SOUTHERN FLEURIEU COASTAL ACTION PLAN AND CONSERVATION PRIORITY STUDY 2007

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More Information

Further information about the Southern Fleurieu Coastal Action Plan and Priority Study including copies of the report and CD-ROM can be obtained from the Coast, Estuary and Marine Officer for the Southern Fleurieu Peninsula.

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EXECUTIVE SUMMARY

This is a conservation assessment and coastal action plan for the Southern Fleurieu coast between Sellicks Beach and Hindmarsh Island. The three Southern Fleurieu councils (Yankalilla, Victor Harbor and Alexandrina), the Adelaide & Mount Lofty Natural Resource Management Board, the Goolwa to Wellington LAP and the Department for Environment & Heritage (DEH) provided resources to enable a consultant and DEH staff to undertake this project. Representatives of these groups made up a steering committee which guided the project.

The goal of the study was to understand and facilitate the conservation, protection and maintenance of the region's natural coastal resources and to establish conservation priorities for places and areas within the region. Early in the project, the Board recognised:

- The need for a detailed review of the state of the coastal natural resource asset of the region, thus establishing a baseline statement for the region;
- To examine the threatening processes;
- To identify opportunities for more effective management at the local scale and to define specific management actions and their priority; and
- To establish a framework of broad actions and targets to guide the regional community.

The study used GIS to collate, analyse and present information retrieved from government, non-government, community groups and local experts.

For the purposes of the assessment a coastal boundary was defined based on natural coastal features such as dunes and salt marshes. Where coastal landforms were absent such as cliff tops, a default distance of 500 metres from the coastline was used. In order to facilitate the analysis and discuss management issues within this coastal zone, it was divided into 'cells' or small sub-regional landform units with an average mapping length of 6 kilometres. Twenty seven of these were defined and were used as a means to analyse, describe and map significant areas.

Conservation and threat values were determined for all cells. A major part of the report is the descriptions and analysis of cells, including local management recommendations.

Conservation and threat values were summed for all points on the digital maps to give a summary of conservation priorities and a summary of threatening processes. A comparison of the summed results of these two analyses shows that a number of areas have high conservation values and a high threat level:

- The beaches and lower slopes of Fishery Beach, Lands End, Cape Jervis and Morgans Beach;
- The cliffs and cliff tops from Newland Head to the Bluff;
- Normanville Dunes.

This result is seen as significant for priority decisions for management actions, and is identified in relevant local actions and the regional actions.

This sand dune and cliffed coast has high conservation values, a range of similar habitats, and extensive areas of remnant vegetation. However, these significant areas are narrow and poorly linked, which reduces their conservation value. The remnant vegetation of the west coast of the Yorke Peninsula is surviving within a landscape that is substantially cleared for agriculture.

A series of recommendations for the region are briefly listed here.

Recommendation 1

The SFCAP Region has high biodiversity values within SA, for species dependent on the coastal environment (offshore there is high marine biodiversity). As a coastal, estuarine and marine region this should receive high priority within a state context.

a) There is a need to build resilience for vegetation remnants by improving connectivity between remnants. Viewed in the long term, this issue is part of regional adaptation to climate change. Broadly, the Southern Fleurieu coastal boundary runs through climatic gradients from Cape Jervis to the NE along the Gulf coast, and to the E along the Southern Ocean coast. A regional "Coastlinks" project should be considered to enhance connectivity for present and future habitats along the coast. *(Action: DEH Naturelinks Group; NRM)*

b) In spite of efforts by many community group members, councils, NRM and Landcare groups, there is considerable infestation of coastal areas by aggressive 'red alert' weeds. There is a need to develop a regional weed strategy to eliminate high priority weeds. (Action: DEH, NRM)

Recommendation 2

The conservation analysis and survey of local actions shows that there are 2 distinctive areas that have conservation values, but both areas are currently neglected. The threat analysis shows these areas have a relatively high threat total. These are the Sir Richard Peninsula and the Tokuremoar Reserve, cells 2 and 4.

The conservation analysis for Sir Richard Peninsula shows that native vegetation associations give average values for coastal dune shrubland, but these have high value (and potential value) for reptile and butterfly larvae habitat dependent on coastal environments. This value appears to be severely threatened by the historical spread of Pyp Grass (*Ehrharta villosa* var *maxima*): since its introduction to the area in the 1930s, (Hilton & Harvey, 2002), this 'red alert' weed has invaded through the entire backdune habitat of the peninsula. At the same time the foredune has been invaded by Sea Wheat Grass (*Thinopyrum junceiforme*), which Hilton and Harvey see as over-stabilising the sand barrier landform, preventing blowout development, reducing normal sand movement into the backdunes, and reducing normal plant habitat diversity within the dunes through reduction in sand movement. The dramatic invasion of the Sir Richard Peninsula by these 2 species threatens to greatly reduce plant diversity and hence the long term sustainability of the area. Any threat to the survival of the active dune system of the peninsula is of regional importance, as well as a formidable management challenge.

Hilton and Harvey (p.189) suggest "an effective management approach should include (i) regular reconnaissance, early recognition and eradication of potential problem species during the establishment phase of their invasion history; (ii) ongoing monitoring of rates of invasion of established species; (iii) understanding processes of invasion; (iv) developing strategies for containment or eradication; and (v) recognising and protecting core conservation areas". This represents a formidable challenge for agencies and the local community, but in view of the extent of the threat and past inaction, this report suggests that immediate response is needed.[1]

The Tokuremoar Reserve

Conservation analysis for this cell is remarkable, considering its location and the threats imposed by rapidly rising population in adjacent areas:

> The total of conservation means shows this to be one of the relatively high conservation value locations within the region, there is little variation in averaged totals across the cell. All plant and animal conservation layers score medium to high means for this cell…the highest value means are for vegetation shape size and connectivity, butterfly larvae habitat, reptile habitat, and priority of vegetation assemblage based on rarity within South Australia. (Grund, 1997)

Grund (1997) notes that the area is in "poor condition, but highly significant as breeding habitat for *Anisynta cynone cynone",* the Blue Cynone butterfly, which is found here. The rating for butterfly larvae habitat was the highest in the region. Reptile habitat is notable, providing refuge for species which are dependent on habitats only found in coastal areas.

The state vulnerable *Coturnix ypsilophora* (Brown Quail), *Cladorhynchus leucocephalus* (Banded Stilt), *Thinornis rubricollis* (Hooded Plover); the state rare *Cereopsis novaehollandiae* (Cape Barren Goose), *Anas rhyncotis* (Australasian Shoveller), *Plegadis falcinellus* (Glossy Ibis), *Gallinago hardwickii* (Latham's Snipe), and *Neophema elegans* (Elegant Parrot) have been recorded in this cell". (Cell Descriptions, cell 4)

[1] See Hilton & James, 2006, for a treatment of the Pyp Grass issue within the neighbouring Coorong National Park. The current research of Kris James at the University of Adelaide, Environmental Studies, is highly relevant to the management of the Sea Wheat Grass issue of Sir Richard Peninsula.

The reserve is tiny in area, but represents a glimpse of the coastal plain before urbanisation: its Crown land Reserve status guards against housing development and privatisation, but without active management, not against the pressure of exploding local population numbers or the dangerous proximity of the Goolwa Dump.

The conservation and threats analysis for the region suggests that both these areas have a high priority for action, and both need active review of their status by relevant groups and agencies. The review of Tokuremoar should consider the vision of the *Tokuremoar Management Plan*, part A (Wright & Seaman, 1997); in many respects the material in the detailed cell description of this report complements this plan. The *Tokuremoar Management Plan* envisaged largely Aboriginal management for the reserve. Should this eventuate, the material within cell 4 could assist this process.

Initially, it is proposed that targeted efforts are made to build community support for on-ground management of these areas, and that these efforts are given high priority.

(Action: NRM, Goolwa to Wellington LAP, Council, Ngarrindjeri representatives, Sir Richard Management Committee, DEH Land Administration Branch)

Recommendation 3

Within the Southern Fleurieu coastal region encompassed by this study there are 23 estuaries. Many of them are tiny creek outlets (such as the Yattagolinga River at Rapid Bay), others are rivers of regional note (such as the Hindmarsh, Inman or Bungala), and the Murray Mouth. Other than the Murray, little is known about these estuaries, their function, water quality or sediment load. They are all seasonally barred entrances. For some the artificial opening of entrances is an issue, although the criteria for opening or closing is unexamined. There is a regional need to examine the biological function of these estuaries (as well as the impact of their pollution load on neighbouring marine areas). In the interim it is suggested that the 'Estuary Entrance Management Support System' that has been developed by Deakin University and a number of Victorian Catchment Boards is used as a starting point in evaluating current opening or closing strategies. This strategy was developed for larger estuaries in Victoria, with greater flow and shorter periods of closure than the Fleurieu estuaries.

(Action: DEH, Marine Conservation; Estuaries Policy. NRM, Councils)

Recommendation 4

There are 2 very high priority areas adjacent to parks, which are worth consideration for an increased level of protection.

a) The area from Deep Creek Conservation Park to Morgans Beach, includes large coastal reserves which have been successfully improved by several community groups. Here a number of strategic actions to improve connection between vegetation blocks would greatly enhance the value of the area.

b) The area including Kings Head to Newland Head Conservation Park is an area of unique scenic value within the state and has seen long successful campaigns of improvement. This area, however, could require protective buffering by zoning, to secure and enhance it.

(Action: DEH, Coast Protection; NRM)

Recommendation 5

The Southern Fleurieu Coastal Action Plan has produced cell descriptions for all of its 27 cells: 19 of these have recorded the presence of the national and state rated vulnerable species *Thinornis rubricollis* (Hooded Plover). This beach nesting bird has been recorded at the majority of sandy beaches within the region. It is the subject of a recovery plan currently being developed within the Department for Environment and Heritage (DEH). The actions and priorities of this recovery plan have been incorporated into the substance of this action plan: they involve detailed local actions to manage foreshore use to minimise impact on the species during the nesting and fledging season. In view of the status of this species, it is here proposed that the SFCAP adopt the Hooded Plover as a focal species, and an image be used as a logo for the plan.

(Action: DEH, Councils)

Recommendation 6

Currently the seasonal extension of the Heysen Trail, the 'Whalers Way' extends from the Bluff to Cape Jervis. Construction of a linking regional coastal footpath from Cape Jervis to Sellicks is under active examination by DEH and Yankalilla Council. It is apparent that such a footpath is a possibility, but the terrain would not allow it to access all scenic cliff areas, and the path would incorporate inland loops. The high scenic values recorded in this study underline the community benefits of such a regional footpath. For many coastal reserves, fencing accompanying path development would be vital to conservation aims, as in Recommendation 1(a) above.

(Action: DEH Natural & Cultural Heritage, Visitor Management Branch; NRM, Councils)

Recommendation 7

The retention of the scenic cliffed coastline from the Bluff to Sellicks Beach has previously depended on the provisions of the Council Development Plan for such scenic values. This has been supported by the topography and road pattern of the region. 'Seachange' population pressures and proximity of high value coastal sites to Adelaide, however, suggest that existing protections might not be strong enough to resist the coastal sprawl of existing urban areas at the following sites: Wirrina, Carrickalinga (north end), Second Valley, Cape Jervis, Tunkalilla Beach, the Bluff. In these circumstances strategic review of existing provisions is needed.

(Action: Coast Protection Board & DEH Coastal Protection Branch; Planning SA; Councils)

Recommendation 8

There is a need for a Southern Fleurieu Coastal Reference Group to pick up the data review presented in this project and drive the actions through the Council and NRM processes. This could be done by a newly constituted group, or a modified version of one of the current existing groups, or the previous Southern Fleurieu Reference Group. It is likely that this Reference Group would need a project officer to foster community/Council/ NRM partnerships for local action.

(Action: Councils, NRM)

Recommendation 9

Interviews with key players from community groups working on the Southern Fleurieu Coast yielded one common recommendation for action: the need to raise community awareness of coastal issues and natural systems. This concern was linked in these interviews to the recent rapid growth in numbers of new residents and in numbers of holiday makers.

There are many opportunities in such a strategy. An important one would be to further develop programmes in existing facilities at Victor Harbor (Victor Harbor High School Marine Interpretation; Whale Information Centre), Normanville (Catchment Centre), Penguin Information Centre at Granite Island, Port Elliot (Bashams Trust facilities), or to develop an interpretation centre based on Rapid Bay Primary School.

A coastal reference group will need to address this as an important regional task. Their natural allies in this would be the managers of the proposed Encounter Marine Park and the Coastal and Marine Advisory Committee of the Adelaide and Mount Lofty NRM Region, together with the Communications Strategy team of that NRM Board.

(Action: Councils, NRM)

Comment
Attached with the report are digital maps, which provide information on a variety of conservation and threat themes. Major databases and a variety of supporting documents are included in appendices.

Improving Integration

In all states of Australia coastal management is carried out by a multiplicity of state agencies and coastal councils (see Appendix 13), working with a variety of community groups, and all within a changing framework of Commonwealth grant priorities. The difficulties of integrating and implementing meaningful strategies and actions within this complex array of agencies and regulations have led many to frustration. In 1993 the Resource Assessment Commission noted that this situation had been the subject of several dozen reviews, leading to 'Paralysis by Analysis'. The complexities of the situation have been described by several authors; recently by Harvey & Caton, 2003, who noted the problems of lack of Commonwealth development or commitment to a coastal policy at the national level.

Most states have now attempted to address the issue of multiple agency involvement through whole of government coastal policy development: Tasmania, New South Wales, Victoria, Queensland and West Australia all have structures in place to address the issue of integration. In South Australia the development of whole of government coastal policy has not been seen as of sufficient priority to merit action in this area, and integration has been addressed in a more piecemeal fashion. The Coast Protection Board has attempted to clarify its role through the development of its own policy (2002) for action within the scope of the Coast Protection Act 1972. However, the situation has changed since the promulgation of the 1972 Act and revision is long overdue, a process which appears to be moving within a glacial timescale.

Thus a regional coastal project, such as the Fleurieu Coastal Action Plan, is attempting to work within a complex framework that has been built from the history of state law and agency development over the last 30 years. Knowledge of how to work within this system in part relies on understanding of the roles and responsibilities of various players. A contribution to this is offered in Appendix 13.

In addition to this the Fleurieu Coastal project itself may also be a contribution. Integration, or working together effectively, can only proceed on the basis of trust and good communication. This project has proceeded to date (1/2007) through communication and cooperation between the Yankalilla, Victor Harbor and Alexandrina councils, SA Department for Environment and Heritage, AMLR NRM Board, and the Goolwa to Wellington LAP. The cooperation has been at the officer level, but significant institutional sharing of data and resources has occurred to date. The writer suggests this is a form of integration, making a contribution at the regional level, because at this scale many people could appreciate that action is needed.

1 INTRODUCTION

1.1 Purpose of the Study

The goal of this study is to understand and facilitate the conservation, protection and maintenance of the Southern Fleurieu natural coastal resources, and to establish conservation priorities for places and areas within the region. The report also outlines suggested actions to address threatening processes at specific locations within the region. The study updates and extends the *Southern Fleurieu Coastal Action Plan 1997* by Caton Environmental Planning.

1.2 Definition of the Southern Fleurieu Coast

The Southern Fleurieu coast extends from Cactus Canyon Sellicks Beach on the eastern side of the Gulf St Vincent to the southern coast of Hindmarsh Island opposite the Murray Mouth. It includes the entire Peninsula, and the nearshore islands, a coastline of approximately 170 km, or one-twentieth in length of the coastline of the state.

Figure 1. The extent of the Southern Fleurieu Coast

The map above shows that the coastal region of the Southern Fleurieu comprises the sea coast of Alexandrina, Victor Harbor and Yankalilla councils and falls within the regions of both the Adelaide and Mount Lofty Ranges and the South Australian Murray Darling NRM Board regions.

The coast is defined for this study to include land above mean high water mark that, because of its vegetation, its landforms or because of its interaction with coastal processes can be described as coastal in nature. Elsewhere the boundary has been taken as 500m from low water springs. Thus, at Newland Head, west of Victor Harbor, the coastal zone encloses sand dune vegetation over 2 kilometres wide, while running north-east towards Victor Harbor where the 500m boundary applies.

Figure 2. An example of the definition of the coastal boundary in this study

The Southern Fleurieu coastal region comprises a variety of coastal environments, including: high to medium energy cliffed coast from Sellicks Beach to the Bluff, (this section includes two large beaches at Normanville and Tunkalilla); the urbanised south coast plain, with beaches and headlands, from Victor Harbor to Goolwa; and the Murray Mouth estuary and the Sir Richard Peninsula.

1.3 Definition of Coastal Cells

Twenty seven coastal cells have been defined for the region on the basis of physical parameters: landform, coastal wind and wave energy levels, shown in Appendix 17 (Combined Fleurieu reference maps). These cells are used in the report for mapping significant areas, i.e. as the geographical units for which conservation priority, threats and actions are to be established. The cells are numbered F1 at Hindmarsh Island, along the coast to F27 at Myponga.

The cells define relatively small sub-regional scale landform units along the coast: thus a bay between headlands, a sand dune mass, or an area of low cliffs of common orientation may be coastal cells. On Figure 2 above, cell 15 is defined, and part of cells 14 and 16.

The size of individual cells varies, but the average length of coastline of a cell is approximately 6 kilometres. The cells provide units of workable scale in terms of bringing together a large amount of data for an area small enough to discuss local management issues.

1.3.1 Action Summary Table

CELL	PROPOSED ACTION	PRIORITY	KEY PLAYERS	AMLR FINANCIAL PLAN MANAGEMENT ACTION TARGET: M.A.T. NUMBER
F1. Hindmarsh Island Intertidal samphire flats	F1.1 Detailed high resolution mapping of topography of low lying land.	High (Cons / Threat)	Commonwealth Natural Disasters Mitigation Program, SA DEH.	MAT 6.2.9
	F1.2 (Sea level rise) Review of buffer zone provisions to allow for species migration within the Development Plan. Also review of flood hazard issues for shacks.	High (Cons / Threat)	Council DEH, Landcare volunteers.	MAT 6.2.9 MAT 8.3.9
F1. Marshy swales	F1.3 Continue priority support for on-going restoration program of wetlands.	High (Cons / Threat)	Council NRM, Landcare, DEH.	MAT 8.3.5
	F1.4 Review of agreements on positioning of fences around wetlands.	High (Cons / Threat)	PIRSA, Landcare, Council.	MAT 8.3.5
	F1.5 Explore opportunities to establish vegetation corridors linking remnant vegetation blocks.	Medium (Cons)	NRM, Landcare.	MAT 8.3.9
F1. Whole cell	F1.6 Targeted control of priority weed species. Pursue educational opportunities to reduce incidences of the use of invasive garden species.	Medium (Threat)	NRM, Council, Landcare volunteers.	MAT 8.6.1
	F1.7 Agency enforcement with regard to jetties and land reclamation.	Medium (Soc / Econ)	DEH, Council.	
F2. Sir Richard Peninsula Nearshore waters	F2.1 Record incidents of water quality affecting users of nearshore waters.	Low (Hazard)	SLSC, Council.	MAT 6.2.2
F2. Beach	F2.2 Record incidents relating to conflict of beach use and vehicles.	Low (Hazard)	SLSC, Sir Richard Peninsula Ctte. Council	
	F2.3 Signage to keep vehicles below spring tide mark OR F2.4 Consider a ban on vehicles on the beach (note: the Hooded Plover is EPBC listed)	High (Cons / Threat)	Sir Richard Peninsula Cttee Council	MAT 8.3.6 MAT 8.5.5
	F2.5 Review the practice of informal camping near the Murray Mouth.	Medium (Threat)	Sir Richard Peninsula Cttee Council	
	F2.6 Continuation of monitoring of nearshore and beach sand levels through the Coast Protection Board beach profiles.	Low (Hazard)	Coast Protection Board. Council	
F2. Dune	F2.7 Restore fence at foredune. Monitor incursions into the foredune. Explore options for restoration of the dune, (cut brush; jute matting; re-vegetation).	High (Cons / Threat)	Sir Richard Committee, NRM.	MAT 8.3.8 MAT 8.3.5
	F2.8 Monitor and manage foot traffic.	Medium (Threat)	Sir Richard Committee, NRM.	MAT 8.3.5
	F2.9 Targeted control of weed species. Pursue educational opportunities to reduce incidences of the use of invasive garden species.	Medium (Threat)	Sir Richard Committee, NRM.	MAT 8.6.1 MAT 8.6.3
F2. Estuarine shore	F2.10 Local input as necessary to the current management process.	Medium (Cons)	Community groups, Council.	MAT 8.5.7
	F2.11 Detailed high resolution mapping of topography to define potential sea level rise hazard.	Low (Hazard)	Commonwealth Natural Disasters Mitigation Program, SA DEH	MAT 6.2.9

F2. Whole cell	F2.12 Review the inclusion of the whole peninsula in Coorong CP and Ramsar site.	High (Cons / Threat)	SA DEH – NPWS, Commonwealth DEH, NRM.	MAT 8.1.3 MAT 8.1.9
F3. Goolwa Beach	F3.1 Interpretive sign on nesting Hooded Plovers and dogs. Fencing of nests.	High (Cons / Threat)	DEH HP Recovery Project, Council.	MAT 8.3.6 MAT 8.5.5
	F3.2 Review the need to allow 4WD beach access.	Medium (Threat)	Council.	
F3. Dune	F3.3 Explore opportunities to better manage foot traffic impacts in dunes and rehabilitate damaged areas as required.	Medium (Threat)	Council, Community Goolwa -> W, LAP.	MAT 8.1.14
	F3.4 Pursue opportunities for community education to reduce the impacts on the Beach Road dunes.	Medium (Threat)	Council, Community, Goolwa-> W, LAP.	MAT 8.1.13
	F3.5 Targeted control of weed species. Pursue educational opportunities to reduce incidences of the use of invasive garden species.	Medium (Threat)	Council, Community, Goolwa-> W, LAP.	MAT 8.6.3
	F3.6 Continuation of monitoring of nearshore and beach sand levels through the Coast Protection Board beach profile established at Beach Road.	Low (Hazard)	Coast Protection Board, Council.	
F4. Tokuremoar Whole cell	F4.1 Review of the conservation status of the reserve by DEH Land Administration Branch, Coast Protection and NPWS, NRM, in light of conservation values and increasing threats.	High (Cons / Threat)	DEH, SA Dept of Aboriginal Affairs and Reconciliation, NRM.	MAT 8.1.3
F4. Whole cell	F4.2 Review and updating of the management plan by a group including NRM, CP Branch, local residents and Aboriginal people.	High (Cons / Threat)	Local LAP, Council, CP Branch DEH, NRM Board, Ngarrindjeri people.	MAT 8.1.9 MAT 8.3.10 MAT 8.5.5
	F.4.3 Review of Development plan zoning of coastal dunes.	Medium (Threat)	Council.	
	F4.4 Development of strategy to manage indigenous fauna habitat.	High (Cons / Threat)	Local LAP, NRM, Volunteers.	MAT 8.3.5
	F4.5 Targeted control of weed species. Pursue educational opportunities to reduce incidences of the use of invasive garden species. Immediate review of access control issues.	High (Cons / Threat)	Local LAP, NRM, Volunteers.	MAT 8.6.3
F4. Melaleuca swamp	F4.6 Review opportunities to establish a monitoring regime of flooding regime, groundwater levels and groundwater quality.	Medium (Threat)	NRM, Community volunteers.	MAT 6.2.9, 8.1.11
F4. Beach and dune	F4.7 Notices to inform dog owners about nesting seasons and Hooded Plover; erection of warning fences at nests.	High (Cons / Threat)	Volunteers, Council.	MAT 8.3.6 MAT 8.5.5
F5. Surfers Beach	F5.1 Notices informing public on plovers and requesting restraint on dogs in spring and summer.	High (Cons / Threat)	Council.	MAT 8.3.6. MAT 8.5.5.
F5. Cliff top reserves	F5.2 Weed control and re-vegetation program. Signs to discourage garden waste dumping.	Medium (Threat)	Council and community partnership.	MAT 8.6.3
	F5.3 Warning signs of cliff instability.	High (Hazard)	Council.	
F5. Dunes at E. end of cell	F5.4 Signage and access control to reduce impact of foot traffic.	Medium (Threat)	Council and community partnership.	MAT 8.3.5

F5. Beach and dunes	F5.5 Development of educational materials for seasonal visitors / holiday homes.	Medium (Threat)	Council and community partnership.	MAT 8.1.13
	F5.6 Continued monitoring of sand levels through CPB profile.	Low (Hazard)	Coast Protection Board.	
F6. Middleton Middleton Creek riparian reserve	F6.1 Weed control and re-vegetation program within riparian reserve.	Medium (Threat)	Council and community partnership.	MAT 8.6.3
	F6.2 Signs to discourage garden waste dumping.	Medium (Threat)	Council and community partnership.	MAT 8.3.6
F6. Beach, dune and low bluff	F6.3 Continued monitoring of sand levels through CPB profile and cliff top pegs.	Medium (Threat)	Coast Protection Board.	
	F6.4 Ensure the buffer zone protection offered by coastal reserves is not encroached upon	High (Hazard)	Council.	
F6. Stormwater systems leading to creek and beach	F6.5 Review impact on foreshore and creek of current stormwater arrangements.	Medium (Threat)	Council.	MAT 6.2.4
F7. Bashams, Headlands	F7.1 Continue access control through plantings, utilising indigenous coastal plants, and signage.	Medium (Cons)	Council and Bashams Trust.	MAT 8.3.5
	F7.2 Respond to high numbers of weed species through increased effort	Medium (Threat)	Bashams Trust.	MAT 8.6.3
F7. Beach	F7.3 Support access control by signage	Medium (Threat)	Council, Bashams Trust.	MAT 8.3.5
	F7.4 Signage on Hooded Plover. Community monitoring in nesting season	High (Cons / Threat)	Bashams Trust, DEH HP Recovery Program.	MAT 8.5.5
	F7.5 Beach pole monitoring	Low (Hazard)	Coast Protection Board, Council, Bashams Trust.	
	F7.6 Continuation of monitoring at CPB profile	Low (Hazard)	Coast Protection Board.	
F7. Dunes	F7.7 Respond to high numbers of weed species through increased effort, targeting red alert species.	Medium (Threat)	Bashams Trust.	MAT 8.6.3
	F7.8 Use of wind drift fencing, where appropriate	Medium (Threat)	Bashams Trust.	
	F7.9 Support access control by signage	Medium (Threat)	Council. Bashams Trust.	
	F7.10 Revise zoning to include dunes in coastal zone	Low (Cons)	Council. State Planning, DEH (CPB)	MAT 8.3.5
F7. Coastal Slopes	F7.11 Continue effort to implement Bashams Park plan	Medium (Cons)	Bashams Trust.	MAT 8.3.8
	F7.12 Management of use of park by clubs, including appropriate information giving	Medium (Soc / Econ)	Council, Bashams Trust.	
F7. Whole cell	F7.13 Amphitheatre, caravan park, former dairy farm buildings (needing further improvement) provide the basis of the physical infrastructure) for an interpretation/ education centre within Bashams Park	Medium (KP region)	Council, Bashams Trust, State Agencies.	MAT 8.1.13
F8. Horseshoe Bay. Reserves behind beach	F8.1 Minimise increase in structures which reduce future flexibility through development plan provisions.	Low (Hazard)	Council.	
F8. Beach & dune	F8.2 Minimise/ or seek alternatives to hard structures at rear of beach.	High (Soc / Econ)	Council.	
	F8.3 Use of sand drift fences. Access control.	Medium (Threat)	Council & Community	
	F8.4 Continue beach profile monitoring.	Low (Hazard)	Coast Protection Board,	

F8. Pullen Island	F8.5 Monitoring of bird populations.	Low (Cons)	NPW.	MAT 8.1.12
F9. Knights Beach	F9.1 Continuation of community beach pole monitoring.	Medium (Soc / Econ)	Community, CPB	
F9. Dunes	F9.2 Target residences with educational materials with regard to weed dumping.	High (Soc / Econ)	Coastcare group and Council.	MAT 8.6.3
	F9.3 Implementation of management plan by Taylor (2003).	High (Soc / Econ)	Council and Coastcare group.	MAT 8.3.8
	F9.4 Improvement of signage at path entrances and by railway reserve. Strategic use of sand drift fencing.	High (Soc / Econ)	Council and Coastcare group.	MAT 8.3.5
	F9.5 Adequate access infrastructure, signage.	High (Soc / Econ)	Council and Coastcare group.	MAT 8.3.8
F9. Bluff	F9.6 Erosion control at outlets. Review of stormwater catchments, to slow peak runoff.	Medium (Threat)	Council.	MAT 6.2.4
F10. Watson's Gap to Hindmarsh River Dunes	F10.1 Target residences with educational materials, with regard to weeds.	High (Soc / Econ)	Coastcare group and Council.	MAT 8.6.3
	F10.2 Implementation of management plan by Taylor (2003).	High (Soc / Econ)	Council and Coastcare group.	MAT 8.3.8
	F10.3 Improvement of signage at path entrances and by railway reserve. Strategic use of sand drift fencing	High (Soc / Econ)	Council and Coastcare group.	MAT 8.3.5
F10. Stormwater outlets	F10.4 Erosion control at outlets. Review of stormwater catchments, to slow peak runoff.	Medium (Threat)	Council.	MAT 6.2.4
F10. Watson's Gap	F10.5 Revise zoning provisions to reflect appropriate hazard standards.	Low (Hazard)	Council.	
F11. Hindmarsh R. to Inman R. Granite Island	F.11.1 Continue implementation of Granite Island Recreation Park Vegetation Management Plan 2004-2008.	Medium (KP cell; Cons)	Friends of Granite Island.	MAT 8.3.8
	F11.2 Support research to clarify causes of population decline. As an interim measure, fence the causeway against foxes, dogs and cats. Implement a rat control program.	High (Soc / Econ)	Friends, NPWS, Council.	MAT 8.1.12 MAT 8.3.2
F11. Beaches and Dunes	F11.3 Support Council and Coastcare campaigns to eradicate red alert weeds. Review access control.	Medium (Threat)	Coastcare, Council, NRM.	MAT 8.6.3.
	F11.4 Continue beach pole observations. Analyse and report back on existing record as a matter of urgency. Complete engineering study.	High (Hazard)	Coastcare, CPB, Council.	
	F11.5 Maintain and analyse profile records. Initiate photopoint monitoring of beaches. Ensure the strongest possible protection within the development plan for coastal reserves (recreation now, buffer zones in the future). Where possible, seek to extend coastal reserves.	Low (Hazard)	CPB, Council.	
	F11.6 Detailed high resolution mapping of topography.	Low (Hazard)	DEH, Commonwealth Natural Disasters Mitigation Program.	
	F11.7 Community monitoring of Hooded Plover nesting sites on beach and dunes.	High (Cons / Threat)	Community, Council.	MAT 8.5.5

F11. Hindmarsh River Estuary banks and floodplain	F11.8 Significance of small areas of native vegetation within the river floodplain needs recognition through proactive management: assess opportunities to establish buffers; signage.	High (Cons / Threat)	Council and Community groups	MAT 8.3.5
	F11. 9 Develop an estuary entrance management support system (1), to investigate other options and reasons for making opening / closing decisions.	Medium (Cons / Soc / Econ)	Council.	MAT 8.3.1
F11. Coastal reserves	F11.10 Maintain reserves as buffer areas (see beaches and dunes above).	Low (Hazard)	Council.	
F12. Inman R. to The Bluff. Reefs	F12.1 Development of interpretive signage relating to biota of platform reef. Development of educational materials in conjunction with Victor Harbor High School.	High (Cons / Threat)	DEH (Marine Conservation) Victor Harbor High School Council.	MAT 8.3.2 MAT 8.2.9
	F12.2 Support setting up of community Reefwatch intertidal monitoring group (data collection, kits, methodology).	High (Cons / Threat)	Reefwatch, Flinders University, NRM.	MAT 8.2.9
F12. Lower Inman floodplain	F12.3 Continue re-vegetation program of the Lower Inman floodplain, and habitat management to improve vegetation patch connectivity.	High (Cons / Threat)	Council & community.	MAT 8.3.1 MAT 8.3.8
F12. Dunes near Kent Reserve	F12.4 Continued weed control and access management within the dune area adjacent Kent Reserve. Pursue opportunities for signage.	Medium (Cons)	Council & community.	MAT 8.6.3
F12. Estuary Entrance	F12.5 Develop an estuary entrance management support system for the Inman, (1), to investigate other options and reasons for making opening / closing decisions.	Medium (Cons)	Council.	MAT 8.3.1
F13. The Bluff Walking track and carparks	F13.1 Maintenance and improvement of car park and walking track and interpretation.	High (Soc / Econ)	Council.	MAT 8.3.5
F13. Whole cell	F13.2 Continuation of Bluff Re-vegetation Plan.	High (Cons / threat)	Council & Community.	MAT 8.3.5
	F13.3 Continuation of Bluff Re-vegetation Plan. Target priority weeds.	High (Cons / Threat	Council & Community.	MAT 8.3.5
F14. The Bluff to Newland Head Cell outside Conservation Park	F14.1 Assign high priority to the continuation of work to conserve this area.	High (Cons / Threat)	NRM.	MAT 8.3.5
	F14.2 Explore opportunities to link remnant vegetation blocks; improving connectivity and long term resilience.	Medium (Cons)	DEH, NRM.	MAT 8.1.4
	F14.3 Explore opportunities to buffer remnancy values, through land acquisition or land management agreements.	Medium (Cons)	DEH, NRM.	MAT 8.1.4
	F14.4 Explore possibility of further extending the park, to include the whole of this cell.	Medium (Cons)	DEH, NRM.	MAT 8.1.3
	F14.5 Explore options for protection based on landscape values; cp. Adelaide Hills Face Zone legislation.	Medium (Cons)	Planning SA. Tourism SA.	MAT 8.1.3
F14. Whole cell	F14.6 Continue detailed work to promote indigenous species through erosion control, weed control and planting. Continue and extend targeted weed control strategies aimed at 'red alert' weeds.	High (Cons / Threat)	NRM, Friends and Coastcare groups.	MAT 8.6.3

F15.	This cell is a conservation park. The actions relating to this park can be viewed in the management plan available at www.environment.gov.au DEH is the key stakeholder. Key actions include conserving the parks' biodiversity, creating buffer zones and linking remnant vegetation adjoining these parks.			
F16. Parsons Beach to Tunkalilla Head. Whole cell	F16.1 Improve signage and upgrade the Heysen Trail where possible, (whole cell).	Medium (Soc / Econ)	DEH, Natural & Cultural Heritage.	
F16. Cliffs and lower slopes of valleys	F 16.2 For cliffs and lower valley slopes undergoing accelerated erosion, negotiate improved land management practices with landholders.	Medium (Threat)	NRM, Landowners	MAT 6.1.6
	F16.3 Fence estuaries and riparian land against stock.	Medium (Threat)	NRM, Landowners.	MAT 6.1.6
F17. Tunkalilla Head to Deep Creek. Beaches and dunes	F17.1 Fencing to exclude stock from the beach and dune.	Medium (Threat)	Landowners, NRM.	MAT 6.1.6
	F17.2 Weed eradication and re-vegetation program for the dunes.	Medium (Threat)	Landowners, NRM.	MAT 8.6.3
	F17.3 Signage of Heysen Trail entrance and exit to Tunkalilla Beach.	Medium (Soc / Econ)	DEH, Natural & Cultural Heritage.	
	F17.4 Community monitoring of Hooded Plover nesting sites on beach and dunes. Interpretive signage at Heysen Trail entrances to beach.	High (Cons / Threat)	Community, NRM.	MAT 8.5.5
F17. Coastal slopes	F17.5 Where coastal slopes show accelerated erosion, negotiate improved land management practices with landholders.	Medium (Threat)	Landowners, NRM.	MAT 6.1.6
F18.	This cell is a conservation park. The actions relating to this park can be viewed in the management plan available at www.environment.gov.au DEH is the key stakeholder. Key actions include conserving the parks' biodiversity, creating buffer zones and linking remnant vegetation adjoining these parks.			
F19. Fishery Beach to Cape Jervis. Coastal slopes within reserves, Crown and CPB land Council land and adjacent to carpark	F19.1 Maintenance of access control at Fishery Beach carpark.	High (Cons / Threat)	Council, CPB.	MAT 8.4.6
	F19.2 Rehabilitation of tracks and planting within Crown coastal reserves.	High (Cons / Threat)	CPB.	MAT 8.6.3
	F19.3 Ensure high level of track maintenance and marking.	High (Cons / Threat)	CPB.	
	F19.4 Weed control, to prevent spread.	Medium (Threat)	Council.	MAT 8.6.3
F19. Riparian slopes, adjacent to Fishery Creek	F19.5 Extension of riparian planting and fencing program adjacent to Fishery Creek.	High (Cons / Threat)	Cape Jervis Landcare.	MAT 6.1.8
	F19.6 Rehabilitation of damaged slopes adjacent lower Fishery Creek.	Medium (Threat)	NRM.	MAT 8.1.6
F19. Whole cell	F19.7 Develop a strategy to acquire land and land management agreements to improve connectivity between remnant vegetation blocks.	High (Cons / Threat)	DEH, Council, Community.	MAT 8.1.4

F20. Cape Jervis to Rapid Head Morgans Beach and dune	F20.1 Exclude 4WD access to steep coastal bluff and dune at Morgans Beach.	High (Cons / Threat)	DEH Coast Protection, Council, Aboriginal Partnership – Dept Premier & Cabinet, Aboriginal Heritage.	MAT 10.1.1
	F20.2 Reconfigure car parking at Morgans Beach to reduce vehicle access to beach and shore platform.	High (Cons / Threat)		MAT 10.1.1
	F20.3 Access control from carparks at Morgans Beach.	High (Cons / Threat)	Council, CP Board.	MAT 8.3.5
	F20.4 Interpretive signage re. vegetation at carpark.	Medium (Cons)	DEH, Land Administration Br.,	MAT 8.3.5
			NRM, Cape Jervis volunteers.	
F20. Shore platform: Morgans to Cape Jervis	F20.5 Erect interpretive signs re Geological Monument at both ends of the shore platform between morgans and Cape Jervis.	Medium (Cons)	Council, Geological Society of Aust., SA Branch.	MAT 10.2.1
	F20.6 Negotiate with ferry operators and users to prevent further dumping to extend lorry parking.	High (Cons / Threat	DEH Coast Prot., EPA, Council, Australian Maritime Authority.	
F20. Coastal slopes	F20.7 Exclusion of ORV by fencing coastal slopes.	High (Cons / Threat)	Council, NRM, Coastal Protection Board.	MAT 8.3.5
	F20.8 Runoff diversion from paths and tracks to reduce rill and gully development on coastal slopes.	High (Cons / Threat)	Council, NRM, Coastal Protection Board	MAT 6.1.6
F20. Coastal Crown land NE of Morgans Beach	F20.9 Development of regional coastal trail.	Medium (Soc / Econ)	NPW Visitor Management Services	
F21. Rapid Bay Cliffs	F21.1 It is proposed that DEH champion a 'Coastlinks' project along this coast, aiming to link remnant vegetation patches in coastal reserves and adjacent lands.	High (Cons / Threat)	DEH, AML NRM Board.	MAT 8.3.1
	F21.2 Establishment of a coastal footpath.	Medium (Soc / Econ)	NPWS Visitor Management Services.	
F21. Beach and gravel backshore	F21.3 Extend current work to plant the gravel backshore.	Medium (Cons)	Rapid Bay Primary School Council.	MAT 8.3.5
F21. Nearshore dive sites	F21.4 Project support for upgraded facilities for scuba divers in the context of planning the jetty and the approaches construction.	Medium (Cons)	DTEI, Council.	
F21. Rapid Bay settlement	F21.5 Planning and development of an interpretation centre based on Rapid Bay Primary School or adjacent site.	High (Soc / Econ)	DEH (Marine Conservation, Coast Protection), Rapid Bay Primary School, Council.	MAT 8.1.13
F22. Second Valley & Wirrina Cliff tops	F22.1 Review of Development Plan protection of cliff top land.	High (Soc / Econ)	Council.	MAT 10.3.8
	F22.2 Development of a program of acquisition of coastal land to link coastal reserves.	High (Cons / Threat)	DEH (Naturelinks Group), NRM.	MAT 8.3.1
	F22.3 Fencing of remnants on Crown land. Consideration of other remnants for landowner Heritage Agreement as above.	High (Cons / Threat)	DEH, NRM.	MAT 8.35
	F22.4 Development of regional coastal trail.	Medium (Soc / Econ)	NPW Visitor Management Services.	

