Regional Biodiversity Management Plan

Upper Spencer Gulf Regional Sustainability Planning

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Acknowledgments

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Abbreviations

BDBSA – Biological Databases of South Australia

BRD – Bycatch reduction device

EPBC Act – *Environment Protection and Biodiversity Conservation Act 1999*

FRDC – Fisheries Research and Development Corporation

IUCN – International Union for the Conservation of Nature

LEC – Listed threatened ecological community

LGA – Local government area

NERP – National Environmental Research Program

RESIC – Resources and Energy Sector Infrastructure Council

SARDI – South Australian Research and Development Institute

SDM – Species distribution models

SGEDI – Spencer Gulf Ecosystem and Development Initiative

SNES – Species of national environmental significance

SPRAT – Species profile and threats (database)

USG – Upper Spencer Gulf

USG CPG – Upper Spencer Gulf Common Purpose Group

Executive Summary

The Spencer Gulf and its environment is a highly valuable resource. It is an important region for economic activity and development. The Gulf supports many social and recreational uses as well as delivering a range of services for the region. A healthy Gulf is essential for strong economic outcomes, social activities and service provision.

Properly managed development, understanding the existing industry and environmental interactions of other Gulf users, alongside those from new developments, is a priority. Poor management often means that multiple uses result in cumulative impacts and detrimental economic and social outcomes. Conversely, an integrated understanding can deliver significant economic benefits – part of these were recently valued at over $100 million across the Spencer Gulf (Econsearch 2015). The research in this report is an important component that assists the development and use of such integrated knowledge.

This report is focused on the Upper Spencer Gulf cities of Port Pirie, Port Augusta and Whyalla. These cities received funding, under the Australian Government's Sustainable Regional Development program, to build sustainability capacity in the Upper Spencer Gulf. This research and report is a component of the Sustainable Regional Development program. It delivers the Regional Biodiversity Management Plan that is related to this funding.

The University of Adelaide’s Environment Institute conducted the research. It was carried out in collaboration with The University of Queensland’s National Environmental Research Program (NERP) Environmental Decisions Hub.

The objectives of this project were to 1) Consolidate existing environmental data for the Upper Spencer Gulf region and identify critical gaps; 2) Map and evaluate the extent and condition of listed threatened ecological communities and species; 3) Consolidate and analyse connectivity requirements for biodiversity to enhance ecosystem resilience at the regional scale and adapt to a changing climate; 4) Engage with key stakeholders on biodiversity conservation outcomes; and 5) Identify impact avoidance and mitigation measures in response to anticipated development.

All biological features within the three local government areas of Whyalla, Port Augusta and Port Pirie were identified including species/communities listed under Australian or South Australian legislation. Where possible, spatial data for these species were obtained from public databases or from the Department of the Environment and species distribution models produced. The conservation prioritisation software Zonation was then used to identify areas of high conservation priority. Priority areas for conservation were identified by taking the top 30% of the landscape with the highest priority ranks. Three scenarios [baseline value, current clearing (assuming areas that have been cleared for urbanisation, infrastructure or agriculture no longer support biodiversity), current condition (assuming areas that have been cleared partially support biodiversity)] were evaluated. Barriers to dispersal of marine species and coastal communities (seagrass, saltmarsh, mangroves) were then explored by mapping all existing infrastructure which might affect movement under future sea level rise.

A total of 529 species (395 terrestrial, 134 marine) of conservation concern were identified, of which 19 had more than 15% of their mapped distribution within the three local government areas of Whyalla, Port Augusta and Port Pirie. Areas of highest priority for conservation changed depending on the scenario considered and whether terrestrial biodiversity was considered alone or if both marine and terrestrial biodiversity was considered. The most realistic scenario accounting for the condition of the landscape showed that existing ports overlapped with high existing biodiversity. Considering marine biodiversity along with terrestrial biodiversity resulted in greater priority being placed on coastal areas. Across the whole of Spencer Gulf the LGAs with the highest proportion of their area classified as high priority (top 30% of the landscape) were Port Augusta, Whyalla, Port Lincoln and Yorke Peninsula South. Port Pirie and the Port Pirie LGA coastline was also considered highest conservation priority. Existing infrastructure, predominantly roads, forms a significant barrier to inland movement of coastal communities under potential sea level rise.

Developing adaptation strategies to sea-level rise poses a challenge to policy makers, but climate change needs to be integrated into protocols for planning such that the future distributions of ecosystems and species can be predicted. Intertidal and supratidal saltmarsh faces the most barriers to inland movement particularly in the Whyalla LGA. Mangrove habitats are at less risk in the short term as there are fewer barriers within 500m of their distribution.

Keywords

Upper Spencer Gulf, biodiversity, marine, terrestrial, species distribution model, conservation prioritisation, connectivity

Introduction

Spencer Gulf is South Australia's most important economic growth area and a vital region for the state's mining pipeline and associated infrastructure. It services mineral and energy resource activities across the state and into western New South Wales. At the same time it is the site of a number of pre-eminent fisheries as well as an important recreational and environmental area.

With numerous potential developments, alongside established resource activities with long futures (such as BHP Billiton's Olympic Dam, Arrium steel operations, Santos, sustainably certified prawn fisheries and important aquaculture regions) there is the potential for uses to conflict. Moreover, this is an area of high environmental value incorporating significant seagrass, saltmarsh and mangrove areas alongside endangered land and sea species. The region is also the home of the only known large (and spectacular) breeding aggregation of the giant Australian cuttlefish.

A lack of deep-water port facilities to meet export capacity close to proposed developments has led to at least five companies proposing new port developments in Spencer Gulf and the Resources and Energy Sector Infrastructure Council (RESIC) indicating that at least three new ports may be required (RESIC 2011).

The Australian Government recognises Upper Spencer Gulf (USG) as a priority area and as such funded several research projects under the Sustainable Regional Development program. USG was selected as an eligible region based on the high rate of growth linked to potential mining developments and the associated infrastructure and services. The government works collaboratively with state and regional stakeholders to promote and inform environmental, social and economic sustainability within the region. There is a focus on matters of national environmental significance, protected under national environmental law, and other priority environmental values such as the giant Australian cuttlefish, *Sepia apama*. The upper Spencer Gulf population of giant Australian cuttlefish has previously been proposed for listing as critically endangered under the EPBC Act, but was considered not eligible for inclusion because at the time (2010) it was not considered taxonomically distinct from the rest of the *Sepia apama* for the purposes of the EPBC Act (69365 listing advice: http://www.environment.gov.au/biodiversity/threatened/species/pubs/69365-listing-advice.pdf). Despite this, it remains the only known breeding aggregation of cuttlefish in the world, and is an important species for ecotourism where breeding individuals can be easily accessed from shore near Point Lowly. There is, however, some concern regarding the decline in abundance of the species in Upper Spencer Gulf.

The three city councils are important community institutions with governance, policy and planning responsibilities in the region. This report enables the cities to enhance leadership and outcomes for overall sustainability, alongside progressive development and environmental protection, of the region.

Objectives

Objectives of the project are to –

1. Consolidate existing environmental data for the Upper Spencer Gulf region and identify critical gaps
2. Map and evaluate the extent and condition of listed threatened ecological communities and species, including *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) protected ecological communities and species (including migratory)
3. Consolidate and analyse connectivity requirements for biodiversity to enhance ecosystem resilience at the regional scale and adapt to a changing climate
4. Engage with key stakeholders on biodiversity conservation outcomes in a low carbon future/changing climate
5. Identify impact avoidance and mitigation measures in response to anticipated development

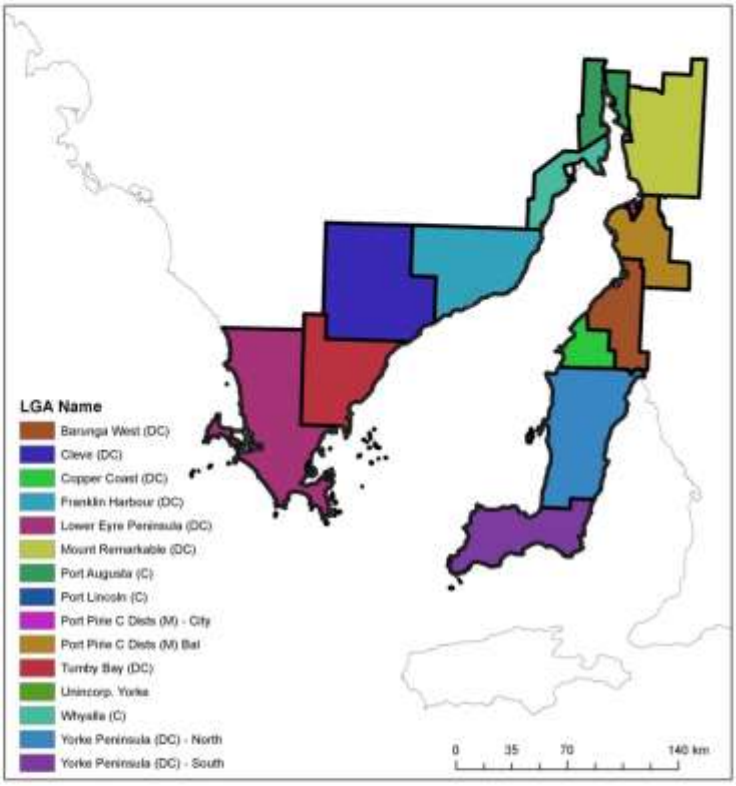
Methods

Species occurrence and environmental data

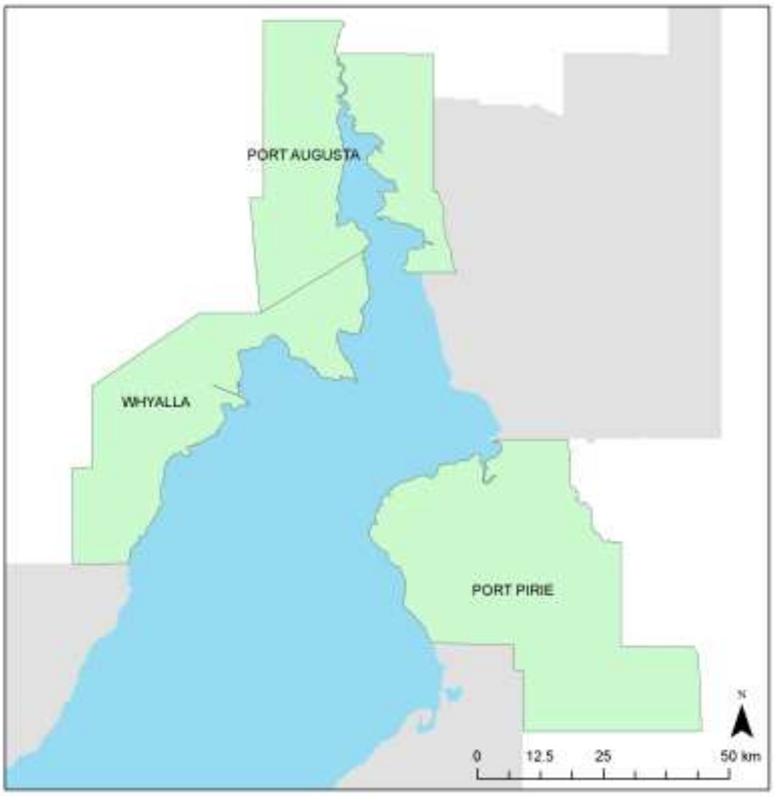
The first step involved identifying all biological features within the three council regions (Whyalla, Port Augusta, Port Pirie) that were considered to be of conservation importance, including threatened species and ecological communities. We determined a Spencer Gulf boundary that encompassed all local government areas contacting the Spencer Gulf coastline. This area therefore includes the lower Eyre and Yorke Peninsulas and associated ports, and covers 30,844 km^2 of land (Figure 1a). The focus for this report is on the Upper Spencer Gulf (Figure 1b).

All species and communities listed under Australian (*Environment Protection and Biodiversity Conservation Act 1999*) or SA legislation (*National Parks and Wildlife Act 1972*) were identified in the Upper Spencer Gulf region, including 5 threatened ecological communities and 509 species (Appendix A, Table A). Of the 509 species, 387 were terrestrial, 52 were marine, and 70 inhabit both marine and terrestrial habitats (e.g. penguins, and seals). Terrestrial data have been previously identified by the National Environmental Research Program (NERP) Environmental Decisions Hub as part of an earlier project (Tulloch et al. 2014). Marine data were identified from the Department of the Environment's Species Profile and Threats (SPRAT) database which maps the distributions of all Species of National Environmental Significance (SNES) listed under the *Environment Protection and Biodiversity Conservation Act 1999*.

An additional 15 layers representing marine communities were also sourced, resulting in 529 terrestrial and marine biodiversity features in total. The distributions of reef, coastal saltmarsh, samphire, mangrove, *Melaleuca*, sedge and cyanobacterial systems were obtained from the South Australian State Benthic Habitats database (Department of Environment, Water and Natural Resources). Comprehensive benthic habitat mapping in marine waters is restricted to inshore areas of Spencer Gulf (Figure 2). The South Australian State Benthic Habitats layer for seagrass and spatial covariates (seabed depth, temperature and salinity, detritus content, current velocity, predicted occurrence of rocky reef habitat) were recently used to predict the spatial occurrence and percent cover for seagrasses, based on statistical models, in unsurveyed regions of the Gulf (Gillanders et al. 2015). This map of predicted seagrass occurrence and percent cover of seagrasses conditional on seagrass presence was then used for subsequent objectives (see Gillanders et al. 2015).



(a)



(b)

Figure 1. Local government areas with (a) land boundaries contacting the Spencer Gulf coastline and (b) just showing the three LGAs of interest (Whyalla, Port Augusta and Port Pirie).

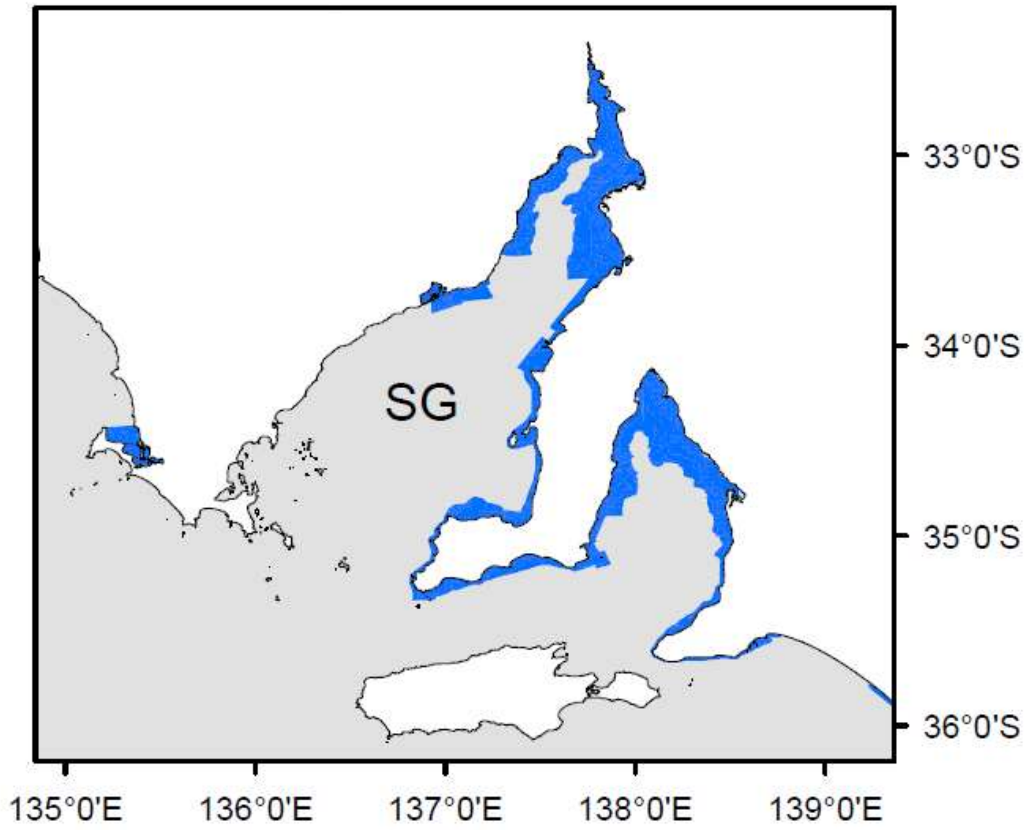


Figure 2. The spatial extent of comprehensive marine benthic mapping for South Australia (blue regions), illustrating that benthic habitat information is currently unavailable for much of Spencer Gulf (SG). From Gillanders et al. (2015).

We also investigated recent research on the giant Australian cuttlefish, *Sepia apama*. This involved searching databases, and discussions with key cephalopod researchers in South Australia to determine existing projects.

