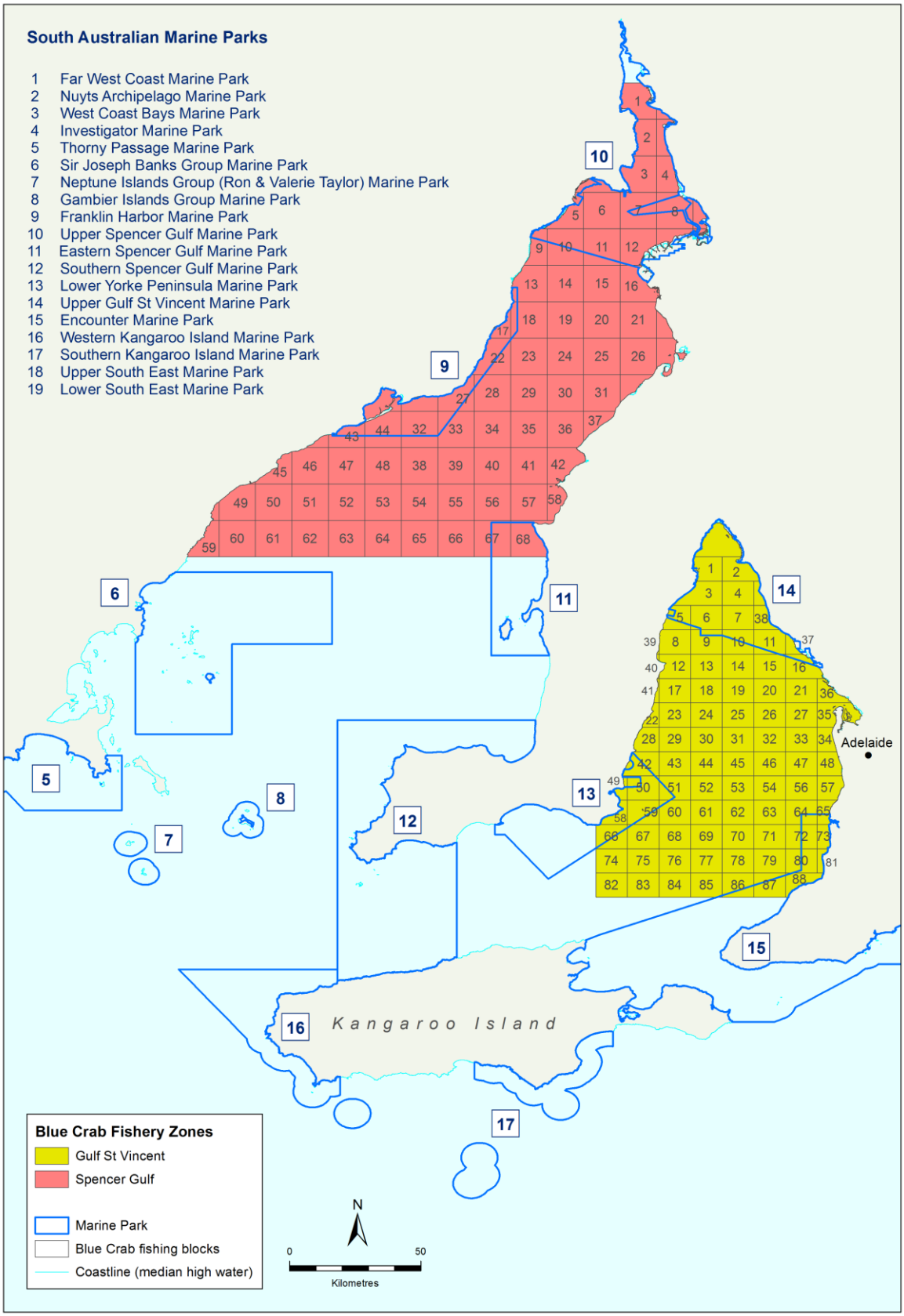
C7. Abalone fishing (Southern Zone) Marine park boundaries and the overlap with map codes and spatial assessment units for the Southern Zone Abalone Fishery