F22. Foreshore	F22.5 Erection of interpretive signs at access points to geological monuments at Second Valley and Wirrina.	Medium (Cons)	Geological Society of Australia – S.A. Branch	MAT 10.2.1
	F22.6 Interpretation of HMAS Hobart and offshore shipwrecks placed at the Wirrina boat ramp.	Medium (Cons / Soc / Econ)	DEH, Marine Heritage. Council	MAT 10.2.1
	F22.7 Redevelop site, to cater for day visitors.	Medium (Soc / Econ)	Council	
F22. Parananacooka River estuary	F22.8 Continued fencing and revegetation of riparian land at the Parananacooka River estuary.	High (Cons / Threat)	Council, Landholders NRM	MAT 8.3.5.
F23. Lady Bay Whole cell	F23.1 Development of a strategy to involve and raise capacity within the community to conserve natural coastal heritage.	High (Cons / Threat)	NRM, Council, Community Groups	MAT 8.3.1
F23. Dunes north of Yankalilla River	F23.2 Implement existing weed strategy for the Normanville Dunes.	High (Cons / Threat)	NRM, Council, Community Groups	MAT 8.6.2, 8.6.3
	F23.3 Continued effort in dune re-vegetation. Resist further development incursions into dunes.	High (Cons / Threat)	Council Community, DEH (Land Administration Branch, Coast Protection).	
F23. Dunes south of Yankalilla River	F23.4 Review development plan provisions: consider change from 'Country Township', to 'Coastal Zone', in order to recognise coastal dunes and hazard potential; consider changing area immediately landward of the dunes from 'Tourist Accomodation' to recognise potential impact of uses in this area on the dunes.	Medium (Threat); Low (Hazard)	Council.	MAT 10.3.8
F23. Foreshore SW of Little Gorge	F23.5 Review the lease provisions of these shacks, with a view to their removal.	Low (Hazard)	Council.	
F23. Beach	F23.6 Community monitoring of Hooded Plover nests in season. Warning fencing at nests. Notices to dog owners and pedestrians.	High (Cons / Threat)	Community, Council, DEH.	MAT 8.5.5
	F23.7 Signs indicating access to beach at Lady Bay.	Low (Soc / Econ)	Council.	
F24. Bungala to Carrickalinga Creek Whole cell	F24.1 Development of a strategy to involve and raise capacity within the community to conserve natural coastal heritage.	Medium KP (Cons)	NRM, Councils.	MAT 8.3.1
F24. Beach	F24.2 Community monitoring of Hooded Plover nests on beach and foredunes in spring and summer. Temporary fencing of nests. Interpretation of dangers to birds and request for restraint to dogs by owners.	High (Cons / Threat)	Council, Community, DEH.	MAT 8.5.5
F24. Dune	F24.3 Continued effort in dune revegetation. Resist further development incursions into dunes.	High (Cons / Threat)	Council Community, DEH (Land Administration Branch, Coast Protection).	MAT 8.3.5
	F24.4 Improve access control through fencing, notices and upgrading existing paths.	High (Cons / Threat)	NRM, Council Community.	MAT 8.3.5
	F24.5 Implement existing weed plan for the dunes.	Medium (Threat)	NRM, Council, Community.	MAT 8.6.3
	F24.6 Maintain Council effort to inform public of the ban on sandboarding.	Medium (Threat)	Council.	MAT 8.3.5
	F24.7 Vegetation rehabilitation to enhance butterfly larvae habitat within the dunes.	Medium (Cons)	NRM, Council Community.	

F24. Bungala River estuary	F24.8 Catchment management to reduce sediment and nutrient load to Bungala estuary.	Medium (Threat)	Landcare, NRM, Marine Park.	MAT 6.1.6
	F24.9 Investigation of surface debris in Lower Bungala, with a view to use of gross pollutant traps.	Medium (Threat)	Council.	MAT 8.2.7
	F24.10 Develop an estuary entrance management support system (1), to investigate other options and reasons for making opening / closing decisions.	Low (Cons)	Council.	MAT 8.2.7
	F24.11 Investigation of options to improve the Bungala floodplain above the caravan park.	Low (Soc / Econ)	Council.	MAT 8.2.8
F25. Carrickalinga Beach	F25.1 Community monitoring of Hooded Plover nesting on beach and dune. Temporary fencing of nests. Notices alerting public to the presence of this species and requesting owner control of dogs.	High (Cons / Threat)	Council, DEH, Community.	MAT 8.5.5
F25. Dune	F25.2 Access control to dunes, through fencing, notices and paths.	Medium (Threat)	Council, Community.	MAT 8.3.5
	F25.3 Weed control and re-planting.	Medium (Threat)	Council Community.	MAT 8.6.3
	F25.4 Continue and maintain notices proclaiming Council ban on sandboarding.	Medium (Threat)	Council.	
	F25.5 Improvements in the stormwater system to reduce gross pollutants and erosive impact of stormwater discharge into the dunes.	Medium (Threat)	Council.	MAT 6.1.5
F25. Carrickalinga Creek estuary	F25.6 Catchment management to reduce sediment and nutrient load to Carrickalinga Estuary. Further implementation of wetland management plan.	Medium (Threat)	NRM, Community, Council.	MAT 6.1.6 MAT 8.2.7
	F25.7 Develop an estuary entrance management support system (1), to investigate other options and reasons for making opening / closing decisions.	Medium (Threat)	Council.	MAT 8.2.7
	F25.8 Give local priority to efforts to improve and conserve high conservation values of the estuarine flats. Further implementation of wetland management plans.	High(Cons / Threat)	Council, Community.	MAT 8.3.5
	F25.9 Review wetland feasibility study in the light of the IPCC projections for sea level rise.	Low (Hazard)	Council.	
F26. Carrickalinga to Myponga Head Cliff tops	F26.1 Review of Development Plan protection of cliff top land.	Medium (Threat)	Council.	MAT 10.3.8
	F26.2 Development of a program of acquisition of coastal land to link isolated vegetation remnants. Take opportunities to link to inland vegetation.	High (Cons / Threat)	DEH (Naturelinks Group), NRM.	MAT 8.3.1
	F26.3 Fencing of remnants on clifftop Crown land. Consideration of other remnants for landowner Heritage Agreement.	High (Cons / Threat)	DEH, NRM.	MAT 8.3.5
	F26.4 Development of regional coastal trail.	Medium (KP)	DEH, Natural & Cultural Heritage.	
F26. Foreshore	F26.5 Erection of interpretive signs at access points to geological monuments at Carrickalinga Head.	Medium (Cons)	Geological Society of Australia – South Australian Branch	MAT 10.2.1

F27. Myponga Head to Sellicks Cliffs	F27.1 Stock exclusion, through fencing of coastal reserves along cliffs.	Medium (Threat)	NRM	MAT 8.3.5
	F27.2 Review of opportunities to link remnant vegetation patches along cliff top. Review opportunities to create vegetation corridors to link coastal remnants with inland vegetation.	High (Cons / Threat)	NRM, DEH Naturelinks Group.	MAT 8.3.1
F27. Estuary	F27.3 Construction and implementation of an estuary and estuary flats management plan, in order to address the complex issues involved in estuarine improvement.	High (Cons / Threat)	DEH, District Council of Yankalilla, Local landowners.	MAT 8.2.7
F27. Beach and Dune	F27.4 Weed control and revegetation of dune areas.	Medium (Threat)	Yankalilla & Myponga Dunecare.	MAT 8.6.3
	F27.5 Retention of sand through sand drift fencing.	Medium (Threat)	DEH, local dunecare.	
	F27.6 Beach pole monitoring of beach sand levels.	Medium (Threat)	DEH, local dunecare.	
F27. Reefs	F27. 7 Erection of warning sign explaining that harvesting from the shore platform is a prohibited action. Interpretation of inter tidal fauna.	Medium (Cons)	PIRSA, DEH.	MAT 8.3.5

Themes and Databases

Melaleuca halmaturorum
Photographed by Ron Sandercock

Yankalilla River Estuary
Photograhed by Mary Crawford

Melaleuca halmaturorum
Photographed by Ron Sandercock

2 DESCRIPTION OF THEMES AND DATABASES

Representation of themes and databases

[This section draws heavily on 'Description of themes and databases' by Nerissa Haby, in Caton et al 2006, and the careful records of the processes used, kept by Matthew Royal]

A variety of data was used to describe conservation values and threats in the Southern Fleurieu coastal region. 41 datasets were assembled, and these are listed below.

Conservation Layers

1. Communities & Species with Threatened Status

   1A. Priority of vegetation species based on the status of the community (threatened status) (Coastal Dune and Clifftop)
   1B. Priority of vegetation assemblage based on the rarity of the community in SA (those with <20 records within SA) (Coastal Dune and Clifftop – Species & Floristic).
   1C. Priority of sites with threatened flora (threatened status).
   1D. Priority of sites with threatened fauna (threatened status).
   1E. Priority of sites based on total number of threatened species (total number of threatened species).

2. Endemic Species and Communities; Biodiversity

   2A. Priority of vegetation assemblage based on the distribution of endemic plant communities (>50 % of records within the Southern Fleurieu) Coastal Dune and Clifftop –Species & Floristic.
   2B. Priority of vegetation assemblage based on the distribution of endemic habitat (>50 % of habitat within the Southern Fleurieu) Saltmarsh.
   2C. Priority of vegetation assemblage based on the proportion present within coastal units (Floristic Vegetation).
   2D. Priority of sites based on species richness (total number of species).

3. Significant Bird Habitat on the Fleurieu Peninsula

   3A. Priority of sites based on the threatened status of the significant birds in Southern Fleurieu region.

4. Significant Reptiles and Amphibian Habitats in Southern Fleurieu

   4A. Priority of vegetation assemblage as habitat for reptiles and amphibians (Conservation Status).
   4B. Priority of vegetation assemblage as habitat for reptiles and amphibians (Regional Abundance).
   4C. Priority of vegetation assemblage as habitat for reptiles and amphibians (Regional Coastal Distribution).
   4D. Priority of vegetation assemblage as habitat for reptiles and amphibians (Coastal Dependency).

5. Significant Butterfly Habitats in Southern Fleurieu

   5A. Priority of vegetation assemblage as habitat for butterflies.

6. Focal Species within the Southern Fleurieu

   6A. Priority of location (vegetation remnant / coastal unit) based on the distribution of the Hooded Plover (Focal Species).

7. Vegetation Patch Metrics

   7A. Priority of remnant vegetation based on patch size.
   7B. Priority of vegetation assemblage based on connectivity (minimum distance to nearest patch).
   7C. Priority of vegetation assemblage based on the presence of remnant vegetation (<1ha).
   7D. Priority of vegetation assemblage based on patch Edge to Interior ratio.

8. Heritage

   8A. Aboriginal sites.
   8B. European Heritage sites.
   8C. Natural Heritage.
   8D. Geological Heritage 1 (Geological Monuments).
   8E. Geological Heritage 2 (Coast Protection Board Report).

Threatening Processes Layers

a) Acid Sulphate Soils (actual & probable from saltmarsh habitats)
b) Campsites: Formal & Informal
c) Development Zoning
d) Dumps & Wastewater Treatment Plants
e) Dune Stability
f) Cliff Stability
g) Land Ownership
h) Land Use
i) Mining Activities
j) Vegetation Isolation (lack of connectivity between vegetation patches)
k) Vegetation Degradation
l) Vegetation Shape (shapes allowing increased invasion)
m) Vegetation Patch Size (smaller patches allowing increased invasion)
n) Viewshed Analysis (increased threat due to sea views)
o) Viewscape Analysis (increasing threat due to aesthetics of the coastal zone)
p) Distribution of known environmental weeds

These datasets were selected from what was available at the time in state and museum databases. Although considerable processing of information was done, only two new sets of data were systematically collected: campsites and cliff stability. However, local expert knowledge was generously provided, and used to greatly improve the report.

Data was categorised into low to high importance and assigned scores 0 to 9: the way in which this categorisation was done is detailed for each dataset, and is set out below.

The analysis of the data using GIS software is described in 2.3; listing of ownership of datasets is in 1.1 and limitations of the data and the methodology are outlined in 2.5.

The South Australian Biological Survey provided the core data for the analysis. This data was collected systematically using a sampling system (Heard & Channon, 1997). Two assumptions were made to enhance the representation of data within the analysis:

a) Flora and fauna recorded at survey points were assumed to occur throughout the vegetation patch, unless there was evidence to the contrary. The Floristic Vegetation dataset derived from aerial photograph analysis, was frequently used to enhance the information available from the survey point data. See listing in 1.1.

b) Fauna recorded within the coastal boundary was assumed to be likely to be found in nearby suitable habitat, whether recorded by survey within the vegetation patch or not. This was particularly significant in the distribution of reptiles, 3.3.

2.1 Conservation Layers

2.1.1 Communities and Species with Threatened Status

1A. Priority of Vegetation Species based on the status of the community (Coastal Dune and Clifftop communities)

The floristic field survey of the South Australian Coastal Dune and Clifftop Survey, Opperman 1999, (CDCS below) provides the most extensive distribution of flora survey sites throughout the Fleurieu coastal zone. This survey applied a standard and systematic method (Heard & Channon, 1997), leading to the collection of consistent data that may be used, for instance, to assess the distribution of threatened, endemic and rare communities. Vegetation communities

identified as nationally, state or regionally threatened in the CDCS were rated (0 – 9), as below.

Prioritisation within theme:

1A.1. National Status (Appendix 10)

N:	U:	Q:	K:	R:	V:	E:
0	0	2	3	5	7	9

Where: N: Not significant, U: Uncommon, Q: Possible Significance, K: Possibly threatened, R: Rare, V: Vulnerable, E: Endangered

1A.2. SA Status (Appendix 10)

N:	U:	Q:	K:	R:	V:	E:
0	0	2	3	5	7	9

Where: N: Not significant, U: Uncommon, Q: Possible Significance, K: Possibly threatened, R: Rare, V: Vulnerable, E: Endangered

1A.3. Regional Status (Appendix 10)

N:	U:	Q:	K:	R:	V:	E:
0	0	2	3	5	7	9

Where: N: Not significant, U: Uncommon, Q: Possible Significance, K: Possibly threatened, R: Rare, V: Vulnerable, E: Endangered

1B. Priority of vegetation assemblage based on the rarity of the community within SA (those with <20 records within SA; Coastal Dune and Clifftop communities)

The CDCS was used to identify those communities considered rare within coastal South Australia, i.e. less than 20 records within the whole state.

Prioritisation within theme:

No Priority	16-20 records in SA	11-15 records in SA	6-10 records in SA	1-5 records in SA
0	6	7	8	9

1C. Priority of sites with threatened flora (threatened status)

This drew on existing databases containing the National, State and Regional status of species of flora. However, additional data was collated, which is included, such as species lists supplied by Ron Taylor. As a result some 180 species of nationally, state and regionally threatened species of flora were identified within the Southern Fleurieu coastal region.

Prioritisation within theme:

1C.1. National status (EPBC Act Status Code)

N:	U:	Q:	K:	T:	R:	V:	E:
0	0	2	3	5	5	7	9

Where: N: Not significant, U: Uncommon, Q: Possibly significant, K: Possibly threatened, T: Threatened, R: Rare, V: Vulnerable, E: Endangered

1C.2. SA status (NPWSA Act Status Code)

N:	U:	Q:	K:	T:	R:	V:	E:
0	0	2	3	5	5	7	9

Where: N: Not significant, U: Uncommon, Q: Possibly significant, K: Possibly threatened, T: Threatened, R: Rare, V: Vulnerable, E: Endangered

1C.3. Regional status (BSG Regional Rating & R. Taylor's Regional ratings for plants found on Fleurieu Peninsula.)

N:	U:	Q:	K:	T:	R:	V:	E:
0	0	2	3	5	5	7	9

Where: N: Not significant, U: Uncommon, Q: Possibly significant, K: Possibly threatened, T: Threatened, R: Rare, V: Vulnerable, E: Endangered

1D. Priority of sites with threatened fauna (threatened status)

This has been obtained from existing databases containing National, State and Local status of species of fauna, together with data added from expert contributions from R Grund, G Carpenter and A Milne. Values obtained from these ratings were combined to produce a single layer for analysis.

Prioritisation within theme:

1D.1 National Status (EPBC Act Status Code)

Item	Criterion	Category	
		Vulnerable	Endangered
1	It has undergone, is suspected to have undergone or is likely to undergo in the immediate future:	a substantial reduction in numbers	a severe reduction in numbers
2	Its geographic distribution is precarious for the survival of the species and is:	limited	restricted
3	The estimated total number of mature individuals is:	limited	low
and	(a) evidence suggests that the number will continue to decline at:	a substantial rate	a high rate
or	(b) the number is likely to continue to decline and its geographic distribution is:	precarious for its survival	precarious for its survival
4	The estimated total number of mature individuals is:	low	very low
5	The probability of its extinction in the wild is at least:	10% in the medium-term future	20% in the near future
	Priority	**5**	**9**

1D.2. SA status (Review of the Status of Threatened Species 2003)

N:	U:	Q:	K:	R:	V:	E:
0	0	2	3	5	7	9

Item	Criterion	Category		
		Rare (TSSA)	Vulnerable (IUCN)	Endangered (IUCN)
1	It has undergone a population reduction in the form of an observed, estimated, inferred or suspected reduction of at least:	>50% loss abundance and / or area occupied	20% over 10 years or 3 generations	50% over 10 years or 3 generations
2	Extent of occurrence estimated to be limited:	20 000 km^2 OR 2000 and highly fragmented	20 000 km^2	5000 km^2
and	Fragmented to a limited number of locations, continuing decline and extreme fluctuations		< 10 populations	< 5 populations
3	Population size estimated to be limited:	<3000 mature indiv.	< 10 000 mature indiv.	< 2500 mature indiv.
and	Continuing a rate of decline		>10% / 10 yrs or 3 generations	>20% / 5 yrs or 2 generations
4	Population estimated to be limited		< 1000 mature indiv.	250 mature indiv.
5	Quantitative analysis predicts extinction in the wild		>10% within 100 yrs	>20% within 20 years or 5 generations
	Priority	**1**	**5**	**9**

1D.3. Regional status (Birds – Graham Carpenter & BSG Regional Ratings for remaining fauna)

Category					
Common (C)/ Not Significant (N)	Uncommon (U)	Indeterminate (K)	Rare (R)/ Threatened (T)	Vulnerable (V)	Endangered (E)
Considered widespread throughout most of its known distribution and under no immediate threat.	Although not an IUCN category, the term uncommon has been introduced to indicate plants, animals or vegetation types that are inadequately conserved or declining but are not yet threatened.	Likely to be Rare or Vulnerable but current information on populations are grossly inadequate to provide a better estimate of its conservation significance.	Considered to be at risk due to the low numbers of individuals even though no or little decline has been detected.	Considered likely to become endangered in the immediate future given current trends in populations and reasons for decline.	Considered to be in danger of becoming extinct in the wild in the immediate future given current trends in populations and reasons for decline.
0	1	3	5	7	9

1E. Priority of sites based on total number of threatened species (total no. threatened species)

The total numbers of flora and fauna species were summarised for each remnant vegetation patch, using a combination of the data on which layers 1C and 1D are based.

Prioritisation within theme:

No Priority	13-37 threatened species of plant / animal	37-59 threatened species of plant / animal	59-92 threatened species of plant / animal	>92 threatened species of plant / animal
0	2	4	6	9

Where "threatened" incorporates both flora and fauna and up to 5 categories, K: Possibly threatened, T: Threatened, R: Rare, V: Vulnerable, E: Endangered, for each.

2.1.2 Endemic Species and Communities; Biodiversity

2A. Priority of vegetation assemblage based on the distribution of endemic plant communities (>50 % of records within Southern Fleurieu), Coastal Dune and Clifftop communities.

The statewide coverage of the CDCS survey was used to compare Southern Fleurieu with other coastal regions of South Australia: if more than 50% of records of a plant community were found within the Southern Fleurieu coastal boundary, it was rated, as in the table below. This rating thus reflected the degree of endemism to the coast of the Southern Fleurieu.

Prioritisation within theme:

No priority	50.1-60 % records in SA	60.1-70 % records in SA	70.1-80 % records in SA	80.1 + 100% records in SA
0	3	5	7	9

2B. Priority of vegetation assemblage based on the distribution of endemic Habitat (>50 % of habitat within Southern Fleurieu) (Saltmarsh communities)

Coastal saltmarsh and mangrove mapping undertaken systematically around the state by the Coast Protection Branch, Department for Environment and Heritage SA, provides an endemism rating for saltmarsh plants areas within the Southern Fleurieu coast. However, only 2.3% of the coastal area is saltmarsh, recorded entirely within cells 1 and 2, (near the Murray Mouth).

Prioritisation within theme:

No priority	50.1-60% records in SA	60.1-70% records in SA	70.1-80% records in SA	80.1 + % records in SA
0	6	7	8	9

2C. Priority of vegetation assemblage based on the proportion of vegetation within coastal cells/ SA (Floristic Vegetation)

This layer was based on data from the national inventory of vegetation associations: a further reflection of the degree of endemism of associations within the Southern Fleurieu coast.

Prioritisation within theme:

No priority	50.1-60% records in SA	60.1-70 % records in SA	70.1-80 % records in SA	80.1 + % records in SA
0	6	7	8	9

2D. Priority of sites based on species richness, total number of flora and fauna species

This layer is based on a total number of plant and animal species recorded within each vegetation patch (>1 ha.). This rating reflected something of the value of large vegetation remnants to conservation priority.

Prioritisation within theme:

No Priority	63-102 species per patch	102-137 species per patch	137-183 species per patch	183-247 species per patch	247-333 species per patch	333-384 species per patch	>384 species per patch
0	3	4	5	6	7	8	9

2.1.3 Significant Bird Habitats of the Fleurieu Peninsula

3A. Priority of sites based on the threatened status of the significant birds in Southern Fleurieu region.

Bird lists for cells within the Southern Fleurieu were obtained from published records; these data were culled by Graham Carpenter, Department of Land Water & Biodiversity, to select significant species. National and State ratings were available from existing databases; updated regional ratings were obtained from Graham Carpenter.

Prioritisation within theme:

3A.1 National Status (EPBC Act)

Item	Criterion	Category	
		Vulnerable	**Endangered**
1	It has undergone, is suspected to have undergone or is likely to undergo in the immediate future:	a substantial reduction in numbers	a severe reduction in numbers
2	Its geographic distribution is precarious for the survival of the species and is:	limited	restricted
3	The estimated total number of mature individuals is:	limited	low
and	(a) evidence suggests that the number will continue to decline at:	a substantial rate	a high rate
or	(b) the number is likely to continue to decline and its geographic distribution is:	precarious for its survival	precarious for its survival
4	The estimated total number of mature individuals is:	low	very low
5	The probability of its extinction in the wild is at least:	10% in the medium-term future	20% in the near future
	Priority	**5**	**9**

3A.2 SA status (Review of the Status of Threatened Species 2003)

Item	Criterion	Category		
		Rare (TSSA)	Vulnerable (IUCN)	Endangered (IUCN)
1	It has undergone a population reduction in the form of an observed, estimated, inferred or suspected reduction of at least:	>50% loss abundance and / or area occupied	20% over 10 years or 3 generations	50% over 10 years or 3 generations
2	Extent of occurrence estimated to be limited:	20 000 km^2 OR 2000 and highly fragmented	20 000 km^2	5000 km^2
and	Fragmented to a limited number of locations, continuing decline and extreme fluctuations		< 10 populations	< 5 populations
3	Population size estimated to be limited:	<3000 mature indiv.	< 10 000 mature indiv.	< 2500 mature indiv.
and	Continuing a rate of decline		>10% / 10 years or 3 generations	>20% / 5 yrs or 2 generations
4	Population estimated to be limited		< 1000 mature indiv.	250 mature indiv.
5	Quantitative analysis predicts extinction in the wild		>10 % within 100 years	>20 % within 20 years or 5 generations
	Priority	**1**	**5**	**9**

3A.3 Regional status (Birds – Graham Carpenter)

Category					
Common (C)/ Not Significant (N)	**Uncommon (U)**	**Indeterminate (K)**	**Rare (R)/ Threatened (T)**	**Vulnerable (V)**	**Endangered (E)**
Considered widespread throughout most of its known distribution and under no immediate threat.	Although not an IUCN category, the term uncommon has been introduced to indicate plants, animals or vegetation types that are inadequately conserved or declining but are not yet threatened.	Likely to be Rare or Vulnerable but current information on populations are grossly inadequate to provide a better estimate of its conservation significance.	Considered to be at risk due to the low numbers of individuals even though no or little decline has been detected.	Considered likely to become endangered in the immediate future given current trends in populations and reasons for decline.	Considered to be in danger of becoming extinct in the wild in the immediate future given current trends in populations and reasons for decline.
0	**1**	**3**	**5**	**7**	**9**

2.1.4 Significant Reptiles and Amphibian Habitats in Southern Fleurieu

4A. Priority of Habitat for Reptile and Amphibians (based on the conservation status)

State Biological Survey records for reptiles and amphibians at locations within the coastal boundary were supplemented by expert input from Tim Milne. This was then linked to national and state ratings for species, as follows.

Prioritisation within theme:

4A.1. National Status (EPBC Act)

Item	Criterion	Category	
		Vulnerable	**Endangered**
1	It has undergone, is suspected to have undergone or is likely to undergo in the immediate future:	a substantial reduction in numbers	a severe reduction in numbers
2	Its geographic distribution is precarious for the survival of the species and is:	limited	restricted
3	The estimated total number of mature individuals is:	limited	low
and	(a) evidence suggests that the number will continue to decline at:	a substantial rate	a high rate
or	(b) the number is likely to continue to decline and its geographic distribution is:	precarious for its survival	precarious for its survival
4	The estimated total number of mature individuals is:	low	very low
5	The probability of its extinction in the wild is at least:	10% in the medium-term future	20% in the near future
	Priority	**5**	**9**

4A.2. SA status (Review of the Status of Threatened Species 2003)

Item	Criterion	Category		
		Rare (TSSA)	**Vulnerable (IUCN)**	**Endangered (IUCN)**
1	It has undergone a population reduction in the form of an observed, estimated, inferred or suspected reduction of at least:	>50% loss abundance and / or area occupied	20% over 10 years or 3 generations	50% over 10 years or 3 generations
2	Extent of occurrence estimated to be limited:	20 000 km^2 OR 2000 and highly fragmented	20 000 km^2	5000 km^2
and	Fragmented to a limited number of locations, continuing decline and extreme fluctuations		< 10 populations	< 5 populations
3	Population size estimated to be limited:	<3000 mature indiv.	< 10 000 mature indiv.	< 2500 mature indiv.
and	Continuing a rate of decline		>10% / 10 yrs or 3 generations	>20% / 5 yrs or 2 generations
4	Population estimated to be limited		< 1000 mature indiv.	250 mature indiv.
5	Quantitative analysis predicts extinction in the wild		>10% within 100 yrs	>20% within 20 years or 5 generations
	Priority	**1**	**5**	**9**

4B. Priority of Habitat for Reptile and Amphibians (based on Regional Abundance)

Species found in surveys (Biological Survey Group) have been supplemented by expert knowledge of reptiles in the area from Tim Milne, to include species that have a high likelihood of being present in the area.

Prioritisation within theme:

Common	Uncommon	Rare
1	5	9

4C. Priority of Habitat for Reptile and Amphibians (based on Regional Coastal Distribution)

Species found in surveys (Biological Survey Group) have been supplemented by expert knowledge of reptiles in the area from Tim Milne, to include species that have a high likelihood of being present in the area.

Prioritisation within theme:

Widespread	Restricted
1	9

4D. Priority of Habitat for Reptile and Amphibians (Coastal Dependency)

Species found in surveys (Biological Survey Group) have been supplemented by expert knowledge of reptiles in the area from Tim Milne, to include species that have a high dependency on the coast as habitat.

Prioritisation within theme:

No dependence on coastal habitat	Partial Dependence	Dependent
1	5	9

2.1.5 Significant Butterfly Habitats of the Southern Fleurieu

5A. Priority of vegetation assemblage as habitat for butterflies

Based of the work of R. Grund (1997 & pers. comm. 2006) showing those areas identified as priority habitats for butterfly larvae. This habitat can be both remnant vegetation and landscape based.

Prioritisation within theme:

Not significant	Habitat with potential for threatened species following considerable restoration.	Habitat, with significant patches, with possible potential for threatened species.	Significant habitat in mixed to poor condition, but with considerable potential for threatened species.	Highly significant, extensive butterfly habitat, suffering degradation; suitable for revegetation and/or re-introduction of rare species.	Highly significant, extensive butterfly habitat, suitable for additional revegetation with foodplants.	Unique, extensive butterfly habitat (rare foodplants or breeding habitat); containing rare or locally significant butterfly species.
0	1	3	5	7	8	9

2.1.6 Focal Species Within the Southern Fleurieu

6A. Priority of location (vegetation remnant / coastal unit) based on the distribution of Hooded Plover (Focal Species)

Nineteen of the twenty-seven coastal cells of the Southern Fleurieu have published records of Hooded Plover, *Thinornis rubricollis*.

This layer is based on communication with the Science and Conservation Directorate of DEH, where a Hooded Plover recovery plan is under construction. Emma Stephens has provided input on recent sightings and nesting locations. The national status of the species under the EPBC Act is under review, but it appears likely to be listed as endangered; the Hooded Plover is listed as endangered in South Australia.

Prioritisation within theme:

Absent	Previously Recorded Site	Key Nesting Location
0	5	9

2.1.7 Fragmentation and Isolation of Remnant Vegetation Communities

Vegetation patch metrics in this section are derived from current mapping of remnant vegetation. The methodology used here was developed by Nerissa Haby and Matthew Royal for the conservation priorities study of the Northern Yorke NRM region, (Caton et al 2006, section 2).

7A. Priority of remnant vegetation based on patch size

Details of remnant vegetation patch size are readily available from current mapped data.

Prioritisation within theme:

< 1 ha	1-5 ha	5-30 ha	30-100 ha	100-500 ha	500-1500 ha	>1500 ha
0	4	5	6	7	8	9

7B. Priority of vegetation assemblage based on connectivity (minimum distance to nearest patch)

The minimum distance between a patch and its nearest neighbour is used in this study to indicate the degree of connectivity. A series of categories were determined to indicate the value of the patch based on classifying minimum distance between patches. The priority values were applied to whole vegetation blocks.

Prioritisation within theme:

>10 km	5-10 km	2-5 km	1-2 km	75-1000 m	501-750 m	251-500 m	101-250 m	0-100 m
1	2	3	4	5	6	7	8	9

Where the priority of vegetation communities is identified through its distance to the nearest patch.

7C. Priority of remnant vegetation based on presence

This layer provides the opportunity to value patches of remnant vegetation < 1 ha that were excluded from other themes used in the analysis. Small patches provide refuge and resources throughout the landscape, thus this layer was created to include this value in the analysis.

Prioritisation within theme:

Absent	Present
0	9

7D. Priority of vegetation assemblage based on patch shape: Edge to Interior ratio

The clearance of native vegetation for development has left many patches with irregular shapes. Along the coast many remnants are linear in form; however this shape leaves them vulnerable to increased risk of invasion by exotic plants and by predators. Vegetation patch shapes with large rounded (less degraded) habitat will withstand invasion and further degradation better than elongated or irregular patches, where more edge perimeter will allow easier invasion etc. Some animals prefer areas away from patch edges, and thus shape is relevant to habitat.

A simple method to express the degree of edge effect was applied to each of the vegetation blocks within the Southern Fleurieu coastal boundary:

Relative edge effect = perimeter (m) / area (ha)

Patches containing a high proportion of interior habitat will have a relatively small perimeter and large area; the relative edge effect will have a small value, hence a large priority score in the table below.

Prioritisation within theme:

No Priority	E / I >600	E / I 501-600	E / I 401-500	E / I 301-400	E / I 201-300	E / I 101-200	E / I 0.1-100
0	3	4	5	6	7	8	9

2.1.8 Heritage

8A. Aboriginal Heritage sites

Locations of registered sites obtained from the Department for Premier and Cabinet to be shown as a presence/ absence layer.

Prioritisation within theme:

Not significant	Significant sites
0	9

Where the presence and absence of significant sites are identified as significant (category 1) or insignificant (category 0) within the Southern Fleurieu boundary.

8B. European Heritage Sites

This layer identifies sites designated as 'European Heritage' on the State Heritage Register, or the Register of the National Estate.