Mapping and evaluating the extent and condition of listed threatened ecological communities and species

Spatial data for threatened species identified above were obtained as point locations from online public databases (Atlas of Living Australia, eBird) and the Biological Databases of South Australia (BDBSA), and EPBC Act-listed threatened species and ecological community data were provided as Species of National Environmental Significance (SNES) polygons by Department of the Environment. We divided the study area into units of 250 by 250 metres, resulting in a grid of 842,101 planning cells that included 480,602 in the terrestrial region, and 361,499 cells in the marine region. By including both the marine and terrestrial parts of the region, we avoided artificially truncating distributions at the coastline, a common problem with models that are restricted to either terrestrial or marine landscapes. Species distribution models (SDMs) were produced using MaxEnt (Phillips et al. 2006; Elith et al. 2011), thereby providing the likelihood of observing a species in each unit, given the environmental conditions that exist there relative to the environmental conditions in units where the species is known to occur (Phillips and Dudik 2008). To reduce the influence of observed biases in the species occurrence data (with data heavily biased towards populated areas and roads), we also manipulated the background data used in the modelling process by introducing a sampling bias layer that mimics the biases in the occurrence data (Phillips et al. 2009). Further details of the modelling methodology can be found in the National Environmental Research Program (NERP) Environmental Decisions Hub Upper Spencer Gulf modelling project (Tulloch et al. 2014).

There were 177 species with fewer than 20 occurrence points in the study region for which models could not be produced due to too few data for accurate predictions – all of the marine species except for the seagrass, and 55 of the terrestrial EPBC Act-listed species. For these species, we reclassified SNES maps produced at a 1 km resolution across Australia to rasters. The polygon data representing the listed threatened ecological communities (LEC) were converted to rasters using the same method. We used the following classification to convert qualitative mapping to quantitative distribution predictions:

1. Known to occur = Probability of occurrence 1
2. Likely to occur = Probability of occurrence 0.75
3. May occur = Probability of occurrence 0.5

Finally, there were 124 State-listed species for which there were no SNES maps, and for which there were too few occurrence points to derive models. For each of these species, point occurrence data were converted to a presence-absence raster.

We used the conservation prioritisation software Zonation v.3.1 (Moilanen et al. 2005; Moilanen et al. 2012) to identify areas of high conservation priority within the USG region. Zonation uses information about biodiversity features, their relative occurrences, and biological needs, to create a hierarchal conservation ranking of sites across any given landscape. This approach allows the diversity of important land and marine species and communities to be considered alongside potential stressors and actions that may protect priority areas or species. The hierarchal ranking of sites is created through a removal process in which all sites (grid cells) in the landscape are initially assumed to be protected. Cells that cause the smallest marginal loss in conservation value are progressively removed until no cells are left, i.e. the least valuable grid cells are removed first and the most valuable cells are retained until the end, producing a priority value for each cell. We used default settings for core-area Zonation, which removes the cell with the smallest value for the most valuable occurrence over all species in the cell. In this setting, a cell gets high value if even one species has a relatively important occurrence there. Priority areas for conservation were identified by taking the top 30% of the landscape with the highest priority ranks.

Three scenarios were evaluated:

1) Baseline value.
   We identified the distribution of areas across the entire USG region that are of high environmental suitability and maximise representation of biodiversity features. This prioritisation was done without considerations of land tenure or current levels of land clearing. The conservation value of a given grid cell was based purely on the environmental suitability for biodiversity features within that cell (as defined by the maps of biodiversity features).
2) Current clearing (assuming areas that have been cleared for urbanisation, infrastructure or agriculture no longer support biodiversity).
   We assessed how biodiversity features are currently protected by identifying the distribution of areas that maximise representation of biodiversity features across the uncleared portion of the USG CPG region, and assigning highest priority to currently protected areas (IUCN category I-IV only). This allows areas that are uncleared to contribute more to landscape conservation value than cleared areas, and areas that are protected to contribute the most within the uncleared zone.
3) Current condition (assuming areas that have been cleared partially support biodiversity).

We identified the distribution of areas across the entire USG CPG region that maximise representation of biodiversity features whilst considering the extent to which a given cell has been impacted by either infrastructure or clearing. This prioritisation was done without considerations of land tenure.

These scenarios were initially carried out only for the 403 terrestrial biodiversity features of conservation significance, then compared with the same set of scenarios but including an additional 125 marine biodiversity features (529 features in total, Figure 3). EPBC Act and SA State listed species were all weighted evenly because although weightings of features are possible within Zonation this requires consultation through workshops with stakeholders along with experts in the field of systematic conservation planning which was not possible within the current project.

Connectivity requirements for biodiversity

We explored the distribution of barriers to dispersal of marine species and key coastal communities of interest (seagrass, saltmarsh, mangroves). We mapped all existing infrastructure – roads, pipelines, railway, and powerline easements, which might act as barriers to movement of coastal communities under the influence of future sea level rise. An infrastructure 'effect zone' was developed from this map, by buffering the infrastructure based on results of a previous expert elicitation that derived the likely area of impact of infrastructure. We took the average effect zone based on differing responses of taxonomic groups to infrastructure, and buffered the infrastructure and cleared areas by 500m. This assumes that environmental suitability is decreased within 500m of the infrastructure. For the purposes of this analysis, we took a worst-case scenario, assuming that within this infrastructure effect zone, coastal communities would not be able to colonise when moving to avoid sea level rise. This was a reasonable assumption, as results of the previous expert elicitation in the report on the effects of infrastructure on the whole of the Spencer Gulf and surrounding area showed that plant species would most likely have their habitat suitability reduced to 22 to 46% of their current habitat suitability within 500 m of the infrastructure development (Tulloch et al. 2014).

Results, Discussion and Conclusion

Mapping and evaluating the extent and condition of listed threatened ecological communities and species

A total of 529 species comprising 395 terrestrial and 134 marine species of conservation concern were identified (Table 1). The majority of these were terrestrial plants followed by terrestrial and marine birds (Table 1). Twenty ecological communities were also used. Few frog, insect and invertebrate species have been identified from the study region as of conservation concern. Many (n=425) of these species are not listed under the EPBC Act (Table 2). A small number are listed as critically endangered (n=5), endangered (n=39) or vulnerable (n=56) under the EPBC Act (Table 2). A greater number of species are listed under South Australian legislation (Table 3).

Table 1. Species and communities of concern in the study region.

Taxonomic Group	*Marine*	*Terrestrial*	Total
BIRD	64	110	174
COMMUNITY	12	8	20
FISH	38	1	39
FROG		1	1
GROUNDBIRD	1	16	17
INSECT		1	1
INVERTEBRATE	1		1
MAMMAL	15	13	28
PLANT		227	227
REPTILE	3	18	21
Total	**134**	**395**	**529**

Table 2. EPBC Act listing status of species of concern in the region.

Group	Not listed	Critically Endangered	Endangered	Vulnerable	Conservation Dependent
BIRD	150	1	8	15	
COMMUNITY	15	2	2	1	
FISH	35			1	3
FROG	1				
GROUNDBIRD	15		1	1	
INSECT	1				
INVERTEBRATE	1				
MAMMAL	17		4	7	
PLANT	180	2	20	25	
REPTILE	10		5	6	
Total	**425**	**5**	**39**	**56**	**3**

Table 3. SA listing status of species in the Upper Spencer Gulf.

Group	Rare	Rare(Subsp)	Vulnerable	Endangered	Endangered(Subsp)
BIRD	65	7	22	13	
FISH					
FROG	1				
GROUNDBIRD	6	3	3	2	1
INSECT					
INVERTEBRATE					
MAMMAL	8		7	3	
PLANT	134	1	51	34	2
REPTILE	9	1	4	3	
Total	**223**	**1**	**86**	**55**	**3**

Of the identified features of conservation interest, there were 19 with more than 15% of their mapped distribution within the three LGA areas of Whyalla, Port Augusta and Port Pirie (Table 4, Figure 3). One is a SA-listed reptile, 1 is a nationally-listed reptile (Krefft's Tiger Snake), 11 are SA-listed threatened plants, and the remaining five are coastal vegetation communities. Of these, 5 have all of their mapped South Australian distribution within the LGAs and are of high conservation concern. Figure 3 shows the known populations of the species, mostly centred around Port Augusta and scattered throughout the LGA of Port Pirie, except for the coastal communities that share boundaries with all three LGAs, and the western grass wren which is restricted to Whyalla and the west coast of the Spencer Gulf.

Table 4. List of species occurring in the Whyalla, Port Augusta and Port Pirie LGAs, that have at least 15% of their distribution within that area (* signifies EPBC Act-listed).

Biological feature	**Common name**	**Taxonomic group**	**Total mapped range in SA (km^2)**	**Percentage of mapped SA distribution within the 3 LGAs (%)**
Elachanthus glaber	Shiny Elachanth	Plant	0.1	100
Emydura macquarii	Macquarie Tortoise	Reptile	0.1	100
Leptinella reptans	Creeping Cotula	Plant	0.1	100
Solanum eremophilum	Rare Nightshade	Plant	0.1	100
Supratidal Mangrove	Supratidal Mangrove	Community	0.1	100
Wurmbea latifolia	Broad-leaf Nancy	Plant	0.1	50
Supratidal Samphire	Supratidal Samphire	Community	239.7	44
Intertidal Samphire	Intertidal Samphire	Community	221.5	44
Intertidal Cyanobacteria	Intertidal Cyanobacteria	Community	12.7	42
Aristida australis	*Aristida australis*	Plant	0.2	33
Elatine gratioloides	Water Wort	Plant	0.2	33
Sarcozona bicarinata	Ridged Noon-flower	Plant	0.4	33
Intertidal mangrove	Intertidal Mangrove	Community	150.8	30
Senecio longicollaris	Riverina Fireweed	Plant	378.3	29
Malacocera gracilis	Slender Soft-horns	Plant	0.9	29
Phlegmatospermum eremaeum	Spreading Cress	Plant	0.3	25
*Notechis ater ater**	Krefft's Tiger Snake	Reptile	666.1	21
Triglochin minutissima	Tiny Arrowgrass	Plant	0.3	20
*Amytornis textilis myall**	Western Grass wren	Bird	0.3	15

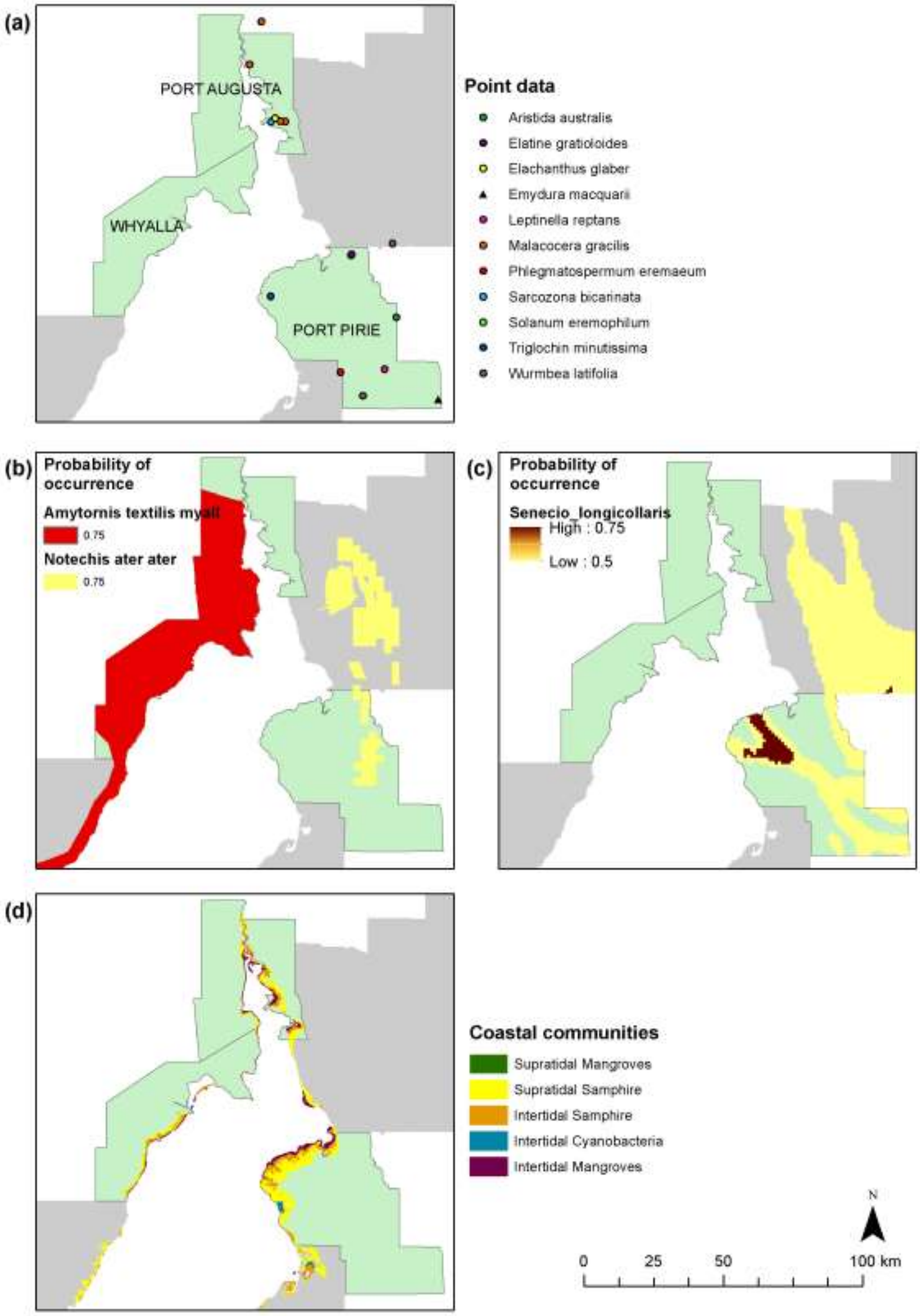


Figure 3. Maps of species occurring in the Whyalla, Port Augusta and Port Pirie LGAs, that have at least 20% of their distribution within that area, showing (a) species with point data only, (b, c) species with distribution maps, and (d) coastal communities. LGA areas are highlighted in green (Whyalla, Port Augusta, Port Pirie) or grey (other LGA areas).

The areas of highest priority for conservation changed depending on whether we considered original baseline conditions (i.e. pre-clearing; Figure 4a and 5a), compared with if we only prioritised areas that were uncleared by infrastructure or agriculture or urban development (Figure 4b and 5b), or if the contribution of cleared areas to biodiversity was limited by the condition of the land (Figure 4c and 5c). The most realistic scenario accounting for the condition of the landscape showed that all ports overlapped with high existing biodiversity priority despite being degraded and heavily impacted by infrastructure development (Figure 4c and 5c).

Priority areas were also located in different parts of the landscape if only terrestrial biodiversity was considered (Figure 4) compared with if both marine and terrestrial species and ecosystems were considered important for planning (Figure 5). Importantly, more priority was placed on the coastal areas, and less priority was placed on the inland areas particularly of Whyalla and Port Augusta LGAs (Figure 5).

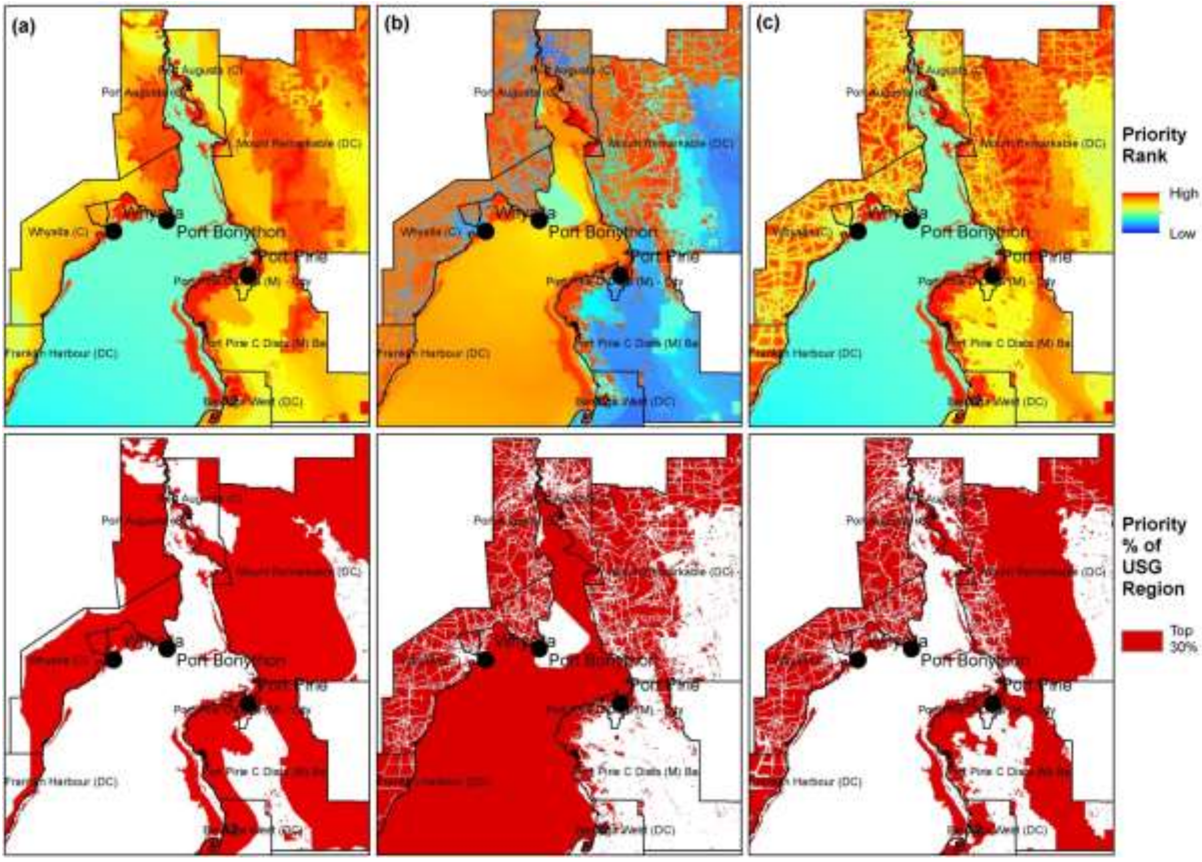


Figure 4. Terrestrial conservation value of the Upper Spencer Gulf. (a) represents a pristine environment, (b) represents if we account for current local effects of urban development and linear infrastructure, and (c) represents accounting for future and diffuse effects of clearing, urban development and linear infrastructure. Maps on the top row represent the rankings of every unit in the landscape, with units of higher conservation priority (representing best complementary areas for all biodiversity features) in red, and lowest-ranked units in blue. Maps on the bottom row represent just the top 30% of the landscape. In this ranking, no exclusively marine features were used (403 biological features in total).

