Conserving Marine Biodiversity in South Australia - Part 1 - Background, Status and Review of Approach to Marine Biodiversity Conservation in South Australia

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"The last word in ignorance is the man who says of an animal or plant: 'What good is it?' If the land mechanism as a whole is good, then every part is good, whether we understand it or not. If the biota, in the course of eons, has built something we like, but do not understand, then who but a fool would discard seemingly useless parts? To keep every cog and wheel is the first precaution of intelligent tinkering."
Aldo Leopold, Round River, 1953

INTRODUCTION

1 INTRODUCTION

The marine and estuarine waters of South Australia represent some of the most unique and biologically diverse waters to be found in Australia, and the world. This uniqueness and diversity is due primarily to the richness and endemism of the marine temperate fauna and flora of southern Australia and also, the geographical location and physical characteristics of the South Australia's coastal environments (Edyvane 1996). Compared to other regions of the temperate Australia, South Australia has a wide range of coastal landforms and marine habitats and also, a variety of oceanographic conditions, including a high degree of variability in sea temperatures (Edyvane 1996). Of particular significance are the two large, sheltered tidal gulf ecosystems of Gulf St Vincent and Spencer Gulf, which provide habitat for some of the largest areas of temperate, mangrove, seagrass and tidal saltmarsh communities in Australia. In addition, the marine fauna and flora of South Australia include both, the typical cold temperate biota of Tasmania, Victoria and southern New South Wales and also, the transitional warm to cool temperate biota of southern Western Australia (Womersley 1981). These factors have combined to produce a rich diversity of organisms and communities along the South Australian coast, which in many instances is unparalleled, both in Australia and at a global level.

Not only do the temperate marine environments of South Australia contain very high levels of marine biodiversity and endemism, but our waters are also becoming increasingly recognised as an area of global conservation significance for many species of rare and endangered marine mammals. For this reason there is a clear imperative to establish marine conservation management frameworks, which can both protect the key conservation values of our marine environment, but also, can provide for the human use, particularly along some of the more populated sections of our coastal environment.

1.1 The `Unique South' - Southern Australia's Temperate Marine Biota

The marine environments of temperate Australia contain some of the highest levels of marine biodiversity and endemicity in Australia, and also, the world. Many of the same factors that have made Australia's terrestrial fauna and flora, unique and biologically diverse - have also, resulted in some of the highest levels of biodiversity and endemicity in marine biota in the world. These factors include the long period of geological isolation; the large continental landmass of Australia, particularly the extensive continental shelf; the long east-west, ice-free, extent of the southern coastline (ie. the longest stretch of south facing coastline in the Southern Hemisphere); and also, the characteristic low nutrient status of the Australia's coastal waters - have all contributed significantly to the biological diversity of Australia's temperate marine environments (Edyvane 1996). Low nutrient regimes generally promote biological diversity and co-evolutionary strategies to rapidly harvest, utilise and recycle limited nutrient resources. In temperate Australia, the long period of geological isolation has been particularly important in producing very high levels of marine endemism (Poore 1995). While the marine flora and fauna of tropical Australia and the Indo-Pacific mixed some 20 mya (when the continental plates of Australia and South East Asia collided), the marine biota of southern temperate Australia has remained isolated for over 65 million years - resulting in some of the highest levels of endemism in the world (Poore 1995).

The temperate waters of Australia extend from south west Western Australia, along the southern coast of Australia, to southern New South Wales and includes the waters of Victoria and Tasmania and are recognised as a major marine biogeographic region, known as the Flindersian Province (Figure 1.1) (Womersley 1981, 1990). Within this broad region, the coastal waters of South Australia waters contain both, the warm to cool temperate biota of southern Western Australia and also, the cold temperate biota of Victoria, Tasmania and southern New South Wales. This cold temperate element (west of Robe, South Australia) has been recognised by some biogeographers as a distinct subprovince of the Flindersian - the Maugean Subprovince (Knox 1963). In many ways, South Australia is at the heart of the `Unique South', as it's marine biota encompasses these 2 distinctive regions, within a region of very high biodiversity and endemism.

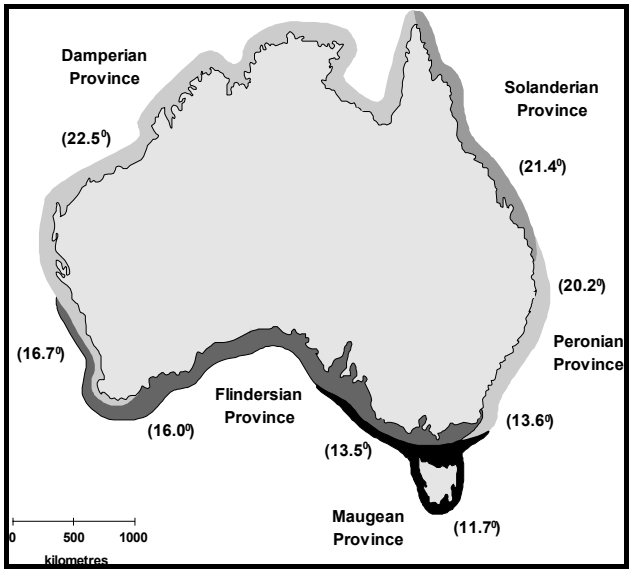

Figure 1.1 **Marine biogeographical provinces of Australia, and average surface sea temperatures (after Womersley 1990).**

The marine biota of the southern temperate coast of Australia, as mentioned above, has some of the highest levels of marine biodiversity and endemism in Australia, and the world. This is particularly the case for the marine flora and also, invertebrate taxa, such as bryozoans, ascidians, nudibranchs, molluscs and echinoderms (Womersley 1990, Shepherd 1991, Poore 1995). Within the Flindersian Province, approximately 1,155 species of macroalgae, 22 species of seagrasses, 600 species of fish, 110 species of echinoderms and 189 species of ascidians have been recorded (Shepherd 1991, Wilson & Allen 1987, Womersley 1990). Of these, approximately 85% of fish species, 95% of molluscs and 90% of echinoderms are endemic (Poore 1995). In contrast, approximately 13%, 10% and 13% of fish, mollusc and echinoderms, respectively, are endemic in the tropical regions of Australia (Poore 1995) (see Table 1.1). Similarly, the marine macrofloral diversity and endemism in the temperate regions of Australia is among the highest in the world. The richness of the temperate macroalgal flora (ie. 1155 species) is 50-80% greater than for other comparable regions around the world, with approximately 800 species and over 75% endemism recorded in the red algae alone (Womersley 1990). The level of temperate species biodiversity in macroalgae is approximately three times the level recorded in the tropical regions of Australia, where approximately 200 - 400 species of macroalgae have been described (Womersley 1990).

	TEMPERATE		TROPICAL	
TAXON/GROUP	***no. of species***	***degree of endemism***	***no. of species***	***degree of endemism***
macroalgae	1,155	75% (red algae)	400	low
seagrass	22	95%?	15	low
fish	600	85%	1,900	13%
echinoderms	220	~90%	high	13%
asteroids	50	high	?	
crinoids	7	high	high	
ophiuroids	74	high	?	
echinoids	49	high	?	
holothurians	40	80%	?	
ascidians	210	73%	?	?
molluscs	?	95%	?	10%
cnidaria				
anthozoa	200	?	high	?
hydrozoa	200	high	low	?
scyphozoa	10	?	high	?
sponges	~1,000	high	?	?
bryozoa	~500	high	low	?
pycnogonids	50	T	low	?

Table 1.1 **Marine biodiversity in Australia (adapted from Shepherd & Thomas 1982, Poore 1995).**

Similarly, Australia's waters also contain the highest level of species diversity and endemism for seagrasses in the world, with the greatest levels of speciation and endemism in temperate waters, where 22 species have been recorded (cf. to 15 species in tropical waters) (Shepherd & Robertson 1989). In the family of seagrass commonly called "Tapeweed" or *Posidonia* species, southern Australia has recorded the greatest number of species in the world. Within temperate Australian waters, the seagrass meadows of the southern coast of Western Australia (9,000 km^2), and Spencer Gulf (5,520 km^2) and Gulf St Vincent (2,440 km^2), comprise the largest (and most diverse) temperate seagrass ecosystems in Australia, and the world (Shepherd & Robertson 1989). In contrast, seagrass abundance (and diversity) is low in temperate south-eastern Australia, where the high energy coastline restricts seagrass to estuaries and protected bays. For instance, seagrass occupies approximately 500 km^2 in coastal Tasmanian waters, 150 km^2 in the waters of New South Wales and 100 km^2 in Victoria waters (Kirkman 1997).

BOX 1.1 WHAT ARE MARINE PROTECTED AREAS ?

The establishment of Marine Protected Areas is widely regarded, both nationally and internationally, as one of the most effective mechanisms for protecting biodiversity while permitting the sustainable use of natural resources. As an island continent, Australia has a diverse range of coastal, marine and estuarine environments. These range from the tropical ecosystems of northern Australia (such as coral reefs and tropical mangrove forests), to the cool temperate ecosystems in the south (such as kelp forests and deep-water sponge beds). As a developed nation with a maritime area larger than the continent itself (ie. 894 million hectares), and as a signatory to international conventions like the *Convention on Biological Diversity* (UNEP 1994), Australia has a special responsibility for the conservation and management of its marine and coastal environments and their resources. To this extent, Australia is presently regarded as a world leader in marine conservation and management.

`Marine Protected Areas' in Australia range from small, high protection Marine Reserves, to large, multiple-use Marine Parks (like the Great Barrier Reef Marine Park) which permit a wide range of exploitative uses, such as fishing (commercial and recreational), tourism and recreation. Marine Protected Areas can be established for a variety of purposes and it is possible to provide for a range of activities while still protecting the environment. For example, Marine Protected Areas can be reserved for conservation, fisheries management, research, education, social and historical importance, tourism or recreational use - or a combination of any of these - and may also include neighbouring coastal lands and islands. As such, Marine Protected Areas are defined as:

> *`any area of intertidal or subtidal terrain, together with its overlying water and associated flora and fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment.'*

To-date, over 43 million hectares (or 5%) of Australia's waters (comprising States, Territories, External Territories and Commonwealth waters) has been reserved in approximately 148 Marine Protected Areas. Of this total area reserved as Marine Protected Areas in Australia, approximately 89% is in the region of the Great Barrier Reef region - leaving many regions, particularly temperate ecosystems, poorly or under represented, if at all. Recently it has been estimated that 21 out of the 32 biogeographic regions around Australia lack any significant protection as protected areas (Ivanovici 1993). Notable regions included the Gulf of Carpentaria, the Great Australian Bight, and deep offshore regions.

1.2 The Status of Marine Protected Areas in Southern Australia

Despite the level of marine biodiversity and endemism along the temperate southern coast of Australia, the management of ecosystems, habitats, and species of this region, particularly the Great Australian Bight, is significantly under-represented in terms of Marine Protected Areas (or MPAs) (Edyvane 1996) (see Box 1.1). As of 1997 (31/5/97), a total of 148 MPAs, comprising in excess of 43 million hectares (or 5% of Australia's waters) had been established in State, Territory and Commonwealth waters (Cresswell & Thomas 1997). Of the total area reserved as MPAs in coastal waters, the large majority in 1995, ie. approximately 99.5% (or 322,725 km^2), occurred in tropical waters, while only 0.5% (or 1,706 km^2) occur in temperate waters (see Figure 1.2, Table 1.2).

This discrepancy largely reflects the lack of large, multiple-use MPAs in temperate Australia (Edyvane 1996). Similarly, of MPAs reserved in oceanic waters in 1995, approximately 98.6% (or 131,383 km^2) have been reserved in the waters of tropical Australia, while only 1.4% (or 1,880 km^2) have been reserved in temperate waters (Edyvane 1996).

Within tropical Australia, the Great Barrier Reef region is particularly well-represented with regard MPAs, comprising approximately 289,003 km^2 (or 89% of the total area of MPAs reserved in Australia). The present pattern of MPAs in Australia has left many regions, particularly temperate ecosystems, poorly or under represented, if at all (Bridgewater & Ivanovici 1993). Recently it has been estimated that 21 out of the 32 biogeographic regions (identified by the Australian Committee of IUCN) around Australia (see Figure 1.2) lack any significant protection as protected areas (Ivanovici 1993).

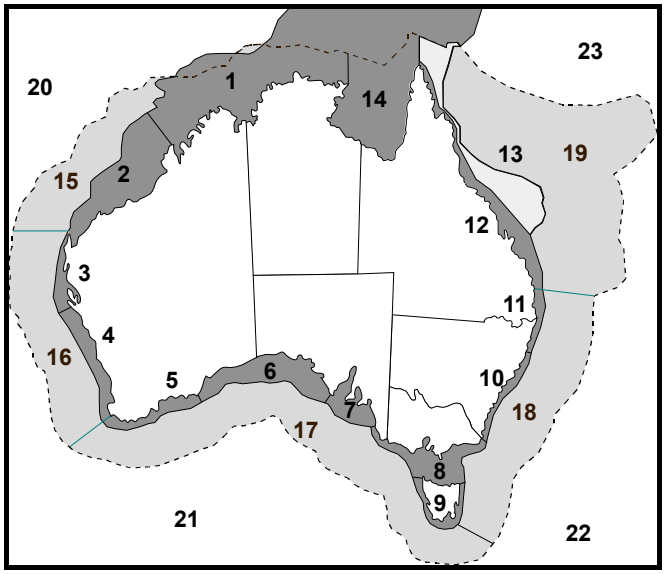

Figure 1.2 **Marine biogeographical regions of Australia according to ACIUCN/CONCOM classification (ACIUCN 1985).**

COASTAL REGION (ACIUCN Region)	TOTAL AREA (km^2)	NUMBER of MPAs	AREA of MPA'S (km^2)	%
TEMPERATE				
Lower West Coast (4)	63,000	4	163.35	0.26
South West Coast (5)	56,000	6	1.84	0.00
Great Australian Bight (6)	186,000	2	2.36	0.00
			(1,664.00)	(0.89)
South Gulfs Coast (7)	93,000	24	361.04	0.39
Bass Strait (8)	151,000	38	572.17	0.38
Tasmanian Coast (9)	31,000	17	555.95	1.79
Lower East Coast (10)	22,000	18	49.81	0.23
Subtotal	**602,000 (28%)**	**109 (42%)**	**1,706.52 (0.5%)**	**0.28**
TROPICS				
Central East Coast (11)	28,000	32	7,500.14	26.79
Northeast Coast (12)	113,000	95	105,623.09	93.47
Great Barrier Reef (13)	183,000	6	183,380.50	100.00
Gulf of Carpentaria (14)	411,000	6	12,116.71	2.95
North Coast (1)	553,000	9	3,056.89	0.55
North West Coast (2)	204,000	0	0.00	0.00
Central West Coast (3)	48,000	4	11,047.73	23.02
Subtotal	**1,540,000 (72%)**	**152 (58%)**	**322,725.06 (99.5%)**	**20.96**
TOTAL	**2,142,000**	**261**	**324,431.58**	

Table 1.2 **Representation of Marine Protected Areas (MPAs) in the coastal marine biogeographic regions of Australia, according to ACIUCN/CONCOM biogeographic classification (adapted from Kelleher *et al.* 1995). The location of each region is referred to in Figure 1.2.**

Within temperate coastal waters, the Tasmanian Coast has 1.8% (or 555 km^2) of it's coastal habitats formally managed as MPAs, the highest of any region in temperate Australia (see Table 1.2). In contrast, within tropical coastal waters, 100% (or 183,380 km^2) and 93% (105,623 km^2) of the habitats of the Great Barrier Reef and North East Coast regions have been formally managed as MPAs, respectively. Of the total area of MPAs reserved in the oceanic waters of temperate Australia, 5,000 km^2 has been reserved in the external territories of Heard and Macdonald Island, while 1,880 km^2 has been reserved in the South East Oceanic region (Kelleher *et al.* 1995). No MPAs have been established at all in the South Oceanic region of Australia .

At the national level, most MPAs have been declared in Commonwealth waters (ie. 367,560.2 km^2 or 84.3% of the total national MPA estate) (see Table 1.3). Most States/Territories (excluding Western Australia and Queensland), have generally contributed little to the national coverage, and vary considerably in their progress in establishing Marine Protected Areas in their jurisdiction (Figure 1.3). Queensland and Western Australia have contributed significantly to the national coverage of MPAs, with 53,028.8 km^2 and 11,466.4 km^2 (or 12.2% and 2.6% of the national total, respectively), reserved as MPAs. Together, MPAs in these States comprise 93.9% of the total MPAs declared in State/Territory waters (Figure 1.3), and in 1991 had 24.5% and 20.3% of their state waters protected as MPAs, respectively (McNeill 1991).

In contrast, in the Northern Territory and in the temperate water States, ie. New South Wales, Victoria, Tasmania, and South Australia, progress has been slow in the establishment of MPAs and they continue to contribute the least to a national representative system of Marine Protected Areas (Kriwoken & Hayward 1991, Kriwoken 1993, McNeill 1991, Neverauskas & Edyvane 1991a, Edyvane 1996). In 1991, these states had 8.7%, 5.4%, 2.8% and 1.4% of their state waters protected as MPAs, respectively, while the territory had 8.2% of its waters protected (McNeill 1991). More recently (in 1998), in South Australia, this proportion has recently increased to 3.1% with the establishment of the Great Australian Bight Marine Park, South Australia's first Marine Park (Edyvane & Andrews 1995), while in Tasmania, there are plans to establish 2 large MPAs in the Kent Group and Port Davey-Bathurst Harbour and 4 additional Marine Reserves (Barrett & Edgar 1998).

State/Territory	No. MPAs	Area MPAs (ha)	IUCN Category	% State /Territory Total	% National Total
Queensland	82	5,302,876	IV, V	77.2	12.155
Western Australia	7	1,146,643	IA,11,VI	16.7	2.628
Northern Territory	3	223,946	IV,VI	3.3	0.513
New South Wales	8	85,803	VI	1.3	0.197
South Australia	15	59,580	II	0.9	0.137
Victoria	12	50,312	VI, none	0.7	0.115
Tasmania	3	172	IV	0.003	0.000
Commonwealth	18	3,6756,019	IA,VI	NA	84.254
TOTAL (AUST)	**148**	**43,625,351**			

Table 1.3 **Number and area of MPAs found in each State, Territory and Commonwealth jurisdiction, as up until 31/5/97 (from Cresswell & Thomas 1997).**

In examining the status of MPAs in Australia, it is essential to examine the protected area management category of the MPA to determine the values being protected, and importantly, the degree of protection (vs. exploitation) being afforded the marine habitats, species within the MPA. In examining the types of MPAs in Australia, it is clear that different states afford different levels of protection for MPAs with the same nomenclature (see Table 1.4). For instance, an Aquatic Reserve in South Australia affords significantly higher levels of protection (ie. IUCN Protected Area Category II), than an Aquatic Reserve in New South Wales (Category IV), which allows fishing.

In nearly all States/Territory in Australia, except South Australia and Western Australia, all established MPAs provide for resource utilisation activities (Categories IV-VI). As a consequence, the total area of MPAs dedicated for strict nature conservation and preservation purposes (Categories I and II) is minimal in Australia and comprise 6.6% (ie. 2 848 272 ha), compared with the strict multiple-use MPA (Categories VI) which comprises 81.2% (ie. 35 426 842 ha) of the total area of MPAs in Australia (see Table 1.5).

Type of MPA	Number	Area (ha)	Jurisdiction	IUCN Category
Aquatic Life Reserve	2	279	NT	IV
Aquatic Reserve	21	16,653	NSW, SA	IV, II
Fish Habitat Area	73	582,553	QLD	IV
Fish Sanctuary	2	3,330	QLD	IV
Historic Shipwreck	10	973	Cwth	IA
Marine National Nature Reserve	5	2,029,484	Cwth	IA
Marine Nature Reserve	4	748,907	TAS, WA	IV, IA
Marine Park	16	35,334,175	Cwth, NT, QLD, WA	VI, VI, V, VI
Marine Reserve	8	101,364	Cwth, NSW, VIC	VI, VI, VI
Other Parks	6	46,910	VIC	None
Whale Sanctuary	1	43,730	SA	II
Total	**148**	**43,625,351**		

Table 1.4 **Number and types of MPAs found in each State, Territory and Commonwealth jurisdiction, including the, as up until 31/5/97 (from Cresswell & Thomas 1997)**

Within tropical Australia, the high degree of research and marine conservation management efforts in the Great Barrier Reef region have largely underpinned the multiple-use management of the Great Barrier Reef Marine Park and particularly the management of marine-based tourism, coastal development and fishing. In contrast, fisheries management has largely driven marine conservation management in temperate Australia. As a consequence, MPAs have been typically small, and focussed principally on fisheries habitat management objectives, such as the protection of critical nursery, breeding, spawning and feeding habitats for commercial species. However, there is a clear need to utilise multiple-use MPAs in temperate Australia in managing coastal land-use and particularly, the rapidly expanding sea-based aquaculture industry in the sheltered coastal regions of South Australia, Tasmania, and to a lesser extent, Victoria and Western Australia.

IUCN Category	No. MPAs	Area MPAs (ha)	% National Total
IA	16	2,779,192	6.4
II	16	6, 080	0.2
IV	80	586,334	1.3
V	7	4,716,993	10.8
VI	23	35,426,842	81.2
none	6	46,910	0.1
TOTAL (AUST)	**148**	**43,625,351**	**100**

Table 1.5 **The status of protected area management categories for Marine Protected Areas in Australia (from Cresswell and Thomas 1997).**

The need for greater research and conservation management efforts in the temperate Australia is also highlighted by the increasing interest in the economic potential of Australia's EEZ, and the need to resolve potential user-group conflicts, particularly between fisheries and mineral and petroleum interests and significant marine biodiversity values in the region. Even in remote areas, like the Great Australian Bight, there is a need to resolve potential conflicts between offshore commercial fisheries, mineral and petroleum interests and the expanding marine-mammal based ecotourism in the region, particularly at Esperance and Albany (WA), and at Yalata (SA). Within inshore areas, sea-based aquaculture developments, such as intensive fish-farming, also have the potential to conflict with conservation values and other interests in the region.

2 SOUTH AUSTRALIA'S MARINE ECOSYSTEMS AND BIODIVERSITY

2.1 Oceans, Gulfs and Estuaries - South Australia's Oceanographic Environments

South Australia nearshore waters extend over 6 million hectares and encompass a wide range of surface sea temperatures, salinities and oceanographic conditions. Oceanic sea temperatures vary from the cool temperate waters of the southeast (where annual sea temperatures fluctuate from 12-14^{o}C), to the transitional warm temperate waters of the Bight region in the west of the state (where annual sea temperatures fluctuate from 16-20^{o}C) (Figure 2). In the sheltered gulf systems of South Australia (ie. Gulf St.Vincent and Spencer Gulf), fluctuations in annual sea temperatures are even greater. In Spencer Gulf sea temperatures fluctuate from 14^{o}C in winter to 25^{o}C in summer. In contrast, in the southeast of South Australia, a summer "upwelling" of cooler water maintains fairly uniform year-round sea temperatures of 12-14^{o}C (Lewis 1981).

While waters of South Australia's (like much of Australia) are generally nutrient poor, localised, cool nutrient-rich waters of upwellings have contributed directly to the productivity of nearshore coastal regions (Figure 3). The coastal upwellings in the southeast region (Lewis 1981), and to a lesser extent the southwestern Eyre Peninsula and western Kangaroo Island area (Wenju *et al*. 1990, Ward & McLeay 1998), represent some of the most significant upwellings along the whole of the southern Australian coastline. These regions are characterised by high levels of benthic biodiversity and also, productivity (as recognised by the development of major commercial fisheries, such as lobster and abalone). The upwellings in the southern Eyre Peninsula have recently been linked to pilchard abundance in the region (Ward & McLeay 1998), and are likely responsible also for the very high concentration of seabirds and marine mammals in the region.

Similarly, the seasonal influence of the currents also have a major influence on South Australia's oceanographic environments and marine biodiversity. In particular, the warm waters of the Leeuwin Current (Rochford 1986) are thought to be responsible for the dispersal of many tropical pelagic marine organisms from the warm waters of the north-west of Australia to the southern coast of Australia (Maxwell & Cresswell 1981).

2.1.1 Productivity

The levels of nutrients and phytoplankton in waters of South Australia, are generally low (apart from areas of localised upwellings). As such, primary productivity in South Australian coastal waters, particularly in the gulfs, is dominated by vast and diverse assemblages of seagrasses. The carbon fixed by seagrasses in coastal waters provides a source of energy for grazers and detritivores in seagrass communities. These animals provide prey for a suite of fish, molluscan, and crustacean predators that migrate to coastal and oceanic waters. Predator prey relationships based on those taxa associated with seagrass beds include pelagic species such as sharks, and other large fish such as tuna. Seagrasses, which form a key component of coastal food webs, are also important habitats for the juveniles of many important fish species including whiting, garfish, and crabs. For these reason, anthropogenic or human impacts such as coastal discharge, including sewage, have potential to damage seagrasses, modify habitats, and affect coastal food chains.