The priority value for European Heritage sites was based on the proportion of European Heritage site area within the Coastal Cells.

Prioritisation within theme:

Not significant	Significant sites
0	9

Where the presence and absence of significant sites are identified as significant (category 1) or insignificant (category 0) within the Southern Fleurieu boundary.

8C. Natural Heritage sites

This layer identifies sites designated ‘natural heritage’ on the State Heritage Register, or the Register of the National Estate.

Prioritisation within theme:

Not significant	Significant sites
0	9

Where the presence and absence of significant sites are identified as significant (category 1) or insignificant (category 0) within the Southern Fleurieu boundary.

8D. Geological monuments

Geological monuments are defined by the Geological Society of Australia, South Australian Branch and the data is held by Primary Industry, Mines Department (Wayne Cowley). Layers locating geological monuments are readily available from PIRSA and are also held by DEH.

Prioritisation within theme:

Not significant	Significant sites
0	9

Where the presence and absence of significant sites are identified as significant (category 1) or insignificant (category 0) within the Southern Fleurieu boundary.

2.2 Threatening Processes Layers

2.2.1 Acid Sulphate Soils

The priority of the saltmarsh habitats is dependent on the potential for that area to develop Acid Sulphate Soil (ASS) conditions; based on the classification developed by the CSIRO and the CPB (see Coast Protection Board, 2003).

Prioritisation within theme:

No Saltmarsh / Calc Areas	Marine/ Sand	Potential ASS (S)	Potential ASS (I)	Potential ASS (d)	Potential ASS (m)	Actual ASS
0	1	3	5	5	7	9

2.2.2 Campsites

These have been obtained from local knowledge (A. Eaton), aerial photography and land use data. The category 'formal camping' below, includes Council camping and caravan sites and National Parks campsites. Informal sites are those identified as informal sites that are regularly, but sometimes infrequently, used.

Prioritisation within theme:

No Campsites	Formal Camping	Informal Camping
0	5	9

2.2.3 Development Potential

Currently available in existing layers. Planning SA development zones which are termed Developed / Allowing Further Development, are considered a threat. Where development is not allowed there is no threat potential.

Prioritisation within theme:

Not Developed/ No Development Allowed	Developed/ Allowing Development
0	9

2.2.4 Dump and Wastewater Processing Sites

Currently available in existing layers (E.I.A Branch: refer to GIS layer used in assessing the "SA Coastal Land Development Suitability").

Prioritisation within theme:

No dump/ wastewater processing site	Dump/ wastewater processing site present
0	9

2.2.5 Dune Stability

This layer was created from aerial photographic data (February 2005) by the Coast Protection Branch DEH, and checked for this project (September 2006). All coastal dunes were categorised as having potential dune hazard; unvegetated dunes were classed as 'actual dune hazard'.

Prioritisation within theme:

No Dunes	Potential Drift Hazard	Actual Drift Hazard
0	5	9

2.2.6 Cliff Stability

This layer was created for this project in May 2006, from oblique aerial photography (May 2003) and checked on vertical aerial photography. The data refers to coastal cliffs and steep slopes adjacent to river mouths and estuaries.

Prioritisation within theme:

Cliff Stable	<50m & Potential Instability	>50m & Potential Instability	<50m & Actual Instability	>50m & Actual Instability
0	3	5	7	9

2.2.7 Land Ownership

Currently available in existing layers (E.I.A Branch: refer to GIS layer used in assessing the "SA Coastal Land Development Suitability").

Prioritisation within theme

Private Properties	SA Water Reserves	Crownland Areas	Forestry SA Reserves	Road & Railway Reserves	Heritage Agreement Properties	NPWSA Reserves
9	4	4	4	4	1	0

2.2.8 Land Use

Land use is derived from a Planning SA Land use layer recorded in 2005. Land use was rated for this project according to its threat potential to conservation values.

Prioritisation within theme:

Residential/ Commercial/ Public Inst/ Util & Industy/ Roads	Golf/ Recreation/ Education/ Retail/ Vacant_Res	Agriculture/ Horticulture/ Livestock/ Rural Residential	Vacant Land - Rural	NPWSA Reserves/ Areas not covered by Land-use codes
9	9	7	7	0

2.2.9 Mining Activities

Exploration leases and mining tenements are regulated by PIRSA Mining, and recorded publicly on the PIRSA website. Mining is rated according to its potential for impact on conservation values, without regard to rehabilitation potential.

Prioritisation within theme:

No threat from Mining Activities	Exploration Lease Application	Exploration` Lease	Actual Mining Tenement
0	5	7	9

2.2.10 Vegetation Isolation

Currently created layers as part of 2.1.7 Fragmentation and Isolation of Remnant Vegetation Communities. The opposite of the vegetation connectivity layer, as part of the conservation layers.

Prioritisation within theme:

Reversed from the patch connectivity layer created as part of the conservation layers

>10 km	5-10 km	2-5 km	1-2 km	751-1000 m	501-750 m	251-500 m	101-250 m	0-100 m
9	8	7	6	5	4	3	2	1

2.2.11 Vegetation Degradation

Information for this theme may be available from data collected during existing surveys. For simplicity and consistency it can be necessary to interpret the degradation of a community through the number of exotic plant species recorded.

Prioritisation within theme:

>20% of vegetation community comprised of introduced species	16-20% of vegetation community comprised of introduced species	10-15% of vegetation community comprised of introduced species	6-10% of vegetation community comprised of introduced species	<5% of vegetation community comprised of introduced species	0% of vegetation community comprised of introduced species
9	7	5	3	1	0

Where the priority of vegetation communities is based on the proportion of introduced species within it.

2.2.12 Vegetation Patch Shape

Currently created layers as part of 2.1.7 Fragmentation and Isolation of Remnant Vegetation Communities.They are used as a measure of possible invasion of threatening species due to shape. Vegetation patch shapes with large rounded (less degraded) habitat will withstand invasion and further degradation better than elongated or irregular patches, where more edge perimeter will allow easier invasion. Some animals prefer areas away from patch edges, and thus shape is relevant to habitat.

Prioritisation within theme:

No Vegetation	E / I >600	E / I 501-600	E / I 401-500	E / I 301-400	E / I 201-300	E / I 101-200	E / I 0.1-100
0	9	7	6	5	4	3	2

Where the priority of vegetation communities is based on the proportion of introduced species within it.

2.2.13 Vegetation Patch Size

Currently created layers as part of 2.1.7 Fragmentation and Isolation of Remnant Vegetation Communities. The opposite of the vegetation connectivity layer. Easily calculated for Patch ID in existing layers (E.I.A Branch). Suggests that those patches with a larger size have a reduced threat of being lost or overrun with non-indigenous species as they are more robust and likely to remain in their current “natural state”.

Prioritisation within theme:

< 1 ha	1-5 ha	5-30 ha	30-100 ha	100-500 ha	500-1500 ha	>1500 ha
9	7	6	5	4	2	1

2.2.14 Viewshed Analysis

This layer is used to highlight the increased pressure that a coastal vista /sea-view places on that area of land.

Prioritisation within theme:

No sea view	Sea views
0	9

Where the presence and absence of significant sites are identified as significant (category 1) or insignificant (category 0) within the Southern Fleurieu boundary.

2.2.15 Viewscape Analysis

This layer uses the study that Andrew Lothian carried out throughout the state to score areas for scenic value. As such those areas with a higher scenic value will contribute to a higher threat value in this layer due to their increased desirability for development and the like.

Prioritisation within theme:

No viewscape value	3 – 3.9 value	4 – 4.9 value	5 – 5.9 value	6 – 6.9 value	7 – 7.9 value	8 – 8.9 value
0	4	5	6	7	8	9

The higher the viewscape number the more Aesthetically pleasing the area of coast is seen in Andrew Lothian's study therefore an inherent increased desirability.

(Lothian, A, 2005)

2.2.16 Distribution of known environmental weeds

This layer has been developed in the Coast and Marine Protection Branch and Urban Biodiversity section of DEH (Sandercock and Petherick). See 4.3 and Appendix 11.

2.3 Method Of Rating Priority

By M Royal

2.3.1 Using Desktop GIS Analysis to Highlight Conservation Priorities Within This Study

One feature of the Southern Fleurieu Coastal Study is the aim to highlight areas of conservation priority within the coastal zone using desktop GIS techniques. Moreover it aims to allow comparison of areas of high conservation priority to those areas with perceived threat processes operating to pinpoint areas in need of more protection or management. To do so, data from numerous databases, not often drawn upon together, was combined to add as much up-to-date information from as many sources as possible. The numerous data sources utilised and created as part of the project are listed in 2.3.

The analysis undertaken within this study can be separated into two components: analysis of conservation priorities and analysis of threat processes, both following a similar workflow. In general the analysis commenced using data in its original base GIS state, whether the layers currently existed in databases or were created from additional data sources specifically obtained for the project.

Features within each GIS layer were categorised from low importance to high importance using priority values (scaled 0 to 9), established for each data theme by the working group, depending on what characteristics the features of each GIS layer possessed. A more detailed explanation of these priority values and how they were applied to the data is discussed in section 2, Description of Themes and Databases.

Once each GIS layer was characterised using conservation priority or threat process values each data theme was rasterised as a geo-referenced 25 x 25m grid layer. These raster layers, covering the entire Southern Fleurieu coastal boundary, used priority values assigned to the features within each base GIS layer to provide grid values. The conversion of base GIS layers to raster grids allows the vast amount of spatial data used to be quickly and effectively summarised and analysed using the raster layers' coincident grid nature.

Having successfully rasterised each of the conservation priority and threat process data layers, the next step was to combine those numerous layers into two raster layers. One raster layer focused on the combined conservation priority areas and the other on the combined threatening process areas. The resulting 'detailed

conservation priority raster analysis layer' and the 'detailed threatening processes raster analysis layer' form the basis for many of the GIS conclusions drawn in the project. These layers allow areas of high conservation priority and contrasting high threat, from numerous coincident conservation and threat types, to be pinpointed at the base grid level of 25 x 25m. While easily highlighting small portions of the landscape with higher conservation or threat levels, a need to generalise this at a manageable scale to identify areas of higher priority resulted in the 'conservation priority analysis coastal cell summary' and the 'threatening processes analysis coastal cell summary'.

Both of the final summary layers are the result of statistical analysis carried out on each of the individual conservation priority and threat process raster layers. Each raster layer was statistically summarised by calculating the mean of all grid cell values within each coastal cell. Having summarised each raster analysis layer the mean of each coastal cell would provide the priority value for the entire coastal cell. Furthermore, by combining the raster analysis layer summaries together (finding the total sum of the means for all themes within the coastal cells) a combined 'conservation priority analysis coastal cell summary' and a combined 'threatening processes analysis coastal cell summary' were created.

These combined coastal cell summary layers form the basis of a number of conclusions drawn within this study. The higher the mean value is, the greater the proportion of the area within that coastal cell, which achieves a high value for the combined conservation priority and threatening processes. The ability to determine those coastal cells with a high combined conservation priority due to higher conservation priorities within a number of the layers is a matter of working out those coastal cells with the highest combined conservation priority value. This process quickly yields which of the coastal cells requires more attention than others. Furthermore by carrying out the same process on the combined threatening process layer, coastal cells influenced by a number of significant threatening processes can be quickly determined. The determination of high conservation priorities and threatening processes at a coastal cell level will serve as a pointer to specific areas within these coastal cells requiring conservation management by reverting back to the detailed 25x25m raster analysis layers created earlier.

The GIS analysis undertaken provided an effective means of pinpointing areas within the Southern Fleurieu coastal zone that have high conservation value due to a reinforcement of a variety of conservation priorities in some areas and not others. Specifically the ability to interrogate numerous sources of data within multiple data themes makes it a comprehensive and reliable desktop analysis using the most up-to-date information available. Additionally, the analysis layers are quickly updated if additional detailed or current information becomes available.

2.4 GIS Datasets Table

GIS Datasets used in the Southern Fleurieu Coastal Management Plan					
Existing GIS Datasets used within the Southern Fleurieu Coastal Conservation Plan:					
GIS Dataset	**Mapping Scale**	**Positional Accuracy**	**Custodian/ Source**	**Currency Date**	**Description**
Natural Features					
Coastal Hazard Mapping	1:50000	0 - 50m	DEH - Coastal Protection	Feb-05	Coastal hazard mapping - mapping of sand dunes & storm surge areas.
Coastal Wetlands	1:50000	0 - 50m	DEH - Coastal Protection	Dec-04	Location of coastal wetlands as identified in the Australian Wetlands Database.
Floristic Vegetation	Varied	0 - 250m	DEH - Environmental Information	Sep-06	Location of Floristic Vegetation types.
Geological Monuments	Varied	0 - 150m	PIRSA	Feb-05	Location of Geological Monuments registered with the Geological Society of Australia.
National Estate Register - Natural	Varied	0 - 150m	Australian Heritage Commission	Feb-05	Natural locations of significance within the Australian Heritage Commission (AHC) Statutory Register of the National Estate (RNE).
Native Vegetation - Cover	Varied	0 - 250m	DEH - Environmental Information	Sep-06	Mapping of the presence / absence of native vegetation.
New Zealand Fur Seal Colonies	1:50000	0 - 500m	DEH - Bio. Survey & Monitoring	Jul-04	Significant NZ Fur Seal breeding and hall out sites for habitat conservation purposes.

Planted Vegetation	Varied	0 - 250m	DEH - Environmental Information	Aug-03	Location of Vegetation Plantations.
SA Coastline	1:10000	0 - 25m	DEH - Environmental Information	Dec-05	Location of mean sea level.
Seabird Colonies	1:50000	0 - 500m	DEH - Bio. Survey & Monitoring	Jul-04	Significant seabird habitat sites within SA.
Tidal Saltmarsh and Mangrove Habitat Mapping	1:10000	0 - 50m	DEH - Coastal Protection	Jun-06	Tidal saltmarsh and mangrove habitat mapping.
Viewshed Raster	25x25m Grid	0 - 50m	DEH - Coastal Protection	Jun-05	Viewshed grid covering the southern Fleurieu Coastal Boundary.
Adininistrative / Regional Boundaries					
Aquatic Reserves	1:50000	0 - 100m	PIRSA - SARDI	Sep-06	Aquatic Reserves (*Fisheries Act 1982*).
Built-Up Areas	1:50000	0 - 25m	DEH - Environmental Information	Jun-05	Location of Built-up areas.
Council/ LGA Boundaries	Various	0 - 30m	DEH - Environmental Information	Sep-06	Location of Local Government Areas / Councils extents.
Digital Cadastre Database Land Parcels	Varied	0 - 30m	DEH - Environmental Information	Sep-06	Legal land parcel boundaries within the state.
EPA Licence Sites	Cadastre Based	0 - 30m	EPA	May-05	Location of EPA licence sites.
Geomorphic Regions	1:50000	0 - 50m	DEH - Coastal Protection	Sep-06	Coastal Protection Branch Geomorphic Region boundaries.
Herbarium Regions	1:50000	0 - 500m	DEH - Bio. Survey & Monitoring	Sep-06	Regions of South Australia adopted by the State Herbarium.
Land Development Zones	Cadastre Based	0 - 30m	Planning SA	Sep-06	Planning zones and policy areas derived from council development plans.
Land Use Boundaries	Cadastre Based	0 - 30m	Planning SA	Sep-06	Land use.
Mineral Exploration Licence Applications	Varied	0 - 150m	PIRSA	Sep-06	Location of Mineral Exploration Licence Applications (*Mining Act 197*1).
Mineral Exploration Licences	Varied	0 - 150m	PIRSA	Sep-06	Location of Mineral Exploration Licences (*Mining Act 197*1).
Mining Tenements	Varied	0 - 150m	PIRSA	Sep-06	Location of Mineral Production Tenements (*Mining Act 1971*).
National Estate Register - Aboriginal	Varied	0 - 150m	Australian Heritage Commission	Feb-05	Aboriginal locations of significance in the Australian Heritage Commission (AHC) Statutory Register of the National Estate (RNE).
National Estate Register - European	Varied	0 - 150m	Australian Heritage Commission	Feb-05	European locations of significance in the Australian Heritage Commission (AHC) Statutory Register of the National Estate (RNE).
Native Vegetation Heritage Agreements	Cadastre Based	0 - 30m	DEH - Environmental Information	Sep-06	Native vegetation Heritage Agreement area boundaries (*Native Vegetation Act 1991*).
Natural Resource Management Regions	Cadastre Based	0 - 30m	DLWBC	Sep-06	Natural Resource Management Region boundaries (*NRM Act 2004*).
Petroleum Exploration Licence Applications	Varied	0 - 150m	PIRSA	Sep-06	Location of Petroleum Exploration Licence / Permit Applications (*Petroleum Act 2000*, *Petroleum (Submerged Lands) Act*, *1982*, or *Petroleum (Submerged Lands) Act 1967*).

Petroleum Exploration Licences	Varied	0 - 150m	PIRSA	Sep-06	Location of Petroleum Exploration Licences / Permits (*Petroleum Act 2000*, *Petroleum (Submerged Lands) Act 1982*, or *Petroleum (Submerged Lands) Act 1967*).
Petroleum Production Tenements	Varied	0 - 150m	PIRSA	Sep-06	Location of Petroleum Production Licences (*Petroleum Act 2000*, *Petroleum (Submerged Lands) Act 1982*, or *Petroleum (Submerged Lands) Act 1967*).
Protected Areas - NPWS and Conservation Reserve Boundaries	Cadastre Based	0 - 30m	DEH - Bio. Survey & Monitoring	Dec-04	NPWS Reserve boundaries (*NPW Act 1972*) & NPWS conservation reserve boundaries (*Crown Lands Act 1929*).
Quarries	1:50000	0 - 50m	DEH - Environmental Information	Sep-06	Location of Quarries.
Roads	1:50000	0 - 50m	DEH - Environmental Information	Sep-06	Location of road centrelines.
Railways	1:50000	0 - 50m	DEH - Environmental Information	Sep-06	Location of railways.
SA Water Land	Cadastre Based	0 - 30m	SA Water	Jan-05	Location of SA Water lands.
Statewide Crown Land	Cadastre Based	0 - 30m	DEH - Crownlands SA	Feb-06	Legal land parcel boundaries within the state held under the control of the Crown.
Survey Records					
Biological Survey Database - Vegetation	Varied	0 - 1000m	DEH - Bio. Survey & Monitoring	Sep-06	Vegetation survey sites completed by the Biological Survey of SA.
Biological Survey Database - Vertebrates	Varied	0 - 1000m	DEH - Bio. Survey & Monitoring	Sep-06	Vertebrate fauna survey sites completed by the Biological Survey of SA.
Bird Atlas: Birds Australia	Varied	0 - 5000m	Birds Australia	Oct-01	Opportuntistic bird survey sites collected by field ecologists associated with Birds Australia.
Coastal Dune and Clifftop Vegetation Survey Sites (CDCS Survey Sites)	Varied	0 - 1000m	DEH - Coastal Protection	Feb-05	Vegetation survey sites taken from the biological databases highlighting Coastal Dune and Clifftop specific communities from Oppermann's 1999 Coastal Dune and Clifftop Vegetation Survey (CDCS).
Opportunistic Survey Database – Vegetation	Varied	0 - 5000m	DEH - Bio. Survey & Monitoring	Sep-06	Opportunistically collected vegetation data - collected by various sources.
Opportunistic Survey Database – Vertebrates	Varied	0 - 5000m	DEH - Bio. Survey & Monitoring	Sep-06	Opportunistically collected vertebrate fauna data - collected by various sources.
Rare and Threatened Plant Populations	Varied	0 - 1000m	DEH - Bio. Survey & Monitoring	Sep-06	Vegetation sites corresponding to DEH's Rare and Threatened Plant Population database.
Reserve Survey Database - Vegetation	Varied	0 - 1000m	DEH - Bio. Survey & Monitoring	Sep-06	Vegetation data collected within reserves by various sources.
Reserve Survey Database - Vertebrates	Varied	0 - 1000m	DEH - Bio. Survey & Monitoring	Sep-06	Vertebrate fauna data collected within reserves by various sources.

GIS Datasets created for the Southern Fleurieu Coastal Conservation Project:					
GIS Dataset	**Mapping Scale**	**Positional Accuracy**	**Custodian/ Source**	**Currency Date**	**Description**
Natural/ Administrative/ Regional Features & Boundaries					
Butterfly Habitats	1:50000	0 - 250m	Rodger Grund	Sep-06	Significant butterfly locations within the coastal boundary obtained from DEH butterfly expert Rodger Grund
Campsites	1:10000	0 - 50m	DEH - Coastal Protection	Sep-06	Location of known sites used for camping within the Southern Fleurieu Coastal Boundary.
Cliff Hazard Mapping	1:50000	0 - 50m	DEH - Coastal Protection	Sep-06	Cliff hazard mapping - Location of various erosional states of the Southern Fleurieu Cliffs.
Coastal Boundary	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	The study area used within the Southern Fleurieu project to determine the coastal region. An area outlined by the mean sea-level and the furthest landward edge of either saltmarsh & mangorve habitats, sand dune complexes, native vegetation blocks considered coastal or a 500m buffer from the coastline.
Coastal Cell Boundaries	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Using the Coastal Boundary as a basis, it was divided into 'Cells' of similar coastal features, wave / fetch exposure & type.
Hooded Plover Areas	1:50000	1 - 50m	DEH - Science & Conservation	Sep-06	Significant Hooded Plover locations found within the Southern Fleurieu coastal study area.
Reptile Habitats	Varied	1 - 250m	DEH - Urban Forests	Sep-06	Reptile habitat locations as described by reptile experts Tim Milne & Clare Petherick at Urban Forests.
State Heritage Register	Varied	0 - 50m	DEH - Heritage SA	Sep-06	Locations of Coastal Use, Natural, European & Aboriginal Heritage noted in the State Heritage Register Database.
Study Vegetation Blocks	Varied	0 - 250m	DEH - Coastal Protection	Sep-06	Uniquely identifies all the native vegetation blocks within the coastal boundary.
Local Vegetation Survey	1:50000	0 - 1000m	Ron Taylor	Sep-06	Vegetation species locations within coastal cells obtained from local expert Ron Taylor.
Survey Records (Points created from tables)					
Raster Analysis Layers Created From GIS Datasets Listed Above:					
GIS Dataset/ Raster Layer	**Resolution**	**Positional Accuracy**	**Custodian/ Source**	**Currency Date**	**Description**
Conservation Priority Raster Layers					
1A - CDCS Threatened Communities conservation priority layer	25 x 25m Grid	Up to 10 Grid Cells (0 - 250m)	DEH - Coastal Protection	Sep-06	Conservation priority of vegetation assemblages based on the status of the Coastal Dune and Clifftop vegetation communities (threatened status).
1B - Southern Fleurieu CDCS rare plant communities conservation priority layer	25 x 25m Grid	Up to 10 Grid Cells (0 - 250m)	DEH - Coastal Protection	Sep-06	Conservation priority of vegetation assemblages based on the rarity of Coastal Dune and Clifftop vegetation communities (those with <20 records within the state).
1C - Threatened flora conservation priority layer	25 x 25m Grid	Up to 10 Grid Cells (0 - 250m)	DEH - Coastal Protection	Sep-06	Conservation priority of sites with threatened Flora (threatened status).
1D - Threatened fauna conservation priority layer	25 x 25m Grid	Up to 10 Grid Cells (0 - 250m)	DEH - Coastal Protection	Sep-06	Conservation priority of sites with threatened Fauna (threatened status).
1E - Total threatened species conservation priority layer	25 x 25m Grid	Up to 10 Grid Cells (0 - 250m)	DEH - Coastal Protection	Sep-06	Conservation priority of sites based on total number of threatened species (total no. threatened species).
2A - Southern Fleurieu CDCS endemic plant communities conservation priority layer	25 x 25m Grid	Up to 10 Grid Cells (0 - 250m)	DEH - Coastal Protection	Sep-06	Conservation priority of vegetation assemblages based on the distribution of endemic Coastal Dune and Clifftop vegetation communities (> 50% of records within Southern Fleurieu area of interest).

2B - Endemic Saltmarsh and Mangrove Habitat communities conservation priority layer	25 x 25m Grid	Up to 2 Grid Cells (0 - 50m)	DEH - Coastal Protection	Sep-06	Conservation priority of vegetation assemblages based on the distribution of endemic Saltmarsh and Mangrove Habitat communities (> 50% of records within Southern Fleurieu area of interest).
2C - Endemic Floristic communities conservation priority layer	25 x 25m Grid	Up to 2 Grid Cells (0 - 50m)	DEH - Coastal Protection	Sep-06	Conservation priority of vegetation assemblages based on the distribution of endemic Saltmarsh and Mangrove Habitat communities (> 50% of records within Southern Fleurieu area of interest).
2D - Species richness conservation priority layer	25 x 25m Grid	Up to 10 Grid Cells (0 - 250m)	DEH - Coastal Protection	Sep-06	Conservation priority of sites based on species richness (total no. species).
3 - Significant bird habitats conservation priority layer	25 x 25m Grid	Up to 10 Grid Cells (0 - 250m)	DEH - Coastal Protection	Sep-06	Conservation priority of vegetation assemblages as habitat for birds.
4A - Significant reptile and amphibian habitats (conservation status) conservation priority layer	25 x 25m Grid	Up to 10 Grid Cells (0 - 250m)	DEH - Coastal Protection	Sep-06	Conservation priority of vegetation assemblage as habitat for reptiles and amphibians based on conservation status.
4B - Significant reptile and amphibian habitats (regional abundance) conservation priority layer	25 x 25m Grid	Up to 10 Grid Cells (0 - 250m)	DEH - Coastal Protection	Sep-06	Conservation priority of vegetation assemblage as habitat for reptiles and amphibians based on regional abundance.
4C - Significant reptile and amphibian habitats (regional coastal distribution) conservation priority layer	25 x 25m Grid	Up to 10 Grid Cells (0 - 250m)	DEH - Coastal Protection	Sep-06	Conservation priority of vegetation assemblage as habitat for reptiles and amphibians based on regional coastal distribution.
4D - Significant reptile and amphibian habitats (coastal dependency) conservation priority layer	25 x 25m Grid	Up to 10 Grid Cells (0 - 250m)	DEH - Coastal Protection	Sep-06	Conservation priority of vegetation assemblage as habitat for reptiles and amphibians based on coastal dependency.
5 - Significant butterfly habitats conservation priority layer	25 x 25m Grid	Up to 10 Grid Cells (0 - 250m)	DEH - Coastal Protection	Sep-06	Conservation priority of vegetation assemblage as habitat for butterflies.
6 - Hooded Plover (focal species) habitat conservation priority layer	25 x 25m Grid	Up to 10 Grid Cells (0 - 250m)	DEH - Coastal Protection	Sep-06	Conservation priority of location (vegetation remnant/ coastal unit) based on the distribution of the Hooded Plover (focal species).
7A - Vegetation patch size conservation priority layer	25 x 25m Grid	Up to 10 Grid Cells (0 - 250m)	DEH - Coastal Protection	Sep-06	Conservation priority of remnant vegetation based on patch size.
7B - Vegetation patch connectivity conservation priority layer	25 x 25m Grid	Up to 10 Grid Cells (0 - 250m)	DEH - Coastal Protection	Sep-06	Conservation priority of remnant vegetation based on connectivity (minimum distance to nearest patch).
7C - Presence of vegetation patch <1ha conservation priority layer	25 x 25m Grid	Up to 10 Grid Cells (0 - 250m)	DEH - Coastal Protection	Sep-06	Conservation priority of vegetation assemblages based on the presence of remnant vegetation <1ha.
7D - Vegetation patch shape conservation priority layer	25 x 25m Grid	Up to 10 Grid Cells (0 - 250m)	DEH - Coastal Protection	Sep-06	Conservation priority of vegetation assemblages based on patch Edge to Interior Ratio or Relative Edge Effect (REE). Where REE = Perimeter (m) / Area (ha).
Indigenous Heritage Sites conservation priority layer	25 x 25m Grid	Up to 5 Grid Cells (0 - 150m)	DEH - Coastal Protection	Sep-06	Conservation priority of significant Indigenous Heritage Sites.
European Heritage Sites conservation priority layer	25 x 25m Grid	Up to 5 Grid Cells (0 - 150m)	DEH - Coastal Protection	Sep-06	Conservation priority of significant European Heritage Sites.
Natural Heritage Sites conservation priority layer	25 x 25m Grid	Up to 5 Grid Cells (0 - 150m)	DEH - Coastal Protection	Sep-06	Conservation priority of significant Natural Heritage Sites.
Geological Monuments conservation priority layer	25 x 25m Grid	Up to 5 Grid Cells (0 - 150m)	DEH - Coastal Protection	Sep-06	Conservation priority of significant geological monuments.
Detailed 25 x 25m Conservation Priority Analysis Layer	25 x 25m Grid	Up to 10 Grid Cells (0 - 250m)	DEH - Coastal Protection	Sep-06	The final combined conservation priority analysis layer - created by summing all the individual conservation priority layers (listed above) together into one layer - the highest priority areas being the result of numerous conservation priorities having an influence on that location.
Threatening Processes Raster Layers					
Acid Sulphate Soils threat layer	25 x 25m Grid	Up to 2 Grid Cells (0 - 50m)	DEH - Coastal Protection	Sep-06	Priority of locations based on the threat from the presence of Acid Sulphate soils.
Campsite threat layer	25 x 25m Grid	Up to 2 Grid Cells (0 - 50m)	DEH - Coastal Protection	Sep-06	Priority of locations based on the threat from the increased activity associated with campgrounds of an informal (high threat) or formal (medium threat) type.

Development Zoning threat layer	25 x 25m Grid	Up to 2 Grid Cells (0 - 50m)	DEH - Coastal Protection	Sep-06	Priority of locations based on the threat from the ability through zoning regulations to develop the land.
Dump & Wastewater Treatment Plant threat layer	25 x 25m Grid	Up to 2 Grid Cells (0 - 50m)	DEH - Coastal Protection	Sep-06	Priority of locations based on the threat from the presence of waste dumps / infills / storage facilities and treatment plants.
Dune Stability threat layer	25 x 25m Grid	Up to 2 Grid Cells (0 - 50m)	DEH - Coastal Protection	Sep-06	Priority of locations based on the threat from the presence of dunes and their likelihood to shift when disturbed.
Cliff Stability threat layer	25 x 25m Grid	Up to 2 Grid Cells (0 - 50m)	DEH - Coastal Protection	Sep-06	Priority of locations based on the threat from the presence of cliff and their vulnerability to erosion.
Land ownership threat layer	25 x 25m Grid	Up to 2 Grid Cells (0 - 50m)	DEH - Coastal Protection	Sep-06	Priority of locations based on the type of land ownership present and the threat that that type of ownership creates.
Land use threat layer	25 x 25m Grid	Up to 5 Grid Cells (0 - 150m)	DEH - Coastal Protection	Sep-06	Priority of locations based on the type of land use present and the threat that that land use creates.
Mining activity threat layer	25 x 25m Grid	Up to 5 Grid Cells (0 - 150m)	DEH - Coastal Protection	Sep-06	Priority of locations based on the level of mining activity possible (from no activity, through possible exploration to extractive processes) and the threat that that activity creates.
Vegetation Isolation threat layer	25 x 25m Grid	Up to 10 Grid Cells (0 - 250m)	DEH - Coastal Protection	Sep-06	Priority of locations based on the threat from a lack of connectivity between vegetation patches.
Vegetation degradation threat layer	25 x 25m Grid	Up to 10 Grid Cells (0 - 250m)	DEH - Coastal Protection	Sep-06	Priority of locations based on the threat from the degradation level of the vegetation patches.
Vegetation patch shape threat layer	25 x 25m Grid	Up to 10 Grid Cells (0 - 250m)	DEH - Coastal Protection	Sep-06	Priority of locations based on the threat from the shape of the vegetation patches.
Vegetation patch size threat layer	25 x 25m Grid	Up to 10 Grid Cells (0 - 250m)	DEH - Coastal Protection	Sep-06	Priority of locations based on the threat from the size of the vegetation patches.
Viewshed threat layer	25 x 25m Grid	Up to 5 Grid Cells (0 - 150m)	DEH - Coastal Protection	Sep-06	Priority of locations based on the threat from that area having a favourable outlook on the sea and an ability to develop on that area.
Viewscape threat layer	25 x 25m Grid	Up to 5 Grid Cells (0 - 150m)	DEH - Coastal Protection	Sep-06	Priority of locations based on the threat due to increased aesthetics of coastal areas - based on previous work carried out by DEH.
Weed threat layer	25 x 25m Grid	Up to 10 Grid Cells (0 - 250m)	DEH - Coastal Protection	Sep-06	Priority of locations based on the threat from weed species within the vegetation patches.
Detailed 25 x 25m Threatening Processes Analysis Layer	25 x 25m Grid	Up to 10 Grid Cells (0 - 250m)	DEH - Coastal Protection	Sep-06	The final combined threat analysis layer - created by summing all the individual threatening processes layers listed above into one layer - the highest priority areas being the result of numerous threatening processes having an influence on that location.

Analysis Coastal Cell Summary Layers Created From Analysis Raster Layers Listed Above:					
GIS Dataset	**Mapping Scale**	**Positional Accuracy**	**Custodian/ Source**	**Currency Date**	**Description**
Summarised Coastal Cell Conservation Priority Layers					
1A - CDCS Threatened Communities conservation coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary of the conservation priority for vegetation assemblages based on the status of the Coastal Dune and Clifftop vegetation communities (threatened status).
1B - Southern Fleurieu CDCS rare plant communities conservation coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary of the conservation priority for vegetation assemblages based on the rarity of Coastal Dune and Clifftop vegetation communities (those with <20 records within the state).
1C - Threatened flora conservation coastal cell threat summary layer	1:50000	0 - 250m	DEH – Coastal Protection	Sep-06	Coastal cell summary of the conservation priority for sites with threatened flora (threatened status).
1D - Threatened fauna conservation coastal cell threat summary layer	1:50000	0 - 250m	DEH – Coastal Protection	Sep-06	Coastal cell summary of the conservation priority for sites with threatened fauna (threatened status).
1E - Total threatened species conservation coastal cell threat summary layer	1:50000	0 - 250m	DEH – Coastal Protection	Sep-06	Coastal cell summary of the conservation priority for sites based on total number of threatened species (total no. threatened species).

2A - Southern Fleurieu CDCS endemic plant communities conservation coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary of the conservation priority for vegetation assemblages based on the distribution of endemic Coastal Dune and Clifftop vegetation communities (> 50% of records within Southern Fleurieu area of interest).
2B - Endemic Saltmarsh and Mangrove Habitat communities conservation coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary of the conservation priority for vegetation assemblages based on the distribution of endemic Saltmarsh and Mangrove Habitat communities (> 50% of records within Southern Fleurieu area of interest).
2C - Endemic Floristic communities conservation priority coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary of the conservation priority for vegetation assemblages based on the distribution of endemic Saltmarsh and Mangrove Habitat communities (> 50% of records within Southern Fleurieu area of interest).
2D - Species richness conservation priority coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary of the conservation priority for of sites based on species richness (total no. species).
3 - Significant bird habitats conservation priority coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary of the conservation priority for of vegetation assemblages as habitat for birds.
4A - Significant reptile and amphibian habitats (conservation status) conservation coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary of the conservation priority for of vegetation assemblage as habitat for reptiles and amphibians based on conservation status.
4B - Significant reptile and amphibian habitats (regional abundance) conservation coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary of the conservation priority for of vegetation assemblage as habitat for reptiles and amphibians based on regional abundance.
4C - Significant reptile and amphibian habitats(regional coastal distribution) conservation coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary of the conservation priority for vegetation assemblage as habitat for reptiles and amphibians based on regional coastal distribution.
4D - Significant reptile and amphibian habitats(coastal dependency) conservation coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary of the conservation priority for vegetation assemblage as habitat for reptiles and amphibians based on coastal dependency.
5 - Significant butterfly habitats conservation coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary of the conservation priority for of vegetation assemblage as habitat for butterflies.
6 - Hooded Plover (focal species) habitat conservation coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary of the conservation priority for location (vegetation remnant/ coastal unit) based on the distribution of the Hooded Plover (focal species).
7A - Vegetation patch size conservation coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary of the conservation priority for remnant vegetation based on patch size.
7B - Vegetation patch connectivity conservation coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary of the conservation priority for remnant vegetation based on connectivity (Minimum distance to nearest patch).
7C - Presence of vegetation patch <1ha conservation coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary of the conservation priority for vegetation assemblages based on the presence of remnant vegetation <1ha.
7D - Vegetation patch shape conservation coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary of the conservation priority for of vegetation assemblages based on patch Edge to Interior Ratio or Relative Edge Effect (REE). Where REE = Perimeter (m) / Area (ha).
Indigenous Heritage Sites conservation coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary of the conservation priority for significant Indigenous Heritage Sites.
European Heritage Sites conservation coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary of the conservation priority for significant European Heritage Sites.
Natural Heritage Sites conservation coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary of the conservation priority for significant Natural Heritage Sites.