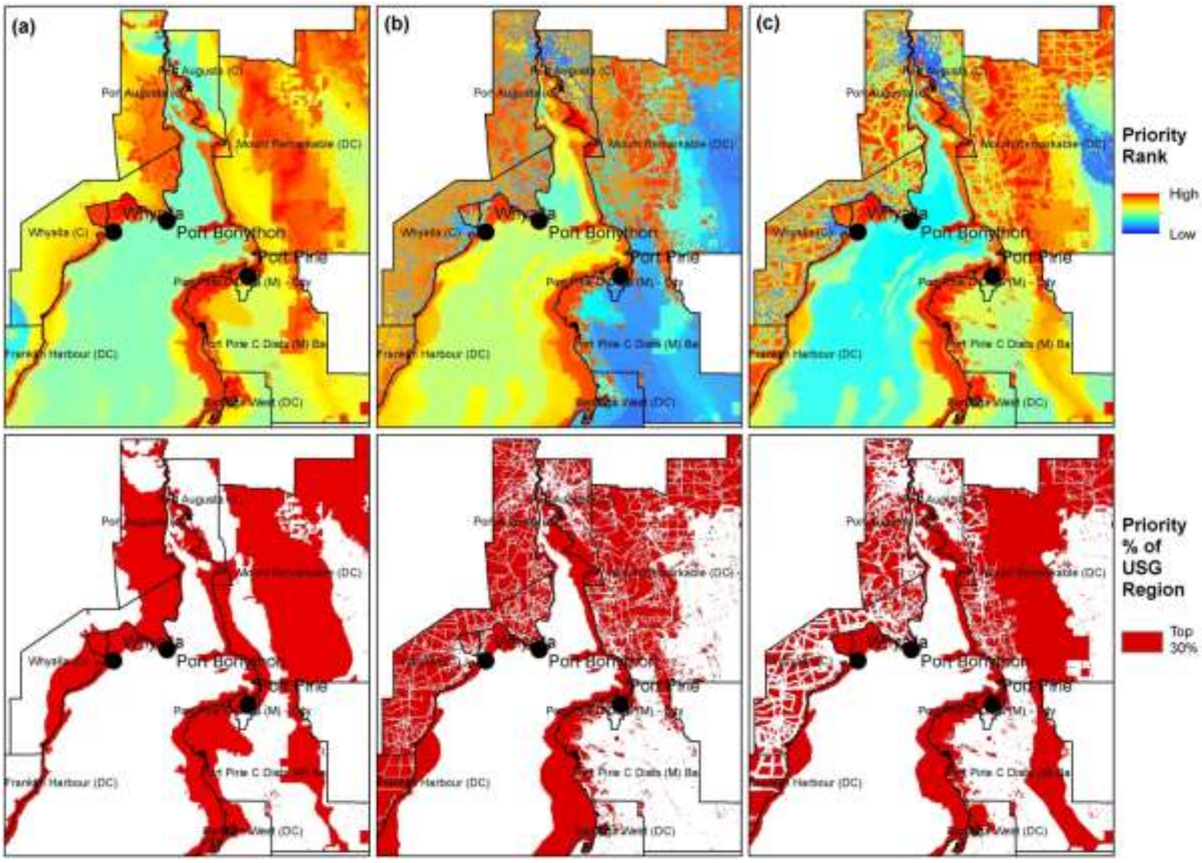


Figure 5. Terrestrial and marine conservation value of the Upper Spencer Gulf. (a) represents a pristine environment, (b) represents if we account for current local effects of urban development and linear infrastructure, and (c) represents accounting for future and diffuse effects of clearing, urban development and linear infrastructure. Maps on the top row represent the rankings of every unit in the landscape, with units of higher conservation priority (representing best complementary areas for all biodiversity features) in red, and lowest-ranked units in blue. Maps on the bottom row represent just the top 30% of the landscape. In this ranking, all terrestrial and marine features were used (529 biological features in total).

We added the priority rank values for each of the six scenarios together (a value between 0 and 1 where 1 equals top priority and 0.01 represents lowest priority; Figure 6), to explore robustness in the priority rankings of each cell to uncertainty in the true condition of the landscape (e.g. Kujala et al. 2013). Across the whole of the Spencer Gulf, the LGAs with the highest proportion of their area classified as highest priority regardless of which biodiversity features were considered, and how we assumed cleared land contributed to biodiversity, were Port Augusta, Whyalla, Port Lincoln, and Yorke Peninsula South. The marine and terrestrial area around Port Pirie and along the Port Pirie LGA coastline was also always considered highest conservation priority (top 30% of the landscape) regardless of whether terrestrial or marine biodiversity was considered (Figure 6).

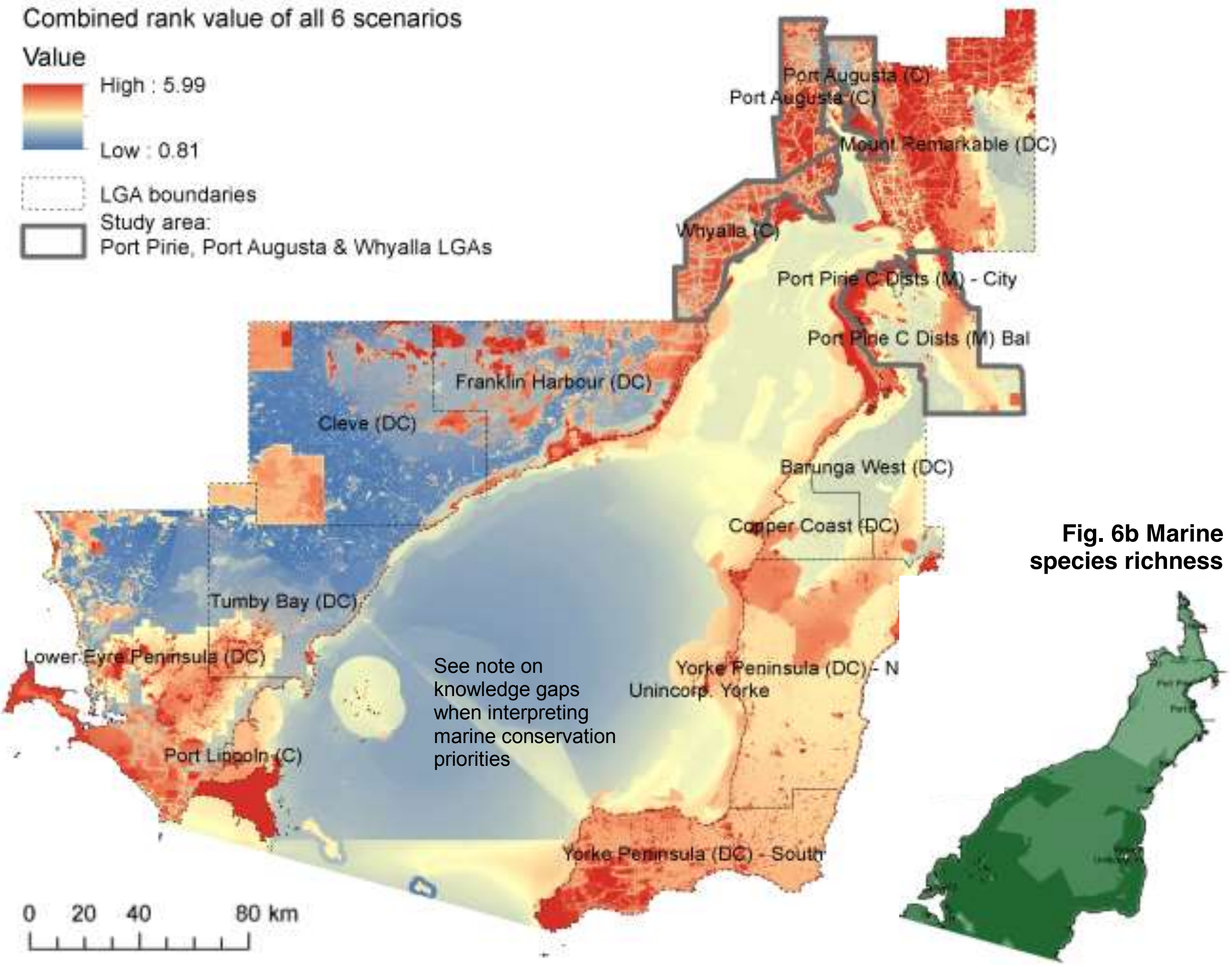


Figure 6. Combined priority rank values for all six planning scenarios, showing the total added score for each cell in the landscape; a value between 0 and 1 where 1 equals top priority for conservation of all biodiversity features and 0.01 represents lowest priority. Please note that there are an absence of data on species and communities in deeper water areas of the Spencer Gulf. The marine species richness inset (Fig. 6b and 7) shows that little is known about the diversity and importance of particular regions of the Gulf for marine life. The corresponding conservation priority (main figure) should, consequently, not be used to imply that the Gulf's marine conservation priority is low. This knowledge gap is an important focus and requires further investigation.

There is a lack of knowledge with respect to marine species and ecological communities. Figure 7 demonstrates this gap with respect to land based species and communities.

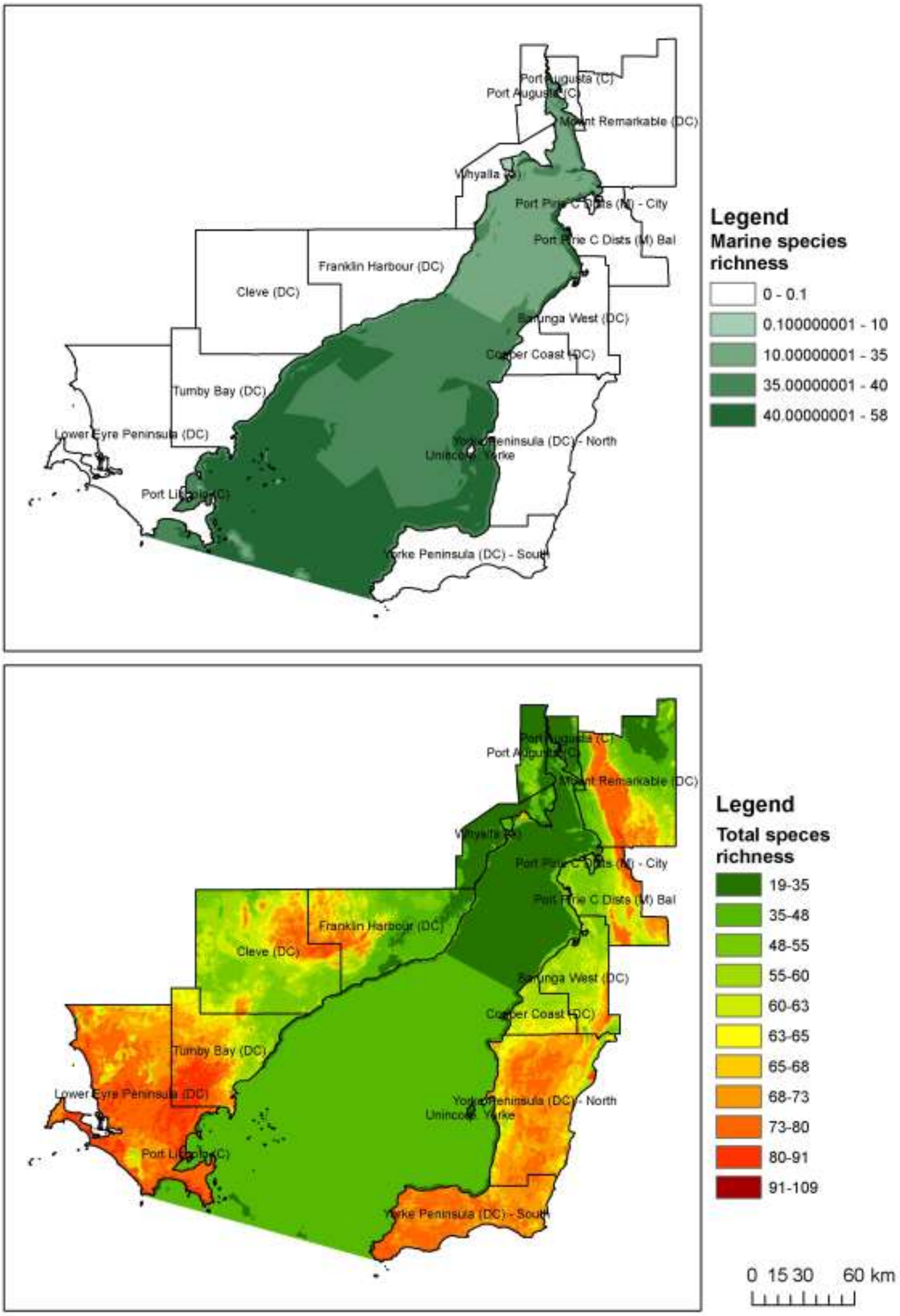


Figure 7: Species richness illustrating relative lack of knowledge of marine species. Note: this figure is based on species that are listed in State or Australian government databases.

Connectivity requirements for biodiversity

Up to 40% of the immediate landscape around the coastal communities (within 500m) is impacted by infrastructure that forms a barrier to inland movement under sea level rise (Figure 7). This infrastructure effect zone is predominantly a result of the existing road network (Table 5). This figure increases up to 57% of the landscape within 1km of communities affected by infrastructure for samphire, and 35% of the landscape for mangroves and seagrass. These barriers will prevent movement of samphire and mangrove communities inland with rising sea level, particularly in the Whyalla LGA (Figure 8) and the western side of the Port Augusta LGA (Figure 9). Fewer barriers to inland dispersal exist in the Port Pirie LGA (Figure 10).

Table 5. Barriers to movement of coastal communities inland under potential future sea level rise.