2.1.2 Estuaries

South Australia's predominantly semi-arid climate results in irregular freshwater inputs into the marine environment and also, the phenomenon of `inverse estuaries', ie. estuaries which are often more saline at the top, rather at the mouth of the estuary. These estuaries predominate in the semi-arid and arid regions of Australia and generally receive irregular freshwater inputs, and flow (and flood) only after local rains have fallen. Gulf St Vincent and Spencer Gulf represent the largest temperate inverse estuaries in Australia (cf. with the tropical inverse estuaries of Shark Bay and Exmouth Gulf, in Western Australia). The arid climate of South Australia has also resulted in many ephemeral creeks and the lowest number of estuaries in Australia (Bucher & Saenger 1989). For these reasons, estuaries are of considerable conservation significance in South Australia, and many are of national conservation significance (see Table 2.1). Of the 783 major estuaries and enclosed marine waters, identified in Australia (415 tropical, 170 subtropical and 198 temperate), 15 occur in South Australia, compared with 307 in Queensland; 145 in Western Australia; 137 in the Northern Territory; 81 in New South Wales; 63 in Tasmania; and 35 in Victoria (Bucher & Saenger 1989).

Coastal estuaries in Australia, as elsewhere in the world, are seriously threatened by human activities (Hutchings & Saenger 1987). As such, there has been considerable documentation on the decline of estuarine resources, in particular seagrass beds, which have suffered fragmentation, and loss and destruction, through such practices as sewage discharges, urban run-off, dredging, boating, and land reclamation (Shepherd *et al*. 1989).

Estuaries are of special importance in South Australia because of the State's generally arid nature. The majority of rivers in South Australia are temporary streams which flow (and flood) only

after local rains have fallen. Hence, many of the estuaries receive irregular freshwater inputs. For this reason, many have been called "reverse estuaries" because they are often most saline at the top, rather than at the mouth, of the estuary.

Region	Coastal And Marine Wetlands Of National Importance
COORONG	Coorong Lagoon (including Lake Alexandrina, Lake Albert),Tookayerta and Finniss River.
EYRE	Davenport Creek (Tourville Bay), Streaky Bay (Acraman Creek), Point Labatt, Baird Bay, Lake Newland, Lake Hamilton, Coffin Bay, Tod River, Tumby Bay.
KANGAROO ISLAND	American River, Cygnet River, D'Estres Bay, Rocky River, Breakneck River, North West River, South West River.
SPENCER GULF	upper Spencer Gulf mangroves (from Port Augusta, south to Whyalla and Jarrold's Point, Fisherman's Bay and Port Broughton), Franklin Harbor.
GULF ST VINCENT	Clinton, Barker Inlet estuary, Wills Creek, Davenport Creek, Port Gawler.
SOUTH-EAST	Butchers and Salt Lakes, Ewens Ponds, Piccaninnie Ponds and the coastal lakes of Lake Robe, Eliza, George, and St Clair.

Table 2.1 **Coastal and marine wetlands in South Australia of recognised national importance, as identified in the 'Directory of Important Wetlands in Australia' (ANCA 1996).**

The small numbers of rivers which were permanent at the time of European settlement have been severely affected by their use as water supply sources. This has resulted in a drastic reduction in their flow, and the virtual elimination of flow downstream of storage and diversion structures. This has had major impacts on the extent of flowing water available as habitat, and points to the urgent need for the State's remaining streams to be protected from development (EPCSA 1988). A number of rivers and streams have already been identified in South Australia as being of outstanding environmental value and consequently recommended for declaration as wetland reserves (Lloyd & Balla 1986) (see Table 2.2).

Region	Wetland Type	Locations in South Australia
SOUTH EAST	Swamps (5)	Marshes, Mt McIntyre perched swamps, Mt Lyons perched swamps, Lake Frome-Mullins Swamp, Sawpit Swamp.
	Lakes (3)	Bool Lagoon, Woolwash, Blue Lake
	Rivers (1)	Eight Mile Creek (the only significant river in the whole region).
RIVER MURRAY	Swamps (2)	Opposite Cooinda, Complex N. of Swan Reach.
	Lakes (19)	Coorong, Lakes Alexandrina & Albert, River Marne mouth, Milang....Roonka, Irwin Flat, Chowilla Region.
	Rivers (5)	Tookayerta Creek, Dawson Creek, Finniss River, Marne River, River Murray Channel (none of the Murray's main channel is within a conservation park or reserve), Murray Mouth (including islands within Lake Alexandrina).
GULFS	Swamps (5)	Ducknest Ck Perched Swamps (FP), Myponga Swamp (FP), Peesey Swamp (YP), Grainger Lagoon (KI).
	Lakes (5)	Big Swamp (EP), Lake Wangary (EP), White Lake (KI), Lake Ada (KI), Halls Rd. Salt Lake (KI), Cygnet River Billabongs (KI).
	Rivers (4)	Little Para River (M), Tod River (EP), Harriet River (KI), Stunsail Boom River (KI), Cygnet River (KI).
LAKE EYRE		Enbarka Swamp, Tirrawirra Swamp, Coopers Creek. Mound springs (9) - Francis Swamp, Mt Dennison, Billa Kalina, Neales River.
WESTERN PLATEAU		Lake Newland, Lake Hamilton and Sheringa Lagoon

Table 2.2 **Inland waters of South Australia of outstanding environmental value recommended for status as Wetland Reserves (from Lloyd & Balla 1986, Edyvane 1996). (FP=Fleurieu Peninsula; M=Metropolitan; YP=Yorke Peninsula; EP=Eyre Peninsula; KI=Kangaroo Island).**

Bucher & Saenger (1989) in an inventory of Australian estuaries, have identified 5 (out of 15) estuaries under threat in South Australia (ie. threat to fisheries and conservation values). These include: the Coorong, due to increasing salinity in the lower reaches of the Murray River, reduced flow and lower flood frequency; Port Adelaide River, due to poor water quality from pollution, and threat of adjacent urban and industrial development; Second Creek, Port Pirie, due to the threat from the nearby sewage treatment works; Port Pirie, due to run off and discharges from shipping, residential and heavy industrial development; northern Spencer Gulf, due to potential poor water quality from port facilities, sewage treatment plant, power station and urban run off from Port Augusta (see Table 2.3).

Estuaries	F	T	C	A	E	L	Q	W	I	M	S
Coorong	H	P	H	M	M	I		310	<1	0	0
Port Adelaide River	H	P	M	H	C	I		3	12	17	13
Port Davis Creek	M	N	M	M	S	I		3	<1	2	10
Fisherman Creek	M	N	M	L	S	I		14	8	12	10
Third Creek	L	N	L	M	S	I		40	25	7	17
Second Creek	M	P	M	L	S	I		24	21	13	0
Port Pirie	M	P	M	H	M	I		1	7	2	13
Northern Spencer Gulf	H	P	H	H	S	I		3	2	6	12
Franklin Harbour	M	N	M	L	S	H		69	67	17	
Port Douglas	M	N	M	L	S	M		119	<1	3	
Venus Bay	M	N	M	L	U	I	E	65	15	<1	
Baird Bay	L	N	L	L	U	I	E	45	0	0	
Blanche Port	M	N	M	L	U	I	E	32	7	3	
Smokey Bay	M	N	M	L	U	I	R	10	11	8	
Tourville Bay	M	N	H	L	U	I	E	16	42	13	

Table 2.3 The status of estuaries in South Australia (from Bucher & Saenger 1989).

Note:

F fisheries value [H=high, M=moderate, L=low]
T threat [R=real, P=perceived, N=none]
C conservation value [H=high, M=moderate, L=low]
A amenities value [H=high, M=moderate, L=low]
E ecological status [U=unaffected, S=slightly, M=moderately, C=considerably affected]
L land use [I=>75% developed, H=50-75%, M=25-50%]
Q water quality [E=excellent]
W area of water [km^2]
I intertidal flats [km^2]
M mangroves [km^2]
S samphires [km^2]

Fisheries Value
Criteria considered include the importance of the estuary as a recreational or commercial fishing ground, significance as a breeding/nursery area for exploitable stocks, use or suitability for use as mariculture site and records of potentially exploitable stocks.

Conservation Value
Criteria considered include the importance of the estuary as a scientific reference area (eg. representative example of a habitat type, a convenient study site, type locality, etc.), a remnant example of the natural condition in an otherwise developed area, its general habitat resources, educational value, unique habitat types, unusual communities, habitat for rare or endangered species, range limits and breeding/nursery grounds for fish, etc. other than commercial species.

However, only 3 of these estuaries have been assessed as "moderately" or "considerably affected" ecologically by human activities: Port Adelaide River (considerably), the Coorong (moderately), and Port Pirie (moderately). Port Douglas (25-50% cleared) and Franklin Harbour (50-75% cleared) are also significant estuaries in that their catchments are the only catchments which are not `intensively developed' (ie. >75% cleared of native vegetation).

2.2 Rocky Cliffs and Gulfs, to Mangrove Shores - South Australia's Coastal Environments

The coastline of South Australia extends over 3700 kilometres (including Kangaroo Island, but excluding the offshore islands) and is characterised by a wide range of coastal habitats. These coastal habitats range from the rough-water rocky shores and sandy beaches of the south-east and west coast, to the extensive calm-water mudflats, seagrass and mangrove habitats of the gulf regions (Womersley & Edmonds 1958). Sandy beaches and rocky shores dominate South Australia's coast occupying approximately 59% and 33% of the coastline (Fairweather & Quinn 1995). These habitats are particularly common in the swell-dominated oceanic regions of South Australia, which for the most part face the full force of the Southern Ocean, and as such, experience some of the highest wave energies in Australia. On rocky shores, steeply sloping, ancient Precambrian granites or gneisses dominate wave-exposed capes and promontories. Between these areas, on surf-beaten coasts, particularly on the west coast of South Australia, limestone cliffs derived from ancient consolidated sand dunes (and up to 90 metres high along the Nullarbor Cliffs), occur over hundreds of kilometres of coast. In contrast the sheltered mangrove habitats occupy only 8% of the coastal habitat of South Australia (Fairweather & Quinn 1995) and are largely confined to the gulf systems of Gulf St Vincent and Spencer Gulf, which together represent some of the largest, sheltered coastal marine wetland ecosystems to be found anywhere in temperate Australia.

Along the exposed coast of the Great Australian Bight to the mouth of Murray River, sediment transport is largely a result of ocean swell and storm generated currents (Harris 1995), due largely to the lack of significant drainage to the sea. Within sheltered areas of low coastal relief, redistribution of coastal sediments result in shallow coastal embayments, dominated by tidal saltmarshes, mangroves and seagrass (eg. Spencer Gulf, Gulf St Vincent), while in exposed coastal areas of high wave energy (eg. the Great Australian Bight and south-east South Australia), these reworked sediments form large transgressive sand dunes.

Offshore, the wide, swell-dominated, open shelf waters off South Australia, particularly the Otway region of south-eastern South Australia (ie. Lacepede and Bonney Shelf) and Great Australian Bight (ie. Eucla Platform), have allowed some of the largest modern, cool-water, open shelf accumulations of carbonate sediments in the world (Gostin *et al*. 1988). Export of sediment from land to the wide continental shelf is low because of South Australia's low continental relief and predominantly arid climate. Together with the cold water upwelling ocean waters, these shelf conditions have resulted in luxuriant growths of carbonate-producing bryozoans and coralline algae, together with sponges, molluscs, asteroids, benthic and some planktonic foraminifera. These organisms form the basis for the accumulation of Holocene sediments, which generally contain a high proportion of bryozoans. In the open coastal areas of South Australia (eg. the Great Australian Bight and south-east South Australia), winds and persistent south-west long-period swells, erode and continuously rework these carbonate sediments on the inner shelf and supply much of the sediment for extensive beach and dunal systems which dominate these regions (Gostin *et al*. 1988).

2.2.1 Offshore Islands[1]

There are over 150 islands off the South Australian coast, from Kangaroo Island at 4 400 square kilometres, to a variety of rocks and reefs of less than a hectare (see Robinson *et al.* 1996 for a recent comprehensive review). The islands are all remnants of the much larger Australian landmass that existed at a time of lowered world sea levels during the last ice age 17 000 years ago. When sea levels rose these islands were cut off from the mainland and samples of flora and fauna of that time were isolated with them. The islands are largely free from foxes, cats and rabbits introduced with European settlement. As a consequence, some islands have retained species of animals which have become extinct on the mainland such as the stick-nest rat. For the same reason they are extremely important places where seals and seabirds can return safely to land to rest and breed (Robinson *et al*. 1996).

2.2.2 Gulf Ecosystems

The large sheltered gulf ecosystems of South Australia are of particular ecological significance. In South Australia, the vast low-lying supratidal areas of Gulf St Vincent and Spencer Gulf provide habitat for some of the largest areas of temperate seagrass, mangrove, and tidal saltmarsh communities in Australia. Together, mangrove and saltmarsh communities along the South Australian coast total 82 000 ha, with the largest communities occurring in northern Spencer Gulf (46 000 ha) and Gulf St Vincent (20 000 ha). Other substantial communities occur in lower Spencer Gulf (6 000 ha), on the west coast of Eyre Peninsula (9 000 ha) and on Kangaroo Island (7 000 ha) (DELM 1993).

The grey mangrove (*Avicennia marina)* found in the upper intertidal sandy mud flats, is the only mangrove along the southern Australian coast. In South Australia it covers 230 km^2, due principally to the extent of sheltered habitats within the gulf ecosystems (Galloway 1982). Likewise, extensive areas of salt-tolerant coastal samphire communities, including plants such as *Sarcocornia* and *Halosarcia* (relatives of the more familiar saltbush) also occur within the gulf ecosystems, forming extensive zones in the upper intertidal to supratidal level adjacent to the mangrove forests.

Extensive temperate seagrass meadows within the gulfs provide essential habitat for marine organisms, which form the basis for much of the state's commercial and recreational fisheries. Seagrasses occur over 15 000 km^2 in South Australia (Greenwood & Gum 1986). The most extensive meadows, dominated by *Posidonia* species, occur in Spencer Gulf (3,700 km^2) and Gulf St Vincent (1,530 km^2) (Shepherd & Robertson 1989). Other species such as *Amphibolis antarctica, A.griffithii* and *Heterozostera tasmanica* occupy edges, blowouts and smaller areas. *Halophila australis* is sparse but widespread in both gulfs, with *Zostera mucronata* and *Z.muelleri* occurring intertidally (Shepherd & Robertson 1989). Seagrass meadows are also in Backstairs Passage, offshore from Robe and in bays on the west coast of Eyre Peninsula.

The waters of Spencer Gulf are among some of the most commercially productive in South Australia, particularly for marine scalefish species and Western King Prawn (*Penaeus latisulcatus*). In 1996/97, Spencer Gulf accounted for 81% of the State's total catch for Western King Prawn, while Gulf St Vincent and the west coast fisheries accounted for 10% and 8%. Northern Spencer Gulf itself provides approximately 45% of the State's marine scalefish catch and more than 45% of the State's blue crab catch, although the bulk of the these catches occurs between Moonta and Ward Spit.

2.2.3 Northern Spencer Gulf

Within the gulfs, the benthic flora and fauna of northern Spencer gulf is characterised by a significant and very distinctive relict tropical element (Shepherd 1983, Edyvane 1995). For this reason it has been identified as a distinctive biogeographical region, known as the Northern Spencer Gulf Bioregion (Edyvane & Baker 1995, IMCRA in press). Although most of the algae recorded in northern Spencer Gulf have intermediate warm to cool temperate affinities (occurring throughout the southern Australian region), some algal species (*Hormophysa triqueta*, *Sargassum decurrens*, *Asparagopsis taxiformis* and *Platysiphonis mutabilis)*, appear to have distinct warm temperate affinities, occurring only westward of the South Australian Gulfs.

[1] Text by A Robinson, in `Description, Use and Management of South Australia's Marine and Estuarine Environments' (1998).

Several species of colenterates found in the region are also distinctly tropical and sub-tropical in distribution. These include: the endemics, *Echinogorgia* sp., *Scytalium* sp. and *Telest multiflora*; and the ascidian, *Sucozoa pedunculata*, which is known only from upper Spencer Gulf and Investigator Strait region (Kott 1972, 1975, Grasshoff 1982, Utinomi & Shepherd 1982, Verseveldt 1982, Shepherd 1983). Recent discoveries of other rare fauna of essentially tropical affinity include the first Australian records of *Pisione* and *Hesionura* polychaetes in Spencer Gulf (Hartmann-Schroeder & Parker 1990a, b).

In addition, a number of invertebrate species are known only from (or generally confined to) the upper Spencer Gulf region. They include the bryozoan, *Bugula* sp., the flatworm, *Ancoratheca australiaensis*, the opisthobranch, *Discodoris* and the ophiuroid, *Amphiura trisacantha* is apparently rare elsewhere (Baker & Devaney 1981). The region is also the only known South Australian record of the cosmopolitan coelenterate, *Virgularia mirabilis*.

2.2.4 Reef Communities

Subtidal reefs in South Australia essentially reflect the coastal geology of the state (see Section 2.1.2) and comprise predominantly low profile, Pleistocene limestone (ie. calcarenite) reefs, and on the wave-exposed capes and promontories of the state (eg. southern Eyre Peninsula, southern Kangaroo Island, southwest Yorke Peninsula, southern Fleurieu Peninsula), steeply sloping, Precambrian granites or gneisses reefs (Edyvane 1996). In these latter coastal areas which experience strong wave action, intertidal horizontal calcareous rock platforms or sandy beaches commonly occur between the granitic headlands.

The intertidal ecology of South Australian rocky shores has been relatively well-described (Womersley & Edmonds 1958, Womersley 1990). In contrast, it has only been since the advent of SCUBA apparatus in the 1960s, that ecology of subtidal communities has been seriously investigated. To this end, the South Australian subtidal studies by Shepherd and co-workers (Shepherd & Sprigg 1976, Shepherd 1983, Shepherd & Womersely 1970, 1971, 1976, 1981) represent the first comprehensive research studies into the ecology of subtidal temperate reefs in Australia.

The ecology of subtidal temperate reefs in Australia is characterised by the structural dominance and diversity of large macroalgae and an abundance of sessile and mobile invertebrate assemblages (ie. sponges, bryozoans, ascidians, hydroids, echinoderms, molluscs, crustaceans) (for recent views, see Underwood & Chapman 1995, Keough & Butler 1996). In the southeast of South Australia (east of Robe), wave-exposed nearshore reefs are dominated by large canopy-forming species of brown macroalgae, such as the Giant Kelp (*Macrocystis angustifolia)*, *Phyllospora comosa* and the just subtidal, Bull Kelp (*Durvillea potatorum)* (Womersley 1981, Womersley & King 1990, Underwood & Kennelly 1990). East of Robe, wave-exposed nearshore reefs are dominated by smaller (ie. up to 2m high), canopy-forming brown macroalgae, such as *Ecklonia radiata, Seirococcus axillaris, Scytothalia dorycarpa* and in moderately-exposed areas, species of *Cystophora* and *Sargassum.*

In areas of high wave exposure and localised, cold-water oceanic upwellings (ie. south-east, southern Eyre Peninsula, south-western Yorke Peninsula), very high levels of macroalgal diversity (ie. 95-125 dominant species) occur on nearshore reefs, particularly for species of Rhodophyta (ie. red algae) (Shepherd 1981, Edyvane & Baker 1996). Species of articulate and crustose coralline red algae are particularly prevalent in these mixed-red algal communities, and are known to form key microhabitats for the larvae of economically-important invertebrates (such as Blacklip Abalone) (Shepherd & Turner 1985). In contrast areas, areas of low macroalgal diversity (ie. 15-20 dominant species) occur in areas where is there is generally a high predominance of sandy habitats and/or seagrass communities (ie. Eucla Bioregion, southern Fleurieu Peninsula and northern Spencer Gulf) (Edyvane & Baker 1996). In recent years, ecological studies have been undertaken examining broadscale patterns of benthic biodiversity along the South Australian coast (Edyvane & Baker 1996) and also, in understanding the role of physical and biological processes on macroalgal community structure on subtidal reefs in Gulf St Vincent and Fleurieu Peninsula (Collings 1989, 1996, Emmerson 1992, Cheshire *et al.* 1996).

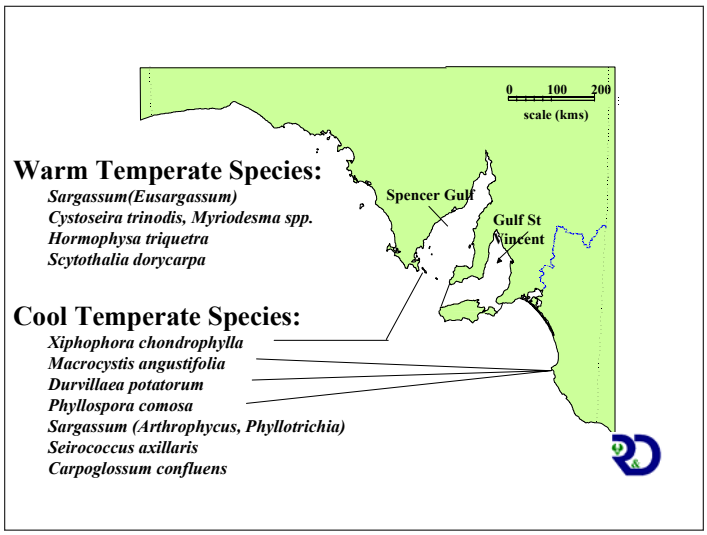

Figure 2.1 **Marine biogeography and distributional limits of the major brown macroalgae in South Australia.**

Many of the marine species which inhabit the temperate reefs of Australia are characterised by short larval periods and localised dispersal. For these reasons, there is a great tendency for local and regional rarity and endemism in temperate waters, with species distributions characterised by small, isolated, localised populations. For instance, the marine flora of Ward Island (western Eyre Peninsula) is very distinctive in the dominance of a number of generally rare or uncommon plants, including the red algae *Glaphrymenia, Kallymenia, Claudea elegans,* and *Solieria,* the brown algae, *Cystophora congesta* and four species of the green alga *Codium* (including the rare *C.laminariodes)* (Edyvane & Baker 1996).

Reefal habitats are highly important for a number of economically-important species, including the Blacklip Abalone and the Southern Rock Lobster. However very little is known of the habitat linkages of these species, and their trophic interactions with other reefal organisms on South Australian reefs.

In contrast to seagrass habitats, the impacts of human activities on reefs in South Australia is virtually unknown. Following anecdotal reports, a recent detailed study (Cheshire *et al.* 1997) has shown a loss of robust larger brown algae from northern reef systems off the metropolitan Adelaide coast. In contrast, southern reefs (ie. Aldinga, Noarlunga and Hallet Cove) were generally dominated by *Ecklonia* and other large brown algae, such as species of *Cystophora* and *Sargassum*.

The absence of brown algae and an increase in opportunistic and turf-forming algae on the northern reefs, could possibly be due to either anthropogenic inputs (ie. nutrient pollution and/or turbidity from adjacent sewage and stormwater inputs) or a natural north-south gradient in wave exposure (or differences benthic ecology) and requires further detailed investigations (Cheshire et al. 1997). However, the presence of *Ecklonia radiata* only on the vertical surfaces of the Glenelg Blocks (within the vicinity of the Patawalonga outfall) does suggest that the recruitment of this large brown algae is more sensitive to the effects of sedimentation rather than effluent (Cheshire *et al.* 1997).

2.2.5 Sandy and Soft-Sediment Habitats

Sandy and soft-sediment shores and their biotic assemblages are unlike any other marine benthic habitat. In contrast to rocky shores, sandy and soft-sediment habitats are characterised by their three-dimensional nature (ie. depth is an important variable); range of grain size, depth and chemistry of the sediments (which exerts a profound influence on the types of organisms living within it); large size range of organisms which include some that ingest the sediment matrix, as well as living on or within it; and the lack of large attached plants and dominance of microscopic primary producers (see review by Fairweather & Quinn 1995). Importantly, soft-sediment habitats provide the contiguity of habitat with other types, such as seagrasses, mangroves, saltmarsh and open ocean which facilitates the movement of organisms among them – both between and within different stages of their life cycles.

As elsewhere in the world, unvegetated, soft-sediment shores remain one of the most under-researched marine benthic habitats in Australia (Fairweather 1990, Fairweather & Quinn 1995). In Australia soft-sediment research has been neglected in favour of studies on coral reefs, mangroves, rocky shores and vegetated habitats within estuaries (Fairweather & Quinn 1995). In a review of research papers published between 1980-1987, Fairweather (1990) reported that only 10% of the 729 papers examined dealt with sandy bottoms, and only 6% with muddy bottoms. This is despite the fact that sandy shores represent on average, approximately 47% (or 36-68%) of Australia's coastline, while muddy shores (particularly adjacent to mangrove forests) comprise approximately 21% (or 1-48%) of the coastline (Fairweather & Quinn 1995).

Soft-sediment research studies in Australia are very limited and have largely been descriptive (ie. species lists and zonation schemes) with a few quantitative or semi-quantitative studies (ie. community descriptions linked to depth zonation), and include tidal flat studies (Rainer 1981), subtidal soft-sediment studies on detailed examinations of spatial and temporal variation (Jones 1987, Morrissey *et al.* 1992) and quantitative surveys of benthos in Port Phillip Bay (Poore & Rainer 1979). Significantly, soft-sediment research in Australia has benefited considerably from foreign scientists who have established research programs in Australia, particularly on tidal flats in Western Australia (ie. Black & Peterson 1987, Peterson & Black 1987) and sandy beaches in NSW and Western Australia (ie. Dexter 1983, 1984, MacLachlan & Hesp 1984).