Geological Monuments conservation coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary of the conservation priority for significant geological monuments.
Detailed summarised conservation priority coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	The final coastal cell summary of the combined conservation priority analysis layer - created by summing all the individual conservation priority layers (listed above) together into one layer. The highest priority areas being the result of numerous conservation priorities having an influence on that location.
Summarised Coastal Cell Threatening Processes Layers					
Acid Sulphate Soils coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary for the priority of locations based on the threat from the presence of Acid Sulphate soils.
Campsite coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary for the priority of locations based on the threat from the increased activity associated with campgrounds of an informal (high threat) or formal (medium threat) type.
Development zoning coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary for the priority of locations based on the threat from the ability through zoning regulations to develop the land.
Dump & wastewater treatment plant coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary for the priority of locations based on the threat from the presence of waste dumps / infills/ storage facilities and treatment plants.
Dune Stability coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary for the priority of locations based on the threat from the presence of dunes and likelihood to shift when disturbed.
Cliff Stability coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary for the priority of locations based on the threat from the presence of cliff and their vulnerability to erosion.
Land ownership coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary for the priority of locations based on the type of land ownership present and the threat that that type of ownership creates.
Land use coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary for the priority of locations based on the type of land use present and the threat that the land use creates.
Mining activity coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary for the priority of locations based on the level of mining activity possible (from no activity through possible exploration to extractive processes) and the threat that the activity creates.
Vegetation connectivity coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary for the priority of locations based on the threat from a lack of connectivity between vegetation patches.
Vegetation degradation coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary for the priority of locations based on the threat from the degradation levels of the vegetation patches.
Vegetation patch shape coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary for the priority of locations based on the threat from the shape of vegetation patches.
Vegetation patch size coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary for the priority of locations based on the threat from the size of the vegetation patches.
Viewshed coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary for the priority of locations based on the threat from that area having a favourable outlook of the sea and an ability to develop on that area.
Viewscape coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary of the priority of locations based on the threat due to increased aesthetics of coastal areas - based on previous work carried out by DEH.
Weeds coastal cell threat summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	Coastal cell summary for the priority of locations based on the threat from weed species within the vegetation patches.
Threatening processes analysis coastal cell summary layer	1:50000	0 - 250m	DEH - Coastal Protection	Sep-06	The coastal cell summary for the final combined threat analysis layer was created by summing all the individual threatening processes layers listed above into one layer. The highest priority areas were the result of numerous threatening processes having an influence on that location.

2.5 Variation of Data Coverage Between Coastal Cells

By Brian Caton

The GIS based conservation and threat analyses used in this project employed data sets from many different sources, as is detailed in 1.1 above. These data sets were originally assembled for a variety of different purposes, and their differing character results in variable coverage between areas within the Southern Fleurieu coastal boundary. Some data sets by their nature give a complete coverage within the region: for example, development plan zoning covers the entire study area, since the Development Act requires councils to zone their areas. Some data sets appear to give complete coverage, but on examination show limitations: for instance, sites of significant indigenous heritage (in a buffered form) are represented in all cells, as presence or absence. However, since many sites of significance are not represented on the state register, this variable may be under represented within the analysis. The geological heritage layer raises another kind of issue: all defined Geological Monuments are shown on this layer; however, there may be locations of great geological significance not seen or described because they are covered by superficial deposits.

Other data layers are the results of differing kinds of sampling or recording, and these various methodologies give rise to a variety of issues. Most data within this project relates to remnant vegetation, significance or diversity of flora and fauna. Work by the state Biological Survey Group is a core part of these data sets, and is undertaken by systematic sampling and descriptive procedures (Heard & Channon, 1997). Sample points however, are irregularly distributed and are chosen to represent the larger remnant patches. Figure 3, below gives an indication of the variation in coverage between cells for the layers that relied on these data.

While the map below identifies cells with no sample points, it does not show the cells with several sample points. Haby (in Caton et al 2005) points out a number of issues in the use of vegetation survey data in the Northern Yorke NRM region, which also apply in the Southern Fleurieu:

- Lack of fine scale mapping suitable for the interpretation of vegetation communities along the coastal zone;
- Lack of habitat mapping including the diversity of vegetation communities within a remnant patch and the extent of those communities;
- Possible lack of ground-truthing of smaller remnants during vegetation community mapping;
- Difficulty in interpreting the extent of vegetation communities due to a lack of consistent vegetation descriptions;
- The indirect production of inland vegetation community fragments during the creation of the NY coastal boundary; and
- Lack of habitat mapping leading to the assumption that remnant vegetation patches are homogeneous and species detected at a survey site will occur throughout the patch.

The latter point is a very significant one in this project. In the case of reptile and butterfly layers, it was necessary to identify areas where the presence of various species was likely from the habitat (since direct evidence was not available). However, in rating priority, these areas received a lower score than those where direct positive evidence was available.

The Conservation Analysis used in this project required identifying the total sum of means from a number of themes. Themes represented the condition of remnant vegetation communities (14 themes), significant or a diversity of flora and fauna (8 themes), sites of heritage significance (3 themes) and sites of geological and geomorphic significance (3 themes). Some cells within the Southern Fleurieu coast, however, did not contain data for particular layers; leaving areas deficient in data for the analysis (see Figure 3, below).

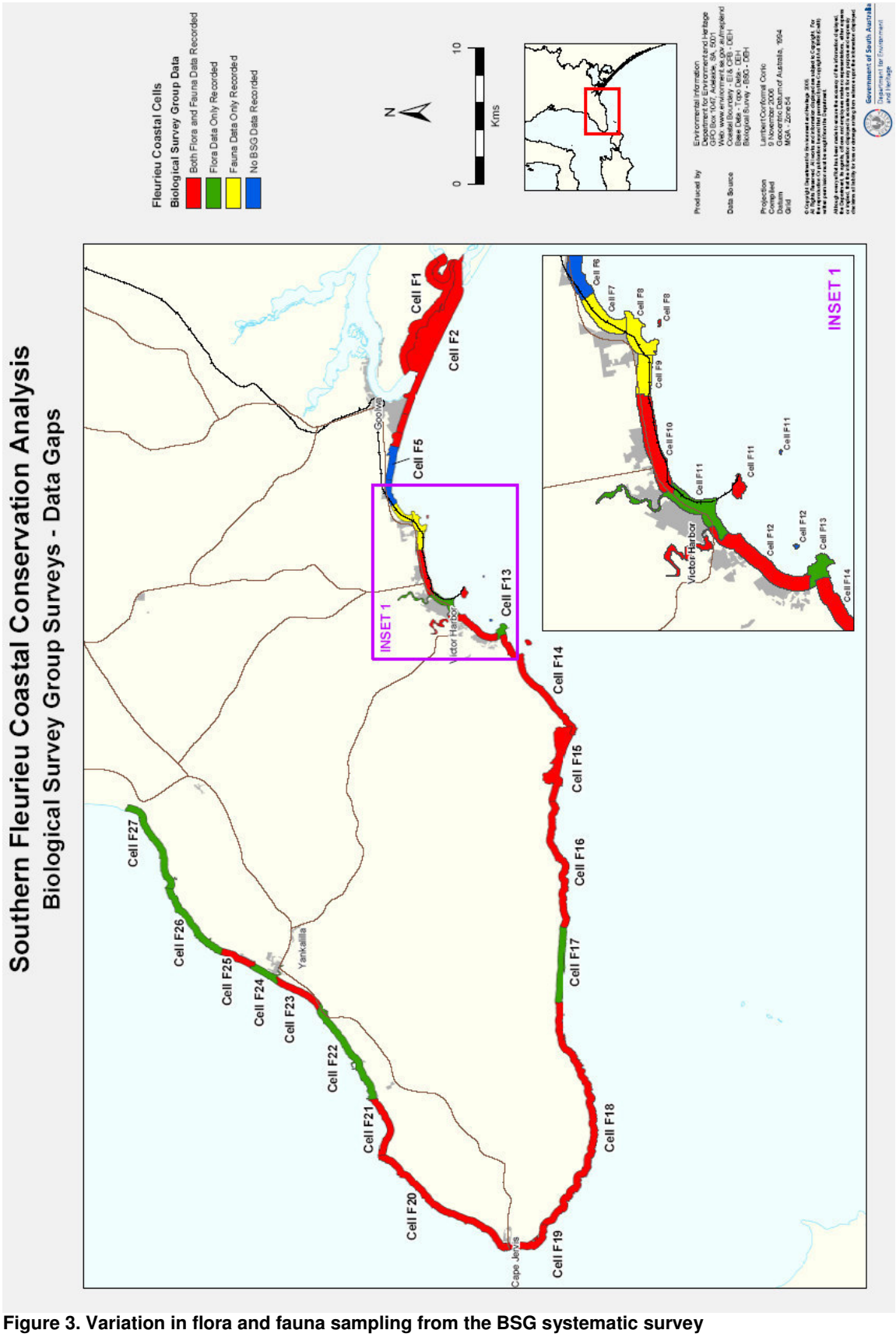


Figure 3. Variation in flora and fauna sampling from the BSG systematic survey

Limitations were also experienced in using available fauna and flora data. These generally reflected issues experienced with the design and implementation of surveys:

- The restrictive nature of surveys to larger and intact remnant patches. For example bias occurs where vegetation survey sites are usually selected in “good” remnants of native vegetation and introduced species are consequently under-represented;

- The inability to thoroughly survey the Southern Fleurieu coastal zone during past surveys (especially for fauna);

- The inability to determine the accurate distribution of threatened species during general biological surveys, and;

- Collection of species localities outside of preferred habitat types.

Animals can be hard to locate and move with seasons to search for food or visit breeding grounds. For example, the White-bellied Sea-eagle has been sighted in excess of 50 km away from known nesting locations. Additional factors leading to a change in the distribution and abundance of species at known sites may include long-term seasonal change, which may result in the alteration of movement patterns of some migratory species (Kendall et al. 2004). This may lead to the identification of a species at an uncommon locality within the databases used in this analysis.

Some capacity was available to manipulate data for the analysis. For example, data correlating with vegetation communities or coastal cells were represented at the scale of patch or cell, respectively. However, records of flora, fauna and significant sites occurring outside of a remnant patch and not considered to occur throughout the entire coastal cell, were under-represented in the analysis by comparison.

Conservation Themes

Spinifex hirsutus
Photographed by Ron Sandercock

Dianella revolta – Newland Head
Photographed by Ron Sandercock

Xanthorrhoea semiplana – Lands End
Photographed by Alison Eaton

3 CONSERVATION THEMES

3.1 Flora

By Doug Fotheringham

3.1.1 Native Vegetation Cover

Pre European vegetation cover

The Pre- European vegetation map in the Atlas of South Australia (Griffen T and McCaskill M 1986) shows Fleurieu Peninsula covered by Woodland, Forest and Coastal Succession. The term Coastal Succession was used to describe a complex of coastal plant communities occurring on the tidal flats, along beaches, on dunes and behind coastal clifftops exposed to salt spray.

Clearance

Giffen and McCaskill comparing 1945 and 1980 vegetation maps estimated that vegetation cover on Fleurieu Peninsula had been reduced from 240,000 ha to 90,000 ha representing a 60% reduction. A report prepared by the Interdepartmental Committee on Vegetation Clearance in 1976 (Harris C 1976) noted that clearances over small holdings had produced a fragmented complex. Outside of parks vegetation was mainly restricted to steep valleys and hillsides.

Remnant native vegetation cover along the Southern Fleurieu coast

Remnant native vegetation cover along the Fleurieu coastal region has been electronically mapped from aerial photography. The Department for Environment and Heritage is the custodian of this spatial dataset. The dataset title is *Native Vegetation Cover – Agricultural Region*. Information about this dataset is provided in the text box below.

1 DEH DATA SET NATIVE VEGETATION COVER – AGRICULTURAL REGIONS

Description: The dataset provides mapping coverage of the Agricultural Regions of the State, indicating native vegetation cover. The Native Vegetation Cover layer is a composite derived from various regionally based mapping projects. Significantly, native grasslands (with some exceptions) are absent from this mapping.
Dataset Use: The dataset is used as a basis for determining native vegetation statistics for the agricultural region, and is used for native vegetation mapping products. This dataset represents the State Government's key native vegetation mapping layer for the agricultural region of SA. It should not be assumed that this dataset represents all native vegetation cover present in the agricultural region of SA due to the limitations of the mapping methodology.
Limitations: This mapping is based on extrapolation of point based sampling and interpretation of imagery (aerial photography and /or satellite imagery). Sources of error can occur in the extrapolation process and in the interpretation of the imagery. While some field checking is undertaken, it is not feasible to field check all mapping. This mapping does not include areas of grassland and scattered trees. Spatial accuracy is at best +- 7 metres for the Southern Fleurieu region.
Issues identified for the Southern Fleurieu coast: Some tests were undertaken to measure the accuracy of the vegetation cover mapping along the Southern Fleurieu coast using rectified aerial photography. This revealed several issues:

- Long narrow blocks along dune crests were often not mapped;
- Positional accuracy of block boundaries were often more than 20 metres from agreement;
- Block shapes were not always in agreement; and
- Open shrubland communities on supratidal flats were often not mapped.

The mapping is continually being updated. These difficulties may be overcome with new databases.

Analysis of this dataset has provided the following general information:

- There are 94 individual blocks of native vegetation along the Southern Fleurieu coast greater than 1 hectare in size;

- In total there is 2549 hectares of native vegetation cover, including 205 ha of saltmarsh;

- In terms of area 29% of the Southern Fleurieu coast has native vegetation cover;
- 1235 hectares occur in Conservation Parks;
- 10 hectares are subject to Heritage Agreements; and
- 681 hectares are within a National Park.

Appendix 4 shows the percent remnant vegetation cover within each coastal cell along the Southern Fleurieu coast. Each coastal cell has been classed and colour coded according to percent vegetation cover and a map produced for each. This is shown in Figure 4, which provides a general picture of the distribution of the remnant vegetation. Most of the native vegetation cover is found along the south coast between Cape Jervis and Victor Harbor.

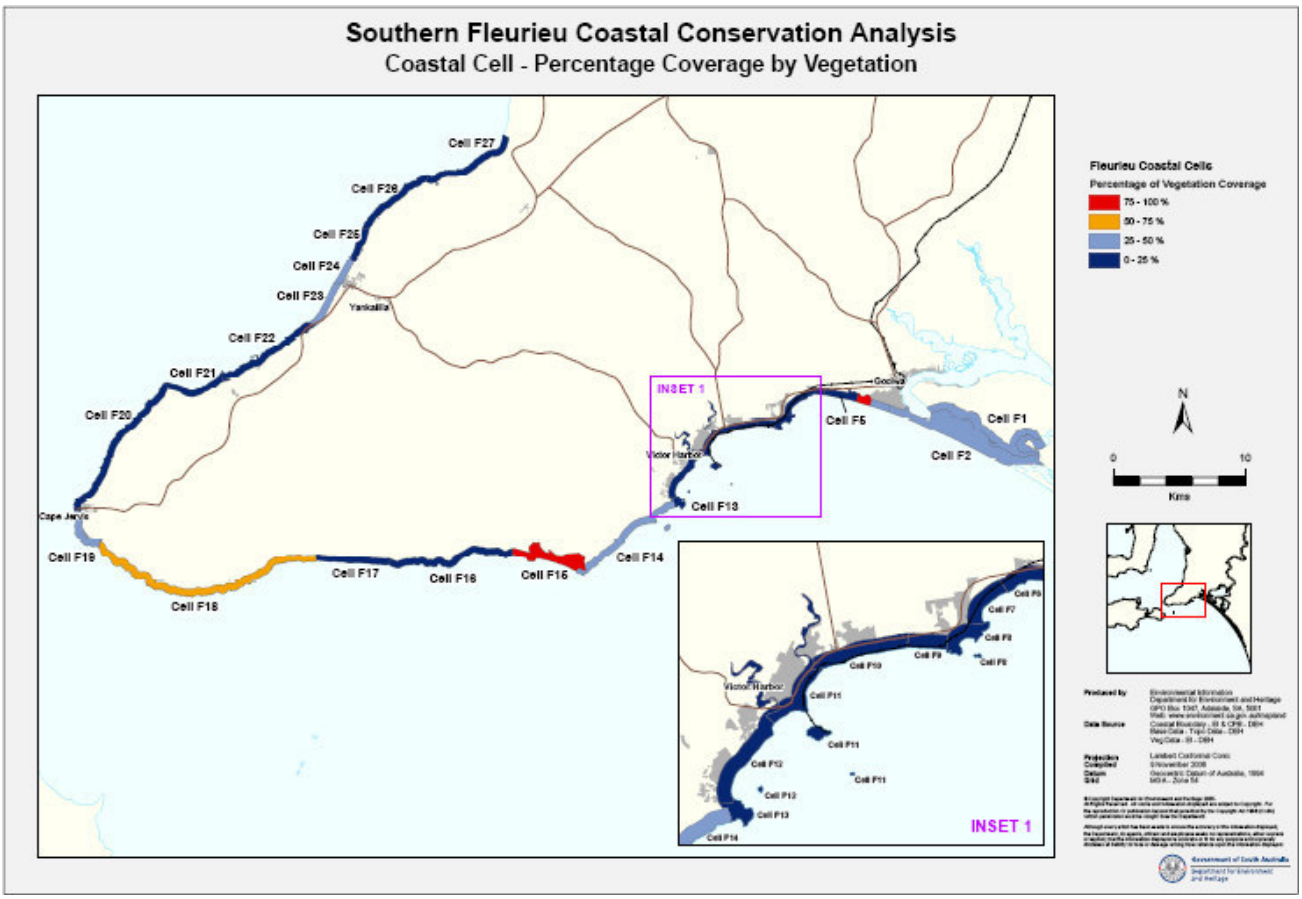


Figure 4. Percent Coverage by Vegetation

3.1.2 Floristic Communities

The Southern Fleurieu coast varies in annual rainfall from 500 to 800 mm. It has varying coastal exposure, landforms and soils. As a result of differences in these factors there is a variety of plant habitats occupied by different plant communities. Floristic mapping of Southern Fleurieu coast has been undertaken as part of the Biological Survey Program of South Australia. Vegetation classes are based primarily on dominant species, and structure. Broad floristic groupings were found in the study area from this mapping.

Oppermann, 1999, described the results of a statewide survey of the coastal dune and clifftop habitats in South Australia. The coastal dune and clifftop surveys were between October 1995 and November 1997. The survey also used site data from previous surveys for the analysis. A major purpose of this survey was to describe and measure the structure and composition of the coastal dune and clifftop communities. Another objective was to identify sites, plants and communities of conservation significance. Survey methodology conformed to the Biological Survey Program standards detailed by Heard and Channon (1997). Forty-five quadrat sites were surveyed within the Southern Fleurieu coastal boundary and a total of 1072 sites were used state wide for the analysis. Cluster analysis was used to determine meaningful floristic groupings.

Floristic groupings were described using a Specht / Muir derived structural table shown in Appendix 16, Glossary (Specht / Muir). No mapping was undertaken.

Table 1. Dominant Floristic Communities in Southern Fleurieu Coast, Coastal Dune and Clifftop Study 1999

Structural Class	Floristic group	SA Total	Fleurieu Total	% SA total
Grassland	*Spinifex sericeus / Euphorbia paralias*	42	4	9.5
Mallee	*Eucalyptus diversifolia/Clematis microphylla*	36	2	5.6
Mallee	*Eucalyptus diversifolia/Gonocarpus mezianus*	9	5	55.6
Sedgeland	*Gahnia lanigera/Lepidosperma congestum*	18	2	11.1
Sedgeland	*Lepidosperma gladiatum*	8	1	12.5
Shrubland	*Leucopogon parviflorus*	16	3	18.8
Shrubland	*Acacia paradoxa*	13	8	61.5
Shrubland	*Beyeria lechenaultii/Acrotriche patula*	11	3	27.3
Shrubland	*Leucopogon parviflorus/ Olearia axillaris*	150	3	2.0
Shrubland	*M. lanceolata/A. patula/L. discolor*	37	4	10.8
Shrubland	*Olearia axillaris/Rhagodia candolleana ssp.candolleana*	64	4	6.3
Shrubland	*Olearia ramulosa/Calytrix tetragona*	5	5	100.0
Trees	*Allocasuarina verticillata*	11	1	9.1

BOLD = 50 + % sites found in Southern Fleurieu Coast

Shaded = less than 20 sites total in South Australia

Table 1 shows 13 floristic groups identified from the 45 quadrats surveyed in coastal dune and clifftop habitats along the Southern Fleurieu coast. The table also shows for each floristic group the total number of quadrat sites recorded for South Australia. There are 3 floristic communities where greater than 50% of sites are found in the Southern Fleurieu coastal zone. Eight floristic groups have less than 20 site records for South Australia. Management of these floristic communities is particularly important.

Information assembled by Oppermann (1999) provided detail about each of the plant communities. This information has been summarised for 8 vegetation communities that within the Southern Fleurieu coast, show a high degree of endemism and also a degree of rarity for South Australia. These important coastal vegetation communities are listed below with a description, location map, cell locations, and a photograph of each. Extra comments relevant to the Southern Fleurieu coastal region have been added.

***Spinifex hirsutus* / *Euphorbia paralias* Grasslands (Shrublands)**

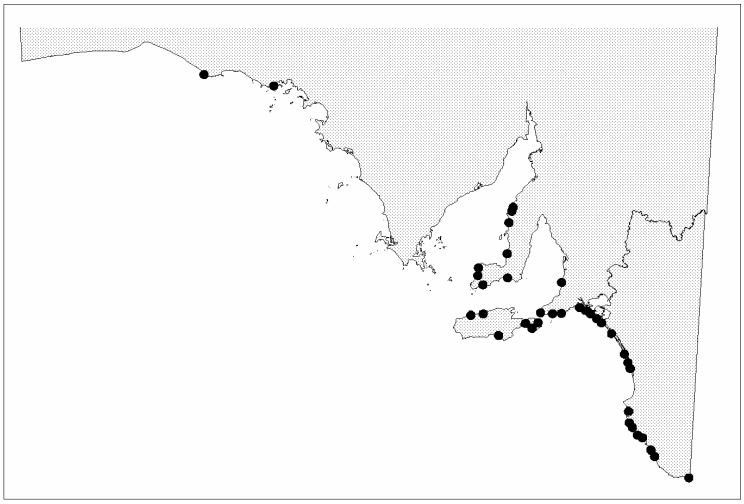
Description:
A strong group located mainly on foredunes, predominantly in the south facing coastline. The average number of species is moderately low with an unusually high proportion of herbs and grasses.

Distribution of sites in geomorphic regions: NUL – Nullarbor; HOB – Head of Bight; EPW – Eyre Peninsula, West; EPS – Eyre Peninsula, South; EPE – Eyre Peninsula East; SPG – Spencer Gulf ;YOP – Yorke Peninsula; SVG – St Vincent Gulf; KIS – Kangaroo Island South; KIE – Kangaroo Island East; KIN – Kangaroo Island North; FLP – Fleurieu Peninsula; COO – Coorong; SOE – South East.

HOB	EPW	YOP	SVG	KIN	KIS	KIE	FLP	COO	SOE
1	1	9	1	2	1	3	4	11	9

Number of plant species:

Min	Max	Average
3	19	10.52



Dominant species:

Euphorbia paralias
Spinifex hirsutus

Indicator species:

**Cakile maritima ssp. maritima*

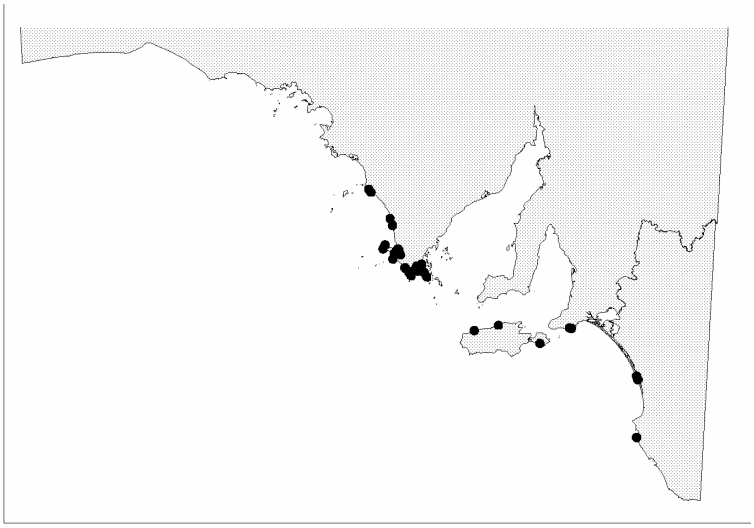
Figure 5. *Spinifex sericeus/Euphorbia paralias* grassland at Tunkalilla Beach (PID 15953)

***Eucalyptus diversifolia* / *Clematis microphylla* Mallees**

Description:
A very strong group particularly on southern Eyre Peninsula. Predominantly occurring Quaternary dune fields. There is a distinctive overstorey with few understorey species in common.

Distribution of sites in geomorphic regions: (see under Spinifex above for abbreviations in this table)

EPW	EPS	KIN	KIE	FLP	COO	SOE
5	24	2	1	2	2	1



Number of plant species:

Min	Max	Average
4	38	17.89

Dominant overstorey species:

Eucalyptus diversifolia

Dominant understorey species:

Clematis microphylla

Sub-dominant species:

Melaleuca lanceolata

Figure 6. *Eucalyptus diversifolia/Clematis microphylla* Mallee near Newland Head (PID 15964)

***Eucalyptus diversifolia* / *Gonocarpus mezianus* Mallee**

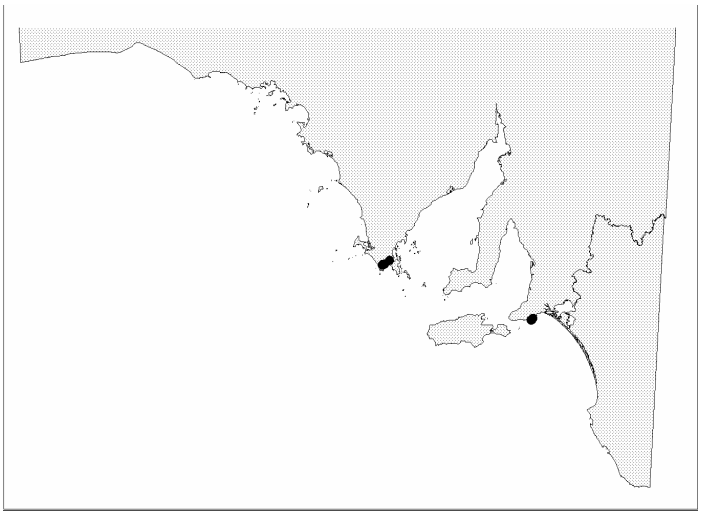
Description:
A moderately strong group located predominantly on cliffs. The connecting species is a herb but there are high abundances of Eucalypts throughout the group with a high number of understorey plant species. Five of the 9 sites are found on the Southern Fleurieu coast.

Distribution of sites in geomorphic regions: (see under Spinifex above for abbreviations in this table)

EPS	FLP
4	5

Number of plant species:

Min	Max	Average
21	62	41.78



Dominant overstorey species:

Eucalyptus diversifolia

Dominant understorey species:

Danthonia setacea var. setacea

Gonocarpus mezianus

Schoenus breviculmis

Sub-dominant Species:

Acacia pycnantha

Acrotriche cordata

Hibbertia riparia (glabriuscula)

Xanthorrhoea semiplana ssp.

Indicator Species:

Brachyloma ericoides ssp. Ericoides

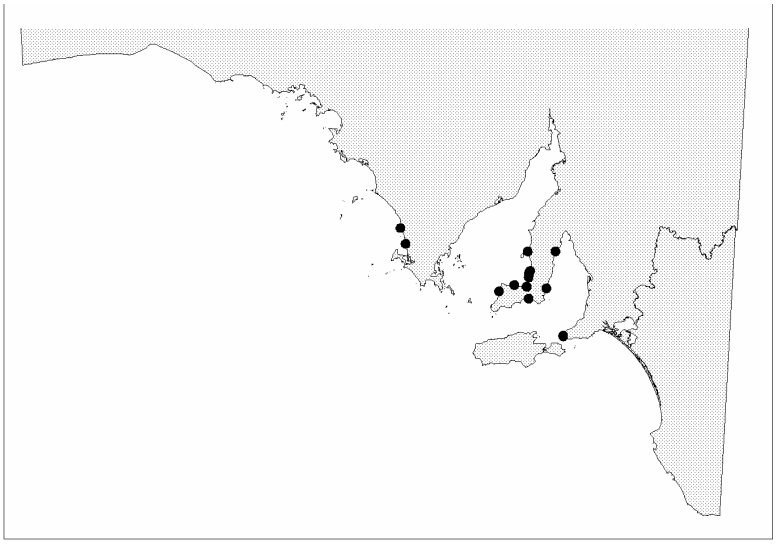
Figure 7. *Eucalyptus diversifolia* / *Gonocarpus mezianus* Mallee near Waitpinga (PID 15990)

***Gahnia lanigera* / *Lepidosperma congestum* Low sedgelands**

Description:
A moderately strong group located in the central part of the coastline on predominantly dunefields.

Distribution of sites in geomorphic regions: (see under Spinifex above for abbreviations in this table)

EPW	EPS	YOP	SVG	FLP
1	1	12	2	2



Number of plant species:

Min	Max	Average
15	40	26.89

Dominant species:

Gahnia lanigera

Helichrysum leucopsideum

Lepidosperma congestum

Sub-dominant species:

Lomandra effuse

Figure 8. *Gahnia lanigera* / *Lepidosperma congestum* Low sedgelands near Cape Jervis (PID 15983)

***Lepidosperma gladiatum* Sedgelands**

Description:
A very strong group located in the eastern part of the coastline on dunefields. There are low proportions of many of the life forms in the plant communities

Distribution of sites in geomorphic regions: (see under Spinifex above for abbreviations in this table)

YOP	KIN	FLP	SOE
5	1	1	1

Number of plant species:

Min	Max	Average
8	25	16.63

Dominant species:

Lepidosperma gladiatum

Indicator species:

Acacia nematophylla

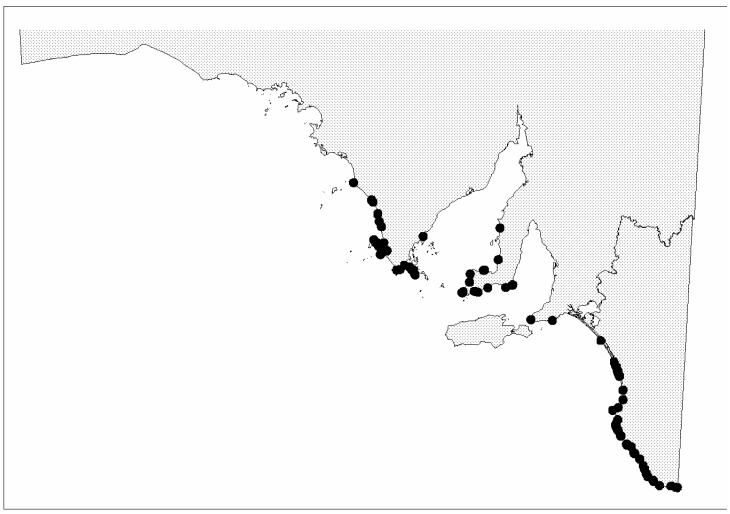
Figure 9. *Lepidosperma gladiatum* Sedgelands near Deep Creek (PID 15952)

***Leucopogon parviflorus* / *Olearia axillaris* Shrublands**

Description:
A strong group located predominantly on dunefields along the eastern part of the coastline. This is the largest group and includes very common coastal species. There is a distinctive overstorey with a wide distribution of life forms in the understorey.

Distribution of sites in geomorphic regions: (see under Spinifex above for abbreviations in this table)

EPW	EPS	YOP	FLP	COO	SOE
9	30	22	3	24	62



Number of plant species:

Min	Max	Average
8	36	20.59

Dominant overstorey species:

Leucopogon parviflorus

Olearia axillaris

Dominant overstorey species:

Carpobrotus rossii

Clematis microphylla

Rhagodia candolleana ssp. candolleana

Sub-dominant species:

Acacia longifolia var. sophorae

Lepidosperma gladiatum

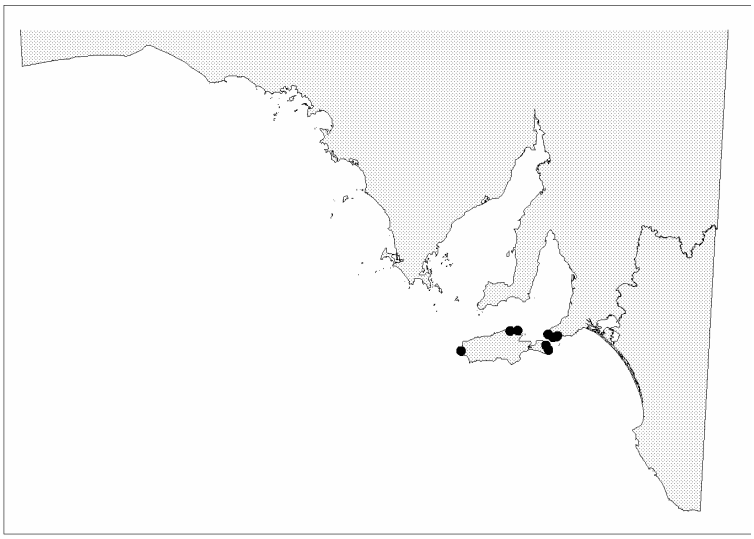
Figure 10. *Leucopogon parviflorus* / *Olearia axillaris* Shrublands near Cape Jervis (PID 15969)

***Acacia paradoxa* Shrublands**

Description:
A very strong group located predominantly on slopes of metasediments. There is a distinctive overstorey with few understorey plants.

Distribution of sites in geomorphic regions: (see under Spinifex above for abbreviations in this table)

KIN	KIS	KIE	FLP
1	1	3	8



Number of plant species:

Min	Max	Average
8	31	17.69

Dominant species:

Acacia paradoxa

Indicator species:

Astroloma humifusum

Figure 11. *Acacia paradoxa* Shrublands near Cape Jervis (PID 15982)

***Beyeria lechenaultii/ Acrotriche patula* Shrublands**

Description:
A moderately strong group located predominantly on cliffs of the adjacent map sheets of Yankallila and Noarlunga. A structurally diverse plant community with a moderately high number of species.

Distribution of sites in geomorphic regions: (see under Spinifex above for abbreviations in this table)

EPS	SVG	FLP
3	5	3

Number of plant species:

Min	Max	Average
20	42	26.82

Dominant species:

Acrotriche patula

Beyeria lechenaultii

Comesperma volubile

Sub-dominant Species:

Danthonia caespitosa

Olearia ramulosa

Pomaderris paniculosa ssp. paniculosa

Indicator Species:

Calytrix tetragona

Gahnia lanigera

Lepidosperma viscidum

Maireana enchylaenoides

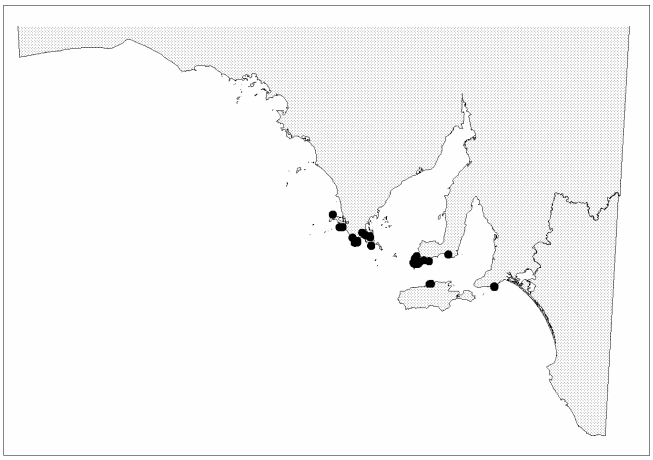
Figure 12. *Beyeria lechenaultii/ Acrotriche patula* Shrublands along the Gulf St Vincent coastline (PID 15970)

***Melaleuca lanceolata* / *Acrotriche patula* / *Lasiopetalum discolor* Shrublands/Mallees**

Description:
A moderately strong group located on dunefields and cliffs. There are a high number of species in a variable plant community with a predominantly low shrub understorey.