	Percentage of landscape within 500m of community covered by infrastructure					***Percentage of landscape within 1km of community covered by infrastructure***				
	Road	Rail	Power line	Water pipes	Oil/Gas Pipeline	Road	Rail	Power line	Water pipe	Oil/Gas Pipeline
Seagrass	16.97	0	4.21	0	0.19	35.17	0.29	8.71	0.01	0.40
Samphire saltmarsh										
- Stranded tidal	10.48	0.39	1.33	0.01	0.23	19.23	0.55	2.96	0.01	0.36
- Supratidal	29.86	0.79	5.16	0.01	0.13	49	1.1	12.45	0.02	0.33
- Intertidal	32.3	0.87	6.48	0	0.27	56.94	1.56	13.2	0.01	0.52
Mangrove										
- Supratidal	0.06	0.04	0	0	0	0.13	0.06	0.05	0	0
- Intertidal	1.58	0.03	3.58	0	0.29	35.44	1.12	9.72	0.52	0

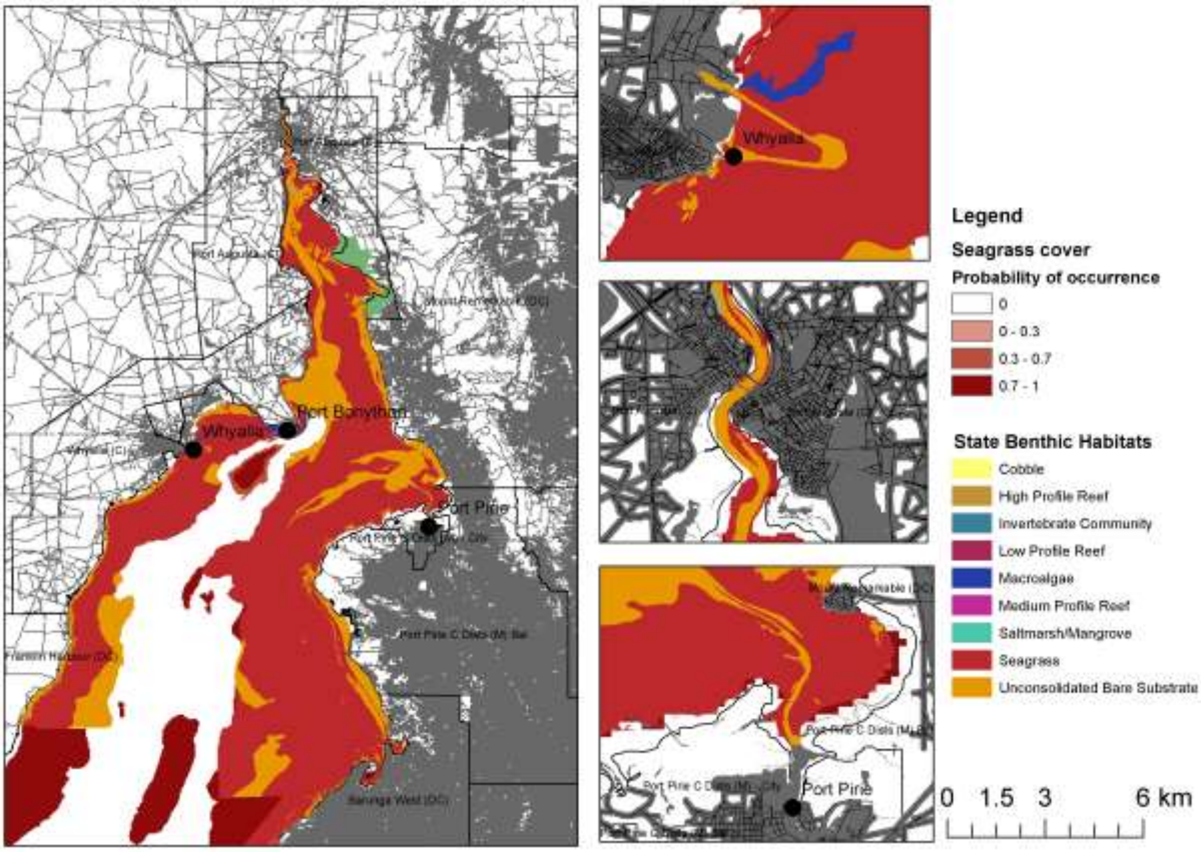


Figure 8. Mapping of potential barriers to inland dispersal of saltmarsh and other coastal habitats. Grey areas represent infrastructure effect zones and cleared areas, and black lines in the right boxes represent actual infrastructure lines. White areas represent uncleared areas. Right boxes represent city areas of Whyalla (see Figure 8 for entire LGA), Port Augusta (see Figure 9 for entire LGA) and Port Pirie (see Figure 10 for entire LGA) respectively.

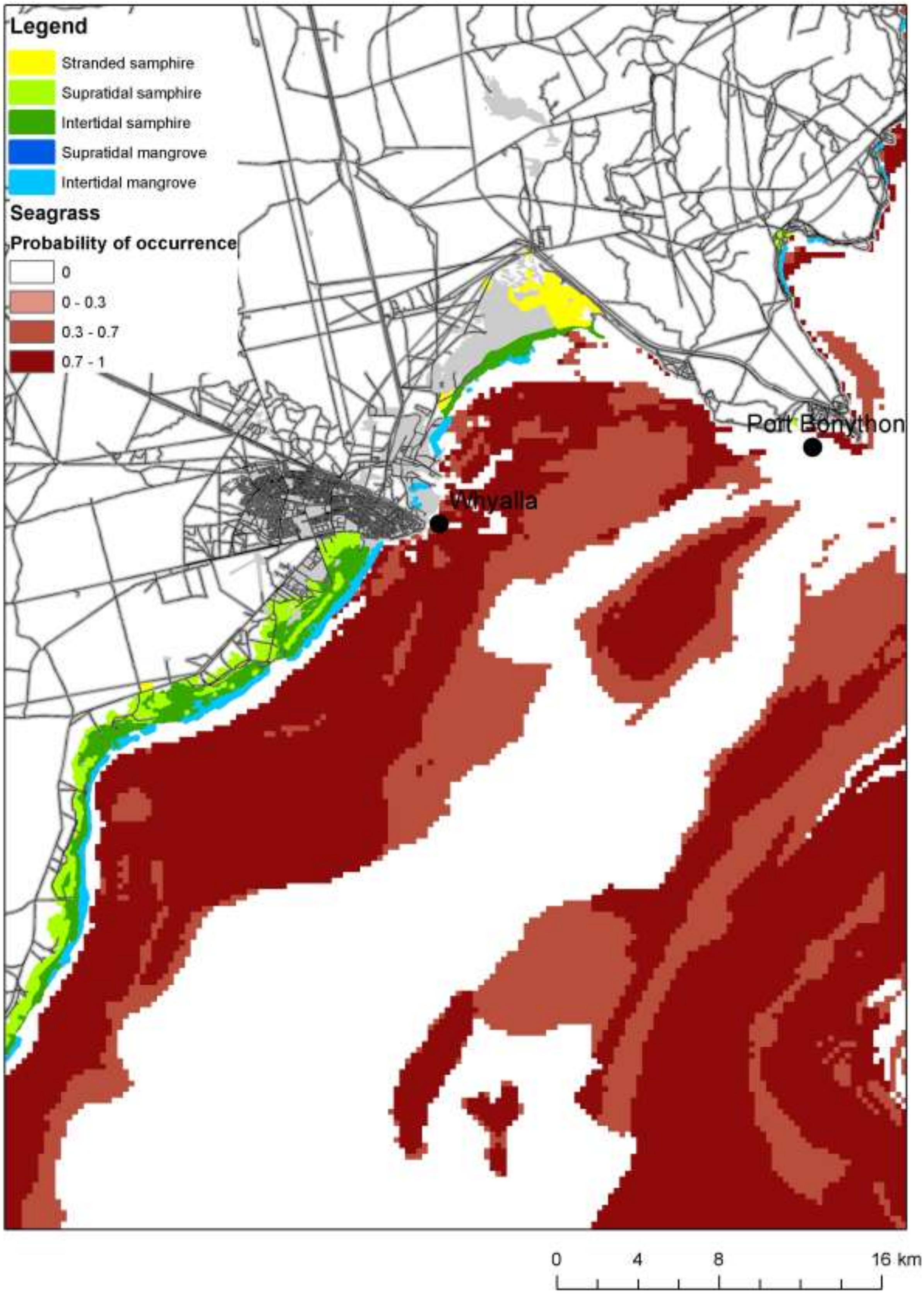


Figure 9. Potential barriers to inland dispersal of saltmarsh and other coastal habitats in the Whyalla LGA. Dark grey lines represent current infrastructure barriers (roads, railways, pipelines) and light grey represents cleared land.

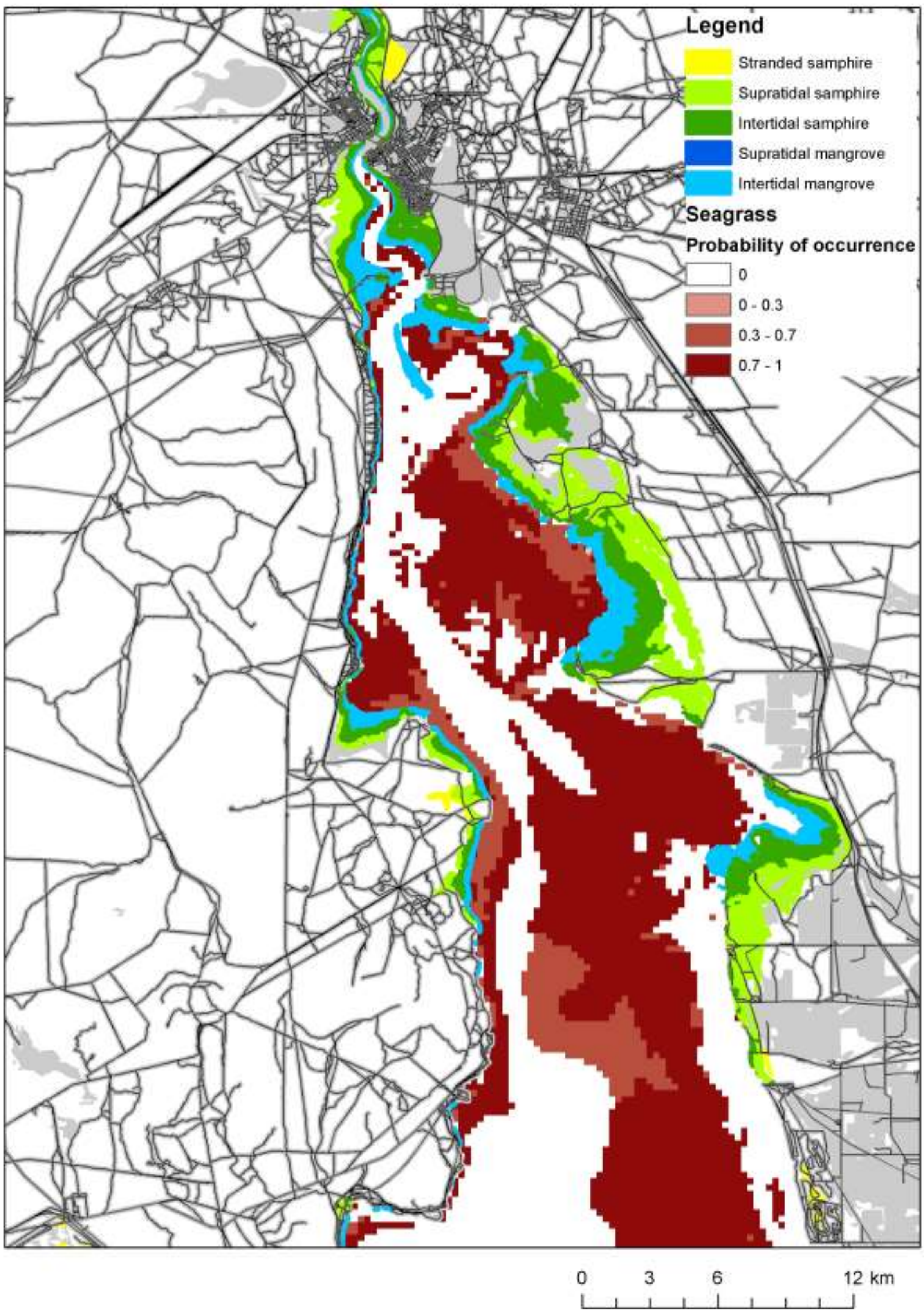


Figure 10. Potential barriers to inland dispersal of saltmarsh and other coastal habitats in the Port Augusta LGA. Dark grey lines represent current infrastructure barriers (roads, railways, pipelines) and light grey represents cleared land.

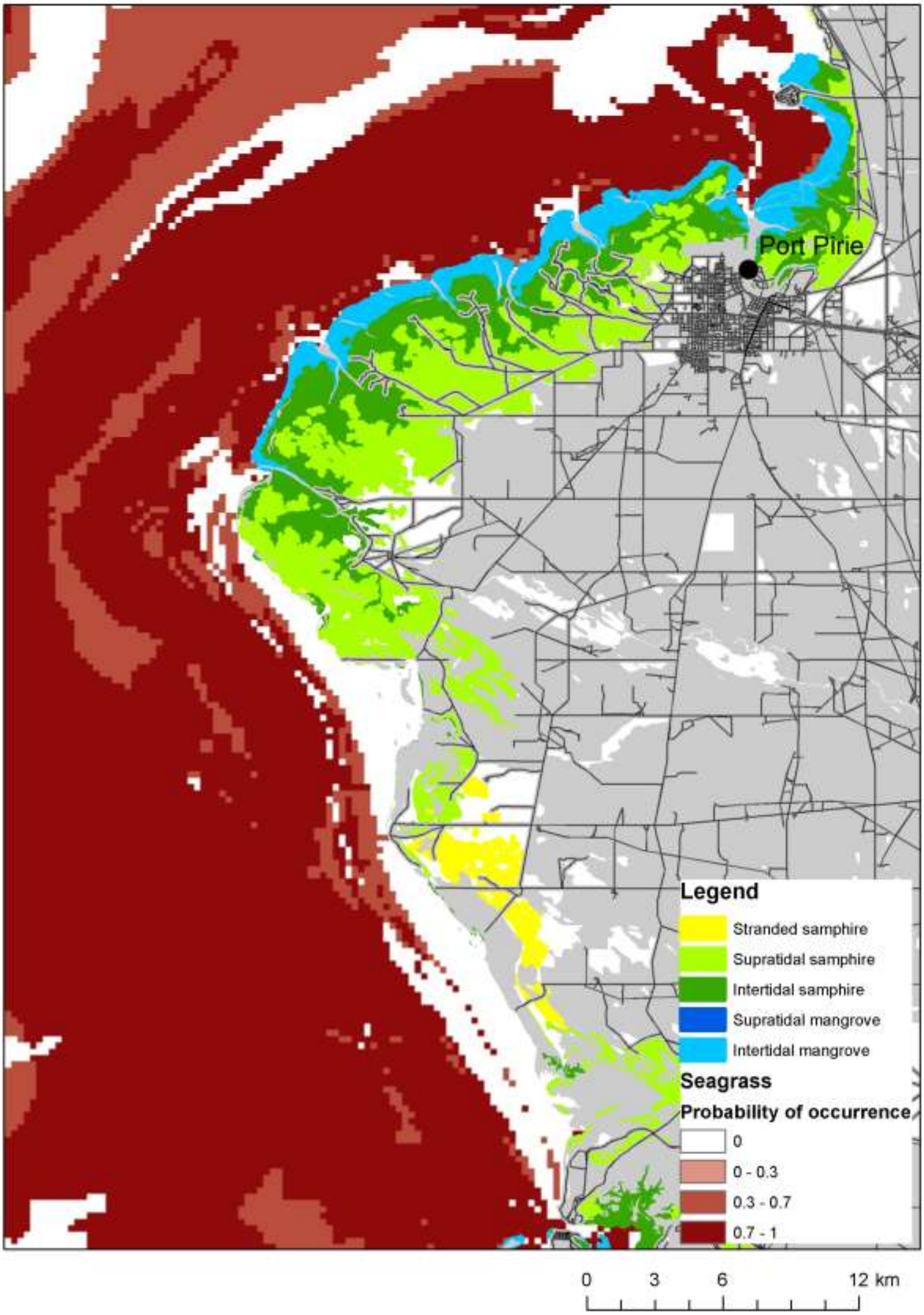


Figure 11. Potential barriers to inland dispersal of saltmarsh and other coastal habitats in the Port Pirie LGA. Dark grey lines represent current infrastructure barriers (roads, railways, pipelines) and light grey represents cleared land.

Giant Australian cuttlefish

The available information on giant Australian cuttlefish in Spencer Gulf has recently been reviewed as part of the Spencer Gulf natural history book (Gillanders and Payne 2014). In addition, as part of the regional sustainability planning in the Upper Spencer Gulf, a desktop review of *S. apama* related research including population trends, threats, shipping impacts and management was undertaken along with an investigation of the potential impacts of shipping on *S. apama* (Woodcock et al. 2014). Shipping noise and turbidity were found to have no effect on hatching success of *S. apama* eggs or on the metabolic rate of adults, although only the sound pressure component of noise was investigated.

Two further Fisheries Research and Development Corporation (FRDC) reports have focused on giant Australian cuttlefish. The first developed a standard methodology for on-going monitoring and assessment of cuttlefish on the breeding aggregation at Point Lowly, which also aims to characterise the habitat where they spawn (Steer et al. 2013). A preliminary investigation as to causes of the decline in abundance was also undertaken, but few relationships were found (Steer et al. 2013). A further study focused on data from a bycatch survey in USG and suggested that numbers throughout the USG had declined not just those aggregating to breed (Prowse et al. in press). The other FRDC project investigated the utility of mechanical-separating bycatch reduction devices (BRD) in the SA Spencer Gulf Prawn Fishery to reduce issues associated with unwanted giant Australian cuttlefish and blue crabs (Kennelly 2014). Results showed that whilst further research was required reductions in terms of numbers and weights of giant Australian cuttlefish were possible with BRDs and that these devices had minimal impacts on targeted prawns.

Other FRDC-funded research is currently aimed at:

1. Quantifying the relative abundance and biomass of South Australia's giant Australian cuttlefish breeding population at Point Lowly and providing an assessment of the spawning ground's habitat condition and water quality.

2. Searching for alternate spawning areas throughout northern Spencer Gulf.

3. Characterising the natural spawning substrate with the intention of using this information to design and develop artificial habitat that may promote spawning in areas where habitat is limited.

4. Assessing whether there are abnormally high levels of metals accumulating in giant Australian cuttlefish in northern Spencer Gulf.

5. Quantifying cuttlefish by-catch in the commercial fishing sector.

6. Determining the movement and fine scale population structure of giant Australian cuttlefish in northern Spencer Gulf.

Updates on these projects can be found at:
http://www.pir.sa.gov.au/fisheries/recreational_fishing/target_species/cuttlefish

Final reports are due during 2015.