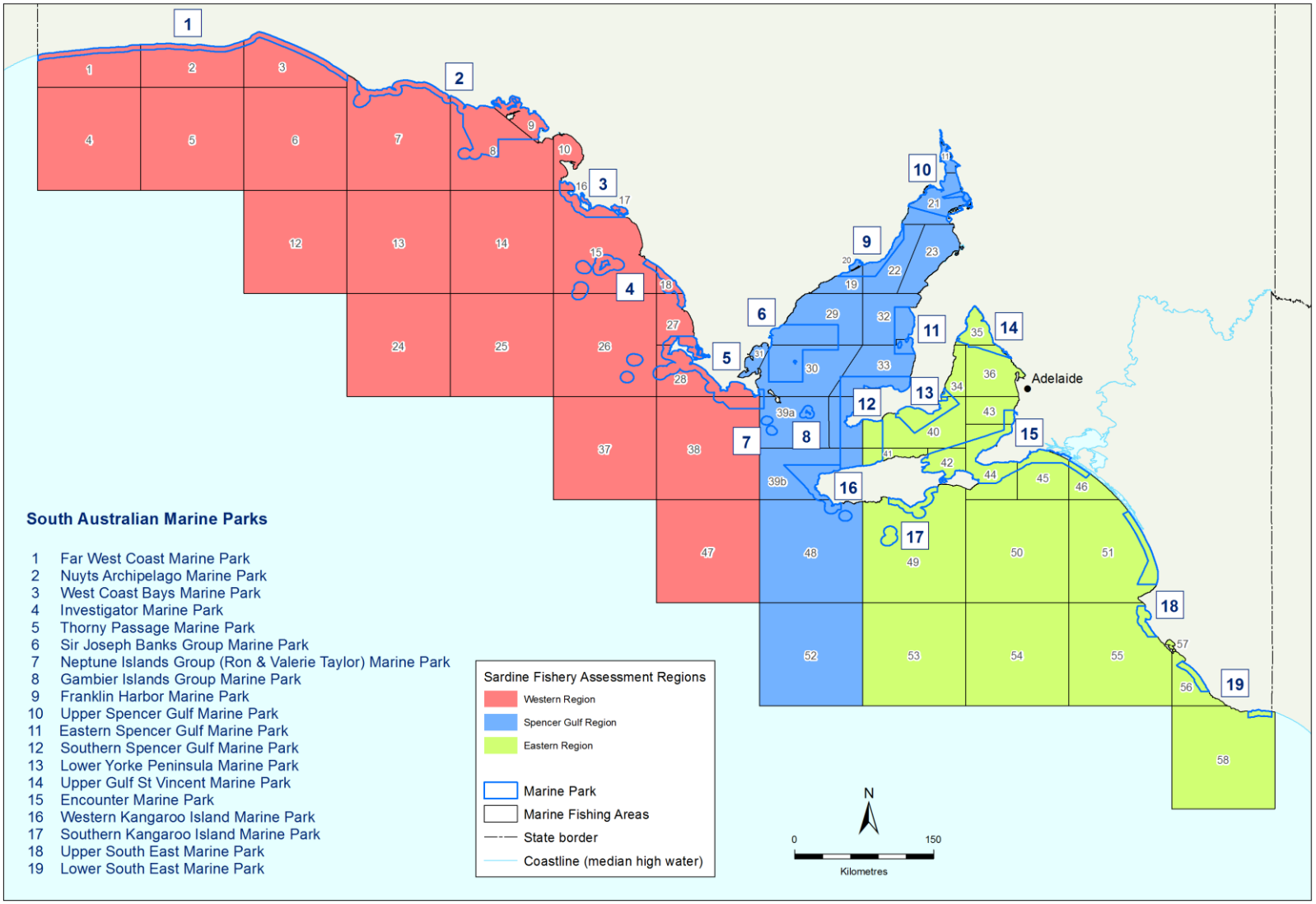
C8. Prawn fishing Marine park boundaries and the overlap with fishing blocks for the West Coast, Spencer Gulf, and Gulf St Vincent Prawn Fisheries