Distribution of sites in geomorphic regions: (see under Spinifex above for abbreviations in this table)

EPS	YOP	KIN	FLP
18	13	2	4



Number of plant species:

Min	Max	Average
18	49	30.81

Dominant overstorey species:

Melaleuca lanceolata

Dominant understorey species:

Acrotriche patula

Lasiopetalum discolor

Sub-dominant species:

Beyeria lechenaultii

Eucalyptus diversifolia

Gahnia lanigera

Indicator species:

Acrotriche cordata

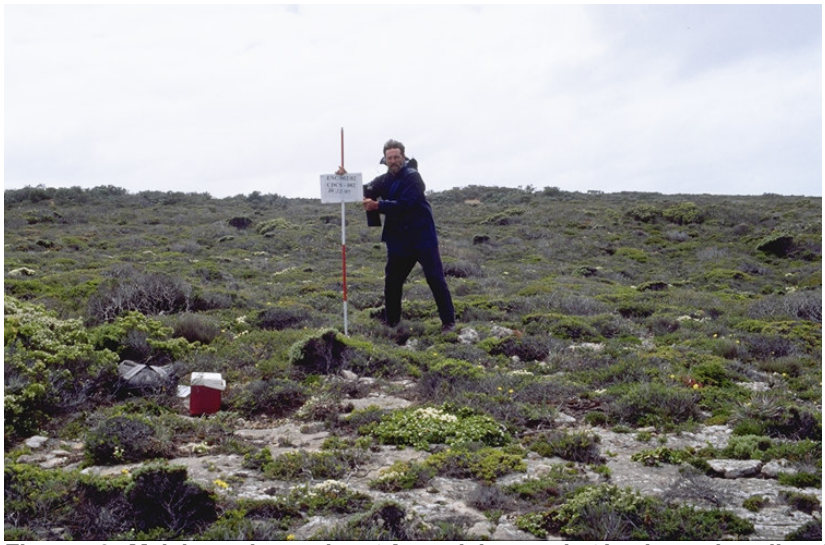


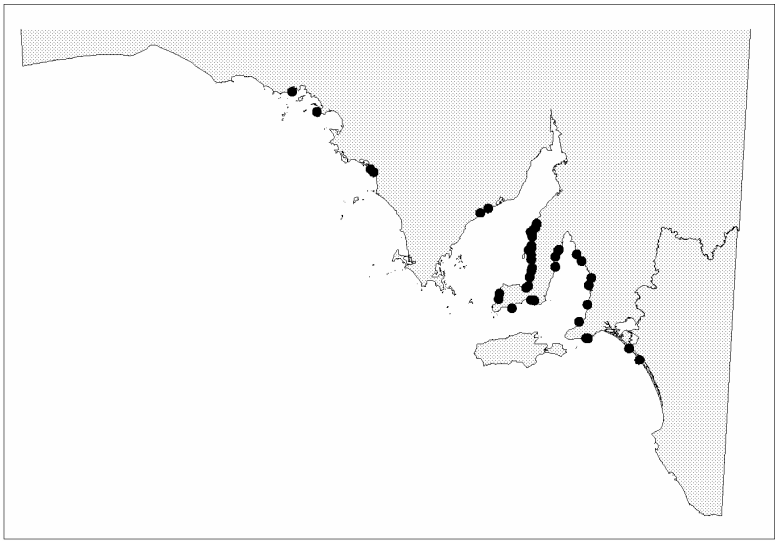
Figure 13. *Melaleuca lanceolata* / *Acrotriche patula* / *Lasiopetalum* discolour Shrublands/Mallees at Newland Head (PID 15929)

***Olearia axillaris* / *Rhagodia candolleana ssp. candolleana* Shrublands**

Description:
A large moderately strong group located along the coastline on predominantly dunefields.

Distribution of sites in geomorphic regions: (see under Spinifex above for abbreviations in this table)

EPW	EPE	YOP	SVG	FLP	COO
4	3	39	11	4	3



Number of plant species:

Min	Max	Average
9	31	19.50

Dominant overstorey species:

Olearia axillaris

Dominant understorey species:

Rhagodia candolleana ssp. candolleana

Tetragonia implexicoma

Threlkeldia diffusa

Sub-dominant species:

**Lagurus ovatus*

Indicator species:

Acacia ligulata

Figure 14. *Olearia axillaris* / *Rhagodia candolleana* ssp. *candolleana* Shrublands near Newland Head (PID 15960)

***Olearia ramulosa* / *Calytrix tetragona* Shrubland**

Description:
A moderately strong group in the Cape Jervis area on moderate to steep slopes of Precambrian metasediment cliffs. A mixture of mainly low shrubs with grasses and vines.

Distribution of sites in geomorphic regions:

FLP
5

Number of plant species:

Min	Max	Average
7	27	18.80

Dominant overstorey species:

Olearia ramulosa

Dominant understorey species:

Calytrix tetragona

Danthonia caespitosa

**Lagurus ovatus*

Muehlenbeckia gunnii

Senecio lautus

Indicator Species:

Ptilotus spathulatus forma spathulatus

Figure 15. *Olearia ramulosa* / *Calytrix tetragona* Shrubland near Second Valley (PID 15937)

***Allocasuarina verticillata* Forests**

Floristic Group 18: 11 quadrats

Description:
A very strong group which is located on cliffs and hills of metasediments across the central coastline. There is a distinctive overstorey with few common understorey species.

Distribution of sites in geomorphic regions: (see under Spinifex above for abbreviations in this table)

EPS	KIN	KIE	FLP
4	5	1	1

Number of plant species:

Min	Max	Average
2	29	12.55

Dominant overstorey species:

Allocasuarina verticillata

Indicator Species:

Cheilanthes austrotenuifolia

Figure 16. *Allocasuarina verticillata* Forests near Blowhole Beach (PID 15942)

3.1.3 Saltmarshes

Within the Southern Fleurieu study area there are 205 ha of saltmarsh habitat compared with a total of 194,000 ha within South Australia. All of the mapped saltmarsh is located within the residual Murray Mouth estuary, however small areas of marsh too small to be mapped occur at a number of locations. The project to classify and map saltmarshes in South Australia is described by Fotheringham, 2000. The main purpose of the project was to compile a state wide digital coverage of mangrove and saltmarsh habitats. In conjunction with the classification and mapping transect lines were levelled to survey the plant communities occurring within the different habitats. Plant communities were described and surveyed in accordance with Biological Survey Program standards.

The classification and mapping of the saltmarshes and mangroves have been completed and are described by Canty and Hille, 2002. The habitat classification was based on landform, tidal class, estuarine class, vegetation cover and condition. Sixty-nine habitat classes were defined during the mapping process for South Australia. Within the Southern Fleurieu coastal boundary 4 habitat classes have been mapped.

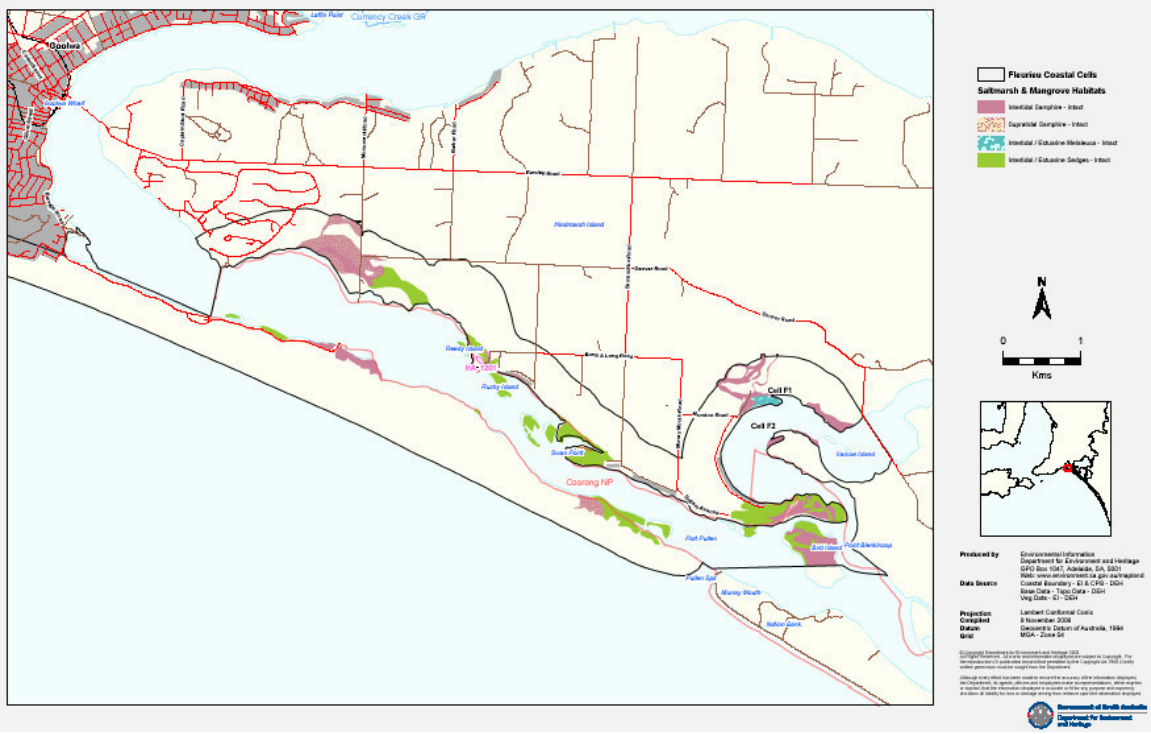


Figure 17. Saltmarsh habitat classes mapped near the Murray Mouth

Intertidal Samphire habitat (Figure 18) – Intertidal flats in sheltered waters occupied by a variety of halophytic plants herbaceous or shrubby forming both dense to sparse herblands and dense to sparse shrublands generally fringing the landward edge of the mangrove zone. Plants in this zone have adaptations to cope with frequent seawater inundation. 22784 hectares have been mapped in South Australia with 69 ha (0.3%) occurring in the study area.

Figure 18. Intertidal Samphire habitat

Intertidal / estuarine Melaleuca habitat (Figure 19) Intertidal flats with a freshwater influence occupied by *Melaleuca halmaturorum* (Swamp Paperbark) mid dense to sparse woodland. 22 hectares have been mapped in SA, 3.5 ha (16%) occurring within the study area. This is a rare habitat in SA.

Figure 19. Intertidal Melaleuca habitat

Intertidal / estuarine Sedges habitat (Figure 20)– Intertidal flats with a freshwater influence occupied by sedges often in association with *Melaleuca halmaturorum* Swamp Paperbark. 431 hectares mapped in South Australia of which 99 ha (23%) occurs in the study area. This is a rare habitat in South Australia.

Figure 20. Intertidal / estuarine Sedges habitat

Supratidal Samphire habitat (Figure 21)– Supratidal flats above the reach of astronomical tides but within the zone flooded by storm tides occupied by a variety of halophytic shrubby plants forming mid dense to very sparse shrublands. These plants have to tolerate very high soil salinity and in places long periods of inundation due to ponding during winter months. The halophytes are replaced by saltbush communities at the landward fringe of these habitats. 23906 hectares have been mapped in South Australia but only 33 ha (0.1%) occur in the study area.

Figure 21. Supratidal Samphire habitat

There is good representation of South Australia's estuarine saltmarsh habitats in the study area. Management of these habitats should be a particular focus of local coastal management.

3.1.4 Coastal Plant Species

Two lists of vascular plants found within the Southern Fleurieu coast boundary are provided and are shown in the appendices. One of the lists containing 608 species (shown in Appendix 7) is derived from the DEH plant record database. The second list, of 614 species (shown in Appendix 9) is from the records of opportunistic collecting by a local plant collector Ron Taylor. These lists compare with a total of 3,519 species known to occur in SA. A large number of species characteristic of the Mt Lofty ranges are present. The species lists also reflect the variation of environmental conditions along the coast such as shelter, soil and rainfall differences.

232 species found within the Southern Fleurieu coast boundary have a conservation status based on a recent review of existing determinations that follow those used by Lang and Kraehenbuehl 1998. Herbarium regions are used for the regional status determinations. The Southern Fleurieu coast study area is located in the Southern Lofty region.

The list of species with a conservation status is shown in Appendix 6. This list is based on both the DEH and Taylor plant records. In addition to the State and regional level determinations which are listed under Section 7, 8 and 9 of the *National Parks and Wildlife Act 1972* there are also national ratings that are listed under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*. Four species shown in Table 2 below are listed as nationally endangered or vulnerable. Plants rated nationally as vulnerable or endangered require the preparation of recovery plans under legislative requirements of the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*.

Table 2. Nationally rated plants recorded within the Southern Fleurieu Coast

Euphrasia collina ssp. Osbornii (Osborn's Eyebright)	Endangered	A small plant 15-20 cm tall, white to pink or lavender flowers and pale inside.
Olearia pannosa ssp pannosa (Silver Daisy Bush)	Vulnerable	Spreading shrub to undershrub with silver leaves up to 1.5 metres high with white to white/mauve flowers.
Spyridium coactilifolium (Butterfly Spyridium)	Vulnerable	Spreading shrub with rusty tomentose leaves less than 1 metre high.
Glycine latrobeana *(Clover Glycine)*	Vulnerable	A small perennial herb in the pea family. It grows 10 cm tall and is generally found in grassy woodlands and native grasslands.

Indigenous Fauna

Cunningham's Skink
Photographed by Peter Matejcic

Redcapped Plover
Photographed by Mary Crawford

Painted Dragon
Photographed by Sharie Detmar

3.2 Birds

[This section follows the habitat descriptions used by Haby, (in Caton et al 2006)]

Bird species identified within the Southern Fleurieu coastal region were listed from the 2005 'Atlas of Australian Birds', an exercise which yielded some 190 species. This list was examined by Graham Carpenter from the Department of Water Land & Biodiversity and reduced to those species which are listed as significant at the Commonwealth, State or Local level: a total of 61 species – the majority of threatened species currently detected within the Southern Fleurieu region. These birds are listed, together with the cells where they have been located, in Appendix 1. The habitat of these species within the Southern Fleurieu is briefly discussed below.

3.2.1 Bush Birds

The following threatened species inhabit woodland and dense shrubland within the Southern Fleurieu coastal region.

Painted Button-quail (*Turnix varia),* Brush Bronzewing (*Phaps elegans),* Yellow-tailed Black-Cockatoo (*Calyptorhynchus funereus),* Shining Bronze-cuckoo (*Chrysococcyx lucidus),* Yellow Thornbill (*Acanthiza nana modesta),* Black-chinned Honeyeater (*Melithreptus gularis gularis),* Scarlet Robin (*Petroica multicolor boodang),* Crested Shrike-tit (*Falcunculus frontatus),* Elegant Parrot (*Neophema elegans).*

These species show a variety of habitat. The Painted Button Quail, the Brush Bronzewing and the Elegant Parrot search for food on the ground; the former two for insects and seeds amongst the ground litter, the Elegant Parrot is omnivorous, consuming a mixed diet of seeds, fruits and invertebrates. These birds are ground nesting within wood or heath areas.

The Shining Bronze Cuckoo, Yellow Thornbill, Black Chinned Honeyeater, Scarlet Robin and Crested Shrike tit prefer an arboreal habit and forage for insects above ground These species also nest above ground. The Yellow-tailed Black Cockatoo consumes seeds and pine cones amongst woodland branches, but is also prepared to ground forage for seeds.

Species occupying woodland associations are at risk from habitat loss by clearance; of predation by foxes, feral cats and dogs; of degradation of habitat from high grazing pressure by stock, rabbits and abundant native herbivores; and herbicide and pesticide drift.

Heathland

The Beautiful Firetail (*Stagonopleura bella bella),* Chestnut-rumped Heathwren (*Calamanthus pyrrhopygius parkeri),* and Southern Emu-wren (*Stipiturus malachurus intermedius)* are found in restricted locations within the Southern Fleurieu coastal area. The Beautiful Firetail is seed eating and prefers water edge sites. The endangered Chestnut-rumped Heathwren and Southern Emu-wren are insectivorous and prefer dense cover. These species are primarily at risk from habitat loss and are the subject of species recovery plans.

3.2.2 Beaches, Dunes and Headlands

The Rock Parrot, *Neophema petrophila*, is a terrestrial species preferring to forage on the ground, low shrubs and among rocks and tidal flats of the coastline for seeds and fruits.

Orange-bellied Parrot, *Neophema chrysogaster,* is a seasonal visitor to the beaches of the eastern end of the Southern Fleurieu foraging for seeds amongst the coastal dune grasslands and low shrublands.

Threats to bush bird species using coastlines are similar to those faced by waders.

3.2.3 Waders

RIVERS, LAKES, SALTMARSH

Little Egret	*Egretta garzetta*
Cattle Egret	*Ardea ibis*
White-necked Heron	*Ardea pacifica*
Intermediate Egret	*Ardea intermedia*
Nankeen Night Heron	*Nycticorax caledonicus*
Australasian Bittern	*Botaurus poiciloptilus*
Glossy Ibis	*Plegadis falcinellus*
Royal Spoonbill	*Platalea regia*
Buff-banded Rail	*Rallus philippensis*
Lewin's Rail	*Rallus pectoralis*
Baillon's Crake	*Porzana pusilla*
Spotless Crake	*Porzana tabuensis*
Latham's Snipe	*Gallinago hardwickii*
Black-tailed Godwit**	*Limosa limosa*
Bar-tailed Godwit**	*Limosa lapponica*
Whimbrel**	*Numenius phaeopus*
Eastern Curlew**	*Numenius madagascariensis*
Wood Sandpiper**	*Tringa glareola*
Sanderling	*Calidris alba*
Long-toed Stint	*Calidris subminuta*
Pectoral Sandpiper**	*Calidris melanotus*
Banded Stilt*	*Cladorhynchus leucocephalus*
Golden-headedCisticola	*Cisticola exilis*

ROCKY SHORES, REEFS

Grey-tailed Tattler**	*Heteroscelus brevipes*
Pied Oystercatcher	*Haematopus longirostris*
Sooty Oystercatcher	*Haematopus fuliginosus*
Eastern Reef Egret	*Egretta sacra*

BEACHES, TIDAL FLATS

Pied Oystercatcher	*Haematopus longirostris*
Sooty Oystercatcher	*Haematopus fuliginosus*
Whimbrel**	*Numenius phaeopus*
Ruddy Turnstone**	*Arenaria interpres*
Lesser Sand Plover**	*Charadrius mongolus*
Greater Sand Plover**	*Charadrius leschenaultii*
Hooded Plover**	*Thinornis rubricollis*
Common Sandpiper**	*Actitus hypoleucos*

** N. hemisphere migrant

* N. Australia migrant

Waders require a variety of resources throughout the coast and, in some cases, terrestrial wetlands. Habitats preferred by waders include a combination of sheltered bays, estuaries, lagoons, mudflats, sandflats, spits, banks, near-coastal wetlands, seagrass, saltmarsh, mangroves, rocky coasts, rocky platforms, dunes and / or reef environments.

Preferred roosting sites are predominantly trees near wetlands, and mangroves, beaches, banks, spits, sand / shell bars, dunes, saltmarsh and shrubs, rocky areas, reefs, platforms, artificial structures and cliffs, with preferred nesting sites including trees, sandy areas, such as spits and low islands, among seaweed, vegetation or rocks or sand along beaches, offshore islands, ephemeral saltlakes and fresh, brackish and saline wetlands. Many wader species (approximately 35% of the list above) migrate to Australia during non-breeding season.

Threats to waders include a whole range of catchment and local management actions undertaken for economic or recreational reasons: in particular, modification of tidal flats due to modification of sediment or water movement is significant. Predation by foxes, feral cats and dogs and abundant native species (such as Silver Gulls) and decline in prey abundance due to fishing and human disturbance.

3.2.4 Diving Birds

The Great Crested Grebe (*Podiceps cristatus)* is the only species of threatened diver within the Southern Fleurieu coastal zone. Belonging to the family Podicipedidae, this species prefers freshwater bodies over coastal habitats, but is often located within coastal habitats during non-breeding season. The species dives for fish. Nest sites are constructed in freshwater wetlands with aquatic vegetation and open water. In open water, surface vegetation and edges of well-flooded cover will be used for roosting.

Grebes are susceptible to a decline in prey abundance due to fishing and pollution, loss of habitat for development and recreation, diversion of fresh water from natural coastal water bodies, high grazing pressure by stock in wetland habitats, pesticide and herbicide spray drift.

3.2.5 Seabirds

Five species of Seabirds have been identified within the coast of the Southern Fleurieu. These include the White-bellied Sea-eagle, *Haliaeetus leucogaster*, Pacific Gull, *Larus pacificus*, Kelp Gull *Larus dominicanus*, Fairy Tern, *Sterna neries* and the Common Tern *Sterna hirundo*).

The White-bellied Sea-eagles depend upon a variety of coastal habitats, terrestrial wetlands, water bodies and offshore islands. The White-bellied Sea-eagle prefers to hunt in open terrestrial habitats, inshore waters, islands, coral reefs, cays, bays, inlets, estuaries, mangroves and beaches, to hunt for birds, reptiles, fish, mammals, crustaceans and carrion, while the Osprey prefers large patches of water to locate fish, small terrestrial vertebrates, seabirds and crustaceans.

White-bellied Sea-eagles nest along cliffs, rock pinnacles, escarpments, tall trees, and Osprey on high positions, or positions surrounded by water, rocky headlands, stacks, cliffs, palm trees, dead trees and artificial platforms.

The Pacific Gull, Little Tern and Fairy Tern require coastal habitats, but have some ability to adapt to the changes in landscape and use salt fields, and in the case of the Pacific Gull, sewage ponds, paddocks and dumps. The Little Tern will nest in artificial banks, freshly deposited soil, some vegetation and the Fairy Tern in islands of dredge spoil.

The Pacific Gull forages along the coastline between the high water mark and shallow water, sandy beaches, exposed mudflats and mud banks. Whether the species breeds in South Australia and what habitat requirements are needed are as yet unknown.

The Common Tern and Fairy Tern both forage in shallow water and roost on sandy beaches, spits, banks and bars. The Fairy Tern requires sand spits, bars, banks, ridges, islands of dredge spoil, rocky islands, stacks, bare sand, near vegetation for suitable nest sites.

The seabirds listed above are at risk of predation by foxes, feral cats and dogs, and abundant native species, such as the Silver Gull, are at risk of loss of habitat from development and recreation, human disturbance, management of salt fields and sewage ponds, increasing vegetation cover along beaches, disrupted sand flow, loss of prey through fishing and pollution, and firewood collection. Some species, such as predatory birds, might also be at risk of hunting.

3.2.6 Wildfowl

Seven species of wildfowl have been identified in the Southern Fleurieu coastal zone. These include Brown Quail *Coturnix ypsilophora,* Blue-billed Duck *Oxyura australis,* Musk Duck *Biziura lobata,* Cape Barren Goose *Cereopsis novaehollandiae,* Australasian Shoveler *Anas rhynchotis,* Chestnut Teal *Anas castanea,* and the Hardhead *Aythya australasica.*

These species require terrestrial wetlands and coastal habitats; foraging at the edge of wetlands, on mud flats and in shallow water, or in deep water and amongst fringing vegetation, respectively. The fowl roost in a variety of locations including the water's edge, in dead trees and branches, grasslands and mudflats nearby, but require hollows or aquatic vegetation growing above the water and away from the edge of the wetland.

The herbivorous Cape Barren Goose occurs predominantly within grasslands and terrestrial wetlands, foraging in the grasslands, wetlands, mudflats and roosting nearby. The species nests on offshore islands, coming to the mainland to feed, often in paddocks with grazing stock, when feed available on the offshore islands has been depleted.

Wildfowl face a variety of risks including conflict of land use in agricultural areas, high grazing pressure by stock, rabbits and abundant native fauna, pollution, habitat loss from herbicide and pesticide spray drift and firewood collection.

3.3 Reptiles and Amphibians of the Southern Fleurieu Coastal Zone

By Claire Petherick

3.3.1 Identification of Reptile and Amphibian Species Occurring within the Southern Fleurieu Coastal Zone

State biological survey data and museum records show 19 reptile and amphibian species have been documented within the Southern Fleurieu Coastal Zone. One of these species, Cunningham's Skink (*Egernia cunninghami*), is considered vulnerable at the state level.

The data available provides a starting point for analysis of the conservation value of reptiles and amphibians, although there are numerous limitations that affect the ability to reflect true conservation values. For example, one limitation is that records are limited to site survey locations and have not been undertaken across all 27 southern Fleurieu coastal cells, (see Figure 3). The number and location of survey sites selected is usually based upon the distribution of existing sites in the area and local knowledge. Funding, time and access constraints also dictate the number of sites that can be visited.

Another limitation is that fauna surveying is a difficult exercise, as species are mobile by nature. Reptiles also seek protection under rocks, fallen logs and leaf litter which makes surveying a time-consuming exercise.

Given the above limitations, herpetology expert Tim Milne (Nature Conservation Society of South Australia) agreed to examine the available records to determine any other reptile and amphibian species also likely to be present in the Southern Fleurieu coastal zone.

Based upon Tim's knowledge of the region, reptile species and their habitat requirements, the list of reptile and amphibian species likely to occur in the Southern Fleurieu coastal zone was increased to 37. This includes three species considered rare at the state level. Table 3 details reptile and amphibian species of the Southern Fleurieu coastal zone and their corresponding conservation status at the state level (no species of national significance believed to be present). In addition, Table 4 identifies each species level of dependency on the coast, their abundance in the Southern Fleurieu (rare, uncommon or common), and regional coastal distribution (as identified by Tim Milne).

3.3.2 Distribution of Reptiles and Amphibian Species within the Southern Fleurieu Coastal Zone

The distribution of the 37 reptile and amphibian species within the Southern Fleurieu coastal zone can be determined by examining survey location sites and noting cells species are likely to occupy given their specific habitat requirements. Herpetology expert Tim Milne was able to develop a list detailing the habitat(s) each species occupies, which was then used to extrapolate which habitats occur in particular cells and therefore which cells / vegetation blocks may support particular species. The results of this distribution analysis are featured in Table 4 (refer to individual cell analysis for cell-specific species lists).

Table 3. Reptile and Amphibian Species of the Southern Fleurieu Coastal Zone

Common Name	Species	Conservation Status (SA)	Level of Dependency on Coast	Abundance	Regional Coastal Distribution
Adelaide Snake-lizard	*Delma molleri*		Not Dependent	Common	Restricted
Black Tiger Snake	*Notechis ater*				
Bougainville's Skink	*Lerista bougainvillii*		Not Dependent	Common	Widespread
Brown Toadlet	*Pseudophryne bibronii*		Not Dependent	Uncommon	Widespread
Brown Tree Frog	*Litoria ewingii*		Not Dependent	Common	Widespread
Bull Frog	*Limnodynastes dumerili*		Not Dependent	Common	Widespread
Common Froglet	*Crinia signifera*		Not Dependent	Common	Widespread
Common Long-necked Tortoise	*Chelodina longicollis*		Not Dependent		
Common Scaly-foot	*Pygopus lepidopdus*		Not Dependent	Uncommon	Widespread
Cunningham's Skink	*Egernia cunninghami*	Vulnerable	Partially Dependent	Rare	Restricted
Dwarf Skink	*Menetia greyii*		Not Dependent	Common	Restricted
Eastern Bearded Dragon	*Pogona barbata*		Not Dependent	Common	Widespread
Eastern Blue-tounge	*Tiliqua scincoides*		Not Dependent	Common	Widespread
Eastern Brown Snake	*Pseudonaja textilis*		Not Dependent	Common	Widespread
Eastern Three-lined Skink	*Bassiana duperreyi*		Not Dependent	Common	Widespread
Eastern Tiger Snake	*Notechis scutatus*		Not Dependent	Uncommon	Restricted
Four-toed Earless Skink	*Hemiergis peronii*		Partially Dependent	Uncommon	Restricted
Garden Skink	*Lamphropholis guichenoti*		Not Dependent	Common	Widespread
Heath Goanna	*Varanus rosenbergi*	Rare	Partially Dependent	Rare	Restricted
Lined Worm Lizard	*Aprasia striolata*		Not Dependent	Common	Widespread
Little Whip Snake	*Suta flagellum*		Not Dependent	Uncommon	Widespread
Loggerhead Turtle	*Caretta caretta*		Not Dependent		
Mallee Black-headed Snake	*Suta spectabilis*		Not Dependent	Uncommon	Restricted
Mallee Snake-eye	*Morethia obscura*		Partially Dependent	Common	Restricted
Marbled Gecko	*Christinus marmoratus*		Not Dependent	Common	Widespread
Olive Snake-lizard	*Delma inornata*	Rare	Not Dependent	Uncommon	Restricted
Painted Dragon	*Ctenophorus pictus*		Dependent	Common	Restricted
Painted Frog	*Neobatrachus pictus*		Not Dependent	Common	Widespread
Red-bellied Black Snake	*Pseudechis porphyriacus*		Not Dependent	Common	Widespread
Sleepy Lizard	*Tiliqua rugosa*		Not Dependent	Common	Widespread
Southern Grass Skink	*Pseudemoia entrecasteauxii*		Not Dependent	Common	Restricted
Southern Four-toed Slider	*Lerista dorsalis*		Not Dependent	Uncommon	Restricted
Spotted Grass Frog	*Limnodynastes tasmaniensis*		Not Dependent	Common	Widespread
Tawny Dragon	*Ctenophorus decresii*		Not Dependent	Common	Widespread
Three-toed Earless Skink	*Hemiergis decresiensis*		Not Dependent	Common	Widespread
White's Skink	*Egernia whitii*		Not Dependent	Common	Widespread
Yellow-bellied Water Skink	*Eulamprus heatwolei*	Rare	Not Dependent	Common	Restricted

Table 4. Reptile & Amphibian Species Distribution in the Southern Fleurieu

Species	Common Name	Habitat Occupies	Cell Recorded	Cells Species May Occupy
Adelaide Snake-lizard	*Delma molleri*	Woodland, Coastal Shrubland, Shrubland, Grassland		F1,F2,F3,F4,F5,F8.F9,F10,F11,F12,F13, F14,F15,F16,F17,F18,F19,F20,F21,F22, F23,F24,F25,F26,F27
Black Tiger Snake	*Notechis ater*		F1	
Bougainville's Skink	*Lerista bougainvillii*	Woodland, Coastal Shrubland, Shrubland, Grassland	F15	F1,F2,F3,F4,F5,F8,F9,F10,F11,F12,F13, F14,F15,F16,F17,F18,F19,F20,F21,F22, F23,F24,F25,F26,F27
Brown Toadlet	*Pseudophryne bibronii*			F1,F2,F10,F11,F12,F14,F16,F17,F18,F19, F20,F22, F23,F24,F25
Brown Tree Frog	*Litoria ewingii*	Woodland, Shrubland, Grassland, Sedgeland	F20	F1,F2,F4,F5,F8,F10,F11,F12,F13,F14, F15,F16,F17,F18,F19,F20,F22,F23,F24, F25,F26,F27
Bull Frog	*Limnodynastes dumerili*	Woodland, Shrubland, Grassland, Sedgeland		F1,F2,F4,F5,F8,F10,F11,F12,F13,F14, F15,F16,F17,F18,F19,F20,F22,F23,F24, F25,F26,F27
Common Froglet	*Crinia signifera*	Woodland, Shrubland, Grassland, Sedgeland		F1,F2,F4,F5,F8,F10,F11,F12,F13,F14, F15,F16,F17,F18,F19,F20,F22,F23,F24, F25,F26,F27
Common Long-necked Tortoise	*Chelodina longicollis*	Watercourses		F1,F2,F3,F4,F5,F7.F9,F10,F11,F12,F14, F15,F16,F17,F18,F19,F20,F21,F22,F23, F24,F25,F26,F27
Common Scaly-foot	*Pygopus lepidopdus*	Woodland		F11,F12,F14,F16,F17,F18,F19,F20,F22, F23,F24,F25
Cunningham's Skink	*Egernia cunninghami*	Coastal Cliffs	F14, F18	F12,F13,F15,F16,F17,F19,F20,F21,F22, F23
Dwarf Skink	*Menetia greyii*	Woodland, Coastal Shrubland		F2,F3,F4,F5,F9,F10,F11,F12,F14,F15, F16,F17,F18,F19,F20,F21,F22,F23,F24, F25,F26
Eastern Bearded Dragon	*Pogona barbata*	Woodland, Coastal Shrubland, Shrubland, Grassland	F15	F1,F2,F3,F4,F5,F8.F9,F10,F11,F12,F13, F14,F16,F17,F18,F19,F20,F21,F22,F23, F24,F25,F26,F27
Eastern Blue-tounge	*Tiliqua scincoides*	Woodland, Coastal Shrubland, Shrubland, Grassland	F12	F1,F2,F3,F4,F5,F8.F9,F10,F11,F13,F14, F15,F16,F17,F18,F19,F20,F21,F22,F23, F24,F25,F26,F27
Eastern Brown Snake	*Pseudonaja textilis*	Woodland, Coastal Shrubland, Shrubland, Grassland	F7	F1,F2,F3,F4,F5,F8.F9,F10,F11,F12,F13, F14,F15,F16,F17,F18,F19,F20,F21,F22, F23,F24,F25,F26,F27
Eastern Three-lined Skink	*Bassiana duperreyi*	Woodland, Shrubland		F1,F2,F3,F4,F5,F8.F9,F10,F11,F12,F13, F14,F15,F16,F17,F18,F19,F20,F21,F22, F23,F24,F25,F26,F27
Eastern Tiger Snake	*Notechis scutatus*	Sedgeland		F1,F2,F3,F4,F5,F7F9,F10,F11,F12,F14, F15,F16,F17,F18,F19,F20,F21,F22,F23, F24,F25,F26,F27
Four-toed Earless Skink	*Hemiergis peronii*	Coastal Shrubland	F14, F15	F2,F3,F4,F5,F9,F10,F18,F19,F20,F21, F22,F23,F24,F25,F26
Garden Skink	*Lamphropholis guichenoti*	Woodland	F15, F18	F11,F12,F14,F17,F19,F20,F22,F23,F24, F25
Heath Goanna	*Varanus rosenbergi*	Woodland, Shrubland, Coastal Shrubland		F1,F2,F3,F4,F5,F8,F9,F10,F11,F12,F13, F14,F15,F16,F17,F18,F19,F20,F21,F22, F23,F24,F25,F26,F27
Lined Worm Lizard	*Aprasia striolata*	Woodland, Shrubland		F1,F2,F3,F4,F5,F8,F9,F10,F11,F12,F13, F14,F15,F16,F17,F18,F19,F20,F21,F22, F23,F24,F25,F26,F27
Little Whip Snake	*Suta flagellum*	Woodland, Shrubland	F8	F1,F2,F4,F11,F12,F13,F14,F15,F16,F17, F18,F19,F20,F22,F23,F24,F25,F27
Loggerhead Turtle	*Caretta caretta*		F20	
Mallee Black-headed Snake	*Suta spectabilis*	Woodland, Shrubland		F1,F2,F4,F8,F11,F12,F13,F14,F15,F16, F17,F18,F19,F20,F22,F23,F24,F25,F27
Mallee Snake-eye	*Morethia obscura*	Woodland	F15	F11,F12,F13,F16,F17,F18,F19,F20,F22, F23,F24,F25
Marbled Gecko	*Christinus marmoratus*	Woodland, Shrubland	F14, F15, F18	F1,F2,F3,F4,F5,F8.F9,F10,F11,F12,F13, F16,F17,F19,F20,F21,F22,F23,F24,F25, F26,F27
Olive Snake-lizard	*Delma inornata*	Woodland, Grassland		F1,F2,F11,F12,F14,F16,F17,F18,F19,F20, F22,F23,F24,F25
Painted Dragon	*Ctenophorus pictus*	Coastal Shrubland		F2,F3,F4,F5,F6,F7,F8.F9,F10,F11,F12, F14,F15,F16,F17,F18,F19,F20,F21,F22, F23,F24,F25,F26,F27
Painted Frog	*Neobatrachus pictus*	Woodland, Sedgeland, Grassland, Coastal Shrubland, Sedgeland		F1,F2,F3,F4,F5,F8.F9,F10,F11,F12,F13, F14,F15,F16,F17,F18,F19,F20,F21,F22, F23,F24,F25,F26,F27

Red-bellied Black Snake	*Pseudechis porphyriacus*	Woodland, Coastal Shrubland, Shrubland, Grassland		F1,F2,F3,F4,F5,F8.F9,F10,F11,F12,F13, F14,F15,F16,F17,F18,F19,F20,F21,F22, F23,F24,F25,F26,F27
Sleepy Lizard	*Tiliqua rugosa*	Woodland, Coastal Shrubland, Shrubland, Grassland	F15	F1,F2,F3,F4,F5,F8.F9,F10,F11,F12,F13, F14,F15,F16,F17,F18,F19,F20,F21,F22, F23,F24,F25,F26,F27
Southern Grass Skink	*Pseudemoia entrecasteauxii*	Woodland, Shrubland	F1	F2,F3,F4,F5,F8.F9,F10,F11,F12,F13,F14, F15,F16,F17,F18,F19,F20,F21,F22,F23, F24,F25,F26,F27
Southern Four-toed Slider	*Lerista dorsalis*	Woodland, Coastal Shrubland		F2,F3,F4,F5,F9,F10,F11,F12,F14,F16, F17,F18,F19,F20,F21,F22,F23,F24,F25, F26
Spotted Grass Frog	*Limnodynastes tasmaniensis*	Woodland, Shrubland, Grassland, Sedgeland		F1,F2,F4,F5,F8,F10,F11,F12,F13,F14, F15,F16,F17,F18,F19,F20,F22,F23,F24, F25,F26,F27
Tawny Dragon	*Ctenophorus decresii*	Woodland	F16, F18	F11,F12,F14,F17,F19,F20,F22,F23,F24, F25
Three-toed Earless Skink	*Hemiergis decresiensis*	Woodland, Shrubland	F18	F1,F2,F3,F4,F5,F8.F9,F10,F11,F12,F13, F14,F15,F16,F17,F19,F20,F21,F22,F23, F24,F25,F26,F27
White's Skink	*Egernia whitii*	Woodland, Coastal Shrubland, Shrubland, Grassland	F14, F15, F18	F1,F2,F3,F4,F5,F8.F9,F10,F11,F12,F13, F16,F17,F19,F20,F21,F22,F23,F24,F25, F26,F27
Yellow-bellied Water Skink	*Eulamprus heatwolei*	Woodland, Shrubland		F1,F2,F3,F4,F5,F7,F9,F10,F11,F12,F14, F15,F16,F17,F18,F19,F20,F21,F22,F23, F24,F25,F26,F27

3.3.3 Conservation Value Allocation

To display reptile and amphibian species as a GIS conservation layer for this study it was necessary for individual species to be allocated a conservation value on a scale of between 1 and 9, with 1 being the lowest and 9 being the highest. Values were assigned based upon species official conservation status, level of dependency on the coast, abundance in the Southern Fleurieu and their regional coastal distribution (as previously outlined in Table 3).

