National Parks South Australia

Baseline and predicted changes for the Upper South East Marine Park

DEWNR Technical report 2016/28

SOUTH AUSTRALIA

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

Baseline and predicted changes for the Upper South East Marine Park

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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

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Summary

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

The Upper South East Marine Park (USEMP) covers an area of 906 square kilometres and overlaps both the Coorong and Otway Bioregions. The USEMP is divided into two sections and covers the areas 11 kilometres north of Tea Tree Crossing to the Maria Creek outlet in Kingston (Coorong bioregion), and from Wright Bay to the northern most point of Stinky Bay (Otway Bioregion). There are 3 SZs which cover about 10 per cent of the total park area, 4 HPZs (about 45 per cent) and 2 GMUZs (about 45 per cent). The USEMP accommodates various marine industries including commercial fishing and tourism. An SPA for harbour activities is situated adjacent to Robe and includes the Cape Dombey SZ. An SPA for aquaculture is located off long beach in the Lacepede Bay SZ.

The marine park management plans, including the USEMP 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 USEMP 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 summarises the available baseline information and indicators for the values, drivers and pressures that are identified in the conceptual model. 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 statewide marine parks network.
- In 2008, the *Marine Parks Act 2007* came into operation, providing for the establishment of a comprehensive, adequate and representative system of marine parks.
- In 2009, the outer boundaries of 19 marine parks were proclaimed following statewide public consultation.
- Between 2009 and 2011, fourteen Marine Park Local Advisory Groups worked with Government and the broader community to provide local advice for the development of draft management plans with zoning for each of the 19 marine parks in the network.
- In August 2012, 19 draft management plans and zoning were released for public comment along with economic, social and environmental impact statements, based upon the draft zoning (Bailey et al. 2012a, b).
- In November 2012, following further statewide public consultation, the 19 marine parks management plans and zoning of the marine parks was finalised with 42 GMUZs, 59 HPZs, 83 SZs, 27 RAZs and 52 SPAs designated across the parks. The zoning (except for fishing restrictions inside SZs) took effect when the *Marine Parks (Zoning) Regulations 2012* commenced in March 2013.
- In 2014, the SA Marine Parks Commercial Fisheries Voluntary Catch / Effort Reduction Program was completed. Because the SZs displaced some commercial fishing, the voluntary catch and effort reduction program was implemented to ensure that any redistribution of commercial fishing did not threaten the sustainability of other areas (PIRSA 2013a).

Figure 1. South Australia's network of 19 marine parks showing marine park outer boundaries, 8 marine bioregions and highlighting the Upper South East 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?

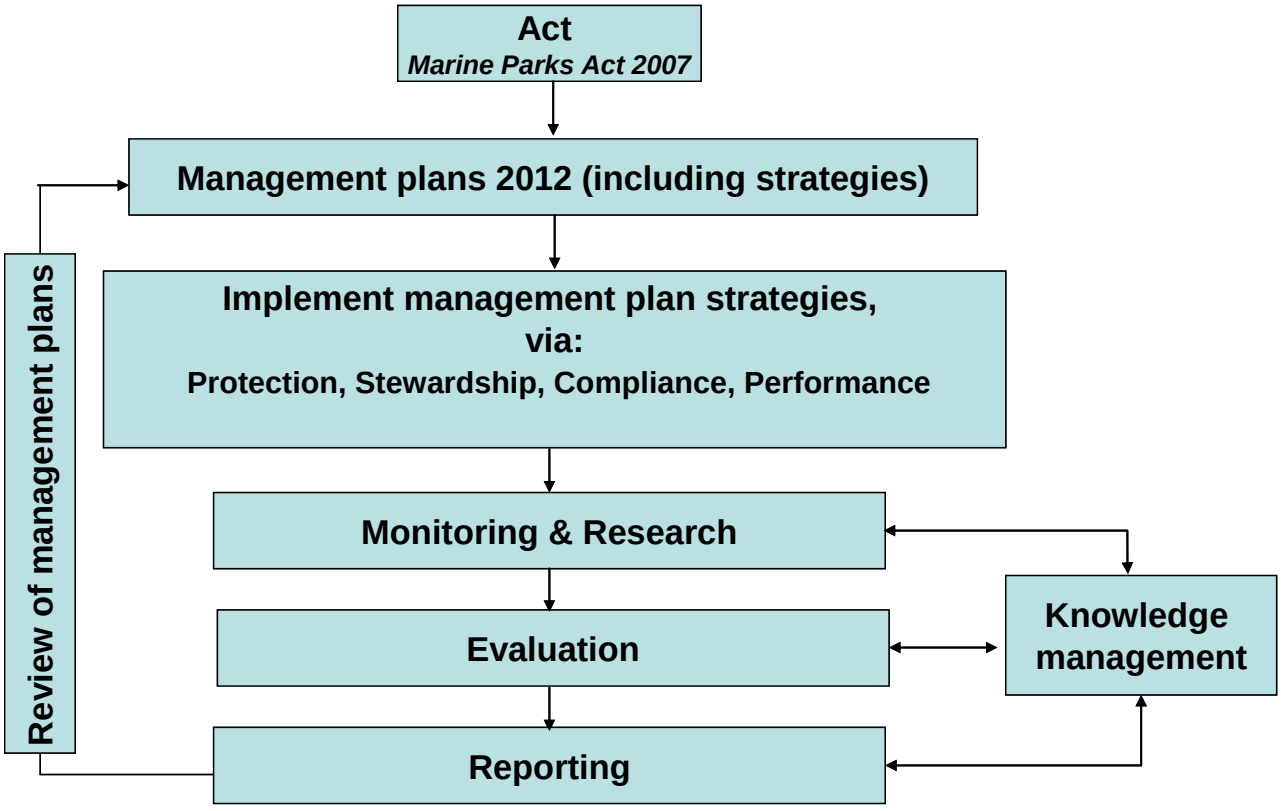


Figure 2. Adaptive management cycle for the marine parks MER program

1.3 Structure and aims of this report

This baseline report for the Upper South East Marine Park (USEMP) 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 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 the comprehensiveness, adequacy and representativeness of the network of marine parks.

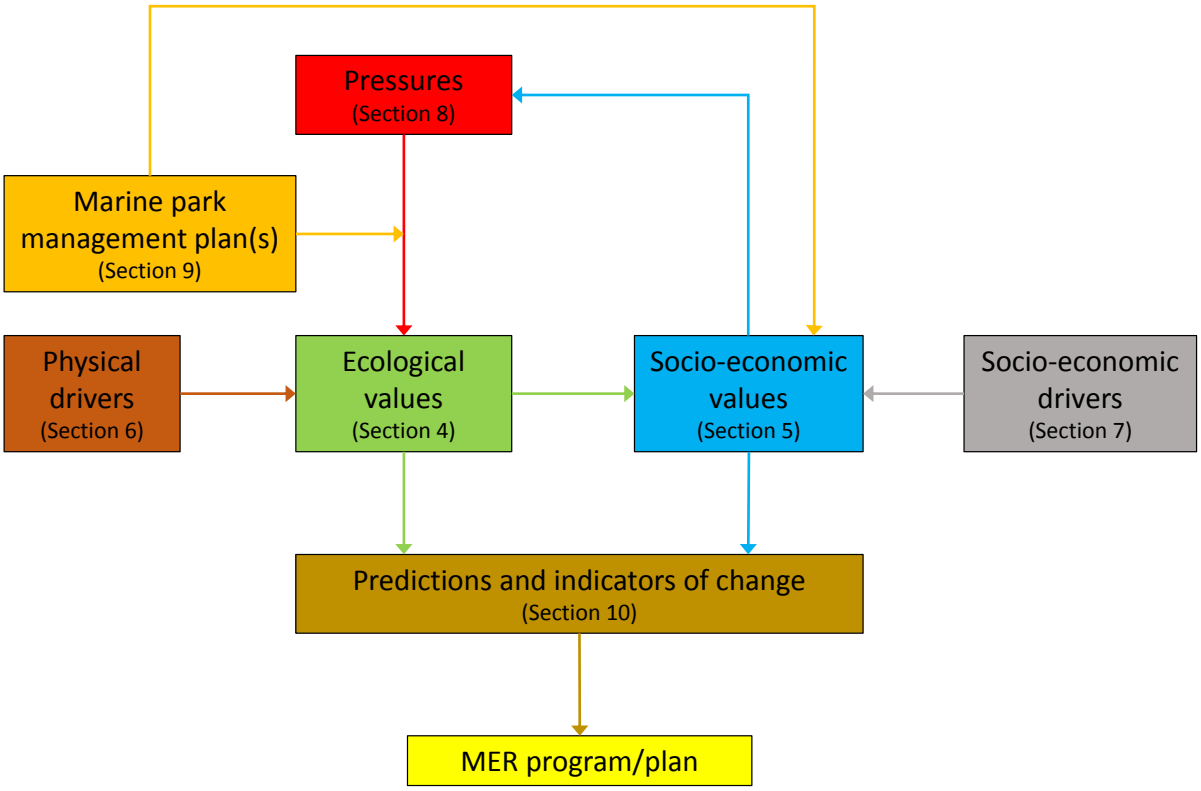


Figure 3. Framework for the baseline report that indicates how Sections 4 to 9 of this report are linked and used to inform Section 10 on predictions and indicators of change. All components of the framework will be used to inform the MER program. The direction and colour of the arrows indicates the 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 Upper South East Marine Park (USEMP) covers an area of 906 square kilometres and overlaps both the Coorong and Otway Bioregions (Figure 1). The USEMP is divided into two sections and covers the areas 11 kilometres north of Tea Tree Crossing to the Maria Creek outlet in Kingston (Coorong bioregion), and from Wright Bay to the northern most point of Stinky Bay (Otway Bioregion). There are 3 SZs which cover about 10 per cent, 4 HPZs (about 45 per cent) and 2 GMUZs (about 45 per cent, Figure 4). The USEMP accommodates various marine industry including commercial fishing and tourism. An SPA for harbour activities is situated adjacent to Robe and includes the Cape Dombey SZ. An SPA for aquaculture is located off long beach in the Lacepede Bay SZ (Figure 4).

The USEMP is adjacent to conservation parks and coastal towns. The largest population centres are Robe and Kingston. The USEMP is adjacent to several land conservation areas (Figure 4) including the Coorong National Park, Little Dip Conservation Parks and Guichen Bay Conservation Parks, and includes the Baudin Rocks Conservation Park. The region experiences warm summers and cool winters (Bureau of Meteorology 2015a). The annual freshwater runoff is 28,850 gigalitres (National Water Commission 2007).

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

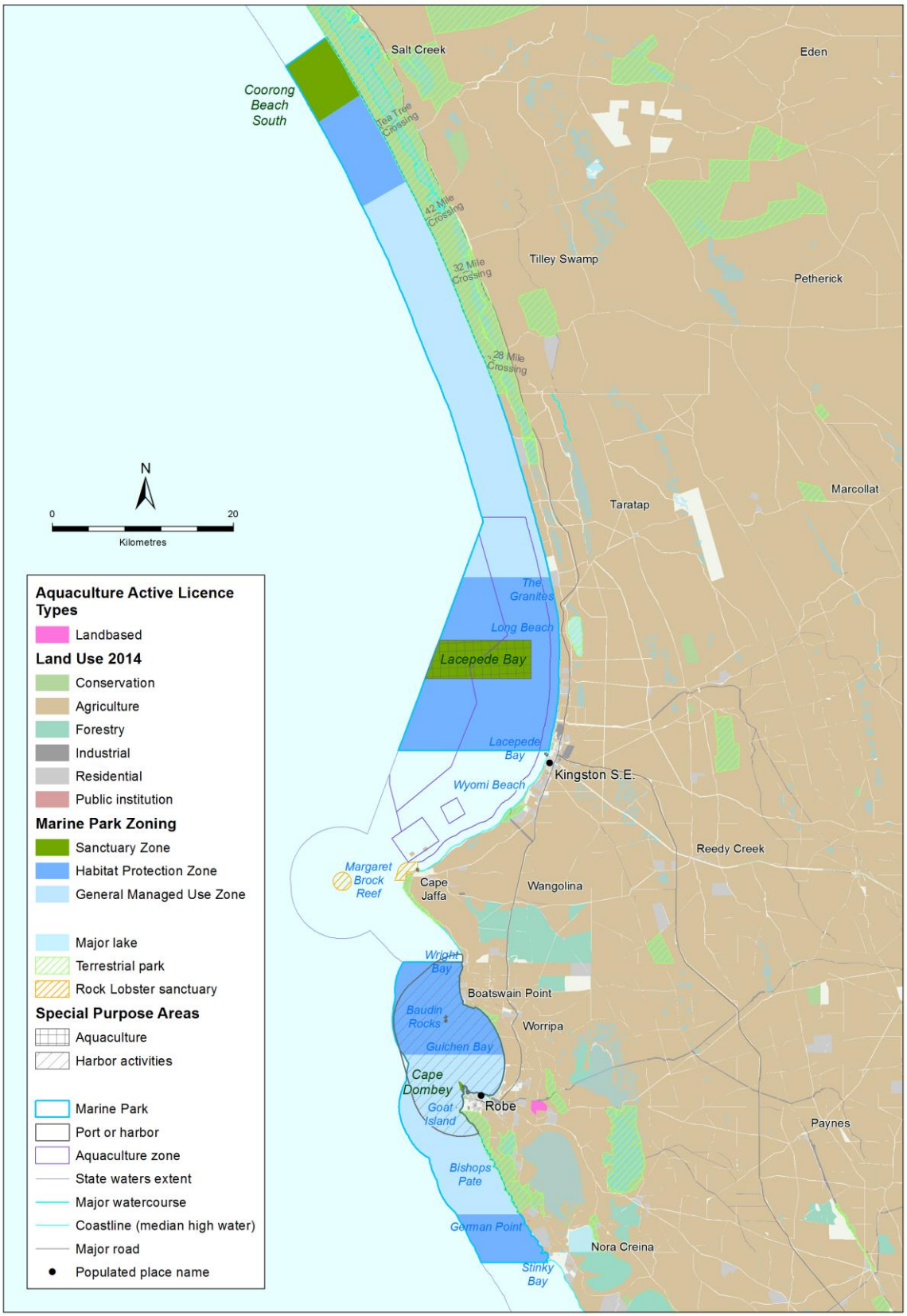


Figure 4. Map of the Upper South East Marine Park showing important features of the marine park and adjacent land areas. Further information on marine and land uses is shown in Appendix C.

3 Conceptual model

The conceptual model of the USEMP (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, while healthy reef ecosystems sustain the rock lobster stock, which is used by commercial and recreational fishers. 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.

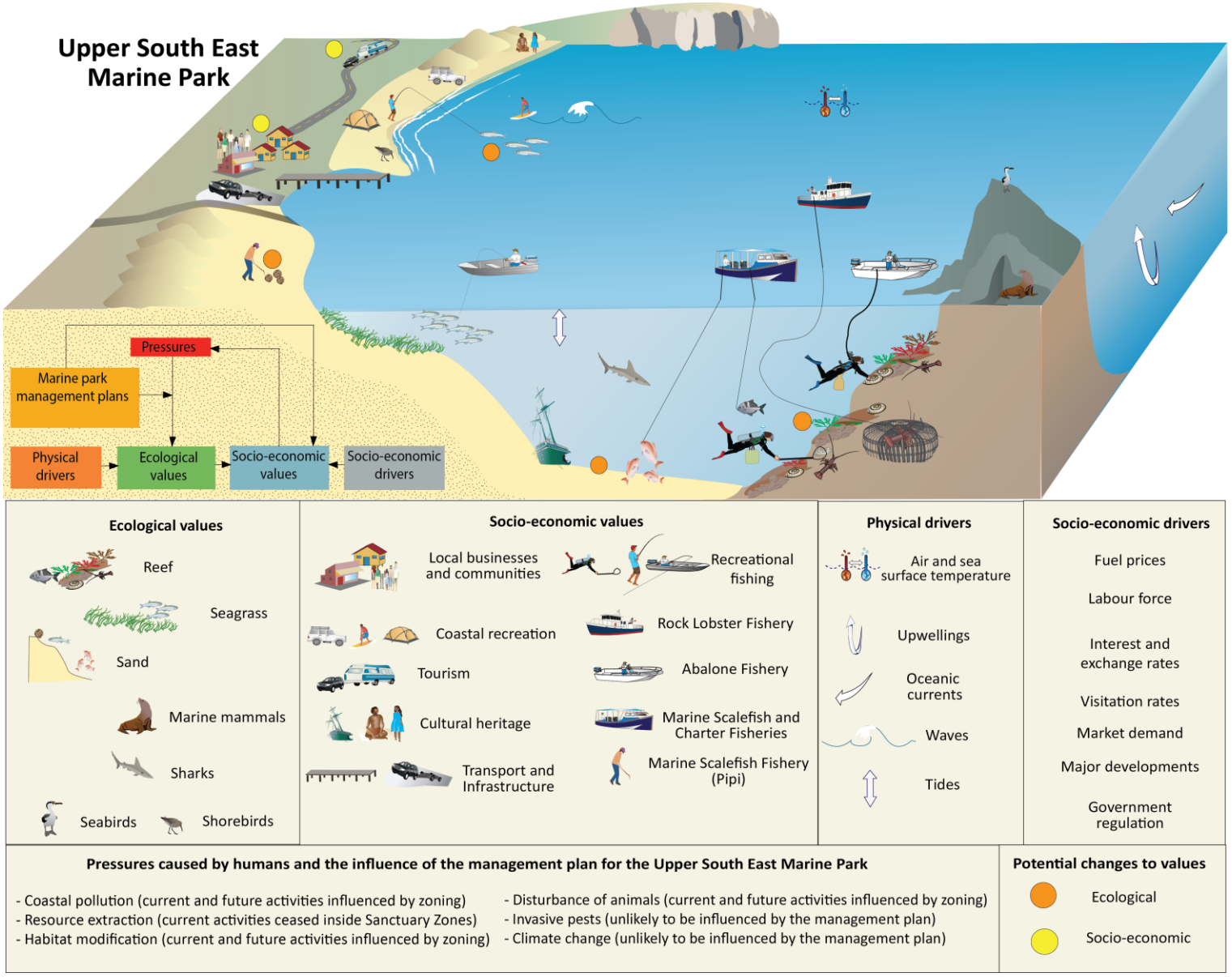


Figure 5. Conceptual model for the Upper South East Marine Park

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 USEMP (DENR 2010, Bailey et al. 2012b). Additional information on the ecological values of the USEMP 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. 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 2009). About 49 per cent of the benthic habitats of the USEMP 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 10 per cent has been mapped at a broad scale (1:100,000) using satellite imagery (DEWNR 2015e, Edyvane 1999a, b, Figure 6). The remainder (41 per cent) of the subtidal habitats in the USEMP are not mapped. The mapping of the 3 SZs in the USEMP is summarised in Table 1. The entire shoreline of the USEMP 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 USEMP. Mapping type includes: fine scale (DEWNR 2015c, d, Miller et al. 2009); broad scale (DEWNR 2015e, Edyvane 1999a, b).

SZ	Mapping type
Coorong Beach South	Broad scale inshore for about 37 per cent of the zone
Lacepede Bay	Fine scale inshore for about 69 per cent of the zone, broad scale elsewhere
Cape Dombey	Broad scale

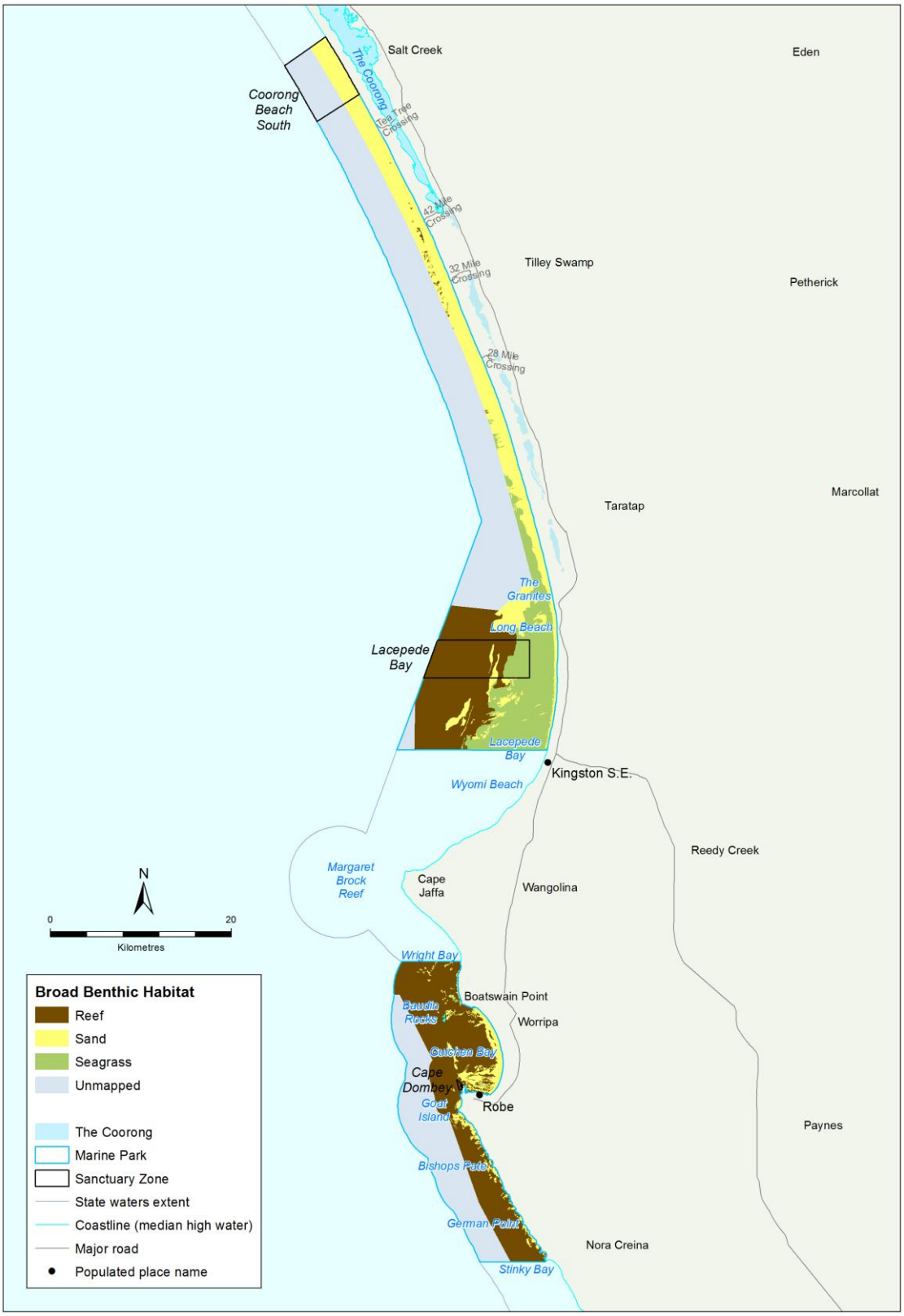
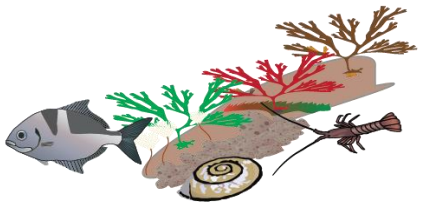


Figure 6. Benthic habitats of the Upper South East Marine Park based on fine and broad scale mapping. Source: DEWNR (2015c, d, e), Miller et al. (2009), Edyvane (1999a, b).

4.1 Reef

Large areas of reef occur in Lacepede Bay and from Wright Bay to Stinky Bay (Figure 6).



Baseline information on reef relevant to the USEMP includes:

Spatial extent of reef habitat

- Intertidal reefs extend along about 9 kilometres of the mainland coastline of the USEMP (see Appendix B). The shoreline extent of intertidal reefs on islands in the USEMP has not been mapped.
- About 263 square kilometres of subtidal reef have been mapped in the USEMP (Figure 6). About 378 square kilometres of seafloor in the USEMP have not been mapped (see Appendix B).

Size, abundance and diversity of reef communities

- Fish, invertebrate and macroalgal diversity and abundance were surveyed by divers at 4 sites (1 inside the Cape Dombey SZ) at a depth of 5 metres during autumn 2012 and a further 10 sites (1 inside the Cape Dombey SZ and four inside the Lacepede Bay SZ) at a depth of 10 metres during autumn 2014 (DEWNR and the University of Tasmania unpublished data). In addition, 3 sites at Margaret Brock Reef (outside the park boundary) were surveyed at depths of 5 or 10 metres in autumn 2014 (DEWNR and the University of Tasmania unpublished data). About 40 fish, 45 invertebrate and 170 macroalgal taxa were recorded during the surveys. The 2012 and 2014 survey sites are shown in Figure 7 and Figure 8.
- Fish and invertebrate diversity and abundance were surveyed using baited traps at 2 subtidal reef locations in Guichen Bay at depths between 10 and 20 metres during April and June 2009. A total of 2 species were recorded (Rowling et al. 2009).
- Fish and invertebrate diversity and abundance were surveyed using baited remote underwater video systems (Cappo et al. 2003) at 3 subtidal reef locations in Lacepede Bay and Guichen Bay. The surveys were undertaken at depths between 10 and 20 metres during April and June 2009 (Rowling et al. 2009). A total of 17 species were recorded (Rowling et al. 2009). Algae and sedentary invertebrate diversity and biomass were surveyed using benthic sled tows at the same 3 subtidal reef locations during April and June 2009. A total of 61 algae and 29 invertebrate species were recorded (Rowling et al. 2009).
- Giant kelp (*Macrocystis pyrifera*) distribution was inferred from the composition of wrack deposits on beaches at 7 locations in Lacepede Bay and near Robe (5 within HPZs) between June 2005 and December 2007 (Duong 2010).
- Assessments are conducted on a regular basis for a number of commercially-fished species that use reef habitat, including the Rock Lobster, Abalone, Marine Scalefish and Charter Boat Fisheries (Linnane et al. 2015, Mayfield et al. 2015, Fowler et al. 2013a, 2014a, Steer et al. 2007, 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 7. Map showing reef sites that have been surveyed for fishes, invertebrates and macroalgae inside and outside the Lacepede Bay Sanctuary Zone of the Upper South East Marine Park

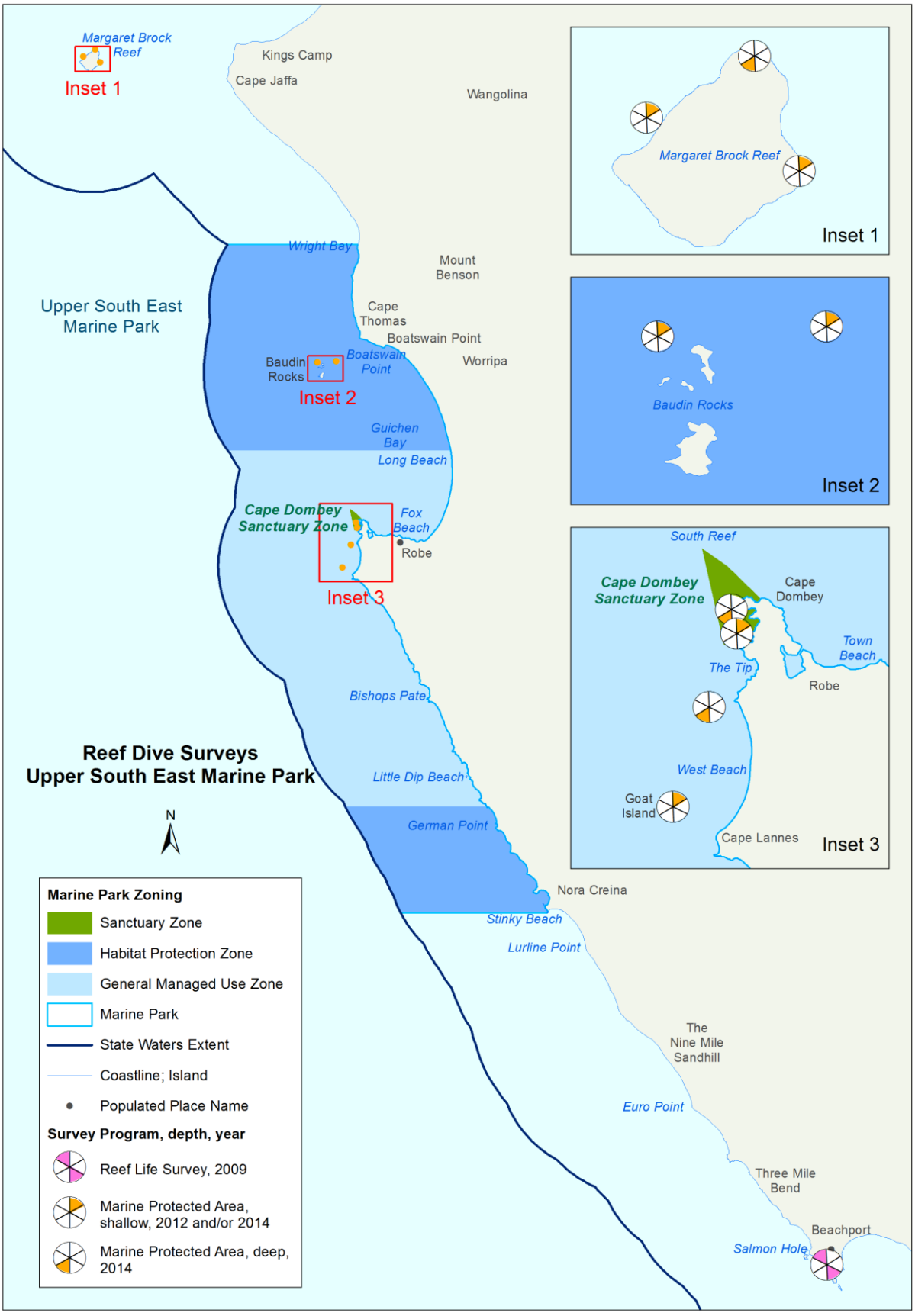


Figure 8. Map showing reef sites that have been surveyed for fishes, invertebrates and macroalgae inside and outside the Cape Dombey Sanctuary Zone of the Upper South East Marine Park

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 2009 (DEWNR and the University of Tasmania unpublished data, Figure 8) were used to infer condition of subtidal reefs in the USEMP from canopy cover calculated using the methods of Brook and Bryars (2014). The canopy cover of reefs in the USEMP was below the threshold for classification as 'good' (60 per cent cover: Turner et al. 2007, Collings et al. 2008) in both 2012 and 2014, both inside and outside of SZs (Figure 9). Different reefs were surveyed in 2012 and 2014.