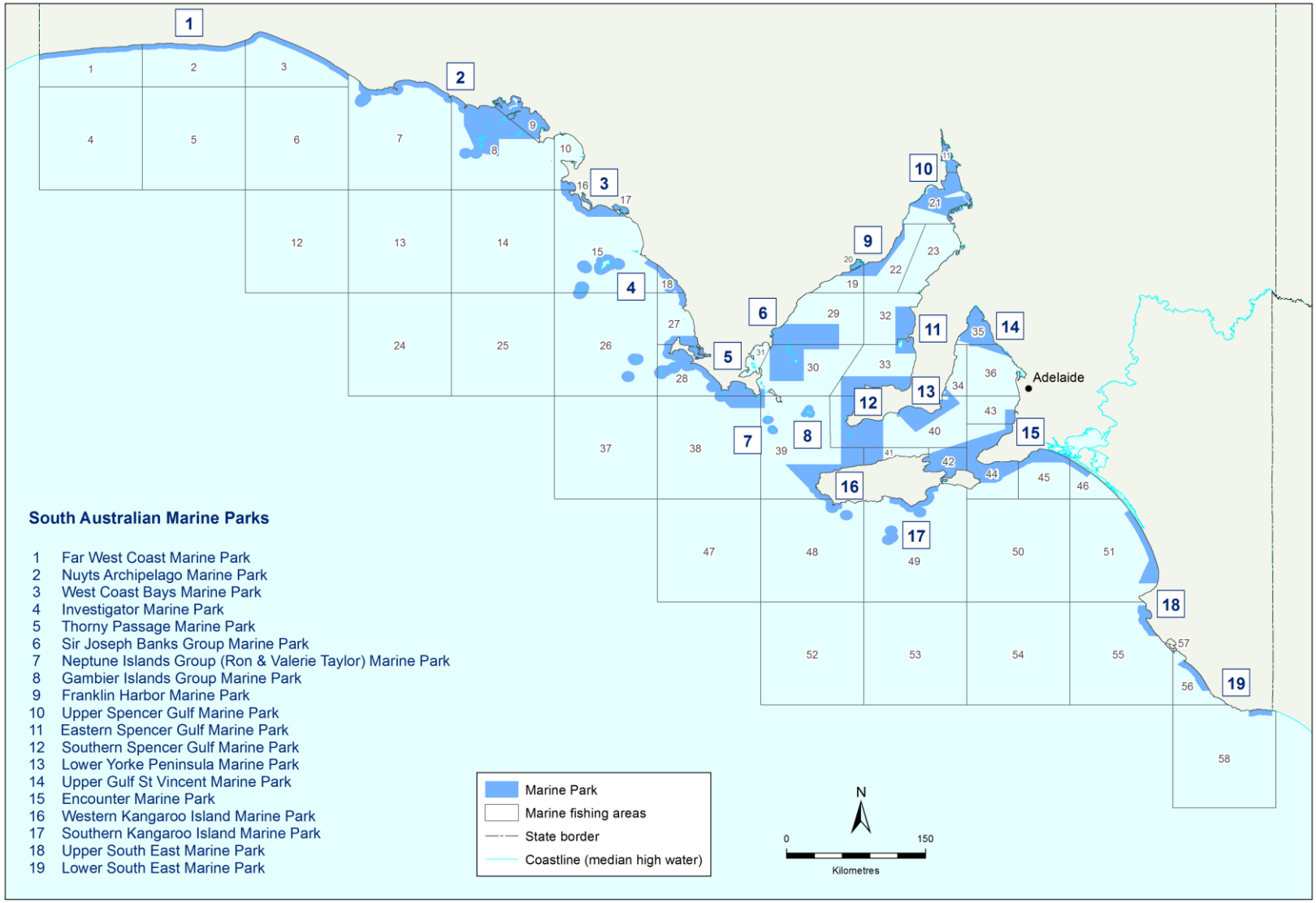
C9. Blue crab fishing Marine park boundaries and the overlap with fishing blocks for the Spencer Gulf and Gulf St Vincent zones of the Blue Crab Fishery