Engagement with key stakeholders

Three stakeholder workshops were conducted throughout the project, involving representatives from Local, State and Australian Governments and researchers. Attendees included Local Government CEO's and planning staff, Australian Government Department of Environment and the National Environmental Research Program, Department of Environment, Water and Natural Resources, Coast Protection Board, Department of State Development, South Australian Research and Development Institute, Department of Planning, Transport and Infrastructure, Regions SA and the regional Natural Resources Management Boards.

The first workshop, held in June 2014, explored existing environmental datasets, monitoring and planning already occurring in the Upper Spencer Gulf. The second workshop (October 2014) was held in conjunction with the Upper Spencer Gulf Climate Change and Hazard Reduction Strategy to ensure consistency of approach in the use and application of climate change projections.

The third workshop presented the preliminary results of the project and commenced discussion about opportunities to continue cross-agency collaboration to support implementation of project outcomes. Results were also presented to forums involving regional stakeholders and key industries based in the Upper Spencer Gulf, including Alinta, Arrium, BHP Billiton, Nyrstar and Santos. Feedback was also received from local government as well as industry and community. The Upper Spencer Gulf Common Purpose Group was consulted throughout the project as the key leadership alliance in the region.

Impact avoidance and mitigation measures

Developing robust adaptation strategies to sea–level rise poses a serious challenge to policy makers (Nicholls and Cazenave 2010). The impacts of sea level rise on coastal communities and ecosystems can be large, yet there are numerous uncertainties regarding the application of adaptation strategies (Nicholls and Cazenave 2010). Sea level rise can lead to an increased risk of flooding (Nicholls 2004), changes in the distribution and function of coastal ecosystems (e.g. mangroves, corals, saltmarshes, seagrass, Nicholls 2004; Hoegh-Guldberg and Bruno 2010), as well as a need for coastal armouring (e.g. levees and seawalls, Fankhauser 1995). During the last decade, the importance of integrating climate change into protocols for planning, mostly by predicting future distribution of ecosystems and species, has been emphasised (Hamann and Aitken 2013; Maggini et al. 2013; Shoo et al. 2014). Climate change will impact species in different ways and to different extents - for example some species will significantly lose and others gain habitat (Traill et al. 2011).

Because there is uncertainty in how and if coastal vegetation communities will move inland under changed future environmental conditions and sea level rise, we explored potential barriers to this climate change adaptation option for communities (Table 5, Figures 7, 8, 9 and 10), rather than attempting to predict highly uncertain future community distributions. Intertidal and supratidal samphire saltmarsh is likely to face the most barriers to inland movement, with 50-60% of the nearby available land for inland movement (within 1km of existing saltmarsh) covered by roads and therefore impermeable to colonisation (Table 5), particularly in the Whyalla LGA (Figure 8). This inability to disperse to new locations when the current environmental conditions change is concerning given predictions that saltmarshes could decline in area by 20 to 45% under future climate change (Craft et al. 2009). Mangrove habitats are not at risk of barriers to movement within 500m of existing locations, and seagrass faces infrastructure barriers across less than 20% of nearby (within 500m) land. However, both seagrass and intertidal mangroves face infrastructure barriers to dispersal across more than a third of the landscape between 500m and a kilometre from existing habitat boundaries (Table 5), particularly in the Whyalla LGA and Port Augusta LGA (Figures 8 and 9).

For communities such as saltmarsh that can move inland in the Upper Spencer Gulf and require protection under the *Environment Protection and Biodiversity Conservation Act 1999*, private lands will be critical to achieving conservation targets for coastal communities, with much of the land immediately adjacent these communities under private ownership mostly for agriculture (see Figures 9 and 10). In the short term, the only way forward for conservation in these regions of high biodiversity value and high human use is to leverage funding using private land conservation policies that can target the most important land areas for conservation (see Figures 5, 6 and 7). The continuum of mechanisms for promoting private land conservation ranges from more formal mechanisms such as conservation contracts, covenants, tax incentives or voluntary stewardship schemes, to informal actions such as sustainable farming (Hanley et al. 2012). One possibility for investing in private land conservation in areas possibly subject to sea level rise in the future is the implementation of mobile easements that account for uncertainty and dynamics in biodiversity distributions and agricultural suitability over time (Sussman et al. 2010). It was beyond the scope of this study to explore alternative actions for dealing with climate change impacts on communities such as private land conservation incentives, but we strongly suggest that this is an area for future investment and research.

The integration of a sea level rise inundation model with intertidal and subtidal ecosystem migration models (e.g. Saunders et al. 2013), and spatial planning, could assist in understanding how the Spencer Gulf will respond to a changing climate and sea level rise, and finding effective future management strategies.

Climate change scenarios at the scale and detail required do not exist for this region. In order to understand the potential impacts on biodiversity it is important to note that sea level impacts and other changes associated with climate and acidification of the oceans are unlikely to be uniform across the state. As a result, we recommend that the adaptation pathways approach, as adopted by the Eyre Peninsula Integrated Climate Change Planning report, be used to identify key decision points for biodiversity protection in this region (Siebentritt et al. 2014). That is, an integrated marine and terrestrial planning approach would identify and prioritise timelines for the generation of necessary background information. It also clarifies the decision points required to address conservation and sustainability priorities – such as to facilitate threatened communities or important fish breeding habitat to move (when this is possible). The types of information required include maps of sea level rise at fine enough scale for the region, digital elevation modelling, detailed mapping that relates to hydrology of the region and vulnerability to changing sea surface temperature and hydrology. The latter information is necessary given the shallow nature of the gulf.

There is significant uncertainty regarding expansion of ports and future shipping in the region. Port development will affect the marine area as well as terrestrial areas with corridors necessary to transport material to the ports. Several projects are commencing associated with the SGEDI to develop the knowledge and tools necessary for integrated marine management using shipping and ports as a case study. As part of this initiative detailed analysis of current shipping activities and likely future shipping scenarios will be investigated. A workshop is also being planned associated with implementation of integrated marine management and learning from past experience both nationally and internationally.

Implications and Recommendations

In summary, the Spencer Gulf and terrestrial environment within the three city local government areas supports a significant range of economic and social activity. While this report has not set out to quantify such benefits, these environmental services and the values of them are likely to be highly important. Consequently, activity to protect and allow adaptive responses (under development as well as future climate change situations) may assist and even be essential for the long-term viability of the cities.

This report has identified a number of key issues and considerations that will assist future, effective management and planning, as follows:

SPECIES DISTRIBUTION, ABUNDANCE AND CONDITION

- There are relatively good maps of the marine habitats in shallow coastal waters, but such maps are lacking for deeper waters of the Gulf and there is a poor understanding of the distribution and abundance of most marine species. However, even for areas that have been mapped there is a poor understanding of the condition of these habitats (e.g. seagrass).

- The condition of marine areas is yet to be determined. Various modelling approaches that incorporate depth, bathymetry, current shipping pathways and other activities may help understand areas which are potentially in better condition than others.

- An improved understanding of condition of areas may be more informative than knowledge of distribution as it is likely to indicate areas where biodiversity may be at threat or pristine areas that could be targeted for conservation. Similarly, appropriate areas could be targeted for monitoring to address potential impacts.

- Better mapping of all marine waters and understanding of distribution of species will assist with prioritising marine areas in relation to development scenarios. Similar areas on land are generally prioritised under different scenarios, but the same does not occur in marine areas.

SEA LEVEL RISE MODELLING

- Saltmarsh and mangrove habitats provide important ecosystem services and are important habitats for a variety of organisms including some commercially important species. They are also important for a range of regulating functions (e.g. nutrient recycling, protection from natural disturbances, climate regulation). Unfortunately, the resolution of current sea level rise models is too coarse (1m) to be able to predict how sea level rise may impact on these habitats and the Upper Spencer Gulf generally, given much of the area is shallow, flat and low lying.

- Due to existing infrastructure, there is little opportunity for landward retreat of saltmarsh habitat under sea level rise. Several factors are important for assessing how sea level rise may affect marine habitats, particularly given different species and ecological communities will have differing abilities to adapt to climate change or move. Local conditions are also important in terms of whether habitats can move or not (e.g. mangrove – local landscape, topography, likelihood to be inundated are all important). A fine scale model of how sea level rise is likely to occur in the region, the link between the sea level rise model and potential communities at threat, a map of barriers (which have been identified in our study) and also an understanding of the population dynamics of the species concerned will be important to gain a more fulsome appreciation of likely impact and adaptation options.

SPECIES CONNECTIVITY

- Connectivity could also be incorporated into future prioritisation assessments. Such approaches are relatively new and would require information on the dispersal ability of species. To determine dispersal abilities of all species would be time consuming but it could be possible to identify target species for which connectivity may be important and incorporate into prioritisation assessments.

- It is likely not necessary to improve connectivity for all species however. Consideration should be given as to which species are most likely to benefit from assessment of connectivity requirements or which species have been isolated (e.g. as a result of infrastructure, urbanisation etc) as a result of development. There should be strong reasons for restoring connectivity as it can also facilitate movement of invasive species. It should also be noted that many areas with few infrastructure barriers are located on agricultural land, necessitating the need for private land conservation and restoration incentives.

REGIONAL AND LOCAL GOVERNMENT PLANNING

- In responding to climate change there will be "adaptation tipping points." It is important for regional and local government leaders to understand what may be considered an adequate response for decisions in the short-medium timeframe will become inadequate at some point in the future. It is possible to map a set of key, likely decision points by implementing an 'adaptation pathways approach'. Mapping out a timeline of when key decisions need to be made, takes into account and helps to manage the inherent uncertainty of these changes.

- The local government authorities should be clear about their own objectives and targets for management of biodiversity. Our Appendix provides information on the species that occur within each local government area, which may be helpful in identifying regional flagships from key species of conservation concern. For example, species with a high proportion of their range within a local government area may be targeted as regional or flagship species and the local community including land owners better informed. To support this, species distribution data from this report can be accessed as spatial layers. This may assist councils to interpret and enquire into each species and its distribution in the local area, and consider this against, for example, land tenure.

- Local government biodiversity objectives should be informed by species risk, national and state priorities as well as local considerations, noting there are also regulatory responsibilities that must be met. Additionally, the profile of a particular species, community connection and concern about it and/or the environmental services provided by an ecological community should be considered – for example is a species well known and valued by people living, or visiting, the area - should it be? Can the rarity of some species, those that are relatively unique to individual council areas, become an opportunity for engagement and community/government action around protection and restoration? Are there specific environmental regions valued for recreation? How can such a connection be enhanced for better and more effective biodiversity protection? Are there other community and the drivers that can be leveraged for a connection to threatened species and communities?

- The Upper Spencer Gulf cities may need to consider altering planning policy in both the relevant volume of the Planning Strategy and in local Development Plans to enable the cities to identify and prioritise land areas where coastal species (such as mangroves, salt marsh and seagrass) are able to move inland in the face of sea level rise. This policy should strongly discourage (through non-complying triggers and/or provisions as objectives and principles) the construction of any barrier to such species movement and encourage the removal of existing barriers.

To help address these issues, the following recommendations are provided:

1. Undertake modelling and mapping of marine habitats, particularly in deeper waters of Upper Spencer Gulf, including species distribution and abundance.

2. Undertake modelling and assessment of marine habitat condition, and establish appropriate areas for ongoing monitoring of potential impacts.

3. Consider future identification of conservation priority areas utilising different weightings to species based on features such as EPBC Act and SA State listing and involving consultation through workshops with stakeholders and experts in the field of systematic conservation planning.

4. Prioritise marine areas in the Upper Spencer Gulf relation to development scenarios.

5. Develop a fine scale model of sea level rise in the Upper Spencer Gulf to better inform species and communities at threat and potential for movement.

6. Give further consideration to species and localities in the Upper Spencer Gulf most likely to benefit from improved connectivity.

7. Consider implementing an ‘adaptation pathways approach’ across the Upper Spencer Gulf to determine appropriate timeframes for key decision-making in response to climate change.

8. Review local government biodiversity objectives informed by a combination of species risk, national and state priorities and local values.

9. Consider altering planning policy within the Planning Strategy and in local Development Plans to enable the cities to identify and prioritise land areas where coastal species are able to move inland in the face of sea level rise.

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Appendix A

Table A. Species list with presence/absence data for three key council areas (only shown for terrestrial species) showing scientific and common name, terrestrial vs marine, key taxonomic grouping and SA listing (R, rare; V, vulnerable; E, endangered; CE, critically endangered; CD, conservation dependent, ssp, listed as a subspecies), EPBC Act listing and whether considered migratory, marine or cetacean under the EPBC Act. Also shown are the type of data used (SDM, point, SNES), and SNES number where relevant.

Scientific Name	Common Name	Data used	SNES no.	Terr/ Marine	Taxonomy	Conservation Status		Percentage of SA range in LGA (%)		
						SA	EPBC Act	Whyalla LGA	Port Augusta LGA	Port Pirie LGA
Acacia alcockii	Alcock's Wattle	SDM		Terr	PLANT	R				
Acacia araneosa	Spidery Wattle	SDM		Terr	PLANT	E	V			
Acacia barattensis	Baratta Wattle	SDM		Terr	PLANT	R				
Acacia carneorum	Needle Wattle	SDM		Terr	PLANT	V	V		0.18	
Acacia confluens	Arkaroola Wattle	SDM		Terr	PLANT	V				
Acacia cretacea	Chalky Wattle	SNES	10689	Terr	PLANT	E	E			
Acacia dodonaeifolia	Hop leaved Wattle	SDM		Terr	PLANT	R				
Acacia enterocarpa	Jumping-jack Wattle	SDM		Terr	PLANT	E	E			
Acacia glandulicarpa	Hairy-pod Wattle	SDM		Terr	PLANT	E	V			
Acacia gracilifolia	Graceful Wattle	SDM		Terr	PLANT	R		0.44	6.40	24.70
Acacia hexaneura	Six-nerve Spine-bush	SDM		Terr	PLANT	R			0.02	5.83
Acacia imbricata	Imbricate Wattle	SDM		Terr	PLANT	R		0.01	0.03	1.95
Acacia iteaphylla	Flinders Range Wattle	SDM		Terr	PLANT	R				
Acacia lineata	Narrow Linde-leaved Wattle	POINT		Terr	PLANT	R				
Acacia menzelii	Menzel's Wattle	SNES	9218	Terr	PLANT	V	V			
Acacia montana	Mallee Wattle	SDM		Terr	PLANT	R			3.63	
Acacia pinguifolia	Fat-leaf Wattle	SDM		Terr	PLANT	E	E			
Acacia praemorsa	Senna Wattle	SDM		Terr	PLANT	E	V			
Acacia rhetinocarpa	Resin Wattle	SDM		Terr	PLANT	V	V			

Acacia rhigiophylla	Dagger-leaf Wattle	SDM		Terr	PLANT	R					1.60
Acacia simmonsiana	Desert Manna Wattle	POINT		Terr	PLANT	R					
Acacia spilleriana	Spiller's Wattle	SDM		Terr	PLANT	E	E				
Acacia whibleyana	Whibley Wattle	POINT		Terr	PLANT	E	E				
Acanthiza iredalei	Slender-billed Thornbill	SDM		Terr	GROUNDBIRD	ssp					
Acanthiza iredalei	Slender-billed Thornbill (western ssp)	SDM		Terr	GROUNDBIRD	R					
Acanthocladium dockeri	Spiny Everlasting	SDM		Terr	PLANT	E	CE		15.00	15.15	9.10
Actitis hypoleucos	Common Sandpiper	SDM		Terr	BIRD	R		Migrat			
Amytornis striatus	Striated Grasswren	POINT		Terr	GROUNDBIRD	R					
Amytornis textilis modestus	Thick-billed Grasswren	SDM		Terr	GROUNDBIRD	V					
Amytornis textilis myall	Western Grasswren	SNES	64454	Terr	GROUNDBIRD	Endemic					
Anas rhynchotis	Australasian Shoveler	SDM		Terr	BIRD	R			47.90	26.10	
Anhinga novaehollandiae	Australasian Darter	SDM		Terr	BIRD	R				0.01	8.84
Anogramma leptophylla	Annual Fern	POINT		Terr	PLANT	R				0.01	16.87
Anthocercis anisantha ssp anisantha	Port Lincoln Ray-flower	POINT		Terr	PLANT	R					
Aphelocephala pectoralis	Chestnut-breasted Whiteface	SDM		Terr	GROUNDBIRD	R					
Aprasia parapulchella	Pink-tailed Worm-lizard	SNES	1665	Terr	REPTILE		V			100.00	
Aprasia pseudopulchella	Flinders Worm-lizard	SDM		Terr	REPTILE	R	V				
Apus pacificus	Fork-tailed Swift	SDM		Terr	BIRD			Migrat	0.01	0.50	22.65
Ardea ibis	Cattle Egret	SDM		Terr	BIRD	R		Migrat			
Ardea intermedia	Intermediate Egret	SDM		Terr	BIRD	R		Migrat	0.09	0.18	7.89
Ardea modesta	Great Egret	SNES	82410	Terr	BIRD			Migrat	0.27	0.51	9.80
Ardenna carneipes	Flesh-footed Shearwater	SNES	82404	Terr	BIRD	R		Migrat	3.45	3.73	5.77
Ardeotis australis	Australian Bustard	SDM		Terr	BIRD	V					
Arenaria interpres	Ruddy Turnstone	SDM		Terr	BIRD	R		Migrat	0.67	0.66	0.00
Aristida australis	Aristida australis	POINT		Terr	PLANT	R					
Asperula syrticola	Southern Flinders Woodruff	POINT		Terr	PLANT	R					100.00
Atriplex kochiana	Koch's Saltbush	SDM		Terr	PLANT	V					
Austrostipa breviglumis	Bamboo Spear-grass	SDM		Terr	PLANT	R					