Tables 5a-5d provide a summary of the allocation system used to assign conservation values to reptile and amphibian species. It is important to note that the individual components (GIS layers) of the value allocation system cannot be compared to one another – all are considered equally important in determining the conservation regime and need to be examined separately.

Table 5a. Conservation Value Allocation System (Part 1) - Conservation Status (State)

Value	Conservation Status
9	Endangered
5	Vulnerable
1	Rare

Table 5b. Conservation Value Allocation System (Part 2) - Species Dependency on Coastal Habitats

Value	Level of Coastal Dependency
9	Dependent
5	Partially dependent
0	Not dependent

Table 5c. Conservation Value Allocation System (Part 3) - Species Abundance in the Southern Fleurieu Coastal Region

Value	Abundance
9	Rare
5	Uncommon
1	Common

Table 5d. Conservation Value Allocation System (Part 4) - Regional Coastal Distribution / Species Affinity to the Coast

Value	Regional Coastal Distribution
9	Restricted
1	Widespread

3.3.4 Results

The conservation value allocation system highlights a number important reptile species and significant reptile and amphibian habitats in the Southern Fleurieu coastal zone. A brief discussion of key species, including description, distribution and habitat requirements, is provided in the following section, along with photographs and species specific distribution maps. Information on species with restricted distributions is also provided as impacts upon the habitats they occupy will have direct affects on certain reptile and amphibian species. Significant habitats are discussed in further detail in the conservation analysis component of this Plan.

3.3.5 Species of State Significance Present in the Southern Fleurieu Coastal Zone

Cunningham's Skink (*Egernia cunninghami*)

Cunningham's Skink is a large species that is readily identified by the distinctive spiny keels on each back scale (most pronounced on the tail). It is active during the day and feeds on fruits and seeds, invertebrates, and occasionally small vertebrates. Cunningham's Skink commonly shelters in crevices in rock formations and boulder slopes, from which its spiny scales make its removal by predators almost impossible.

There are two main populations in the Southern Mount Lofty Ranges, one of which is located along the coastal cliffs of the Southern Fleurieu Peninsula from Normanville to Victor Harbor. Cunningham's Skink has a Vulnerable rating at the state level. The species is partially dependent on coastal habitats and is considered rare in the southern Fleurieu coastal zone.

Heath Goanna (*Varanus rosenbergi*)

The Heath Goanna can grow to 1.5 metres. It displays a blackish base colour dotted with pale yellow or white, interlaced with a series of black bands. Its belly is pale with reticulated black or grey bands. It has a restricted distribution in the Southern Fleurieu, inhabiting woodlands, shrublands and coastal shrublands where it feeds upon other reptiles, insects, small mammals, and carrion. The species is considered Rare in South Australia and the Southern Fleurieu coastal zone.

It is worthwhile noting that anecdotal evidence from Western Australia suggests young Heath Goanna are vulnerable to predation by foxes with sightings of younger individuals being more common in areas that have been subject to fox-baiting.

Olive Snake-Lizard (*Delma inornata*)

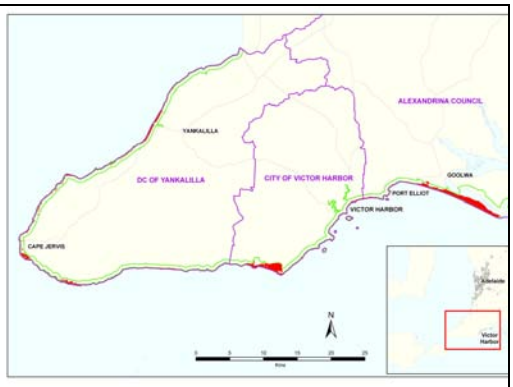
The Olive Snake-Lizard is a species of legless lizard featuring deep brown colouring on its back, often with a yellow throat. The species is classified as Rare in South Australia. It has a restricted distribution in the Southern Fleurieu, inhabiting woodland and grassy areas where it feeds upon on small invertebrates. It is considered uncommon on the coast.

Yellow-bellied Water Skink (*Eulamprus heatwolei*)

The Yellow-bellied Water Skink has an olive-brown base colour on the back with darker flecks, and dark flanks featuring lighter spots. A pale stripe runs from the mouth upwards to the front of the ear opening. The Yellow-bellied Water Skink is a ground dwelling species that feeds on an array of invertebrates and small vertebrates. It is Rare in South Australia. The species is restricted to watercourses and permanent swamps and is common in the southern Fleurieu coastal zone.

Painted Dragon (*Ctenophorus pictus*)

The Painted Dragon is a coastal dependent species which is restricted to coastal dune systems, with a preference towards large, relatively intact coastal shrublands. It commonly shelters in short burrows in sandy soils. It is a common species in the Southern Fleurieu coastal zone.



Mallee Snake-eye (*Morethia obscura*)

Limited information available. Species is partially dependent on the coast, distribution restricted to woodlands. Common in Southern Fleurieu.

3.3.6 Species with Restricted Distributions in the Southern Fleurieu Coastal Zone

Adelaide Snake-lizard (*Delma molleri*)

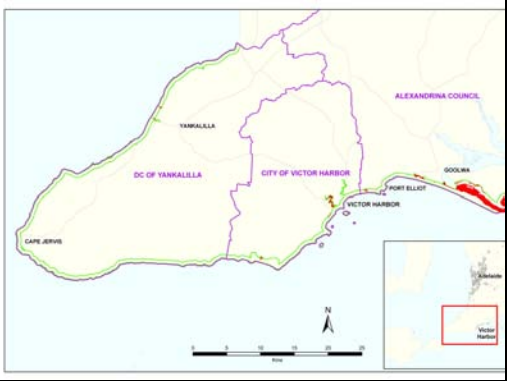
Commonly sighted legless lizard growing to 20 cm in length, featuring light brown colourings with a blackish-grey cap. Bears a resemblance to a juvenile eastern brown snake (*Pseudonaja textilis*). Not dependent on the coast, distribution restricted to woodlands, coastal shrublands, shrublands and grasslands. Common on the Southern Fleurieu.

Southern Four-toed Slider (*Lerista dorsalis*)

A burrowing species which feeds on insects in loose sand or soil or beneath stones and logs. Restricted to woodlands and coastal shrublands, although not dependent on the coast. Uncommon in the Southern Fleurieu coastal zone.

Dwarf Skink (*Menetia greyii*)

A diurnal species, commonly found in leaf litter or grasses. Restricted to woodlands and coastal shrublands, although not dependent on the coast. Common in the Southern Fleurieu coastal zone.

Southern Grass Skink (*Pseudemoia entrecasteauxii)* Restricted to woodlands and shrublands, usually found on or around timber debris or foraging in leaf litter. Not dependent on the coast although common in the Southern Fleurieu coastal zone.	
Eastern Tiger Snake (*Notechis scutatus*) Venomous species that mainly feeds on frogs. Nocturnal in warmer conditions. Restricted to sedgelands and not dependent on the coast. Uncommon in the Southern Fleurieu coastal zone.	
Mallee Black-headed Snake **(*Suta spectabilis*)** A nocturnal species often found sheltering under timber, rocks ground litter, or in abandoned insect and reptile burrows. Distribution restricted to woodlands and shrublands, not dependent on the coast. Uncommon in the Southern Fleurieu coastal zone.	

3.4 Butterflies

Butterfly habitat has been included as a layer in the conservation analysis for this project. In 1997 a survey of the majority of the Southern Fleurieu coast was undertaken by Roger Grund. It identified areas of native vegetation remnants containing food plants favoured by butterfly larvae, together with comments on the health of those remnants (Grund, 1997).

Grund's survey was undertaken to identify remaining major vegetation remnants in region. Within the remnants identification of food plants for threatened butterfly species was undertaken as well as identification of species currently remaining. This work was based on the notion that butterfly populations are controlled by larval food plants.

Gahnia lanigera

Gahnia filum

(Photographs by Ron Sandercock)

Table 6. Southern Fleurieu: Butterfly Species and Larval Foodplants

[FAMILY] Species	Common Name	Vulnerability (Grund)	Larval Foodhost
[HESPERIIDAE] (Skippers)			[Skipper butterflies are entirely dependent on tussock grasses]
Anisynta cynone cynone	Cynone Skipper	Vulnerable	Native & introduced grasses, incl. e.g. *Brachypodium distachyon*
Anisynta cynone gracilis	Cynone Skipper	Rare	Native & introduced grasses, incl. e.g. *Brachypodium distachyon*
Herimosa albovenata albovenata	White-veined Skipper	Rare	*Stipa eremophila; S. scabra falcata; S. semibarbata*
Hesperilla chrysotricha leucosia	Chrysotricha Skipper	Vulnerable	*Gahnia duesta; G. filum; G. sieberiana; G.trifida*
Hesperilla donnysa diluta	Donnysa Skipper	Rare	*Gahnia ancistrophylla; G. duesta; G. filum; G. sieberiana; G.trifida*
Hesperilla idothea clara	Flame Skipper	Rare	*Gahnia clarkei; G. radula; G. sieberiana; G.trifida*
Motasingha trimaculata trimaculata	Trimaculata Skipper	Rare	*Lepidosperma carphoides; L. viscidum*
Antipodia atralba	Black and White Skipper	Local	*Gahnia ancistrophylla; G. duesta; G. lanigera*
Sub-family [SATYRINAE] (Browns)			
Geitoneura acantha ocrea	Southern Ringed Xenica	Rare	*Microlaena stipoides; Poa tenera; Themeda triandra*
[LYCAENIDAE] (Coppers & blues)			
Ogyris amaryllis meridionalis	Amarylis Azure	Local	*Amyema melaleucae; A. miquelii; A. pendulum pendulum; A. presseii.* Larvae attended by small ants
Ogyris genoveva genua	Genoveva Azure		*A. miquelii; A. pendulum pendulum.* Larvae attended by sugar ants
Ogyris otanes	Small brown Azure	Vulnerable	Larval stage spent in sugar ant nests
Ogyris idmo halmaturia	Large brown Azure	Endangered	*Choretrum glomeratum glomeratum.* Larvae attended by sugar ants
Theclinesthes albocincta	Grund's Blue	Local	*Adriana* spp. incl. *klotzshii*
Jalmenus icilius	Icilius Blue	Rare	*Acacia* spp. incl. *anceps, aneura aneura, pycnantha, retinodes, uncifolia, victoriae victoriae.* Larvae attended by small black ants

In the Southern Fleurieu, the area covered in the 1997 included wide coastal areas from Sellicks to Rapid Bay and from Newland Head to Murray Mouth. In 2006 Grund extended his work to include Deep Creek Conservation Park and areas of scrub near to Cape Jervis, thus allowing the completion of the database for this project.

Within this area significant privately held sites include Myponga and Yankalilla Rivers; two small cliff sites north of Carrickalinga; and some *Gahnia trifida* wetlands in the southern areas of the peninsula. These sites need heritage agreements. Other significant sites are in reserve status.

Table 7. Sites Identified by Grund (1997) (and updates, 2006) within the Southern Fleurieu Coastal Boundary

Location	Cell	Foodplants for thr. sp.	Obse-rved Butter-fly Sp	Likely thr.sp.	Land Status	Veg. Condition / Significant Butterfly species	Rehabilitation Suitability	Score
Newland Head	F15	✓	Thr. + C	✓	CP NPWS	Extensive varied habitat with valuable hostplant patches. Pressure of kangaroo grazing. Presence of *Hesperilla chrysotricha A. atralba Theclinesthes albocincta.*	Possible to rehabilitate fringe areas and reintroduce *Jalmenus icilius, Ogyris otanes, Ogyris idmo, O. amaryllis, M. trimaculata, A. cynone cynone, G. acantha, O. genoveva*	9
Goolwa "CP"	F4	✓	Thr. + C	✓	NPWS (un dedic.)	Fair condition, but highly significant as major breeding habitat for *Anisynta cynone cynone. Also present Hesperilla donnysa diluta, Theclinesthes albocincta*	*H. chrysotricha, J. icilius, O. amaryllis*	9
Deep Creek CP						Extensive varied habitat with valuable hostplant patches. Presence of *H. chrysotricha, H. idothea, G. acantha*,	Possible to rehabilitate and reintroduce *Ogyris otanes, Ogyris idmo, O. amaryllis, M. trimaculata, O. genoveva*	9

Sellicks Cliffs Coastal Reserve	F27	✓	C	✓	Coastal reserve	Degraded coastal heath	*A. cynone gracilis*	7
Carrickalinga Beach	F25	✓	C	-	Coastal reserve	Dunes in poor condition	*J. icilius, T. albocincta, A. cynone gracilis, O. amaryllis*	7
Normanville Dunes	F24, F23	✓✓	Thr. + C	✓	Coastal reserve	Dunes in good condition but degraded by *Acacia sophorae*. Presence of *J. icilus*	*T. albocincta, A. cynone gracilis, O. amaryllis, O. otanes*	9
Second Valley, sea cliffs	F22	✓	C	✓	Coastal reserve	Coastal cliff heath, degraded by grazing pressure	*A. cynone gracilis, T. albocincta,*	7
Rapid Bay cliffs	F21	✓	C	✓	Coastal reserve	Cliffs provide habitat, cliff tops degraded by grazing pressure	*A. cynone gracilis, T. albocincta,*	7
Newland Head cliffs to Kings Head and the Bluff	F14, F13	✓	-	-	Coastal reserve	Coastal heath, sparse food plants; but many records of butterfly species in adjacent conservation park	*A. atralba M. trimaculata,*	7
Hindmarsh River Mouth, coastal reserve	F10	✓	C	(✓)	Coastal reserve	Significant site with rare foodplants	*T. albocincta, H. donnysa diluta*	7
Dunes: Surfers to Goolwa	F5, F6	✓	C	✓	Coastal reserve	Coastal dunes in mixed condition and under great pressure	*T. albocincta, A. cynone cynone, O. amaryllis*	5
Sir Richard Peninsula	F2	✓	C		SA Water reserve	Extensive barrier dune mass and fringing swamp, extensive areas of exotics	*T. albocincta, A. cynone cynone O amaryllis*	7
Hindmarsh Island, Murray Mouth Lookout Reserve	F1	✓	C	✓	Coastal reserve	Sand dune, with potential for supporting introduced foodplants	*A. cynone cynone*	5
Victor Harbor, Inman River Floodplain	F12	✓	C	✓	Council Reserve	Extensive well watered reserve, with considerable scope for introduced foodplants. Many old records of threatened species	*H. chrysotricha, T. albocincta, G. acantha, A. cynone cynone*	5
Goolwa Golf Course & Heritage Areas	F4	✓	Thr. + C	✓	Private, part Heritag e listed	Significant woodland and heath site *with A. cynone cynone, T. albocincta, O. amaryllis, H. donnysa diluta*	*M. trimaculata*	9
Myponga River Gorge and Estuary	F27	✓	Thr. + C	(✓)	Private, SA Water	Estuarine system is rare, but considerably degraded by sedimentation and altered flow regime. *O. genoveva, O. amaryllis, G. acantha, H. chrysotricha*	*H. donnysa diluta, A. cynone gracilis, J. icilius*	9
Carrickalinga North, Whitelaw Road	F26	✓	Thr.	(✓)	Private & coastal reserve	*Gahnia lanigera* heath is one of two sites in region: presence of *Antipodia atralba*		9
Carrickalinga North Canyon	F26	✓	C	-	Private & coastal reserve	*Gahnia lanigera* heath and *E. diversifolia* heath	*T. albocincta*	9
Yankalilla, Bungala R & Hay Flat Road Creek	F24	✓	C	(✓)	Private & council reserve	Degraded wetland	*H. chrysotricha, G. acantha*	1
Yankalilla, Little Gorge	F23	✓	-	-	Private	Degraded through grazing		3
Yankalilla River (lower fraction only within boundary)	F23	✓	Thr. + C	(✓)	Private	Degraded wetland and valley woodland, but with numerous native veg remnants, not yet developed for housing. Presence of very large *O. olane* colony	Has considerable potential	8
Lady Bay Sea Cliffs	F23	✓	-	✓	Private	Coastal heath on very steep cliff slopes; vegetation on grazed tops virtually destroyed		3
Lady Bay					Private & coastal reserve	Coastal heath on degraded sand plain	*A. cynone gracilis, T. albocincta*	7
Wirrina Cove Resort & Anacotilla River	F22	✓	C	✓	Private & coastal reserve	Several and varied remnants; only cliff and coastal heath in good condition	*A. cynone gracilis, T. albocincta, O. amaryllis*	3

Cape Jervis, Lands End		✓	R		Private & coastal reserve	*Gahnia lanigera* heath, southernmost known in region; *A. atralba* present	*T. albocincta, M. trimaculata*	9
Second Valley, Parananaco o-ka River	F22	✓	C	✓	Private & Council reserve	Clearing and grazing have left the valley in poor condition	*H. chrysotricha*	1
Rapid Bay, Yattogolinga River	F21	✓	C	✓	Private & Council reserve	Clearing and grazing have left the valley in poor condition	*H. chrysotricha*	1
Victor Harbor, Lower Reaches of the Hindmarsh River	F11	✓	C	(✓)	Private	Degraded. Considerable re-vegetation needed to establish habitat	*H. chrysotricha, H. idothea, G. acantha*	1
Port Elliot, Watsons Gap swamp	F10	✓	Thr.	✓	Road reserve & private	A large remnant of *Gahnia filum* marshland on south side of road – a very significant feature	*A. cynone cynone, H. donnysa diluta*	8
Hindmarsh Island, Monument Road marshland	F1	✓	-	✓	Private	Saline chenopod grassland suitable for vulnerable skipper *Anisynta cynone cynone*	*A. cynone cynone, H. donnysa diluta*	8
Hindmarsh Island, Mundoo Channel & Boggy Creek	F1	✓	-	-	Private	Significant melaleuca stands and sedge swamp in good condition	*H. donnysa diluta*	5

Values for GIS analysis

9 – Unique, extensive remnant butterfly habitat containing breeding colonies of threatened butterflies. Highly significant, extensive butterfly habitat (rare foodplants or breeding habitat); containing rare or locally significant butterfly species.

8 – Highly significant, extensive butterfly habitat, suitable for additional revegetation with foodplants for threatened butterfly species and / or reintroduction of threatened butterfly species.

7 – Highly significant, extensive butterfly habitat, suffering degradation; suitable for additional revegetation with foodplants for rare or locally significant butterfly species and / or reintroduction of rare or locally significant butterfly species.

5 – Significant habitat in mixed to poor condition, but with considerable potential for threatened species.

3 – Habitat, with significant patches, with possible potential for threatened species.

1 – Habitat with potential for threatened species following considerable restoration.

Following discussion with Roger Grund, habitat was scored for its actual or potential value to butterfly larvae, together with the species status, as indicated above.

Heritage

Basham's Beach
Photographed by Alison Eaton

Morgan's Beach
Photographed by Ron Sandercock

Crushing & Dressing Works (c. 1863)
of the Talisker Silver / Lead Mine
Photographed by Ron Sandercock

3.5 Heritage

3.5.1 Aboriginal Heritage sites

Coastal lands of the Southern Fleurieu Peninsula have been the traditional country of the Ngarrindjeri and Ramindjeri people in the south, and the Kaurna people on the Gulf coast. Ross, 1984, has produced a summary and discussion of Kaurna Aboriginal sites in the Southern Mount Lofty Ranges for the Anthropological Society of South Australia. These show a preference for coastal sites over inland sites, because of the availability of food and water resources; coastal dune and river mouth sites being especially popular as campsites and meeting grounds. However, it should be remembered that the coastline has only been in its present position for the last 7000 years; when Aboriginal people arrived in the area, possibly 20,000 years ago, sea level was lower, and the coastline was located south of Kangaroo Island. Movement by land to KI and other islands would have been possible at that time. Records of coastal sites older than 7000 years have flooded by the rising sea level of the Post-Glacial Transgression.

Aboriginal heritage sites that have been registered on the State Heritage Register have been used in the conservation analysis. These sites are buffered on the digital maps to the cell level; thus if the cell contains a registered site, the whole cell would be given a high value for this digital layer. This process had two values for the analysis: firstly, Aboriginal sites contributed to the identification of places with a high conservation priority; secondly, the digital layer flags those areas where there is registered Aboriginal significance, for the users of this report. This is aimed to trigger a dialogue between users of the locality and the Aboriginal custodians of the site.

There are obvious shortcomings in this analysis. Some sites are notified, to the Department of Heritage, but not registered - these do not appear in the analysis. Other sites are of great significance to Aboriginal people, but are neither registered nor notified, and hence not counted in the analysis. The buffering introduces another problem: by buffering sites, they are to some extent protected, but within the analysis their value is diluted by extending over a large area. To take an extreme hypothetical case: if all significant sites were recorded and located on the digital map, it would be likely that there be one or more in every cell. In this scenario, through buffering to the cell level the entire coastal region would receive the same priority score, thus for this data set there would be no discrimination between one area and another, thereby defeating the object of the analysis. In reality, the process used here identifies about half the coastal cells as containing significant sites. Clearly, buffering reduces the discrimination of the analysis spatially, and the scoring method does not introduce any relative values for differing sites.

3.5.2 European Heritage sites

European heritage sites listed as ‘natural heritage’ on the State Heritage Register and on the Register of the National Estate are represented as a layer within the digital conservation analysis by presence or absence.

There are a number of European heritage registers currently in use in Australia: World Heritage, National Heritage, Commonwealth Heritage, Register of the National Estate, State Heritage and Local Heritage (these are discussed within Appendix 13). World, National and Commonwealth registers, however, have not recorded sites within the region, and sites on Local Heritage lists are shown on digital maps in the appendix (digital based Arc Reader map).

3.5.3 The Register of the National Estate

Criteria for entering a place on the Register of the National Estate (RNE) by the Australian Heritage Council are given in full in Appendix 13. These criteria relate to Australia’s natural and cultural history and include flora, fauna, geomorphology and geology, as well as human use, occupation and aesthetics. Listing demonstrates the national significance of a place; this may influence management plans and development decisions. Under the EPBC Act the Commonwealth Minister for Environment and Heritage must take listing into account in any relevant decision.

The majority of the listings on the RNE are historic buildings within the coastal towns. These urban sites have not been used in this prioritisation, as they were unlikely to be part of the NRM region financial plan. However, ‘natural areas’ within the Southern Fleurieu coastal region are listed.

3.5.4 State Heritage Register

The State Heritage Register is a list of places of heritage value to the State. Places are entered in the Register by the State Heritage Authority, under the provisions of the *Heritage Act 1993*, and acting on advice from the

Heritage Branch. Criteria for entering on the state register are similar to the RNE, and these criteria are listed in full in Appendix 13.

3.6 Geological Monuments within, or partially within Fleurieu Coastal Boundary

The Southern Fleurieu coast is significant in the history of the study of geology in South Australia. At a number of key sites within the coastal cliffs and shore platforms of the rocky Fleurieu, key information is found relating to a number of geological themes. These include evidence of the geological conditions of the early Adelaide Geosyncline; evidence of the Delamerian Orogeny granitic rocks; and evidence of Permian glaciation. These sites have been visited and described by generations of geologists and are the subject of ongoing re-interpretation.

Apart from the limestone and dolomite quarry at Rapid Bay, there is little extractive industry within the Southern Fleurieu coastal boundary; removal of sand for glass making from the Normanville Dune ceased a generation ago. This does not mean that geological resources are not of value to the region: geology and related landform variation provides the basis of the scenic attraction of many parts of the coast. Also, the variable nature of the underlying rocks provides the basis of variation in soil quality within the coastal boundary. Thus the geology and geomorphology is of both scientific and economic value to the region and its natural resources management. For these reasons geological monuments have been used in the conservation analysis.

3.6.1 Geological Monuments

The concept of a geological monument “is a site showing features of outstanding geological or physiographic significance that is considered by the community of earth scientists to be worthy of conservation”, (McBriar & Giles, 1984, p.2). Monuments are examined in the field and assessed; the geology may be representative of wider features, or rare. If taken together, the geological monuments should represent the geological history of the state.

The list of Geological Monuments is reviewed and revised by the Geological Heritage Sub-committee of the SA Division of the Geological Society of Australia Incorporated. Information on geological monuments is stored at Primary Industries and Resources South Australia and at the South Australian Museum.

In brief, the sites listed in this report document the geological history of the region, as identified by the leading geologists of the state and supported by published documentation. As such they are of high conservation priority, and a score assigned to the appropriate coastal cell represents this. The presence or absence of a significant geological site within a coastal cell can be seen in the digital maps which form part of this report.

3.6.2 Conservation of Significant Geological Sites

While geological monuments are irreplaceable and need to be conserved, the means of conservation varies from site to site. Some need protection by reservation; others by fencing or access control; while more well-known sites may benefit from site interpretation. Almost all are threatened if development and earthmoving are proposed at the site and the list of monuments should be included as an attachment to the council development plans.

Selected details taken from listing of Geological Monuments by the Geological Society of Australia, SA Branch

1113 Geol Monument: CAPE JERVIS

Significance: Type section of the Cape Jervis Formation, unconformity with underlying Kanmantoo group. Also provides evidence for Permian glaciation (sediments, boulder erratics).

Preservation State: Trail bike activity has caused some damage; rubbish dump on top of the Permian beds is unsightly.

Comments: Rubbish dump closed approximately 1988. Part of monument area within National Estate area.

National Estate Y: State Heritage Y: Protection in Park N.

1119 Geol Monument: CARRICKALINGA HEAD

Significance: Type section of the Carrickalinga Formation. Outcrop of Normanville and Kanmantoo group contact.

Preservation State: Adequate.

Comments: Value of the research into stratigraphy of the lower Cambrian rocks. Popular tourist area and study area for students studying stratigraphy.

National Estate Y: State Heritage N: Protection in Park N.

1111 Geol Monument: CONGERATINGA RIVER, SOUTH COAST

Significance: Key area for elucidating the structural geology of the Fleurieu Peninsula, (basement - cover contact overturned, deformed conglomerates – pebbles, folding, overturned bedding, Permian glacial deposits, shearing, thrust fault, unconformity. **Preservation State:** Proterozoic rocks are safe from development; younger gravels within the creek bed have been covered and developed over.

Comments: Great for teaching purposes; structural tool.

National Estate N; State Heritage; N Protection in Park N.

1400 Geol Monument: DELAMERE - STOCKYARD CREEK (QUARRY A)

Significance: Hyolithids in the Sellick Hill Formation.

Preservation State: Adequate, so long as the area remains in its present rural state. Outcrop is safe.

Comments: Good for teaching principles of stratigraphy. The area still requires close study before the rock relationships are completely understood.

National Estate N; State Heritage N; Protection in Park N.

1401 Geol Monument: DELAMERE - STOCKYARD CREEK (QUARRY B)

Significance: uppermost Fork Tree Limestone.

Preservation State: Adequate, so long as the area remains in its present rural state. Outcrop is safe.

Comments: The area still requires close study before the rock relationships are completely understood.

National Estate N; State Heritage N; Protection in Park N.

1117 Geol Monument: DELAMERE - STOCKYARD CREEK (YOHOE CREEK)

Significance: Represents a complete sequence of metamorphosed equivalents of the Sellicks Hill section (Cambrian metasediments, cross bedding, folds, fossils, hyolithids, low grade regional metamorphism, Neoproterozoic rocks, Neoproterozoic/Cambrian contact).

Preservation State: Adequate, so long as the area remains in its present rural state. Outcrop is safe.

Comments: The area including road cuttings and creek bed are good for teaching principles of stratigraphy. The area still requires close study before the rock relationships are completely understood.

National Estate N; State Heritage N; Protection in Park N.

1331 Geol Monument: ENCOUNTER BAY REGION - GRANITE ISLAND

Significance: Outcrop of Delamerian Orogenic granite bodies (Encounter Bay granites and Victor Harbor granite. Dykes, xenoliths, unconformities).

Preservation State: Adequate, the relevant areas are located within recreation reserves. The outcrop is massive and resistant to erosion.

Comments: Easy access to Granite Island as it is a popular tourist attraction. Ideal location for teaching purposes.

National Estate Y; State Heritage Y; Protection in ParkY.

1115 Geol Monument: ENCOUNTER BAY REGION - NEWLAND HEAD TO ROSETTA HEAD/THE BLUFF

Significance: Key area in the state where the effects of metamorphism and tectonism can be clearly seen. Outcrop of Encounter Bay Granite and the nature of the contact with the metasediment is visible. Petrel Cove Formation type section. Amphibolite dykes, Cambrian metasediments, contact metamorphism, copper.

Preservation State: Adequate, the relevant outcrop is located on or near the coast which should prevent any major disruptions. Road widening along the road on Rosetta Head could destroy the outcrop though most of the relevant areas are located within recreation reserves. Western part is within Newland Head Conservation Park.

Comments: Ideal location for teaching purposes.

National Estate Y; State Heritage N; Protection in Park Y.

Note: only Rosetta Head and Wright Is. are listed on the Register of the National Estate.

1330 Geol Monument: ENCOUNTER BAY REGION - PORT ELLIOT

Significance: Outcrop of Delamerian Orogenic granite bodies (Encounter Bay granites - Port Elliot granite), between Commodore Headland and Knights Beach. Granites, dykes, xenoliths, unconformities seen.

Preservation State: Adequate. Pullen Island is a conservation park and the other parts of this region belong to a recreation park. The outcrop is massive and has not been drastically affected by coastal erosion.

Comments: Ideal location for teaching purposes. Permian glaciation event has shaped much of the topography and till deposits are found underlying the recent cover.

National Estate Y; State Heritage N; Protection in Park N.

1112 Geol Monument: FLEURIEU PENINSULA, SOUTH COAST

Significance: Excellent exposure of the metasediments of the Kanmantoo Group. Type section for the Kanmantoo group sediments.

Preservation State: Adequate. Parts of the designated area are currently located within conservation parks. The rest of the section is unlikely to be developed due to the remote location, steep coastline and limited access.

Comments: A continuous, lengthy, coastal section, extending from Deep Creek to Parsons Beach. The area is of great geological and geomorphological interest and is a coastline of great natural beauty; it is relatively untouched and should be preserved in this state. Access to the coast is limited (part of monument area within National Estate area).

National Estate: N State Heritage Y; Protection in Park N.

1512 Geol Monument: FLEURIEU PENINSULA, TALISKER MINE

Significance: Remnants of old stone mine buildings, including the stamp battery and powder house, in the vicinity of several shafts. Arsenopyrite, galena, en echelon quartz veins seen.

Preservation State: Good.

Comments: Within Talisker Conservation Park.

National EstateY; State Heritage Y; Protection in Park.

1128 Geol Monument: HARRIS ROCK, LITTLE GORGE AREA

Significance: Glaciation evidence on crystalline gneiss of Palaeoproterozoic rocks: glacial erratics, glaciated outcrops, striations.

Preservation State: Good, pasture.

Comments: Most westerly known occurrence of glaciation.

National Estate N; State Heritage N; Protection in Park N.

1328 Geol Monument: INMAN VALLEY AREA (GREY SPUR)

Significance: Basement exposure, unconformable contact between Palaeoproterozoic and Neoproterozoic rocks.

Preservation State: Good condition. Most features are safe, though rural activity has accelerated erosion.

Comments: Ideal for teaching purposes. Part of monument area within National Estate area.

National Estate Y; State Heritage N; Protection in Park N.

1114 Geol Monument: INMAN VALLEY AREA (SELWYN ROCK)

Significance: Evidence of Permian glaciation in the Inman Valley area. Glacially modified valley forms; moraine, erratics, striations, grooved glacial pavements, pluck marks.

Preservation State: Good condition, located within a conservation park, though surrounding rural activity has accelerated gully erosion. Comparable records of the Permian glaciation are seen only in South Africa.

Comments: Ideal location for teaching. Inman valley area geological monuments have been subdivided into two separate entries.

National Estate Y; State Heritage Y; Protection in Park N.

1126 Geol Monument: INMAN VALLEY TOWNSHIP STRIATED BEDROCK

Significance: Extensive Permian glaciation on glacially smoothed Kanmantoo metasediments. Accesibility makes it very good for teaching.

Preservation State: Good, outcrops near bridge are well exposed.

Comments: A future bridge may threaten the outcrop.

National Estate N; State Heritage N; Protection in Park N.

1110 Geol Monument: LITTLE GORGE - SOUTH YANKALILLA BEACH

Significance: Contact of the Crystalline basement and Neoproterozoic rocks. Outcrop of basement rock.

Preservation State: Adequate. The best/interesting outcrops occur in locations were development would not likely take place.

Comments: Also section 80. The exposure and access to the basement makes an ideal location for teaching purposes.

National Estate N; State Heritage N; Protection in Park N.

1116 Geol Monument: MIDDLETON BEACH

Significance: Type section of the Middleton sandstone, with sedimentary structures, also overturned bedding and schistosity

Preservation State: Adequate, the coast is protected by the coastal protection board and in good condition.

Comments: Ideal location for teaching and research purposes, area should be preserved as is.

National Estate N; State Heritage N; Protection in Park N.

1329 Geol Monument: MIDDLETON QUARRY

Significance: Only area in the Kanmantoo group section where second-generation structures dominate; also large scale cross bedding.

Preservation State: Adequate. Threat of quarry being filled and further quarrying could destroy the magnificent fold structures. The quarry is located on private property.

Comments: Area has great value for research and teaching purposes; should be preserved as is.

National Estate N; State Heritage N; Protection in Park N.

1118 Geol Monument: MYPONGA BEACH

Significance: Excellent outcrop of Sellick Hill Limestone and Fork Tree Limestone. Best known locality for Hyolithes. Reference section for the Sellick Hill Limestone.