Overseas, tidal flats are known to be important because they have high biodiversity (Warwick 1993), are good indicators of environmental health (due to providing the ecosystem service of improving water quality), their biota are important as food for prawns, fish and birds, and they serve as settlement sites for larvae (these last two factors make them integral to recreational and commercial fisheries) (Fairweather & Quinn 1995). Due to the paucity of experimental studies, there are presently no cohesive theories about any aspects of the ecology of soft sediment intertidal assemblages in Australia (Fairweather & Quinn 1995). Similarly, our understanding of trophic interactions on sandy beaches and hence the flows of energy in soft-sediment ecosystems, is limited.

In South Australia, sandy and soft-sediment habitats comprise approximately 59% and 9% of our coastal shores. These habitats are particularly dominant in the sheltered gulfs and also, along the high wave energy sections of the coast and continental shelf (ie. Great Australian Bight, Coorong), where large deposits of Holocene carbonate sediments (some of the largest in the world) are continually reworked. Despite this, ecological or biological studies have, until very recently, been limited or absent. Sandy shore studies in South Australia have primarily concentrated on beach morphodynamics (Short & Hesp 1980, Short *et al.* 1986, Short and Fotheringham 1986), or continental shelf sediment dynamics (see review by Gostin *et al.* 1988), with few ecological studies.

Womersley and Edmonds (1958) described a generalised intertidal zonation scheme for beaches in South Australia, and identified the following zones: supralittoral zone dominated by *Talorchestia quadrispinosa*; a littoral zone dominated by the isopods, *Actaecia pallida* and *Cirolana woodjonesi*, and the bivalves *Amphidesma cuneata* and *Donax (Plebidonax) deltoides*; and an upper sublittoral with *D.deltoides* and the portunid crab *Ovalipes bipustulatus.* Overseas and Australian studies indicate that zonation on sandy beaches is dynamic and variable, and varies between beach types, with fewer zones being present on reflective rather than dissipative beaches, because of the absence of fauna on the lower shore in the former (McLachlan & Jaramillo 1995). Competition and predation generally exert limited influence on zonation on open sandy shores, with many communities exhibiting marked temporal variability, often coupled to seasons and reflected in changing zonation patterns (McLachlan & Jaramillo 1995). Rhythmic behaviour also varies and determines zonation, particularly in crustaceans, which display marked circatidal rhythms in midshore, but also circadian rhythms in the supralittoral and sublittoral. As major coastal habitat types in South Australia, there is a critical need for beach and intertidal mudflat ecological studies.

In contrast, there have been several ecological studies on subtidal soft-bottom communities in South Australia. These studies were primarily undertaken as part of series of descriptive studies on subtidal benthic marine habitats in the 1970s and 1980's (Shepherd 1983, Shepherd & Sprigg 1976, Shepherd & Womersley 1970, 1971, 1976, 1981), and more recently in the 1990's (Edyvane & Baker 1995, 1996a-d).

Further, our knowledge of subtidal soft-sediment habitats has been recently enhanced by several major studies on the soft-sediment communities of metropolitan Adelaide (Cheshire & Kildea 1993, Cheshire *et al.* 1996) and Boston Bay, Port Lincoln (Cheshire *et al.* 1996a, b), examining the ecological effects of sand dredging and the environmental impacts of sea-based tuna farms, respectively. Further research is required on productivity, ecological processes and the role of soft-sediment communities in nearshore coastal ecology and dynamics (ie. trophic dynamics, inter-habitat linkages).

In addition, the effect of prawn trawling activities on soft bottom habitats in both Gulf St Vincent and Spencer Gulf, although uninvestigated, is likely to have been considerable. Studies both in Australia and overseas have demonstrated that bottom trawling activities result in significant modification or destruction of habitat, with resultant changes in the structure or composition of benthic communities (Craik *et al.* 1990). This should be a high priority area for future research.

2.3 Marine Flora - Mangroves, Saltmarshes, Seagrasses and Seaweeds

2.3.1 Mangroves

Mangroves are individual marine plants, species (and habitats) which grow in the intertidal zone (above mean sea level). The coastal mangrove flora of Australia occupies approximately 11 500 km^2 (ie. the third largest area of mangroves in the world) and is one of the richest in the world, comprising 39 species, or 56% of the total number of species recorded world-wide (Hutchings and Saenger 1987, Robertson & Alongi 1996). Mangroves generally occur in warm humid tropical climates, and in areas of low wave action, high rainfall (or abundant freshwater runoff) and extensive intertidal zones composed of fine-grain sediment. Mangroves are thus generally associated with low energy, muddy shorelines, particularly tropical tidal deltas. However, they can grow on a wide variety of substrates including sand, volcanic larva or carbonate sediments.

Approximately 39 species and 11 238 km^2 (or 93%) of Australia's mangroves occur in the tropics-subtropics, where they typically form tall closed forests (up to 30m tall),. In temperate Australia (ie. at latitudes greater than 30^0S), mangrove diversity is reduced to only 1 species, *Avicennia marina*), which forms open woodlands or shrublands (up to 8m tall).

In South Australia, mangrove forests are composed solely of one species, the Grey Mangrove, *Avicennia marina*, which forms open coastal woodlands (up to 5m tall). Mangrove forests occur at a number of sheltered sites on the South Australian coast and cover a total area of approximately 230 km^2 (EPCSA 1988) – the largest area of temperate mangroves in Australia. The most significant stands occur near Ceduna on the West Coast, Franklin Harbour near Cowell, around the northern ends of Gulf St Vincent and Spencer Gulf, near Port Pirie and between Port Adelaide and Port Gawler (see Figure 2.2) (Butler *et al.* 1977). Approximately 56% (ie. 113 km^2) of South Australia's mangroves are currently protected in 7 separate reserves. Very few ecological studies have been undertaken on mangroves in South Australia, and there is a need for detailed research, particularly estuarine dynamics and the role of coastal wetlands (ie. mangroves and saltmarshes) in the coastal nearshore foodwebs of the gulfs.

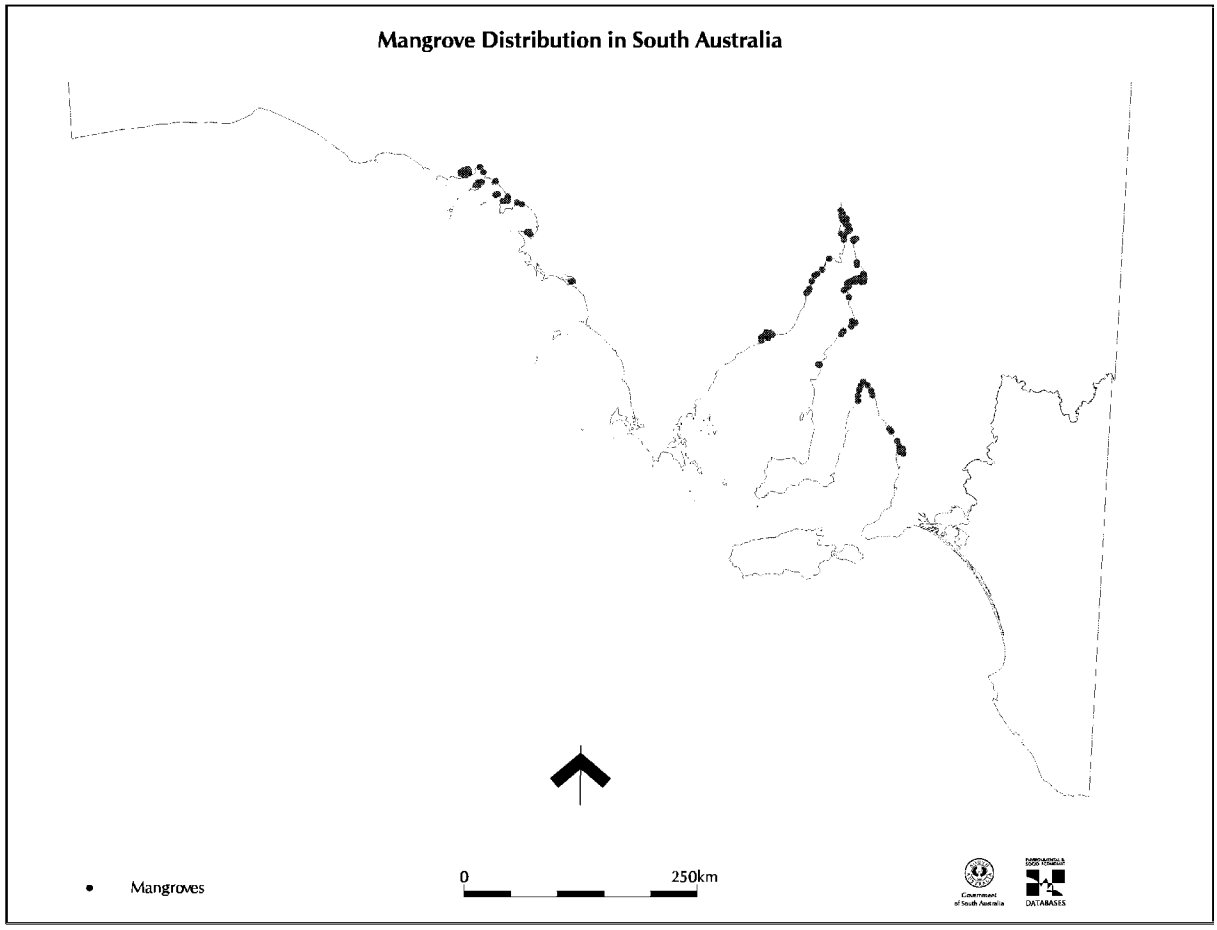

Figure 2.2 Distribution of the Grey Mangrove, *Avicennia marina*, in South Australia.

As a group, mangroves share several highly specialised adaptations for living in the intertidal zone – exposed breathing roots (or pneumatophores), support systems (ie. horizontal roots, buttresses, prop roots), salt excreting leaves and viviparous water dispersed propagules (Robertson & Alongi 1996).

Mangroves are of considerable ecological significance as a coastal habitat, due to their high productivity as nursery, feeding or breeding areas for fish, crustaceans and waterbirds; the physical shelter and refuge they provide for juvenile fish and crustaceans; their associated tidal flats which provide abundant habitat for seabirds and waders; and their importance as the basis of tropical coastal and estuarine foodchains (Hutchings & Saenger 1987, Robertson & Alongi 1996). In arid and semi-arid regions of Australia, where forests are limited, mangroves provide a key habitat for terrestrial birds. Mangroves also provide an important sink for nutrients and provide physical protection of coast (from cyclones and storms).

In urban areas, mangroves also support a wide range of recreational education and tourism activities, but are also highly vulnerable to the impacts of coastal development and habitat loss (eg. marinas, landfills, port and urban developments), changes in catchment hydrology, pollution (ie. oil spills, eutrophication), and human activities (see Hutchings & Saenger 1987).

Approximately 8% of Australia's mangroves are legally protected via reserves, with approximately two-thirds occurring in Queensland. Clearance of mangroves in Australia is regulated in all States/Territory by permits and fines for illegal clearance, however, New South Wales and Western Australia also have a "no net loss of mangroves" policy.

In South Australia the removal of mangroves is controlled both by regulations under the Fisheries Act, 1971-1982, and also, the Harbours Act, 1936-1981, which controls the development of coastal land. However, mangroves are still under considerable threat in South Australia due to small, incremental losses.

These losses arise from adjacent urban and industrial developments, such as the salt-ponds and waste and land-fill areas in the Port River estuary region which are preventing the natural landward colonisation of mangroves (Burton 1982); from changes in terrigenous sediment flow which are altering the seaward colonisation of mangroves in the northern metropolitan area (Burton 1982); from trampling of seedlings and pneumatophores by recreational fishers in the Barker Inlet-Port River estuary and Port Gawler region); from the effects of the recent oil spill in upper Spencer Gulf; and north of metropolitan Adelaide, from the effects of drift seaweed and seagrass, smothering young seedlings and adult trees and preventing the recruitment of young plants (Connolly, 1986, Edyvane 1991a, Bayard 1992, Fairhead 1995). Together, these threats pose significant potential losses of mangroves in South Australia.

In addition, another eight areas of mangroves have been recognised as being subject to physical disturbance (recreational activities and structural development): Arno Bay, Cowell, Whyalla South, Whyalla North, Port Augusta South, Port Pirie, Port Broughton, St Kilda. Another three areas are affected by possible leaching of contaminants from nearby tailings or slag-heaps: Port Augusta, Port Pirie South, Whyalla (Burton 1984). A monitoring program has been recommended at these sites. A system has been devised to monitor the condition of mangroves in South Australia and to detect and identify any areas undergoing stress (Burton 1984).

2.3.2 Coastal Saltmarshes

In contrast to mangroves, the species richness of tidal saltmarshes in Australia increases with latitude (see recent review by Adam 1995). Spencer Gulf and Gulf St Vincent contain some of the largest and most diverse areas of temperate saltmarshes in Australia. These highly productive intertidal environments provide key habitat for organisms of both, marine and terrestrial origin: eg. roosting sites for migratory wading birds; feeding and refuge areas for fish (Morton et al. 1987, Connolly *et al.* 1997); and rare or endangered species of high conservation value (*Centrolepis cephaloformis, Halosarcia flabelliformis, Wilsonia* spp. DELM 1993; orange-bellied parrot in Victoria).

Tidal saltmarshes are also an essential hydrological buffer between seaward mangroves and terrestrial ecosystems, regulating salinity and water velocity, and decreasing the suspended sediment load entering the marine environment.

In South Australia, as elsewhere in Australia, saltmarshes are under considerable threat from agricultural, urban and industrial developments. Unlike mangroves, saltmarshes are presently afforded no legislative protection in South Australia. In the Adelaide metropolitan and northern beaches area alone, some 80% of the original saltmarshes have been lost to land reclamation for salt-pans and industrial development. Although saltmarsh communities in South Australia are highly diverse (Fotheringham *pers.comm*.), no inventory has ever been conducted to determine the status of these communities in South Australia. This should be a high priority area for future research.

2.3.3 Seagrasses

Similarly the extensive meadows of seagrass within the gulfs comprise some of the largest temperate seagrass meadows in Australia, providing an essential habitat for marine organisms and forming the basis for much of the state's commercial and recreational fisheries. Seagrasses occur over approximately 9 620 km^2 in South Australia, and together with Western Australia, represent one of the largest temperate seagrass ecosystems in the world (Shepherd et al. 1989). The most extensive seagrass meadows (dominated by *Posidonia* species), occur in the clear, shallow, sheltered gulf waters of Spencer Gulf (5 520 km^2) and Gulf St Vincent (2,440 km^2) (see Figure 2.3). While the meadows are principally dominated by species of *Posidonia*, other species such as *Amphibolis antarctica, A.griffithii* and *Heterozostera tasmanica* occupy edges, blowouts and smaller areas. *Halophila australis* is sparse but widespread in both gulfs, with *Zostera mucronata* and *Z.muelleri* occurring intertidally (Shepherd & Robertson 1989). Other major areas of seagrass meadows in South Australia include the large shallow embayments on the western coast of Eyre Peninsula (ie. Streaky Bay, Smoky Bay, Murat Bay, Fowlers Bay) (880 km^2), Lacepede Bay and offshore from Robe (255 km^2), and wherever suitable substrate occurs.

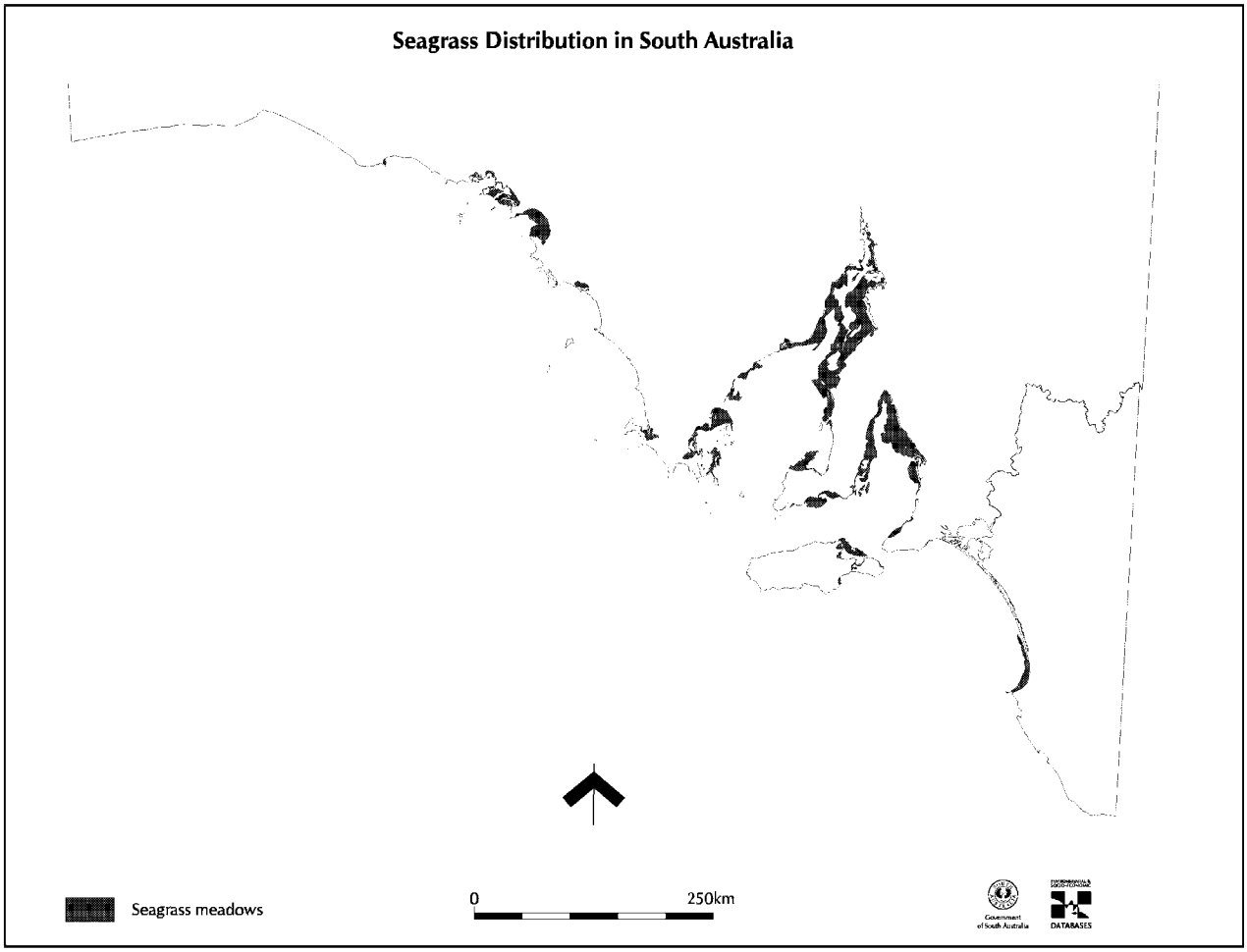

Figure 2.3 Distribution of seagrasses in South Australia.

There are 12 recorded species of seagrasses in South Australia. South Australian waters are the geographical limit of a number of seagrass species of warm temperate affinities (Kirkman 1998) (see Figure 2.4). As such, species in the genera *Posidonia* and *Amphibolis* decline in number from east to west, with decreasing water temperatures. Encounter Bay is the easterly limit of *A.griffithii*; Lacepede Bay of *P.sinuosa*; Rivoli Bay of *P.coriacea* and *P.denhartogii*; and Port MacDonnell of *P.angustifolia*. In contrast, the cool temperate species, such as *Halophila australis, A.antarctica, Heterozostera tasmanica* and *Zostera muelleri* and *Z.mucronata*, are distributed throughout the region.

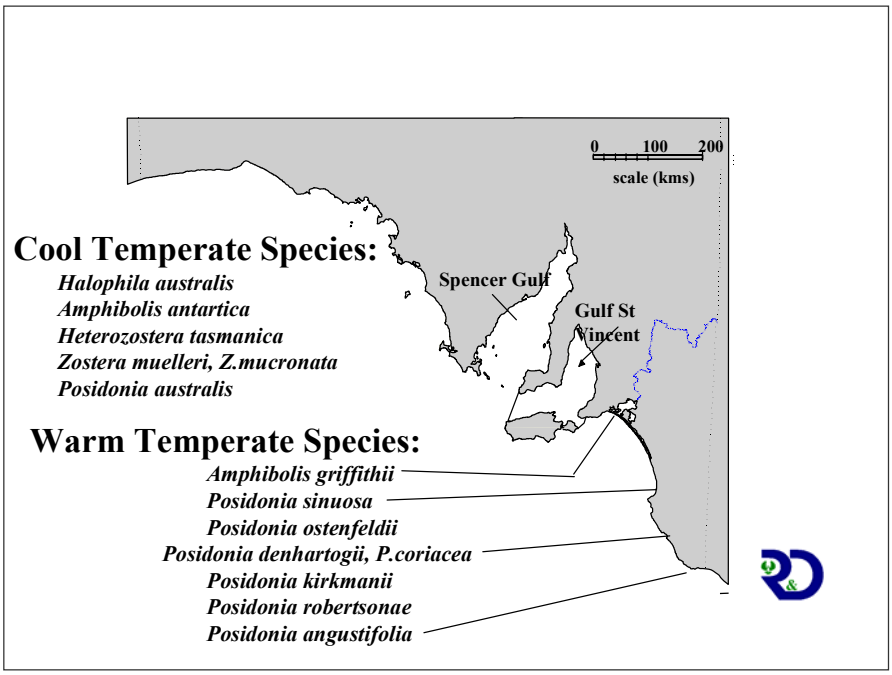

Figure 2.4 Marine biogeography and distributional limits of seagrass species in South Australia.

Seagrass meadows are particularly important for a number of reasons: as primary producers they occupy the base of the food chain; they provide important or `critical' habitats such as nursery, breeding or feeding areas for the juveniles and adults of many fish, crustaceans and other marine animals, including a large number of commercial species (Bell & Pollard 1989, Howard *et al*. 1989); and their extensive root and rhizome systems stabilise nearshore sediments and sand banks, enhancing coastal water clarity and reducing coastal erosion (Scoffin 1971).

The sheltered gulf ecosystems of Gulf St Vincent and Spencer Gulf comprise the largest areas of seagrass in the state, providing the essential basis for much of our commercial and recreational fisheries and playing an important role in stabilising sea-bed sediments. These areas however are also the areas under greatest threat of increased urban and industrial development and consequently, land-based marine discharges. As mentioned previously, seagrass communities are particularly sensitive to the effects of sewage and stormwater discharges.

Seagrass beds are one of the important habitats within estuaries threatened by development (see review by Shepherd et al. 1989, Salm 1989). Seagrass habitats in Australia, as elsewhere in the world, have been lost, fragmented and damaged through such practices as sewage discharges, urban runoff, dredging, boating, and land reclamation (Shepherd et al. 1989). In South Australia, sewage and stormwater discharges are thought to be responsible for the loss since 1935 of approximately 5 000 hectares of seagrass off metropolitan Adelaide (Neverauskas 1987, Clarke & Thomas 1987, Shepherd *et al*. 1989).

2.3.4 Macroalgae (Seaweeds)

Outside the gulf regions, the oceanic waters of South Australia represent one of the richest areas of seaweed diversity in the world, particularly for brown and red seaweeds (Womersley 1959, 1981, 1984, 1987). While many of the 1200 recorded species of macroalgae in South Australia extend into the cooler waters of Victoria and Tasmania and the warmer waters of Western Australia, by far the highest concentration of species is found in the transitional waters of South Australia (Womersley 1981. In addition, the greater majority of these species are highly endemic to southern Australian waters. For instance, over 75% of the red seaweeds recorded in this region are endemic (Womersley 1981).

The marine macrofloral diversity and endemism in the temperate regions of Australia is among the highest in the world. The richness of the temperate macroalgal flora (ie. 1155 species) is 50-80% greater than for other comparable regions around the world, with approximately 125 species of Chlorophyta (green algae), 225 of Phaeophyta (brown algae) and about 800 of Rhodophyta (red algae). This is largely due to the length of the southerly-facing rocky coast line (ie. the longest,

ice-free, temperate coastline in the world) and the long period of geological isolation (Edyvane 1996). While other regions around the world, such as Japan and the Pacific North America, have recorded a higher number of macroalgal species (ie. 1 452 and 1 254 species, respectively), the coastal waters of these regions encompass a wide range of climatic conditions, from arctic to tropical (see Table 2.4 below).

Region	Coast Length (km)	Temperature Range	Number of Species
Southern Australia	5,500	cold-warm temperate	1,155
NE North America	8,000	arctic-warm temperate	399
Pacific North America	12,000	arctic-tropical	1,254
Japan	6,500	subarctic-subtropical	1,452
New Zealand	6,970	subantarctic-warm temperate	835

Table 2.4 Global patterns of macroalgal biodiversity (after Womersley 1990).

Within Australia, the level of temperate species biodiversity in macroalgae is approximately three times the level recorded in the tropical regions of Australia, where approximately 200 - 400 species of macroalgae have been described (Womersley 1990). Many of the macroalgae recorded along the southern coast of Australia are endemic to the region, with over 75% endemism recorded in the red algae, and 57% and 30% recorded for brown and green algae (Womersley 1990). It has been estimated the extent of knowledge may be as high as 90% or more, leaving at least 100 species yet to be discovered or described.

The most remarkable aspect of the southern temperate macroalgal flora is the diversity of red algae, particularly the large number of genera recorded only from southern Australia. Of the 658 genera (and 4000 species) of red algae which occur world wide, approximately 43% of the genera and 20% of the species occur in southern Australia (Womersley 1990). Along the southern Australian coast approximately 83% of the macroalgal flora occurs in the eastern region (ie. Maugean Subprovince), 60% occur in the eastern region (west of Robe), and 45% occur generally along the entire coast.