Austrostipa densiflora	Foxtail Spear-grass	POINT		Terr	PLANT	R		0.08	0.83	17.66
Austrostipa echinata	Spiny Spear-grass	SDM		Terr	PLANT	R				
Austrostipa gibbosa	Swollen Spear-grass	SDM		Terr	PLANT	R				2.34
Austrostipa multispiculis	Many-flowered Spear-grass	POINT		Terr	PLANT	R				18.23
Austrostipa nullanulla	Club Spear-grass	SDM		Terr	PLANT	V				
Austrostipa petraea	Flinders Range Spear-grass	SDM		Terr	PLANT	R		16.00	3.96	0.20
Austrostipa pilata	Prickly Spear-grass	SDM		Terr	PLANT	V		0.80	7.70	4.95
Austrostipa tenuifolia	Long-awn Spear-grass	POINT		Terr	PLANT	R				
Bassiana trilineata	Western Three-lined Skink	POINT		Terr	REPTILE	R				
Bettongia penicillata ogilbyi	Brush-tailed Bettong	SNES	66844	Terr	MAMMAL	R				
Billardiera sp Yorke	Lehmann's Apple-berry	POINT		Terr	PLANT	E				
Biziura lobata	Musk Duck	SDM		Terr	BIRD	R				
Bossiaea peninsularis	Bossiaea	POINT		Terr	PLANT	V		0.19	1.54	7.24
Botaurus poiciloptilus	Australasian Bittern	SNES	1001	Terr	BIRD	V	E			
Bothriochloa macra	Pitted Beard Grass	SDM		Terr	PLANT	R				
Brachyscome breviscapis	Short-stem Daisy	POINT		Terr	PLANT	R				
Brachyscome ciliaris var	Brachyscome ciliaris var. subintegrifolia			Terr	PLANT	R				
Brachyscome eriogona	Brachyscome eriogona	SDM		Terr	PLANT	R		0.26	5.94	19.18
Brachyscome xanthocarpa	Yellow-fruit Daisy	POINT		Terr	PLANT	R				
Burhinus grallarius	Bush Stonecurlew	SDM		Terr	GROUNDBIRD	R				
CNES 124	Eyre Peninsula Blue Gum (Eucalyptus petiolaris) Woodland			Terr	COMMUNITY		E			
CNES 36	Peppermint Box (Eucalyptus odorata) Grassy Woodland of South Australia			Terr	COMMUNITY		CE			3.92
CNES 37	Iron-grass Natural Temperate Grassland of South Australia			Terr	COMMUNITY		CE			
CNES 86	Grey Box (Eucalyptus microcarpa) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia			Terr	COMMUNITY		E			
Cacatua leadbeateri	Major Mitchell's Cockatoo	SDM		Terr	BIRD	R				0.07
Caladenia intuta	Ghost Spider Orchid	SNES		Terr	PLANT	E	CE	32.98	8.30	
Caladenia macroclavia	Large-club Spider-orchid	SNES		Terr	PLANT	E	E			

Caladenia bicalliata ssp	Western Daddy-long-legs	SDM		Terr	PLANT	R			32.98	8.30	
Caladenia brumalis	Winter Spider-orchid	SDM		Terr	PLANT	V	V		32.98	8.30	
Caladenia conferta	Coast Spider-orchid	SNES	55000	Terr	PLANT	E	E		32.98	8.30	
Caladenia dilatata	Late Spider-orchid	SDM		Terr	PLANT	E			32.98	8.30	
Caladenia flaccida	Drooping Spider-orchid	POINT		Terr	PLANT	V			32.98	8.30	
Caladenia gladiolata	Bayonet Spider-orchid	SNES	8079	Terr	PLANT	E	E		32.98	8.30	
Caladenia pusilla	Pigmy Caladenia	POINT		Terr	PLANT	R					
Caladenia saxatilis	Star Spider-orchid	POINT		Terr	PLANT	R					
Caladenia sp Southeast	Sand Spider-orchid	POINT		Terr	PLANT		E				
Caladenia stellata	Star Spider-orchid	POINT		Terr	PLANT	R					
Caladenia tensa	Inland Green-comb Spider-orchid	SNES	24390	Terr	PLANT		E				
Caladenia woolcockiorum	Woolcock's Spider-orchid	SNES	55023	Terr	PLANT	E	V			0.12	7.30
Caladenia xantholeuca	Flinders Ranges White Caladenia	SNES	55025	Terr	PLANT	E	E				
Calamanthus cautus	Shy Heathwren	SDM		Terr	GROUNDBIRD	R				0.08	7.02
Calamanthus pyrrhopygius	Chestnut-rumped Heathwren	POINT		Terr	GROUNDBIRD	E	E		4.41	1.87	0.82
Calidris acuminata	Sharp-tailed Sandpiper	SDM		Terr	BIRD		V	Migrat			
Calidris alba	Sanderling	SDM		Terr	BIRD	R		Migrat	0.12	0.28	6.41
Calidris bairdii	Baird's Sandpiper	POINT		Terr	BIRD			Migrat			
Calidris canutus	Red Knot	SDM		Terr	BIRD			Migrat			
Calidris ferruginea	Curlew Sandpiper	SNES	856	Terr	BIRD			Migrat	0.07		4.61
Calidris melanotos	Pectoral Sandpiper	SDM		Terr	BIRD	R		Migrat	1.09	6.40	13.22
Calidris minuta	Little Stint	POINT		Terr	BIRD		E	Migrat	0.01	0.03	10.02
Calidris ruficollis	Red-necked Stint	SDM		Terr	BIRD			Migrat			
Calidris subminuta	Long-toed Stint	SDM		Terr	BIRD	R		Migrat	0.07	0.24	5.21
Calidris tenuirostris	Great Knot	SDM		Terr	BIRD	R		Migrat	0.00	0.02	4.03
Calochilus pruinosus	Mallee Beard Orchid	POINT		Terr	PLANT	R			0.07		13.05
Calyptorhynchus funereus	Yellow-tailed Black Cockatoo	SDM		Terr	BIRD	V					
Caretta	Loggerhead Turtle	SNES	1763	Terr	REPTILE	E	E	Migrat			
Centrolepis cephaloformis ssp	Cushion Centrolepis			Terr	PLANT	R			5.46	4.63	2.40

Centrolepis cephaloformis ssp murr	Cushion Centrolepis		murr	Terr	PLANT	R			5.46	4.63	2.40
Ceratogyne obionoides	Wingwort	SDM		Terr	PLANT	R					
Cereopsis novaehollandiae	Cape Barren Goose	SDM		Terr	BIRD	R			7.02	3.08	11.40
Chalcites lucidus	Shining Bronze Cuckoo	SDM		Terr	BIRD	V					
Charadrius australis	Inland Dotterel	SDM		Terr	BIRD			Migrat	0.01	0.33	0.52
Charadrius bicinctus	Double-banded Plover	SDM		Terr	BIRD			Migrat	11.62	36.49	0.94
Charadrius leschenaultii	Greater Sand Plover	SNES	877	Terr	BIRD			Migrat			0.25
Charadrius melanops	Black-fronted Dotterel	SNES	878	Terr	BIRD			Migrat	0.22		
Charadrius mongolus	Lesser Sand Plover	SNES	879	Terr	BIRD	R		Migrat			
Charadrius ruficapillus	Red-capped Plover	SDM		Terr	BIRD			Migrat			26.59
Charadrius veredus	Oriental Plover	SNES	882	Terr	BIRD			Migrat	0.20	0.28	5.93
Chelonia mydas	Green Turtle	SNES	1765	Terr	REPTILE		V	Migrat			
Choretrum chrysanthum	Yellow-flower Sour-bush	SDM		Terr	PLANT	R					
Christella dentata	Soft Shield-fern	POINT		Terr	PLANT	R				0.09	3.02
Cinclosoma castanotum	Chestnut Quailthrush	SDM		Terr	GROUNDBIRD	ssp					
Citrus glauca	Desert Lime	SDM		Terr	PLANT	V					
Cladium procerum	Leafy Twig-rush	POINT		Terr	PLANT	R			1.41	10.74	9.60
Cladorhynchus leucocephalus	Banded Stilt	SDM		Terr	BIRD	V					
Climacteris affinis	White-browed Treecreeper	SDM		Terr	BIRD	R			0.28	0.62	6.43
Codonocarpus pyramidalis	Slender Bell-fruit	SDM		Terr	PLANT	E	V				
Commersonia multiloba	Trailing Commersonia	POINT		Terr	PLANT	E					
Corcorax melanorhamphos	White-winged Chough	SDM		Terr	BIRD	R			0.65	0.73	0.27
Corybas expansus	Dune Helmet-orchid	POINT		Terr	PLANT	V			1.42	0.93	7.81
Coturnix ypsilophora	Brown Quail	SDM		Terr	GROUNDBIRD	V					
Crassula exserta	Large-fruit Crassula	SDM		Terr	PLANT	R			0.43	1.62	6.13
Crassula peduncularis	Purple Crassula	POINT		Terr	PLANT	R					1.18
Crassula sieberiana	Sieber's Crassula	POINT		Terr	PLANT	E					
Cryptandra campanulata	Long-flower Cryptandra	SDM		Terr	PLANT	R					
Cullen parvum	Small Scurf-pea	SDM		Terr	PLANT	V					

Dasycercus cristicauda	Crest-tailed Mulgara	SDM		Terr	MAMMAL		E				
Dasyurus geoffroii	Western Quoll	POINT		Terr	MAMMAL	E	V				
Daviesia benthamii ssp	Mallee Bitter-pea			Terr	PLANT	R					
Daviesia pectinata	Thorny Bitter-pea	SDM		Terr	PLANT	R			0.07	0.11	0.59
Daviesia sejugata	Disjunct Bitter-pea	POINT		Terr	PLANT	E					0.01
Dermochelys coriacea	Leathery Turtle	SNES	1768	Terr	REPTILE	V	E	Migrat			
Desmocladus diacolpicus	Bundled Cord-rush	POINT		Terr	PLANT	V			5.46	4.61	2.40
Dianella longifolia var	Pale Flax-lily			Terr	PLANT	R					
Diuris behrii	Behr's Cowslip Orchid	POINT		Terr	PLANT	V					
Dodonaea procumbens	Trailing Hop-bush	SDM		Terr	PLANT	V	V				
Dodonaea subglandulifera	Peel Hill Hop-bush	SDM		Terr	PLANT	E	E				7.15
Drosera stricticaulis	Erect Sundew	SDM		Terr	PLANT	V					
Echinopogon ovatus	Forest Hedgehog Grass	POINT		Terr	PLANT	R					
Echiopsis curta	Bardick	POINT		Terr	BIRD	R					
Egretta garzetta	Little Egret	SDM		Terr	BIRD	R		Migrat			
Egretta sacra	Pacific Reef Heron (Eastern Reef Egret)	SDM		Terr	BIRD	R		Migrat	0.22	0.81	11.05
Elachanthus glaber	Shiny Elachanth	POINT		Terr	PLANT	R			0.13	0.01	0.06
Elatine gratioloides	Water Wort	POINT		Terr	PLANT	R					
Emydura macquarii	Macquarie Tortoise	POINT		Terr	REPTILE	V					
Eragrostis infecunda	Barren Cane-grass	SDM		Terr	PLANT	R					100.00
Eremophila barbata	Blue Range Emubush	POINT		Terr	PLANT	R					
Eremophila gibbifolia	Coccid Emu-bush	POINT		Terr	PLANT	R					
Eremophila parvifolia ssp	Small-leaved Emubush			Terr	PLANT	R					
Eremophila subfloccosa ssp glandul	Green-flower Emubush	POINT		Terr	PLANT	R					
Eriocaulon carsonii ssp	Salt Pipewort			Terr	PLANT	E					50.00
Eryngium ovinum	Blue Devil	SDM		Terr	PLANT	V					
Eucalyptus albens	White Box	SDM		Terr	PLANT	R					
Eucalyptus behriana	Broad-leaf Box	SDM		Terr	PLANT	R				0.07	14.65
Eucalyptus calycogona ssp spaffordii	Spafford's Square-fruit Mallee	POINT		Terr	PLANT	R					

Eucalyptus conglobata ssp	Cong Mallee			Terr	PLANT	R					
Eucalyptus cretata	Darke PeakMallee	SDM		Terr	PLANT	R					
Eucalyptus macrorhyncha ssp	Red Stringybark			Terr	PLANT	R					0.01
Eucalyptus percostata	Devil's Peak Mallee	SDM		Terr	PLANT	R					9.19
Eucalyptus wyolensis	Wyola Mallee	SDM		Terr	PLANT	R					
Eudyptula minor	Little Penguin	SDM		Terr	GROUNDBIRD			Mar			
Euphrasia collina ssp	Osborn's Eyebright			Terr	PLANT	E			0.00		0.08
Falco hypoleucos	Grey Falcon	POINT		Terr	BIRD	R					0.53
Falco peregrinus	Peregrine Falcon	SDM		Terr	BIRD	R				100.00	
Falcunculus frontatus	Crested Shriketit	POINT		Terr	BIRD	R			0.55	1.70	6.36
Festuca benthamiana	Bentham's Fescue	POINT		Terr	PLANT	R					
Frankenia plicata	Frankenia plicata	SDM		Terr	PLANT	V	E				
Gallinago hardwickii	Latham's Snipe	SNES	863	Terr	BIRD	R		Migrat			
Gallinago megala	Swinhoe's Snipe	SNES	864	Terr	BIRD			Migrat			
Gallinago stenura	Pin-tailed Snipe	SNES	841	Terr	BIRD			Migrat			
Gerygone fusca	Western Gerygone	SDM		Terr	BIRD	R					
Glycine latrobeana	Clover Glycine	SNES	13910	Terr	PLANT	V	V				
Glycine tabacina	Variable Glycine	POINT		Terr	PLANT	V					8.32
Goodenia benthamiana	Small-leaf Goodenia	POINT		Terr	PLANT	R					
Goodenia chambersii	Goodenia chambersii	SDM		Terr	PLANT	R					
Grevillea halmaturina	Prickly Grevillea	POINT		Terr	PLANT	R					
Grevillea pauciflora ssp leptophylla	Narrow-leaf Grevillea	POINT		Terr	PLANT	R					
Grus rubicunda	Brolga	SDM		Terr	BIRD	V					
Haeckeria cassiniiformis	Dogwood Haeckeria	POINT		Terr	PLANT	R					
Haegiela tatei	Small Nut-heads	POINT		Terr	PLANT	R					
Haematopus fuliginosus	Sooty Oystercatcher	SDM		Terr	BIRD	R					
Haematopus longirostris	(Australian) Pied Oystercatcher	SDM		Terr	BIRD	R			0.02	0.05	0.03
Haliaeetus leucogaster	White-bellied Sea-Eagle	SDM		Terr	BIRD	E		Migrat	0.01	0.02	0.71
Haloragis eyreana	Prickly Raspwort	SDM		Terr	PLANT	E	E				0.93