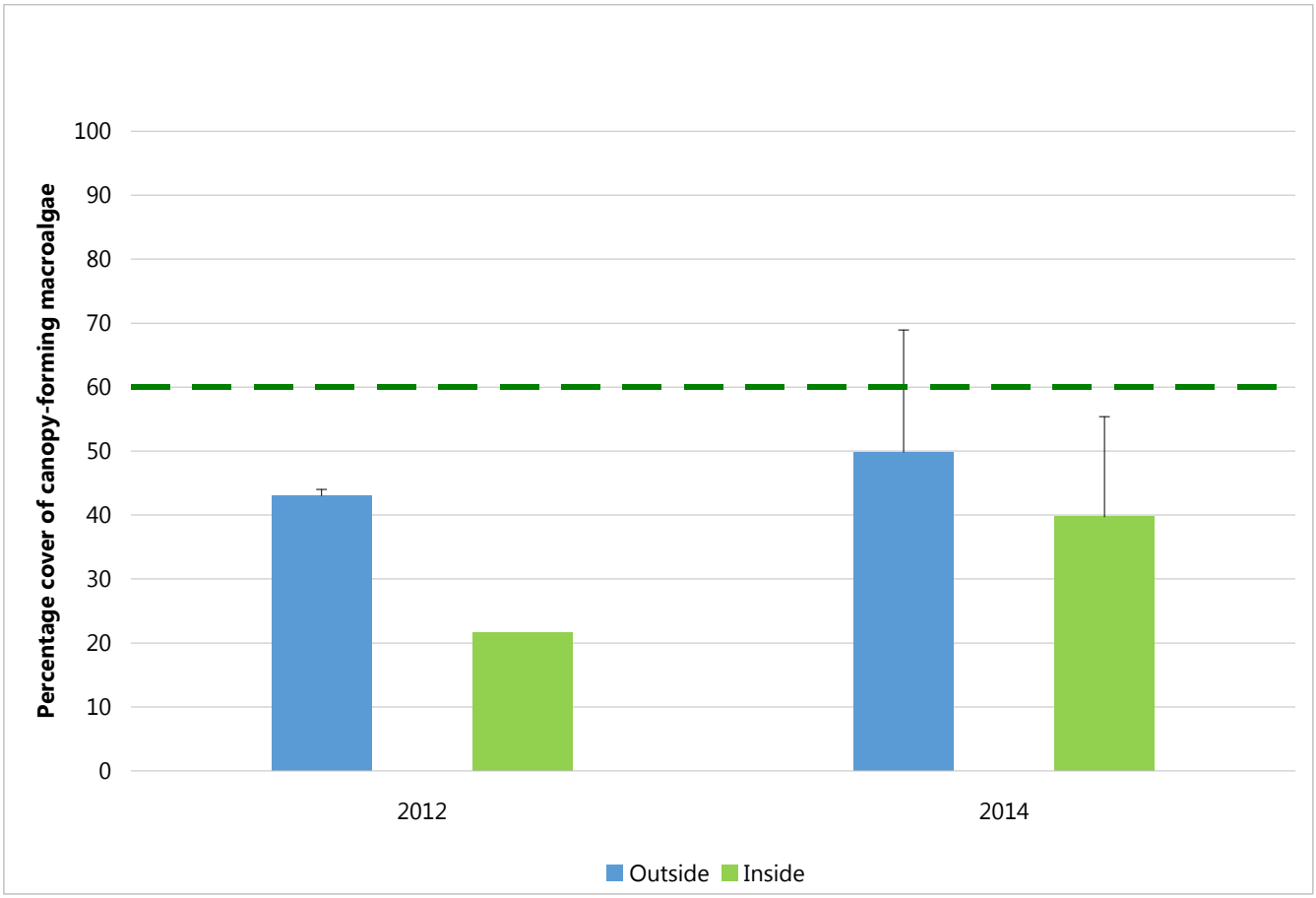
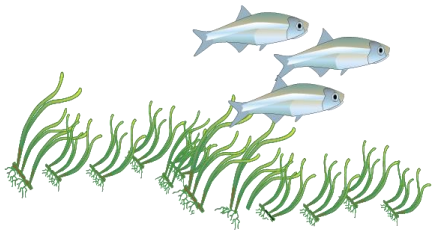


Figure 9. Percentage canopy cover of subtidal reefs surveyed during 2012 and 2014. Canopy cover estimates derived from unpublished DEWNR and the University of Tasmania data following the method described by Brook and Bryars (2014). Reefs with a canopy cover greater than 60 per cent (dashed line) are considered to be in 'good'condition (Turner et al. 2007, Collings et al. 2008). Note that different reefs were surveyed in 2012 and 2014.

4.2 Seagrass



The largest areas of seagrass occur in Lacepede Bay (Figure 6).

Baseline information on seagrass relevant to the USEMP includes:

Spatial extent of seagrass habitat

- A total of 101 square kilometres of seagrass has been mapped in the USEMP (Figure 6). About 378 square kilometres of seafloor in the USEMP have not been mapped (see Appendix B).
- One area of seagrass loss has been quantified by divers at Lacepede Bay within a HPZ during spring 2004 and autumn 2005. Seagrass near an artificial drainage system has receded seaward by about 84 metres over the past 20 years (Wear et al. 2006).

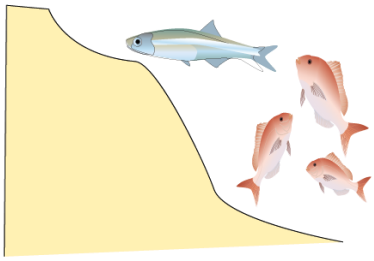
Size, abundance and diversity of seagrass communities

- Seagrass diversity and cover were surveyed by divers at 5 sites (2 near sea finfish aquaculture cages) in Lacepede Bay during November 2002 to quantify the potential impacts of sea finfish farming (Bryars 2003).
- Fish and invertebrate diversity and abundance were surveyed using beam trawls at 1 subtidal seagrass location in Lacepede Bay inside an HPZ at a depth of 10 metres during April and June 2009. A total of 51 species were recorded (Rowling et al. 2009).
- Fish and invertebrate diversity and abundance were surveyed using baited traps at 1 subtidal seagrass location in Lacepede Bay inside an HPZ at a depth of 10 metres during April and June 2009. A total of 3 species were recorded (Rowling et al. 2009).
- Fish and invertebrate diversity and abundance were surveyed using baited remote underwater video systems (Cappo et al. 2003) at 1 subtidal seagrass location in Lacepede Bay inside an HPZ at a depth of 10 metres during April and June 2009 (Rowling et al. 2009). A total of 5 species were recorded (Rowling et al. 2009).
- Seagrass, algae and sedentary invertebrate diversity and biomass were surveyed using a benthic sled tow in Lacepede Bay during April and June 2009. A total of 2 seagrass, 14 algae and 10 invertebrate species were recorded (Rowling et al. 2009, see above).
- 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 (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, area, length and epiphyte loads sampled on surveys at two sites adjacent to drains in Lacepede Bay during 2004/05 (Wear et al. 2006). Seagrasses at both sites were concluded to be in poor condition with reduced seagrass leaf densities and leaves of reduced stature.

4.3 Sand



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

Baseline information on sand relevant to the USEMP includes:

Spatial extent of sand habitat

- Sandy beaches extend along about 125 kilometres of the mainland coastline of the USEMP (Appendix B). The shoreline extent of island beaches in the USEMP has not been mapped.
- About 165 square kilometres of sand have been mapped in the USEMP (Figure 6). About 378 square kilometres of seafloor in the USEMP have not been mapped (see Appendix B).

Size, abundance and diversity of sand communities

- Sediment types and benthic invertebrate diversity and abundance were surveyed using sediment core samples from 4 locations (all within HPZs) at depths between 10 and 20 metres during April and June 2009. A total of 53 species were recorded (Rowling et al. 2009).
- Assessments are conducted on a regular basis for a number of commercially-fished species that use sand habitat including the Lakes and Coorong, Marine Scalefish and Charter Boat Fisheries (Fowler et al. 2013a, Earl and Ward 2014, 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).

Sand habitat condition

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

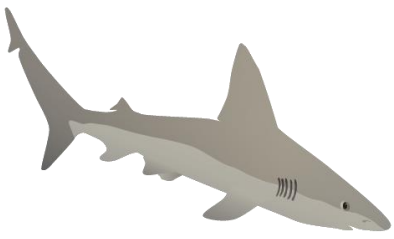
4.4 Mangrove

There are no mangroves in the USEMP (Figure 6).

4.5 Saltmarsh

There is no saltmarsh in the USEMP (Figure 6).

4.6 Sharks



The USEMP is used by a number of shark species, including blue shark, dusky whaler, smooth hammerhead, school shark, white shark, shortfin mako and porbeagle (DENR 2010). The USEMP is within a relatively productive area for gummy sharks in the South Australian Marine Scalefish Fishery (Fowler et al. 2012, 2013b, 2014b, see Section 8.2.1).

Baseline information on sharks relevant to the USEMP 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 USEMP is used by a number of marine mammal species, including the Australian sea lion, long-nosed fur seal (formerly New Zealand fur seal), Australian fur seal, blue whale, 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. Blue whales feed in several areas between the eastern Great Australian Bight and Cape Otway in Victoria between November and May each year (Gill et al. 2011).

Baseline information on marine mammals relevant to the USEMP includes:

- There is a haul-out site for the Australian seal lion at Baudin Rocks (Robinson et al. 1996).
- There is a breeding site for the long-nosed and Australian fur seal at Baudin Rocks (Shaughnessy et al. 2014).
- The abundance of blue whales between the eastern Great Australian Bight and Cape Otway has been monitored annually between 2001 and 2007 (Gill et al. 2011, Figure 10). Blue whale abundance between Cape Jaffa and Cape Nelson in Victoria peaks from January to April, coinciding with greater upwelling intensities and increased food availability (Gill et al. 2011).

4.8 Seabirds

The USEMP is used by a number of seabird species, including black-faced cormorant, crested tern, fairy tern, little penguin, pied cormorant and silver gull (DENR 2010). Some of these species are resident while others are more transient, visiting the USEMP to rest, breed and/or feed.

Baseline information on seabirds relevant to the USEMP includes:

- The distribution and abundance of breeding sites for 16 species of seabird have been surveyed numerous times since 1971 (Copley 1996, DEWNR 2015g). Goldsworthy and Page (2010) reviewed the distribution and abundance of crested terns, little penguins, short-tailed shearwaters and flesh-footed shearwaters. Crested terns and little penguins breed at Baudin Rocks within the USEMP, including estimated populations of about 1,500 and 100 pairs, respectively (Copley 1996). There are also breeding sites for the black-faced cormorant and pied cormorant (Copley 1996).

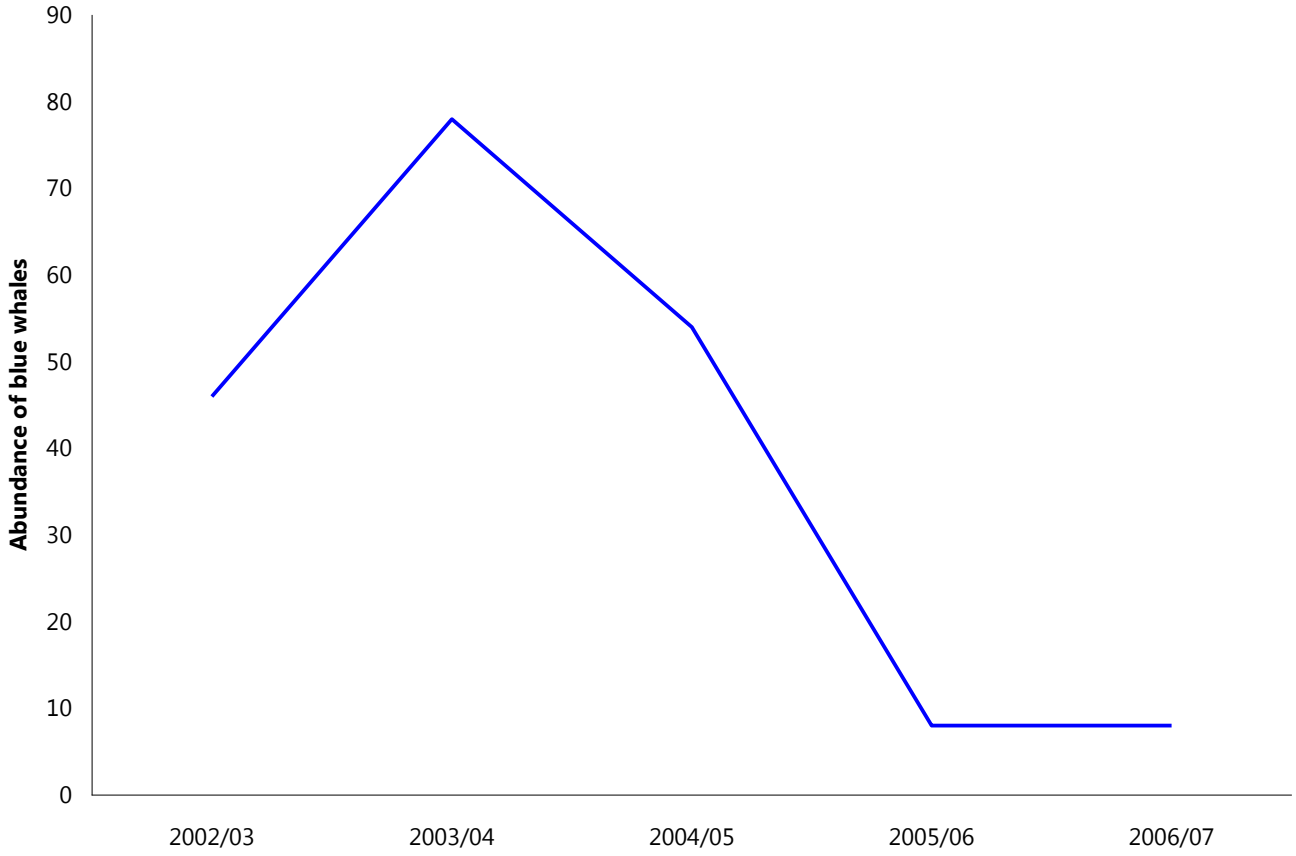
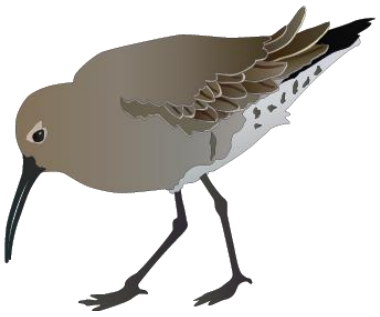


Figure 10. Abundance of blue whales recorded by aerial surveys between Cape Jaffa and Cape Nelson (Victoria). Source: Gill et al. (2011)

4.9 Shorebirds



The USEMP is used by a number of shorebird species for breeding and feeding, including pied and sooty oystercatchers, hooded plover, red capped plover, common sandpiper and masked lapwing (DENR 2010, Christie and Jessop 2007). Habitat includes the Coorong which is a Wetland of National Importance (Department of the Environment 2015). Some of these species are resident and others migrate to the USEMP from interstate or overseas.

Baseline information on shorebirds relevant to the USEMP includes:

- Diversity and abundance have been surveyed along the Limestone Coast since 1981, including sites within this park at Nora Creina, Creina Bay, Boatswain Point, Wright Bay and Guichen Bay. Counts were recorded from 2 to 22 times per site for 15 species of shorebird (Christie and Jessop 2007). These data are a subset of an ongoing statewide dataset that is maintained by the Shorebirds 2020 Project (BirdLife Australia 2015).

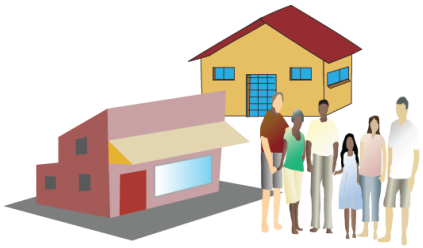
5 Socio-economic values

Monitoring socio-economic values will be a core component of the marine parks MER program. For the purpose of the baseline reports, socio-economic values are summarised according to 8 broad categories: local businesses and communities, coastal recreation, tourism, cultural heritage, transport and aquaculture, 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 USEMP (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 Australia framework for assessment of the impacts of marine parks on socio-economic values and this framework will be adopted in the MER program.

5.1 Local businesses and communities

Most local businesses and communities are based within the vicinity of Kingston or Robe. Most information in this section is reported for the Kingston-Robe and The Coorong Statistical Areas Level 2 or the Robe, Kingston and The Coorong Local Government Areas, or the Upper South East 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 USEMP includes:

- The Australian Bureau of Statistics provides annual estimates of the resident population. This information is presented for several spatial scales including Statistical Areas Level 2 and Local Government Areas (see Appendix C) as a time-series covering the previous decade (ABS 2015a). Between 2004 and 2014, the population growth in South Australia was about 10 per cent, and the estimated resident population and population growth for Local Government Areas relevant to the USEMP were (ABS 2015a, Figure 11):
    - The Coorong: a decrease of about 5 per cent (300 persons) to 5,586 persons
    - Kingston: growth of about 1 per cent (25 persons) to 2,368 persons
    - Robe: growth of about 4 per cent (55 person) to 1,431 persons

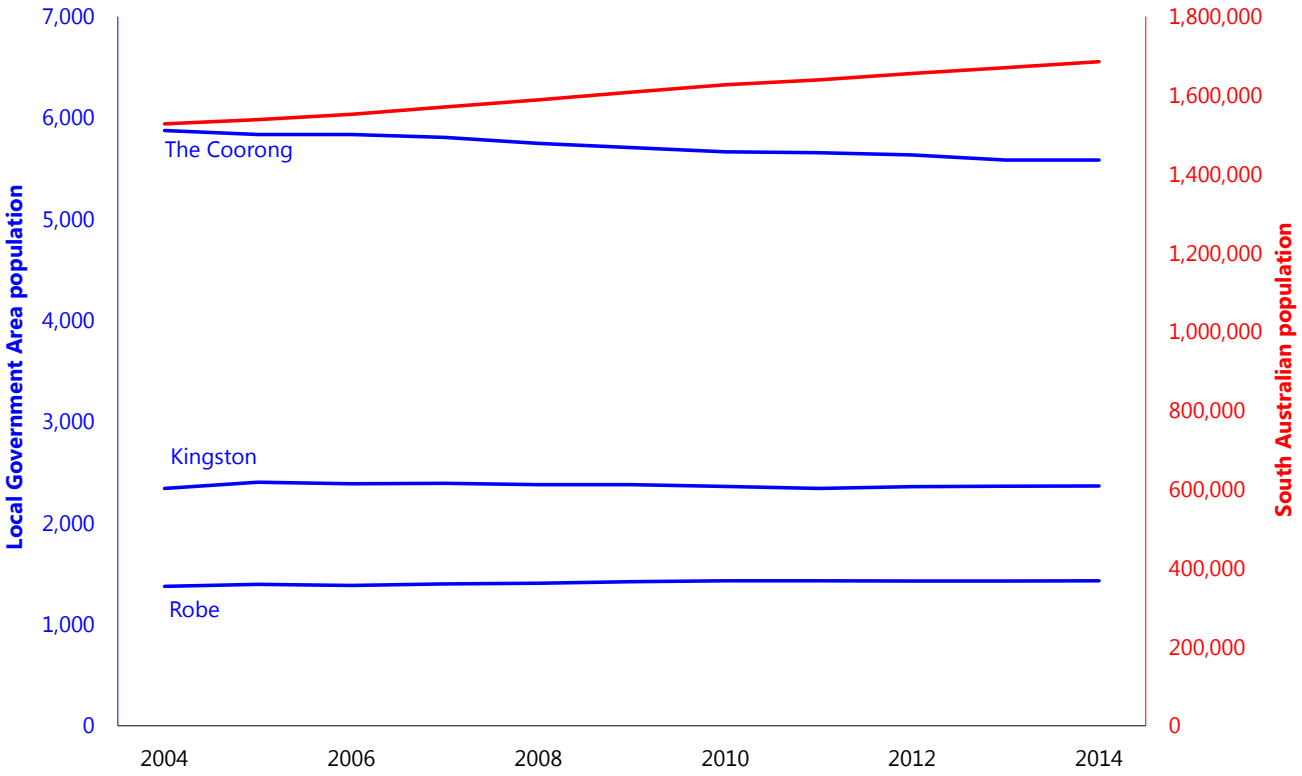


Figure 11. Population trends in The Coorong, Kingston and Robe Local Government Areas compared with South Australia. Source: ABS (2015a)

5.1.2 Production and employment

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

Baseline information on production and employment relevant to the USEMP 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 USEMP (see Appendix C) were (National Economics and .id 2015):
    - The Coorong: $293 million, representing 0.32 per cent of gross state product in the same year (about $90 billion).
    - Kingston: $124 million, representing about 0.13 per cent of gross state product in the same year.
    - Robe: $95 million, representing 0.1 per cent of gross state product in the same year.
- Gross regional product for the Upper South East region (Kingston and Robe Local Government Areas, see Appendix C) was $146 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 (34 per cent), jobs (32 per cent) and exports (53 per cent) in the Upper South East region in 2009/10 (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 the Kingston-Robe and The Coorong Statistical Areas Level 2 (see Appendix C) was 555 and 765, respectively, of which 283 and 440 were in the agriculture, forestry and fishing sector, respectively (ABS 2015b).
- 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, there were 723, 974 and 2347 jobs in the Robe, Kingston and The Coorong Local Government Areas, respectively (National Economics and .id 2015). In 2006, about 80 per cent of jobs from the Upper South East region (see Appendix C) 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 the Robe, Kingston and The Coorong Local Government Areas was 3.3, 3.4 and 6.3 per cent, respectively, while the South Australian rate was 6.7 per cent at the same time (Department of Employment 2015, Figure 12). 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).

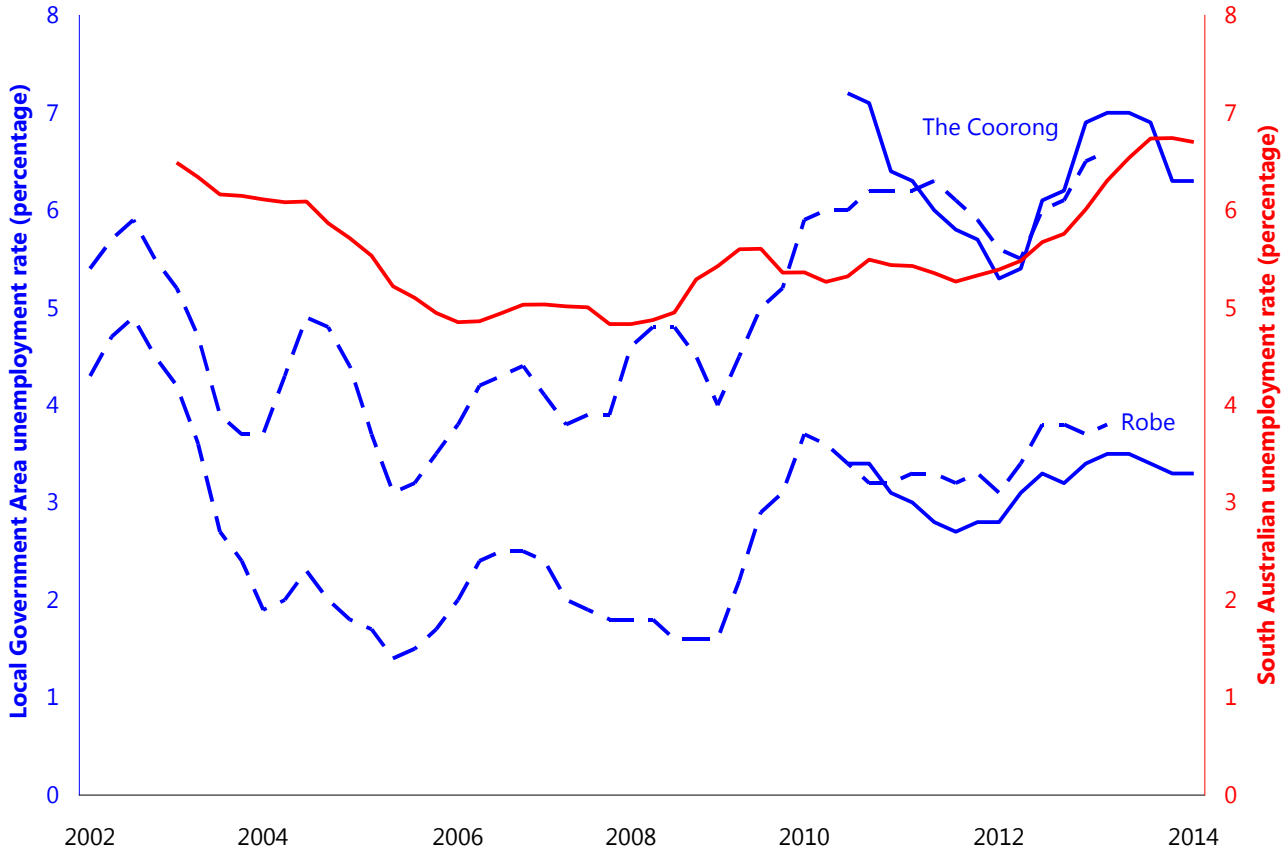


Figure 12. Unemployment rate The Coorong and Robe Local Government Areas compared with South Australia. Dotted blue line shows data for Statistical Local Areas (see Appendix C) which are similar to Local Government Areas, but are no longer used for reporting. Note that unemployment trends for Kingston (not presented) are similar to those at Robe. 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 USEMP 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 Upper South East region (see Appendix C), and reported that:

  - the number of building approvals increased by 39 per cent between 2001/02 and 2010/11, compared with a 3 per cent increase in South Australia.

  - the average value per approval increased from $135,000 to $270,000 (100 per cent) between 2001/02 and 2010/11, compared with $128,000 to $236,000 (85 per cent) in South Australia.

- Bailey et al. (2012b) reported house price information sourced from RP Data Pty Ltd. The median house price in the Upper South East region (see Appendix C) increased from about $85,000 to $298,000 (251 per cent) between 2000/01 and 2010/11, 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 2015h). 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 USEMP between 1990 and 2014 were (Figure 13):
    - The Coorong: increased from about $28,000 to $160,000.
    - Kingston: increased from about $40,000 to $221,000.
    - Robe: increased from about $15,500 to $317,000.

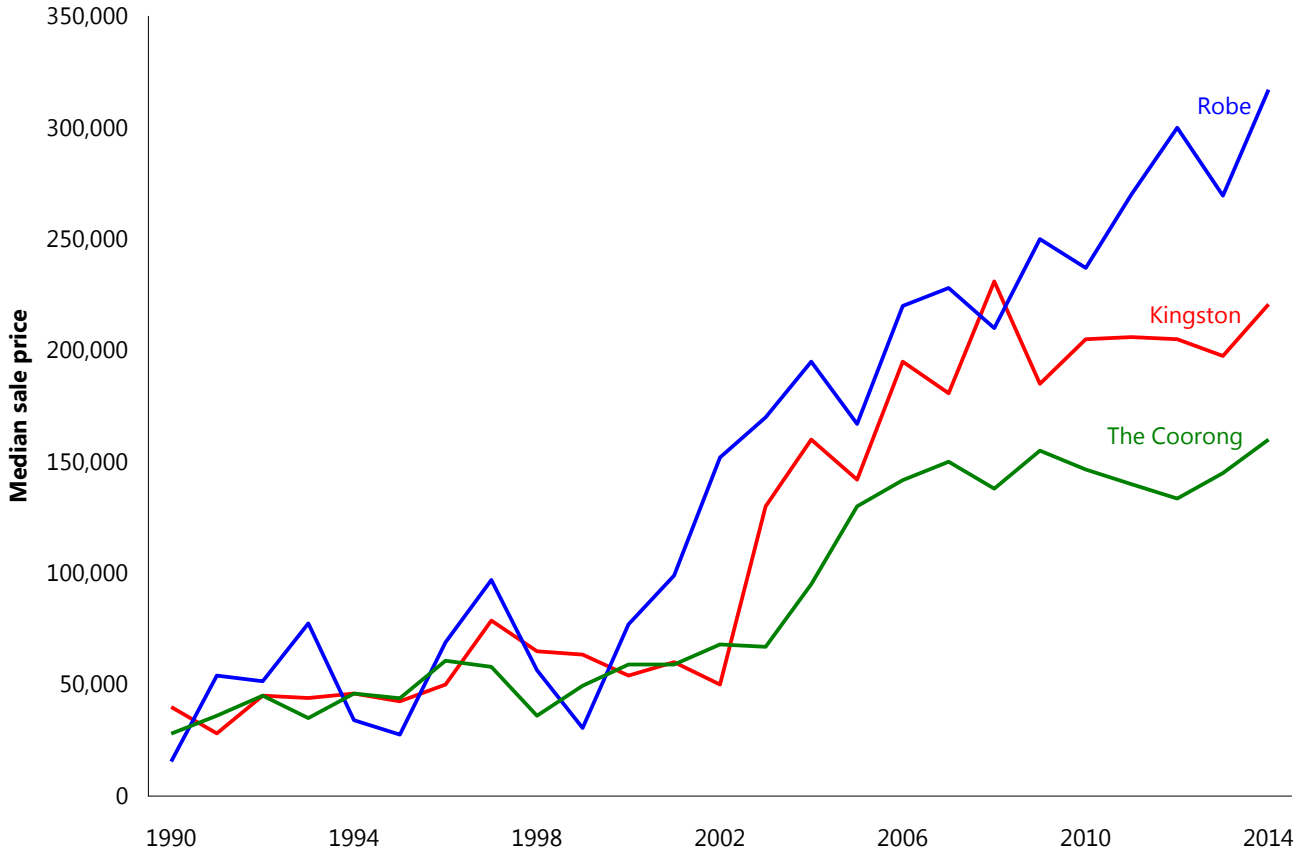


Figure 13. Median sale price for residential properties in The Coorong, Kingston and Robe Local Government Areas. For each property, these data only include the most recent sale which is a transfer of the full value and whole of land. There is potential volatility in the median price due to random fluctuations in the quality of properties sold in particular years. Source: DEWNR (2015h).

5.1.4 Socio-economic advantage and disadvantage

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

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 socio-economic advantage and disadvantage based on income, education, employment, occupation, housing and other information from the five-yearly census (ABS 2011a). In 2011, The Coorong and Kingston Local Government Areas were in the lowest 40 and 50 per cent (i.e. relatively disadvantaged) and Robe was in the highest 30 per cent (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.

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 USEMP includes:

- Regular (about annual) phone surveys of the general public have been commissioned by DEWNR to gauge community support and perceptions on a range of factors related to the marine environment and marine parks in South Australia (e.g. Square Holes 2015). Community attitudes towards marine parks in South Australia indicated between 79 and 95 per cent support for marine parks (Figure 14). Support for marine parks in the local area of the people who were surveyed has typically been lower (between 58 and 79 per cent, Figure 14). In 2015, support for marine parks in general versus those in their local area was 82 and 72 per cent, respectively, for South East respondents (from Kingston, Robe and Beachport and Mount Gambier, Square Holes 2015).