Encompassing the 2 major biogeographical regions of the Flindersian Province, South Australia's waters contain some of highest levels of biodiversity for marine macroalgae along Australia's temperate coast. As such, South Australia contains the cold temperate macroalgal flora of the Maugean Subprovince (east of Robe) and also, flora typical of the warm to cool temperate eastern region (west of Robe) (Womersley 1990). For these reasons, Robe is the major westerly geographical limit of a number of key macroalgal taxa which characterise the Maugean Subprovince. These include, the large kelp, *Macrocystis angustifolia,* the bull kelp, *Durvillaea potatorum,* and other large brown algae such as *Phyllospora comosa.*

The southern Australian macrofloral is also characterised by a small number of tropical species and isolated species of tropical genera (Womersley 1990). These generally occur in sheltered bays and inlets where temperatures are high enough for the species to survive, particularly in the sheltered waters of South Australia. The northern Spencer Gulf region is particularly noteworthy for the occurrence of several tropical macroalgae species, such as *Acetabularia calyculus, Hormophysa triquetra* and *Sargassum decurrens.* Other tropical species known from South Australia include *Asparagopsis taxiformis, Liagora farinosa, Sarconema filiforme, Taenioma perpusillum, Laurencia brongniartii* and *L.paniculata*; and also, the tropical genus *Dasycladus (*represented by the single species, *D.densus)*, recorded only from warm waters of Point Fowler (at the head of the Great Australian Bight) and *Avrainvillea (A.clavatiramea)*, which occurs along the entire southern coast (Womersley 1990). Such taxa may be relicts from earlier periods of warmer water conditions along southern Australia.

Also, noteworthy in the South Australian flora are a few deep-water Mediterranean taxa of Phaeophyta, which have been collected from deepwater (eg. *Discosporangium mesarthrocarpum, Sphacella subtilissima* and a species of *Zosterocarpus*) (Womersley 1990).

2.4 Marine Invertebrates [2]

The remarkable biological diversity of South Australia's waters is not restricted to marine flora.

Little is known about the taxonomic or distributional details of most small-sized invertebrates. About 60% of Australian marine invertebrates are undescribed and the figure is most likely higher for southern Australia and South Australia in particular. Almost every group of animals in temperate waters of southern Australian exhibits over 90% species endemism (Wilson & Allen 1987).

South Australian waters have the richest assemblage of ascidians or 'sea squirts' recorded in the world, with over 200 described species (Greenwood & Gum 1986). Many of these species have been recorded from near the offshore islands of the Great Australian Bight region and among the extensive limestone cave systems of western Eyre Peninsula and the South-East. Species of Crustacea (lobsters, prawns & crabs) provide a significant commercial resource. There is a large variety of very interesting smaller species as well as the large deep-sea crab *Pseudocarinus gigas,* the largest crab in the world by weight.

Species of Mollusca such as abalone, oysters, and scallops are of economic importance. Of the Cephalopoda (squids, cuttle fish, octopus etc.), *Sepioteuthis australis* or calamari is an important commercial and recreational species. *Sepia apama* is one of the largest cuttle fish in the world, *Octopus maorum flindersi* is of commercial importance and is one of the largest octopuses and the octopus *Grimpella thaumastocheir* is an interesting relict restricted to the coast between Edithburgh and Port Lincoln. Other molluscs are also well represented in South Australia such as nudibranchs or "sea-slugs" with over 500 recorded species (Greenwood & Gum 1986). Volutes, cones and cowries represent a relict tropical fauna with noteworthy species such as the giant baler shell *Melo miltonis* on the West Coast and the black cowrie *Cypraea* (Zoila) *friendii* which occurs across southern Australia and has evolved into several subspecies, some of which are very rare.

Echinoderms (starfish, sea urchins etc.) are also an important faunal element of southern Australian waters. The starfish genera *Nectria* (8 species) and *Uniophora* (several species) are particularly common and unique to the area. The sea-urchin *Heliocidaris erythrogramma* is very common. South Australia is also the home of the world's smallest starfish, *Patiriella parvipara*, which is restricted to granite outcrops near the high-water mark along the coast between Port Lincoln and Ceduna.

Among the lesser known invertebrate groups, the Investigator Strait - Backstairs Passage region is home to a wide range of ancient brachiopods (or 'lamp shells'), rare free-living corals and bryozoans. Bryozoans (or 'lace corals') reach their greatest species diversity in temperate southern Australia, particularly in South Australia, due to the wide continental shelf, where they contribute to about 80% of the total shelf sediments. In this respect, bryozoans are the temperate equivalents of the hermatypic corals of the tropics of Australia. Sponges are also very common and diverse in southern Australia but very little is known about their systematics or ecology. Sponges are a potential source of 'biologically active' compounds.

The status of invertebrates of economic importance (such as the Southern Rock Lobster, Western King Prawn and Green and Blacklip Abalone) are relatively well-known in South Australia (Prescott *et al.* 1997, Carrick 1997, Kangas & Jackson 1997). However, the status of the remainder of the invertebrate fauna is poorly known. In part this is due to the lack of taxonomic knowledge and research. Of the 6440 species estimated to occur in South Australian waters, only a third of these have been collected and described to date (EPCSA 1988). Some groups such as the jellyfish and echinoderms are well-documented, however other groups such as sponges, acoelomate worms and plankton, are either variable in growth forms, small in size or belong to groups that are difficult to identify.

2.5 Marine Fish Fauna

The marine fish fauna of South Australia is generally typical of the Flindersian Province of southern Australian coastal waters (Scott *et al.* 1980). As such, many of the species recorded in South Australian waters, have also been recorded in southern and south-western Western Australian waters, and to a lesser extent, in the waters of western Victoria and north-west Tasmania. Of the 422 species of fish recorded from South Australia, more than 370 species are recorded from marine waters (Scott *et al.* 1980). Of these, 77 species are utilised commercially, with 15-20 species contributing most to the annual commercial fisheries catch.

[2] Text from Zeidler W & K Edyvane (1998). Marine Invertebrates. In, `Description, Use and Management of South Australia's Marine and Estuarine Environment', edited by RK Lewis, K Edyvane & N Newland.

Despite the Flindersian nature of South Australia's fish fauna, recent biogeographical studies on the Australia's fish fauna have recognised a weak but unique zoogeographic province within Gulf St Vincent and Spencer Gulf (CSIRO 1996). As such, the Spencer and St Vincent Gulf Province has been identified as one of nine distinct biogeographical provinces recognised for the fish fauna in Australia's coastal shelf waters (CSIRO 1996). The province is characterised by a small endemic element and relict element of subtropical species, particularly species of the family Sygnathidae (ie. pipefishes, seahorses, seadragons). These species include Verco's Pipefish (*Vanacampus vercoi*), which is known only from South Australia (ie. Spencer Gulf, Gulf St Vincent and Kangaroo Island); the Little Pipehorse (*Acentronura australe)*, which is known only from Carnac Island (WA) and Gulf St Vincent and Cape Jervis; the Tiger Pipefish *(Filicampus tigris),* which is known from tropical waters, Port Lincoln and elsewhere in Spencer Gulf; and Tyron's Pipefish *(Campichthys tryoni*), which is known from southern Queensland and Gulf St Vincent (Gommon *et al.* 1994*)*.

Other indicator species of this province include, the Crested Threefin (*Norfolkia cristata*), which is known only from South Australia, where is occurs from Victor Harbor to the Investigator Group of Islands; and the Coastal Stingaree (*Urolophus orarius*), which is known only from the Great Australian Bight, off South Australia, where it has been trawled in depths of 20-50m (Gommon *et al.* 1994). The hypersaline and subtropical conditions in the gulfs are unique to temperate Australia and have probably enabled this region to act as refugia for species commonly recorded further north (CSIRO 1996). The gulfs region of South Australia exhibits a strong biogeographical disjunction and acts as a zootone for cool temperate fish species (ie. in the Tasmanian and Bass Strait Provinces) and for a large suite of species from the South Western Province (Western Australia).

Other rare or endangered species which also dominate in South Australian waters include the rare Leafy Sea Dragon (*Phycodurus eques*), an ornately camoflagued sea horse which evades predators by blending in with the leafy fronds of surrounding kelp plants. Another important species is the White Shark (*Carcharodon carcharias*), whose abundance in South Australian waters has led to South Australia's prominence as one of the key sites in the world for scientific research and filming of this species.

Most of the species along the Eyre coast tend to be inshore with fairly permanent resident populations. However, there are some regular migratory visitors such as the Australian Salmon and occasional oceanic vagrants such as oceanic Sunfish (*Mola* sp.), Basking Shark (*Cetorhinus maximus*), Black Marlin (*Makaira indica*), and the Lizardfish (*Saurida undosquamis*). Their presence in these waters can be attributed to the easterly flowing Leeuwin Current (Glover & Olsen 1985).

Many sea-connected waterways occur along the east coast of Eyre Peninsula. Marine and primarily marine species, such as the Congolli (*Pseudaphritis urvillii*), may enter and frequent the estuaries and lower reaches of these and other coastal waterways. Among the native freshwater species, which spend part of their life cycle at sea - the Common Galaxias (*Galaxias maculatus*) and the Black Bream (*Acanthopagrus butcheri*), have been recorded in the Tod River. The Common Galaxias has also been recorded in the North Shield Creek, Lake Wangary and a tributary of Little Swamp. Small-Mouthed Hardyhead (*Atherinasoma microstoma*) have been recorded in the permanent spring-fed saline waters of Lakes Hamilton and Newland, on the west coast south of Venus Bay, while eleven normally marine species of fish have been recorded in Lake Wangary, which has a connection with the sea via Minniribbie Creek. The marine recreational fishery is renowned for the variety of species which provide abundant and excellent sport for line, spear and big-game fishers.

2.6 Marine Reptiles

Three species of tropical and subtropical marine turtles are recorded from South Australian waters, the Loggerhead (*Caretta caretta*), the Green Turtle (*Chelonia miydas*) and the Leathery Turtle (*Dermochelys coriacea*). All three species have the major parts of their ranges in tropical and subtropical waters and individuals encountered in South Australia are likely to be vagrant individuals. Their status here is not known, but all are considered under threat on a world-wide basis, owing to human predation of adults and eggs, and disturbance of breeding beaches (Greenwood & Gum 1986).

2.7 Seabirds [3]

The bird fauna is probably the best known of all the faunal groups in South Australia, owing largely to the efforts of many amateur ornithologists over the years. Information from this source is collated by the Royal Australian Ornithological Union at a national level, and by the State Museum and the South Australian Ornithological Association in South Australia. Despite this the abundance and population trends of practically all species of seabirds breeding in Australia are not known (van Tets & Fullagar 1984).

Sixteen species of seabird have been recorded breeding in South Australia with a further 56 non-breeding species known to visit State waters (Copley P. 1996). This includes seven species of penguin, 12 albatrosses, 28 shearwaters, petrels and diving petrels, four storm-petrels, one gannet, two cormorants, one tropicbird, two skuas, three jaegers, three gulls and eight terns. Two of species of seabird, Little Tern (*Sterna albifrons sinensis*) and Fairy Tern (*Sterna nereis*) are currently listed as `vulnerable' in South Australia, while the Flesh-footed Shearwater (*Puffinus carneipes*) has been listed as `indeterminate status' (Parker & Horton (1990).

About 1.5 million pairs of seabirds breed annually in South Australian waters. The vast majority of these are Short-tailed Shearwaters (*Puffinus tenuirostris*) and White-faced Storm Petrels (*Pelagodroma marina*). The shearwaters breed mostly on islands off the west coast of Eyre Peninsula while the majority of Storm Petrel nesting is on the islands of southern Spencer Gulf (Copley P. 1996, Robinson *et al*. 1996)

The other common breeding species of seabird in South Australia include Little Penguins, Crested, Caspian and Fairy Terns, Silver and Pacific Gulls and Pied and Black-faced Cormorants. Although breeding colonies of most of these species are found on offshore islands, there are very significant breeding populations of Pied Cormorants in the extensive mangrove stands of St Vincent and Spencer Gulfs.

Little Terns are known to breed in South Australia regularly but in low numbers, with only one to a few pairs and possibly not every year. Flesh-footed Shearwaters are known to breed only on one island off the southern tip of Eyre Peninsula. A single pair of Red-tailed Tropicbirds has recently bred on the Neptune Islands. In the past, breeding by Sooty and Bridled terns has been recorded, but permanent breeding colonies do not seem to have become established.

Little is known about long-term population trends in seabirds in South Australia. There is considerable evidence of at least local major population increases of Silver Gulls around urban waste disposal areas, saltfields and coastal towns where food is abundant. The Kelp Gull may also be increasing its range in South Australia and Australia generally. Little Penguin populations are known to fluctuate considerably throughout the species breeding range in South Australia and this may be linked with the abundance of Blue Pilchard schools at sea. The South-East population of Fairy Terns may have declined through human disturbance of their nesting colonies.

Three other species of birds can be considered to have a significant marine connection.

The Cape Barren goose breeds in winter on the islands of the Sir Joseph Banks Group and other islands off western Eyre Peninsula. It then spends the summer in three traditional areas, around Elliston, on southern Eyre Peninsula and around the lakes at the Murray mouth. There has been significant population recovery since a low of perhaps 500 in the 1950's to approximately 3000 today. Regular monitoring is carried out every five years (Robinson *et al*., 1982, Delroy *et al*., 1989, Robinson & Delroy, 1989, Robinson *et al*. 1995) and there is no evidence of a major change in the populations sampled over the last 20 years.

White-bellied Sea Eagles are found all round the Australian coast and penetrates considerable distances inland along river systems. Although they eat a considerable amount of fish, they also hunt extensively on land, taking a variety of birds, mammals and reptiles and even feed on carrion. Sea eagles build large stick nests on cliff ledges or in trees if they are available and most of the larger South Australian offshore islands support a pair of these birds Kangaroo Island is an important breeding stronghold yet they are vulnerable to disturbance and breeding and nest sites need careful management.

[3] Text from Robinson AC (1998). Seabirds. In, `Description, Use and Management of South Australia's Marine and Estuarine Environment', edited by RK Lewis, K Edyvane & N Newland.

The Osprey, unlike the White-bellied Sea Eagle is totally marine feeding exclusively on fish plucked from the water by swooping and diving. South Australia supports the majority of the Osprey breeding population along Australia's southern coast. They build nests on rock stacks or very inaccessible cliffs and are therefore somewhat less vulnerable to disturbance than sea eagles. However, there are examples of abandonment of long-used nesting sites due to human disturbance, for example in Innes National Park. They can become habituated to people as has been demonstrated by a pair nesting on a specially built platform on Ballast Point on Kangaroo Island.

The Osprey and White-bellied Sea Eagle may also be affected by pollution. For both of these species there has been no known breeding records in the upper Spencer Gulf region since 1890 (Greenwood & Gum 1986). The Port Pirie lead and zinc smelter commenced operations in 1889. If the heavy metals released affected the survival of any species, those high on the food-chain would be most likely to be in danger. However, it is possible that other factors may also be involved in the loss of these species of birds.

2.8 Marine Mammals

South Australia's waters are becoming increasingly recognised as an area of global conservation significance for species of rare and endangered marine mammals, particularly in the Great Australian Bight (Edyvane & Andrews 1995). A total of 31 species of marine mammals have been recorded in South Australia's waters. However, very little is known of the occurrence and distribution of many species, with most information to-date largely based on occasional sightings and stranded specimens (Greenwood & Gum 1985). However, of the few species which are known to breed in South Australia's waters, populations are commonly globally significant, comprising a major proportion of the world population for the species (ie. the Southern Right Whale, the Australian Sea Lion, and the New Zealand Fur Seal).

2.8.1 Cetaceans

The Great Australian Bight region itself is now recognised as an area of global conservation significance for the Southern Right Whale *(Eubalaena australis)* - a species formally recognised as both, `endangered' (under the *Commonwealth Endangered Species Protection Act 1992*) and `vulnerable to extinction' (by the World Conservation Union and the International Union for the Conservation of Nature).

While Southern Right Whales each year regularly visit coastal bays and inlets around South Australia, specific areas such as the Head of Great Australian Bight, represent one of the most significant habitats for the breeding and calving of Southern Right Whales in the world (Robinson & Heard 1985, Bannister 1990, Ling & Kemper 1991, Bannister, 1993). (Figure 2.5) Estimates currently put the world population at around 1500 to 3000 individuals, with an Australian population of approximately 400-600 (Bannister 1993).

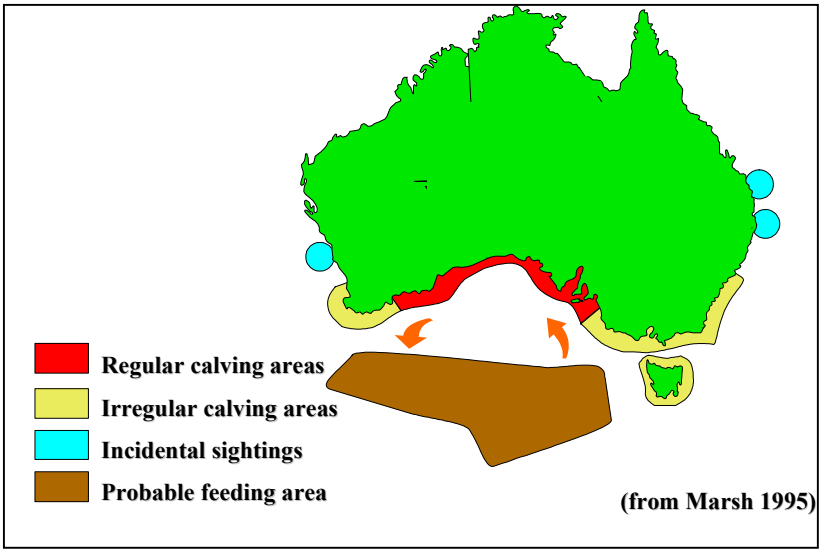

Figure 2.5 **Distribution of the Southern Right Whale in southern Australian waters (from Marsh *et al.* 1995*).***

The Great Australian Bight region is also recognised as a significant seasonal habitat for many other species of rare and endangered marine mammals (Edyvane & Andrews 1995). At least 17 species of cetaceans have been recorded including migratory species such as Blue Whales, Sperm Whales, Minke Whales Humpbacks and Rorquals (Kemper & Ling 1991). Frequent sightings of Sperm Whales and Beaked Whales may be related to the known squid populations off the Ceduna canyons and near the edge of the continental shelf (Kemper & Ling 1991). Killer Whales have also been recorded and their presence is probably related to the abundance of pinnipeds along the western Eyre Peninsula.

Two species of dolphin are commonly sighted in the coastal waters of South Australia, the Bottlenose Dolphin (*Tursiops truncatus*) and the Common Dolphin (*Delphinus delphis*), both of which have a cosmopolitan distribution.

2.8.2 Seals and Sea Lions

Two species of seals or pinnipeds breed in South Australian waters: the rare Australian Sea Lion *(Neophoca cinerea)*, and the New Zealand Fur Seal *(Arctocephalus forsteri)* (see Figure 2.6). The Australian populations of the New Zealand Fur Seal are limited in their distribution to southern

Tasmania and the Great Australian Bight, and are found on the islands of Recherche Archipelago (WA), eastwards to Kangaroo Island (SA). The Australian Sea Lion, which is endemic to Australia, is presently limited to the offshore islands of Western and South Australia, from the Houtman Abrolhos to the islands of Recherche Archipelago (WA), and from Nuyts Archipelago to Kangaroo Island (SA). The Australian Fur Seal (*Arctocephalus pusillus doriferus*) does not breed in South Australian waters (ie. breeding populations are confined to south-eastern Australia, including Tasmania), however, numbers appear to be increasing in SA with records of regular haul out sites in the south-east of the State and in New Zealand Fur Seal colonies on Kangaroo Island (A Robinson, DEHAA, *pers.comm*.).

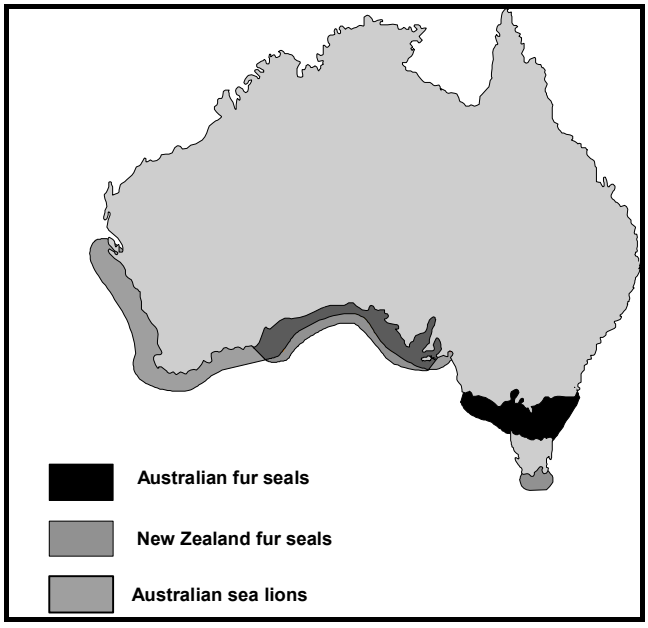

Figure 2.6 Distribution of seals and sealions in Australia (after Marsh *et al.* 1995).

- ***Australian Sea Lion***

The Australian Sea Lion is one Australia's most endangered marine mammals and one of the rarest and most endangered pinnipeds in the world and is endemic to Australia (Gales 1990, Gales *et al.* 1994). The species is recognised as `rare' under South Australian legislation; a `Special Protected Species' in Western Australia; and `rare' by the IUCN. Prior to seal-hunting, this species occurred along the whole of the southern coastline, but is now confined to the waters of South Australia and Western Australia. The estimated world population for this species is 10 000 - 12 000 individuals, with estimated population sizes of 7 500 sea lions in South Australia and 3 100 in Western Australia (Gales 1990, Gales *et al*. 1994). With almost 75% of the world's population for this species, this makes the long-term management and conservation of this species a particular responsibility and obligation for South Australia. Major breeding areas for sea lions in Australia, include the offshore islands off the south coast of Western Australia and western South Australia. Of particular significance is the recent discovery of numerous small breeding colonies along the Nullarbor Cliffs in the Great Australian Bight (Dennis & Shaughnessy 1996).

In South Australia, Australian Sea Lions have been recorded on a total of 69 offshore islands and reefs and three mainland sites (Robinson & Dennis 1988) (see Appendix 1). Major breeding areas for sea lions in Australia, include the islands off the south coast of Western Australia (27 colonies) and western South Australia (23 colonies) (see Table 2.5).

The three largest breeding colonies are in South Australia and include the Pages, Dangerous Reef and Seal Bay, Kangaroo Island (Robinson & Dennis 1988, Gales 1990). In addition to the island colonies, 23 important small groups (comprising 289 individuals), have recently been found along the cliffs of the Great Australian Bight (Dennis & Shaughnessy 1996). Overall, a total of 10 breeding sites (9 of which occurred in SA), and 14 haul out sites were identified for the region. The total population of the Great Australian Bight region in South Australia has been estimated at between 613 and 744, which represents approximately 9.3% of the South Australian population or 6.6% of the total world population for this species (Dennis & Shaughnessy 1996).

These colonies, together with the well-known breeding colony of Point Labatt on western Eyre Peninsula, represent a significant mainland breeding component to the breeding distribution of the Australian Sea Lion.

The significance of the populations of Australian sea lions in the Great Australian Bight is further increased because it is very likely that the populations were never commercially harvested - like many other populations along the southern coasts and islands of Australia last century. Generally, to the point of extinction. This is principally because of the isolation and general inaccessibility of the Great Australian Bight coast, both, from land and sea. Thus the populations have remained intact, providing probably one of the greatest sources of genetic diversity for this species in the world, and also, a very important genetic and geographic bridging population between the South Australian and Western Australian sea lion populations (Dennis & Shaughnessy 1996).

Locality	Estimated Pup Production	Population Estimate
OFFSHORE ISLANDS		
Western Nuyts Reef	43	206.83
Middle Nuyts Reef	43	206.83
Purdie Island	120	577.2
West Island	30	144.3
Fenelon Island	50	240.5
Lound Island	26	125.06
Small S Franklin Island	75	360.75
Small NE Franklin Island	50	240.5
Olive Island	50	240.5
Pearson Island	35	168.35
Ward Island	43	206.83
Jones Island	5	24.05
Liguanea Island	30	144.3
South Neptune Island (N)	4	19.24
Albatross Island	12	57.72
English Island	40	192.4
Dangerous Island	275	1,322.75
North Islet Island	8	38.48
Peaked Rocks	40	192.4
North Casuarina Island	1	4.81
Kangaroo Island	180	865.8
South Pages Island	260	1,250.6
North Pages Island	310	1,491.1
Subtotal SA Islands	**1,730**	**6,600 – 8,300**
Point Labatt	1-3	46-68
Nullarbor Cliffs	86	613 – 774
SA Mainland		**659 – 840**
SA Population		**7,200 – 9,100**
Total World Population		**9,900 – 12,400**
SA Population (% World)		**~73%**

Table 2.5 **Breeding locations and population estimates of Australian sea lions (*Neophoca cinerea*) in South Australia, 1989-1990 summer (from Gales 1990, Gales *et al* 1994, Dennis & Shaughnessy 1996).**

- ***New Zealand Fur Seal***

Although most of the world population of the New Zealand Fur Seal occurs in New Zealand, there are a few colonies in Australia. The Australian population is estimated at a total of 34 700 individuals, with an estimated 27 616 (ie. 80%) occurring in South Australia, 7002 (20%) in Western Australia and 100 (0.3%) in southern Tasmania (Shaughnessy *et al.* 1994). There are 30 breeding localities in Australia; 13 in South Australia, 16 in Western Australia and 1 in southern Tasmania (Shaughnessy *et al.* 1994). Breeding colonies occur on the islands off the southern coast of Western Australia, on islands at the entrance to Spencer Gulf (South Australia), and on Kangaroo Island (Shaughnessy 1990, Shaughnessy *et al.* 1994) (see Table 2.6). Most of the Australian population of fur seals (ie. 77%) is located in central South Australian waters (from Kangaroo Island to the southern Eyre Peninsula) (Shaughnessy *et al.* 1994). The largest Australian breeding colonies for this species occur on the Neptune Islands, which together account for an estimated 61% (ie. 16 836 individuals) of the estimated South Australian population or 49% of the total Australian population for this species (Shaughnessy 1990, Shaughnessy *et al.* 1994). Within the Great Australian Bight, the islands of the Nuyts Archipelago have smaller but nevertheless important colonies of fur seals (and sea lions).