Hamirostra melanosternon	Black-breasted Buzzard	SDM		Terr	BIRD	R					
Himantopus	Black-winged Stilt	SNES	870	Terr	BIRD			Migrat			
Hovea purpurea	Alpine Hovea	POINT		Terr	PLANT	R					
Hydrocotyle diantha	Kangaroo Island Pennywort	POINT		Terr	PLANT	E					
Hydroprogne caspia	Caspian Tern	SDM		Terr	BIRD			Mar			
Hydrurga leptonyx	Leopard Seal	POINT		Terr	MAMMAL	R		Mar	0.22	0.34	6.11
Intertidal Cyanobacteria	Intertidal Cyanobacteria			Marine	COMMUNITY					0.51	42.93
Intertidal Mangroves	Intertidal Mangroves			Marine	COMMUNITY				3.53	15.27	33.07
Intertidal Melaleuca	Intertidal Melaleuca			Terr	COMMUNITY						
Intertidal Samphire	Intertidal Samphire			Terr	COMMUNITY				8.25	18.87	40.03
Intertidal Seagrass	Intertidal Seagrass			Marine	COMMUNITY				0.24	3.40	0.42
Intertidal Sedge	Intertidal Sedge			Marine	COMMUNITY						
Isotoma scapigera	Salt Isotome	SDM		Terr	PLANT	R					
Lachnagrostis limitanea	Spalding Blown-grass	SDM		Terr	PLANT	E	E				
Lachnagrostis robusta	Tall Blown-grass	POINT		Terr	PLANT	R					17.79
Larus dominicanus	Kelp Gull	POINT		Terr	BIRD	R		Mar			
Larus pacificus	Pacific Gull	SDM		Terr	BIRD			Mar			
Lawrencia berthae	Showy Lawrencia	POINT		Terr	PLANT	R			0.02		0.49
Leionema microphyllum	Limestone Phebalium	POINT		Terr	PLANT	R					
Leipoa ocellata	Malleefowl	SDM		Terr	GROUNDBIRD	V	V	Migrat			
Lepidium pseudotasmanicum	Shade Peppercress	POINT		Terr	PLANT	V					
Lepidosperma gahnioides	Lepidosperma gahnioides	POINT		Terr	PLANT	R					
Leptinella reptans	Creeping Cotula	POINT		Terr	PLANT	R					
Leptorhynchos elongatus	Lanky Buttons	SDM		Terr	PLANT	R					
Leptorhynchos scaber	Annual Buttons	POINT		Terr	PLANT	R					
Lerista arenicola	Beach Slider	POINT		Terr	REPTILE	R					
Lerista distinguenda	Dwarf Four-toed Slider	SDM		Terr	REPTILE	R					
Leucopogon clelandii	Cleland's Beard-heath	POINT		Terr	PLANT	R				0.11	6.90
Levenhookia stipitata	Common Stylewort	SDM		Terr	PLANT	R					
Lichenostomus cratitius	Purple-gaped Honeyeater	SDM		Terr	BIRD	ssp					0.05

Lichenostomus cratitius occidentalis	Purple-gaped Honeyeater	POINT		Terr	BIRD	R					0.05
Limicola falcinellus	Broad-billed Sandpiper	SNES	842	Terr	BIRD			Migrat	0.02		1.73
Limosa lapponica	Bar-tailed Godwit	SDM		Terr	BIRD	R		Migrat			
Limosa	Black-tailed Godwit	SDM		Terr	BIRD	R		Migrat			3.78
Limosella granitica	Granite Mudwort	SNES	6704	Terr	PLANT	V	V			0.67	18.17
Lobelia cleistogamoides	Lobelia cleistogamoides	POINT		Terr	PLANT	R					
Lobelia heterophylla	Lobelia heterophylla ssp. centralis	SDM		Terr	PLANT	R					
Logania saxatilis	Rock Logania	POINT		Terr	PLANT	R			0.21	0.18	3.60
Lophoictinia isura	Square-tailed Kite	POINT		Terr	BIRD	E					
Macropus giganteus	Eastern Grey Kangaroo	SNES	231	Terr	MAMMAL	R					
Maireana excavata	Bottle Fissure-plant	SDM		Terr	PLANT	V					
Maireana rohrlachii	Rohrlach's Bluebush	SDM		Terr	PLANT	R					
Maireana suaedifolia	Lax Bluebush	POINT		Terr	PLANT	R			1.42	3.66	10.47
Malacocera gracilis	Slender Soft-horns	POINT		Terr	PLANT	V					
Melaleuca armillaris ssp	Needle-leaf Honey-myrtle			Terr	PLANT	R					
Melaleuca leiocarpa	Pungent Honey-myrtle	SDM		Terr	PLANT	R			6.50	11.36	8.29
Melaleuca oxyphylla	Pointer-leaf Honey-myrtle	POINT		Terr	PLANT	R					
Melanodryas cucullata	Hooded Robin	SDM		Terr	BIRD	ssp					
Mentha satureioides	Native Pennyroyal	POINT		Terr	PLANT	R					
Merops ornatus	Rainbow Bee-eater	SDM		Terr	BIRD			Migrat			
Microeca fascinans	Jacky Winter	SDM		Terr	BIRD	ssp			4.29	5.14	10.08
Microlepidium alatum	Microlepidium alatum	SDM		Terr	PLANT	V	V		2.38	2.56	6.34
Microlepidium pilosulum	Hairy Shepherd's-purse	SDM		Terr	PLANT	R					
Microtis eremaea	Slender Onion-orchid	POINT		Terr	PLANT	E					
Mirounga leonina	Southern Elephant Seal	POINT		Terr	MAMMAL	R		Mar			
Mitrasacme pilosa	Hairy Mitrewort	POINT		Terr	PLANT	V					
Morelia spilota	Carpet Python	SDM		Terr	REPTILE	R					
Myiagra cyanoleuca	Satin Flycatcher	SNES	612	Terr	BIRD			Migrat	0.20	0.59	6.32
Myiagra inquieta	Restless Flycatcher	SDM		Terr	BIRD	R					

Myoporum parvifolium	Creeping Boobialla	SDM		Terr	PLANT	R			3.39	3.06	6.64
Neophema chrysogaster	Orange-bellied Parrot	SNES	747	Terr	BIRD	E	CE	Migrat			
Neophema chrysostoma	Blue-winged Parrot	SDM		Terr	BIRD	V					
Neophema elegans	Elegant Parrot	SDM		Terr	BIRD	R			9.52	11.56	18.53
Neophema petrophila	Rock Parrot	SDM		Terr	BIRD	R			2.34	7.20	12.02
Neophema splendida	Scarlet-chested Parrot	SDM		Terr	BIRD	R					0.29
Northiella haematogaster	Bluebonnet	SDM		Terr	BIRD	ssp					
Notechis ater	Black Tiger Snake	POINT		Terr	REPTILE	ssp			2.76	4.46	10.80
Notechis ater	Krefft's Tiger Snake	SNES	64489	Terr	REPTILE		V		2.76	4.46	10.80
Notomys fuscus	Dusky Hopping-mouse	SDM		Terr	MAMMAL	V	V				
Numenius madagascariensis	Far Eastern Curlew	SDM		Terr	BIRD	V		Migrat	0.44	0.84	12.63
Numenius minutus	Little Curlew	SNES	848	Terr	BIRD			Migrat	0.44	0.84	12.63
Numenius phaeopus	Whimbrel	SDM		Terr	BIRD			Migrat			
Olax obcordata	Olax obcordata	SNES	19590	Terr	PLANT	R					
Olearia adenolasia	Musky Daisy-bush	POINT		Terr	PLANT	R					
Olearia pannosa ssp	Silver Daisy-bush			Terr	PLANT	V					
Olearia pannosa ssp cardiophylla	Velvet Daisy-bush	POINT		Terr	PLANT	R					
Olearia picridifolia	Rasp Daisy-bush	SDM		Terr	PLANT	R					
Ophidiocephalus taeniatus	Bronzeback Legless Lizard	SDM		Terr	REPTILE	R	V			0.11	5.51
Orobanche cernua var	Australian Broomrape			Terr	PLANT	R					
Oxyura australis	Blue-billed Duck	SDM		Terr	BIRD	R					
Ozothamnus scaber	Rough Bush-everlasting	SDM		Terr	PLANT	V			0.07	0.41	8.49
Pachycephala inornata	Gilbert's Whistler	SDM		Terr	BIRD	R			0.25	4.61	8.22
Pachycephala rufogularis	Red-lored Whistler	SNES	601	Terr	BIRD	R	V		11.45	8.21	5.84
Pandion haliaetus	Osprey	SDM		Terr	BIRD	E					
Pedionomus torquatus	Plains Wanderer	SNES	906	Terr	BIRD	E	V				
Petrogale xanthopus	Yellow-footed Rock-wallaby	SDM		Terr	MAMMAL	V	V				
Petroica boodang	Scarlet Robin	SDM		Terr	BIRD	ssp				1.76	3.70
Phalaropus lobatus	Red-necked Phalarope	SNES	838	Terr	BIRD			Migrat			

Phascolarctos cinereus	Koala	SNES	197	Terr	MAMMAL		V				
Phebalium glandulosum ssp macrocalyx	Glandular Phebalium	POINT		Terr	PLANT	E					
Philomachus pugnax	Ruff	SNES	850	Terr	BIRD	R		Migrat			
Philotheca angustifolia ssp	Narrow-leaf Wax-flower			Terr	PLANT	R					
Phlegmatospermum eremaeum	Spreading Cress	POINT		Terr	PLANT	R					
Phyllangium sulcatum	Rock Mitrewort	POINT		Terr	PLANT	V					
Phyllanthus calycinus	Snowdrop Spurge	SDM		Terr	PLANT	R					33.33
Phylloglossum drummondii	Pigmy Clubmoss	POINT		Terr	PLANT	R					
Pimelea williamsonii	Williamson's Riceflower	POINT		Terr	PLANT	R					
Plectorhyncha lanceolata	Striped Honeyeater	SDM		Terr	BIRD	R					
Plegadis falcinellus	Glossy Ibis	SDM		Terr	BIRD	R			2.40	19.83	2.57
Pleuropappus phyllocalymmeus	Silver Candles	SDM		Terr	PLANT	V	V		0.03	0.30	7.01
Pluvialis fulva	Pacific Golden Plover	SDM		Terr	BIRD	R		Migrat			
Pluvialis squatarola	Grey Plover	SDM		Terr	BIRD			Migrat	0.00	0.05	5.56
Poa drummondiana	Knotted Pea	SDM		Terr	PLANT	R			0.06		1.23
Poa fax	Scaly Meadow-grass	SDM		Terr	PLANT	R				0.01	0.51
Podiceps cristatus	Great Crested Grebe	SDM		Terr	BIRD	R			0.01	0.17	3.45
Podolepis jaceoides	Showy Copper-wire Daisy	SDM		Terr	PLANT	R			0.07	0.58	7.68
Podolepis muelleri	Button Podolepis	SDM		Terr	PLANT	V			0.97	2.41	7.93
Polypogon tenellus	Polypogon tenellus	POINT		Terr	PLANT	V				7.12	1.68
Porzana fluminea	Australian Spotted Crake	SDM		Terr	BIRD			Migrat			
Porzana tabuensis	Spotless Crake	SDM		Terr	BIRD	R		Migrat	0.00	0.11	8.91
Prasophyllum calcicola	Limestone Leek-orchid	POINT		Terr	PLANT	V					
Prasophyllum constrictum	Tawny Leek-orchid	POINT		Terr	PLANT	R					
Prasophyllum fecundum	Self-pollinating Leek-orchid	SDM		Terr	PLANT	R					
Prasophyllum goldsackii	Goldsack's Leek-orchid	SNES	2380	Terr	PLANT	E	E				
Prasophyllum occultans	Hidden Leek-orchid	POINT		Terr	PLANT	R					
Prasophyllum pallidum	Pale Leek-orchid	SNES	20351	Terr	PLANT	R	V				
Prasophyllum sp Enigma	Goldsack's Leek-orchid	POINT		Terr	PLANT	E					

Prasophyllum validum	Mount Remarkable Leek-orchid	SNES	10268	Terr	PLANT	V	V				
Prostanthera calycina	West Coast Mintbush	SDM		Terr	PLANT	V	V				
Prostanthera chlorantha	Green Mintbush	POINT		Terr	PLANT	R					
Pseudaphritis urvillii	Congolli	POINT		Terr	FISH						
Pseudemoia baudini	Bight Coast Skink	POINT		Terr	REPTILE	R					66.67
Pseudomys australis	Plains mouse	SDM		Terr	MAMMAL	V	V				
Pseudomys shortridgei	Heath Mouse	POINT		Terr	MAMMAL	E					
Pseudophryne bibronii	Brown Toadlet	SDM		Terr	FROG	R					
Psophodes nigrogularis	Western Whipbird (Eastern subspecies)	SDM		Terr	BIRD	E				0.13	7.51
Psophodes nigrogularis leucogaster	Western Whipbird	SDM		Terr	BIRD	ssp				0.13	7.51
Pterostylis arenicola	Sandhill Greenhood	SNES	17919	Terr	PLANT	V	V				
Pterostylis curta	Blunt Greenhood	POINT		Terr	PLANT	R					
Pterostylis despectans	Mt Bryan Greenhood	SNES	6272	Terr	PLANT	E	E				
Pterostylis sp Eyre	Pterostylis	SNES	64688	Terr	PLANT		V				
Pterostylis sp Halbury	Pterostylis	SNES	64538	Terr	PLANT		E		16.53	9.41	
Ptilotus barkeri	Barker's Mulla	SDM		Terr	PLANT	R					
Ptilotus beckerianus	Ironstone Mulla	SDM		Terr	PLANT	V	V				
Ptilotus erubescens	Hairy Tails	SDM		Terr	PLANT	R					
Pultenaea kraehenbuehlii	Tothill Bush-pea	SDM		Terr	PLANT	R					
Pultenaea trichophylla	Tufted Bush-pea	SDM		Terr	PLANT	R	E				9.96
Pycnosorus globosus	Drumsticks	SDM		Terr	PLANT	V					
Ranunculus sessiliflorus	Annual Buttercup	POINT		Terr	PLANT	V					
Recurvirostra novaehollandiae	Red-necked Avocet	SDM		Terr	BIRD			Migrat			
Rostratula australis	Australian Painted Snipe	SNES	77037	Terr	BIRD	V	E	Migrat			
Rumex dumosus	Wiry Dock	SDM		Terr	PLANT	R					0.19
Rytidosperma tenuius	Short-awn Wallaby-grass	POINT		Terr	PLANT	R					
Santalum spicatum	Sandalwood	SDM		Terr	PLANT	V					
Sarcozona bicarinata	Ridged Noon-flower	POINT		Terr	PLANT	V			8.25	5.51	5.08
Scaevola myrtifolia	Myrtle Fanflower	POINT		Terr	PLANT	R				66.67	

Schoenus laevigatus	Short-leaf Bog-sedge	POINT		Terr	PLANT	R					
Schoenus sculptus	Gimlet Bog-rush	POINT		Terr	PLANT	R					
Sclerolaena blackiana	Black's Bindyi	SDM		Terr	PLANT	R					
Sclerolaena muricata	Five-spine Bindyi	POINT		Terr	PLANT	R					
Scutellaria humilis	Dwarf Skullcap	POINT		Terr	PLANT	R					
Senecio longicollaris	Riverina Fireweed	SNES	82946	Terr	PLANT						
Senecio macrocarpus	Large-fruit Groundsel	SNES	16333	Terr	PLANT	V	V				96.89
Senecio megaglossus	Large-flower Groundsel	SDM		Terr	PLANT	E	V				
Sminthopsis psammophila	Sandhill Dunnart	SDM		Terr	MAMMAL	V	E				
Solanum eremophilum	R Nightshade	POINT		Terr	PLANT	R					
Sphaerolobium minus	Leafless Globe-pea	POINT		Terr	PLANT	R					100.00
Spyridium bifidum ssp bifidum	Marble Range Spyridium	POINT		Terr	PLANT	V					
Spyridium bifidum ssp wanillae	Wanilla Spyridium	POINT		Terr	PLANT	R					
Spyridium erymnocladum	Cloaked Spyridium	SDM		Terr	PLANT	V					
Spyridium leucopogon	Silvery Spyridium	POINT		Terr	PLANT	R					0.00
Spyridium spathulatum	Spoon-leaf Spyridium	POINT		Terr	PLANT	R					
Spyridium tricolor	Rusty Spyridium	SDM		Terr	PLANT	V					
Stackhousia annua	Annual Candles	SDM		Terr	PLANT	V	V				
Stagonopleura guttata	Diamond Firetail	SDM		Terr	BIRD	V					
Sterna hirundo	Common Tern	POINT		Terr	BIRD	R					
Sternula albifrons	Little Tern	SNES	813	Terr	BIRD	E		Mar			
Sternula nereis	Fairy Tern	SDM		Terr	BIRD	E		Mar			
Stictonetta naevosa	Freckled Duck	SDM		Terr	BIRD	V					1.02
Stipiturus malachurus	Southern Emuwren	POINT		Terr	GROUNDBIRD	ssp			2.98	0.94	15.47
Stipiturus malachurus parimeda	Southern Emu-wren (Eyre Peninsula ssp)	SDM		Terr	GROUNDBIRD	E			2.98	0.94	15.47
Strepera versicolor	Grey Currawong	SDM		Terr	BIRD	ssp			0.50	3.11	14.93
Stypandra glauca	Nodding Grass-lily	POINT		Terr	PLANT	V					
Stranded samphire	Stranded samphire			Terr	COMMUNITY				0.50	3.11	14.93
Supratidal Cyanobacteria	Supratidal Cyanobacteria			Marine	COMMUNITY					11.53	