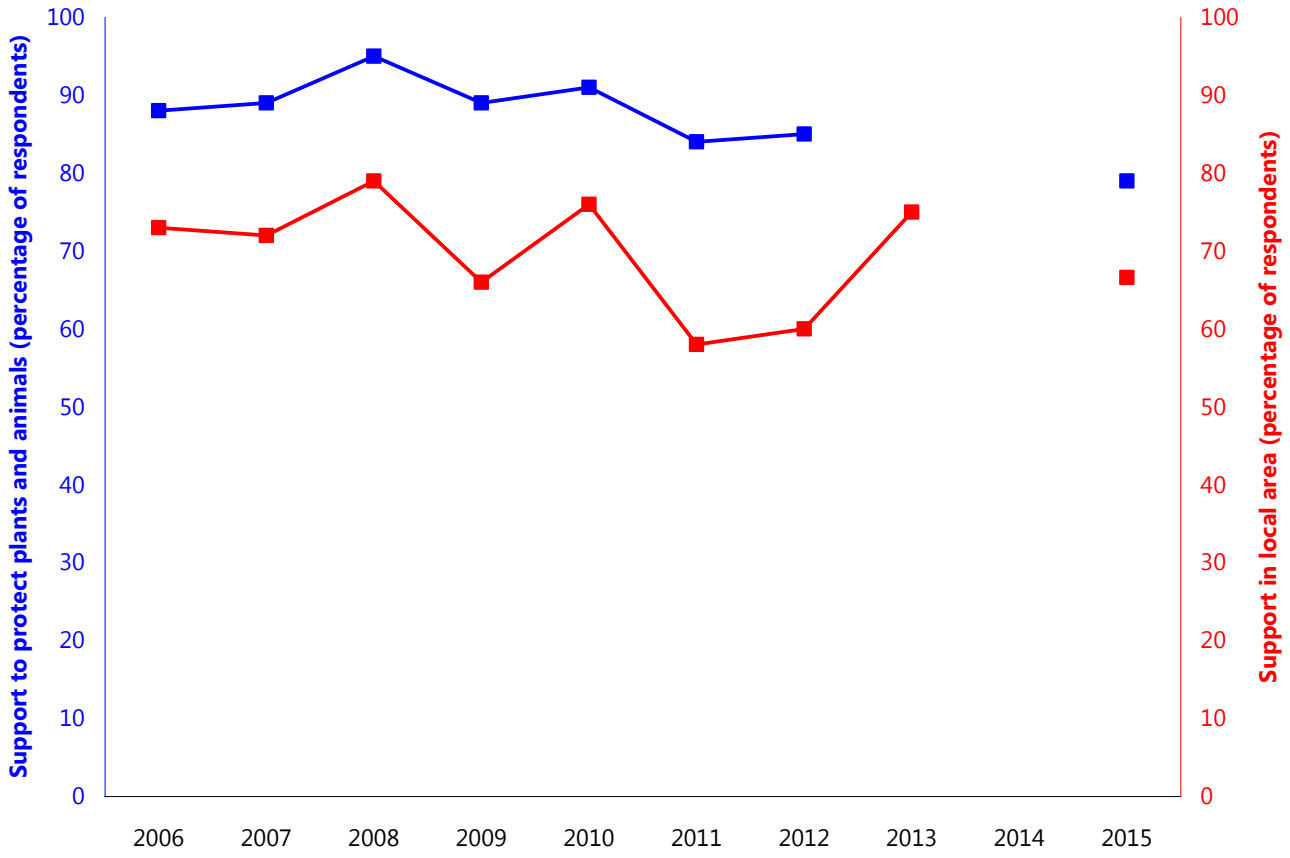


Figure 14. Results of phone surveys regarding support for marine parks to protect marine plants and animals and support in local area. No data were available for 2013 (blue line) or 2014 (both lines). Source: Square Holes (2015).

5.2 Coastal recreation

The USEMP 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 USEMP 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 15). These uses declined after 2007 but have since been stable (Figure 15). In 2015, the general use, fishing and boating participation rates were 54, 22 and 26 per cent, respectively, of South East respondents (from Kingston, Robe, Beachport and Mount Gambier, Square Holes 2015).
- During 2013 and 2014, 20 per cent of domestic visitors to the Limestone Coast tourism region visited the beach, 9 per cent went fishing, and 15 per cent visited national or state parks (South Australian Tourism Commission unpublished data, see Section 5.3).
- The Department of Planning, Transport and Infrastructure publishes annual statewide statistics on boat registrations and licences (DPTI 2015a, b). General boat and jet ski registrations increased by about 6 and 45 per cent, respectively, between 2007 and 2014 (DPTI 2015a, Figure 16). Boat licences varied between 5,000 and

7,000 during the same period (DPTI 2015b, Figure 17). Note that data are available from 1975 but only data from 1992 are presented in Figure 17. 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 Australian coastline (Lothian 2005). The coastlines of the USEMP were rated as having moderate to high (between 6 and 8 out of 10) scenic quality (Lothian 2005).

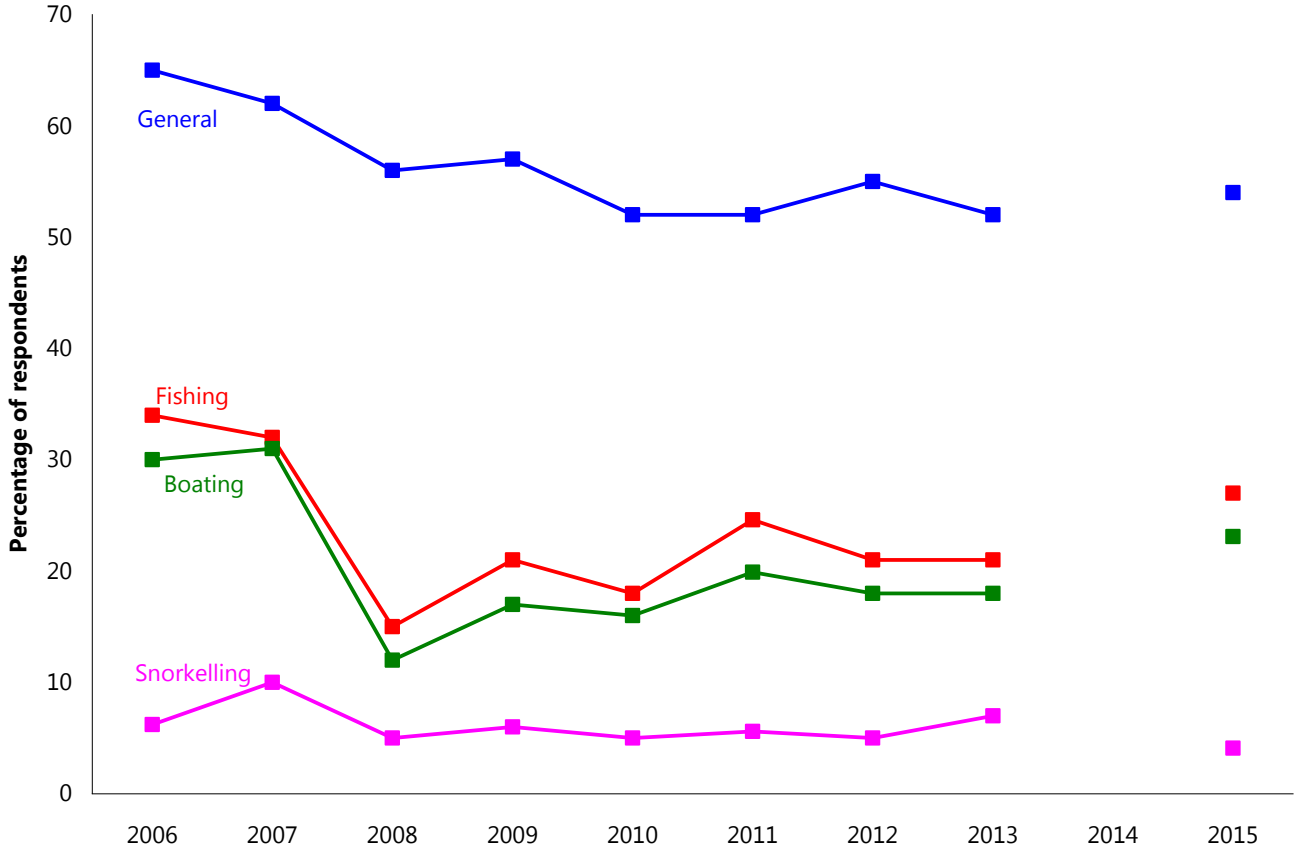


Figure 15. Percentage of phone survey respondents who participate in general recreational, fishing, boating and snorkelling activities in the marine environment at least monthly. No data were available for 2014. Source: Square Holes (2015).

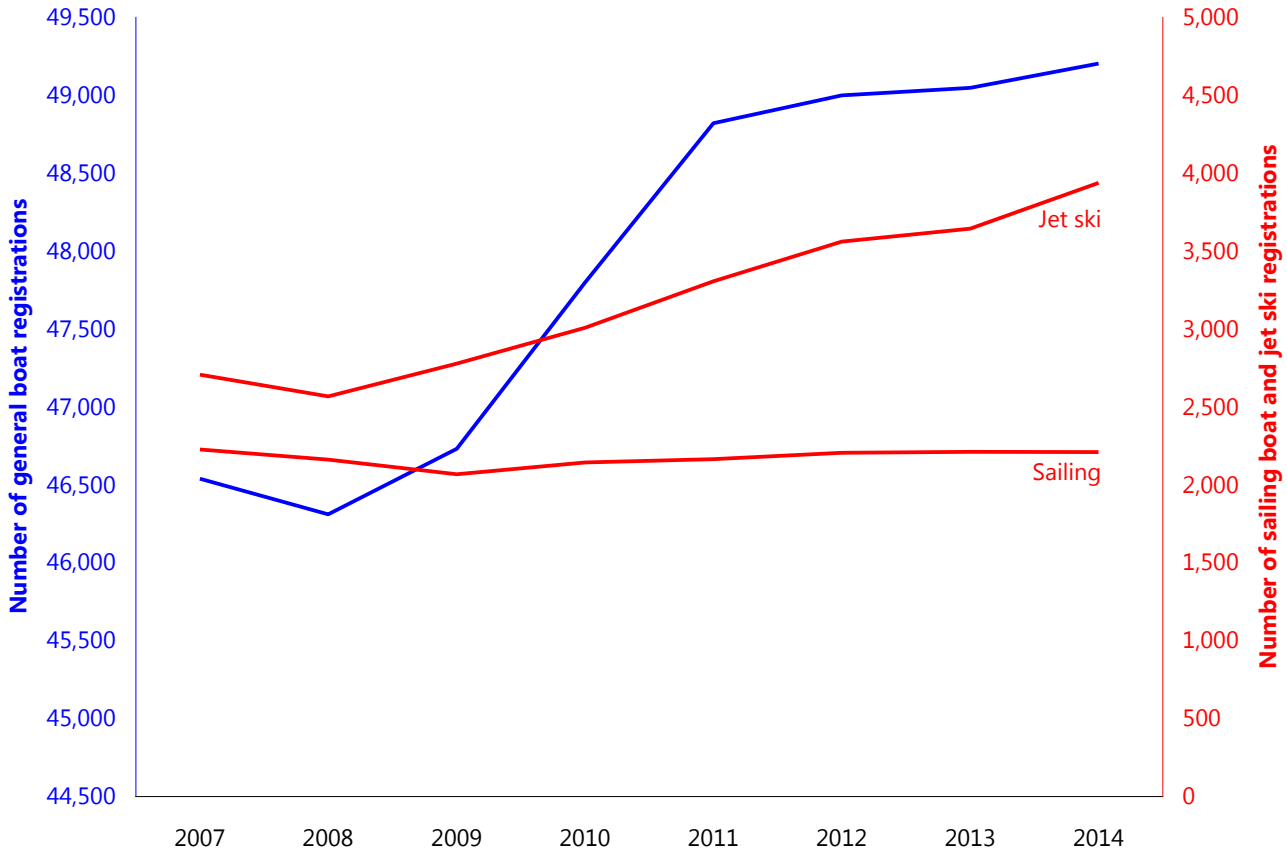


Figure 16. South Australian boat registrations for general boats, and sailing vessels and jet skis. General boat registrations include cabin cruisers, half cabins, cuddy cabins, centre consoles, inflatables, open boats and runabouts. Catamarans are grouped with sailing vessels. Source: DPTI (2015a).

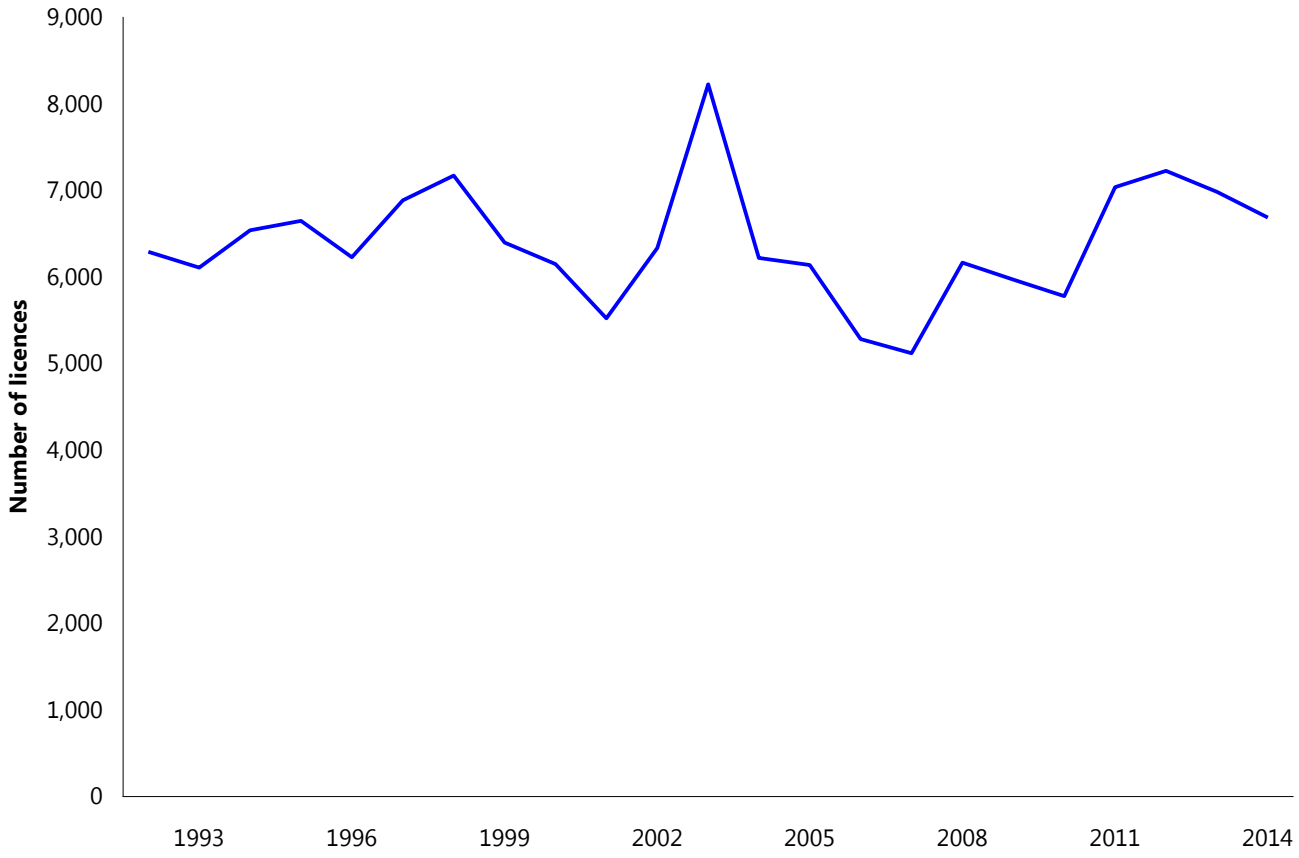


Figure 17. Number of South Australian boat licences. Source: DPTI (2015b).

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), camping and four-wheel driving (DENR 2010; South Australian Tourism Commission 2015).

Baseline information on tourism relevant to the USEMP includes:

- Bailey et al. (2012b) provided information on expenditure by tourists for the Upper South East region (Kingston and Robe Local Government Areas, see Appendix C). Expenditure by tourists in 2009/10 in the Upper South East region of about $29 million contributed about 22 per cent of its total value of exports and generated about 8 per cent of its gross regional product and about 14 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 18 and Figure 19). Expenditure by tourists in the Limestone Coast tourism region (see Appendix C) in 2013/14 was $265 million. 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, 20

per cent of domestic visitors to the Limestone Coast visited the beach, 9 per cent went fishing, and 15 per cent visited national or state parks (South Australian Tourism Commission unpublished data).

- A report by BDA Marketing Planning for Tourism Australia (Australia Consumer Demand Research) based on a survey of international visitors found that beaches were the top Australian attraction, appealing to 53 per cent of visitors, and viewing aquatic wildlife was the top experience, appealing to 50 per cent visitors (Tourism Australia, undated a).
- DEWNR maintains a database of coastal and marine tourism operators in South Australia (DEWNR unpublished data). In 2014, 4 coastal or marine tourism operators used the USEMP offering a range of activities including fishing charters, marine mammal watching, and more general cruises and sight-seeing.

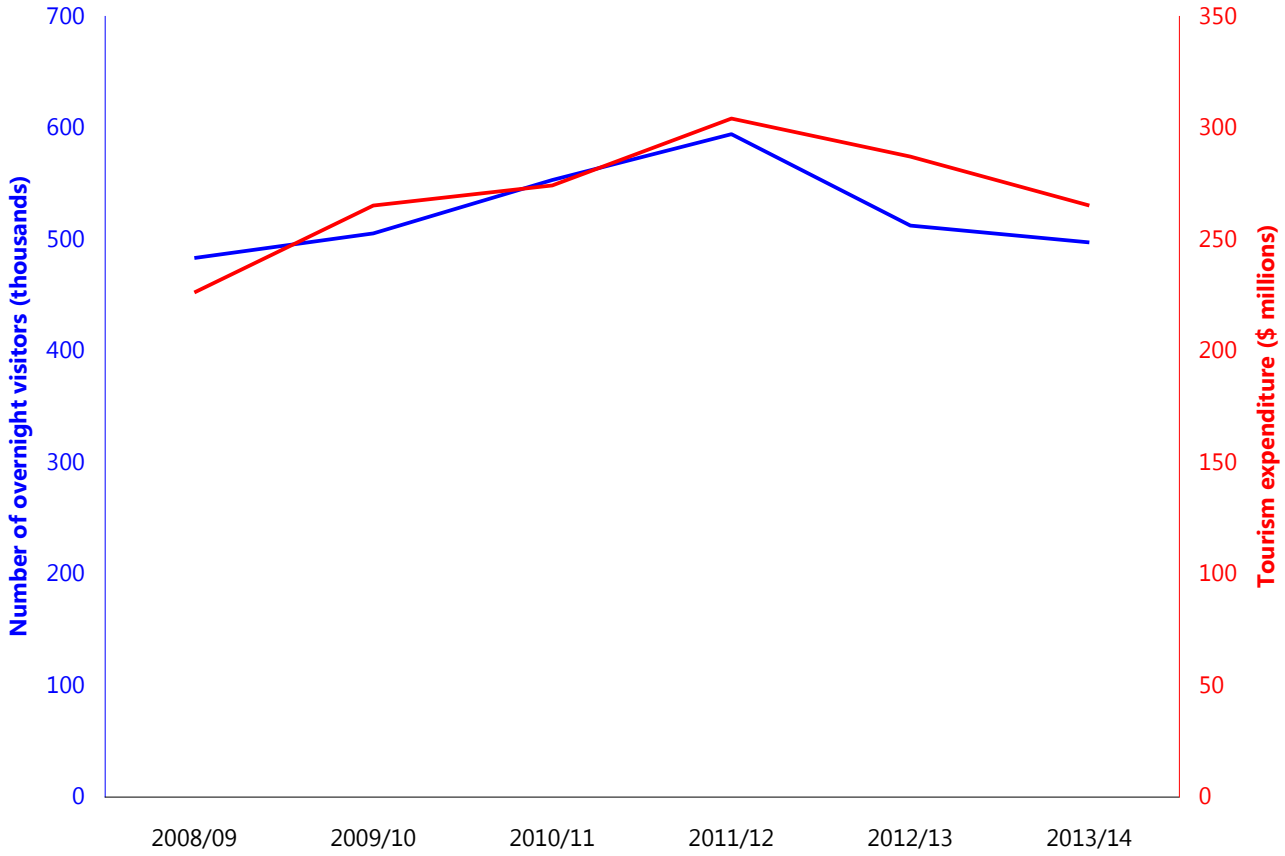


Figure 18. Number of overnight visitors and tourism expenditure for the Limestone Coast tourism region Source: Tourism Research Australia (2015).

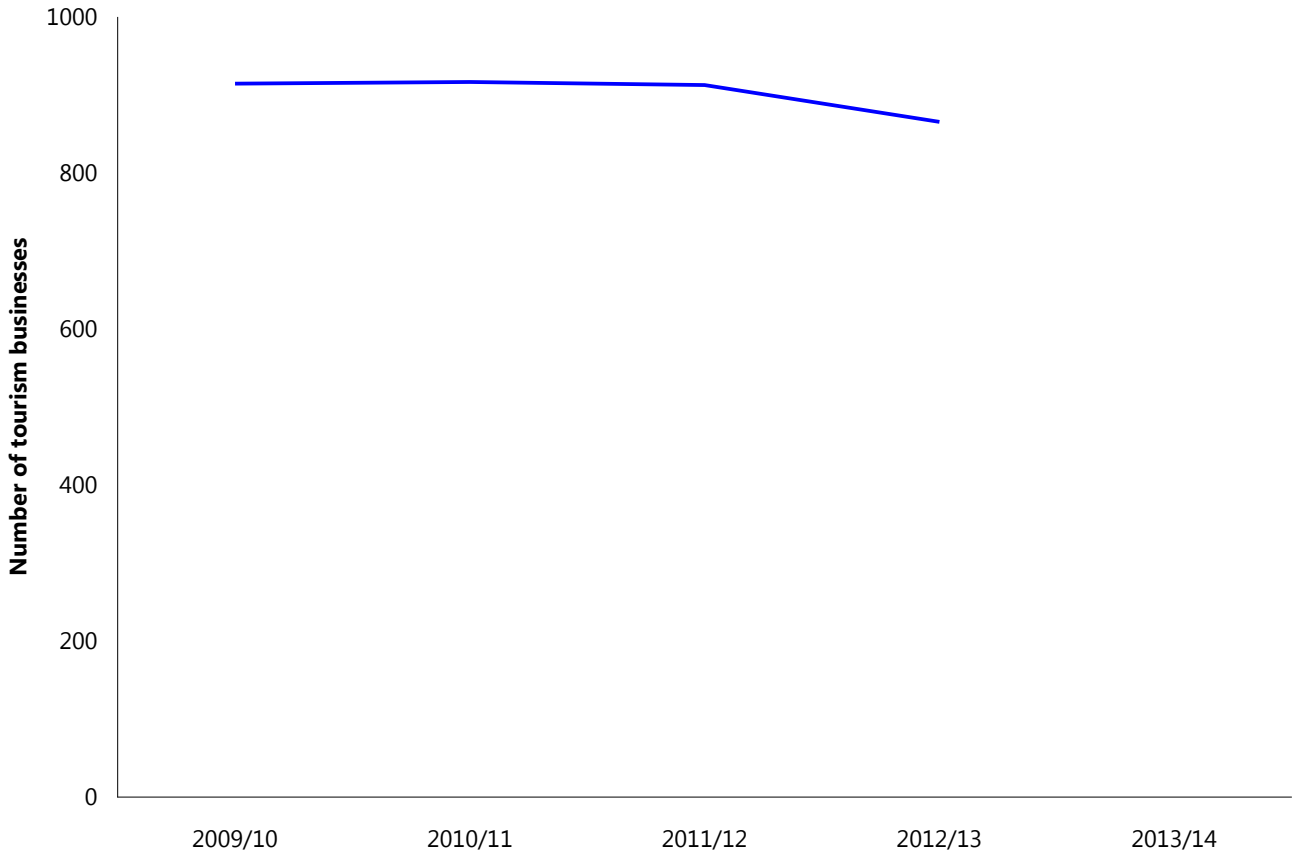
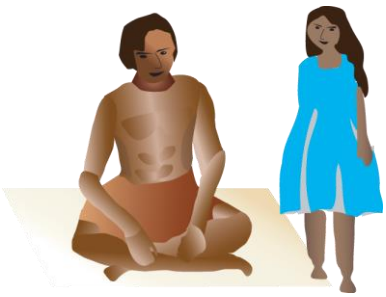


Figure 19. Number of tourism businesses in the Limestone Coast tourism region. No data were available for 2013/14. Source: Tourism Research Australia (2015).

5.4 Cultural heritage

5.4.1 Aboriginal heritage



The Ngarrindjeri, Buandig and Meantank people have traditional associations (which may include Aboriginal traditional fishing) with areas of the Upper South East Marine Park. The Ngarrindjeri native title claim includes some of the Upper South East Marine Park (DENR 2010, National Native Title Tribunal 2015).

Baseline information on Aboriginal heritage relevant to the USEMP 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.

5.4.2 European heritage

Lieutenant James Grant of the Royal Navy was the first British person to describe the coastline and mountains of the South East region in 1800. Shortly after this, Nicolas Baudin and Louis Freycinet explored this coastline and named Cape Dombey, Cape Rabelais and Guichen and Lacepede Bays (DENR 2010).

Baseline information on European heritage relevant to the USEMP 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 USEMP include the Cape Dombey Obelisk (DEWNR 2015i).
- 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 14 shipwrecks in the USEMP (DEWNR 2015j), most of which are fishing vessels (DENR 2010).

5.5 Transport and infrastructure

Transport and infrastructure provide important socio-economic activity and value in the South East region (DENR 2010). There are no ports in the USEMP.

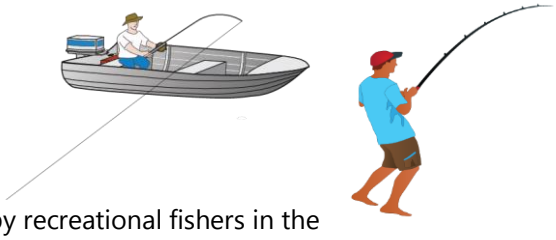
Baseline information on transport and infrastructure relevant to the USEMP includes:

- As of October 2014, coastal infrastructure in the USEMP included 3 breakwaters, 1 jetty, 1 slipway, 1 harbour, 1 marina, and 5 boat ramps (DEWNR 2016a, b, c, d, DEWNR unpublished data).

5.6 Aquaculture

An aquaculture zone is located in Lacepede Bay which allows for the farming of finfish. There are several finfish aquaculture sites in the zone (near Cape Jaffa) but none of these are within the USEMP (DEWNR 2015k).

5.7 Recreational fishing



Recreational fishing has an important socio-economic value across South Australia, including in the USEMP. 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 USEMP include King George whiting, snapper, Australian salmon, and mulloway. For these species, the statewide recreational catch is between 38 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 USEMP 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 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 USEMP (see Appendix C) decreased by 57 per cent from about 84,000 days in 2000/01 to 36,000 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 USEMP decreased by about 67 per cent from about 29,500 in 2000/01 to 9,800 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 20). Recreational fishing activity declined slightly after 2007 but has since been relatively stable (Figure 20). In 2015, 22 and 46 per cent of South East respondents (from Kingston, Robe and Beachport and Mount Gambier) fished at least once each month or each year, respectively.

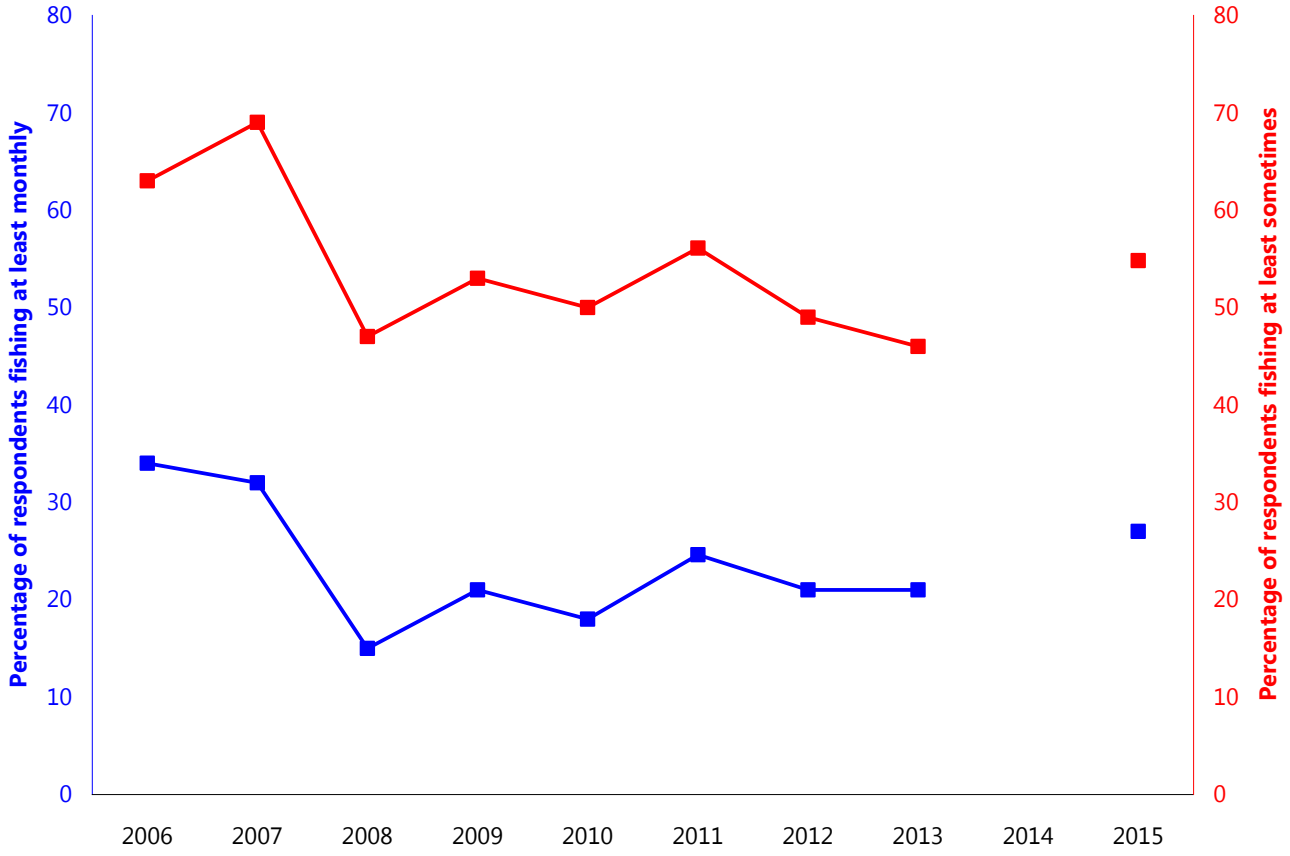


Figure 20. Percentage of statewide phone survey respondents who participate in recreational fishing. No data were available for 2014. Source: Square Holes (2015).