Locality	Pup Number	Population Estimate
Cape Gantheaume (KI)	525	2,572.5
North Casuarina (KI)	442	2,165.8
Cape du Couedic (KI)	477	2,337.3
(elsewhere on Kangaroo Island)	2	9.8
South Neptune Island	1,974	9,672.6
North Neptune Island	1,472	7,212.8
Liguanea Island	555	2,719.5
Little Hummock Island	7	34.3
Four Hummocks Island	42	205.8
Rocky (South) Island	75	367.5
Greenly Island	11	53.9
Ward Island	64	313.6
SA Population	**5,636**	**27,616**
Australian Population **% Australian Population**		**34,700** **(80%)**

Table 2.6 **Breeding locations and population estimates of New Zealand fur seals *(Arctocephalus forsteri)* in South Australia, 1989-90 summer (from Shaughnessy *et al.* 1994).**

Population studies of New Zealand Fur Seals on Kangaroo Island and the South Neptune islands both indicate that populations are in a major expansion phase with exponential increases of 15-20% per year (A Robinson DEHAA, *pers.comm.*). Rates of increase in individual colonies on Neptune Island since 1970 range from 3.1% to 29.2% per year (Shaughnessy *et al.* 1996). This rate of increase is also being observed in fur seal populations elsewhere in the Southern Hemisphere, but nowhere have the populations yet recovered to anything like their pre-sealing population levels.

As the New Zealand fur seal population increases, interaction between fur seals and fishers can be expected to increase (Shaughnessy 1990). This will take the form of interaction with boats and gear, and competition for common prey species. One of the unfortunate outcomes of the former is entanglement of fur seals in marine debris and incidental mortality of seals during fishing activity. Although the fur seals' feeding areas are not known, they spend a considerable proportion of their time either resting or traversing waters in the immediate vicinity of colonies.

For example, adult females spend approximately 70% of their time at sea during summer (Goldsworthy 1989). Therefore some of the adverse effects of the interaction between fishers and fur seals could be alleviated if marine reserves were declared in waters surrounding fur seal colonies. Such reserves could prohibit fishing activity, but it would be unrealistic to prohibit fishing vessels from using well-established anchorages in the lee of fur seal colonies (Shaughnessy 1990).

In recent years, the establishment of fish farms in South Australia is causing significant interactions and entanglements with seals, sea lions and particularly dolphins (Kemper & Gibbs 1997). In addition, breeding populations of *Neophoca cinerea* and *Arctocephalus forsteri* are highly susceptible to disturbance by humans (Gales 1990, Shaughnessy 1990). The most straightforward method of protecting colonies is to give them a prohibited area status and this has been recommended as a management strategy for these species (Gales 1990, Shaughnessy 1990).

3 CONSERVATION OF SOUTH AUSTRALIA'S MARINE BIODIVERSITY

3.1 Marine Protected Areas

The establishment of a representative system of Marine Protected Areas is widely regarded, both nationally and internationally, as one of the most effective mechanisms for protecting marine biodiversity while permitting the sustainable use of natural resources. As an island continent, Australia has a diverse range of coastal, marine and estuarine environments. These range from the tropical ecosystems of northern Australia (such as coral reefs and tropical mangrove forests), to the cool temperate ecosystems in the south (such as kelp forests and deep-water sponge beds). As a developed nation with a maritime area larger than the continent itself (ie. 894 million hectares), and as a signatory to international conventions like the *Convention on Biological Diversity* (UNEP 1994), Australia has a special responsibility for the conservation and management of its marine and coastal environments and their resources. To this extent, Australia is presently regarded as a world leader in marine conservation and management.

`Marine Protected Areas' in Australia range from small, high protection Marine Reserves, to large, multiple-use Marine Parks (like the Great Barrier Reef Marine Park) which permit a wide range of exploitative uses, such as fishing (commercial and recreational), tourism and recreation, managed on an integrated basis. Marine Protected Areas can be established for a variety of purposes and it is possible to provide for a range of activities while still protecting the environment. For example, Marine Protected Areas can be reserved for conservation, fisheries management, research, education, social and historical importance, tourism or recreational use - or a combination of any of these - and may also include neighbouring coastal lands and islands. As such, Marine Protected Areas are defined as:

> *"An area of land/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means." (IUCN 1994)*

While reserve systems in Australia have been in place for terrestrial ecosystems for many decades, the formal conservation of Australia's marine environments and their resources is a relatively recent phenomenon. As of 1997, over 43 million hectares (or 5%) of Australia's waters (comprising States, Territories, External Territories and Commonwealth waters) has been reserved in approximately 148 Marine Protected Areas (Cresswell & Thomas 1997). Of this total area reserved as Marine Protected Areas in Australia, approximately 99.5% is located in tropical regions, with approximately 89% in the region of the Great Barrier Reef region - leaving many regions, particularly temperate ecosystems, poorly or under represented, if at all. Recently it has been estimated that 21 out of the 32 biogeographic regions around Australia lack any significant protection as protected areas (Ivanovici 1993). Notable regions included the Gulf of Carpentaria, the Great Australian Bight, and deep offshore regions.

In South Australia, like many other temperate water States, there is need to formally conserve and protect, the full range of marine ecosystems, habitats and species along the coast and also, ecologically significant habitats; rare, unique and endangered species and habitats; significant physical, natural features and seascapes; significant maritime and cultural heritage; aesthetic and wilderness values; sites for education and recreation; and sites for research and monitoring.

3.2 National Representative System of Marine Protected Areas (NRSMPA)

In 1991, the Commonwealth announced the initiation of a 10 year marine conservation program, called `Ocean Rescue 2000' to ensure the conservation and sustainable use of Australia's marine and estuarine environments. A key component of this initiative was a commitment to expand Australia's existing marine reserve system, through the establishment of a national, representative system of Marine Protected Areas (or NRSMPA), which would protect areas, while permitting appropriate uses and promoting public education (Muldoon & Gillies 1996).

The primary goal for a national, representative system of MPAs is:

> *`to provide for the protection, restoration, wise use, understanding and enjoyment of marine heritage in perpetuity through the creation of a national, representative system of marine protected areas and through management in accordance with the principles of the World Conservation Strategy and the national strategy for Ecologically Sustainable Development of human activities that use or affect the marine environment.'*

BOX 3.1
A GLOBAL NETWORK OF MARINE PROTECTED AREAS

Article 6 of the Convention on Biological Diversity (UNEP 1994) states that signatory Nations shall:

(a) develop national strategies, plans or programs for the conservation and sustainable use of biological diversity or adapt for this purpose existing strategies, plans or programs which shall reflect, inter alia, the measures set out in this convention relevant to the contracting Party concerned; and

(b) integrate, as far as possible and as appropriate, the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plan, programs and policies.'

At the global level, the International Union for the Conservation of Nature (IUCN), through its Commission on National Parks and Protected Areas (CNPPA), has been carrying out a program to promote the establishment of a global representative system of Marine Protected Areas (MPAs).

The primary goal of the IUCN-CNPPA Marine Protected Areas Program is:

`to provide for the protection, restoration, wise use, understanding and enjoyment of the marine heritage of the world in perpetuity through the creation of a global, representative system of Marine Protected Areas and through the management, in accordance with the principles of the World Conservation Strategy, of human activities that use or affect the marine environment.'

South Australia is committed to the protection of marine biodiversity and ecological processes, and the sustainable use of marine resources, through the goals and principles of Ecological Sustainable Development (ESD). This commitment has been ratified through Australia's international responsibilities and obligations under the *Convention on Biological Diversity* (UNEP 1994), and implemented at a national level by States/Territory under the Inter-governmental Agreement on the Environment (IGAE), through the development of national strategies such as the *National Strategy for Ecologically Sustainable Development (1992)*, and the *National Strategy for the Conservation of Australia's Biological Diversity (1996)*. The establishment of a national, representative system of Marine Protected Areas (NRSMPA) is a key responsibility and obligation under the *Convention on Biological Diversity* (UNEP 1994) and also, the *National Strategy for Ecologically Sustainable Development (1992)* (ie. Objective 10.2), and the *National Strategy for the Conservation of Australia's Biological Diversity (1996)* (ie. Objective 1.4).

Establishing a NRSMPA fulfils Australia's international obligations as a signatory to the *Convention on Biological Diversity* (UNEP 1994), which at a global level, through the International Union for the Conservation of Nature (IUCN), Commission on National Parks and Protected Areas (CNPPA), has been carrying out a program to promote the establishment of a global representative system of Marine Protected Areas (MPAs) (see Box 3.1).

3.3 Defining a Framework for a NRSMPA

3.3.1 The Hierarchical Nature of Biodiversity

In conserving marine biodiversity it is important to recognise the hierarchical nature of ecosystems, biodiversity and ecological processes. Biological diversity can be defined at the ecosystem, seascape/landscape, species and genetic level (see Box 3.2). Marine and coastal systems are extraordinarily diverse at all these levels. However, due to the inaccessible nature of the marine environment and the lack of knowledge of marine biodiversity at the species level, the measurement of biodiversity in marine environments is generally most approachable and practical at the level of the seascape or habitat.

In the marine environment, biodiversity occurs at the scale of large marine ecosystems, such as major oceanic and pelagic ecosystems, and is defined by large-scale processes such as oceanography (ie. currents, upwellings), trophodynamics, coastal physiography and basin topography. Similarly, biodiversity also occurs at the smaller scales of ecosystems (eg. open coasts, gulfs), habitats (eg. reefs, estuaries, bays) and biological communities (eg. mangroves, seagrasses, kelp forests, coral reefs). At these scales, patterns in biodiversity may be dominated by small-scale physical processes such as type of substratum, cyclones, storm events, changes in wave exposure, or biological processes such as competition and predation. In defining an ecological representative system of Marine Protected Areas, the full range of marine biodiversity needs to be considered, from the large marine ecosystems, to the habitat and community-level patterns of biodiversity.

BOX 3.2

WHAT IS BIOLOGICAL DIVERSITY ?

The *National Strategy for the Conservation of Australia's Biological Diversity* (1996) defines biological diversity as the variety of all life forms – the different plants, animals, microorganisms, the genes they contain, and the ecosystems of which they form a part. It is not static, but constantly changing; it is increased by genetic change and evolutionary processes and reduced by processes such as habitat degradation, population decline, and extinction. The concept emphasises the inter-relatedness of the biological world. It covers the terrestrial, marine and other aquatic environments.

Biological diversity can be considered at three fundamental levels:

- ***Genetic diversity***

– the variety of genetic information contained in all of the individual plants, animals and micro-organisms that inhabit the earth. Genetic diversity occurs within and between the populations of organisms that comprise individual species as well as among species.

- ***Species diversity***

– the variety of species on earth.

- ***Ecosystem diversity***

– the variety of habitats, biotic communities and ecological processes.

Marine biodiversity conservation in South Australia also needs to take account of coastal and oceanographic change over geological time scales, particularly with respect to the evolution of the coastal and marine environment and also, land-sea dynamics (Ray 1991). For temperate southern Australia, a long period of geological and continental isolation has resulted in high endemism in the marine biota (Edyvane 1996), while continental drift and periods of global warming and cooling have resulted in significant intrusions of warm water from the Indo-Pacific, and importantly, significant sea level changes. In South Australia, the gulfs region are particularly significant, containing not only high levels of endemism, but also, a subtropical element in the marine flora and fauna.

Ecological processes, resource distributions and human impacts can also can be understood, conserved and managed at a range of spatial and temporal scales. Because of the nested hierarchical structure of ecosystems, marine management (including the establishment and management of Marine Protected Areas) needs to examine and occur within several temporal and spatial scales (Ray & McCormick-Ray 1992). The adoption of a scale-adapted approach to environmental management and planning requires both, an understanding of the spatio-temporal hierarchies of patterns and processes in natural systems, and also, a recognition of the scales of human impact, monitoring and management inherent in human-ecosystem interactions (see Table 3.1).

SCALES OF HUMAN-MARINE ECOSYSTEM INTERACTION

Scale	Ecosystem	Major Processes	Human Impacts	Management
Global	Biosphere	topography (ocean basins), oceanography, climate (large-scale)	global warming, sealevel changes	international
1000's kms	bioprovince	topography (large-scale), oceanography (major currents, temperature), climate	global warming, sealevel changes, ecosystem stress, reduced biodiversity	international
100's kms	bioregion	topography, oceanography (upwellings, small currents), sediment supply	pollution, habitat fragmentation, overfishing, species loss, ecosystem stress, reduced biodiversity	national/state
10's kms	biounit	topography, aspect (exposure), tides, storms, sediment supply	pollution, habitat loss, overfishing, population loss, exotic introductions, ecosystem effects	local
1-10's km	habitat	aspect (exposure), storms, community dynamics, tides, depositional processes	pollution, habitat loss, overfishing, aquaculture, dredging, population loss, exotic introductions, ecosystem effects	local
100's metres	site	depth, predation, competition, storms	pollution, habitat loss, aquaculture, dredging population loss, exotic introductions	local

Table 3.1 **Scales of human-marine ecosystem interactions (ie. patterns, processes, human impacts and management) (from Edyvane 1996).**

3.3.2 Classifying Marine Ecosystems - Bioregionalisation

`Bioregionalisation', or the definition of biogeographic regions, is not only an essential step in marine conservation planning, but also, is essential in defining a bioregional planning framework for ecosystem management (Salm & Clarke 1984, ACIUCN 1986, Sherman *et al.* 1990, Ray & McCormick-Ray 1992, Bridgewater & Ivanovici 1993). In natural ecosystems, an understanding of the patterns of biodiversity, particularly habitat biodiversity, is not only essential for identifying an ecologically or biogeographically representative system of protected areas, but is also essential in defining scaled ecological units for holistic, integrated management at the ecosystem level (ie. catchment, landscape or `seascape management') (Forman & Godron 1986, Urban *et al.* 1987, Kessler *et al.* 1992, Grumbine 1994, Klijn 1994). Importantly, the scale and extent to which different human activities affect either biodiversity and/or ecological processes, determines both, the scale and nature of management and monitoring required, and hence, defines the framework for integrated, ecosystem management). As such, biogeographical regions or `bioregions' provide the boundaries and framework for biodiversity or conservation management and the multiple-use management of other specific human activities or uses, such as fisheries, mining, and tourism.

The definition of natural units for management not only facilitates planning and integrated ecosystem management, but also assist local managers and the community in such areas, in understanding the natural characteristics, features, limitations, and complexities of their local marine environments. The process of bioregionalisation classifies similar regions/habitats together at a range of spatial scales, within relatively homogenous, but distinctive, ecological units in terms of their natural biological and physical characteristics. To this end, the definition of such regions not only enable a systematic approach to planning and integrated management, but also, inventory, monitoring and audit of the marine environment and its resources. For marine resources (ie. fisheries, aquaculture, mining), where spatial distributions and dynamics are linked to ecological and physical processes and natural patterns of biodiversity, biogeographic regions provide an ecological framework for management which acknowledges the inherent natural variability and characteristics of marine ecosystems.

3.3.3 IMCRA - A National Template for Marine Biodiversity and Ecosystem Management

The approach to bioregionalisation used in South Australia has formed part of an integrated coordinated State and Commonwealth effort a to develop an *`Interim Marine and Coastal Regionalisation of Australia'* (IMCRA), to assist in the development of a representative system of Marine Protected Areas (Muldoon 1995, IMCRA 1997). The IMCRA classification is principally a `delphic' approach to biophysical regionalisation. In South Australia, this qualitative approach utilised the expertise of marine and coastal biological and physical researchers, results from ongoing field surveys and also, existing descriptive, spatially referenced biophysical coastal and marine data sets and maps. In several states, including South Australia, biogeographic or regional ecosystem classifications have involved utilising analytical multivariate procedures to classify patterns in nearshore ecosystem diversity (eg. Ortiz & Burchmore 1992, Edgar *et al.* 1995, 1997, LCC/DCNR 1995, Stevens 1995, Edyvane & Baker 1995, 1996). To-date, a total of 58 bioregions have been identified for the nearshore marine environments of Australia, on the basis of a wide range of physical and biological descriptors, such as climate, oceanography (water temperature, wave energy), tidal range, coastal geomorphology, biology (habitats, marine mammals, endemic species) (see Figure 3.1). For Australia, the challenge remains the critical integration of the existing terrestrial regionalisation (ie. Interim Biogeographic Regionalisation of Australia), with the marine regionalisation (ie. IMCRA), and also, the integration of inshore and offshore waters.

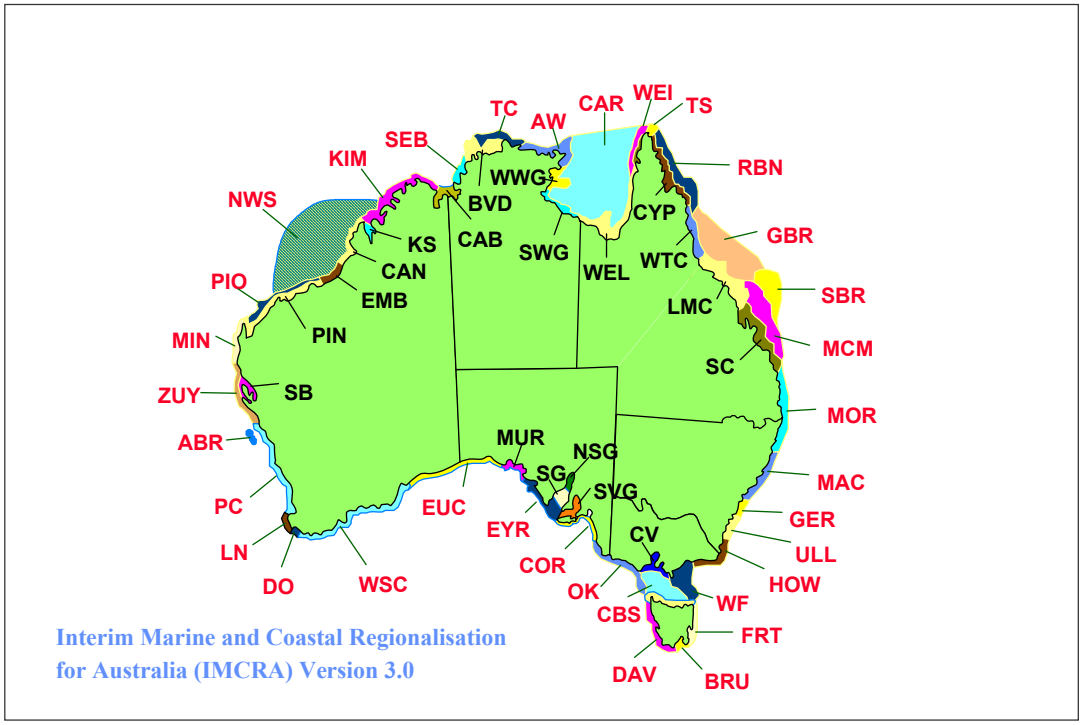

Figure 3.1 **The mesoscale marine ecosystems of Australia as defined under the Interim Marine and Coastal Regionalisation of Australia (IMCRA) project (IMCRA 1997).**

3.4 Defining a Marine Bioregional Planning Framework for South Australia

Planning, including identification of priority areas, is an essential part of a nation's overall strategy for conservation and sustainable use of it's biodiversity. During the 1990's, South Australia, with funding under the Natural Heritage Trust (and the former federal `Ocean Rescue 2000' initiative), has been developing a bioregional planning framework to assist with the establishment of a representative system of MPAs as part of the National Representative System of Marine Protected Areas (NRSMPA), and also, as a strategic tool for the integrated management and conservation of it's coastal and marine environments. Bioregional classification of South Australia's coastal and marine environments is an important initial step in achieving this goal. To this end, a biophysical classification of the range of coastal and marine environments in South Australia can be used to assist in the identification of ecologically or biogeographically representative areas and the 'ecological representativeness' of the existing system of MPAs. In South Australia potential sites for MPAs will also be identified on the basis of representing 'critical habitats' (ie. endangered habitats, nursery areas, etc.).

The current strategy for bioregional identification and classification in South Australia is a systematic, hierarchically scaled one, with a focus on the conservation of biodiversity in the context of ecosystem structure and function. This hierarchical structure of biodiversity is intrinsically linked to the level of functional diversity or ecological processes and attributes. The aim is to identify a set of natural environmental units defined by biophysical parameters. In South Australia, the definition of the bioregional framework has largely been undertaken by the South Australian Research and Development Institute, in collaboration with State and Commonwealth agencies. This has been achieved largely through the undertaking of a comprehensive program of marine habitat and biodiversity mapping (ie. linking spatial environmental and biological data) to define the biogeographical regions of South Australia, and also, identify priority areas for marine conservation, based on regional patterns of diversity (see Box 3.3).

BOX 3.3:
THE SA MARINE BENTHIC SURVEYS PROGRAM – STRATEGIC RESEARCH FOR ECOSYSTEM MANAGEMENT

A knowledge of the spatial distribution and nature of marine ecosystems, habitats and biodiversity is essential for a strategic approach to biodiversity management and also, the integrated, ecological sustainable management of coastal resources. Since 1992, the South Australian Research and Development Institute (SARDI), with assistance from CSIRO Division of Marine Research, the SA Herbarium and SA Museum, have been undertaking one of the most comprehensive marine mapping and biodiversity programs ever undertaken in Australia (Edyvane & Baker 1995, 1996a-d). Remote sensing techniques (using satellite and aerial photography), systematic marine biodiversity surveys and biogeographical analyses, are been used to describe and document the wide range of species, habitats and ecosystems in South Australia's nearshore waters. Since 1992, over 21,000 km^2 of South Australia's nearshore waters (or 3,700 km of coastline) have been mapped, revealing over 9,600 km^2 of seagrass meadows, 4,200 km^2 of nearshore reef systems, and over 8,000 km^2 of soft bottom and sandy habitats.

The detailed information from this program is not only fundamental in priority-setting for marine biodiversity conservation, but also, for the sustainable management of fisheries, aquaculture, tourism and many other coastal and marine uses along the South Australian coast. To this end, identifying the wide range of habitats and ecosystems will enable the full range of State's biodiversity to be fully represented in a reserves system - while defining the scale and boundaries of these ecosystems has assisted the identification of "marine catchments" for ecosystem management. While the boundaries of these marine catchments may not be as sharp as on land - an analogous range of environmental and physical factors (ie. oceanography, bathymetry, geology, and wave exposure) combine to produce a unique range of marine flora and fauna within them.

Existing physical and biological information, and also, information from ongoing field surveys, has principally being used to: develop a biophysical classification of the marine coastal waters of South Australia, at a range of spatial scales ("bioregion", "biounit", local), and also, to identify areas of high conservation value, to assist the establishment of an ecologically or biogeographically representative network of Marine Protected Areas and/or areas for listing on the Register of the National Estate. In developing a marine biogeographical classification, these studies have largely been the part of the coordinated State and Commonwealth effort to develop an *`Interim Marine and Coastal Regionalisation of Australia'* (IMCRA 1997) to assist in the development of a national representative system of Marine Protected Areas (ACIUCN 1986, Ray & McCormick-Ray 1992, Bridgewater & Ivanovici 1993, Muldoon 1995).

The approach to bioregionalisation in South Australia uses the nested, hierarchical concept of ecosystems to develop a five level biophysical classification at the level of :

1 **Pelagic Provinces (100,000s of km^2, gigascale),** which provides a broad scale strategic framework for the integrated management of pelagic resources; suitable for integrated pelagic fisheries management and integrated management of pelagic resources, global reporting, auditing;

2 **Demersal Provinces (10,000s of km^2, macroscale),** which provides a broad scale strategic framework for the integrated management of demersal resources; suitable for integrated demersal fisheries management and integrated management of demersal resources, global reporting, auditing;

3 **Biophysical Regions or `Bioregions` (1,000s of km^2, mesoscale),** which provides a national strategic framework for marine planning and ecological sustainable management of coastal resources; suitable for national biodiversity and conservation planning and priority-setting, pelagic fisheries management, reporting, auditing (eg. national State of the Environment Report);

4 **Biophysical Units or `Biounits' (100s of km^2, microscale),** which provides a regional strategic framework for marine planning and ecological sustainable management of coastal resources; identifies functional ecosystem-level management units (eg. rocky shores, dune barrier systems, archipelagos, shoals or reef systems, coastal peninsula, etc.); suitable for integrated multiple-use management and MPA declaration, regional biodiversity and conservation planning and priority-setting, fisheries management, reporting, auditing, monitoring, impact assessment;

5 and the level of **habitats (1-10s of km^2, picascale),** which provides information to address tactical site management issues at the habitat level (eg. bay, estuary, reefs, seagrass meadows); suitable for nature reserves, fishing closures, monitoring, impact assessment.