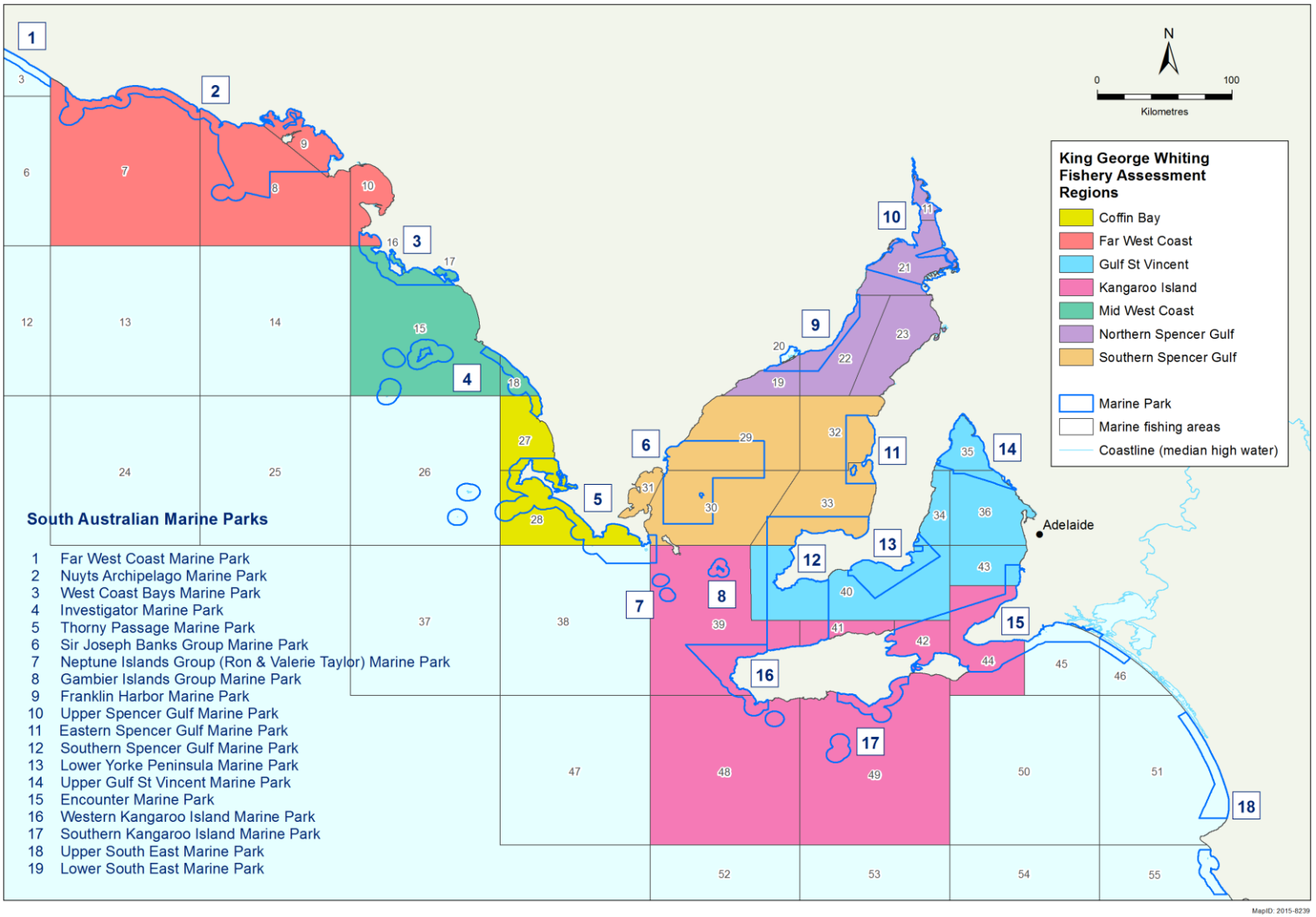
C10. Sardine fishing Marine park boundaries and the overlap with marine fishing areas and fishery assessment regions for the Sardine Fishery



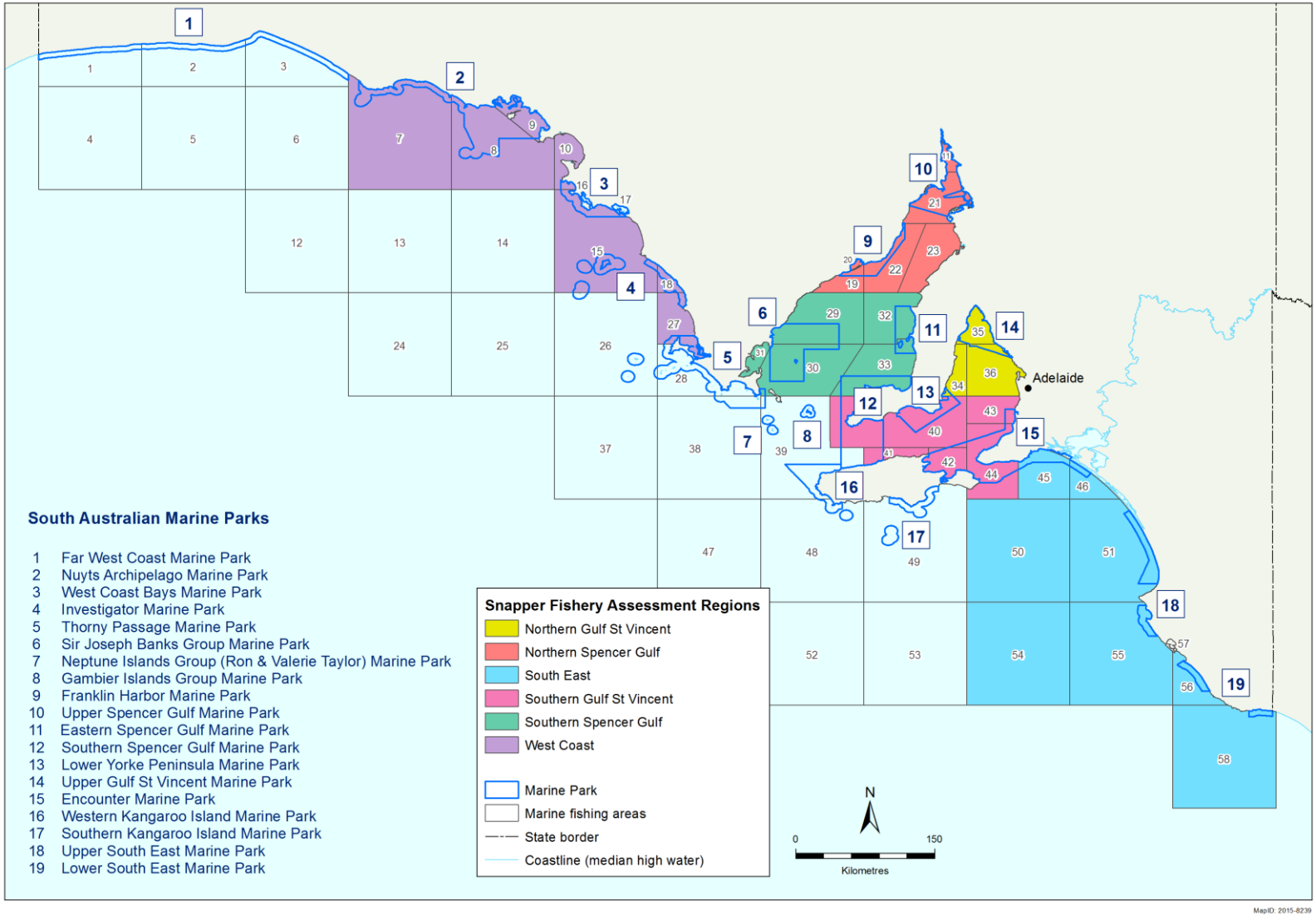
C11. Marine Scalefish fishing Marine park boundaries and the overlap with marine fishing areas for the Marine Scalefish Fishery