Preservation State: Adequate for the outcrop on the foreshore. On the state register and protected by Coastal Protection Board.

Comments: Easy access to locality, ideal location for teaching purposes. Part of monument area within National Estate area.

National Estate Y; State Heritage Y; Protection in Park N.

1109 Geol Monument: NORMANVILLE SAND DUNES

Significance: Relatively untouched sandhills, build up over the last 5000 years; last relics of dunes that were present along the coasts of the St Vincent Gulf. The dunes are of botanic and Archaeological significance.

Preservation State: Endangered. Dunes and vegetation are easily destroyed by almost all activity. Mining of quartz sands has affected the vegetation and dunes.

Comments: Part of monument area within National Estate area.

National Estate Y; State HeritageY; Protection in Park N.

1120 Geol Monument: SECOND VALLEY HARBOUR

Significance: Excellent exposure of mesoscopic folds, foliation and linear features, which are not easily seen elsewhere in the Mt. Lofty Ranges.

Preservation State: Adequate at present. Access pathways should not be extended; any further construction is undesirable.

Comments: Ideal location for teaching purposes.

National Estate N; State Heritage Y; Protection in Park N.

Jetty

1327 Geol Monument: SELLICK BEACH

Significance: Willunga fault, expressed by upturned and overturned Tertiary units unconformably overlying steeply dipping brecciated Cambrian strata.

Preservation State: Adequate.

Comments: Not affected by suburban development.

National Estate N; State Heritage N; Protection in Park N.

1398 Geol Monument: SELLICK HILL (NEW ROAD)

Significance: The Cambrian and Neoproterozoic boundary. Type section for the 'lower Cambrian' units of the Fleurieu Peninsula. The closest locality to Adelaide at which Archaeocyatha occur, in early Cambrian limestones.

Preservation State: Adequate. Exposures occur in road cuttings and in the quarry. Weeds and grasses may cover the contact.

Comments: Archaeocyatha are index fossils for the Cambrian.

National Estate Y; State Heritage N; Protection in Park N.

1230 Geol Monument: STONE HILL

Significance: Exhumed Roche Moutonne.

Preservation State: Relatively unaltered since first discovered by a student of Professor Howchin. Described by Howchin in 1926.

Comments: Glaciation of late Palaeozoic time.

National Estate Y; State Heritage N; Protection in Park N.

1127 Geol Monument: STRANGWAYS HILL STRIATED BEDROCK

Significance: Kanmantoo metasediments show very clear indications of Permian glaciation, chatter marks, grooves and notches.

Preservation State: Outcrop good, other outcrops obscured.

Comments: Part of monument area within National Estate area.

National Estate Y; State Heritage N; Protection in Park N.

1129 Geol Monument: TERTIARY LIMESTONE IN UPPER HINDMARSH RIVER VALLEY

Significance: Fossiliferous limestone, the only outcrop in the Hindmarsh Valley.

Preservation State: Overgrown with vegetation partly obscuring the outcrop.

Comments: The first iron smelter in South Australia was located near here in the1880s.

National Estate N; State Heritage N; Protection in Park N.

1232 Geol Monument: THE BASIN STRIATED BEDROCK

Significance: Striated Kanmantoo Group bedrock; striations up to 50mm deep.

Preservation State: Condition good, at present safe, as it is pasture.

National Estate N; State Heritage N; Protection in Park N.

1513 Geol Monument: TOOKAYERTA CREEK (DRUMLINOID LANDFORMS)

Significance: Late Palaeozoic glacial features on Cambrian rocks.

Preservation State: No external threats.

Comments: Ice movement shown by drumlinoid features in lithified sediments.

National Estate N; State Heritage N; Protection in Park N.

1233 Geol Monument: VICTOR HARBOR ANADARA SHELL BEDS

Significance: Pleistocene Anadara shells in lagoonal sediments six metres above present sea-level.

Preservation State: Condition good, hidden by vegetation that now protects the embankment from erosion and collecting.

Comments: The shells are found by Encounter Bay on the railway line, deposited about 6 m above present sea level along a shoreline; they are up to about 150 000 years Before Present in age, and provide evidence of a warmer climate.

National Estate N; State Heritage N; Protection in Park N.

Threatening Processes

Coastal Disturbance - Motorbikes
Photographed by Jacob Nicolson

Acacia cyclops
Photographed by Ron Sandercock

Coastal Impact
Photographed by Alison Eaton

4 THREATENING PROCESSES

Selected threatening process layers are elaborated below. A general regional discussion of climate change is included in this section; climate change was not suitable for the GIS based analysis, but local potential impacts of projected regional changes were placed in cell descriptions, in section 5.

Planning, Development and Land Use

Development Zoning

Viewscape Analysis (increasing threat due to aesthetics of the coastal zone)

Dumps & Wastewater Treatment Plants

Vegetation Dynamics

Distribution of known environmental weeds

Hazards

Dune Stability

Cliff Stability

Coastal Acid Sulfate Soils

Climate Change

4.1 Development

Development was used in the analysis of threatening processes as it was seen as having the potential to lower the conservation priority values through the ability to develop the land through zoning regulations. Where zoning allowed urban development, high threat scores were allotted; where zoning principles and objectives sought to conserve, low threat scores were given. Mean values for cells are high where a large proportion of the cell is zoned to allow urban or industrial development. Outside the coastal townships, the values for this variable were usually under 4; more than half of the cells in the analysis had a score under 1.

This assessment gives high threat scores for the existing urbanised South Coast areas, with the exception of the coastal reserves: here the lack of a zoned reserve at Horseshoe Bay and Freeman Knob stands out. The coastal townships of Yankalilla appear on this map; however, the lack of a coastal reserve at Lady Bay, Cape Jervis and Myponga are highlighted by this analysis. The Wirrina Tourist Zone gives an extensive area of high threat, and a kilometre of coast with no coastal reserve.

4.2 Coastal Viewscape Analysis

In 2004/5 a South Australian analysis of the scenic value of coastal lands was undertaken by the Department for Environment and Heritage. Where coastal areas had a high score for visual amenity, this was regarded as a pressure for urban development, and hence given a high threat score. The mean threat values for cells in the threats analysis are shown in the graph below.

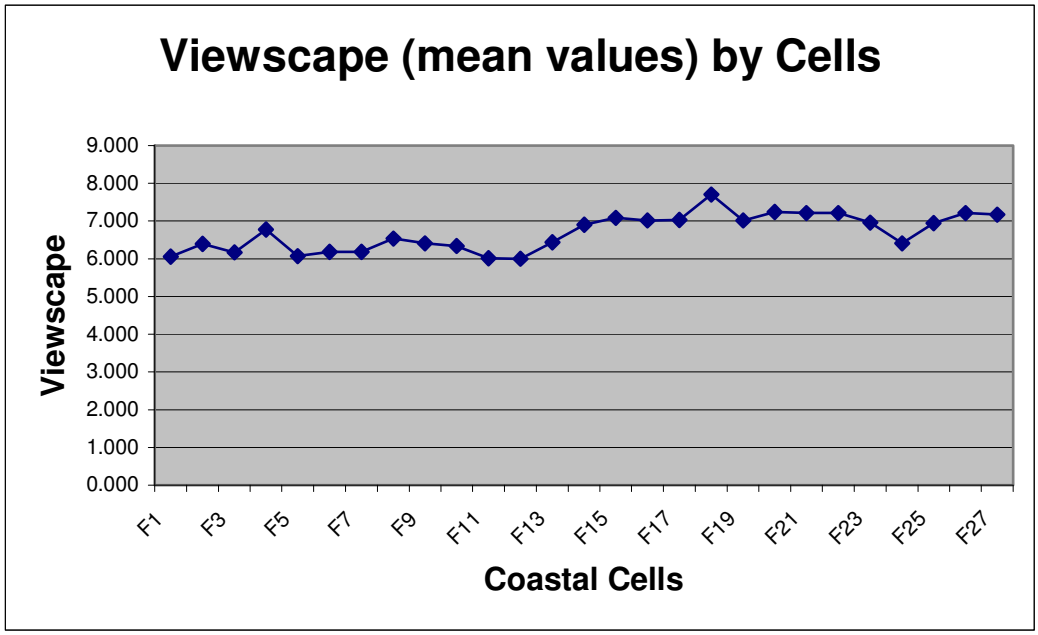


Figure 22. Mean Viewscape values by cells

Figure 22 shows that all parts of the Fleurieu coast have very high coastal landscape values: for all parts of each coastal cell to average scores between 6 and 8 is remarkably high. Within this though, there is a regional contrast: cells along the open cliffs west and north of The Bluff (cell 13) show slightly higher values (7.0 +), than the urbanised coastal plain, cells 1 to 12, averaging 6 to 6.5.

4.3 Dump Sites

Dump sites and waste water treatment plants within or adjacent to the coastal boundary were taken from the digital map, sourced from the EPA by Environmental Information DEH. Thus, the Victor Harbor WWTP on the Inman floodplain, and the dumps at Goolwa, Morgans Beach, Wirrina, and inland from Kings Head are shown.

This layer illustrates the value and the problems of this analysis. The mapped data draws attention to the location of these features, which may be adjacent to sensitive features. For example, the Goolwa dump is adjacent to a valuable conservation site at Tokuremoar reserve, to which it presents threats of fire danger, and also ground and surface water contamination. It is not possible, however, to buffer these features in a way that adequately represents their influence; that is to assign GIS raster point scores in a way that consistently represents their potential threat. On the other hand, an arbitrary choice of a buffer represented in the analysis scores does serve to flag the issue.

4.4 Environmental Weeds Affecting the Southern Fleurieu Coast

C Petherick and R Sandercock

4.4.1 Introduction

Weeds are a major threat to our coast. The coastal strip is particularly vulnerable and accessible to invasion and weed species continue to be an insufficiently recognised ecological problem. The coast supports a range of plants that do not occur naturally in the region. Populations of introduced plants are expanding and pose a threat to the values of the coast, causing major declines in native plant and animal communities.

Weed Threat

Weeds cause many impacts on the coast. Just as in any other natural environment they often grow faster than native plants and successfully compete for sunlight, water, nutrients and pollinators. They also prevent or interfere with natural regeneration. Their capacity to establish and spread, leads to the invasion and displacement of native plant communities, thereby reducing biological diversity and threatening the viability of many plant communities. Floristically and structurally diverse natural vegetation can be changed dramatically to a much-simplified state where one or several weeds may dominate. Coastal heath and native grassland which naturally hold sand dunes together are some of the plant communities, which have been crowded out by weeds, contributing to destabilisation of coastal dune systems. Native fauna is also adversely affected by

the loss of plants that provide shelter, food and nesting habitat, or by animals that thrive in response to the changed conditions. Exotic plants have been introduced to the coast accidentally, often in ballast, or purposely for agricultural or ornamental use. Their spread to the coast has been generally accidental, as a result of various human activities, although spread by fauna, particularly by birds is common. The use of the coast as dumping grounds for domestic garden refuse is a common cause of weed invasion. It is the many disturbances of the coast, which have accelerated the spread of exotic plants within the coastal zone.

Weeds also cause a number of other potential problems such as:

- Providing habitat or a food source for feral animals.
- Altering nutrient content of low fertility soils.
- Altering hydrological cycles.
- Altering dune sand mobility by changing the vegetation cover eg. creating a weed monoculture and increasing beach erosion.
- Increasing fire risk by raising available fuel levels in fire danger periods.
- Reducing visual amenity and aesthetics of natural landscapes.
- Loss of representative examples of original coastal plant communities.

(Adapted from *A Manual of Coastal Dune Management and Rehabilitation Techniques*, NSW Department of Land and Water Conservation, 2001)

4.4.2 Purpose

Weeds are a sign of coastal health. More than 500 weeds species have been recorded in the South Australian coastal zone, which equates to over 30% of the total coastal flora recorded. The Southern Fleurieu coastal region has a high number of exotic flora present, with over 360 species being recorded. The high number of species recorded can also in part be attributed to the extensive surveys undertaken in the region by coastal ecologist Ron Taylor.

In the analysis of 'Conservation Values' the proportion of weeds against natives was used to assess the health or condition of vegetation and to highlight areas that require conservation priority.

Weed species have also been assessed for their threatening values. The following sections identify the highest priority environmental weeds and assign values to weed species to scale threat. The resulting information has been incorporated into the analysis of threatening processes within the Southern Fleurieu coastal region.

4.4.3 Methodology for Determining Priority Weeds & Values

Compilation of Weeds Data

Weed lists for the Southern Fleurieu coastal region were obtained from the State Biological Survey and from local flora expert, Ron Taylor. The lists were amalgamated and consolidated (duplications removed) to produce a single list containing 362 weeds.

A separate weed ratings list was concurrently developed detailing:

- Weeds of National Significance (WONS).
- Alert List of Environmental Weeds.
- Declared Weeds.
- The most common and threatening environmental weed species in the Southern Mt Lofty Ranges, as featured in Nature Conservation Society's (NCS) Bushland Condition Monitoring Manual (both inland and coastal editions).

The ratings list was matched to the regional weed list, which was subsequently worked through to eliminate non-threatening weeds and to assign values to species considered common and threatening.

Assigning Threat Values

To display the weeds as a GIS threat layer for this study, it was necessary for individual species to be allocated a threat value on a scale of between 1 and 9, with 1 being the lowest and 9 being the highest. Values were designed to align with the five threat categories outlined in the NCS Field Guide to Bushland Condition Monitoring Manual: Coastal Vegetation Communities (Croft *et al*, 2006).

Table 8 outlines the five invasive threat categories featured in the Bushland Condition Monitoring manual. The categories are based upon the following:

- The weed's degree of invasiveness or ability to expand into intact scrub
- The weed's capability to disrupt natural processes in bushland
- The degree of difficulty involved in preventing or controlling an infestation.

Table 8. NCS Bushland Condition Monitoring Manual Weed Threat Categories

Category	Description
5	Highly invasive in either disturbed or intact remnant bushland; spreads rapidly producing dense stands and a blanket cover. Potential to eliminate almost all understorey species. Very difficult to control without outside help.
4	Highly invasive in either disturbed or intact bushland, with the potential to spread rapidly and produce very dense stands given favourable habitat and / or vectors. High potential to reduce native species diversity and abundance. Can be controlled with sustained effort.
3	Invasive in intact bushland with moderate potential to reduce native species diversity. Rate of spread is slower than Category 4 and 5 weeds but once present will persist and threaten biodiversity. May produce dense stands over a wide area but can be controlled with sustained effort.
2	Generally only invade disturbed bushland, but may spread rapidly. However, generally only a slight potential to reduce native species diversity, unless present in high densities.
1	Generally only invade disturbed bushland. Often widespread and abundant but not considered a significant threat to biodiversity, unless present at very high densities.

The Bushland Condition weed threat categories provided the basis for assessment in this study; however some adaptation was necessary to incorporate the present and potential distribution of species (i.e. widespread versus limited). Potential for distribution incorporates the number of vectors a species has (greater numbers of vectors enable the species to spread more readily) and the potential area(s) a weed species may inhabit (i.e. preference for specific habitats). Table 9 summarises the weed value allocation system used to assign threat levels to weed species in the Southern Fleurieu coastal region.

Table 9. Weed Value Allocation System

Value	BCM Weed Threat ategory	BCM Weed Threat Category Description	Distribution
9	5	Highly invasive in either disturbed or intact remnant bushland, spreads rapidly producing dense stands and a blanket cover. Potential to eliminate almost all understorey species. Very difficult to control without outside help.	Widespread OR Currently limited with numerous vectors
8			Limited distribution with few vectors
7	4	Highly invasive in either disturbed or intact bushland, with the potential to spread rapidly and produce very dense stands given favourable habitat and / or vectors. High potential to reduce native species diversity and abundance. Can be controlled with sustained effort.	Widespread OR Currently limited with numerous vectors
6			Limited distribution with few vectors
5	3	Invasive in intact bushland with moderate potential to reduce native species diversity. Rate of spread is slower than Category 4 and 5 weeds but once present will persist and threaten biodiversity. May produce dense stands over a wide area but can be controlled with sustained effort.	Widespread OR Currently limited with numerous vectors
4			Limited distribution with few vectors
3	2	Generally only invade disturbed bushland, but may spread rapidly. However, generally only a slight potential to reduce native species diversity, unless present in high densities.	Widespread OR Currently limited with numerous vectors
2			Limited distribution with few vectors
1	1	Generally only invade disturbed bushland. Often widespread and abundant but not considered a significant threat to biodiversity, unless present at very high densities.	N/A

An internal DEH assessment using the value allocation system identified 101 priority environmental weed species. The results were analysed by Southern Fleurieu coastal flora expert Ron Taylor and DEH staff, incorporating local experience and knowledge of weed management.

It should be noted that the surveys undertaken for the original weed lists occurred several years before this Action Plan was developed, thus distributions have changed for some species, with some being much more widespread or effective control implemented. This has been taken into account in the assessment process through the incorporation of local knowledge.

4.4.4 Results

The threat value allocation process identified a total of 85 priority environmental weeds for the Southern Fleurieu coastal region, each featuring a weed threat value between 1 and 9. The results and distribution of species (by cell) are displayed in Table 10.

Table 10. Southern Fleurieu Coastal Region Priority Environmental Weeds and Associated Threat Values

# of Records	Species Name	Common Name	Threat Value	Cell Number
17	*Asparagus asparagoides*	Bridal Creeper	9	2, 4, 8, 9, 10, 11, 13, 14, 15, 19, 20, 23, 24, 26
2	*Asparagus declinatus*	Bridal Veil	8	14, 15
6	*Ehrharta villosa* var. *maxima*	Pyp Grass	8	1, 2, 3, 10, 15
16	*Gazania linearis*	Gazania	8	1, 2, 3, 5, 6, 8, 9, 10, 11, 12, 19, 20, 24, 25, 26
13	*Acacia cyclops*	Western Coastal Wattle	7	1, 4, 5, 6, 9, 10, 11, 12, 19, 20, 21, 22, 23, 24,
27	*Lycium ferocissimum*	African Boxthorn	7	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27
1	*Ulex europaeus*	Gorse	7	23, 24
10	*Chrysanthemoides monilifera* ssp. *monilifera*	Boneseed	6	1, 3, 6, 8, 9, 10, 11, 14, 15, 22
3	*Dipogon lignosus*	Lavatory Creeper	6	9, 10, 11
14	*Leptospermum laevigatum*	Coast Tea-tree	6	1, 3, 5, 6, 8, 9, 10, 11, 12, 13, 14, 16, 17, 25
3	*Polygala myrtifolia*	Myrtle-leaf Milkwort	6	10, 11, 20
5	*Rhamnus alaternus*	Blowfly Bush	6	8, 10, 11, 14, 23, 24
1	*Acacia longifolia* var. *longifolia*	Sallow Wattle	5	14, 15, 24
15	*Acacia saligna*	Golden Wreath Wattle	5	1, 4, 5, 6, 8, 9, 10, 11, 12, 20, 23, 24, 26
2	*Disa bracteata*	African Orchid	5	14, 15
27	*Euphorbia paralias*	Sea Spurge	5	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 22, 23, 24, 26, 27
19	*Euphorbia terracina*	False Caper	5	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 22, 23, 24
5	*Melianthus comosus*	Tufted Honey-flower	5	18, 19, 20, 22, 24, 25
24	*Olea europaea* ssp. *europaea*	Olive	5	2, 3, 4, 6, 7, 9, 10, 11, 12, 13, 14, 15, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27
21	*Oxalis pes-caprae*	Soursob	5	1, 2, 3, 5, 6, 7, 8, 10, 11, 14, 15, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27
7	*Arctotis stoechadifolia*	White Arctotis	4	5, 9, 11, 12, 23, 24, 25
5	*Argyranthemum frutescens*	Marguerite Daisy	4	8, 9, 10, 11, 12, 24
7	*Carpobrotus edulis*	Hottentot Fig	4	2, 4, 5, 6, 9, 13, 15, 25
12	*Coprosma repens*	New Zealand Mirror-bush	4	2, 5, 6, 8, 9, 10, 11, 12, 13, 14
17	*Ehrharta calycina*	Perennial Veldt Grass	4	7, 8, 10, 11, 13, 14, 15, 16, 17, 18, 19, 20, 22, 23, 24, 25
1	*Juncus acutus*	Sharp Rush	4	2, 14
10	*Marrubium vulgare*	Horehound	4	1, 4, 6, 10, 11, 13, 19, 20, 21, 22, 23
11	*Pinus* spp.	Pine spp.	4	2, 4, 6, 8, 9, 10, 11, 12, 15, 23
14	*Solanum linnaeanum*	Apple Of Sodom	4	4, 11, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 26
6	*Agave Americana*	Century Plant	3	5, 9, 10, 11, 12, 15
14	*Brassica tournefortii*	Wild Turnip	3	1, 2, 6, 9, 10, 11, 14, 15, 18, 19, 20, 21, 23, 24, 25
15	*Cynodon dactylon*	Couch	3	1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 15, 16, 17, 20, 23, 25
10	*Diplotaxis* sp.	Wall Rocket	3	
2	*Ferraria crispa* ssp. *crispa*	Black Flag	3	15, 24
9	*Galenia pubescens* var. *pubescens*	Coastal Galenia	3	1, 5, 6, 9, 10, 13, 14, 20, 25
2	*Lupinus cosentinii*	Sand Lupin	3	19, 20
20	*Malva* spp.	Marshmallow spp.	3	1, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 24
8	*Mesembryanthemum crystallinum*	Common Iceplant	3	4, 5, 6, 8, 9, 14, 20, 24
44	*Plantago* spp.	Plantain spp.	3	1, 2, 4, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25, 26, 27
21	*Reichardia tingitana*	False Sowthistle	3	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 15, 18, 19, 20, 21, 22, 25, 27

21	*Scabiosa atropurpurea*	Pincushion	3	1, 2, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 19, 20, 21, 22, 24, 26, 27
1	*Verbascum thapsus ssp. thapsus*	Great Mullein	3	22
7	*Verbascum virgatum*	Twiggy Mullein	3	10, 11, 13, 15, 18, 23,
3	*Zantedeschia aethiopica*	White Arum Lily	3	18, 20, 24
2	*Chondrilla juncea*	Skeleton Weed	2	14, 15
2	*Cynara cardunculus* ssp. *flavescens*	Artichoke Thistle	2	22, 26
4	*Dimorphotheca pluvialis*	Cape Marigold	2	5, 6, 9, 10, 11
20	*Echium plantagineum*	Salvation Jane	2	4, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27
18	*Ehrharta longiflora*	Annual Veldt Grass	2	2, 6, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 25, 26
27	*Lagurus ovatus*	Hare's Tail Grass	2	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27
14	*Limonium* spp.	Lavender spp.	2	1, 2, 4, 5, 6, 8, 9, 11, 12, 14, 15, 16, 19, 21, 22, 26, 27
3	*Matthiola incana*	Common Stock	2	8, 9, 21
8	*Osteospermum fruticosum*	Seascape Daisy	2	5, 6, 8, 9, 10, 11, 12, 23
19	*Pennisetum clandestinum*	Kikuyu	2	1, 3, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 19, 20, 23, 24, 25, 27
4	*Rosa canina*	Dog Rose	2	15, 22, 23, 24, 27
7	*Senecio pterophorus*	African Daisy	2	4, 7, 10, 11, 14, 15, 18
11	*Stenotaphrum secundatum*	Buffalo Grass	2	1, 2, 5, 8, 9, 10, 11, 12, 14, 15
7	*Tamarix aphylla*	Athel Pine	2	2, 5, 6, 8, 9, 11, 24, 25
4	*Tetragonia decumbens*	Sea Spinach	2	20, 23, 25, 27
3	*Aeonium arboretum*		1	5, 9, 12
7	*Aloe* spp.	Aloe	1	9, 11
17	*Arctotheca calendula*	Cape Weed	1	1, 2, 5, 6, 8, 13, 14, 15, 16, 18, 19, 20, 21, 22, 23, 24, 26
11	*Asphodelus fistulosus*	Onion Weed	1	1, 2, 3, 4, 6, 8, 13, 15, 18, 19, 20
23	*Atriplex prostrata*	Creeping Saltbush	1	1, 2, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 22, 24, 25, 26, 27
26	*Avena* spp.	Wild Oat spp.	1	1, 2, 4, 6, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27
57	*Bromus* spp.	Brome spp.	1	1, 2, 4, 6, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27
6	*Carduus tenuiflorus*	Slender Thistle	1	10, 14, 15, 18, 19, 22
2	*Casuarina glauca*	Grey Buloke	1	1, 6
1	*Centaurea calcitrapa*	Star Thistle	1	1
12	*Chenopodium album*	Fat Hen	1	6, 7, 9, 10, 11, 12, 13, 14, 15, 19, 24
12	*Conyza* spp.	Fleabane spp.	1	1, 2, 4, 6, 7, 10, 11, 12, 13, 15, 18
5	*Cotyledon orbiculata* spp.	Cotyledon	1	2, 5, 6, 9, 10, 11
15	*Gomphocarpus cancellatus*	Broad-leaf Cotton-bush	1	2, 4, 10, 13, 15, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27
13	*Helminthotheca echioides*	Ox-tongue	1	4, 6, 9, 10, 11, 12, 14, 22, 23, 24, 26, 27
32	*Hypochaeris* spp.	Cat's Ear spp.	1	1, 2, 3, 4, 6, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26
20	*Lolium* spp.	Ryegrass spp.	1	1, 6, 10, 11, 12, 13, 14, 15, 18, 19, 20, 22, 27
28	*Medicago* spp.	Medic spp.	1	1, 2, 4, 5, 6, 8, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27
14	*Melilotus* spp.	Centaury spp.	1	1, 2, 4, 10, 11, 12, 13, 15, 16, 18, 19, 20, 26
11	*Oenothera stricta* ssp. *stricta*	Common Evening Primrose	1	2, 11, 12, 13, 14, 15, 19, 20, 21, 23, 24, 25
3	*Opuntia* spp.	Cactus spp.	1	
2	*Phalaris minor*	Lesser Canary-grass	1	6, 14
12	*Romulea* spp.	Onion-grass	1	6, 11, 14, 15, 16, 17, 18, 19, 20, 21, 22, 27
35	*Sonchus* spp.	Sow-thistle spp.	1	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 24, 25, 26, 27
11	*Thinopyrum junceiforme*	Sea Wheat-grass	1	1, 2, 4, 5, 6, 7, 15, 22, 23, 24, 25
63	*Trifolium* spp.	Clover spp.	1	2, 4, 6, 8, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27

4.4.5 Highest Priority Weeds – Red Alert Weeds

Part of the process for assessing weeds as a threat within the Bushland Condition Monitoring Manual is identification of 'Red Alert Weeds'. Red Alert weeds are species that are already presenting a major threat to bushland or have the potential to become major threats (ie. the highest priority weeds).

Weeds with a threat category of 3, 4 or 5 are classified as Red Alert Weeds as they have the capacity to spread quickly, even in intact vegetation, and are difficult to control (Croft et al, 2006). The higher the number of Red Alert species present in bushland, the greater the threat of weed invasion in the future. Any category 4 or 5 species should receive immediate attention.

In the context of the weed value allocation process, Red Alert Weeds are those with values from 4 to 9 (refer to Table 9). A total of 29 Red Alert Weeds have been identified in the Southern Fleurieu coastal region through this methodology. The following provides a brief threat analysis for category 4 and 5 weed species (weeds with values in the GIS analysis from 6 to 9).

***Asparagus asparagoides* (Bridal Creeper)**

Bridal creeper is considered to be one of the greatest weed threats to conservation and biodiversity in southern Australia. Listed as a Weed of National Significance, a specific strategy has been developed to contain and minimise its impact in Australia through coordinated management at National, State and Regional levels. Long-term community commitment to fund and implement strategies is required, in addition to promotion of best-practice for bridal creeper infestations where bio-control agents are established.

***Asparagus declinatus* (Bridal Veil)**

Bridal veil is a highly invasive environmental weed that climbs and smothers native vegetation, forming dense canopies which shade out understorey species. While little research has been conducted on the ecology of Bridal Veil, its impacts appear to be similar to those of Bridal Creeper. Given the adverse impacts Bridal Creeper has had on Australia's environment, there is some urgency for research into Bridal Veil to further understand its ecology and potential for spread. With the release of host-specific biological controls for Bridal Creeper, there is a risk that Bridal Veil may become a more serious weed as Bridal Creeper is controlled.

***Ehrharta villosa var. maxima* (Pyp Grass)**

Pyp grass is an environmental weed of high impact originally introduced as a dune stabiliser. It can be a rampant coloniser of disturbed areas, creating thick suffocating thatches which severely impede native seedling penetration and growth. It will grow through existing vegetation and become suppressive by forming closed areas due to mats of deep creeping rhizomes. It can also form thick suffocating canopies.

***Gazania spp.* (Gazania)**

Gazania species are problematic plants which spread readily by water, wind and in dumped refuse. Gazania infestations are found around almost all coastal townships due to their popularity as garden plants. Gazania species readily establish in dunes and severely alter plant communities by suppressing native plants with their high demand for moisture. The sale of these plants by the local nursery industry needs to include a warning of the risks for its use in coastal areas and should not be used in council landscaping projects.

***Acacia cyclops* (Western Coastal Wattle)**

Western coastal wattle is an Australian native species indigenous to the west coast of the state which is considered a serious environmental weed outside of its natural range. It will compete with native pioneer species and when left un-checked may form monocultures which shade out indigenous understorey species. Western coastal wattle needs to be controlled to the stage where it no longer impacts significantly on the natural function of the coastal environment.

***Lycium ferocissimum* (African Boxthorn)**

A declared plant in South Australia, African boxthorn is an aggressive weed that shades and crowds out native vegetation. It often occurs under trees and shrubs where birds roost and when left unchecked, will form dense, impenetrable thickets which often provide habitat for introduced fauna such as rabbits and foxes. African boxthorn's significant presence on the coast gives it the unique status of the only weed species that

rates as a floristic group in the Coastal Dune and Clifftop vegetation study of South Australia. It is present in all but two cells in the Southern Fleurieu coastal zone.

***Ulex europaeus* (Gorse)**

A Weed of National Significance, Gorse is regarded as one of the worst weeds in Australia because of its invasiveness, potential for spread, and its economic and environmental impacts. It is a major agricultural weed in Tasmania and parts of Victoria, and is increasingly becoming a threat as an environmental weed in many national parks and other bushland areas. Gorse commonly grows where rainfall is evenly distributed throughout the year and in the range 650-900 mm. It prefers fertile soils as well as on light sands, heavy clays and disturbed soils. According to the CRC for Weed Management, gorse could potentially infest most of coastal southern Australia based on climate suitability.

***Chrysanthemoides monilifera ssp. monilifera* (Boneseed)**

Boneseed is a Weed of National Significance and declared in South Australia with invasive characteristics including high seed production, a long-lived seed bank and an ability to spread rapidly. It is a serious environmental weed of headlands and dunes.

***Dipogon lignosus* (Lavatory Creeper)**

Lavatory creeper is a vigorous climber which invades disturbed, sandy sites near or on the coast, forming dense canopies which shade and smother native vegetation. It also fixes nitrogen which results in increased soil fertility and subsequently supports other weed species. Lavatory creeper is considered a high weed risk "sleeper" due to its prolonged seed dormancy and the species ability to grow rapidly.

***Leptospermum laevigatum* (Coast Tea-tree)**

Coastal tea-tree is an Australian native indigenous to the east coast of Australia. It invades disturbed dune areas within close proximity to the shoreline, significantly altering natural systems by forming dense thickets and changing fauna habitat.

***Polygala myrtifolia* (Myrtle-leaf Milkwort)**

Myrtle-leaf Milkwort competes with indigenous wattle species and can become very dominant in higher rainfall areas. The species does not need disturbance to colonise and can germinate in heavy shade. It readily regenerates by seed and spreads into coastal dune and cliff top environments via birds, water and ants.

***Rhamnus alaternus* (Blowfly Bush)**

Blowfly bush invades dry coastal vegetation but also lower light conditions in closed shrub and woodlands. Plants are long-lived, with a preference for disturbed soils; however they are also able to germinate in established vegetation. Seed spreads via birds and can therefore be widely dispersed.

4.4.6 Weeds as a Threatening Process – Cell Value Analysis

Assigning values to environmental weeds not only enables identification of the highest priority species, but also allows levels of threat to different coastal areas (cells) to be determined and compared.

Section 4.4.4 features cell-specific priority environmental weed lists and their correlating values. When the values of all priority environmental weeds within each cell are averaged, it provides a nominal value that subsequently enables comparison of this threat layer between cells. These nominal weed threat values have been mapped as a GIS layer and are illustrated in Figure 23.

It is important to note that the presence of higher value weeds in a cell will increase the average; however the collective presence of many lower value weeds will also have a similar influence. Some discussion occurred amongst DEH GIS and scientific staff regarding the possibility of simply presenting the threat value for red alert weeds (those with a value of 4 or greater) per cell so as not to dilute the threat value of higher priority weeds. It was decided that lower priority weeds should still be featured in Figure 1 due to their collective impact and contribution towards the overall threat to an area of coastal vegetation.

Refer to Section 5.1 for detailed discussion concerning weeds as a threatening process in individual cells.

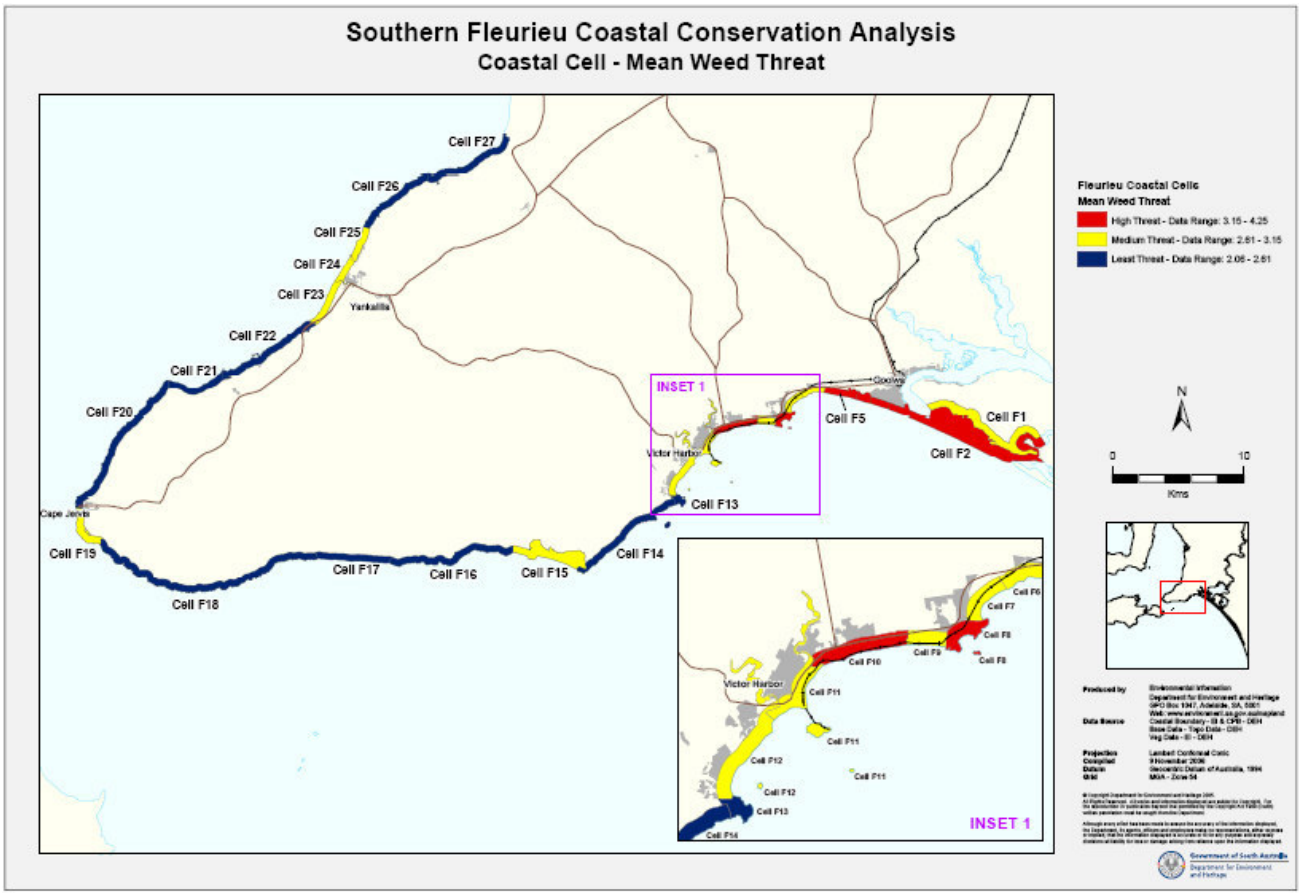


Figure 23. Priority Weed Distribution in the Southern Fleurieu Coastal Zone (detailed, all priorities included)

4.4.7 Other considerations

Non-rated weeds of importance

Several weed species were not rated as high priority environmental weeds during the threat evaluation process, although were still noted as being of importance due to either their usefulness or increasing popularity as garden plants.