In the development of a scaled, hierarchical bioregional planning framework for South Australia, a total of 1 pelagic province, 1 demersal province (and 2 biotones), 8 bioregions, and 35 biounits have been identified (see Table 3.2).

In South Australia, a preliminary bioregionalisation or classification of coastal habitats and ecosystems adopted an `expert panel' or `delphic' approach, utilising existing `qualitative' biophysical / biogeographical information and the best technical judgements of local experts. This involved the formation of a specialist, SA Marine Protected Area Technical Working Group and the hosting of a technical workshop on the biophysical classification of South Australian marine and coastal environments in November 1991. The marine bioregionalisation at the bioregion and biounit incorporated and acknowledged the existing geomorphological classification of the coastal habitats of South Australia by Short *et al*. (1986), which utilised principally physical coastal landform and descriptors, such as wave environment, geology, coastal landform and coastal orientation. The results of this preliminary regionalisation were further refined and validated through ongoing systematic field surveys, knowledge of oceanographic processes, and also, more recently, under the national, *Interim Marine and Coastal Regionalisation of Australia* (IMCRA) project during 1995-1996.

Provinces were defined on the basis of major oceanographic current systems for the pelagic regionalisation, and biogeographic patterns in the marine fish fauna for the demersal classification (CSIRO 1996, IMCRA 1997). In contrast, marine bioregions were defined on the basis of a range of physical descriptors, such as climate, oceanography (ie. temperature, salinity, tides, wave energy, upwellings), geology and coastal geomorphology, estuaries and also, major biogeographic patterns in the marine biota (particularly the sessile fauna and flora, such as mangroves, seagrass, macroalgae). Smaller-scale biounits were defined primarily on the basis of coastal physiography, topography and major marine physical habitat or seascape features (eg. shoal systems, archipelagos, coastal dune barrier systems, etc.) and habitat distributions.

Pelagic Province	**Demersal Province/Biotones**	**Bioregion**	**Biounit**
Gigascale (100,000s km^2)	***Macroscale (10,000s km^2)***	***Mesoscale (1,000s km^2)***	***Microscale (100s km^2)***
Southern Pelagic Province (SPP)	Great Australian Bight Biotone (GABB)	Eucla (EUC)	Nullarbor (NUL) Wahgunyah (WAH)
		Murat (MUR)	Fowlers (FOW) Nuyts (NUY) Streaky (STK)
	Gulfs Province (GulfP)	Eyre (EYR)	Yanerbie (YAN) Newland (NEW) Flinders (FLI) Sheringa (SHR) Douglas (DGL) Whidbey (WHD) Jussieu (JUS) Pondalowie (PON) Gambier (GAM) Gantheaume (GAN)
		Spencer Gulf (SGF)	Dutton (DUT) Franklin (FRK) Tiparra (TIP) Wardang (WAR)
		Northern Spencer Gulf (NSG)	Yonga (YON) Winninowie (WIN)
		Gulf St Vincent (SVG)	Sturt (STU) Investigator (INV) Orontes (ORO) Clinton (CLN) Yankalilla (YNK) Encounter (ENC) Sprigg (SPR) Backstairs (BCK) Nepean (NEP) Cassini (CAS)
	West Bassian Biotone (WbassB)	Coorong (COR)	Coorong (COR)
		Otway (OTW)	Canunda (CAN) Nene (NEN) Piccaninnie (PIC)

Table 3.2 A nested hierarchical bioregional planning framework for South Australia's coastal and marine ecosystems.

3.4.1 `Province' or Large Marine Ecosystem Regionalisation

- ***Pelagic Regionalisation***

The *`Interim Marine and Coastal Regionalisation of Australia'* (IMCRA 1997) classification defines, one gigascale, pelagic province for South Australian waters: the Southern Pelagic Province (SPP). The core area of this province largely encompasses the Flindersian cool temperate marine biota.

- ***Southern Pelagic Province (SPP)***

- ***Area***

– 482,000 km^2

- ***Location***

– Extending from near Albany (WA) in the west, along the southern coast, to Lakes Entrance (Victoria) in the east and enclosing Bass Strait and the Tasmanian waters.

- ***Remarks***

– Largely comprised of Flindersian cool temperate species. The endpoint disjunctions also represent southern limits for warm temperate species in the Eastern and Western Pelagic Biotones (WPB and EPB). Intra-provincial disjunctions occur at Esperance and east of Point Dempster near the western edge of the Baxter Cliffs. In the east, disjunctions occur just east of Kangaroo Island and at Wilsons Promontory

- ***Demersal Regionalisation***

The *`Interim Marine and Coastal Regionalisation of Australia'* (IMCRA 1997) classification defines one macroscale, demersal province for South Australian waters: the Gulfs Province (GulfP), and two biotones: the Great Australian Bight Biotone (GABB) and the West Bassian Biotone (WBassB). Biotones are the zones of transition between core provinces. The provinces and biotones are based on a classification of demersal fish species diversity and richness.

- ***Great Australian Bight Biotone (GABB)***

- ***Area***

– 200,000 km^2

- ***Location***

– Great Australian Bight from Israelite Bay (WA) to Point Brown (SA).

- ***Remarks***

– Weak biotone dominated by species from the South Western Province (SWP) in WA, with a few elements of the Gulf Province (GulfP) in SA. A major disjunction exits near the Recherche Archipelago corresponding to the western limits of a suite of wide-ranging species from the Central Eastern Province (CEP) and Tasmanian Province (TasP), and the eastern limits of the South Western Province. The biotone is also traversed by a large suite of wide-ranging, western, warm temperate species that extend along the southern Australian coast to the Gulf Provinces, Bassian Province (BassP) and the South Eastern Biotone (SEB), and a suite of ubiquitous temperate Australian species that originate in the Central Eastern Province and Biotone (CEP and CEB).

- ***Mesoscale Regions***

– Includes Eucla and Murat regions.

- ***Gulfs Province (GulfP)***

- ***Area***

– 35,379 km^2

- ***Location***

– Comprising the Gulfs of Spencer and St Vincent and enclosing Kangaroo Island. Extends out to the shelf break with a western boundary at Point Brown and an eastern edge at Cape Jervis.

- ***Remarks***

– A weak but unique province with a small endemic element and subtropical relict species. It has a strong disjunction near its northern boundary and acts as a major biotone for cool temperate species (TasP and BassP) and for a large suite of species from the South Western Province (SWP). The hypersaline and subtropical temperature conditions in the Gulfs are unique within temperate Australia and probably enable this region to act as a refugia for warmer water species. Once again, the unique relict nature of the region makes it worthy of recognition from a conservation standpoint (IMCRA 1997).

- ***Mesoscale Regions***

– Includes Eyre, Northern Spencer Gulf, Spencer Gulf and St Vincent regions.

- ***West Bassian Biotone (WbassB)***

- ***Area***
  - 89,751 km^2

- ***Location***

– Extends east from the South Australian Gulfs Province (GulfP), pentrating past King Island to a southern limit at the north-western tip of Tasmania and a northern limit slightly north of Apollo Bay (Victoria).

- ***Remarks***

– Zone of faunal overlap of elements derived mainly from the Tasmanian Province (TasP) and Bassian Province (BassP) to the east, as well as a small suite of extralimital species from the Central Eastern Province (CEP). Also contains elements from the South Western Province (SWP) and Gulfs Provinces (GulfP).

- ***Mesoscale Regions***

– Includes Otway and Coorong regions.

3.4.2 `Bioregion' or Ecosystem-Level Regionalisation

A total of 8 distinct inshore marine biogeographical regions (or "bioregions") have been identified for South Australia (Figure 3.2). The seaward margin of the mesoscale bioregions is the edge of the continental shelf, defined as the 200 metre isobath. These bioregions include from the west: Eucla (Israelite Bay, Western Australia - Cape Adieu, South Australia), Murat (Cape Adieu - Point Labatt), Eyre (Point Labatt - Peake Bay, Cape Borda - West Cape), Northern Spencer Gulf (Point Riley - Port Augusta - Shoalwater Point), Spencer Gulf (Peake Bay - West Cape, Point Riley - Shoalwater Point), St Vincent Gulf (Cape Borda - West Cape, Cape Jervis - Cape Willoughby), Coorong (Cape Jaffa - Cape Borda) and Otway-King (Cape Jaffa - Cape Otway, Victoria - King Island, Tasmania) (see Table 3.3).

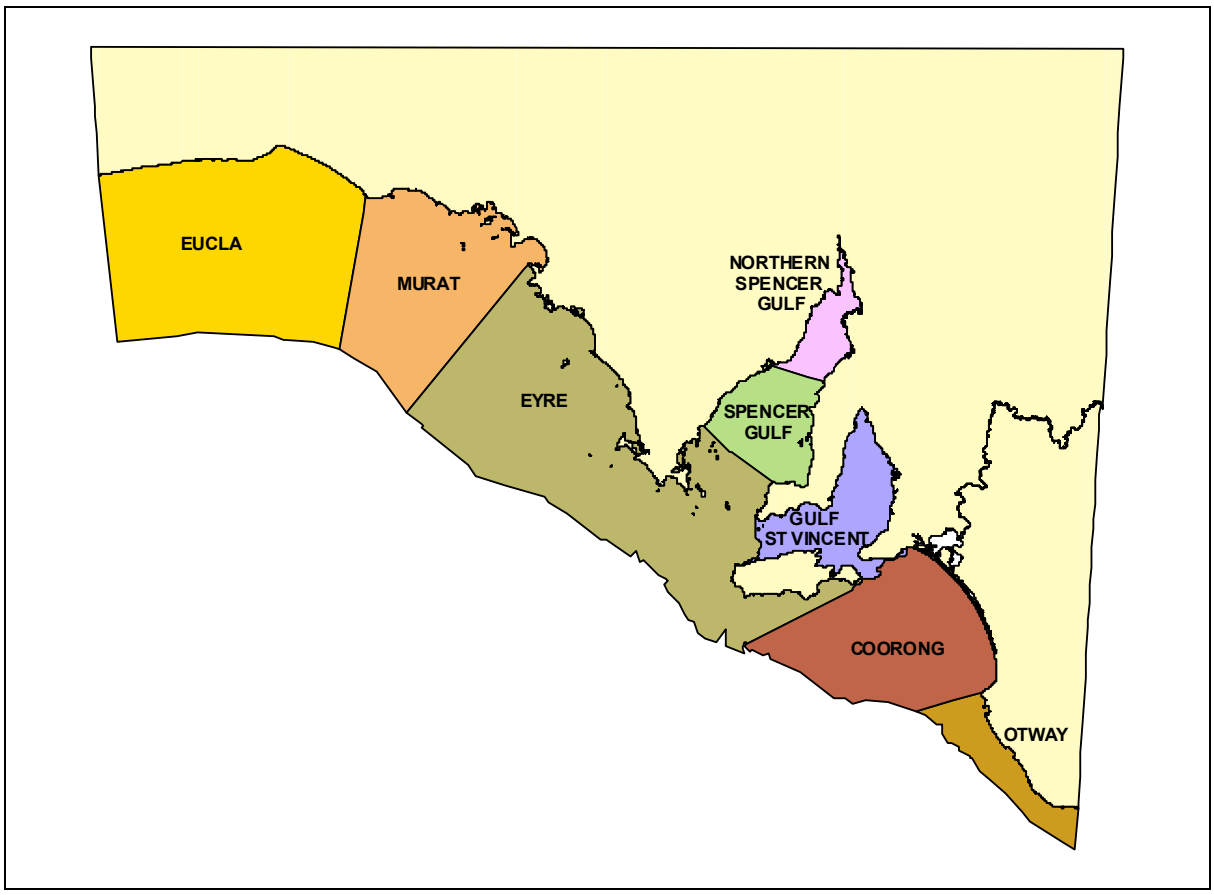

Figure 3.2 The marine bioregions of South Australia.

Bioregion	Total Area of Bioregion (ha)	SA Area of Bioregion (ha)	Major Inshore Habitats	Major Physical/Biological Descriptors
Eucla (EUC)	11,111,514	189,073	Sand (391 km^2, 88.5%) Reef (51 km^2, 11.5)	rocky coast; dominated by the Nullarbor Cliffs and Eucla Basin; warm water Leeuwin Current; microtidal; warm temperate biota, moderate biodiversity
Murat (MUR)	3,558,736	133,703	Seagrass (880 km^2, 61.3%) Sand (309 km^2, 21.5%) Reef (246 km^2, 17.2%)	rocky crenulate coast, embayments; Nuyts Archipelago, seamounts; microtidal; warm temperate biota, extensive seagrass meadows, mangroves
Eyre (EYR)	7,216,500	1,425,723	Sand (1543 km^2, 56.2%) Reef (674 km^2, 24.6%) Seagrass (527 km^2, 19.2%)	rocky coast, offshore islands, seamounts; localised upwellings; microtidal; cool temperate biota, high biodiversity, productivity, importance for marine mammals, seabirds
Spencer Gulf (SGF)	1,187,451	1,199,299	Seagrass (1377 km^2, 41.2%) Sand (1351 km^2, 40.5%) Reef (611 km^2, 18.3%)	tidal plain coast, embayments; shallow offshore gradient; semi-confined, inverse estuary; micro-mesotidal; cool temperate biota, high endemism, extensive seagrass meadows
Northern Spencer Gulf (NSG)	444,803	478,824	Seagrass (4136 km^2, 58.1%) Sand (2487km^2, 34.9%) Reef (493 km^2, 6.9%)	tidal plain coast; shallow offshore gradient; confined, inverse estuary; mesotidal; subtropical-tropical element in biota, high endemism; extensive seagrass meadows, mangroves
St Vincent Gulf (SVG)	1,283,817	1,441,971	Seagrass (2438 km^2, 59.6%) Sand (1057 km^2, 25.9%) Reef (595 km^2, 14.5%)	tidal plain coast; shallow offshore gradient; confined, inverse estuary; micro-mesotidal; cool temperate biota, high endemism, extensive seagrass meadows, mangroves
Coorong (COR)	3,197,170	178,575	Reef (991 km^2, 48.2%) Sand (812 km^2, 39.5%) Seagrass (255 km^2, 12.4%)	large barrier coast; Coorong Lagoon and Murray River; gradational nearshore-offshore gradient; cool temperate biota, moderate biodiversity
Otway (OTW)	3,733,126	120,639	Reef (582 km^2, 87.4%) Sand (84 km^2, 12.6%) Seagrass (0.5 km^2, 0.1%)	small barrier coast; localised upwellings; cold temperate biota, high biodiversity, productivity
Total	**32,000,000**	**5,167,807**		

Table 3.3 A summary of the IMCRA bioregions of South Australia

The marine bioregions of South Australia vary from the oceanic bioregions of Eucla (EUC), Murat (MUR), Eyre (EYR), Coorong (COR) and Otway (OTW), to the gulf bioregions of Spencer Gulf (SGF), Northern Spencer Gulf (NSG) and St Vincent Gulf (SVG). The gulf bioregions are semi-confined or confined inverse estuaries, characterised by tidal plain coasts and landforms, micro-mesotidal tidal ranges, and shallow offshore gradients with extensive intertidal, and supratidal areas (see Table 3.3 and 3.4). The biota is characterised by extensive areas of coastal saltmarshes, mangroves (dominated by the Grey Mangrove, *Avicennia marina*), and subtidal seagrass meadows. Northern Spencer Gulf is characterised by a unique tropical element in the fauna and flora. Together the bioregions of the gulfs are home to 7950 km^2 of seagrass or 82% of the total area of seagrass recorded in South Australia. The most extensive seagrass meadows (dominated by *Posidonia* species), occur in the clear, shallow, sheltered gulf waters of Northern Spencer Gulf (4,136 km^2), with smaller meadows occurring in Spencer Gulf (5,520 km^2) and Gulf St Vincent (2,440 km^2).

Bioregion	Total Area of Bioregion (ha)	SA Area of Bioregion (ha)	Major Inshore Habitats	Major Coastal Landform	Major Marine Activities/Uses
Eucla	11,111,514	189,073	sand>reef	rocky limestone cliffs	very remote area, fishing, mineral & petroleum exploration
Murat	3,558,736	133,703	seagrass>sand>reef	rocky crenulate coast	aquaculture, fishing, tourism
Eyre	7,216,500	1,425,723	sand>reef>seagrass	rocky coast	fishing, tourism, mineral & petroleum exploration
Spencer Gulf	1,187,451	1,199,299	seagrass>sand>reef	tidal plain coast	fishing, aquaculture, shipping
Northern Spencer Gulf	444,803	478,824	seagrass>sand>reef	tidal plain coast	fishing, aquaculture, shipping
St Vincent Gulf	1,283,817	1,441,971	seagrass>sand>reef	tidal plain coast	fishing, tourism, aquaculture, shipping
Coorong	3,197,170	178,575	reef>sand>seagrass	large barrier coast	fishing
Otway	3,733,126	120,639	reef>sand	small barrier coast	fishing, aquaculture
Total	**32,000,000**	**5,167,807**			

Table 3.4 A summary of IMCRA bioregions inshore habitats, coastal landforms and major marine activities.

Habitat	Gulfs Region			Open Coast Region				
	GSV	***SPG***	***NSG***	***Eucla***	***Murat***	***Eyre***	***Coorong***	***Otway***
Intertidal rocky[1] shores	minor	minor	not present				minor	
Subtidal rocky[2] reefs			minor					
Seagrass beds				minor			minor	none known
Mangroves				not present		not present	not present	not present
Intertidal sandy beaches			minor					
Sheltered intertidal flats				not present		not present	not present	not present
Subtidal soft substrata								
Pelagic environment								

Table 3.5 South Australia's major marine, coastal and estuarine habitats by biophysical region.

Notes:

1 Shading indicates habitat/region combinations that occur along the South Australian coast.
2 Major substratum rock types are granite, limestone, calcarenite and sandstone.

In contrast, the oceanic bioregions are dominated by extensive rocky coasts and sandy shores. The oceanic bioregions are characterised by exposed rocky coasts and headlands (comprising Precambrian metasediment cliffs, Pleistocene dune rock cliffs), interspersed with Holocene dune barrier beaches and lagoon deposits in sheltered areas, microtidal tidal ranges, and shallow to moderate offshore gradients (see Table 3.4 and 3.5). The Eucla, Murat and Eyre are characterised by a predominance of rocky coasts, while the Coorong and Otway coasts are typically small barrier coasts. (See Table 3.6)

The Eyre, Coorong and Otway Bioregions experience moderate to high energy wave and swell conditions (experiencing some of the highest wave energies in the State), and are dominated by extensive reefal habitats, sandy bottom substrates and transgressive dune systems. The Eyre and Otway regions are also distinguished by the presence of localised, seasonal, nutrient-rich coldwater upwellings. In contrast, the Murat Bioregion comprises a series of extensive, shallow water embayments, protected by the Nuyts Archipelago, and dominated by extensive seagrass meadows and mangroves. (See Table 3.5 and 3.6)

Bioregion	*seagrass (km^2)*	*% bioregion*	*reef (km^2)*	*% bioregion*	*sand (km^2)*	*% bioregion*	*Total (km^2)*
Eucla	0	0.0	50.7	11.5	391.2	88.5	441.9
Murat	880.1	61.3	246.2	17.2	309.2	21.5	1,435.5
Eyre	527.3	19.2	673.8	24.6	1,542.8	56.2	2,743.9
Spencer Gulf	1,376.7	41.2	610.9	18.3	1,350.8	40.5	3,338.4
Northern Spencer Gulf	4,135.7	58.1	493.3	6.9	2486.5	34.9	7,115.5
St Vincent Gulf	2,437.5	59.6	594.5	14.5	1,057.8	25.9	4,089.8
Coorong	254.5	12.4	990.7	48.2	811.5	39.5	2,056.7
Otway	0.47	0.1	581.9	87.4	83.8	12.6	666.17
Total	**9,612.27**	**43.9**	**4,242.5**	**19.4**	**8,033.6**	**36.7**	**21,887.87**

Table 3.6 Summary of inshore marine habitats mapped for the bioregions of South Australia.

A full detailed description of the bioregions of South Australia is provided in Appendix 1.

3.4.3 `Biounit' or Habitat-Level Regionalisation

A total of 35 biounits have been identified along the inshore coastal waters of South Australia (see Figure 3.3, Table 3.7). These include a total of 30 coastal biounits and 5 offshore biounits, which comprise offshore islands and waters without adjacent mainland coasts (ie. Nuyts, Flinders, Investigator, Gambier, Sprigg). The biounits were delineated on the basis of major coastal physiographic features and the representation and distribution of major marine habitats. The seaward boundary of the gulfs biounits was defined using the 30 m bathymetric contour, on the basis that major habitat changes are known to occur in deeper waters, beyond the photic zone. Similarly, the seaward boundary of the oceanic biounits was defined using the 50 m depth contour, on the basis that the photic zone is known to occur deeper in the clearer oceanic waters of South Australia.

Bioregion/ Biounit	Inshore/ Offshore Biounit	Total Area (ha)	SA Waters (ha)[1]	Major Feature; Physical/Biological Descriptors; Inshore Habitats
EUCLA				
3 Nullarbor	Inshore	842,642	112,959	Nullarbor Cliffs; high energy, limestone cliffs, reefs; sand (11,836 ha, 75.2%) and reef habitats (3,908 ha, 24.8%)
4 Wahgunyah	Inshore	195,381	76,114	Wahgunyah CR; high energy, extensive dune transgressions; mostly sand (27,971 ha, 94.2%) and some reef habitats (1,722 ha, 5.8%)
Subtotal		**1,038,023**	**189,073**	
MURAT				
5 Fowlers	Inshore	146,486	133,702	Fowlers Bay; high energy, rocky limestone coast; mostly reefs (21,666 ha, 81.9%), some sand (3,134 ha, 11.9%) and seagrass habitats (1,639 ha, 6.2%)
6 Nuyts	Offshore	283,165	250,448	Nuyts Archipelago; offshore islands; mostly reefs (2,483 ha, 91.6%), some seagrass (144 ha, 5.3%) and sand habitats (84 ha, 3.1%)
7 Streaky	Inshore	190,949	190,950	Streaky Bay; sheltered embayments, rocky headlands; mangroves, large areas of seagrass (86,163 ha, 77.6%), some sand (22,466 ha, 20.2%), and reef habitats (2,343 ha, 2.1%)
Subtotal		**620,600**	**575,101**	
EYRE				
8 Yanerbie	Inshore	82,854	80,569	Yanerbie Sandpatch; high energy, rocky limestone coastline; sand (9,573 ha, 43.6%), seagrass (6,602 ha, 30.0%) and reef habitats (5,802 ha, 26.4%)
9 Newland	Inshore	45,238	39,714	Newland Barrier; high energy, extensive dune barrier system; mostly sand (4,318 ha, 57.2%) and reef (3,231 ha, 42.8%) habitats
10 Flinders	Offshore	125,957	64,660	Flinders Isles; high energy, offshore islands, seamounts; mostly reef habitats (4,194 ha)
11 Sheringa	Inshore	51,156	42,156	Sheringa Lagoon; high energy, large barrier dune systems; mostly reef habitats (4,605 ha, 94.1%), some sand (224 ha, 4.6%) and seagrass habitats (65 ha, 1.3%)
12 Douglas	Inshore	67,645	66,729	Port Douglas; moderate to low energy, large sheltered embayments, rocky headlands; sand (18,619 ha, 50.1%), seagrass (8,567 ha, 23.1%), and reef habitats (9,965 ha, 26.8%)
13 Whidbey	Inshore	132,689	107,839	Whidbey Isles; high energy, rocky coast, offshore islands, seamounts, localised upwellings; most sand (38, 489 ha, 88.1%) and some reef habitat (5,221 ha, 11.9%)
14 Jussieu	Inshore	240,439	240,439	Jussieu Peninsula; large sheltered embayments, rocky headlands, offshore islands; sand (65,921 ha, 42.9%), seagrass (56,956 ha, 37.1%) and reef habitats (30,649 ha, 20.0%)
15 Pondalowie	Inshore	22,130	22,131	Pondalowie Bay; high energy, rocky coastline, upwellings; sand (15,077 ha, 83.9%), reef (2,862 ha, 15.9%) and some seagrass habitats (25 ha, 0.1%)
16 Gantheume	Inshore	167,363	111,066	Cape Gantheaume; high energy, rocky coast; mostly reef (31,857 ha, 60.5%), sand (19,521 ha, 37.1%) and some seagrass habitat (1,263 ha, 2.4%)
Subtotal		**935,471**	**775,302**	

Table 3.7 Summary of the marine and coastal biounits for the inshore waters of South Australia. [1]SA waters refers to territorial sea, land and inland waters.