5.8 Commercial fishing

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

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 USEMP lies within the Southern Zone of the South Australian Rock Lobster Fishery, which extends from the Murray Mouth to the Victorian border. The fishery allows potting for rock lobster, and various by-product species including Maori octopus. Fishing is conducted on subtidal reef habitat. There are 181 licences in the Southern Zone Rock Lobster Fishery, with the majority of vessels fishing from Robe and Port MacDonnell (Linnane et al. 2015).

Baseline information on the Rock Lobster Fishery relevant to the USEMP includes:

- The annual value of the Southern Zone Rock Lobster Fishery between 2003/04 (when quota system was introduced) and 2013/14 ranged between $65 and $95 million (EconSearch 2015a, Figure 21).
- 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 51 and 55 overlap the USEMP (see Appendix C), and are 2 of the main 4 areas for the fishery that are reported in more detail. More than 35 per cent of the catch in the Southern Zone Rock Lobster Fishery was taken from areas 51 and 55 in 2013/14 (Linnane et al. 2015), and an average of 43 per cent between 1993 and 2011 (Ward et al. 2012).

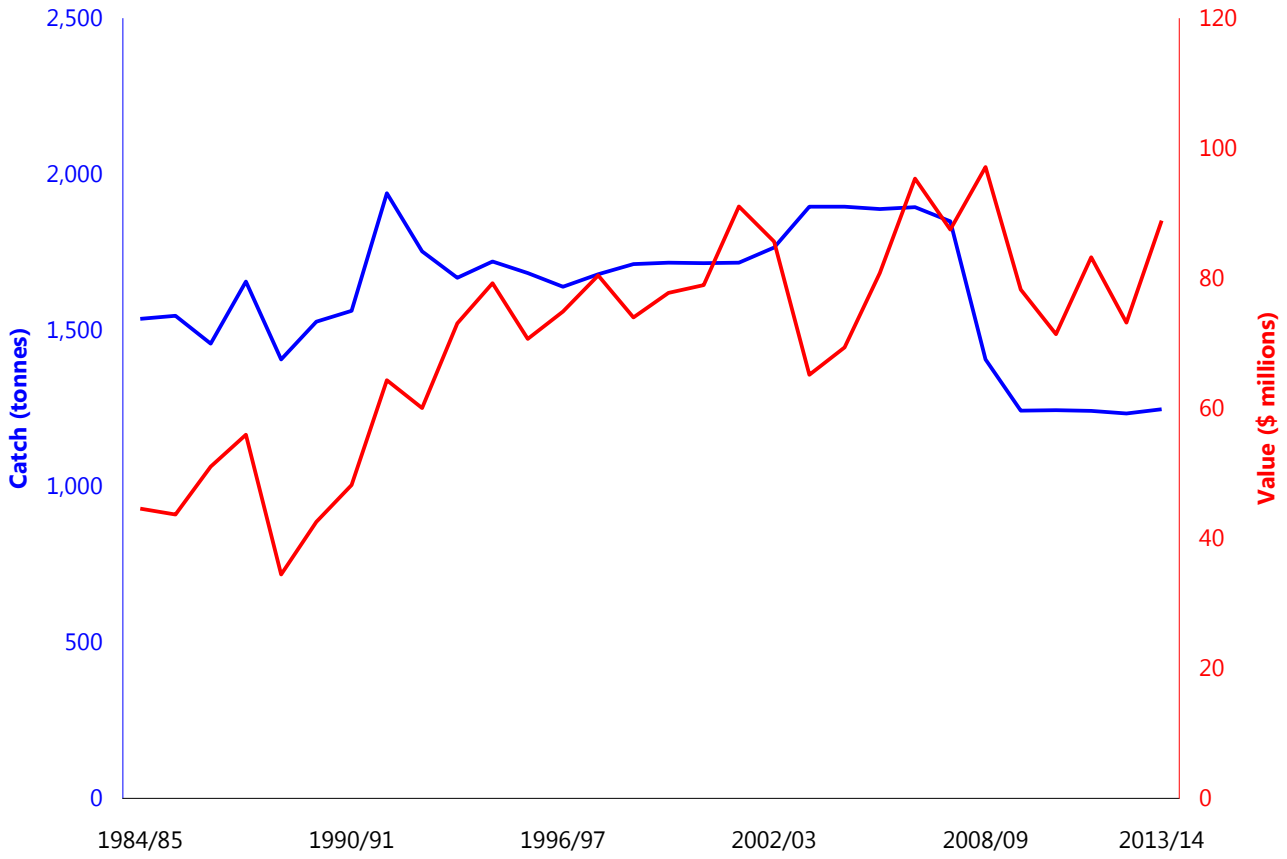


Figure 21. Catch and value of catch for the Southern Zone Rock Lobster Fishery. Value of catch has been adjusted to real terms (2013/14 dollars) using the consumer price index for Adelaide. Source: EconSearch (2015a).

5.8.2 Abalone Fishery

The USEMP lies within the Southern Zone of the South Australian Abalone Fishery, which extends from Cape Jaffa to the Victorian Border, and allows removal of greenlip and blacklip abalone. Fishing is conducted on subtidal reef habitat. There are 6 licences in the Southern Zone (PIRSA 2015a). The main regional area associated with the fishery is Mount Gambier (PIRSA 2009).

Baseline information on the Abalone Fishery relevant to the USEMP includes:

- The annual value of the Southern Zone Abalone Fishery catch rose from about $3.5 million in 1990/91 to a peak of about $10 million in 2000/01, and was about $3.4 million in 2013/14 (EconSearch 2015b, Figure 22).
- 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. 2015). The Cape Jaffa and Nora Creina spatial assessment units overlap the USEMP (see Appendix C). About 4 per cent of the catch in the Southern Zone Abalone Fishery between 2004/05 and 2013/14 was taken inside the Cape Jaffa and Nora Creina spatial assessment units (Mayfield et al. 2015).

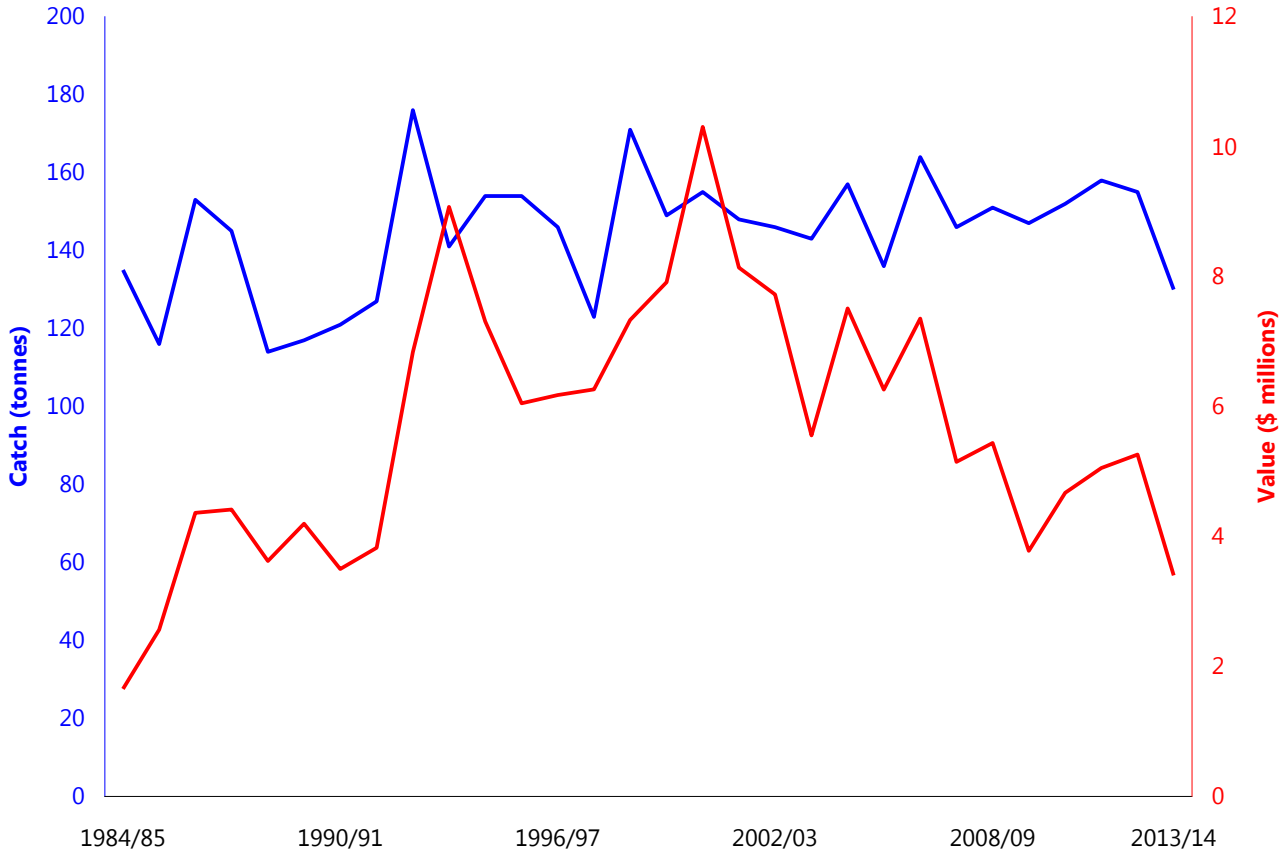


Figure 22. Catch and value of catch for the Southern Zone Abalone Fishery. Value of catch has been adjusted to real terms (2013/14 dollars) using the consumer price index for Adelaide. Source: EconSearch (2015b), Knight and Tsolos (2012).

5.8.3 Prawn Fishery

The Prawn Fishery does not operate in the USEMP.

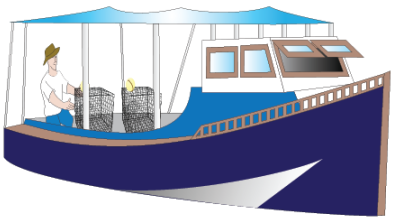
5.8.4 Blue Crab Fishery

The Blue Crab Fishery does not operate in the USEMP.

5.8.5 Sardine Fishery

The Sardine Fishery does not operate in the USEMP.

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.

Baseline information on the Marine Scalefish Fishery relevant to the USEMP 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 2015c, Figure 23).
- The annual statewide Marine Scalefish Fishery catch was about 8,000 tonnes in 1991/92 and about 2,300 tonnes in 2013/14 (EconSearch 2015c, Figure 23).
- 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 (Fowler et al. 2012, 2013a, b, 2014b, Steer et al. 2016). Catches of snapper in marine fishing area 51 were between 11 and 25 tonnes for 2012/13 and 2013/14 and were between 26 and 50 tonnes in 2011/12 (Fowler et al. 2012, 2013b, 2014b).

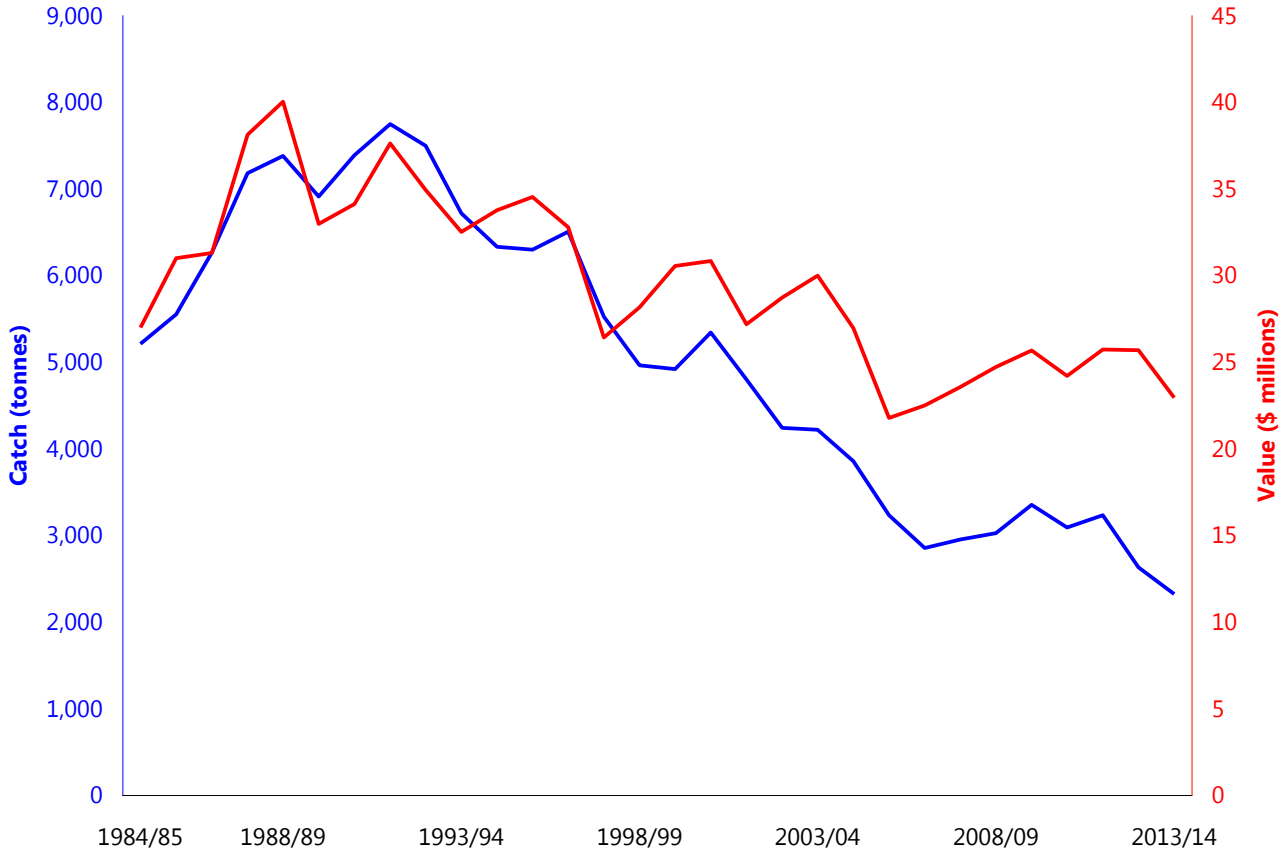
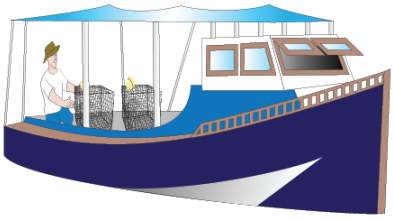


Figure 23. Catch and value of catch for the Marine Scalefish Fishery. Value of catch has been adjusted to real terms (2013/14 dollars) using the consumer price index for Adelaide. Source: EconSearch (2015c) and earlier reports.

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. Between July 2009 and June 2012, 3 operators used Cape Jaffa (between the northern and southern park sections) as their port of departure, and two operators used Robe (Tsolos 2013).

Baseline information on the Charter Boat Fishery relevant to the USEMP 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 2015d, Figure 24).
- 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 Victor Harbor/South East region (see Appendix C) accounted for between 2 and 3 per cent of the statewide catch between 2009/10 and 2011/12 (Tsolos 2013). During this period, there was a decline in the number of fish harvested from about 3,700 to 3,300, a reduction in the proportion of bight redfish in the harvest from 37 to 12 per cent, and an increase in the proportion of King George whiting from 16 to 37 per cent (Tsolos 2013).

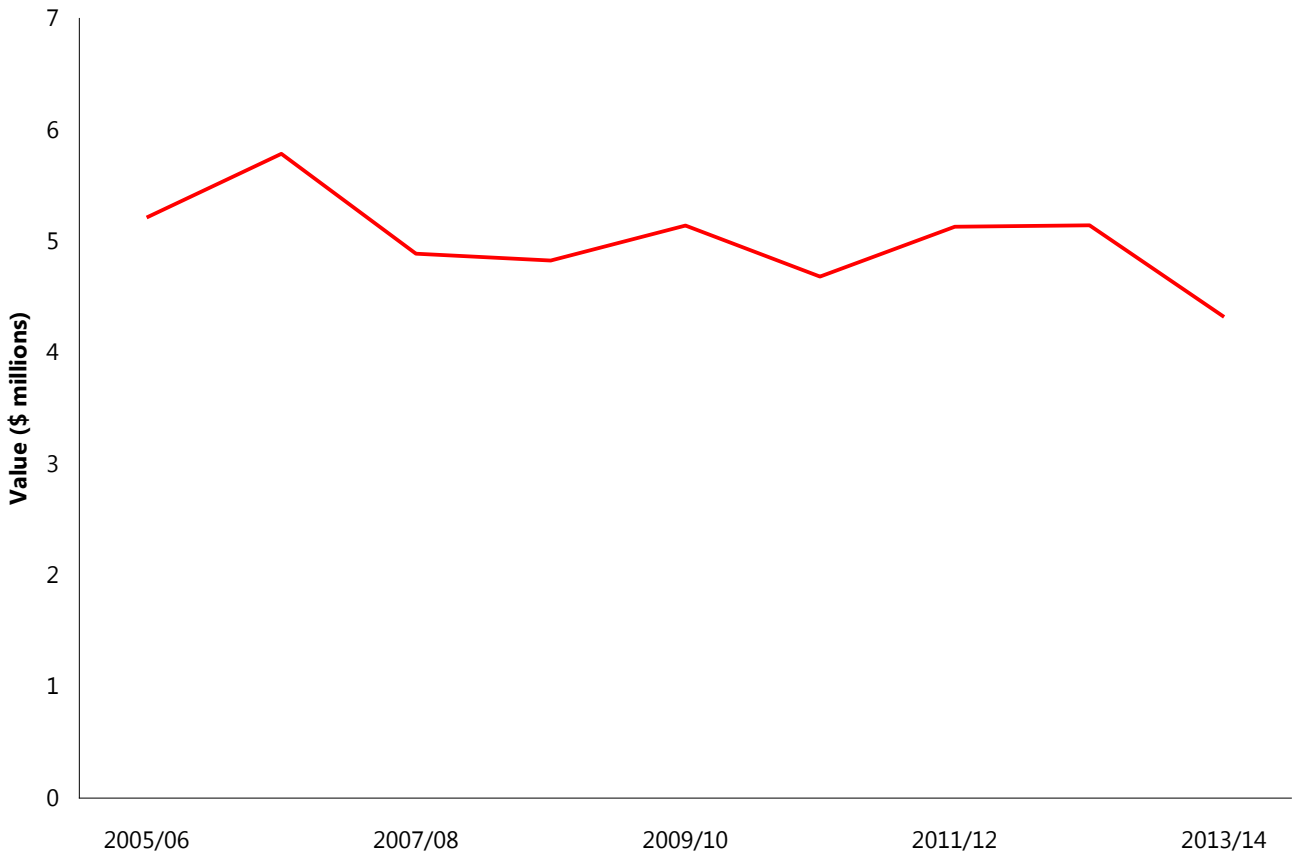


Figure 24. Total revenue for the Charter Boat Fishery. Revenue has been adjusted to real terms (2013/14 dollars) using the consumer price index for Adelaide. Revenue was calculated from the total number of clients and an average price per person. Source: EconSearch (2015d).

5.8.8 Other South Australian managed fisheries

There are no other South Australian managed fisheries known to be operating in the USEMP.

5.8.9 Commonwealth Shark Fishery

The Commonwealth Southern and Eastern Scalefish and Shark Fishery does not operate in the USEMP due to a closure between Victor Harbor and the South Australian border (AFMA 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 25). 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 26).
- EconSearch (2015c, 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).

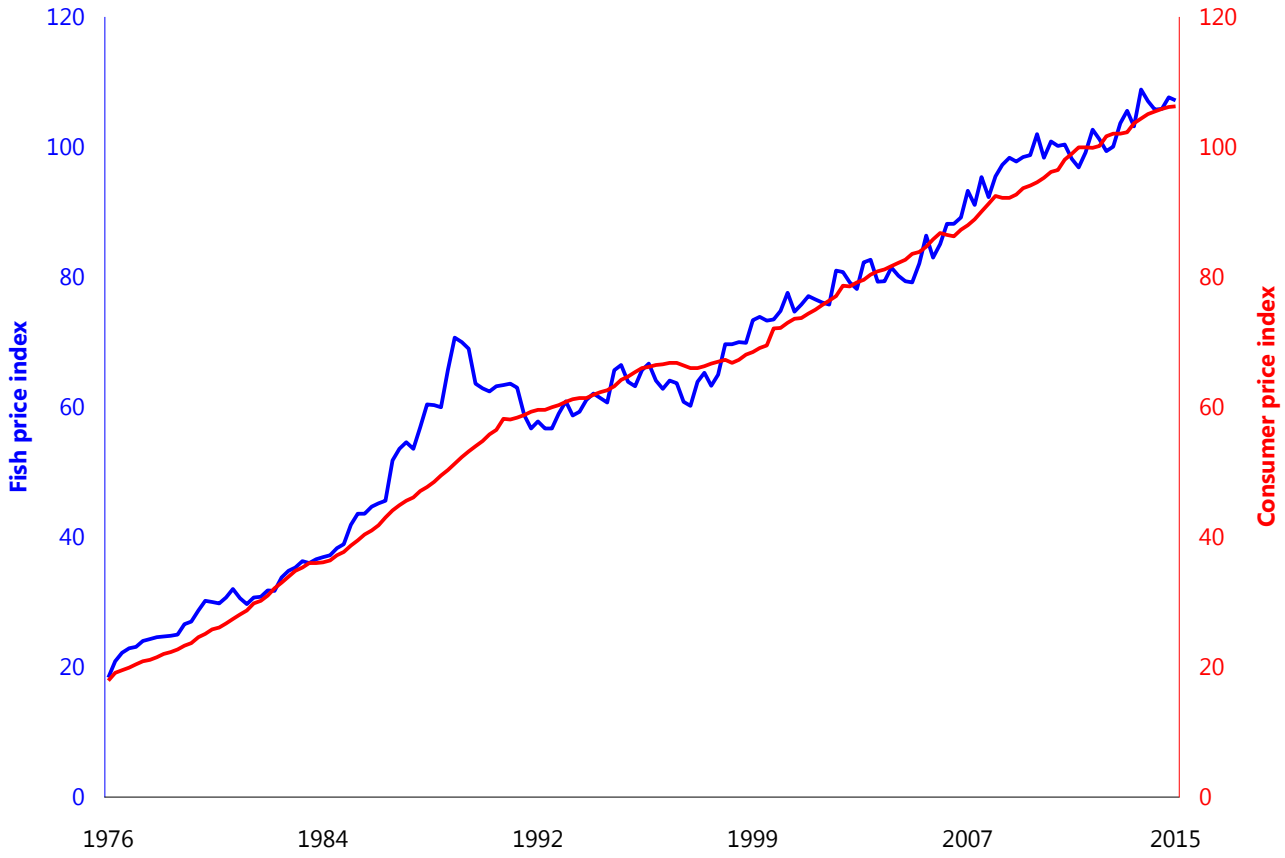


Figure 25. Fish and other seafood price index for Adelaide, compared with Consumer Price Index. Source: ABS (2015f).

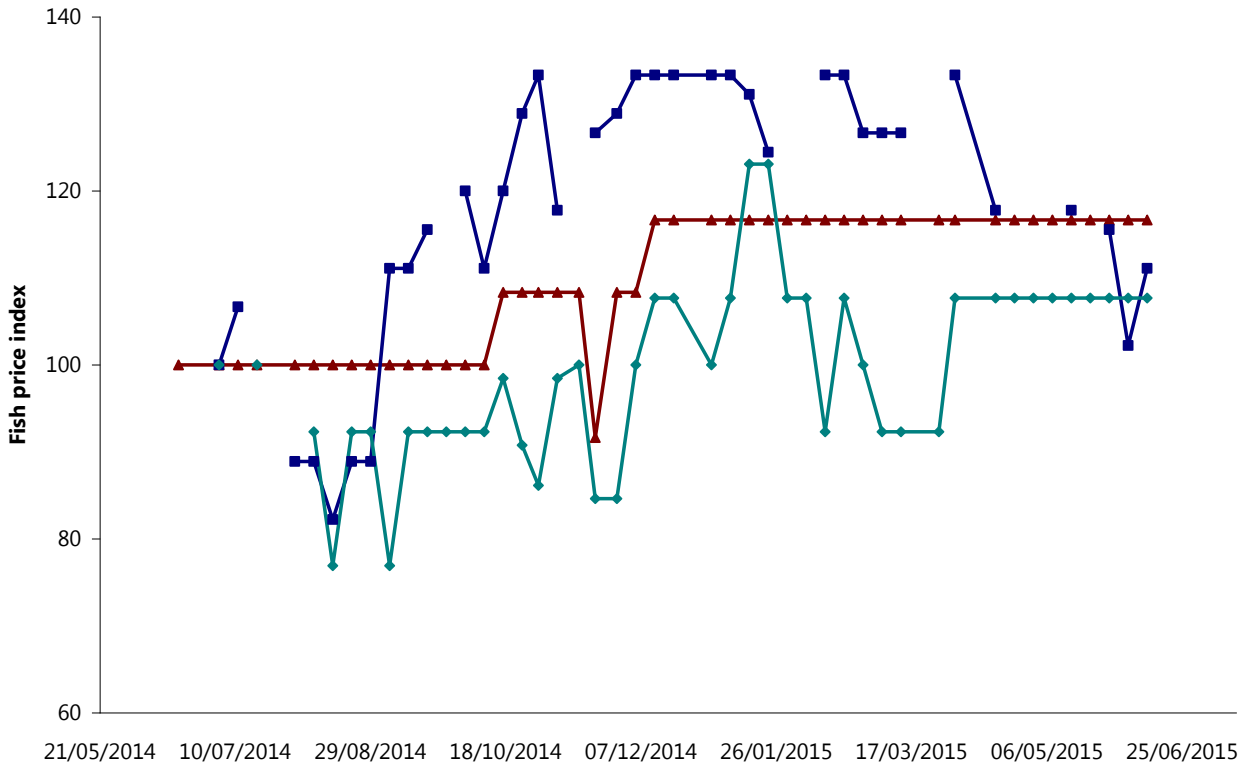


Figure 26. Changes in King George whiting prices at 3 Adelaide stores, with a different colour for each, between June 2014 and June 2015. Price is indexed to a value of 100 on 19 June 2014. Source: DEWNR unpublished data.

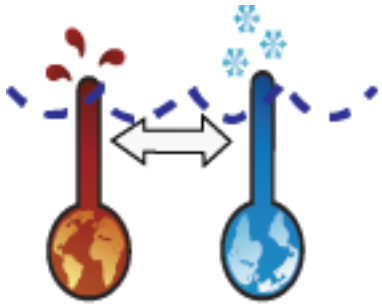
6 Physical drivers

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

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

6.1 Sea surface temperature

Sea surface temperatures within the USEMP range from 14–18 °C in summer to 11–12 °C in winter (DENR 2010). Sea surface temperature follows a seasonal pattern related to air temperature (Bureau of Meteorology 2015b, Figure 27). Sea surface temperature is also influenced by upwellings of cold water and the input of cooler water via the Flinders Current (see Sections 6.4 and 6.5).



Information on sea surface temperature will be required to interpret changes in ecological and socio-economic indicators. For example, inter-annual variations in the amplitude and timing of temperature changes within the USEMP 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).

Baseline information on sea surface temperature relevant to the USEMP 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 IMOS, the Australian Bureau of Meteorology produces high-resolution sea surface temperature data from Advanced Very High Resolution Radiometer sensors on the National Oceanic and Atmospheric Administration satellites and drifting buoy sea surface temperature observations (IMOS 2015).
- The Australian Baseline Sea Level Monitoring Project monitors sea level and meteorological data, including water temperature, at an array of stations, including Portland in western Victoria (Bureau of Meteorology 2015b, Figure 27).
- Temperature data recorded by surface drifters are available from the international Drifting Buoy Data Assembly Center (NOAA 2015a).
- The International Comprehensive Ocean Atmosphere Data Set consists of digital dataset DSI-1173, archived at the (United States Government) National Climatic Data Center. It is the world's largest collection of marine surface in situ observations, with a total of about 185 million records for years between 1784 and 2015 (NOAA 2015b).
- The Extended Reconstructed Sea Surface Temperature dataset is derived from the International Comprehensive Ocean–Atmosphere Data Set (NOAA 2015c, Huang et al. 2015). It is produced on a 2 degree by 2 degree grid and is available as monthly averages extending back to 1854 (NOAA 2015c).
- The COBE SST2 dataset is a global monthly sea surface temperature dataset derived from the International Comprehensive Ocean–Atmosphere Data Set (NOAA 2015d, Hirahara et al. 2014). It is produced on a 1 degree by 1 degree grid and is available as monthly averages extending back to 1854. It can be queried to obtain time series for a particular point and date range (NOAA 2015d).
- The Bureau of Meteorology (2015c) provides sea surface temperature anomaly data (departure from the average of 15.3 degrees between 1961 and 1990) for southern Australia. This dataset is based on an earlier version of the NOAA Extended Reconstructed Sea Surface Temperature (Smith and Reynolds 2004)

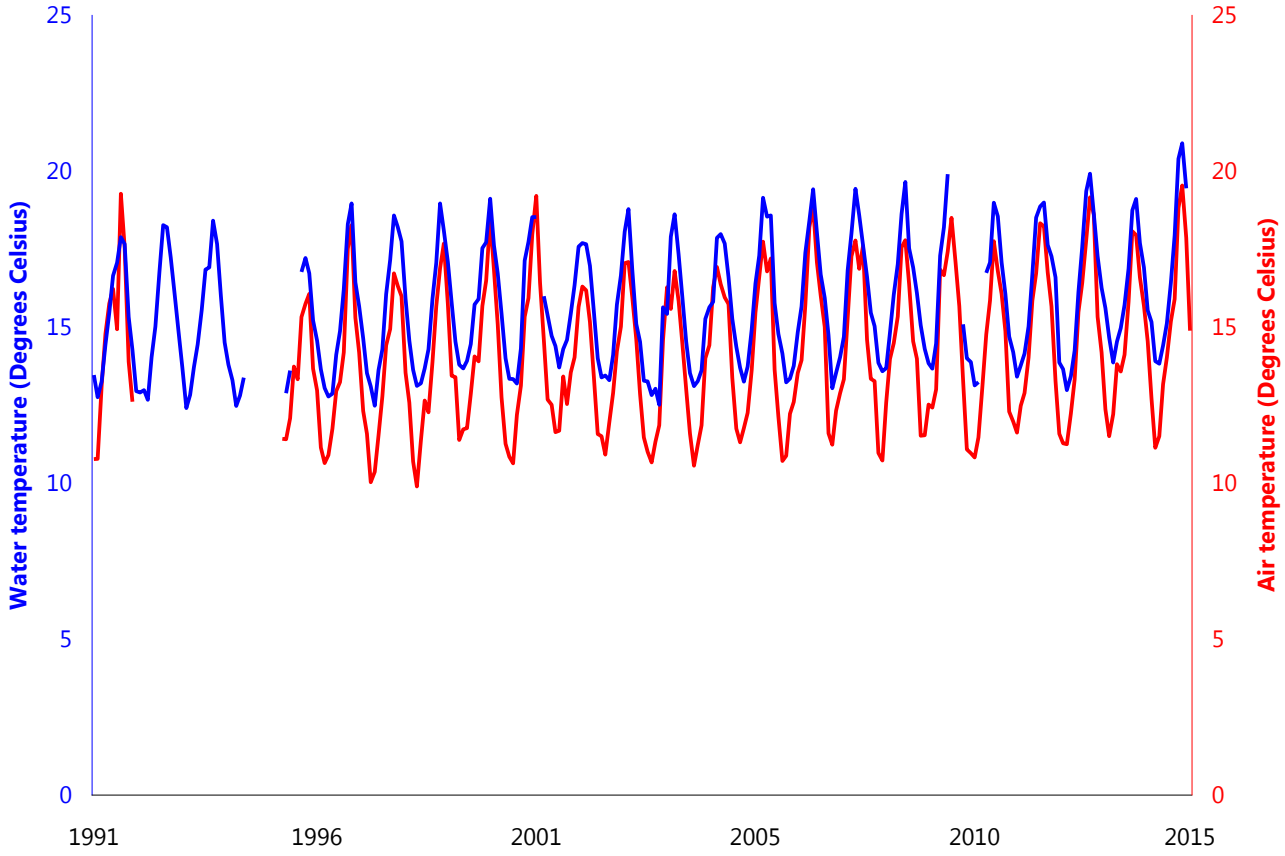
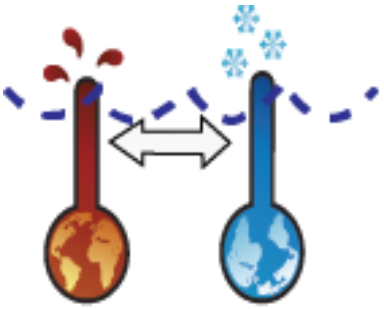


Figure 27. Air and water temperature at the Portland station of the Australian Baseline Sea Level Monitoring Project. Source: Bureau of Meteorology (2015b).