Useful Weeds

Ammophila arenaria (Marram Grass)

Marram Grass was historically introduced to the coast to aid in dune stabilisation projects. While not considered overly invasive, the grass can alter foredune shape, creating steeper dunes that are more prone to erosion by waves. Marram Grass is no longer recommended for revegetation projects due to a preference for utilising local provenance species and advances in propagation techniques for the indigenous species *Spinifex hirsutus* (Rolling Spinifex).

Marram Grass is not usually targeted for control due to the stabilisation benefits it provides and presence of other higher priority environmental weeds. Taylor (N/D) comments that revegetation with native species is deemed to be the only means of control required. Indigenous seedlings can be planted in Marram Grass as the plants provide native seedlings with some protection without impacting on their survival. This method has the advantage of ensuring removal of the plant does not occur without replacement.

Cakile maritima ssp. maritima (Two-horned Sea Rocket)

Sea Rocket is a plant of metropolitan distribution, meaning it is found in coastal zones throughout the world. It is a pioneer species and tends to occupy the incipient dune where conditions are harsh and few species can survive. For this reason, Sea Rocket provides benefit through its ability to trap sand and assist with dune formation processes. Furthermore the species provides habitat and food for indigenous fauna including lizards

and insects. Whilst not indigenous, the plant should not be targeted for removal in the absence of alternative species filling these useful functions.

Garden Plants

Aptenia cordifolia (Heart-leafed Iceplant)

Heart-leafed Iceplant is a succulent creeper gaining popularity as a garden plant. It is likely to be an issue around urban centres where it either spreads from household gardens or is deliberately planted into coastal habitats abutting residential properties. While not currently a major issue, planting of this species should be discouraged and deliberate plantings in the coastal environment removed.

Correa sp.

It has been noted that a nursery-supplied Correa is being utilised in Council landscaping projects. The species is likely to be an Australian native rather than a locally indigenous species and has the potential to become weedy in the Southern Fleurieu coastal zone. It is recommended that Councils discontinue planting this species and look at alternative drought tolerant indigenous species as alternatives.

4.4.8 Declared Weeds of the Southern Fleurieu Coastal Region

It was noted during the weed threat evaluation process, that not all declared species recorded in the Southern Fleurieu coastal region are considered priority environmental weeds. Nevertheless, land managers have responsibilities relating to management of these species, ranging from control to prevention of the sale and movement of particular species, which must be taken into account. Table 11 identifies declared weeds of the Southern Fleurieu coastline, associated management responsibilities, and recorded location (by cell).

Table 11. Location of Declared Weeds of the Southern Fleurieu Coastal Region and Associated Management Responsibilities

Scientific Name	Common Name	Management Responsibilities
Allium vineale	Field Garlic	MSCR
Asparagus asparagoides	Bridal Creeper	MSCR
Asparagus declinatus	Bridal Veil	MSCR
Carduus tenuiflorus	Slender Thistle	*R
Chondrilla juncea	Skeleton Weed	NMSCR
Chrysanthemoides monilifera ssp. *Monilifera*	Boneseed	MSCR
Cirsium vulgare	Spear Thistle	*
Convolvulus arvensis	Field Bindweed	*MSCR(1)
Cuscuta campestris	Chilean dodder	NMSCR
Cynara cardunculus	Wild Artichoke	*MSR
Diplotaxis tenuifolia	Lincoln Weed	*MSR
Echium plantagineum	Salvation Jane	*NMSR
Emex australis	Three-corner Jack	MSCR
Eragrostis curvula	African Love-grass	MSCR (2)
Euphorbia terracina	False Caper	MSCR
Hirschfeldia incana	Buchan Weed	*
Lycium ferocissimum	African Boxthorn	MSCR
Marrubium vulgare	Horehound	NMSCR
Moraea flaccida	One-leaf Cape Tulip	NMSCR
Olea europaea ssp. *europaea*	Olive	CR(3)
Oxalis pes-caprae	Soursob	*MSR(1)
Rosa canina	Dog Rose	NMSCR
Silybum marianum	Variegated Thistle	*MSR
Tamarix aphylla	Athel Pine	S
Urex europaeus	Gorse	MSCR
TOTAL Southern Fleurieu Coastal Zone	**25**	

* Control required in part of state
N Notifiable throughout the state
N notifiable in part of state
M Movement
S Sale
C Control
R Roadsides

(1) Excludes cultivar 'Consul'.
(2) Includes only Olives not planted & maintained for domestic or commercial use.
(3) Control & roadsides only apply to land used for the extraction or removal of soil, loam, sand and gravel.

4.4.9 Potential high priority weeds in the Southern Fleurieu coastal zone

While assessing weeds as a key threat to the Southern Fleurieu coast, it was noted that a number of high priority environmental weeds are not currently present in the region however are highly likely to become established in the future. It is imperative that land managers and communities are aware of these potential high priority weeds and are readily able to identify any new arrivals or outbreaks. Particular species of concern are detailed below. Images of these species are featured in 4.4.11 and are marked as 'early warning' species.

Trachyandra divaricata (Dune Onion Weed)

One of the highest priority weeds on the Adelaide metropolitan coast, Dune Onion Weed can travel via ocean currents and will certainly soon appear in the Southern Fleurieu region. The species would be allocated a weed threat value between 7 and 9 as it rapidly establishes in either intact or disturbed vegetation and is extremely persistent. Control in the Adelaide region is proving to be highly expensive with a persistent, long-term approach to containment and control required.

Oenothera drummondii (Beach Primrose)

Beach Primrose is a new arrival to the Adelaide metropolitan coast. The species has become naturalised along the Queensland and New South Wales coastline and whilst climatic conditions are different in southern Australia, it has displayed properties that indicate the species may become significantly more widespread.

Chrysanthemum monilifera var. rotundata (Bitou Bush)

A weed of national significance (WONS), Bitou Bush was originally introduced to the eastern states as a dune stabiliser for revegetation projects. Having spread prolifically and displaced coastal dune vegetation communities, major funds and community effort are being invested into controlling this species. Recent studies have noted that this species appears to be moving southwards into more temperate climates.

Arctotheca populifolia (Beach Daisy)

Beach daisy is able to withstand the harsh conditions of the beach environment and is a highly invasive weed of foredunes and coastal grasslands. It possesses the ability to cover large areas of accumulating sand, with seed spread occurring via wind and tidal currents. It has become a serious threat to biodiversity in Western Australia and needs to be recognised early to prevent establishment in the Southern Fleurieu coastal zone.

4.4.10 Managing Weeds

Despite longstanding control measures administered by a wide range of natural resource managers, there is evidence of an increasing rate of weed encroachment towards every ecosystem of immediate conservation value within Australia (Agriculture and Resource Management Council of Australia and New Zealand Environment and Conservation Council, 1999). The public ownership and linearity of the coast make the recognition of the weed disturbance problematic. More needs to be done as weeds are having an impact on the coast and no adequate baseline data or monitoring is in place.

While it would be desirable to consider the control of weeds on the coast as a high priority, funds will be a limiting factor and weed management strategies should subsequently aim to reduce or eliminate physical disturbance to native vegetation. In addition, targeting the control of weeds and preventing new incursions in areas of high biodiversity value and in large areas currently relatively free of weeds is vital.

Actions

A number of land management practices can be enacted which could decrease weed ingress, including: rationalising access tracks, restricting fire breaks to only where required, controlling introduced grazing animals, maintaining both weed-free and fertiliser-free buffer zones around native vegetation.

It is imperative that potential introductions of plants for productive or amenity purposes are thoroughly vetted in terms of invasive characteristics. At a local level, many coastal weeds are readily available for purchase from commercial plant nurseries and local produce markets. Information on the risk of garden plants that are known coastal weeds needs to be made available to those who are likely to use these species in near-coastal situations.

Early Warning

The Cooperative Research Centre for Australian Weeds Management is resourcing a project for an early weed warning system. It is a collaborative effort utilising the on-line facilities of the Australian Virtual Herbarium and cooperation between the National and State Weed authorities. As weed flora is constantly changing with new introductions, the collection of specimens and mapping can be vitally important. More resources and development of a centralised weed database with GIS capability could reverse the lack of environmental weed mapping. Pest 2000 is a current database that has been developed for weeds by PIRSA.

A serious weed often appears after it has naturalised and the earlier the awareness of a widening distribution, the greater chance of timely control measure being implemented. With efficient weed risk assessment and rapid response to weed outbreaks, future environmental damage can be minimised.

Acknowledgments

Particular thanks is extended to Southern Fleurieu coastal ecologist Ron Taylor, who provided extensive and highly valuable input in identification of weeds present in the region, their distribution and impacts on the local coastal environment.

4.4.11 Weeds of Concern in the Southern Fleurieu Coastal Region

Priority Rating

Asparagus asparagoides (Bridal Creeper)

9

Asparagus declinatus (Bridal Veil)

Ehrharta villosa var. maxima (Pyp Grass)

8

Gazania linearis (Gazania)

Lycium ferocissimum (African Boxthorn)

7

Acacia Cyclops (Western Coastal Wattle)

Priority Rating

Ulex europaeus (Gorse)

7

Leptospermum laevigatum (Coast Tea-tree)

6

Chrysanthemoides monilifera ssp. monilifera (Boneseed)

Dipogon lignosus (Lavatory Creeper)

6

Polygala myrtifolia (Myrtle-leaf Milkwort)

Priority Rating

Rhamnus alaternus (Buckthorn)

6

Euphorbia paralias (Sea Spurge)

5

Euphorbia terracina (False Caper)

Olea europaea (Olive)

5

Melianthus comosus (Tufted Honey-flower)

Priority Rating

Acacia longifolia ssp. longifolia (Sallow wattle)
Solly Reserve, Victor Harbor
Photograph: Ron Taylor

5

Acacia saligna (Golden Wreath Wattle)

Oxalis pes-caprae (Soursob)

5

Carpobrotus edulis (Hottentot Fig)

4

Solanum linnaeanum (Apple of Soddom)

Priority Rating

Ehrharta calycina (Perennial Veldt Grass)

4

Marrubium vulgare (Horehound)

Juncus acutus (Sharp Rush)

4

Arctotis stoechadifolia (White Arctotis)

Pinus halepensis (Aleppo Pine)

4

Priority Rating

Brassica tournefortii (Wild Turnip)

3

Scabiosa atropurpurea (Pincushion)

Ferraria crispa ssp. crispa (Black Flag)
Photograph: Ron Taylor

3

Malva spp. (Mallow)

Mesemryanthemum cristallinum (Common Iceplant)

3

Galenia pubescens (Coastal Galenia)

Priority Rating

Lupinus cosentinii (Sand Lupin)

3

Cynodon dactylon (Couch)

Agave americana (Century Plant)

3

Reichardia tingitana (False Sow Thistle)

Plantago spp. (Plantain)

3

Verbascum thapsus ssp. thapsus (Great Mullein)
Lady Bay

Priority Rating

Zantedeschia aethiopica (White Arum Lily) Fishery Creek

3

Chondrilla juncea (Skeleton Weed)

2

Tamarix aphylla (Athel Pine)

Tetragonia decumbens (Sea Spinach)

2

Stenotaphrum secundatum (Buffalo Grass)

Priority Rating

Echium plantagineum (Salvation Jane / Paterson's Curse)
Photograph: Jeff Reid (APS)

2

Ehrharta longiflora (Annual Veldt Grass)
Encounter Bay
Photograph: Ron Taylor

Osteospermum fruticosum (Seascape Daisy)

2

Limonium companyonis (Sea-lavender)

Lagurus ovatus (Hare's Tail Grass)

2

Dimorphotheca pluvialis (Cape Marigold)

Priority Rating

Cynara cardunculus ssp. Flavescens
(Atrichoke Thistle)

2

Pennisetum clandestinum (Kikuyu)
The Bluff

Rosa canina (Dog Rose)
Inman Valley
Photograph: Ron Taylor

2

Asphodelus fistulosus (Onion Weed)

1

Avena barbata (Wild Oat)
Encounter Bay
Photograph: Ron Taylor

Priority Rating

Chrysanthemoides monilifera ssp. Rotundata
(Bitou Bush)
EARLY WARNING

No Rating

Diplotaxis tenuifolia (Lincoln Weed)

Matthiola incana (Common Stock)
Fishery Creek

No Rating

Oenothera drummondii (Sandhill Evening-primrose)
EARLY WARNING

Senecio pterophorus (African Daisy)
Photograph: Ron Taylor
Fishery Beach

No Rating

Trachyandra divaricata (Dune Onion-weed)
EARLY WARNING

All photographs other than individually noted taken by Ron Sandercock
Coastal Protection Branch
Department for Environment and Heritage

4.5 Dune Areas

Blowouts, deflation and transgressive dunes are common around the sand dune coast of the Southern Fleurieu coastal region. The causes of dune instability are both natural and human induced. They include storm damage, fire, drought, and plant disease, off road vehicle impact, grazing and clearance. These causes, with regard to any one area, may be multiple and often interlinked. Also the de-vegetation of a dune may be linked to a single event, such as a fire or a storm; but the impact of such an event may be exacerbated by previous circumstances, such as years of drought, or the establishment of a carpark within the dunes.

On high-energy sandy coasts storm damage to the foredune is common, and through natural causes this damage may develop to a large blowout. Primary colonising dune plants may, over time, reclaim this area resulting in a diversity of dune plant species, and habitat, within the dune complex. Diversity of dune plant species is a consideration in decisions to act or not act over dune stabilisation and also in decisions over how to act. Extensive planting of one species of dune plant, Marram, has in the damper parts of the Australian coast in Tasmania and Victoria, resulted in areas where there is a very low number of plant species. In these circumstances Marram has created an apparently stable situation where other plants have found it hard to invade.

However, if there is widespread de-stabilisation, creating an extensive transgressive dunefield, natural revegetation may be slower, and over time large quantities of sand may be transported by the wind. Where large quantities of sand are transported landwards, damage to native vegetation or farmland may occur through burial. In addition, in extreme cases, coastal recession may result from transport of sediment inland from the beach.

Data on unstable dunes was obtained from the existing layer ‘coastal hazards’, based on recent aerial photography. Values (0 – 9) for coastal cells were obtained from this layer. High values were given where dunes were de-vegetated, ‘actual drift hazard’. Medium threat values were given to other dunes, ‘potential drift hazard’.

Generally dune instability is not a problem in this region. Actual instability is identified at the frontal dunes of the Sir Richard Peninsula, Goolwa, and irregularly distributed within Newland Head Conservation Park. Potential instability is recorded at these localities as well as the Normanville Dunes.

4.6 Cliff Stability

High risk is found along the W coast of the peninsula, with the exception of the Normanville embayment. From Cape Jervis to Newland risk is low to medium. Newland Head to the Bluff shows high values, then the coast east of the Bluff values are low, with the exception of medium risks from Middleton to Surfers and at the Port Elliot headlands.

4.7 Coastal Acid Sulfate Soil

Acid sulfate soils are naturally occurring soils with significant percentages of iron sulphide. These soils commonly occur in low-lying coastal areas where the water table is at or close to the surface. They were formed during or after marine inundation, when seawater containing dissolved sulfate covered organic rich environments, such as coastal wetlands, mangroves, salt marshes or Tea-tree thickets. While these soils are below the water table they remain relatively stable, simply being slowly processed by anaerobic bacteria; iron present within the soil combines with sulphur from the sulfate to form iron sulfides.

However, when these soils are exposed to the air, oxidation occurs and sulfuric acid is formed. The acid may simply react with carbonates and clay within the soil, but if a build up of acidic soil water occurs or is flushed to a waterway, damage to life forms may occur. In NSW for example, fish kills have been reported following disturbance to swampy areas near estuaries and coastal lakes.

Coastal acid sulfate soils have been mapped by the CSIRO in South Australia, (Fitzpatrick et al, 2003) and the results included as digital layer within the threats analysis.

CSIRO Acid Sulfate Soil Map Classes for South Australia

Map Legend	Class Description
(a) Actual CASS (disturbed). (b) Potential CASS (disturbed)	**Actual Coastal Acid Sulfate Soils**. Very high risk. (Not in Southern Fleurieu) **Potential Coastal Acid Sulfate Soils in subsoil below 20 cm (up to 1 metre thick) with surface monosulfidic black ooze (MBO)**, intertidal (mainly in samphire). Moderate risk because carbonate layers usually occur above and below.
Potential CASS (mangrove)	**Thick PCASS – mangrove soil**. Mainly in mangroves, with high risk
Potential CASS (tidal stream)	**PCASS of tidal streams** (CPASS underlying, not extensive laterally). Moderate risk.
Potential CASS (intertidal tidal)	**PCASS in subsoil below 20 cm (up to 1 m thick) with surface monosulfidic black ooze (MBO)**, intertidal (mainly in samphire). Moderate risk because carbonate layers usually occur above and below.
Potential CASS (supratidal)	**PCASS in subsoil below 50 cm (up to 1 m thick) with some surface MBO – supratidal**. (Mainly in samphire, salt bush, blue bush or saltpan associated with hypersaline soils where there is less frequent tidal inundation). Moderate to low risk.
Sand	**Soils of sand dunes and ridges**. (No PCASS or CASS within I metre of the surface). Low risk of PCASS below watertable.
Calcarenite/ Aeolianite	**Calcareous soils and hardpans**. (No PCASS, highly neutralising). No or very low risk.
Marine soils	**Marine soils – subtidal and intertidal marine**. (PCASS may be present, CASS neutralised by tides and carbonates). No or very low risk.
Other soils	**Soils associated with other land uses within coastal landforms**. Risk requires individual investigation; guided by adjacent mapped units.

CASS above: Coastal Acid Sulfate Soils

PCASS above: Potential Coastal Acid Sulfate Soils

Mapping of acid sulfate soils in South Australia has been carried out by the CSIRO by a sampling procedure. Within the Southern Fleurieu coastal boundary, sampling points were located near the Murray Mouth.

The Coast Protection Board Policy on Coastal Acid Sulfate Soils (see Coastline 33, January 2003) relates to avoiding or minimising the risk of development in high and moderate risk areas. The Board advises on development applications within coastal zone (as defined on the Development Plan), including advice over PCASS. However, farm drainage schemes and mining activity that have the potential to activate PCASS, have not usually been referred to the Board for assessment. It should be noted that the Development Regulations 1993 (schedule 2, paragraph 5) defines any excavation or filling exceeding 9 cu.m. within the coastal zone as development which requires approval.

Risk of acid sulfate soil development has been assessed as negligible throughout the region, with the exception of the estuarine shores of the Murray Mouth area, where high to medium risk is seen. However, there appears to be potential at the Myponga estuary, Watsons Gap and the Lower Inman, which are under investigation.

4.8 Climate Change

Coastal environments are adapted to climatic variability, for example dry years and wet years, associated with the ENSO (El Nino – Southern Oscillation) changes on a global scale. Climatologists are able to document change and trends over decades and sometimes centuries. Recently, human induced changes in the composition of the atmosphere, through the addition of greenhouse gases, have begun to influence climate.

4.8.1 The Intergovernmental Panel on Climate Change

The Intergovernmental Panel on Climate Change (IPCC) of the World Meteorological Organisation has co-coordinated the work of scientists on climate change since 1989. Three major reviews of global changes and modelled predictions of future changes ('Assessment Reports') have been produced, in 1991, 1996 and 2001. The next assessment report is due in September 2007.

The Third Assessment Report of the IPCC (2001) concluded that:

- Collectively, observations show the world is warming;
- Most of the warming of the last 50 years is attributable to human activities;
- Emissions of greenhouse gases have altered the composition of the atmosphere and will continue to do so throughout the present century;

- Emissions of greenhouse gases and aerosols due to human activities continue to alter the atmosphere in ways that affect the climate system;
- Confidence in the ability of models to project future climates has increased;
- Global average temperature and sea level are projected to rise.

New evidence (Steffen 2006, quoted in Suppiah 2006, p.vii) since the Third Assessment Report of the IPCC (2001) shows:

- Most of the IPCC conclusions have been confirmed or strengthened in recent years.
- The global average surface temperature has increased by 0.7^{o}C during the last century.
- Heatwaves and heavy rainfall have increased in many regions, while glaciers, ice sheets and frosts have decreased.
- Oceans are becoming more acidic.
- The global average sea level has risen 1.7mm per year since 1900.
- There have been shifts in plant and animal locations and seasonal behaviour consistent with global warming.
- The unusual nature of the warming of the past 50 years, relative to the past 1,000 – 2,000 years, has been supported by many other independent studies.
- The influence of human activities has been detected in land-ocean temperature contrasts, the annual cycle of surface temperature over land, the hemispheric temperature contrast, regional (not just global) warming, the height of the tropopause (between the troposphere and stratosphere) and the heating of the oceans.
- New information about climate feedbacks indicates a greater likelihood of warming at the higher end of the uncertainty range.

There now appears little doubt about the direction of change in the model projections: the present doubt is over the amount and the speed of change.

4.8.2 The CSIRO review of climate change in South Australia

The CSIRO has reviewed climate change in South Australia, documenting recent past trends and examining the results of modelling future changes over time spans of decades, (McInnes et.al, 2003, revised in Suppiah et. al., 2006). The work is based on regionally specific modelling as well as the latest findings of the Intergovernmental Panel on Climate Change (IPCC)

4.8.3 Observed climate trends in South Australia

Over the period spanning 1950 to 2005, South Australia's average temperature has increased by 1.2°C, slightly faster than the national trend. 2005 was the warmest year on record in SA. Sea surface temperatures in the region have risen at about half the rate of the land-based temperatures.

Trends in South Australian annual rainfall since 1910 are generally weaker than other parts of the continent. Most of the north-western part of the state has experienced an increasing rainfall trend while southern coastal regions have experienced slight drying trends since 1950.

4.8.4 CSIRO projections for South Australia's climate

Average regional temperature, rainfall, rainfall intensity and potential evaporation projections for the Mount Lofty Ranges region

Projections are made based on standardised scenarios representing the main demographic, economic and technological driving forces of greenhouse gas emissions, 'SRES scenarios', (Suppiah, p.18).

Annual average temperatures are projected to increase to between 0.4 to 1.2℃ by 2030 and 0.8 to 3.5℃ by 2070 and these changes are almost uniform throughout the year. Over the ocean, surface air temperature changes reflect those of sea surface temperature: these show a similar trend with a moderating effect in terms of seasonal variation.

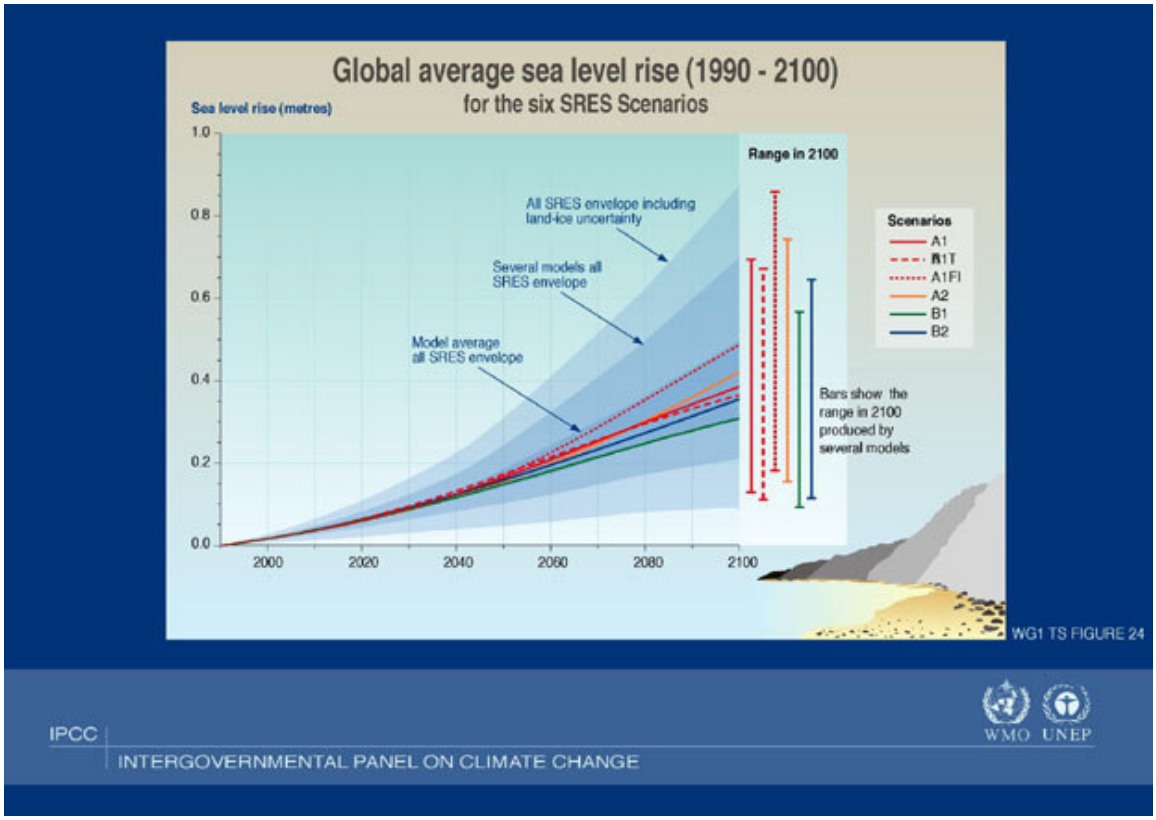
With regard to annual rainfall, decreases of 10% to 1% by 2030, and 30% to 3% by 2070 are projected for areas within 200km of the sea, (Suppiah et.al. p.25); greatest decrease is indicated in spring. However, McInnes et al (p.35) show extreme rainfall events (i.e. periods of intense rainfall) becoming more frequent at all seasons but spring.

Projections of annual potential evaporation indicate increases across the region; average annual water balance shows clear deficits. [Work by Hutson in the Mount Lofty Ranges shows that as a result of changes in water balance there will be a marked fall in normal stream flow. However, intense rainfall events may result in flash floods].

Projections of coastal storms and changing wave conditions

Currently, storm surges of at least half to one metre occur along the South Australian coast; they are caused by W. to S. Westerlies following the passage of fronts and their associated low pressure systems further south. The frequency of winter lows and therefore the frequency of surges decreases by about 20% in the vicinity of SA under enhanced Greenhouse conditions, however, the largest storms show a slight increase in intensity. It should be remembered though that when storm frequency is combined with sea level rise, the probability of a surge at heights within the present range, would increase.

The above represent the best available current scenarios for climate changes within southern South Australia over coming decades. In addition to the above changes, the IPCC predicts a global sea level rise over the next century (and continuing).



As the graph above illustrates, there are a range of sea level scenarios, depending on future levels of emissions and warming. A median value shows a rise of 0.3m by the end of the present century.

Detailed examination of tide gauge records from around the world shows that currently global sea level is rising at an average rate of 1 – 2mm per year, and that sea level has been rising for several decades. The indications are that this rate is increasing: a further acceleration would be needed to equal IPCC projections. Oceanographers indicate that sea level will continue to rise for over 200 years even if carbon dioxide emissions were stabilised now.

Tide gauges also record varying rates of change because of local movements of the land. Sea level rise close to global means is projected for the southern parts of the Gulfs. This appears to apply to the coast from Sellicks Beach to Port Eliott. Bourman et al (2,000) note that geological evidence suggests that in the area from Middleton to the Murray Mouth the land is slowly sinking. Here relative sea level rise rates will be faster that the global average.

McInnes et al (2003) do not discuss changing wave conditions in coastal waters. It is reasonable to assume, however, that under enhanced Greenhouse conditions, changes in wave climate would be expected. Models indicate poleward displacement of climatic zones resulting in a greater frequency of anticyclonic conditions in South Australia's coastal waters. This movement would see the mid-latitude Southern Ocean wind belt, the "Roaring Forties", also displaced south. However, if the changes also result in greater pressure gradients, and hence stronger winds, in the Southern Ocean even in latitudes 50 to 60 South, then South Australian waters will receive a greater percentage of low, long period, swell. At present this is speculative until tested, through year-by-year analysis of wave period frequencies, as recorded by wave rider buoys off Southern Australia.

4.8.5 Impacts of Climate Change within the Fleurieu Region

Changing climatic trends shown by the current records constitute a stress factor for natural and semi-natural habitats within coastal Fleurieu region. Forecast Greenhouse climate scenarios represent a potential risk for coastal habitats: these risks are discussed below.

Tackling Climate Change: South Australia's Greenhouse Strategy. Natural Resources Issues Paper (2005) brings together expert opinion to assess the greenhouse challenge for the natural resources sector within South Australia. The report by McInnes (2003) mentioned above provides the scenario used by this group to discuss the impacts of change. The excerpts below, Appendix A2 of the McInnes report (Biodiversity pp. 29 – 30), address a number of issues relevant to this project:

> Climate change is likely to exacerbate threatening processes already impacting on biodiversity and other natural resources and lead to the accelerated loss of a range of ecosystem services, ecological function, species and ecological communities." In particular, reduced winter and spring rains and the negative soil water balance will threaten all vegetation communities in the region. This will lead to reductions in geographic range of species and ecological communities and increased risk of extinction for species that are already vulnerable…there will be variable impacts of increasing CO2 concentrations on germination, establishment, growth and regeneration of native species.
>
> Currently, the specifics of these changes are not known at the species or community level. It is evident though that, as climatic envelopes shift, species migration will occur. This process will be more difficult in highly fragmented landscapes. That is, where connectivity between remnant vegetation blocks is maintained or enhanced, vegetation systems are likely to show greater resilience, greater capacity to adapt to the changes.
>
> With rapid climate change, highly invasive exotic species are likely to become more dominant in many landscapes…the ability of native species and ecosystems to remain within bioclimatic envelopes by migrating along climatic and geographical gradients will be a fundamental component of any adaptive response. As exotic weeds and animals are good colonizers after disturbance and within stressed ecosystems they are predicted to respond favorably to climate change as local ecosystems and species are threatened by changing conditions.

The current conservation analysis within this study shows the Southern Fleurieu is a significant area for plant species diversity, numbers of threatened species and the rarity of its vegetation communities. The threat analysis within this study shows that the region has high numbers of aggressive invasive weed species, which are widely distributed. The conservation value of the remnant vegetation areas suggests that continuing investment in weed control should be a high priority throughout this coastal region.

All Greenhouse scenarios show sea level rise, though with a wide variation in the amount of elevation; currently, sea levels are slowly rising globally and projections suggest the rate of rise will increase. For the hard rock headlands and small beaches of the southern part of the Fleurieu Peninsula from Sellicks to the Bluff, sea level rise may be a moderate threat. For example, there will be a species change of life forms at shore platforms and near shore reefs if there is no potential for adjustment to changing tide levels.

Some beach recession and foredune erosion will occur: for these ocean and gulf beaches recessions of the order of 5 to 30 metres over the next 50 years will be expected, depending on beach topography, sand supplies and littoral sediment movement. Medium energy beaches protected by reefs and islands near Victor Harbor will be much more variable in their response, depending again on sand supply, rate of sea level rise in relation to sheltering reefs, but more critically on storm frequency and magnitude under changed climatic regimes. Sand barriers between Middleton and Murray Mouth will recede, and there is a slight threat that the sea will break through the Sir Richard Peninsula on the Goolwa side of the barrage. In these circumstances it is important that the DEH monitoring of the profile line at Beach Road Goolwa is maintained, in order to show recession speeds of the Sir Richard Peninsula relative to sea level rise.

Sand beaches respond markedly to changes of wave climate. Increasing frequency of long period swell would be extremely significant for the Southern Fleurieu coast, since these waves are very powerful. Also, long period swell will respond differently to shoaling compared with short period waves; refraction and hence the angle of wave approach to the shore can change. Thus changes in the spectrum of wave periods are capable of significant impact: capable of changing littoral drift speeds, transporting sediment rapidly along the shore, and changing the patterns of erosion and deposition. The power of the long period waves would impact on foredunes.

Beach plan form is affected by the protection afforded by nearshore reefs: beaches build up behind reefs, often in pointed or salient forms; for example, at Hayborough Point, Victor Harbor. Where this protection is reduced by sea level rise, sharp change in beach plan form may occur, with the salient being cut back.

Increased temperatures and aridity will affect beach and dune vegetation. Dune vegetation on the more arid West Coast of South Australia show similar species to the Fleurieu today; however, recovery from storm damage is slower on west coast dunes.

Cliffs respond in varied ways to changes in sea level and wave climate. Most cliffs of the Southern Fleurieu are composed of ancient sedimentary or metamorphic rocks, or - near Victor Harbor – granite: these are resistant to marine erosion. Many of the cliffs of the peninsula have already been affected by soil erosion, following grazing pressure: it is uncertain whether this will increase under greenhouse scenarios. However, the clay marl cliffs east of Middleton, and the aeolianite (calcarenite) of Surfers, could be sharply eroded in storms following relatively small amounts (c. 30cm) of sea level rise.

Urban storm water systems are challenged by projected changes, since many parts of the systems may need to be adapted to peak flows of larger magnitude.

Saltmarsh complexes are particularly vulnerable to sea level rise if barriers exist to species migration: samphire species flourish between mean sea level and the highest astronomic tides. These communities are adapted to frequency of tidal flooding and soil salinity conditions. Salt marsh, mangrove, swamp paperbark and supra-tidal samphire areas near the Murray Mouth will need to retreat together with the advance of the tides, if they are to survive. Even very small sea level changes will impact on the saltmarsh, because of the very low gradients on these coastal areas. Since these areas are important fish nursery habitat, secondary impacts may be expected.

Tidal flows within the Murray Mouth will alter in complex ways following sea level change, while changes in seasonal run-off have the potential to alter critical salinity values. Conservation analysis within this (section 3.1) shows that 2 vegetation communities near the Murray Mouth are rare within the state and over 80% of their occurrence is in this locality: these are the intertidal Melalleuca habitat and the intertidal / estuarine sedges habitat.

Other estuarine areas within the region are potentially vulnerable to these impacts, such as the stands of Swamp Paperbarks near the mouth of the Hindmarsh and Inman Rivers.

Estuarine fish, and other species, are vulnerable to reduced riverine environmental flows, which are anticipated following rising evaporation rates under greenhouse conditions.

Adaptation to Changed Climatic Conditions

The adaptation to changed climatic conditions by land managers, groups, agencies, and Local and State Government will depend on the climate record and the perception of individuals of the need for adaptation. However, the timelines involved in decisions made now, means that some current actions by the Southern Fleurieu community within the coastal region could reasonably be regarded as a ‘no regrets’ response to current scenarios. It is important that decisions made now, especially those with long-term consequences, do not preclude adaptation in the future. The analysis attempted in this section suggests some priorities for immediate action in order to keep options open.

Plans are necessary in that development now does not compromise adaptation in the future. State policy on coastal flooding and erosion is written in to the Council Development Plans. Continuing action is needed to ensure these policies are adhered to. Setbacks and site levels are tied to advice from the Coast Protection Board (CPB). These standards will be subject to periodic revision following IPCC reports and advice from the CPB Mean Sea Level committee. Ongoing sea level rise underlines the value of many coastal reserves as buffers against coastal erosion and providing space for floodwall protection in some urban areas. Many of Victor Harbor’s reserves fall in this category. It is important that incursions into these reserves for private uses are not allowed to compromise such future needs.

Decisions on floodbanks protecting farmland and towns are development matters, subject to the Development Act, within a context of tenure and ownership. Long time lines are associated with these and it is important that decisions made now, do not critically limit choices in the future. The precautionary principle would appear to apply to these classes of decision at the present time. Floodbanks which prevent the retreat of samphire habitats on Hindmarsh Island should be the subject of review in the light of conservation priorities within this study.

The small estuaries of the region have been identified as significant and distinctive habitat. Here, decisions which allow flexibility and setback adjacent to these areas are relevant. Again, floodbanks and hard protection could lead to unpredictable change in these locations and therefore setback strategies are recommended. Development decisions which preclude such options should be avoided.