Bioregion/ Biounit	Inshore/ Offshore Biounit	Total Area (ha)	SA Waters (ha)[1]	Major Feature; Physical/Biological Descriptors; Inshore Habitats
SPENCER				
17 Dutton	Inshore	255,443	255,443	Dutton Bay; sheltered rocky coast; mostly seagrass (25,706 ha, 98.5%), some reef (197 ha, 0.8%) and sand habitats (190 ha, 0.7%)
18 Franklin	Inshore	198,588	198,588	Franklin Harbour; large sheltered embayment; mangroves, sand (87,258 ha, 61.4%), reef (39,361 ha, 27.7%) and seagrass habitats (15,447 ha, 10.9%)
19 Tiparra	Inshore	243,228	243,228	Tiparra Reef; moderately-high energy, extensive shallow seagrass-reef shoal system; seagrass (83,912 ha, 81.3%), reef (4,491 ha, 4.4%) and sand habitats (14,782 ha, 14.3%)
20 Wardang	Inshore	285,583	285,583	Wardang Island; moderate energy, large embayment, rocky headlands; sand (65,722 ha, 44.7%), reef (54, 739 ha, 37.3%), seagrass habitats (26, 458 ha, 18.0%)
21 Gambier	Offshore	536,544	536,544	Deeper water habitats of the Spencer Gulf; Gambier Isles; sand (15,160 ha, 68.4%), seagrass (5,123 ha, 23.1%) and some reef habitat (1,865 ha, 8.4%)
Subtotal		**1,519,388**	**1,519,388**	
NORTHERN SPENCER GULF				
22 Yonga	Inshore	55,267	55,267	Yonga Shoal; sheltered gulf waters, shoals; large areas of seagrass (248,596 ha, 59.1%) and sand (161,715 ha, 38.5%), some reef habitat (10,054 ha, 2.4%)
23 Winninowie	Inshore	423,557	423,557	Winninowie CP; very sheltered gulf waters; mostly sand (37,727 ha, 69.6%) and seagrass habitats (16,484 ha, 30.4%)
Subtotal		**478,824**	**478,824**	

Table 3.7 Summary of the marine and coastal biounits for the inshore waters of South Australia. [1]SA waters refers to territorial sea, land and inland waters.

Bioregion/Biounit	Inshore/ Offshore Biounit	Total Area (ha)	SA Waters (ha)[1]	Major Feature; Physical/Biological Descriptors; Inshore Habitats
GULF ST VINCENT				
24 Sturt	Inshore	183,058	183,058	Sturt Bay; moderate-high energy, large bays, rocky headlands; seagrass (25,611 ha, 75.0%), reefs (5,088 ha, 14.9%) and sand habitats (3,465 ha, 10.1%)
25 Investigator	Inshore	280,063	280,063	Investigator Strait; moderate-high deepwater habitats; sand (490 ha)
26 Orontes	Inshore	183,762	183,762	Orontes Bank; extensive shallow seagrass-reef shoal system; seagrass (51,713 ha, 56.5%), reef (33,745 ha, 36.9%) and sand habitats (6,081 ha, 6.6%)
27 Clinton	Inshore	249,136	249,136	Clinton CR; sheltered gulf waters; large areas of mangroves, seagrasses (132, 576 ha, 84.4%), sand (21,173 ha, 13.5%) and some reef habitat (3,280 ha, 2.1%)
28 Yankalilla	Inshore	51,562	51,562	Yankalilla Bay; moderate energy, bays, rocky headlands; sand (15,845 ha, 62.2%) and seagrass (7,645 ha, 30.0%), some reefs (1,966 ha, 7.7%)
29 Encounter	Inshore	39,389	39,389	Encounter Bay; high energy, rocky coast, bays; mostly reef (5,452 ha, 57.8%), sand (3,482 ha, 36.9%) and some seagrass habitat (505 ha, 5.4%)
30 Sprigg	Offshore	160,548	160,548	Deeper water habitats of Gulf St Vincent
31 Backstairs	Offshore	35,911	35,322	Backstairs Passage; strong tidal currents, deepwater habitats; seagrass (668 km, 52.1%), reef (527 km, 41.1%), and some sand habitats (87 km, 6.8%)
32 Nepean	Inshore	102,304	102,232	Nepean Bay; sheltered embayments; mostly seagrass (23,229 ha, 49.6%), sand (21,523 ha, 45.9%), and some reef habitat (2,124 ha, 4.5%)
33 Cassini	Inshore	45,760	45,760	Cape Cassini; moderate energy, rocky coast; mostly sand (12,943 ha, 81.6), reef (2,263 ha, 14.3%) and some seagrass habitat (662 ha, 4.2%)
Subtotal		**1,331,491**	**1,330,950**	
COORONG				
34 Coorong	Inshore	1,290,715	178,575	Coorong Lagoon; high energy, extensive lagoon system, dune barrier; mostly sand (75,497 ha, 44.2%), reef (70,376 ha, 41.2%) and some seagrass habitat (25,062 ha, 14.7%)
Subtotal		**1,290,715**	**178,575**	
OTWAY				
35 Canunda	Inshore	233,897	84,833	Canunda NP; high energy, rocky coast, dune barriers, offshore reefs; mostly reef (50,552 ha, 90.5%), some sand (5,333 ha, 9.5%) and sparse seagrass (2 ha, <0.1)
36 Nene	Inshore	32,543	19,061	Nene Valley CP; high energy, rocky coast, offshore reefs; mostly reef habitat (9,981 ha, 97.7%), and some sand habitat (234 ha, 2.3%)
37 Piccaninnie	Inshore	44,923	16,746	Piccaninnie Ponds CP; rocky coast, offshore reefs; mostly sand habitats (2,798 ha, 79.6%), some reefs (675 ha, 19.2%) and sparse seagrass (44 ha, 1.3%)
Subtotal		**311,363**	**120,639**	

Table 3.7 Summary of the marine and coastal biounits for the inshore waters of South Australia. [1]SA waters refers to territorial sea, land and inland waters.

Some of the marine biounits identified for South Australia encompass solely state jurisdictional waters (eg. biounits within the gulfs). Other biounits encompass both SA and Commonwealth territorial seas. As expected, the representation and range of marine ecosystems varies considerably between the biounits (see Table 3.8), from the reef-seagrass shoal systems of Orontes and Tiparra, to the offshore islands and seamounts of Whidbey and Flinders, to the large seagrass-dominated embayments of Jussieu and Streaky, to the mangrove-seagrass inverse estuaries of Clinton, Winninowie, and Yonga. The Yonga biounit alone represents over 25% of the total seagrass recorded in South Australia. Other significant ecosystems include the strong tidal current ecosystem of Backstairs, the rocky cliff habitats of Nullarbor and the extensive nearshore reefs systems of Canunda and Nene.

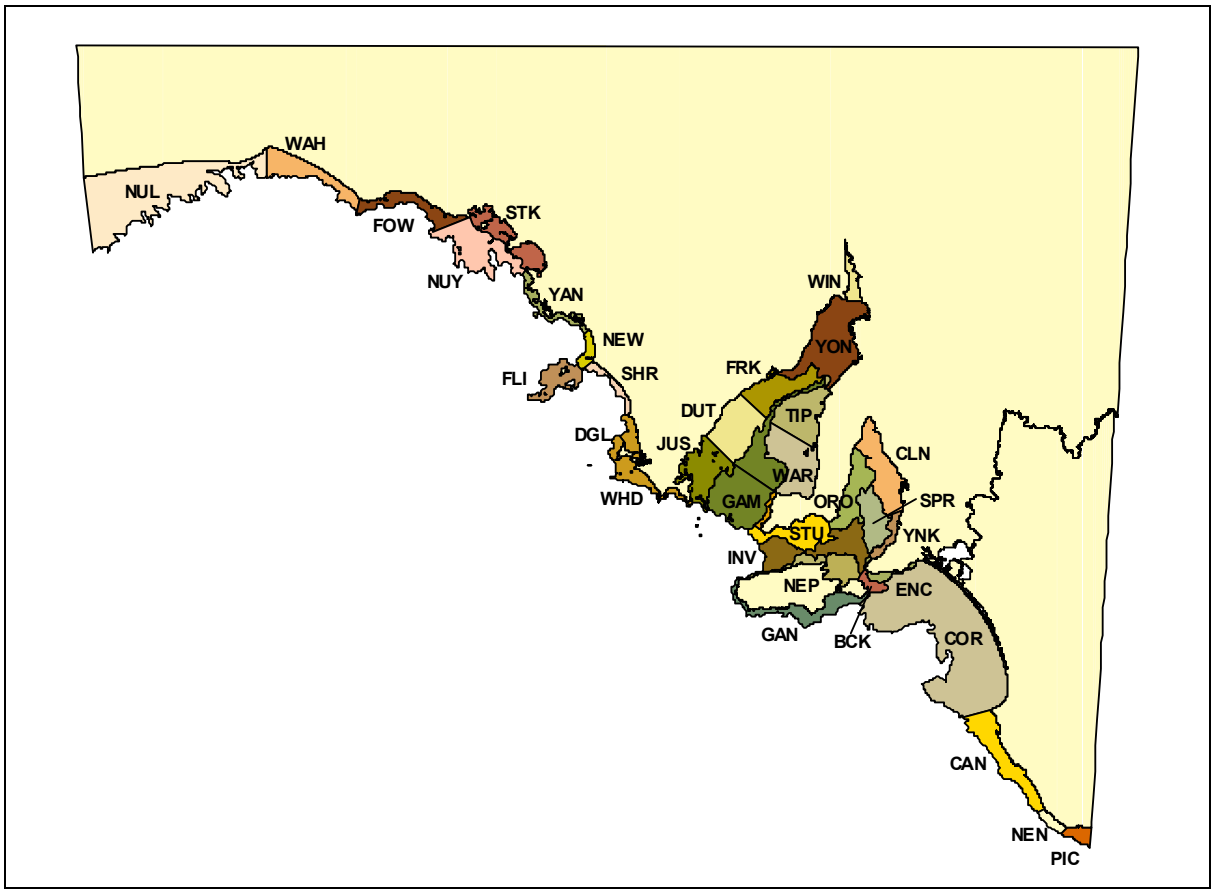

Figure 3.3 **Inshore marine biounits of South Australia.**

Biounit	*Seagrass (ha)*	*% Seagrass biounit*	*Reef (ha)*	*% Reef biounit*	*Sand (ha)*	*% Sand biounit*	*Total (ha)*
1 Nullarbor	0	0.0	3,908	24.8	11,836	75.2	15,744
2 Wahgunyah	0	0.0	1,722	5.8	27,971	94.2	29,693
3 Fowlers	1,639	6.2	21,666	81.9	3,134	11.9	26,439
4 Nuyts	144	5.3	2,483	91.6	84	3.1	2,711
5 Streaky	86,163	77.6	2,343	2.1	22,466	20.2	110,972
6 Yanerbie	6,602	30.0	5,802	26.4	9,573	43.6	21,977
7 Newland	0	0.0	3,231	42.8	4,318	57.2	7,549
8 Flinders	0	0.0	4,194	100.0	0	0.0	4,194
9 Sheringa	65	1.3	4,605	94.1	224	4.6	4,894
10 Douglas	8,567	23.1	9,965	26.8	18,619	50.1	37,151
11 Whidbey	0	0.0	5,221	11.9	38,489	88.1	43,710
12 Jussieu	56,956	37.1	30,649	20.0	65,921	42.9	153,526
13 Dutton	25,706	98.5	197	0.8	190	0.7	26,093
14 Franklin	15,447	10.9	39,361	27.7	87,258	61.4	142,066
15 Yonga	248,596	59.1	10,054	2.4	161,715	38.5	420,365
16 Winninowie	16,484	30.4	0	0.0	37,727	69.6	54,211
17 Tiparra	83,912	81.3	4,491	4.4	14,782	14.3	103,185
18 Wardang	26,458	18.0	54,739	37.3	65,722	44.7	146,919
19 Pondalowie	25	0.1	2,862	15.9	15,077	83.9	17,964
20 Gambier	5,123	23.1	1,865	8.4	15,160	68.4	22,148
21 Sturt	25,611	75.0	5,088	14.9	3,465	10.1	34,164
22 Investigator	0	0.0	0	0.0	490	100.0	490
23 Orontes	51,713	56.5	33,745	36.9	6,081	6.6	91,539
24 Clinton	132,576	84.4	3,280	2.1	21,173	13.5	157,029
25 Yankalilla	7,645	30.0	1,966	7.7	15,845	62.2	25,456
26 Encounter	505	5.4	5,452	57.8	3,482	36.9	9,439
27 Sprigg							
28 Backstairs	668	52.1	527	41.1	87	6.8	1,282
29 Nepean	23,229	49.6	2,124	4.5	21,523	45.9	46,876
30 Cassini	662	4.2	2,263	14.3	12,943	81.6	15,868
31 Gantheume	1,263	2.4	31,857	60.5	19,521	37.1	52,641
32 Coorong	25,062	14.7	70,376	41.2	75,497	44.2	170,935
33 Canunda	2	0.0	50,552	90.5	5,333	9.5	55,887
34 Nene	0	0.0	9,981	97.7	234	2.3	10,215
35 Piccaninnie	44	1.3	675	19.2	2,798	79.6	3,517
Out of biounit	464	3.0	1,580	10.1	13,554	86.9	15,598
Totals	**851,331**	**40.9**	**428,824**	**20.6**	**802,292**	**38.5**	**2,082,447**

Table 3.8 **Inshore subtidal habitats of the coastal and marine biounits of South Australia. Areas of habitats refer only to the limit of inshore aerial mapping.**

4 MARINE BIODIVERSITY AND CONSERVATION MANAGEMENT IN SOUTH AUSTRALIA

4.1 History of Marine Conservation in South Australia

South Australia was the first state in Australia to enact comprehensive legislation specifically to establish marine protected areas (MPAs) (Johnson 1983, 1988). This was done under the *Fisheries Act 1971* which provided specifically for the protection of the aquatic habitat in South Australia, through the creation of Aquatic Reserves. The *Fisheries Act 1971* has since been superseded by the *Fisheries Act 1982*.

Of particular significance was the integration of resource management (under fisheries management regulations) and habitat protection (through the creation of Aquatic Reserves) within the legislation. As such, the *Fisheries Act 1971* provided a comprehensive and integrated, legislative framework for marine conservation, in addition to resource management, for the first time in Australia. This enabled, under the one piece of legislation, not only the establishment of Aquatic Reserves but also, importantly, provided the necessary regulations to restrict and regulate all activities within these protected areas.

The system of Aquatic Reserves was initially established, concurrent with fisheries resource management, by the former Department of Fisheries to `provide for the wise use, protection, appreciation and enjoyment of the South Australian marine habitat' (Johnson 1983). To ensure a greater degree of protection for marine flora and fauna, four broad management objectives were specified for Aquatic Reserves. These included:

- conservation, protection and/or preservation
- fisheries management
- scientific research and/or education
- recreation (Johnson 1983).

The first six Aquatic Reserves, proclaimed in 1971, were established to preserve examples of different marine and estuarine habitats, protect endangered species, and to serve as research sites to learn more about marine and estuarine ecosystems (Johnson 1988). These reserves were: Port Noarlunga Reef and the Onkaparinga Estuary Aquatic Reserve; Aldinga Reef Aquatic Reserve; American River Inlet Aquatic Reserve; Goose Island Aquatic Reserve; Seal Beach-Bales Bay Aquatic Reserve; and West Island Aquatic Reserve. Additional reserves were established in 1973, 1980, 1983 and 1986.

In 1980, the status and management of Aquatic Reserves in South Australia was independently reviewed by Ottaway *et al*. (1980). However, many of the proposed recommendations from this report have not been adopted, including proposed new Aquatic Reserves and extensions to existing reserves.

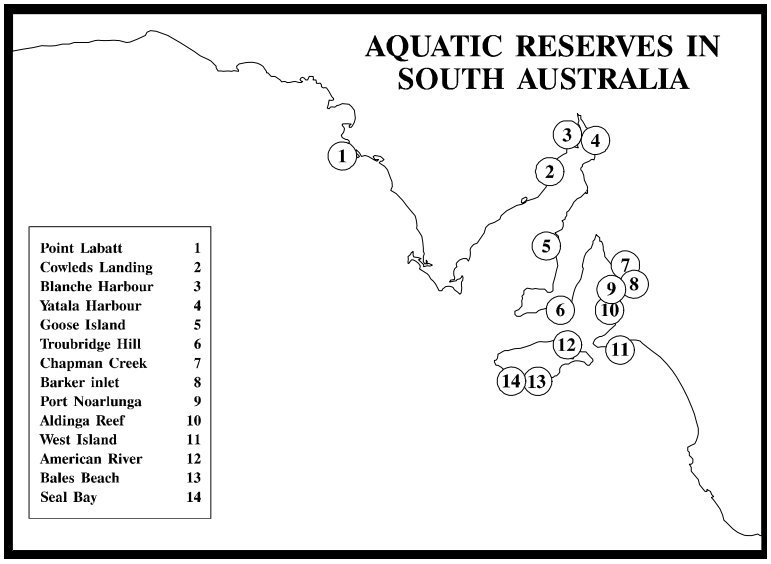

Figure 4.1 Aquatic Reserves in South Australia.

Since 1971, a total of 14 Aquatic Reserves have been established throughout the State (Figure 4.1), covering a range of habitats, and ranging from totally closed areas to areas allowing some recreational fishing. While many types of habitats are either presently not reserved as Aquatic Reserves or poorly represented, the primary goal of the system of Aquatic Reserves in South Australia remains the protection of representative marine and estuarine ecosystems, habitats and communities along the South Australian coast, while permitting appropriate uses and promoting public education.

4.2 Marine Wildlife Management

Under the *Fisheries Act 1982*, protection of all aquatic organisms and their habitat is provided *inter alia* through the proclamation of Aquatic Reserves by the Governor. Marine and estuarine fauna and flora (and the seabed) within Aquatic Reserves can be afforded a high level of protection through the Fisheries Act (Aquatic Reserves) Regulations 1989 which can provide for no access, limited access and/or limited fishing activities within the waters of Aquatic Reserves.

Marine fauna and flora in South Australia are also protected under the *National Parks and Wildlife Act 1972*. Despite this overlap, complementary legislation and jurisdictional arrangements generally exist between the two management agencies, Primary Industries South Australia (Fisheries) and the National Parks and Wildlife Service, to provide effective and uniform protection for marine wildlife in South Australia. While all whales, dolphins, porpoises and seals in Australian waters are completely protected under the Commonwealth Whale Protection Act 1980, recent amendments (June 1993) to the *Fisheries Act* and the *National Parks and Wildlife Act*, now provide uniform penalties to ensure the protection of marine mammals in South Australian waters, with fines of up to $30 000 or imprisonment up to two years for the molestation, injury, death of any marine mammal.

Marine flora in South Australia is also protected under the *Native Vegetation Act 1991*, in addition to the *Fisheries Act 1982* and the *National Parks and Wildlife Act 1972*. However, recent negotiations between the Primary Industries South Australia (Fisheries) and the Native Vegetation Branch (May 1993) have recommended that the powers and functions of the Native Vegetation Council in regard to the clearance of all marine native vegetation below high tide (excluding mangroves) be delegated to the Director of Fisheries. Mangroves in South Australia are also protected by regulations under another piece of legislation, the *Harbours Act 1936*, which controls the development of coastal lands for harbours and the building of marinas.

Under its regulations, the *Fisheries Act* has considerable flexibility to control and manage all activities relating to the taking (alive or dead) of any aquatic organism in South Australian waters. In this regard "fish" under the Fisheries Act is defined as "an aquatic organism of any species and includes the eggs, spat or spawn, or the body, or part of the body (including the shell) of such an organism." The regulations provided under the Fisheries Act enable the control of fishing effort through the use of commercial licenses, quotas, bag limits, minimum size limits and closed seasons. Significant or locally depleted fish species, such as the Blue Groper (*Achoerodus gouldii*), may receive additional year-round protection through closed areas, which effectively act as *de facto* sanctuaries. While the commercially-exploited Western King Prawn (*Penaeus latisulcatus*) is effectively protected from all recreational use. Fish species which are threatened with extinction, such as the Leafy Sea Dragon (*Phycodurus eques*) are completed protected in South Australian waters. Recently, there has been a proposal to prohibit the taking of White Shark (*Carcharodon carcharias*) for commercial purposes (Government of South Australia 1992).

While commercial marine species and marine mammal in South Australia have been afforded protection both, through specific fisheries/activities regulations and through the establishment of Marine Protected Areas, few non-commercial marine species are afforded similar specific legislative protection or management. Despite the very high level of endemism among the marine fauna and flora in South Australia, and the limited distribution of a number of marine species, only 1 non-commercial fish species is currently fully protected in South Australian waters under the *Fisheries Act*: the Leafy Sea Dragon (*Phycodurus eques*). No known rare, endangered or threatened species of invertebrates or marine plants (excluding mangroves) are currently afforded specific habitat or legislative protection in South Australia.

In addition, there is presently no formal legislative protection for ecologically significant marine habitats in South Australia, such as seagrasses or estuaries (as in New South Wales), nor formal habitat management plans or development guidelines to ensure protection and/or sustainable use.

4.3 Key MPA Agencies and Legislation in South Australia

Marine Protected Areas (MPAs) in South Australia may be established under three pieces of legislation: the *Fisheries Act 1982*, the *National Parks and Wildlife Act 1972* and the *Historic Shipwrecks Act 1981*. However, the prime legislative responsibility for the protection of the aquatic habitat lies with the Fisheries Act, with MPAs declared under *National Parks and Wildlife Act* generally comprising intertidal or marine extensions of terrestrial parks. As of June 1998, South Australia had established 22 recognised MPAs comprising at total area of 1,892 km^2 or 3.1% of the states jurisdictional waters (see Table 4.1).

DESIGNATION OF MPA		AREA (HA)	LEGISLATION
AQUATIC RESERVE			
Aldinga Reef		674	South Australian Fisheries Act 1982
American River		1,545	
Barker Inlet-St Kilda		2,087	
Blanche Harbour-Douglas Bank		3,037	
Goose Island		68	
Point Labatt		202	
Port Noarlunga Reef and Onkaparinga Estuary		408	
Seal Bay,		447	
Bales Beach		1,011	
St Kilda – Chapman Creek		1,270	
Troubridge Hill		328	
West Island		34	
Whyalla-Cowlads Landing		3,600	
Yatala Harbour		1,139	
	Subtotal (14)	15,850 (8.4%)	
SANCTUARY			
Great Australian Bight Whale		43,730	
Cape Jaffa		950	
Gleasons Landing		350	
Margaret Brock Reef		314	
Penguin Island-Rivoli Bay		40	
	Subtotal (5)	45,384 (23.9%)	
CONSERVATION PARK NATIONAL PARK			South Australian National Parks and Wildlife Act 1972
Coorong		3,178	
Great Australian Bight Marine		124,732	
	Subtotal	127,910 (67.6%)	
HISTORIC SHIPWRECK PROTECTED ZONE			Historic Shipwrecks Act 1981
'Zanoni'		95 (0.05%)	
	STATE WATERS:	6,094,800 ha	
	STATE TOTAL:	>189,239 ha (3.1%)	

Table 4.1 The present status of Marine Protected Areas (MPAs) in South Australia

Of the 22 recognised MPAs in South Australia, 19 or 612.4 km^2 (ie. 32.4%) have been declared under the *Fisheries Act 1982*; 2 or 1,279.1 km^2 (ie. 67.6%) have been declared under the *National Parks and Wildlife Act 1972*; while 1 MPA or 0.95 km^2 (ie. 0.05%) has been declared under the *Historic Shipwrecks Act 1981* (see Table 4.2). Of the total area of 1,892 km^2 reserved as MPAs in South Australia, 158.5 km^2 (or 8.46%) has been reserved as Aquatic Reserves, and 453.8 km^2 (ie. 23.9%) has been reserved as Sanctuaries, under the *Fisheries Act*. In comparison, 1,279.1 km^2 (ie. 67.6%) of the total area of MPAs has been declared as National Parks, under the *National Parks and Wildlife Act*. Of the total area of MPAs declared in South Australia, 1,683 km^2 (ie. 88%) is represented in the recently established Great Australian Bight Marine Park, which comprises the GAB Whale Sanctuary and the GAB Marine National Park declared under the *Fisheries Act* and *National Parks and Wildlife Act*, respectively (Edyvane & Andrews 1996).

4.3.1 Fisheries Act 1982

MPAs declared under the *Fisheries Act 1982* are managed by Primary Industries South Australia (Fisheries), which has taken prime responsibility for the establishment of MPAs in South Australia. As such, 19 of the 22 recognised MPAs in South Australia have been declared under the *Fisheries Act* as Aquatic Reserves (14) and Sanctuaries (5).