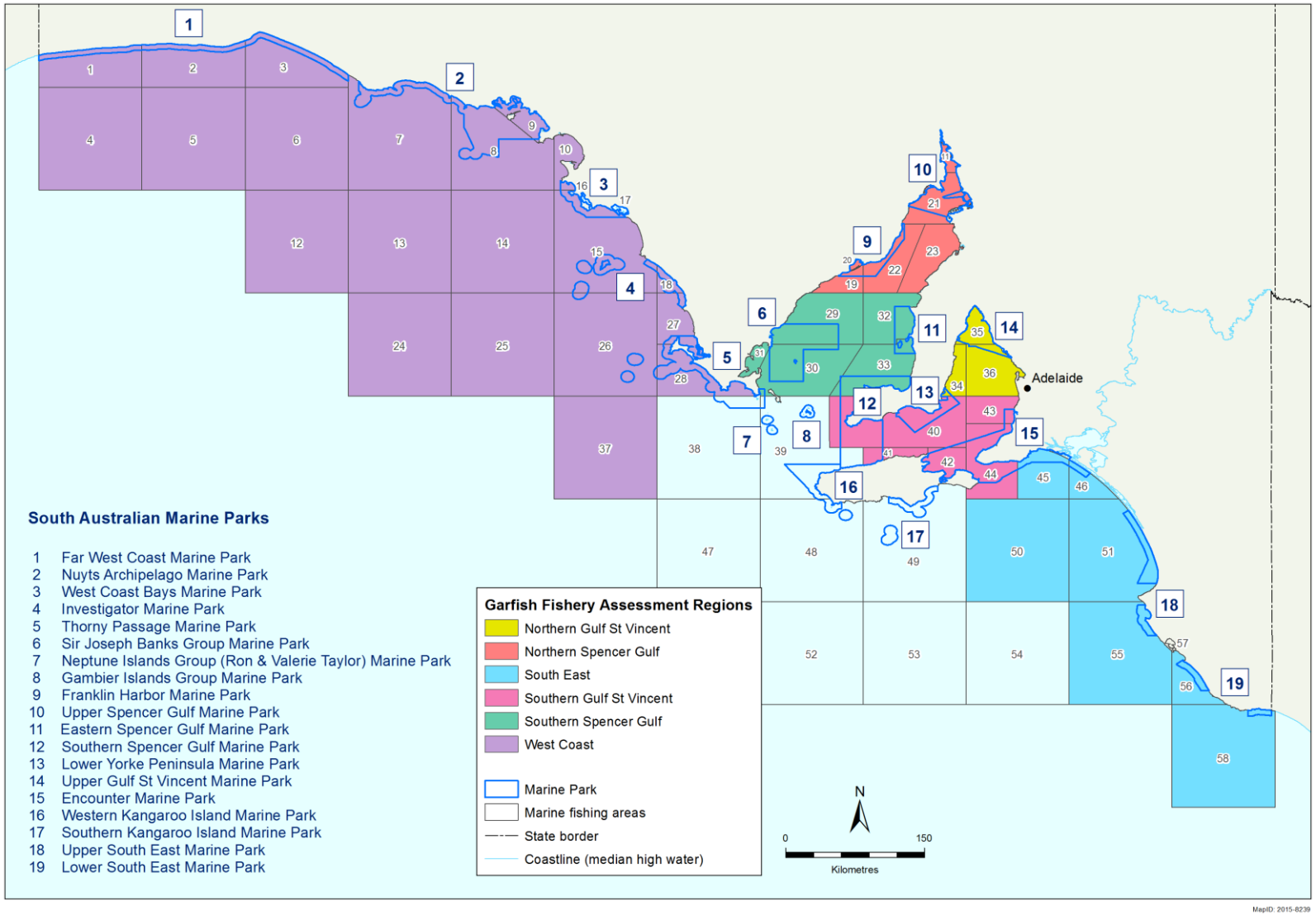
C12. Marine Scalefish fishing (King George whiting) Marine park boundaries and the overlap with marine fishing areas and fishery stock assessment regions for King George whiting in the Marine Scalefish Fishery