Supratidal Mangroves	Supratidal Mangroves			Marine	COMMUNITY						100.00
Supratidal Melaleuca	Supratidal Melaleuca			Marine	COMMUNITY						
Supratidal Samphire	Supratidal Samphire			Terr	COMMUNITY				5.23	13.74	48.14
Swainsona behriana	Behr's Swainson-pea	SDM		Terr	PLANT	V					
Swainsona pyrophila	Yellow Swainson-pea	SNES	56344	Terr	PLANT	R	V				
Synemon discalis	Small Orange-spotted Sun Moth	SNES	81590	Terr	INSECT						
Tecticornia flabelliformis	Bead Samphire	SDM		Terr	PLANT	V	V				
Tecticornia lepidosperma	Tecticornia lepidosperma	POINT		Terr	PLANT	R					7.71
Thalassarche chlororhynchos	Yellow-nosed Albatross	POINT		Terr	BIRD	E		Mar			
Thalassarche melanophris	Black-browed Albatross	POINT		Terr	BIRD	V	V	Migrat			
Thalasseus bergii	Greater Crested Tern	SDM		Terr	BIRD			Mar			
Thelymitra epipactoides	Metallic Sun-orchid	SNES	11896	Terr	PLANT	E	E				
Thelymitra flexuosa	Twisted Sun Orchid	SDM		Terr	PLANT	R					
Thelymitra grandiflora	Great Sun-orchid	POINT		Terr	PLANT	R					
Thelymitra ixioides	Dotted Sun Orchid	POINT		Terr	PLANT	E					
Thinornis rubricollis	Hooded Plover (Hooded Dotterel)	SDM		Terr	BIRD	V					
Thysanotus tenellus	Grassy Fringe-lily	SDM		Terr	PLANT	R					
Thysanotus wangariensis	Eyre Peninsula Fringe-lily	POINT		Terr	PLANT	R			1.44	8.51	15.93
Tiliqua adelaidensis	Pygmy Bluetongue	SDM		Terr	REPTILE	E	E				
Trichosurus vulpecula	Common Brushtail Possum	SDM		Terr	MAMMAL	R					
Triglochin minutissima	Tiny Arrowgrass	POINT		Terr	PLANT	R				0.00	6.56
Tringa brevipes	Grey-tailed Tattler	SDM		Terr	BIRD	R		Migrat			20.00
Tringa glareola	Wood Sandpiper	SDM		Terr	BIRD	R		Migrat	0.04	0.06	1.48
Tringa nebularia	Common Greenshank	SDM		Terr	BIRD			Mar		0.00	10.49
Tringa stagnatilis	Marsh Sandpiper	SDM		Terr	BIRD			Migrat	0.24	0.20	5.48
Turnix varius	Painted Buttonquail	SDM		Terr	GROUNDBIRD	R					
Varanus rosenbergi	Heath Goanna	SDM		Terr	REPTILE	V					
Varanus varius	Lace Monitor	SDM		Terr	REPTILE	R					
Vermicella annulata	Bandy-bandy	POINT		Terr	REPTILE	R					

Veronica decorosa	Showy Speedwell	SDM		Terr	PLANT	R					
Veronica parnkalliana	Port Lincoln Speedwell	POINT		Terr	PLANT	E			0.05	1.06	8.33
Wurmbea decumbens	Trailing Nancy	SDM		Terr	PLANT	R					
Wurmbea latifolia	Broad-leaf Nancy	POINT		Terr	PLANT	V			1.19	1.78	4.12
Xanthorrhoea semiplana ssp tateana	Tate's Grass-tree	POINT		Terr	PLANT	R					
Xenus cinereus	Terek Sandpiper	SDM		Terr	BIRD	R		Migrat			
Zoothera lunulata	Bassian Thrush	POINT		Terr	BIRD	R					
Pelagodroma marina	White-faced Storm-Petrel	SNES	1016	Marine	BIRD			Mar			
Ardenna pacifica	Wedge-tailed Shearwater	SNES	1027	Marine	BIRD			Migrat, Mar			
Ardenna tenuirostris	Short-tailed Shearwater	SNES	1029	Marine	BIRD			Migrat, Mar			
Pterodroma mollis	Soft-plumaged Petrel	SNES	1036	Marine	BIRD		V	Mar			
Halobaena caerulea	Blue Petrel	SNES	1059	Marine	BIRD		V	Mar			0.93
Macronectes giganteus	Southern Giant Petrel	SNES	1060	Marine	BIRD		E	Migrat			
Macronectes halli	Northern Giant Petrel	SNES	1061	Marine	BIRD		V	Migrat			
Diomedea exulans	Wandering Albatross	SNES	1073	Marine	BIRD	V	V				
Eudyptula minor	Little Penguin	SNES	1085	Marine	GROUNDBIRD			Mar			
Caretta	Loggerhead Turtle	SNES	1763	Marine	REPTILE	E	E	Migrat			
Chelonia mydas	Green Turtle	SNES	1765	Marine	REPTILE		V	Migrat			
Dermochelys coriacea	Leathery Turtle	SNES	1768	Marine	REPTILE	V	E	Migrat			
Arctocephalus forsteri	New Zealand Fur-seal	SNES	20	Marine	MAMMAL			Mar	0.13	0.71	5.85
Arctocephalus pusillus	Australian Fur-seal, Australo-African Fur-seal	SNES	21	Marine	MAMMAL			Mar			
Neophoca cinerea	Australian Sea Lion	SNES	22	Marine	MAMMAL	V	V	Mar	3.13	0.85	
Pluvialis fulva	Pacific Golden Plover	SNES	25545	Marine	BIRD	R		Migrat			
Balaenoptera acutorostrata	Minke Whale	SNES	33	Marine	MAMMAL	R		Cet			
Balaenoptera edeni	Bryde's Whale	SNES	35	Marine	MAMMAL	R		Cet			
Balaenoptera musculus	Blue Whale	SNES	36	Marine	MAMMAL	E	E	Cet, Migrat			
Megaptera novaeangliae	Humpback Whale	SNES	38	Marine	MAMMAL	V	V	Cet, Migrat			

Caperea marginata	Pygmy Right Whale	SNES	39	Marine	MAMMAL	R		Cet, Migrat			0.03
Eubalaena australis	Southern Right Whale	SNES	40	Marine	MAMMAL	V	E	Cet, Migrat			
Lagenorhynchus obscurus	Dusky Dolphin	SNES	43	Marine	MAMMAL			Cet, Migrat			
Orcinus orca	Killer Whale	SNES	46	Marine	MAMMAL			Cet, Migrat			
Tringa brevipes	Grey-tailed Tattler	SNES	59311	Marine	BIRD	R		Migrat			20.00
Hydroprogne caspia	Caspian Tern	SNES	59467	Marine	BIRD			Mar			
Catharacta skua	Great Skua	SNES	59472	Marine	BIRD			Mar	5.46	4.63	2.40
Thinornis rubricollis	Hooded Plover (Hooded Dotterel)	SNES	59510	Marine	BIRD	V		Mar			
Ardea ibis	Cattle Egret	SNES	59542	Marine	BIRD	R		Migrat			
Phalacrocorax fuscescens	Black-faced Cormorant	SNES	59660	Marine	BIRD			Mar			
Delphinus delphis	Common Dolphin	SNES	60	Marine	MAMMAL			Cet			
Grampus griseus	Risso's Dolphin	SNES	64	Marine	MAMMAL			Cet			
Diomedea exulans amsterdamensis	Amsterdam Albatross	SNES	64405	Marine	BIRD		E	Migrat, Mar			
Thalassarche melanophris impavida	Campbell Albatross	SNES	64459	Marine	BIRD	V	V	Migrat, Mar			
Thalassarche bulleri	Buller's Albatross	SNES	64460	Marine	BIRD	V	V	Migrat, Mar			
Diomedea exulans gibsoni	Gibson's Albatross	SNES	64466	Marine	BIRD		V	Migrat, Mar			
Carcharodon carcharias	Great White Shark	SNES	64470	Marine	FISH		V	Migrat			0.03
Thalassarche cauta	Shy Albatross	SNES	64697	Marine	BIRD	V	V	Migrat, Mar			
Acentronura australe	Southern Pygmy Pipehorse	SNES	66185	Marine	FISH			Mar			
Campichthys galei	Gale's Pipefish	SNES	66191	Marine	FISH			Mar			0.03
Campichthys tryoni	Tryon's Pipefish	SNES	66193	Marine	FISH			Mar			0.03
Filicampus tigris	Tiger Pipefish	SNES	66217	Marine	FISH			Mar			
Heraldia nocturna	Upside-down Pipefish	SNES	66227	Marine	FISH			Mar			
Hippocampus abdominalis	Big-belly Seahorse	SNES	66233	Marine	FISH			Mar		6.23	
Hippocampus breviceps	Short-head Seahorse	SNES	66235	Marine	FISH			Mar		6.23	
Histiogamphelus cristatus	Rhino Pipefish	SNES	66243	Marine	FISH			Mar			

Hypselognathus horridus	Shaggy Pipefish	SNES	66244	Marine	FISH			Mar			
Hypselognathus rostratus	Knifesnout Pipefish	SNES	66245	Marine	FISH			Mar			
Kaupus costatus	Deepbody Pipefish	SNES	66246	Marine	FISH			Mar			
Leptoichthys fistularius	Brushtail Pipefish	SNES	66248	Marine	FISH			Mar			100.00
Lissocampus caudalis	Australian Smooth Pipefish	SNES	66249	Marine	FISH			Mar			
Lissocampus runa	Javelin Pipefish	SNES	66251	Marine	FISH			Mar			
Maroubra perserrata	Sawtooth Pipefish	SNES	66252	Marine	FISH			Mar			
Notiocampus ruber	Red Pipefish	SNES	66265	Marine	FISH			Mar			
Phycodurus eques	Leafy Seadragon	SNES	66267	Marine	FISH			Mar			
Phyllopteryx taeniolatus	Common Seadragon	SNES	66268	Marine	FISH			Mar			
Pugnaso curtirostris	Pugnose Pipefish	SNES	66269	Marine	FISH			Mar			
Solegnathus robustus	Robust Pipehorse	SNES	66274	Marine	FISH			Mar			100.00
Stigmatopora argus	Spotted Pipefish	SNES	66276	Marine	FISH			Mar	2.98	0.94	15.47
Stigmatopora nigra	Widebody Pipefish	SNES	66277	Marine	FISH			Mar	2.98	0.94	15.47
Stipecampus cristatus	Ringback Pipefish	SNES	66278	Marine	FISH			Mar	2.98	0.94	15.47
Urocampus carinirostris	Hairy Pipefish	SNES	66282	Marine	FISH			Mar			
Vanacampus margaritifer	Mother-of-pearl Pipefish	SNES	66283	Marine	FISH			Mar			
Vanacampus phillipi	Port Phillip Pipefish	SNES	66284	Marine	FISH			Mar			
Vanacampus poecilolaemus	Longsnout Pipefish	SNES	66285	Marine	FISH			Mar			
Vanacampus vercoi	Verco's Pipefish	SNES	66286	Marine	FISH			Mar			
Diomedea exulans	Tristan Albatross	SNES	66471	Marine	BIRD		E	Mar, Migrat			
Thalassarche melanophris	Black-browed Albatross	SNES	66472	Marine	BIRD		V	Mar, Migrat			
Thalassarche chrysostoma	Grey-headed Albatross	SNES	66491	Marine	BIRD		E	Mar, Migrat			
Thinornis rubricollis	Hooded Plover (Hooded Dotterel)	SNES	66726	Marine	BIRD	V		Mar			
Apus pacificus	Fork-tailed Swift	SNES	678	Marine	BIRD			Migrat	0.01	0.50	22.65
Tursiops truncatus s. str.	Bottlenose Dolphin	SNES	68417	Marine	MAMMAL			Cet	0.29	1.29	2.81
Tursiops aduncus	Indian Ocean Bottlenose Dolphin	SNES	68418	Marine	MAMMAL			Cet	0.29	1.29	2.81
Centrophorus zeehaani	Southern Dogfish	SNES	68446	Marine	FISH		CD	Mar			

Galeorhinus galeus	School Shark	SNES	68453	Marine	FISH		CD	Mar			
Carcharhinus obscurus	Dusky Shark	SNES	69104	Marine	FISH			Mar			0.03
Thunnus maccoyii	Southern Bluefin Tuna	SNES	69402	Marine	FISH		CD	Mar			
Rostratula australis	Australian Painted Snipe	SNES	77037	Marine	BIRD	V	E	Migrat			
Sternula nereis	Fairy Tern	SNES	796	Marine	BIRD	E		Mar			
Larus dominicanus	Kelp Gull	SNES	809	Marine	BIRD	R		Mar			
Chroicocephalus novaehollandiae	Silver Gull	SNES	810	Marine	BIRD			Mar			
Larus pacificus	Pacific Gull	SNES	811	Marine	BIRD			Mar			
Sternula albifrons	Little Tern	SNES	813	Marine	BIRD	E		Marine			
Ardenna carneipes eastern Australian population	Flesh-footed Shearwater	SNES	81649	Marine	BIRD	R		Mar, Migrat	3.45	3.73	5.77
Urolophus orarius	Coastal Stingaree	SNES	81873	Marine	FISH						
Ardenna carneipes	Flesh-footed Shearwater	SNES	82404	Marine	BIRD	R		Mar, Migrat	3.45	3.73	5.77
Ardea modesta	Great Egret	SNES	82410	Marine	BIRD			Migrat	0.27	0.51	9.80
Onychoprion fuscata	Sooty Tern	SNES	82847	Marine	BIRD			Mar		0.11	5.51
Sternula nereis	Australian Fairy Tern	SNES	82950	Marine	BIRD		V				
Sepia apama Upper Spencer Gulf population	Spencer Gulf Giant Australian Cuttlefish	SNES	82955	Marine	INVERTEBRATE				0.91	9.87	7.78
Thalasseus bergii	Greater Crested Tern	SNES	83000	Marine	BIRD			Mar			
Lamna nasus	Porbeagle	SNES	83288	Marine	FISH			Migrat			
Tringa stagnatilis	Marsh Sandpiper	SNES	833	Marine	BIRD			Migrat	0.24	0.20	5.48
Alopias vulpinus	Common Thresher	SNES	84071	Marine	FISH			Mar			
Gallinago stenura	Pin-tailed Snipe	SNES	841	Marine	BIRD			Migrat			
Carcharhinus longimanus	Oceanic Whitetip Shark	SNES	84108	Marine	FISH						0.03
Orectolobus maculatus	Spotted Wobbegong	SNES	84109	Marine	FISH						
Limosa lapponica	Bar-tailed Godwit	SNES	844	Marine	BIRD	R		Migrat			
Numenius madagascariensis	Far Eastern Curlew	SNES	847	Marine	BIRD	V		Migrat	0.44	0.84	12.63
Numenius minutus	Little Curlew	SNES	848	Marine	BIRD			Migrat	0.44	0.84	12.63
Philomachus pugnax	Ruff	SNES	850	Marine	BIRD	R		Migrat			
Calidris canutus	Red Knot	SNES	855	Marine	BIRD			Migrat			

Calidris ferruginea	Curlew Sandpiper	SNES	856	Marine	BIRD			Migrat	0.07		4.61
Calidris ruficollis	Red-necked Stint	SNES	860	Marine	BIRD			Migrat			
Calidris tenuirostris	Great Knot	SNES	862	Marine	BIRD	R		Migrat	0.00	0.02	4.03
Gallinago hardwickii	Latham's Snipe	SNES	863	Marine	BIRD	R		Migrat			
Gallinago megala	Swinhoe's Snipe	SNES	864	Marine	BIRD			Migrat			
Cladorhynchus leucocephalus	Banded Stilt	SNES	869	Marine	BIRD	V					
Himantopus	Black-winged Stilt	SNES	870	Marine	BIRD			Migrat			
Recurvirostra novaehollandiae	Red-necked Avocet	SNES	871	Marine	BIRD			Migrat			
Arenaria interpres	Ruddy Turnstone	SNES	872	Marine	BIRD	R		Migrat	0.67	0.66	0.00
Calidris acuminata	Sharp-tailed Sandpiper	SNES	874	Marine	BIRD		V	Migrat			
Calidris alba	Sanderling	SNES	875	Marine	BIRD	R		Migrat	0.12	0.28	6.41
Charadrius leschenaultii	Greater Sand Plover	SNES	877	Marine	BIRD			Migrat			0.25
Charadrius mongolus	Lesser Sand Plover	SNES	879	Marine	BIRD	R		Migrat			
Charadrius ruficapillus	Red-capped Plover	SNES	881	Marine	BIRD			Migrat			26.59
Charadrius veredus	Oriental Plover	SNES	882	Marine	BIRD			Migrat	0.20	0.28	5.93
Erythrogonys cinctus	Red-kneed Dotterel	SNES	883	Marine	BIRD			Migrat			
Haematopus fuliginosus	Sooty Oystercatcher	SNES	892	Marine	BIRD	R					
Haematopus longirostris	(Australian) Pied Oystercatcher	SNES	893	Marine	BIRD	R			0.02	0.05	0.03
Haliaeetus leucogaster	White-bellied Sea-Eagle	SNES	943	Marine	BIRD	E		Migrat	0.01	0.02	0.71
Pandion haliaetus	Osprey	SNES	952	Marine	BIRD	E					
Sea grass	Sea grass	SDM		Marine	COMMUNITY		V				
Macroalgae	Macroalgae	SDM		Marine	COMMUNITY						
Low profile reef	Low profile reef	SDM		Marine	COMMUNITY						
Medium profile reef	Medium profile reef	SDM		Marine	COMMUNITY						
High profile reef	High profile reef	SDM		Marine	COMMUNITY						

*migrat = migratory, mar = marine, cet = cetacean