6.2 Air temperature

Air temperature is relevant to intertidal habitats, because extreme temperatures can result in loss of biota, for example:



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

Baseline information on air temperature relevant to the USEMP 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 Portland in western Victoria (Bureau of Meteorology 2015b). Parameters measured include air temperature (Figure 27).

6.3 Salinity extremes

As the USEMP lies within oceanic water, the salinity would vary little (Millero et al. 2008) and would therefore not be influential on the values of the park.

The USEMP is influenced by creeks and drainage channels entering the sea, such as Salt Creek (South East), Blackford Drain, Maria Creek and Robe Lakes Drain L (DENR 2010).

Baseline information on salinity relevant to the USEMP includes:

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

6.4 Upwellings

The Bonney Upwelling brings cold (11–12 °C), nutrient-rich water in summer across the relatively narrow continental shelf between Portland in Victoria and Robe (Butler et al. 2002). These upwellings are driven by strong south-easterly winds that push surface water away from the coast and encourage deep, nutrient rich, water to flow to the surface (Middleton and Platov 2003, Middleton and Bye 2007). El Niño–Southern Oscillation events are characteristically associated with stronger, more persistent south-easterly winds during summer and can enhance upwellings (Middleton and Bye 2007).

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

- Growth rates in a range of species are influenced by water temperature (see Section 6.1).
- Rock lobster densities may increase due to increased phytoplankton productivity associated with upwellings (Linnane et al. 2015). Catch rates were found to increase in response to decreases in bottom temperature associated with upwellings (Feenstra et al 2014).
- Small pelagic fish including Australian sardines and anchovies benefit from increased phytoplankton production and associated enhancement of zooplankton (Ward et al. 2006). Predators of sardines and anchovies including long-nosed fur seals and southern bluefin tuna may also benefit (Ward et al. 2006, Goldsworthy et al. 2011).
- Blue whales aggregate along this coastline to feed during upwellings between November and May each year, mainly between Port MacDonnell and Warrnambool (Gill et al. 2011, DENR 2010).

Baseline information on upwellings relevant to the USEMP includes:

- An index of upwelling based on wind stress has been developed (following the methods of van Ruth et al. 2010, Figure 28).

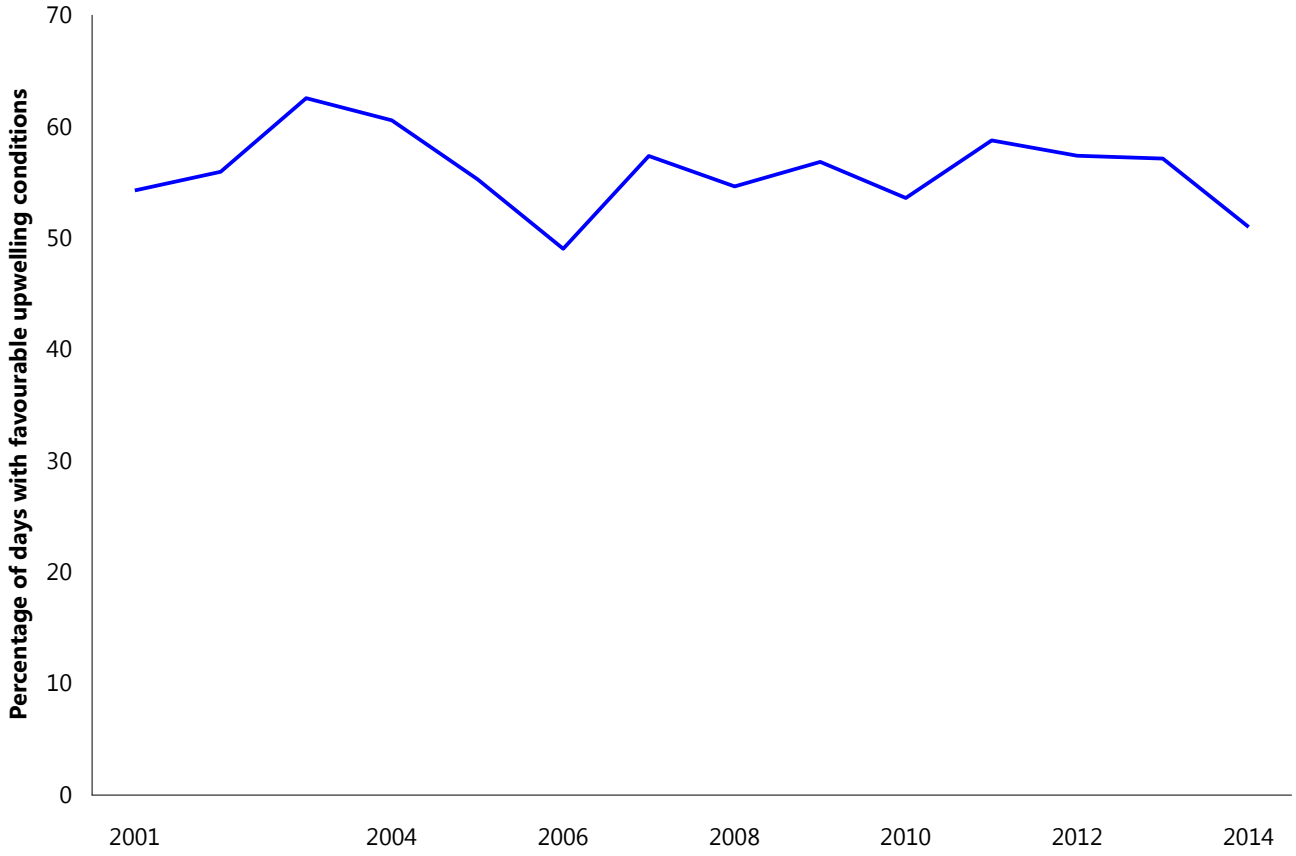


Figure 28. Percentage of days per year with favourable upwelling conditions, using an index of upwelling based on wind stress (following the methods of van Ruth et al. 2010). Data are missing for about 4 weeks in each year between 2000 and 2003 and about 1 week in 2010. Data were sourced from the Integrated Marine Observing System (IMOS) – IMOS is a national collaborative research infrastructure, supported by the Australian Government.

6.5 Oceanic currents

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

Information on oceanic currents 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 relevant to the USEMP.

6.6 Waves

The coastline in this region is exposed to the Southern Ocean. Headlands, coastal cliffs and beach systems in the area are shaped by exposure to high energy waves driven by onshore wind patterns (DENR 2010). Lacepede Bay is exposed to lower wave energy due to its shape (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).

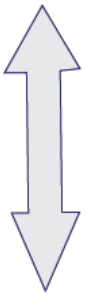
Information on waves will be required to interpret changes in ecological and socio-economic indicators. For example, storms and inter-annual variations in wave energy within the USEMP could influence the following species:

- 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 USEMP includes:

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

6.7 Tides



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

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

Baseline information on tides relevant to the USEMP includes:

- The Australian Baseline Sea Level Monitoring Project records sea level each hour at an array of stations, including Portland in western Victoria (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, Econsearch 2015a, b, c, d, e). Drivers include fuel prices, market forces (e.g. exchange rates, demand and product value), market access (e.g. trade agreements, marketing strategies and trade routes), interest rates on loans, and labour force (e.g. availability, cost). Many of these drivers were assessed as a high risk to the viability of commercial fisheries and must therefore be accounted for when assessing potential impacts of marine parks on commercial fisheries. The implementation of new fisheries management arrangements (outside of marine park management arrangements) can also impact commercial and recreational fisheries, with subsequent flow-on effects to other socio-economic values such as local businesses and tourism.

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

In Australia, tourism made a direct contribution to the economy of $43 billion total GDP 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 2015e).

Baseline information on interest rates includes:

- The Reserve Bank of Australia (2016a) provides a monthly cash rate target (Figure 29). 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 2015e).

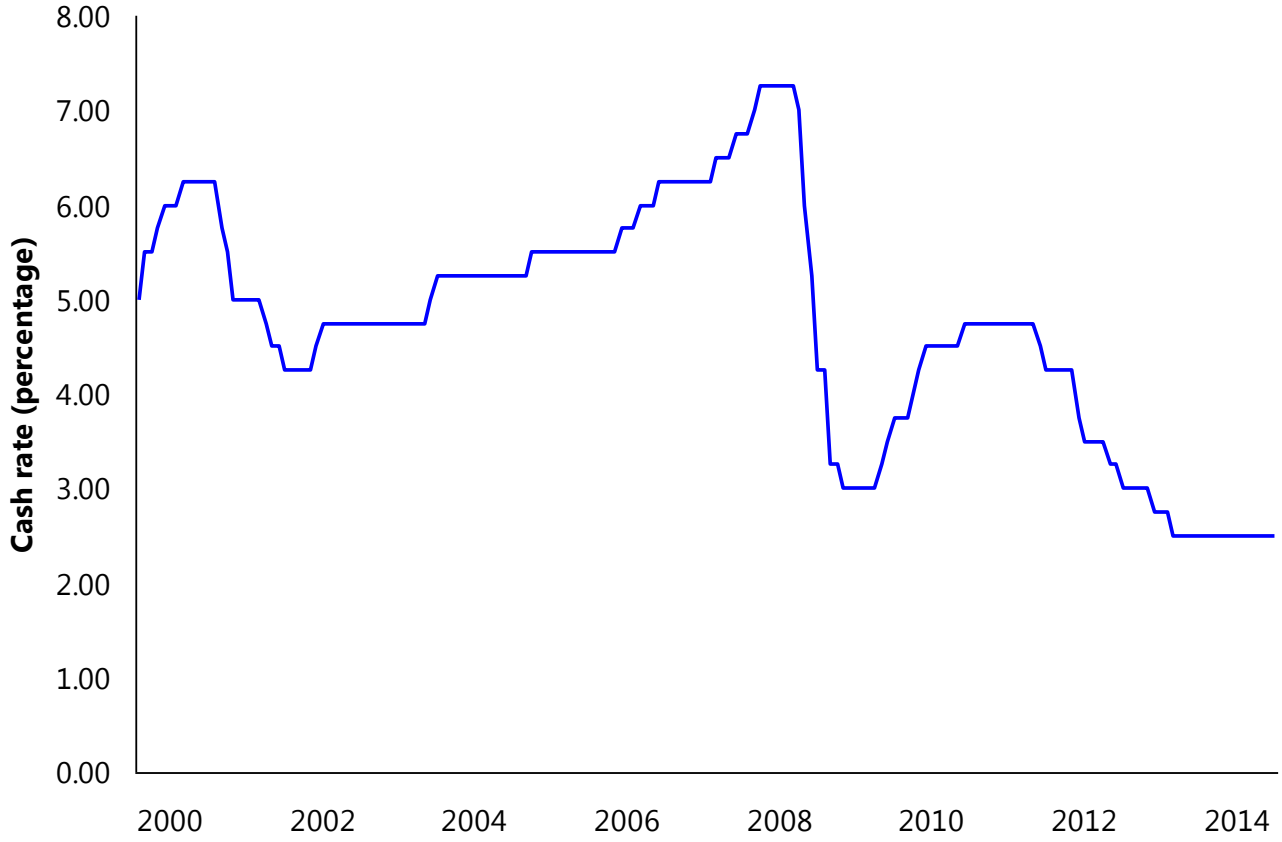


Figure 29. The Australian Target Cash Rate. Source: Reserve Bank of Australia (2016a).

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 30).

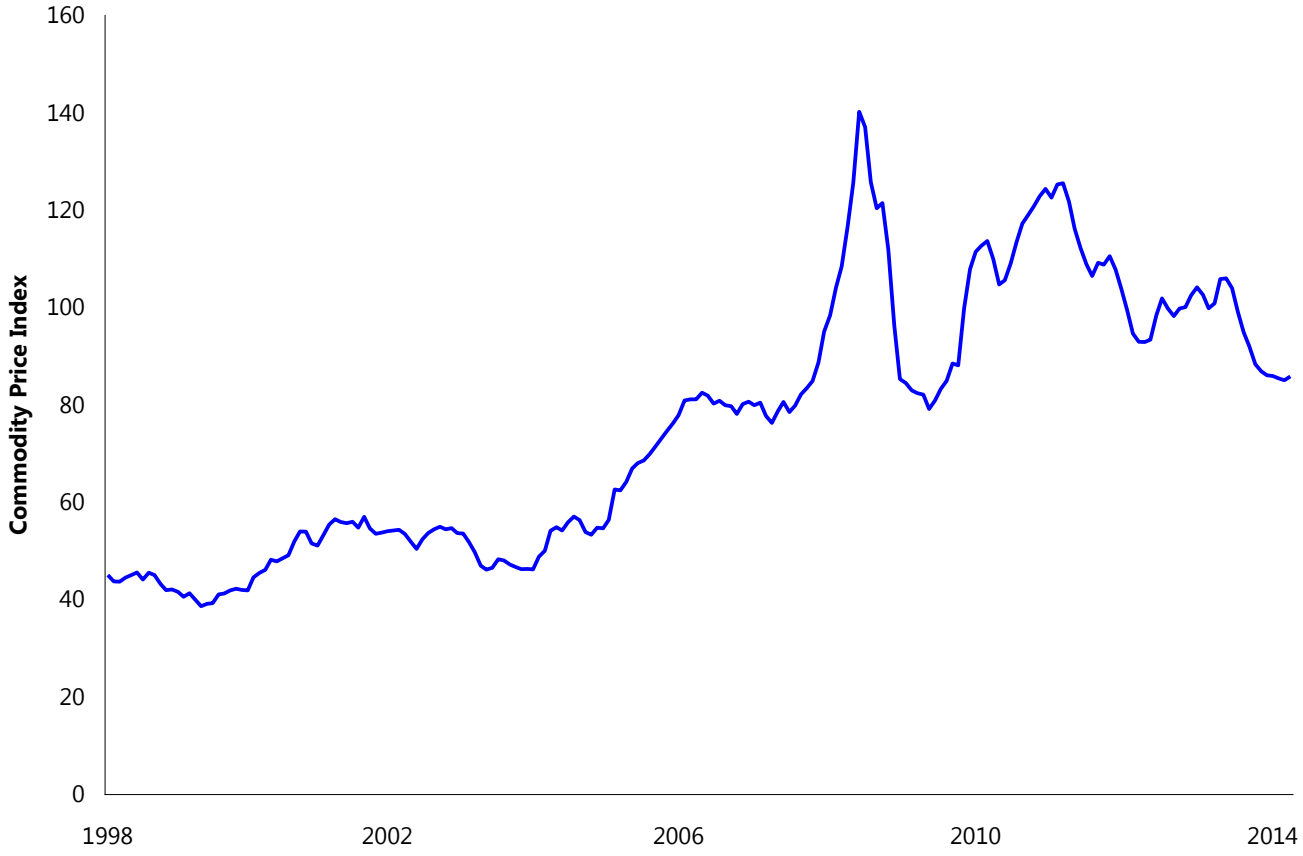


Figure 30. Monthly Commodity Price Index. Source: Reserve Bank of Australia (2016b).

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 2015e).

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 2015e).
- 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 31), 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.

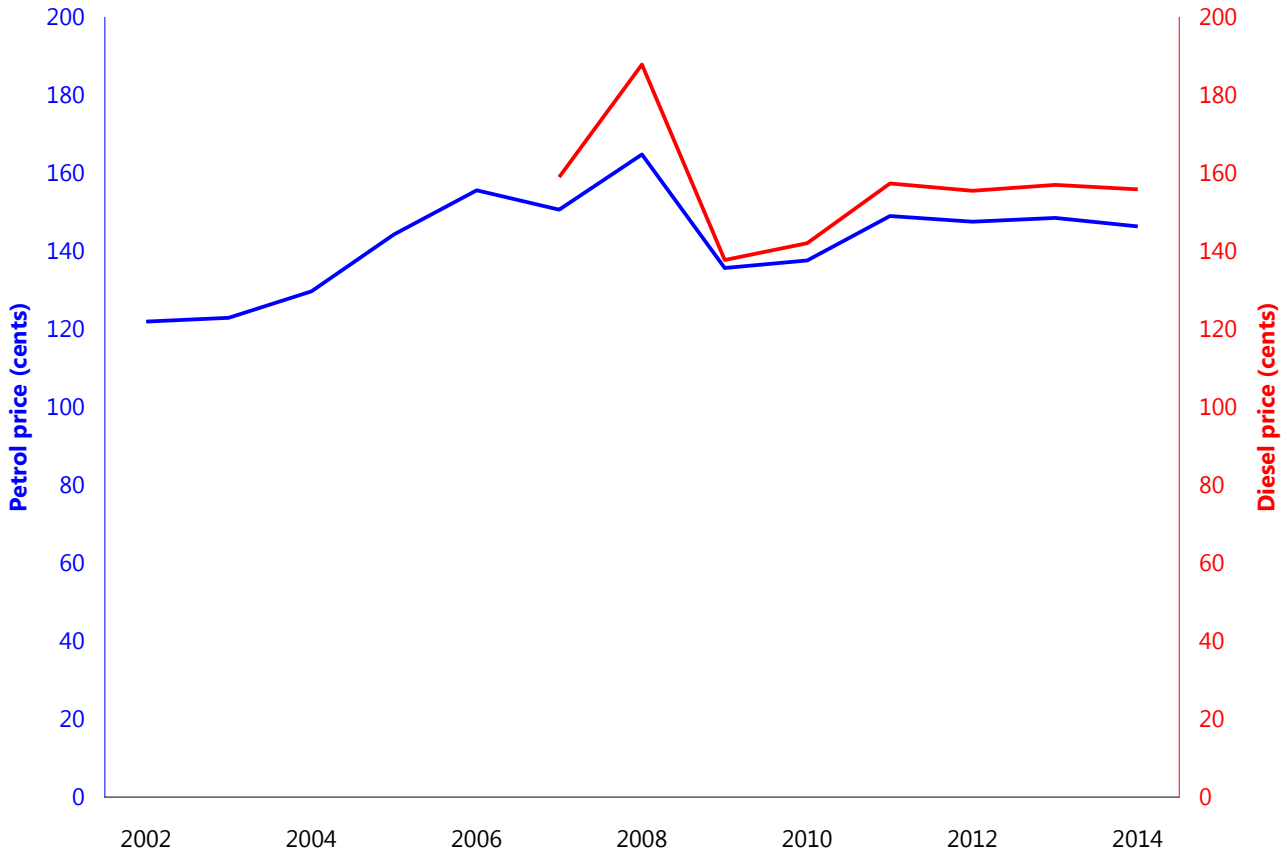


Figure 31. Statewide average retail price (including GST) for diesel and unleaded petrol. Source: Australian Institute of Petroleum (2015).

7.4 Labour force

Wages are a significant cost for most marine-based businesses, including commercial fisheries (EconSearch 2015e). 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 32). The wage price index increased from about 70 in 1998/99 to about 120 in 2013/14 (EconSearch 2015e).
- Employment and unemployment data (see Section 5.1.2).

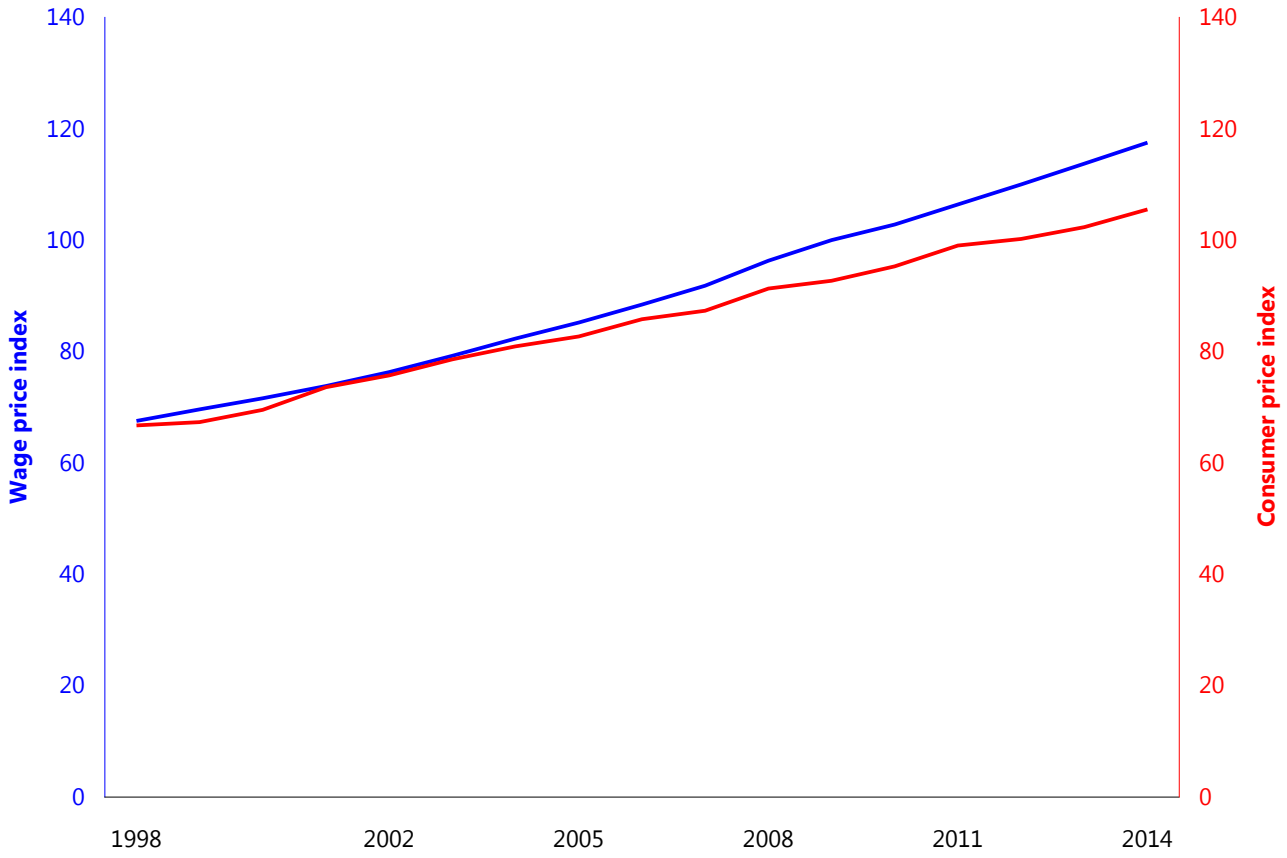


Figure 32. Wage Price Index (June quarter) compared with Consumer Price Index. Source: ABS (2015f, h).

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 2015e). 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 2015e).

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

Baseline information on exchange rates includes:

- The Reserve Bank of Australia (2015) provides monthly updates of exchange rates with 13 currencies. Between 2003 and 2015, the Australian dollar to US dollar exchange rate ratio varied between 0.6 and 1.1, and was about 0.8 in April 2015 (Reserve Bank of Australia 2015, Figure 33). 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 33, Reserve Bank of Australia 2015).

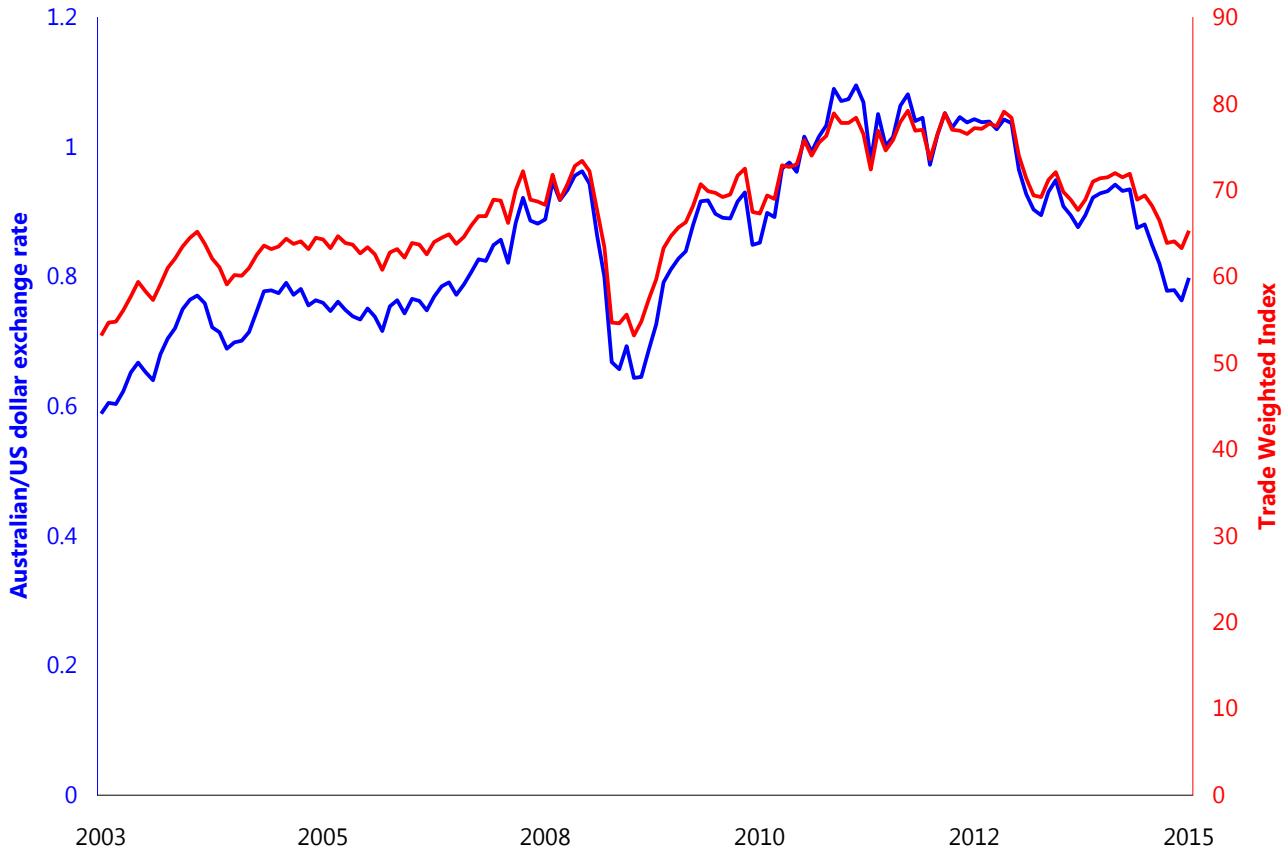


Figure 33. Australian dollar to US dollar exchange rate ratio and Trade-weighted Index. Source: Reserve Bank of Australia (2015).

7.6 Visitation rates

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

Baseline information on visitation rates relevant to the USEMP includes:

- Tourism Research Australia provides regional profiles of international and domestic tourism (Tourism Research Australia 2015). Total number of visitors to the Limestone Coast tourism region (see Appendix C) in 2013/14 was 1,058,000. Data are available for previous years, but are not compatible with 2013/14 due to a change in methods (Tourism Research Australia 2015).
- Primary Industries and Regions South Australia (PIRSA) collates catch disposal records that document daily port of landings for Abalone and Rock Lobster Fisheries. These data could be used to track visitation by abalone and rock lobster fishers to the USEMP.

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 USEMP 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 USEMP include:

- The introduction in 2012 of possession limits for recreational fishers (PIRSA 2011c), which were designed to prevent visiting recreational fishers from stock-piling large amounts of fish. This change may affect the visitation rates of recreational fishers.
- In 2013, new spatial management arrangements were introduced for the Southern Zone Abalone Fishery (Mayfield et al. 2015).

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 USEMP 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 USEMP is minor because of the relatively low level of urban development along the coast (Caton et al. 2011) and moderate levels of surface water run-off (National Water Commission 2007). Because the towns and populations in the area of the USEMP are relatively small, potential impacts on seagrasses are considered to be minor (Bailey et al. 2012b). Localised impacts on seagrass beds have been found adjacent to Blackford Drain and Maria Creek (Wear et al. 2006).

Baseline information on coastal pollution relevant to the USEMP includes:

- The *Australian Water Resources 2005 Report* provides estimates of freshwater runoff for drainage divisions in Australia. There is a moderate amount (28,850 gigalitres) of freshwater runoff in the vicinity of the USEMP (National Water Commission 2007).
- Human population size could be used as a proxy for stormwater (see Section 5.1.1 for indicator of human population).
- PIRSA Aquaculture collates information on aquaculture zoning, and the number and type of active lease types. There is no finfish aquaculture or land-based aquaculture with discharge to the sea in the USEMP.
- Several published studies indicate that water quality parameters such as turbidity (sediment loads) and chlorophyll concentrations of nearshore waters can be monitored using remotely sensed data from Landsat and/or the NASA MODIS-Aqua sensor (Ritchie et al. 2003).