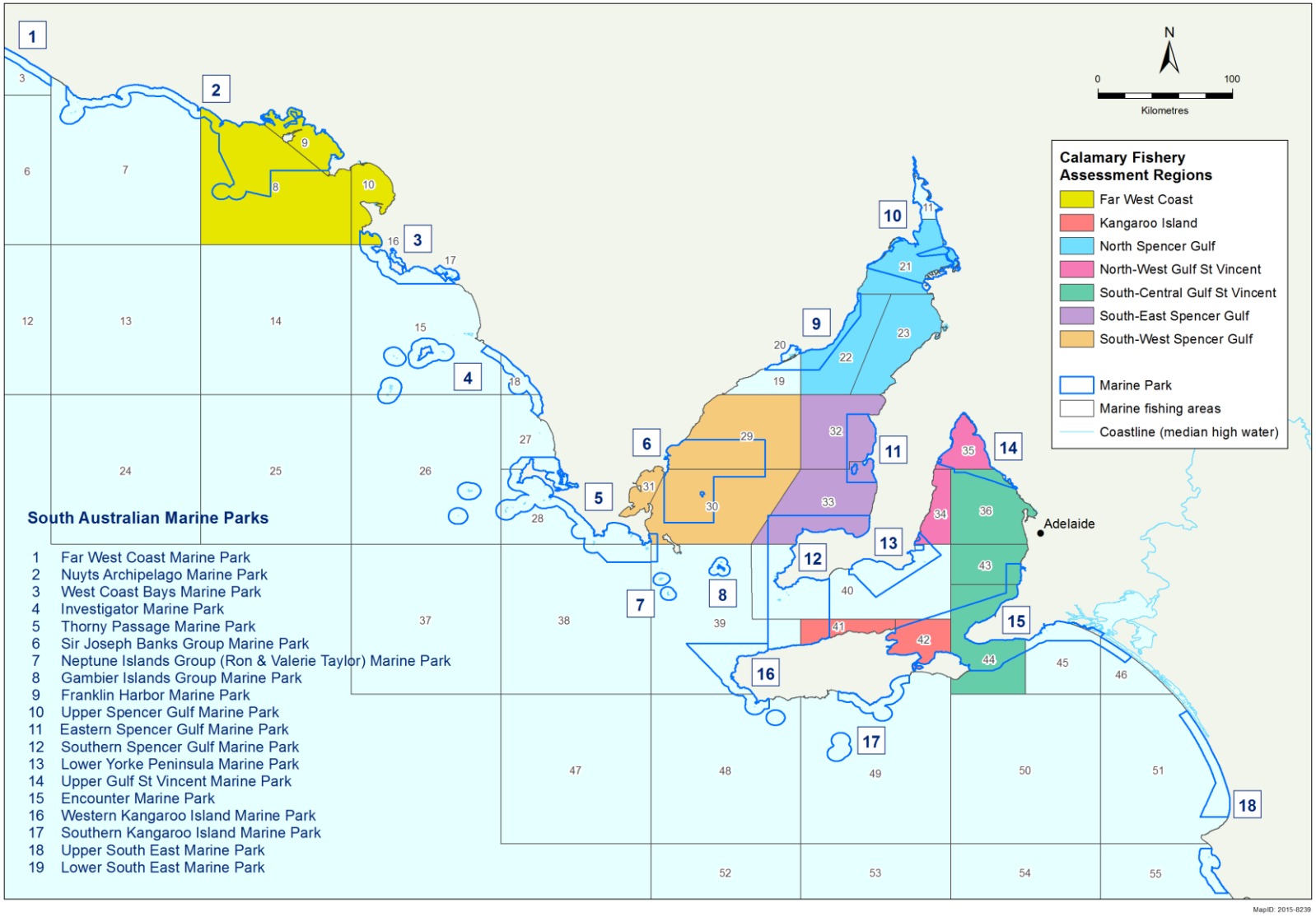
C13. Marine Scalefish fishing (snapper) Marine park boundaries and the overlap with marine fishing areas and fishery stock assessment regions for snapper in the Marine Scalefish Fishery



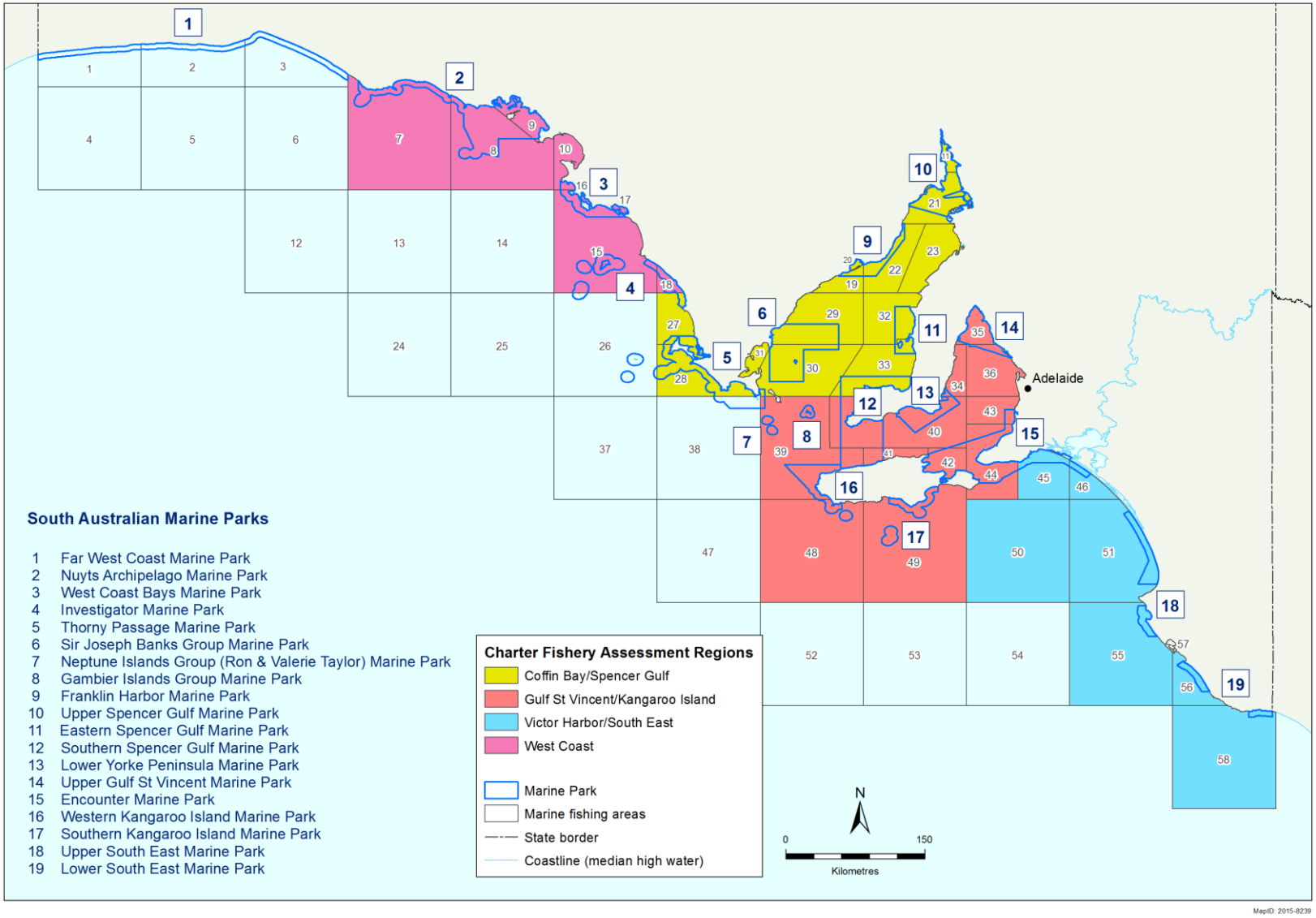
C14. Marine Scalefish fishing (garfish) Marine park boundaries and the overlap with marine fishing areas and fishery stock assessment regions for garfish in the Marine Scalefish Fishery