- Beaches and dunes have been modified by litter and the dumping of green waste (Caton et al. 2011). Litter in Guichen Bay has been quantified by annual litter surveys (Eglinton et al. 2006), with data available for 1997 to 2007 (SARDI unpublished data).

8.2 Resource extraction

8.2.1 Fishing

Four commercial fisheries operate within the marine park, as well as recreational fishing (Section 5). The Prawn, Blue Crab and Sardine Fisheries do not operate within the USEMP. 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 (Mayfield et al. 2015). 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 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 Southern Zone Rock Lobster Fishery was just over 2,000 tonnes in 1980 but annual catches declined until the implementation of a quota system in 1994. Annual catches gradually increased until 2006 following which the total allowable commercial catch was progressively reduced from 1900 tonnes to 1250 tonnes in 2009/10 which has been largely (>99 per cent) caught for the four subsequent years (Linnane et al. 2015).
- The historic average annual catch of rock lobster is available for the 2 reporting areas that overlap the USEMP (marine fishing areas 51 and 55 – see Appendix C). Between 1993 and 2011 the average annual catch was about 66 and 647 tonnes, respectively (Ward et al. 2012), and was 42 and 399 tonnes, respectively, in 2013/14 (Linnane et al. 2015).

- 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 Southern Zone declined from a peak of 0.05 per pot lift in 2000 to 0.01 in 2013/14 (Linnane et al. 2015).

The Southern Zone Rock Lobster Fishery is currently classified as *sustainable* (Linnane et al. 2015).

Commercial Abalone Fishery

The Abalone Fishery applies direct pressure on reef 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 Southern Zone Abalone Fishery were about 3 tonnes between 2000/01 and 2004/05, then increased to about 5 tonnes. The catch declined to about 3.5 tonnes in 2013/14 (Mayfield et al. 2015).
- Annual catches and catch rates of greenlip abalone since 1979 have varied between years and between the Nora Creina and Cape Jaffa spatial assessment units (see Appendix C). Between 2004 and 2011 annual catches were less than 1 tonne for Nora Creina and negligible in Cape Jaffa. In 2013/14, the annual catch was about 1 tonne for Nora Creina and less than one tonne for Cape Jaffa (Mayfield et al. 2015).
- Annual catches of blacklip abalone for the Southern Zone Abalone Fishery peaked in 1992 at around 180 tonnes then remained stable with an average of about 144 tonnes between 1993/94 and 2012/13. In 2013/14, the catch dropped to 126 tonnes, which was 83 per cent of the total allowable commercial catch, and catch rates were at their lowest level since 2001/02 (Mayfield et al. 2015).
- Annual catches and catch rates of blacklip abalone since 1979/80 varied between years and between the Nora Creina and Cape Jaffa spatial assessment units (see Appendix C). Between 2004/05 and 2013/14, annual catches were between 3 and 7 tonnes for Nora Creina and between 0 and 1.5 tonnes for Cape Jaffa. In 2014/15, the annual catch was about 2 tonnes for Nora Creina, and less than 0.1 tonne for Cape Jaffa (Mayfield et al. 2015).

The Southern Zone greenlip and blacklip abalone stocks are classified as *transitional-depleting* (Mayfield et al. 2015).

Commercial Marine Scalefish Fishery

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

- Statewide annual catches of 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 South East snapper stock were less than several tonnes per year up to 2007, peaked at about 239 tonnes in 2010 then declined to about 73 tonnes in 2012 (Fowler et al. 2013a).
- Annual snapper catches within the marine fishing areas that overlap the USEMP (see Appendix C) in 2013/14 were between 11 and 25 tonnes for area 51 and not reported for area 55 (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 South East garfish stocks peaked at 3.2 tonnes in 1986/87, and since fluctuated around 1 tonne. Annual catch in 2010/11 was about 1 tonne. The South East garfish catch contributes less than 0.3 per cent to the state garfish fishery (Steer et al. 2016).
- Annual catches of garfish within marine fishing areas overlapping with the USEMP (see Appendix C) in 2013/14 were confidential for area 51 and not reported for area 55 (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 marine fishing areas overlapping the USEMP (areas 51 and 55, see Appendix C) in 2013/14 were between 6 and 10 tonnes for gummy sharks and confidential for bronze and dusky whalers in area 51 and not reported for area 55 (Fowler et al. 2014b).
- Statewide annual catches of pipi peaked in 2008/09 at around 1250 tonnes but then declined to 470 tonnes by 2008/09. Annual catches in 2009/10, 2010/11 and 2011/12 were limited by TACCs of 300, 330 and 400 tonnes respectively (Ferguson 2013).
- Annual catch of pipi from within this marine park (in the region greater than 60 kilometres from the Murray mouth) was about 50 tonnes in 2011/12 (Ferguson 2013).

The South East snapper stock is classified as *transitional-depleting* because of recent declining levels of catch and catch rate (Fowler et al. 2013a). The South East garfish stock is classified as *undefined* because the catch is too small (less than 1 per cent of the state total) and therefore insufficient information is available (Steer et al. 2014, 2016).

Charter Boat Fishery

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

- The annual statewide retained catch of the Charter Boat Fishery increased from about 110,000 fish or invertebrates in 2006/07 to about 148,000 in 2009/10 and then increased to about 154,000 in 2011/12. King George whiting, snapper and bight redfish were most frequently targeted but at least 70 different marine species were taken, including finfish, rays and skates, sharks, crustaceans, and molluscs (Tsolos 2013).
- The annual retained catch in the Victor Harbor/South East region (see Appendix C) decreased from 3720 to 3302 fish or invertebrates between 2009/10 to 2011/12, while remaining at 2 per cent of the statewide charter boat harvest. During this period, snapper remained the most frequently caught fish, followed by King George whiting, tuna and bight redfish (Tsolos 2013).

Commonwealth Shark Fishery

Commonwealth Southern and Eastern Scalefish and Shark Fishery does not operate in the USEMP.

Recreational fishing

The Recreational Fishery applies pressure on reef, seagrass and sand 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 rock lobster harvest in the Southern Zone in 2013/14 was about 4.4 per cent (about 55 tonnes) of the total allowable commercial catch (Linnane et al. 2015).
- The recreational abalone harvest in the Southern Zone was estimated to be about 230 kg meat weight, equating to about 0.35 per cent of the total allowable commercial catch (Mayfield et al. 2015).
- The recreational King George whiting, snapper, garfish and calamary catches for the South East region in 2006/07 were about 5, 13, 3 and 1.5 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 Southern Zone Abalone Fishery was estimated to account for 118 kg meat weight (Mayfield et al. 2015). Illegal fishing is a recognised risk to the Rock Lobster Fishery, and PIRSA manage this issue through compliance (PIRSA 2011b). Illegal fishing impacts the economics of the Marine Scalefish fishery, particularly in regional communities (PIRSA 2011a).

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

Indigenous fishing

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

8.2.2 Aquaculture

There is no aquaculture in the USEMP.

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 2013, Shepherd et al. 2014).

Most of the habitats in the USEMP 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 USEMP includes:

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

- Fishing equipment and anchors may damage shipwrecks (DEWNR unpublished data) but these pressures have not been quantified in the USEMP.

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, 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, Christie and Jessup 2007, Newsome and Rodger 2013, IWC 2015).

Baseline information on disturbance relevant to the USEMP 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 disturbance.
- Information on aquaculture (see Section 5.6) could be used as an indicator of disturbance.
- Information on recreational and commercial fishing activity (see Sections 5.7 and 5.8) could be used as an indicator of disturbance.
- SARDI collates logbook information on interactions between commercial fisheries and threatened, endangered and protected species (McLeay et al. 2015).

8.5 Pest species

Marine and land pest species may put pressure on ecological values in the USEMP. 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).

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

- A number of invasive marine algae pests have been recorded inside the USEMP (Wiltshire et al. 2010, Figure 34). The impacts of these pests on ecological values are not known.

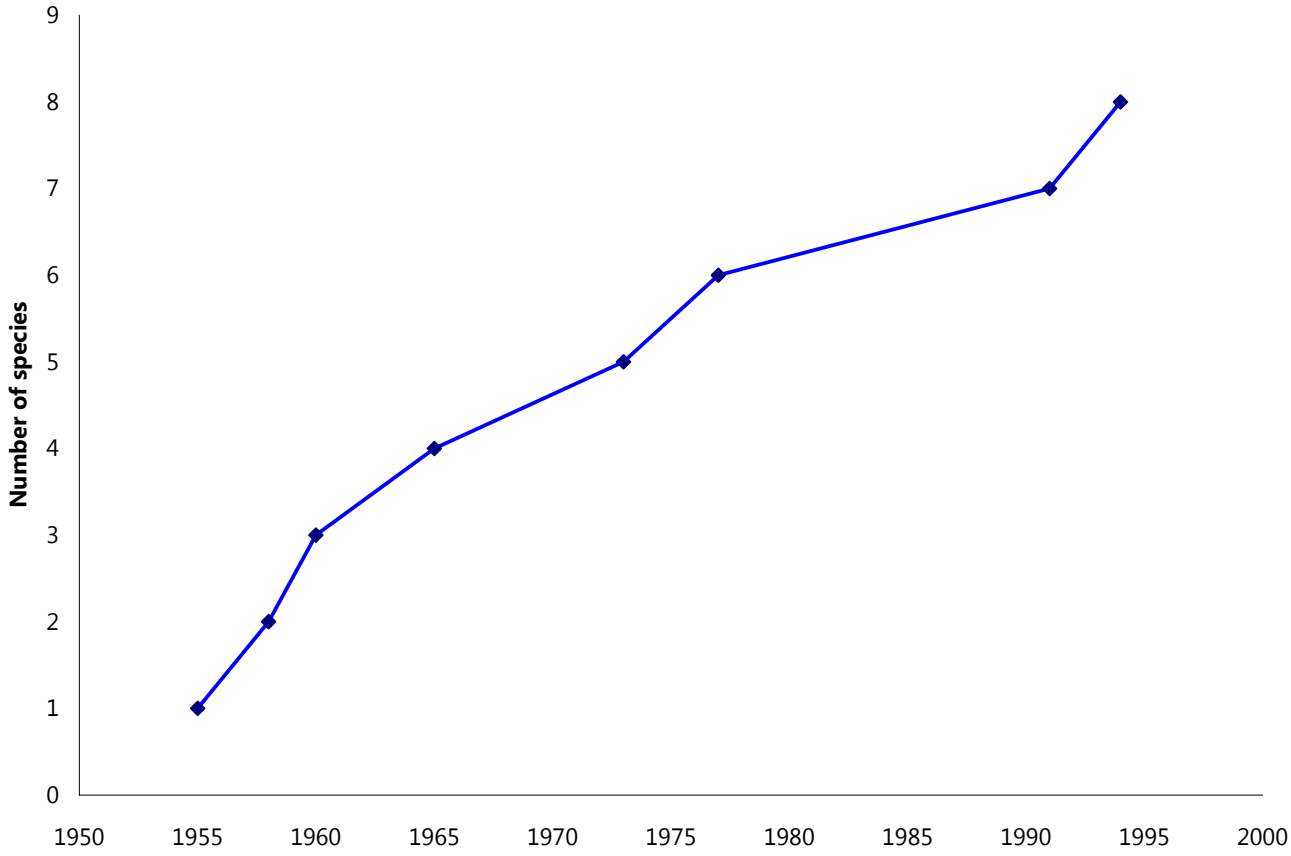


Figure 34. Cumulative count of invasive marine pest species recorded in the USEMP over time. Note that pest surveys have not been standardised between years or locations within the park and records are typically recorded opportunistically. Source: Wiltshire et al. (2010).

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).

8.5.3 Introduced land pests

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

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 (Caughley et al. 1998, West 2008). Feral cats and rodents prey on chicks, adults and eggs, and reduce populations of seabirds and shorebirds (Hughes et al. 2008, Jones et al. 2008b).

Salt tolerant weeds can invade saltmarsh and dune environments and compete with native vegetation. A number of coastal weed species have been observed in the USEMP between Salt Creek and Nora Creina including, bridal creeper, lavatory creeper, African boxthorn, myrtle-leaf milkwort, pyp grass, gazania sea-wheat grass and sharp rush (Caton et al. 2011)

8.6 Climate change

Climate change may place pressure on ecological values of the USEMP 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 Victor Harbor of 0.3–0.8 °C by 2030 and 0.3–3.4 °C by 2090 (Timbal et al. 2015). Sea surface temperature rose by about 0.6 °C over the past century (Suppiah et al. 2006). Increased water temperature may result in the reduction of kelp forests which support populations of molluscs that form an important part of lobster diets (Scientific Working Group 2011). 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 upwelling 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 benefits higher order predators. Conversely, cold water from upwelling may have negative impacts on species that are more successful in warmer water temperatures (see Section 6.1)
- Changes (increases or decreases) in sea surface salinity at Victor Harbor of -0.15–0.15 by 2030 and -1.12–0.37 by 2090 as a result of changes in rainfall (Timbal et al. 2015, CSIRO and Bureau of Meteorology 2015). Changes in salinity affect species by altering the energy expenditure required for osmoregulation (maintaining internal salt balance) as well as the development of larvae. The impacts of salinity change are species- and age-specific (BHP Billiton 2009).
- Sea level rise at Victor Harbor of 0.07–0.17 metres by 2030 and 0.23–0.83 metres by 2090 (Timbal et al. 2015). This poses a threat to intertidal reef habitats in locations where existing land use or a lack of suitable low-lying substrate prevents inland migration (Scientific Working Group 2011, Thorner et al. 2014). Sea level rise may also exacerbate the loss of habitat used by migratory shorebirds both locally, e.g. hooded plover (Garnett et al. 2013), and in South East Asia (Nicol et al. 2015).
- Decreases in ocean pH (increased acidity) at Victor Harbor of 0.06–0.08 by 2030 and 0.06–0.33 by 2090 (Timbal et al. 2015), which may affect the process by which marine animals, e.g. phytoplankton and molluscs, make shells and plates (Secretariat CBD 2009, Brierley and Kingsford 2009, The Royal Society 2005, Hobday et al. 2006, Kleypas et al. 2006).
- Upwelling of cold, nutrient rich water may increase which may increase phytoplankton and krill production benefiting the Rock Lobster Fishery and whale populations. (Butler et al. 2002, Linnane et al. 2015).

- Increased frequency of extreme weather events, including an increase in the average number of days per year that exceed 40 °C increasing from about 0.3 days up to 0.8 days by 2030 and 7.5 days by 2090 (Timbal et al. 2015). An example of the potential impact of extreme weather events is the large-scale seagrass diebacks in Spencer Gulf during low tides combined with extremely hot air temperatures and strong northerly winds (Seddon et al. 2000).

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

9 Marine park management plan

This section outlines the strategies of the marine park management plans and how the USEMP 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 SZs and HPZs were located to minimise impacts on existing developments and activities, including recreational and commercial fishing and other recreational activities. There are no RAZs in the USEMP. 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 zones, 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 SZs and HPZs from a biodiversity and conservation perspective.

The zoning could reduce the cumulative impact of existing and future pressures, and/or improve resilience to pressures that are not addressed by zoning. For example, Ling et al. (2009) showed that commercial fishing of large predatory lobsters reduced the resilience of Tasmanian kelp beds against the climate-driven threat of the sea urchin and thus increased the risk of a fundamental phase shift to widespread sea urchin barrens. Baden et al. (2012) found that human-induced eutrophication in conjunction with overfishing was linked with seagrass losses in Sweden.

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

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

9.2 Pressures influenced by the management 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). Most of the Lacepede Bay SZ meets these criteria and provide additional area from which black water cannot be discharged.

Habitats within the USEMP 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 address issues associated with septic tank overflows, agricultural run-off or pollution associated with shipping.

9.2.2 Resource extraction

Fishing

Prior to the restrictions associated with the management plan, fishing was allowed throughout the USEMP 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*:

- intertidal reef areas to a depth of 2 metres
- seasonal closure for the Rock Lobster Fishery (June to September, inclusive)
- seasonal closure for snapper (1 November to 15 December, Fowler and McGarvey 2014)
- a spatial closure between Victor Harbor and the Victorian border for the Southern and Eastern Scalefish and Shark Fishery (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 Recreational Fishery, PIRSA indicated that catch and effort which was previously associated with the closed zones could be redistributed without impacting on the sustainability of those fisheries (PIRSA 2011d).

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

- About 5.5 tonnes of rock lobster annual catch from SZs within the bounds of the Southern Zone Rock Lobster Fishery, including a confidential amount from the USEMP (Ward et al. 2012).
- About 175 and 128 kilograms of greenlip and blacklip abalone annual catch, respectively, from SZs within the bounds of the Southern Zone Abalone Fishery, including a confidential amount from the USEMP (Ward et al. 2012).
- About 863, 701, 225 and 672 days of handline, haulnet, longline and other annual fishing effort, respectively, from SZs statewide (Ward et al. 2012), equating to a combined total of about 75 tonnes of King George whiting, snapper, southern sea garfish and southern calamary (Econsearch 2014). This included about 1, 0, 26 and 5 days of handline, haulnet, longline and other fishing effort, respectively, from the USEMP (Ward et al. 2012).
- About 1,136 person-days of Charter Boat annual effort was estimated to have been displaced from SZs statewide, including a confidential number of person-days from the USEMP (Ward et al. 2012).

Aquaculture

There is currently no aquaculture in the USEMP, but future expansion could be influenced by the management plan.

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 2015j). Prevention of fishing and possible reduced boating activity within SZs may reduce the potential for damage of shipwrecks.

Habitats within the USEMP 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 2012a). Impacts associated with aquaculture inside GMUZs will be managed under the *Aquaculture Act 2001* which requires aquaculture policies to seek to further the objects of the *Marine Parks Act 2007* (DEWNR 2012b).

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

Protection of habitats from future threats inside SZs and HPZs will have varying benefits for a range of species depending on their level of residency within these zones. For migratory species such as southern right whales and shorebirds, the marine park management 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 USEMP (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) 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 USEMP.

Monitoring programs within the USEMP 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 2009).

9.3 Socio-economic values influenced by the management plan

The marine park management plan is designed to mitigate 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 USEMP 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 2013). The indicators and predictions are summarised in the conceptual model (Figure 5). Predictions and indicators of change are summarised in Table 2.

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 habitat-ecosystems). In addition to possible responses to protection from fishing, many fished (and unfished) species may benefit from the protection of the habitats that they use (Bailey et al. 2012a, b). The theory of ecological change is detailed by Bailey et al. (2012a, see Section 3.1 and Appendices 1–7 of that report).

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

10.1.1 Reef ecosystems

Intertidal reef

Intertidal reef animals were fully protected in South Australia before the implementation of the marine park management plans (Bailey et al. 2012b). 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, blacklip abalone, blue throat wrasse, sweep and/or snapper,

when each considered in isolation, are predicted to increase in size and abundance over the next 20 years inside the Coorong Beach South, Lacepede Bay and/or Cape Dombey SZs of the USEMP (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

There is no mapped intertidal seagrass inside SZs in the USEMP and therefore no changes are predicted.

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). Given that there is likely to be minimal displacement of inshore fishing over subtidal seagrass meadows in the USEMP due to low levels of historical fishing activity (Section 9.2.2), there is limited potential for a response of fished species in seagrass. Potential indicators for monitoring subtidal seagrass ecosystems include size/abundance/diversity of fish, invertebrate and seagrass communities, and seagrass extent.

10.1.3 Sand ecosystems

Intertidal sand

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

A number of fished species use nearshore beach habitats in South Australia (Bryars 2003). Due to uncertainties around fished species' responses in these ecosystems, predictions of change are generally lacking across the park network, although Bryars (2013) did make predictions for some beach fishes. It is possible that beach fishes such as mulloway, Australian salmon, Australian herring and school whiting will temporarily increase in abundance in the Coorong Beach South SZ of the USEMP (Bailey et al. 2012a). Potential indicators for monitoring beach ecosystems include size/abundance/diversity of fish communities.

Subtidal sand

A number of fished species use subtidal sand plains in South Australia (Bryars 2003). Snapper, when considered in isolation, are predicted to increase in size and abundance on sand habitat over the next 20 years inside the Coorong Beach South and Lacepede Bay SZs of the USEMP (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 USEMP.

10.1.5 Saltmarsh ecosystems

There are no saltmarshes in the USEMP.

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 (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). Some shorebird habitats inside marine parks are afforded increased protection. For example, the collection of beach-cast seagrass and macroalgae is prohibited inside SZs. Beach wrack is used by some shorebirds and preventing its collection could benefit some shorebirds. 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.

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

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

10.2.2 Coastal recreation

The marine park zoning accommodates most forms of coastal recreation. Motorised water sports are not allowed in SZs, but the location and size of the SZs in the USEMP should result in negligible impacts on these activities. Recreational fishing continues to be accommodated within the USEMP (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 USEMP include Lacepede Bay and Cape Dombey. Indicators of recreational use include participation rates and the numbers of boat registrations/licences.

10.2.3 Tourism

Changes to fishery-based tourism are likely to be minimal (see Section 10.2.7). During 2013 and 2014, 15 per cent of domestic visitors to the Limestone Coast visited terrestrial parks (South Australian Tourism Commission, unpublished data). Possible benefits of the USEMP for tourism include (Bailey et al. 2012a, b):

- more natural ecosystems, including greater size and abundance of some fish within SZs
- less boating traffic due to the absence of fishing boats within SZs
- greater investment certainty for tourism operators due to protection to ecosystems.

10.2.4 Cultural heritage

There is an expectation that the management 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 USEMP 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 USEMP 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 Lacepede Bay SZ does contain some reef habitat but is not in a high catch area of the fishery.
- The Cape Dombey SZ does contain some reef habitat in a high catch area of the fishery but is negligible in size.
- The Coorong Beach South SZ is likely comprised mostly of sand habitat that is unsuitable for rock lobster.

Abalone Fishery

Change in the fishery due to the USEMP 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.
- The Lacepede Bay SZ does contain some reef habitat but is not in a high catch area of the fishery.
- The Cape Dombey SZ does contain some reef habitat but is negligible in size.
- The Coorong Beach South SZ is likely comprised mostly of sand habitat that is unsuitable for abalone.

Marine Scalefish Fishery

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

- More than the estimated displaced catch has been removed from the fishery through the Commercial Fisheries Voluntary Catch/Effort Reduction Program such that the remaining fishers now have greater relative access to the available biomass. This assumes that historical catch rates in this fishery were the same inside versus outside SZs. It is possible that this assumption is false for some regions (see Kosturjak et al. 2015) because insufficient effort was removed in some localised areas. No data have been published to confirm or reject these assumptions.
- Fishers are mobile and can generally adapt to spatial closures.

- The estimated displaced effort was 0.06 per cent of the total average annual effort in the fishery (EconSearch 2014).

Charter Boat Fishery

Change in the fishery due to the USEMP 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.
- Charter fishers are generally highly mobile and should be able to adapt to the spatial restrictions.
- There are few operators within the USEMP and therefore minimal competition for fishing grounds.
- The USEMP is not a recognised destination for long-range charters from other regions.

Recreational shore fishing

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

- Recreational fishing was mostly accommodated and there are numerous locations still available for shore-based fishing within the USEMP.
- Areas that are readily accessible by shore or that were popular fishing locations have mostly not been lost to recreational fishers.
- Shore-based line fishing is still allowed in the Cape Dombey SZ.
- Shore-based line fishing is now prohibited in the Coorong Beach South SZ, but this section of beach represents only about 6 per cent of the available beach length within the USEMP.

Recreational boat fishing

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

- Recreational fishing was mostly accommodated, and there are numerous locations still available for boat fishing within the USEMP.
- Fishers are mobile and will be able to adapt to spatial restrictions.
- Most of the effort is targeted at inshore areas, where there is a negligible overlap with SZs.
- The Coorong Beach South SZ lies in relatively exposed waters unsuitable for most recreational boats.

Commonwealth Shark Fishery

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

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 pressures, the marine park management plan, physical drivers and socio-economic drivers (Sections 10.3.2–10.3.5).

10.3.1 Assumptions

A major assumption is 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 pressure on the ecological values that they rely upon. For example, increased recreation and tourism activities may cause an increase in disturbance to animals such as marine mammals and seabirds. Multiple pressures may also occur in some areas and understanding the cumulative impact of these on ecological values may present a challenge. To interpret monitoring data on ecological and socio-economic values in the MER program, it will be necessary to monitor information on pressures. A range of potential indicators for pressures is available (Table 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

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

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

Evaluation question 5

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

Outcome 7

Increased stewardship of marine parks and marine environments.

Outcome 8

Marine Parks valued by more people.

Strategies include:

- Provide for public appreciation, understanding and enjoyment of marine parks.
- Provide education to support the implementation of marine parks.
- Seek to involve local communities and stakeholders in the day-to-day management and monitoring of marine parks.
- Foster partnerships to support the implementation of the MER Program incorporating opportunities for community and stakeholder involvement.

Evaluation question 6

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

Outcome 9

Traditional Aboriginal knowledge is preserved and shared when appropriate.

Outcome 10:

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

Strategies include:

- Consider additional protections and/or temporary restrictions where necessary in circumstances of urgency— to protect a feature of natural or cultural heritage significance;
- Work cooperatively with Aboriginal communities to conserve country, plants, animals and culture.
- Encourage Aboriginal people, local communities and stakeholders to preserve traditional and historic knowledge and, where appropriate, share this knowledge with others.

B. Summary of habitats in each zone type

Summary of habitats in the marine park. Total area of benthic habitats excludes 0.1 square kilometres of land, including islands. There are no RAZs in the Upper South East Marine Park. 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 Park
Benthic habitats (square kilometres)					
Reef	58.4	168.9	35.5		262.7
Seagrass	9.8	82.0	9.4		101.3
Sand	87.9	59.9	16.7		164.5
Mangrove					
Saltmarsh					
Not mapped	252.4	99.9	25.3		377.6
Shoreline habitats (kilometres of coastline)					
Reef	5.7	2.2	1.5		9.4
Seagrass					
Sand	68.9	49.0	7.4		125.3
Mangroves					
Saltmarsh					

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.