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

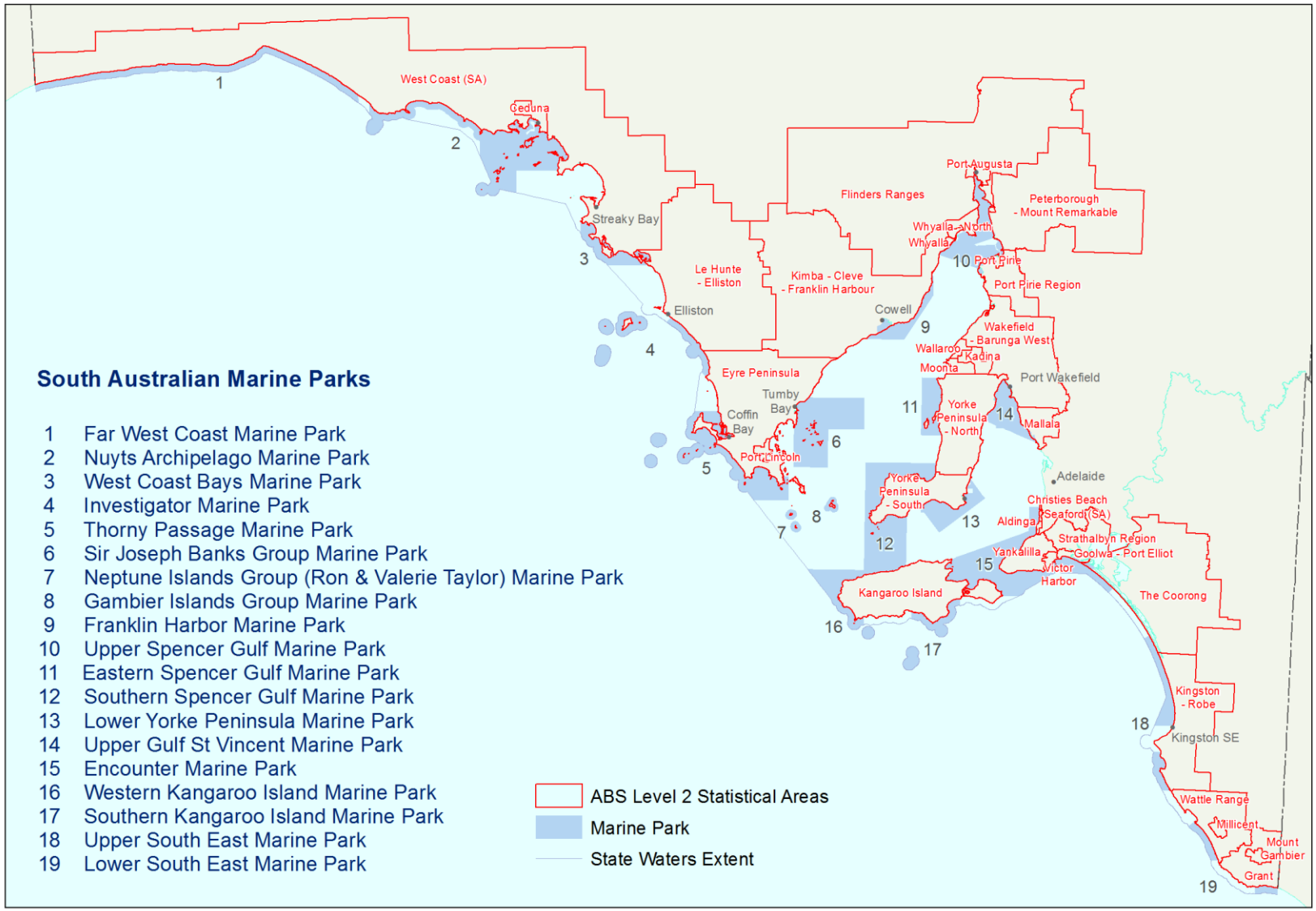


C16. Charter boat fishing Marine park boundaries and the overlap with marine fishing areas and fishery assessment regions for the Charter Boat Fishery



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 the EMP 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.

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.

[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*.

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

ESD — Ecologically sustainable development

GMUZ — General Managed Use Zone

HPZ — Habitat Protection Zone

LGA — Local Government Area

MER — monitoring, evaluation and reporting program

EMP — Encounter Marine Park

RAZ — Restricted Access Zone

SPA — Special Purpose Area

SZ — Sanctuary Zone

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