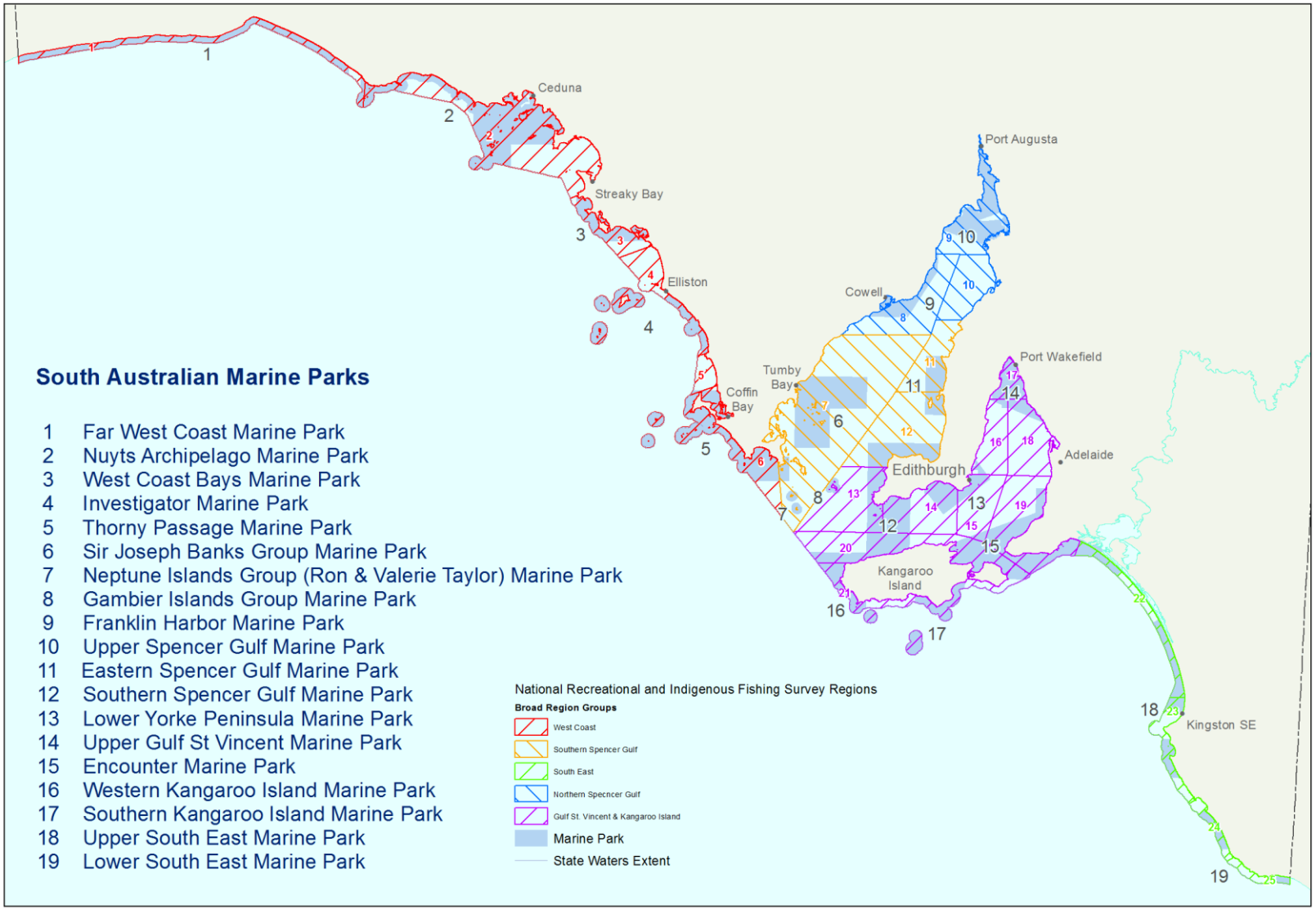
C19. EconSearch regions

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

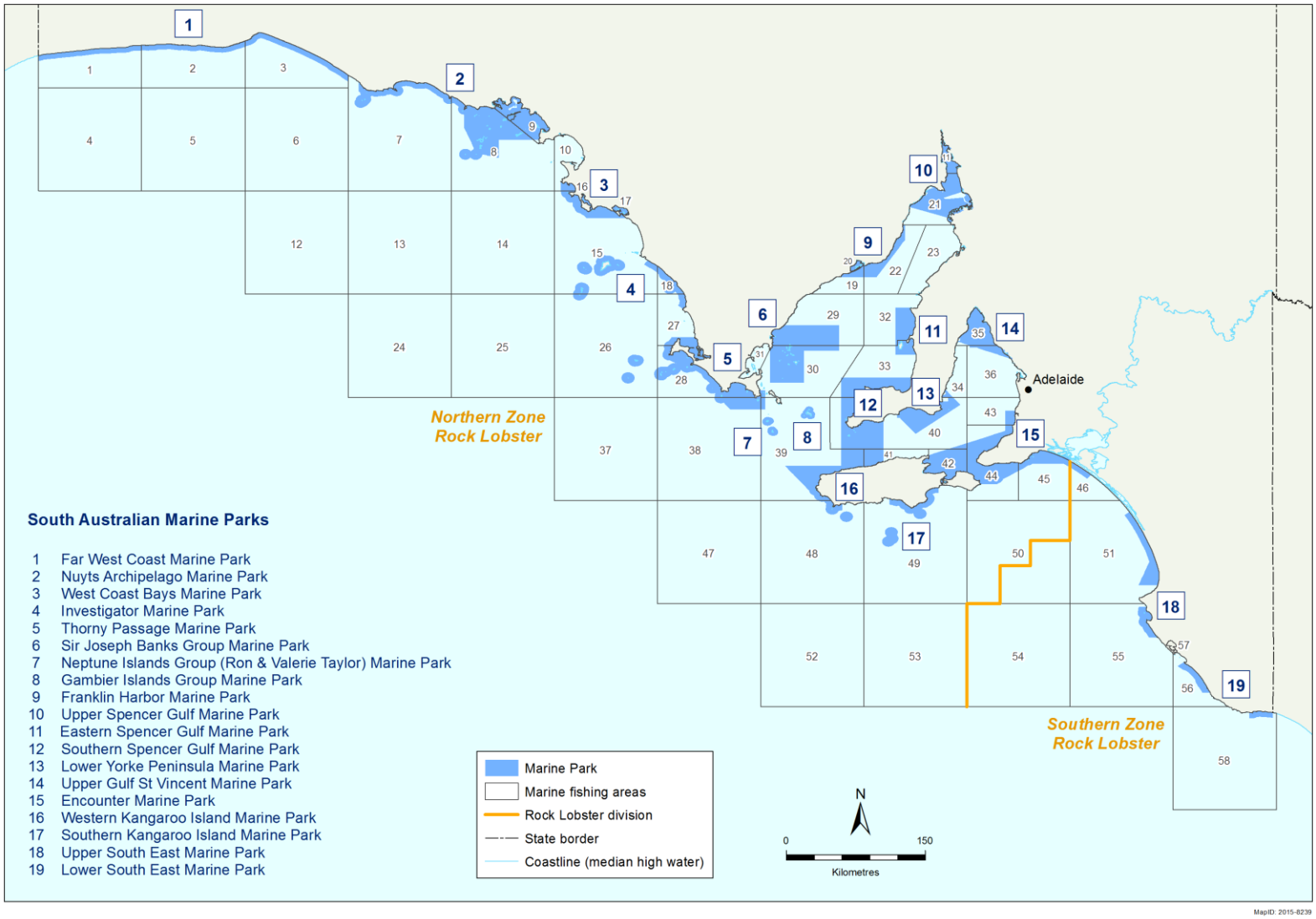
C20. Tourism regions

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

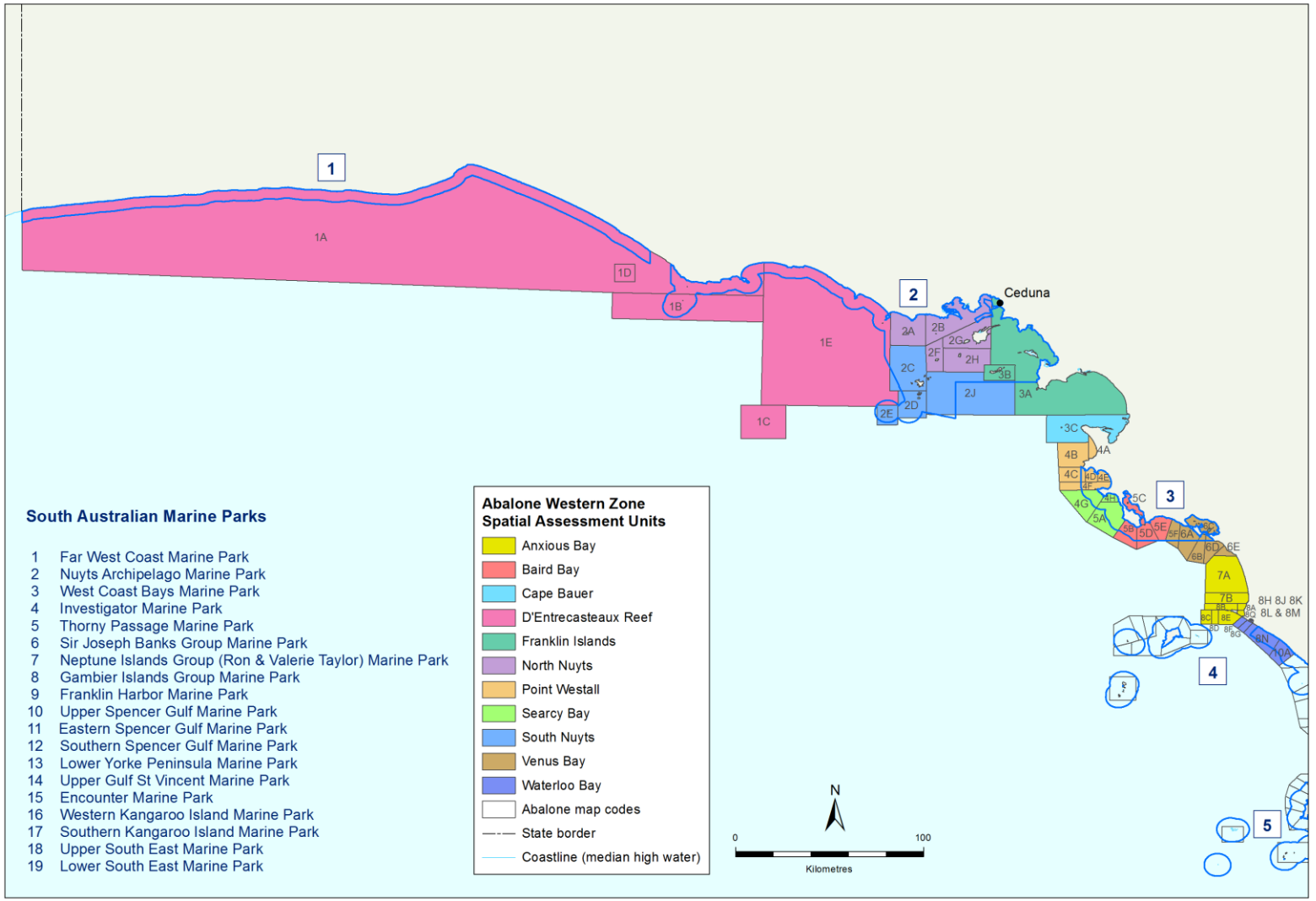
C1. Recreational fishing Marine park boundaries and the overlap with survey areas/regions for the Recreational Fishery



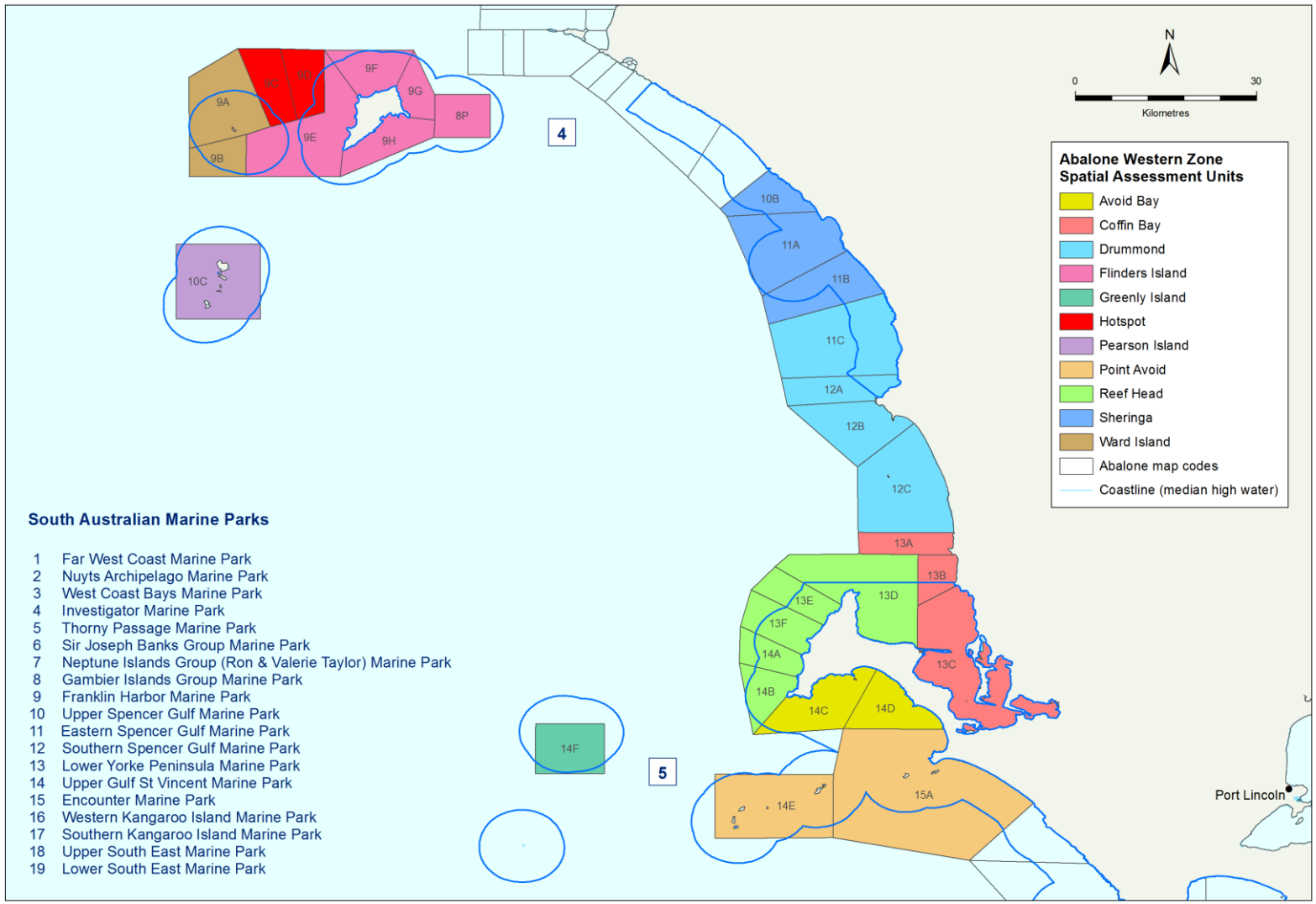
C2. Rock lobster fishing Marine park boundaries and the overlap with marine fishing areas for the Northern Zone and Southern Zone Rock Lobster Fisheries



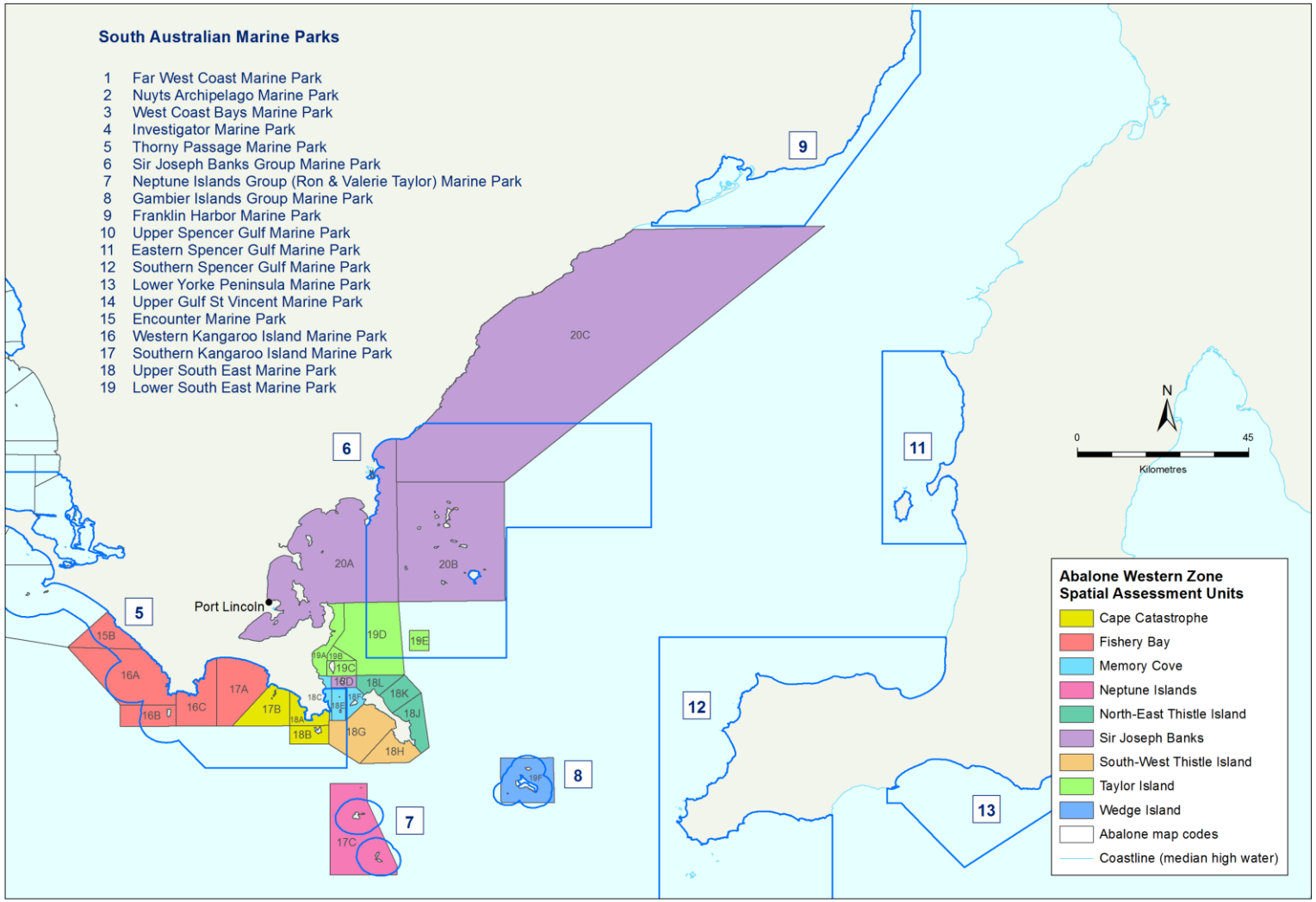
C3. Abalone fishing (Western Zone) Marine park boundaries and the overlap with map codes and spatial assessment units for part of the Western Zone Abalone Fishery off the far-west coast of South Australia



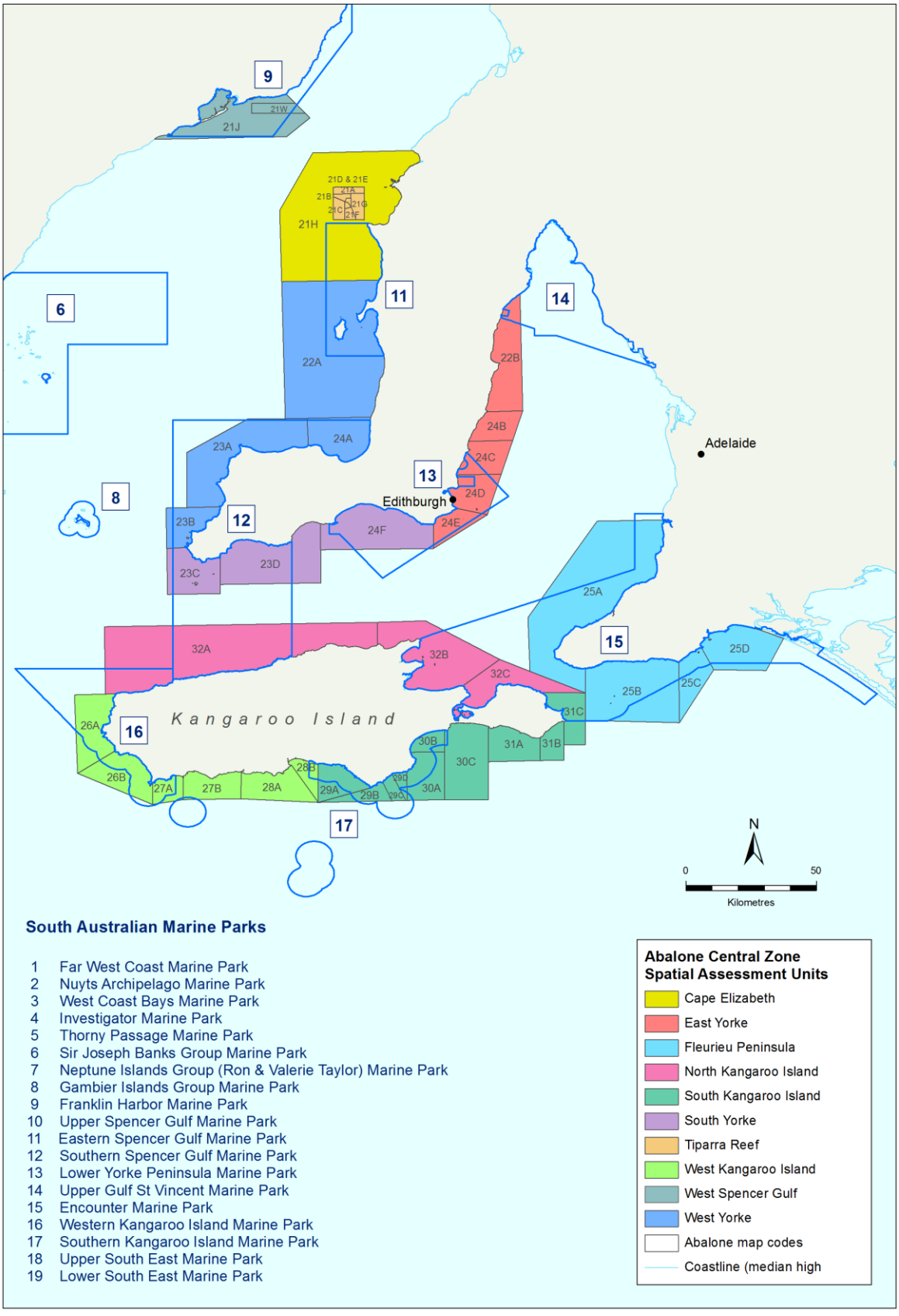
C4. Abalone fishing (Western Zone) Marine park boundaries and the overlap with map codes and spatial assessment units for part of the Western Zone Abalone Fishery off south-west Eyre Peninsula



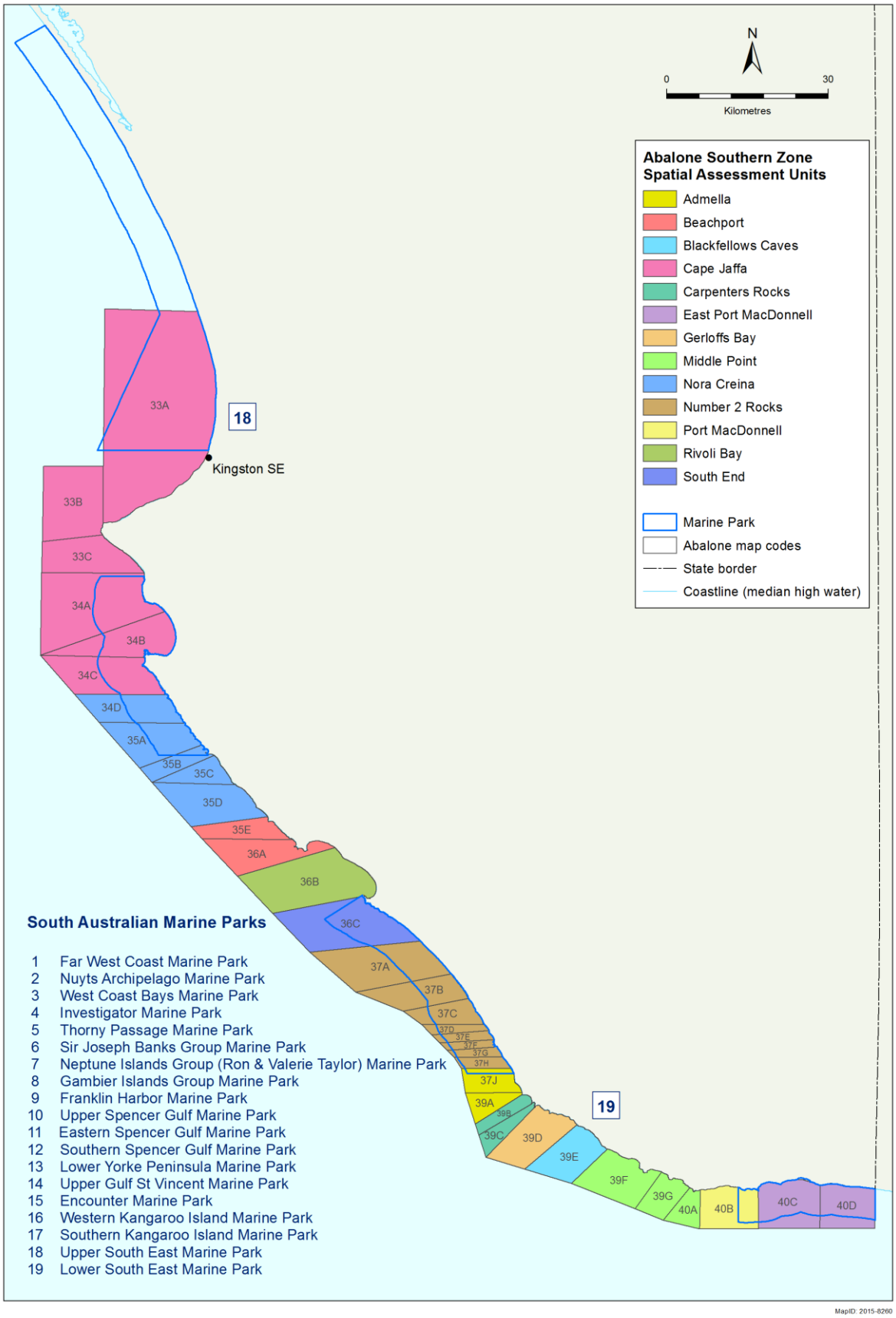
C5. Abalone fishing (Western Zone) Marine park boundaries and the overlap with map codes and spatial assessment units for part of the Western Zone Abalone Fishery off south-east Eyre Peninsula



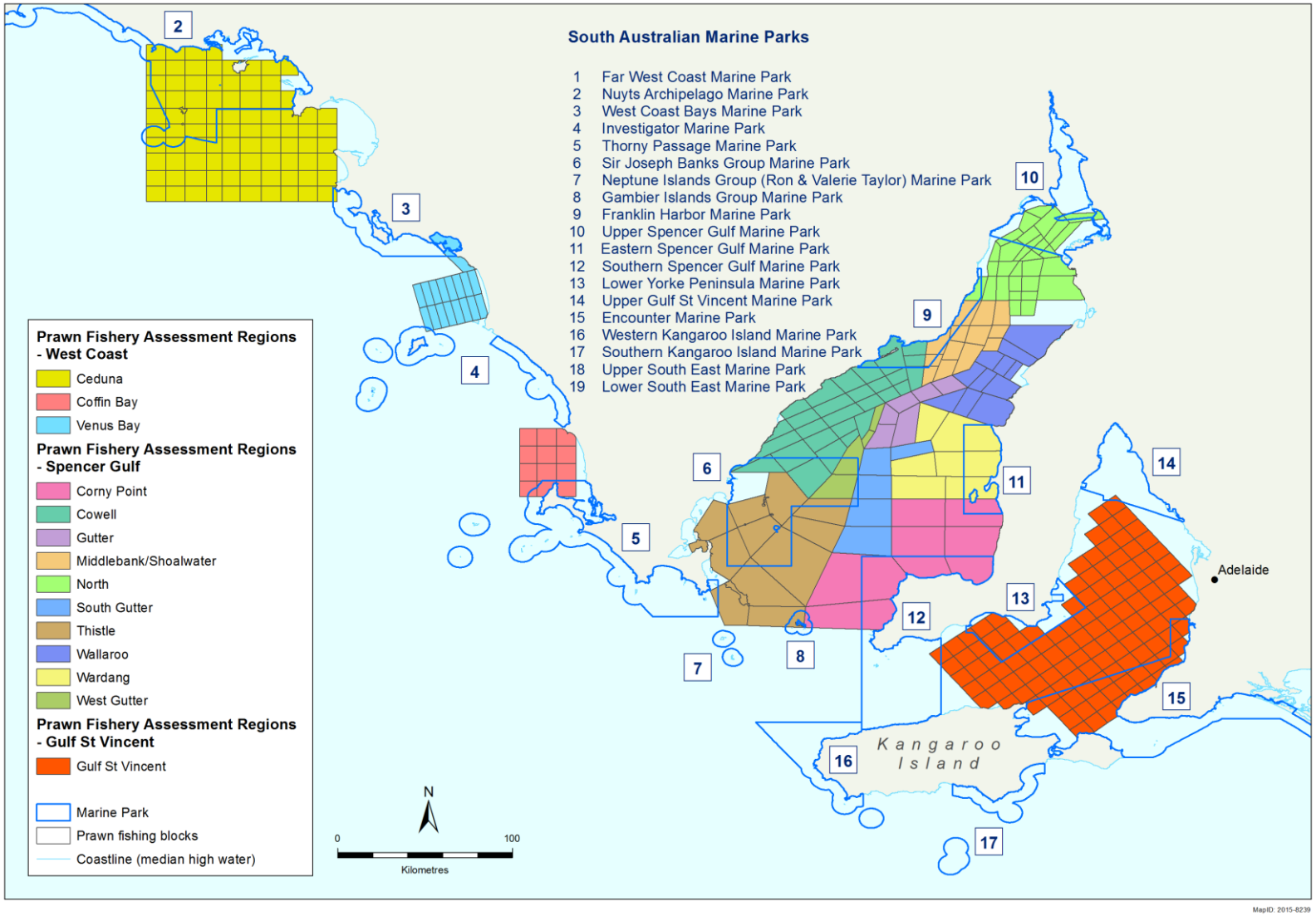
C6. Abalone fishing (Central Zone) Marine park boundaries and the overlap with map codes and spatial assessment units for the Central Zone Abalone Fishery



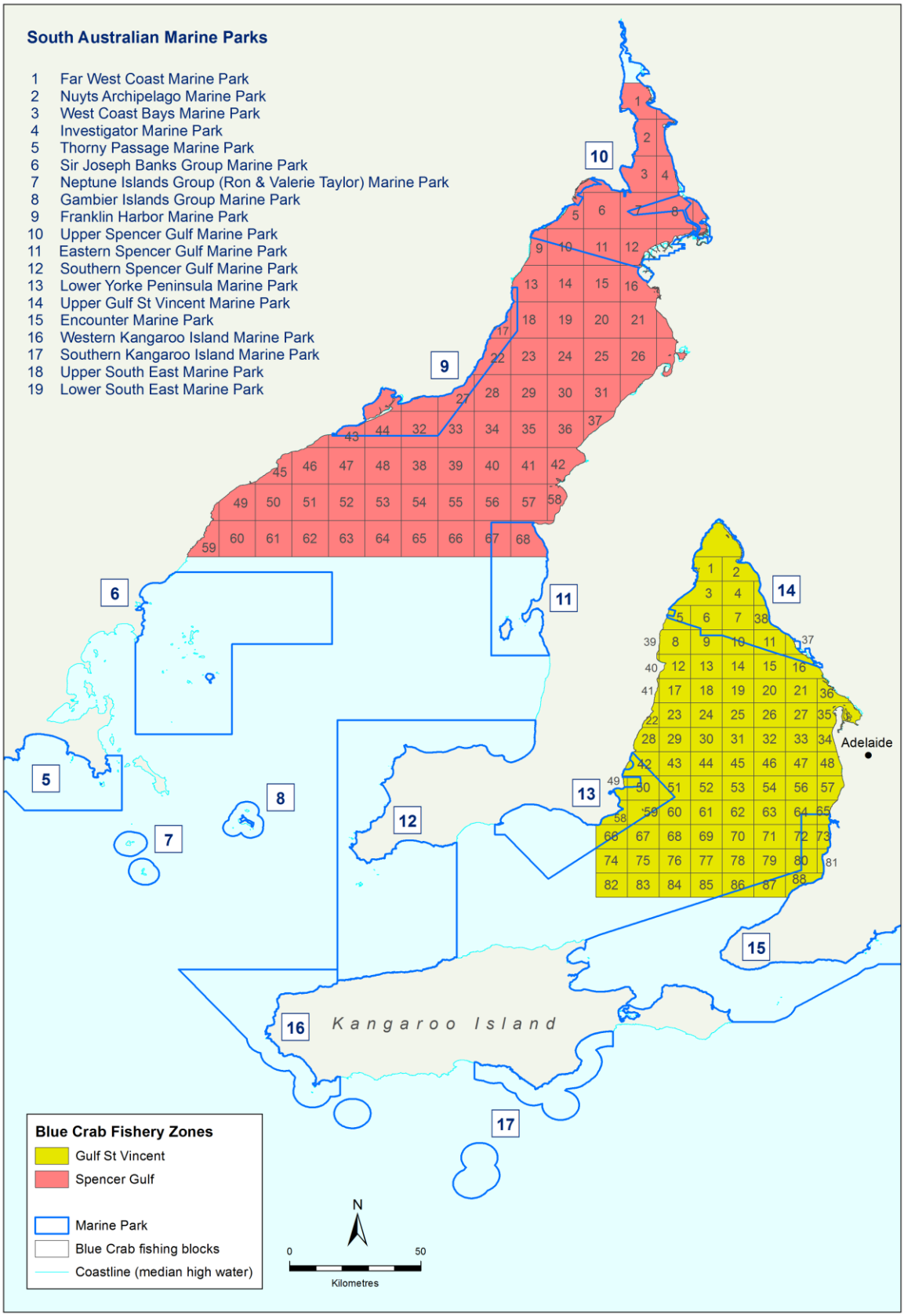
C7. Abalone fishing (Southern Zone) Marine park boundaries and the overlap with map codes and spatial assessment units for the Southern Zone Abalone Fishery



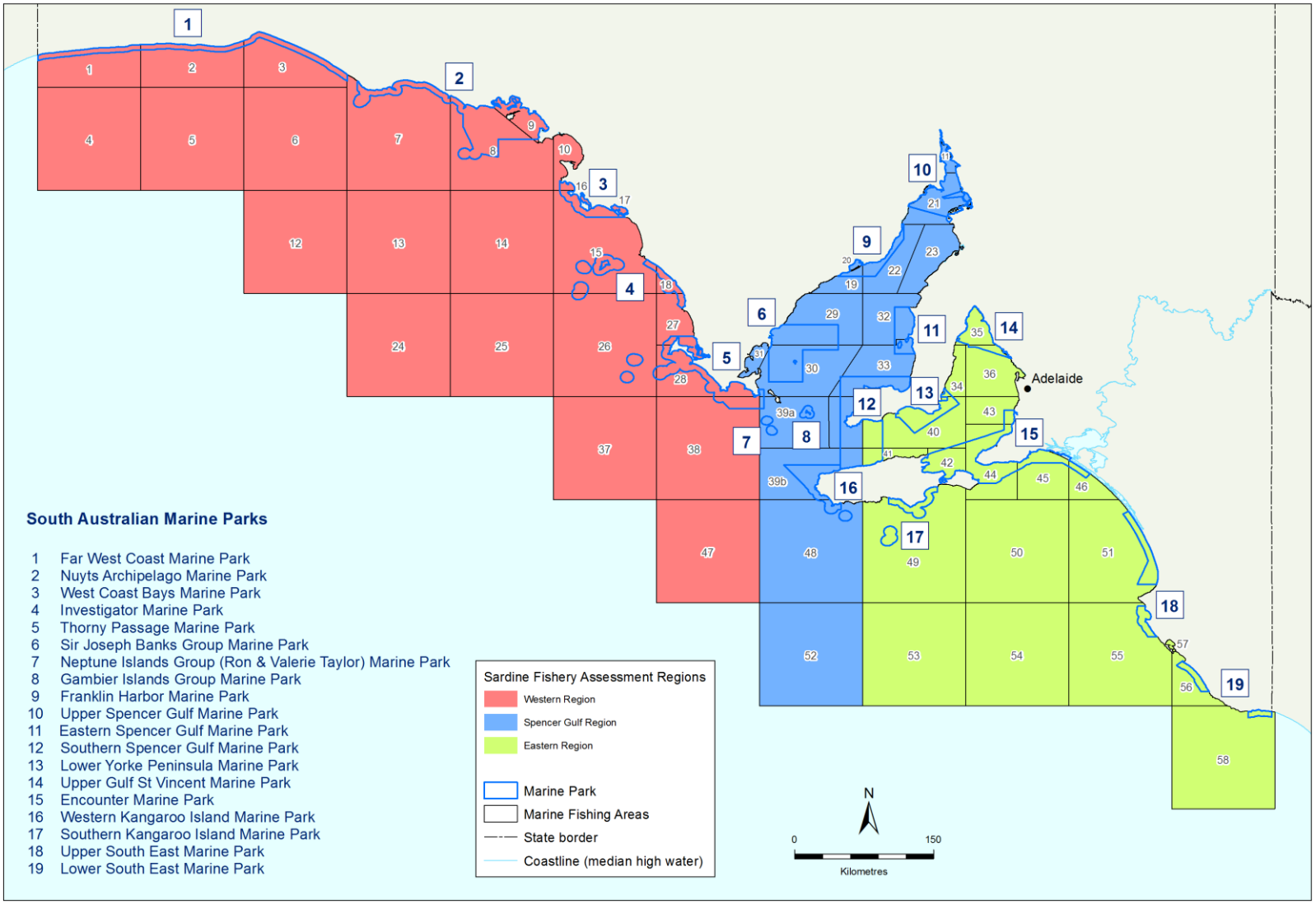
C8. Prawn fishing Marine park boundaries and the overlap with fishing blocks for the West Coast, Spencer Gulf, and Gulf St Vincent Prawn Fisheries



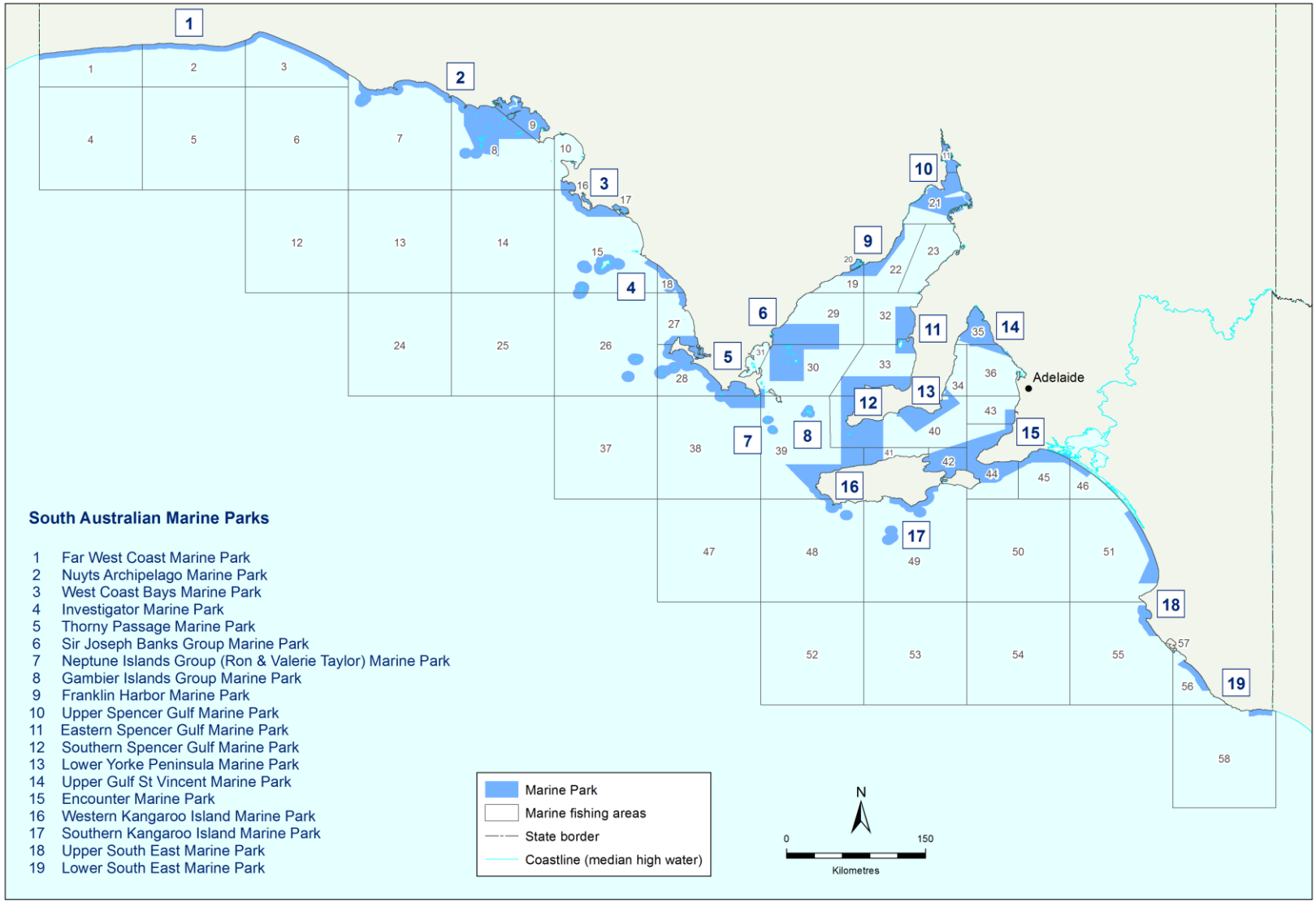
C9. Blue crab fishing Marine park boundaries and the overlap with fishing blocks for the Spencer Gulf and Gulf St Vincent zones of the Blue Crab Fishery



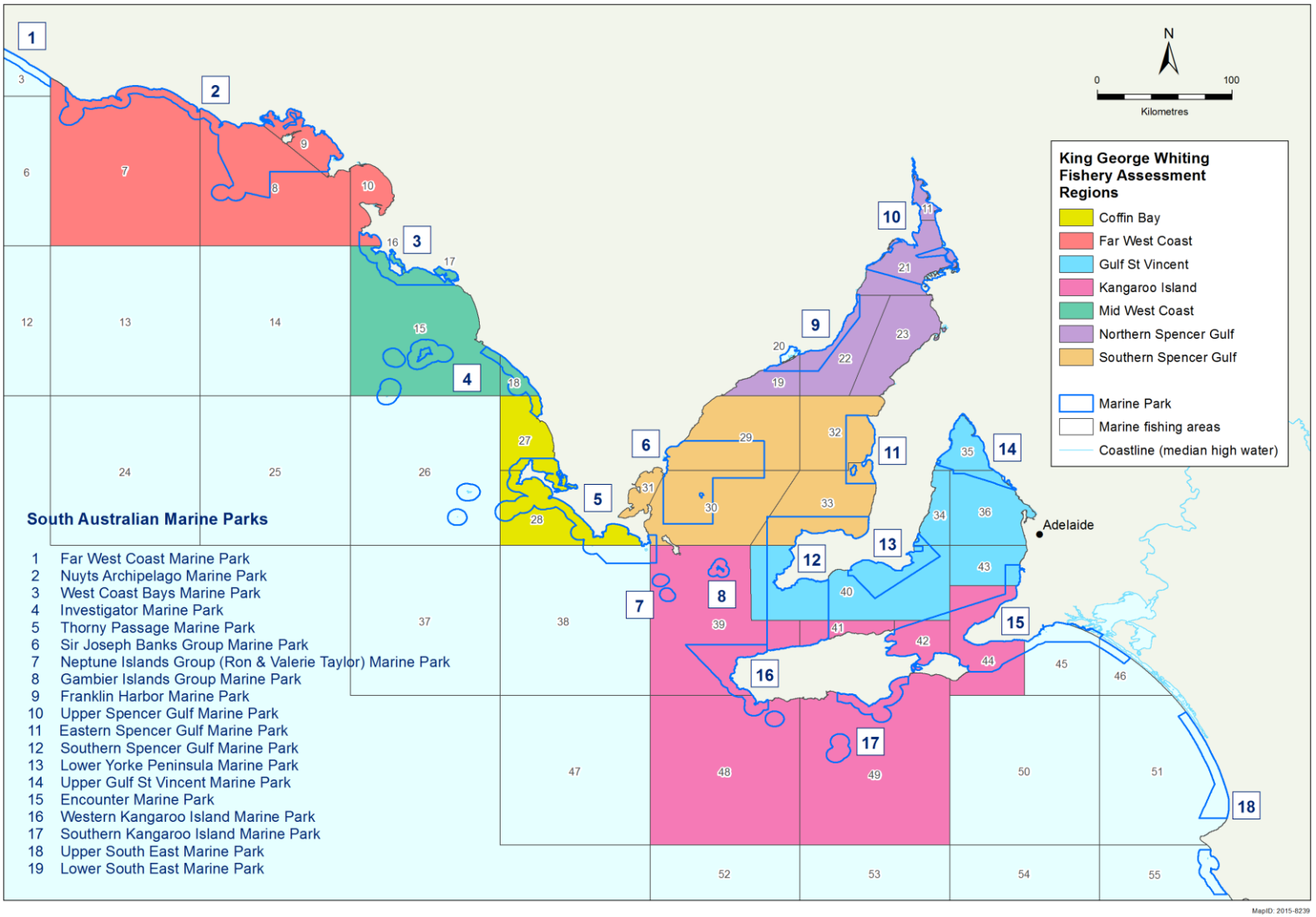
C10. Sardine fishing Marine park boundaries and the overlap with marine fishing areas and fishery assessment regions for the Sardine Fishery



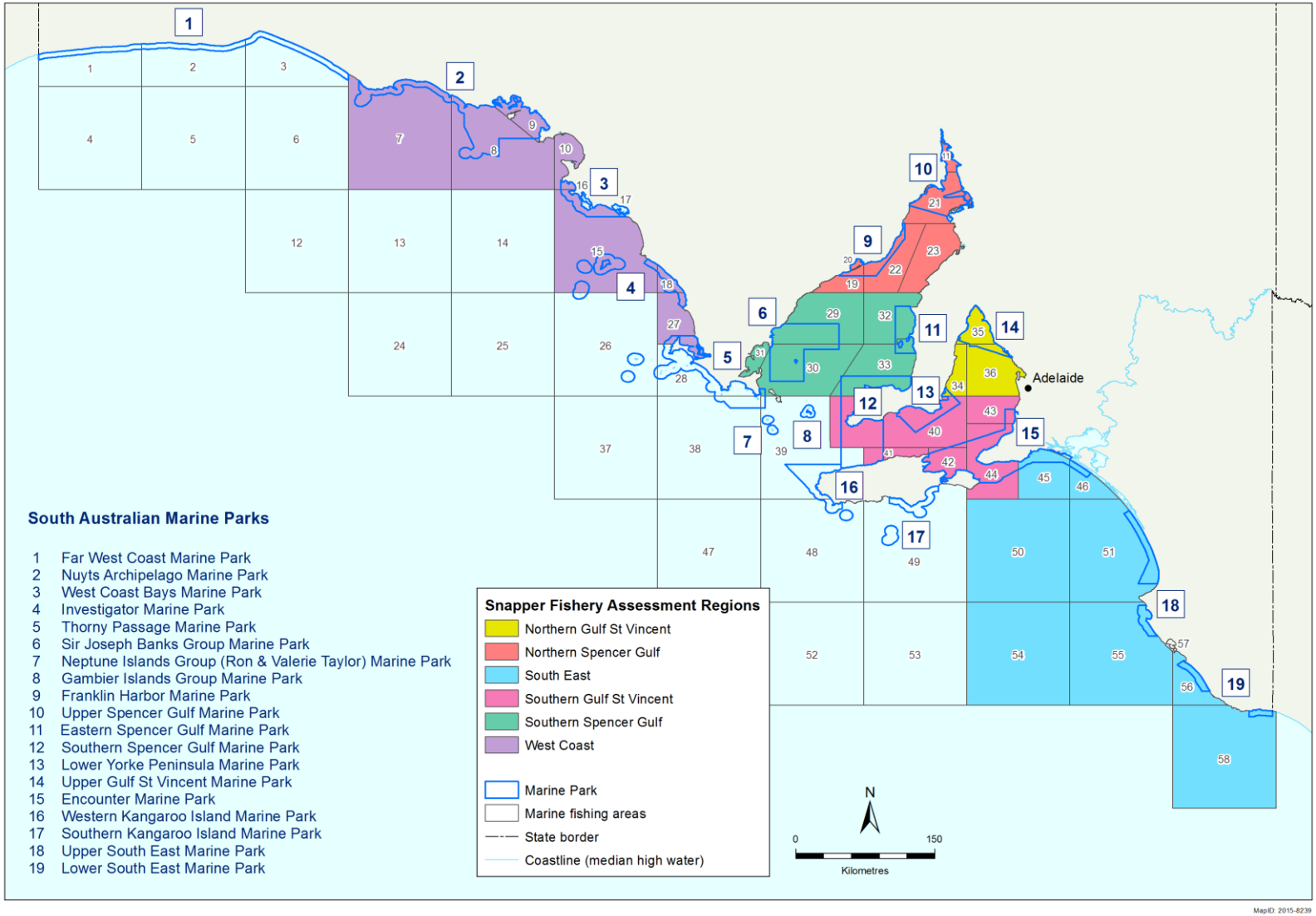
C11. Marine Scalefish fishing Marine park boundaries and the overlap with marine fishing areas for the Marine Scalefish Fishery



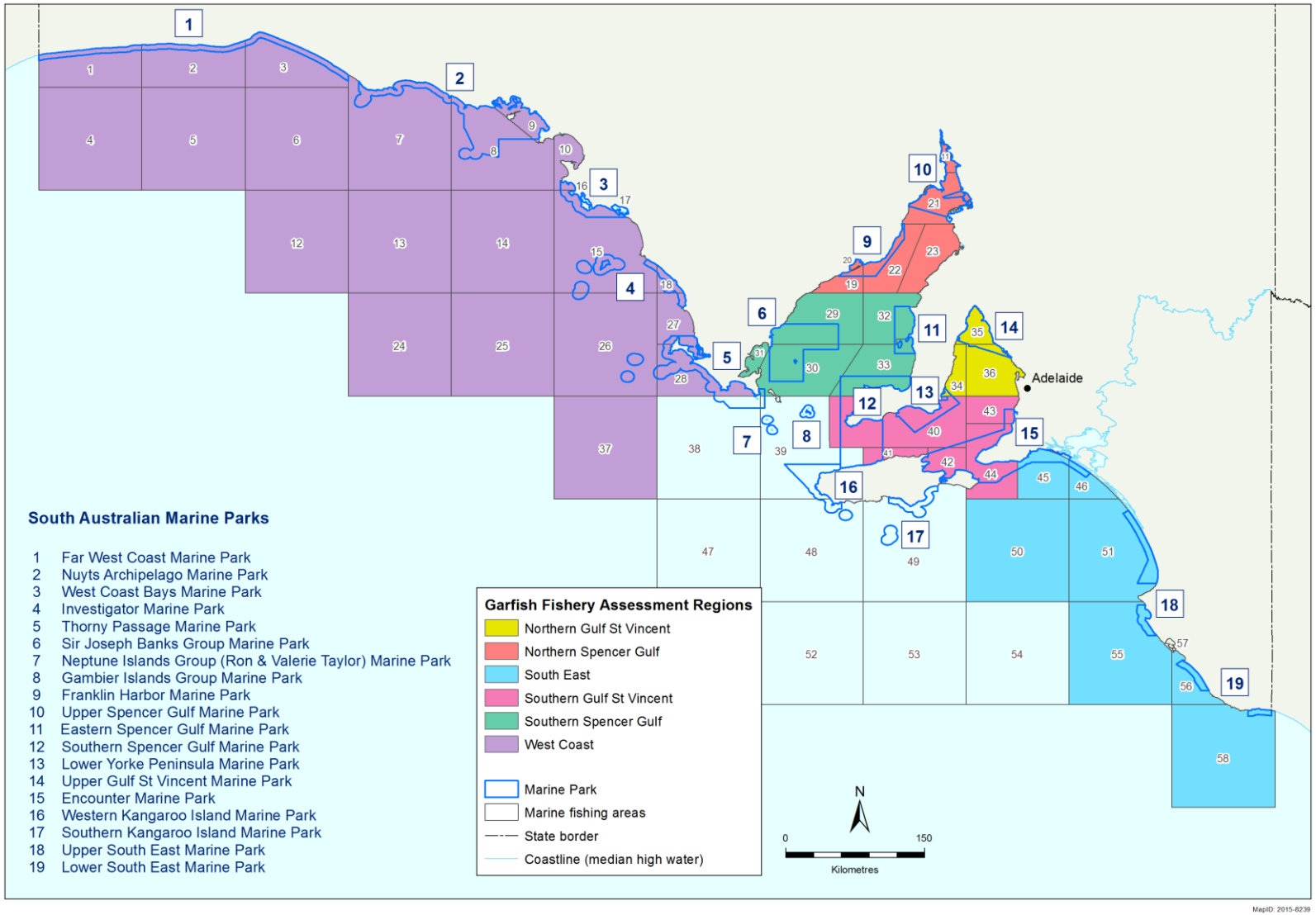
C12. Marine Scalefish fishing (King George whiting) Marine park boundaries and the overlap with marine fishing areas and fishery stock assessment regions for King George whiting in the Marine Scalefish Fishery



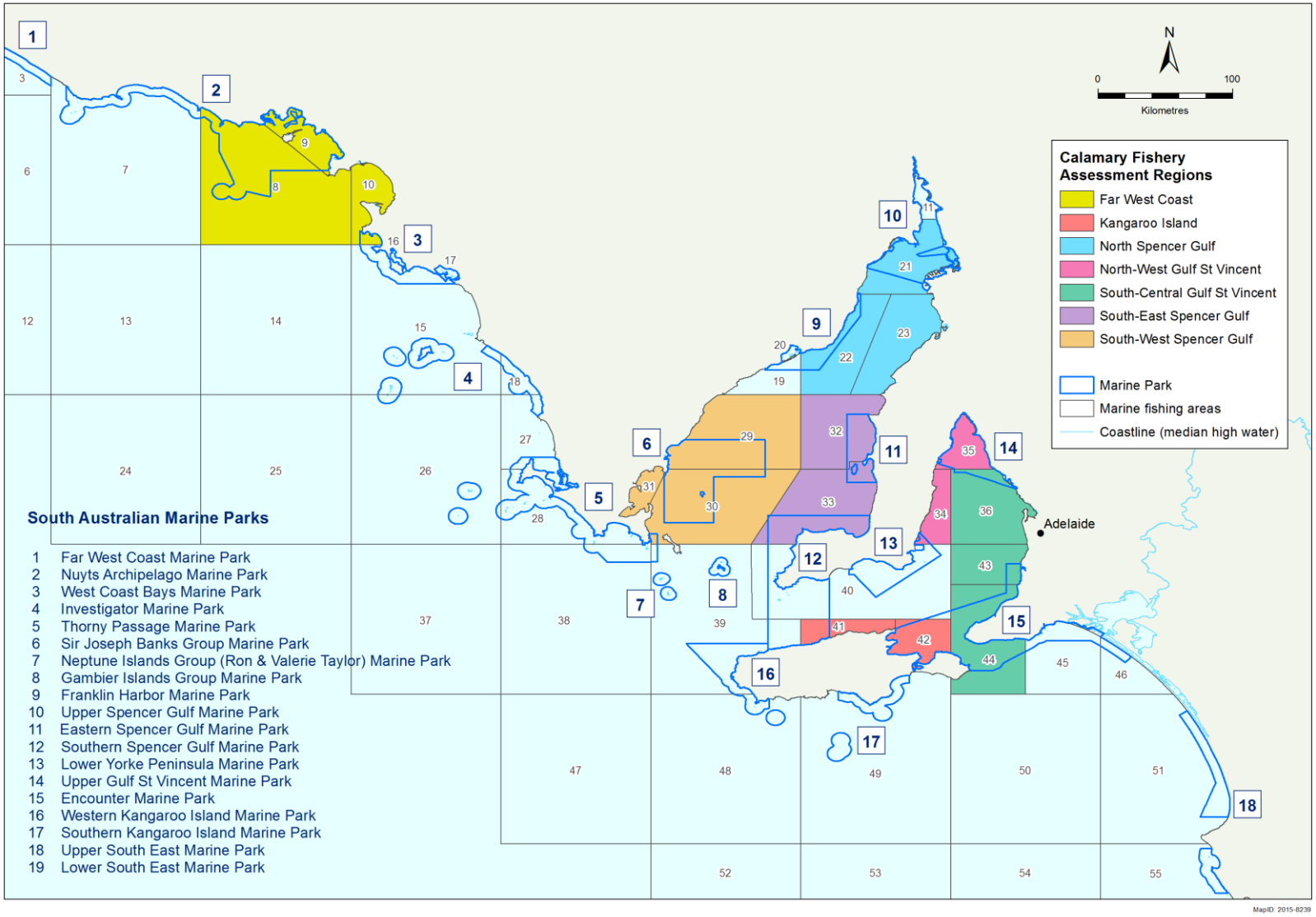
C13. Marine Scalefish fishing (snapper) Marine park boundaries and the overlap with marine fishing areas and fishery stock assessment regions for snapper in the Marine Scalefish Fishery



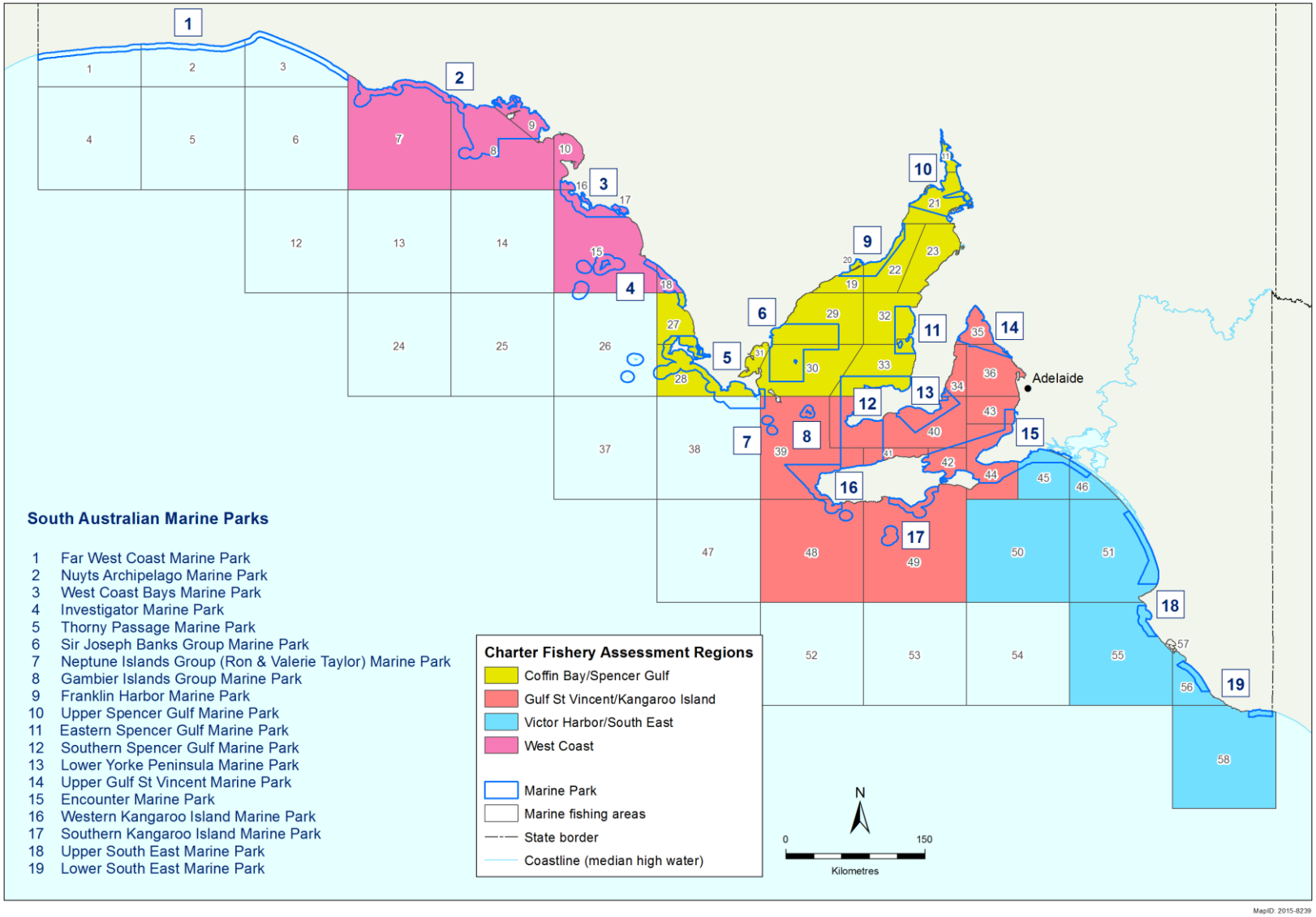
C14. Marine Scalefish fishing (garfish) Marine park boundaries and the overlap with marine fishing areas and fishery stock assessment regions for garfish in the Marine Scalefish Fishery



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

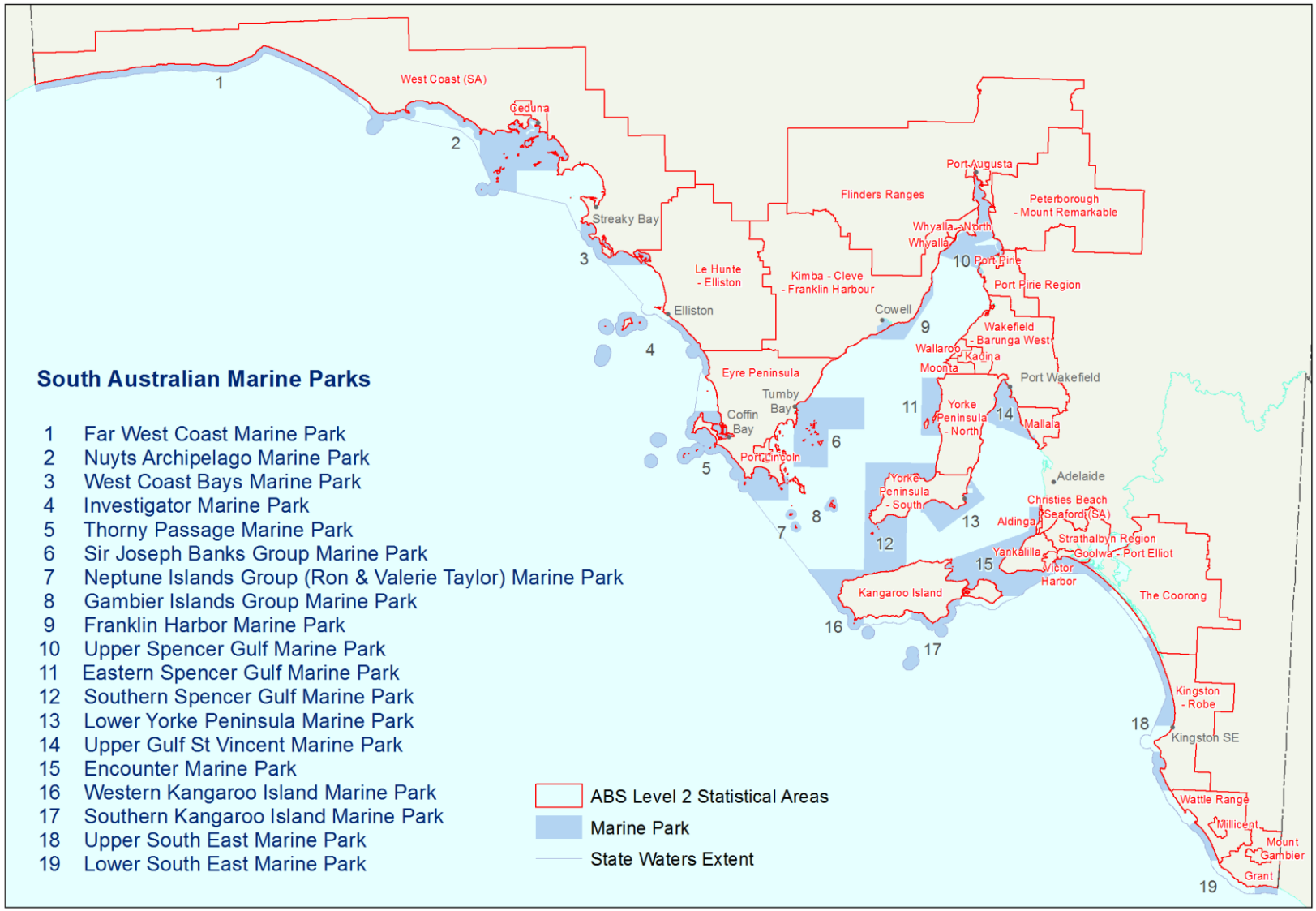


C16. Charter boat fishing Marine park boundaries and the overlap with marine fishing areas and fishery assessment regions for the Charter Boat Fishery



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 USEMP 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

USEMP — Upper South East Marine Park

RAZ — Restricted Access Zone

SPA — Special Purpose Area

SZ — Sanctuary Zone

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

National Parks South Australia