NAME	*YEAR ESTABLISHED*	*AREA (ha)*	*MANAGEMENT FEATURE*	*PERMITTED ACTIVITIES*	*PROHIBITED ACTIVITIES*
Aldinga Reef	1971	505	Education; Recreation.	Boating, diving and swimming; walking on the reef.	Fishing. Collecting / removing all marine organisms.
American River	1971	1,525	Conservation; Fisheries Management.	Boating, diving and swimming.	Fishing. Collecting / removing all marine organisms.
Barker Inlet-St. Kilda	1973	2,055	Recreation; Conservation; Fisheries Management.	Boating and line fishing.	Collecting / removing all marine organisms by any method other than be line fishing.
Blanche Harbour	1980	3,160	Conservation; Fisheries Management.	Boating and the use of handspears for the taking of finfish and shark.	Collecting / removing all marine or organisms by any method other than by handspear.
Goose Island	1971	54	Scientific Research; Education.	Boating, diving and swimming.	Fishing. Collecting / removing all marine organisms.
Point Labatt	1986	230	Protection.	Nil.	Total prohibition on public entry to the reserve.
Port Noarlunga Reef – Onkaparinga Estuary	1971	240 + 60 (300) all marine	Recreation; Education; Conservation (estuary).	Boating, diving; swimming, walking on the reef. Fishig by line is allowed. Throughout the reserve except for within 25m of the reef. Use of a hand net for taking shrimps for bait is allowed within the estuary only.	Bait digging. Line fishing within 25m of the reef. Collecting / removing. Organisms other than the gathering of shrimps for bait within the estuary.
Seal Beach-Bales Bay	1971	1,140	Protection.	Access to Bales Beach.	Public Entry to waters adjacent to Seal Bay. Fishing. Collecting / removing all marine organisms.
St Kilda – Chapman Creek	1980	870	Conservation; Fisheries Management.	Taking of blue swimmer crabs by hand, crab rake or hoop net only.	Fishing. Collecting / removing all marine organisms other than the blue swimmer crab, *Portunus pelagicus*.
Troubridge Hill	1983	460	Conservation; Protection.	Boating, diving, swimming and line fishing.	Collecting / removing allmarine organism by any method other than by line fishing.
West Island	1974	65	Scientific Research; Protection.	Diving and swimming within part of the reserve.	Public entry to part of the reserve is prohibited. Fishing. Collecting / removing all marine organisms.
Whyalla-Cowleds Landing	1980	3,230	Conservation; Fisheries Management.	Boating, diving and swimming. Taking of blue swimmer crabs by hand, crab rake or hoop net only within part of the reserve.	Fishing. Collecting / removing all marine organisms including the blue swimmer crab, *Portunus pelagicus,* througout the major part of the reserve.
Yatala Harbour	1980	1,426	Conservation, Fisheries Management.	Boating, diving and swimming.	Fishing. Collecting / removing all marine organisms.

Table 4.2 South Australia's Aquatic Reserves managed under the Fisheries Act 1982.

The first six Aquatic Reserves, proclaimed in 1971, were established on the basis of recommended national CONCOM endorsed ACIUCN (1986) management objectives, and included sites to: preserve examples of different marine and estuarine habitats, protect endangered species, and to serve as research sites to learn more about marine and estuarine ecosystems (Johnson 1988). These reserves were: Port Noarlunga Reef and the Onkaparinga Estuary Aquatic Reserve; Aldinga Reef Aquatic Reserve; American River Inlet Aquatic Reserve; Goose Island Aquatic Reserve; Seal Beach-Bales Bay Aquatic Reserve; and West Island Aquatic Reserve. Additional reserves were established in 1973, 1980, 1983 and 1986. Since 1971, a total of 14 Aquatic Reserves have been established throughout the State (Figure 4.1), covering a range of habitats, and ranging from totally closed areas to areas allowing some recreational fishing (Table 4.2). Most Aquatic Reserves are unzoned in South Australia. Despite the acknowledged role of estuaries and mangrove areas as nursery and feeding habitats, line fishing and the taking of the Blue Swimming Crab is still permitted in a number of Aquatic Reserves (Table 4.2). Only two reserves have been declared in the last ten years, with the last reserve declared in 1986 (ie. Point Labatt Aquatic Reserve).

While the primary goal of the system of Aquatic Reserves in South Australia remains the protection of representative marine and estuarine ecosystems, habitats and communities along the South Australian coast, while permitting appropriate uses and promoting public education - many types of habitats and management objectives (particularly non-fisheries habitats and objectives) are either presently not reserved as Aquatic Reserves or poorly represented. No management plans are provided for Aquatic Reserves declared under the *Fisheries Act*.

In December 1991 the *Fisheries Act* was amended to include provision for the constitution of Marine Parks and to align declaration and revocation of MPAs with terrestrial parks declared under the *National Parks and Wildlife Act 1972*. Under the amendments the Government may constitute as a Marine Park any waters, or land and waters, considered to be of National significance by reason of the aquatic flora or fauna or the aquatic habitat. The control and administration of all Marine Parks constituted under the *Fisheries Act* (as with Aquatic Reserves) rests with the Minister of Primary Industries.

Four of the five Sanctuaries established under the *Fisheries Act* are for the protection of only one species, the Southern Rock Lobster (*Jasus edwardsii*), and all were declared in the 1970s.

South Australia is the only State in Australia which restricts activities on piers, jetties and wharves. While some authors (eg. Ivanovici 1984, McNeill 1991) have formally recognised netting closures (commercial and recreational) as MPAs (ie. Restricted Use Areas), they are currently not formally recognised as MPAs at the national level (see Cresswell & Thomas 1997). Further, while these areas are widely acknowledged as fish attracting devices and netting is prohibited, these areas are generally not subject to legal bag limits and minimum size limits (except for Abalone and Southern Rock Lobster) when taken by a recreational fisher (Rohan *et al*. 1991).

4.3.2 National Parks and Wildlife Act 1972

MPAs declared in South Australia under the *National Parks and Wildlife Act* are managed by the National Parks and Wildlife Service (Department of Environment, Heritage and Aboriginal Affairs) and consist of 2 National Parks (Coorong National Park, Great Australian Bight Marine National Park). Additional parks were recognised by Ivanovici (1984) and include, 5 Conservation Parks (ie. Clinton, Port Gawler, Troubridge Island, Hallett Cove and Seal Bay). These parks represent marine extension of terrestrial protected areas (down to the low tide mark) and are not formally recognised as MPAs (Cresswell & Thomas 1997).

The Great Australian Bight Marine National Park is the largest single MPA declared in SA and extends 3nm miles seaward from the Nullarbor National Park and the Wahgunyah Conservation Reserve. Parks may be abolished or their boundaries altered by proclamation of the Governor, subject to a resolution passed by both Houses of Parliaments. Management plans are prepared by the Minister for Environment and Natural Resources after comments and suggestions from the National Parks and Wildlife Advisory Committee and the public. Management plans may also include zoning to allow multiple-use of these areas.

4.3.3 Historic Shipwrecks Act 1981

MPAs declared in South Australia under the *South Australian Historic Shipwrecks Act 1981* are managed by the State Heritage Branch (Department of Environment and Natural Resources). While 19 historic shipwrecks have been protected under this act, only 1 shipwreck, the *`Zanoni',* is a recognised MPA. This wreck has a declared protection zone of 0.9 km^2 which protects the habitat and restricts any activities. While the remains of a vessel and any artefacts associated with it, are protected under the *Historic Shipwreck Act*, the fish and marine life on a wreck remain unprotected, unless a protection zone is declared.

Shipwrecks are often significant sites for marine life and are well-known fish attracting devices. As such, abundant marine life is commonly associated with shipwrecks and is often an important element in attracting recreational divers to these sites.

The *South Australian Historic Shipwreck Act*, in line with the *Commonwealth Historic Shipwrecks Act 1976*, affords total protection to vessels and their artefacts in an area of 1.0 km^2. A further 10 historic shipwrecks have been protected in the Commonwealth waters of South Australia under the *Commonwealth Historic Shipwrecks Act 1976*.

4.4 The Status of MPAs in South Australia

While South Australia was the first State in Australia to introduce comprehensive legislation to protect aquatic habitats in 1971 (under the *Fisheries Act*), the last two decades has seen South Australia fail to significantly increase its MPA estate. Between 1986-1998, South Australia increased the percentage of area of its waters protected as MPAs from 1.4% in 1991 (McNeill 1991) to approximately 3.1%. This is in stark contrast to Queensland and Western Australia which, in 1991, had 24.5% and 20.3% of their waters protected as MPAs, respectively (McNeill 1991).

At the national level, most MPAs have been declared in Commonwealth waters (ie. 367,560.2 km^2 or 84.3% of the total national MPA estate) (see Figure 4.3). In contrast, most States/Territories, excluding Western Australia, have generally contributed little to the national coverage, except Queensland and Western Australia, which contributed 53,028.8 km^2 and 11,466.4 km^2 (or 12.2% and 2.6% of the national total). Together, MPAs in these States comprised 93.9% of the total MPAs declared in State/Territory waters (Table 4.3).

In 1997, South Australia contributed 595 km^2 or 0.9% of the total area of MPAs declared in State/Territory waters (or 0.137% of the national total) (see Table 4.3). However, the recent establishment of the Great Australian Bight Marine Park has increased this coverage to 1,892 km^2 (or 0.4% of the national total). Similarly, progress in the establishment of MPAs has also been slow in Victoria and Tasmania, which contributed 0.7% and 0.003% to the State/Territory total. As such, the temperate States of Australia, ie. South Australia along with Tasmania and Victoria, continue to contribute among the least to State/Territory and national coverage of MPAs (see Section 1.2).

State/Territory	No. MPAs	Area MPAs (ha)	IUCN Category	% State/Territory Total	% National Total
Queensland	82	5,302,876	IV, V	77.2	12.155
Western Australia	7	1,146,643	IA,11,VI	16.7	2.628
Northern Territory	3	223,946	IV,VI	3.3	0.513
New South Wales	8	85,803	VI	1.3	0.197
South Australia	15	59,580	II	0.9	0.137
Victoria	12	50,312	VI, none	0.7	0.115
Tasmania	3	172	IV	0.003	0.000
Commonwealth	18	36,756,019	IA,VI	NA	84.254
TOTAL (AUST)	148	43,625,351			

Table 4.3 **Number and area of MPAs found in each State, Territory and Commonwealth jurisdiction, as up until 31/5/97 (from Cresswell & Thomas 1997).**

This low contribution by South Australia to MPAs at a national level is due primarily to significant increases in areas protected as MPAs, by some states, particularly in the last decade (McNeill 1991). These states, particularly Western Australia, Queensland, Victoria and New South Wales, have significantly increased the area of MPAs reserved in their state through the establishment of large, multiple use MPAs - principally as a strategic tool for the integrated management of marine ecosystems. For instance, in 1991, Western Australia declared 5 large, multiple use MPAs. While, between 1986 and 1991, Queensland added more than 400 000 hectares to its MPA estate, from the Gulf of Carpentaria in the north, to Hervey Bay, in the south (Bridgewater & Ivanovici 1993).

In contrast, MPAs in South Australia have largely been declared to protect biodiversity and specific ecologically or economically significant habitats, rather than as areas in which to manage a number of activities and uses, such as fishing, tourism, recreation, education, on a large, regional basis. Consequently, areas reserved as MPAs in South Australia have traditionally been small Aquatic Reserves and intertidal extensions of land-based National Parks (Edyvane 1996). For instance, the newly established Great Australian Bight Marine Park is the only MPA in South Australia greater than 100 km^2 (ie. 1,683 km^2) and comprises 85% of the total MPAs in South Australia. The remaining MPAs range in size from 0.02 - 32.3 km^2 (see Figure 4.2).

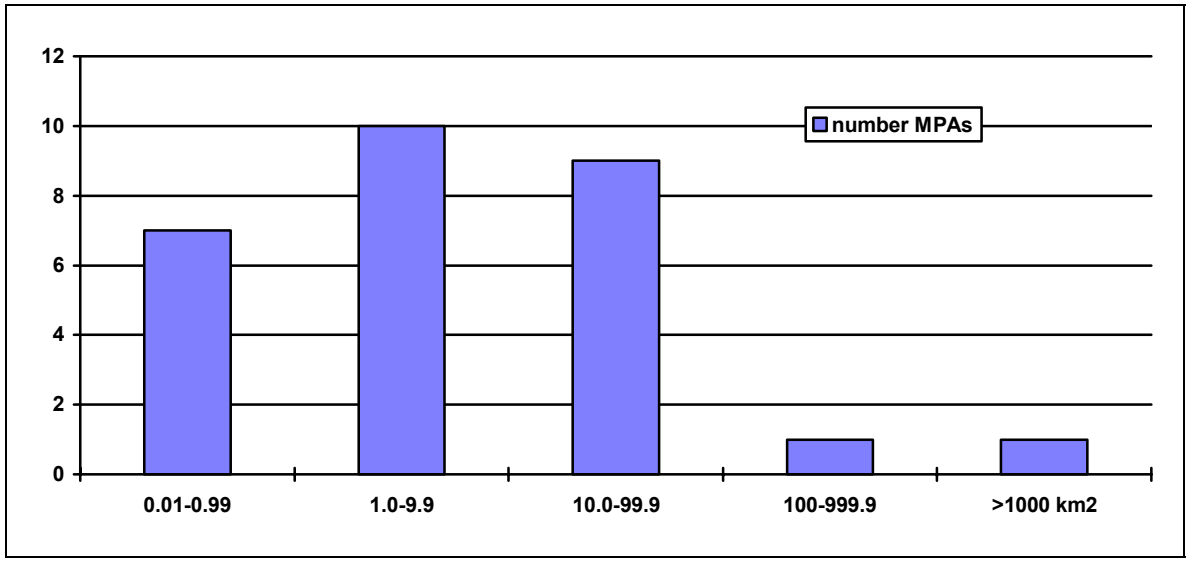

Figure 4.2 **The size distribution of Marine Protected Areas in South Australia (from Edyvane 1998).**

Although most of the areas reserved as MPAs in South Australia have traditionally been small in area, the marine life in these habitats have been afforded a very high level of protection (prohibiting most exploitative activities). This is in contrast with other states, particularly Victoria, New South Wales and Tasmania, where MPAs have been declared, but little protection has been afforded the marine life in these reserves. This has largely been due to the lack of integrated legislation, and also, overlapping jurisdiction and the lack of agency cooperation. In South Australia, the Aquatic Reserves legislation under the *Fisheries Act*, provides for both, the declaration of protected areas and also, the regulations to restrict activities. This has enabled a high level of protection for the marine fauna and flora in Aquatic Reserves.

While a total of 14 Aquatic Reserves have been declared in South Australia since 1971, only two reserves have been declared in the last ten years (see Figure 4.3). The last reserve declared was the Point Labatt Aquatic Reserve in 1986.

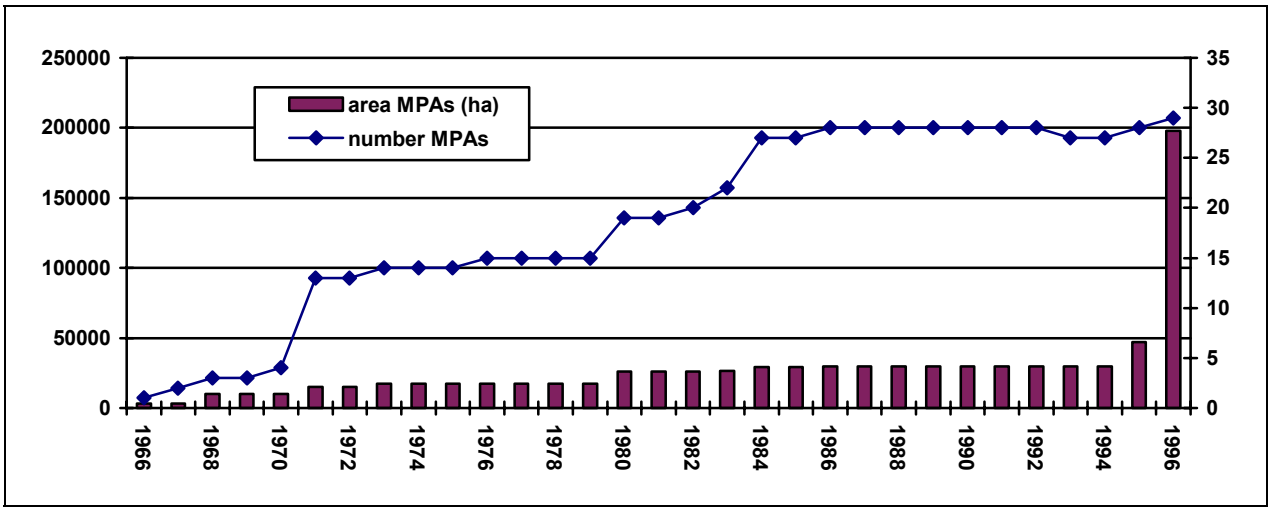

Figure 4.3 **The history of establishment of Marine Protected Areas in South Australia (from Edyvane 1998).**

Many of the MPAs which have been established in South Australia under the *Fisheries Act* however, have been declared for fisheries resource management purposes. As a consequence, a number of management objectives for MPAs are under-represented (Edyvane 1996). For instance, only two MPAs have been declared to protect rare or endangered species or habitats, both these are for the rare Australian Sea Lion; only one historic shipwreck is a recognised MPA, protecting the flora and fauna of the site in addition to the wreck; and only one MPA has been established in South Australia specifically for scientific research purposes (ie. West Island Aquatic Reserve). No MPAs have been established in South Australia (or elsewhere in Australia) specifically to monitor the effects of environmental impacts or global change.

Ecologically and biogeographically, many habitats and bioregions are under-represented as MPAs in South Australia (Edyvane 1996). In particular, kelp communities, soft-bottom benthos, estuaries, beach habitats and wave-exposed cliffs habitats, are significantly under-represented in South Australia.

Biogeographically, major provinces and bioregions are either not represented or poorly represented as MPAs. This includes the habitats, communities or ecosystems of the cold temperate Maugean Subprovince of the south-east (east of Robe), and also, the marine habitats, communities and ecosystems associated with the spectacular limestone cliff formations and dune transgressions on the west coast of South Australia. Of the major biogeographical regions identified for South Australia, the Eucla and gulfs region (ie. northern Spencer Gulf and Gulf St Vincent) are the most well represented in terms of MPAs.

While there is generally considerable cooperation between the two agencies responsible for MPAs in South Australia, there are still a number of areas where management arrangements can be improved. For instance, intertidal ecosystems in South Australia are not subject to uniform management or protection. At present, there is jurisdictional overlap and a lack of agency coordination regarding the management of intertidal habitats in areas adjacent to terrestrial protected areas.

As such, the area between MHWM and MLWM can be reserved under both the *Fisheries Act* and the *National Parks and Wildlife Act*. As a result, Aquatic Reserves declared under fisheries legislation in some cases extend up to the MHWM and in other reserves, extend only to the MLWM. This has led to intertidal ecosystems, such as mangroves, being protected by both, national parks legislation (for eg. Clinton and Port Gawler Conservation Parks), and fisheries legislation (for eg. Barker Inlet - St Kilda, St Kilda - Chapman Creek, Blanche Harbour - Douglas Bank, Whyalla - Cowled's Landing, Yatala Harbour Aquatic Reserves).

In 1996, benthic marine life on all intertidal rocky shores in South Australia were protected from harvesting (down to a depth of 2 metres) under regulations under the *Fisheries Act*. The legislation, which represents the largest and most comprehensive habitat protection of intertidal rocky shores in Australia, was specifically enacted to protect the fauna and flora of intertidal reefs from large-scale harvesting for bait and food. Intertidal fossicking is not prohibited under the legislation.

While an inter-ministerial agreement was signed between the Minister of Fisheries and the Minister for Environment in 1984 to rest responsibility of intertidal ecosystems with the former Department of Fisheries, no formal cooperative management arrangements currently exist between Primary Industries South Australia (Fisheries) and the Department of Environment and Natural Resources) for the cooperative management of intertidal ecosystems. As such, there is a particular need for a uniform approach to regulations, surveillance, education, research and monitoring requirements of intertidal ecosystems.

4.5 Status of MPA Management Objectives

To-date, Primary Industries and Resources South Australia (Fisheries) has established 14 Aquatic Reserves on the basis of the recommended CONCOM endorsed ACIUCN (1986) management objectives (Table 4.2). While the present system of reserves cover a range of habitats, and range from totally closed areas to areas allowing some recreational fishing, a review of MPAs in South Australia should also examine the representation of management objectives recommended for MPAs.

4.5.1 Ecologically Representative Areas

One of the major objectives in the identification and selection of MPAs is the protection of ecologically representative areas within coastal and marine environments (ACIUCN 1986, Kelleher & Kenchington 1993). The coastal waters of South Australia essentially consist of two major biogeographic regions, namely, the cold temperate waters of the south-east, east of Robe (ie. the Maugean Subprovince) and transitional warm to cool temperate waters in the western part of the state, west of Robe (Womersley 1981). Both these regions fall within the larger Flindersian Province, which extends along the southern temperate coast of Australia. Along the South Australian coast, habitats range from high wave energy, rocky shores of the south-east and Great Australian Bight, which face the Southern Ocean, to the very sheltered, estuarine and embayment habitats of the two gulf ecosystems (Spencer Gulf and Gulf St Vincent). To-date, Aquatic Reserves established to protect representative habitats, communities and ecosystems, fall into three major habitat-types: estuaries, mangrove-seagrass communities, and reefs and rocky shores. In some reserves, particularly the larger reserves, several major habitat-types are represented.

On inspection many habitats and bioregions are under-represented as MPAs in South Australia. In particular, kelp communities, soft-bottom benthos, estuaries, beach habitats and wave-exposed cliffs habitats are under-represented. Biogeographically, no habitats, communities or ecosystems have been reserved as MPAs in one of the two major biogeographical regions in South Australia, ie. the cold temperate Maugean Subprovince (east of Robe) in the south-east of South Australia. As such, no MPAs have been established to protect and manage the dominant habitats which characterise this major bioregion, ie. the large kelp forests (ie. *Macrocystis pyrifera*) and the Bull Kelp (*Durvillea potatorum*) communities. Further, the marine habitats associated with the limestone cliff formations and dune transgressions characteristic of the west coast of South Australia (ie. from southern Eyre Peninsula, west to the Western Australian border), are also poorly represented as MPAs. Outside the recently declared Great Australian Bight Marine Park, the Point Labatt Aquatic Reserve (230 hectares) represents the only Aquatic Reserve on the entire west coast of South Australia (Figure 4.1).

Within the warm waters of northern Spencer Gulf, another distinct bioregion has been observed. In contrast to northern Gulf St Vincent, a region with similar temperature and salinity extremes, a distinctly tropical, possibly relict, biogeographic element has been observed in the algal flora of northern Spencer Gulf, while a notable endemic element has been recorded in the epifauna (Shepherd 1983). To-date, 2 small MPAs have been reserved to protect representative habitats in this region (ie. Blanche Harbour-Douglas Bank and Yatala Harbour Aquatic Reserves).

4.5.1.1 Estuaries

Estuaries are significant ecosystems not only because they are the principal buffer zone between freshwater and marine systems, exemplifying the ecological interdependence of the land and the sea, but also because they provide important habitat to many fish and crustaceans at critical stages in their life histories (Bell & Pollard 1989). However, as in many parts of Australia, the estuaries that have been conserved as MPAs in South Australia, have primarily been conserved because of their importance as habitats for fish and macroinvertebrates associated with seagrass beds, rather than as habitats that are representative, unique or contain endangered or rare species (McNeill 1991).

Estuaries are of special importance in South Australia because of the State's generally arid nature. As such, South Australia has the least number of estuaries of any State in Australia. Of the 15 recognised estuaries in the State recognised by Bucher & Saenger (1989), one-third are considered `under threat' or `considerably modified'. Only three of the recognised estuaries have been given habitat protection as Aquatic Reserves. These include the Port Adelaide River (Barker Inlet-St Kilda Aquatic Reserve), the Onkaparinga River (Port Noarlunga Reef and Onkaparinga Estuary Aquatic Reserve) and Blanche Harbour (Blanche Harbour-Douglas Bank Aquatic Reserve). In addition, Bucher & Saenger (1989) recognised 3 estuaries of outstanding conservation value in South Australia: the Coorong (south-east South Australia), northern Spencer Gulf and Tourville Bay (western Eyre Peninsula). Only the Coorong is presently reserved as a MPA. To-date, no estuarine habitats are reserved as MPAs on the entire west coast, or in the south-east of the State.

In addition to the estuaries formally recognised by Bucher & Saenger (1989), several other estuaries of outstanding conservation significance have been identified (Lloyd & Balla 1986). These include, the Little Para River (metropolitan Adelaide), the Tod River (Eyre Peninsula), and three rivers on Kangaroo Island: Harriet, Stunsail Boom and Cygnet rivers. Of particular importance is Eight Mile Creek which represents the only significant river in the whole south-east region.

Of the estuaries reserved as MPAs, the Onkaparinga estuary is particularly significant. Located in the Port Noarlunga Reef and the Onkaparinga Estuary Aquatic Reserve the estuary represents the largest estuary between the Glenelg River in southwestern Victoria and Blackwood River in southwestern Western Australia.

The halophytic samphire community within the reserve is the only example of this community type south of Adelaide along the eastern shores of Gulf St Vincent (Johnson 1988). The estuary type is uncommon elsewhere in Australia and is also a known spawning area for Black Bream (*Acanthopagrus butcheri*) and a nursery area for Yellow Eye Mullet (*Aldrichetta forsteri*).

4.5.1.2 Mangrove-Seagrass Communities

A number of Aquatic Reserves in South Australia have been established in order to protect mangrove and seagrass communities, (and in particular, their role as fish nursery and feeding areas). These reserves include Whyalla-Cowleds Landing (Spencer Gulf), South Australia's largest Aquatic Reserve; Blanche Harbour-Douglas Bank (upper Spencer Gulf); Yatala Harbor); American River Inlet (Kangaroo Island); Barker Inlet-St.Kilda and St.Kilda-Chapman Creek (Adelaide).

Within these reserves, a number of specific habitat-types are generally represented: supra-tidal samphire flats, intertidal mangrove areas (dominated by the Grey Mangrove, *Avicennia marina* var. *resinifera*), intertidal sand and mudflats (often colonised by the intertidal and shallow-water seagrasses, *Heterozostera tasmanica* and *Zosteria muelleri*) and subtidal seagrass meadows (generally dominated by *Posidonia* spp.). In American River Inlet, *Halophila ovalis* also occurs, whilst in Blanche Harbor-Douglas Bank six seagrass assemblages have been described (Shepherd 1983).

In some reserves (such as American River Inlet and the Barker Inlet - St.Kilda aquatic reserves) extensive, intertidal and shallow subtidal seagrass-dominated areas, also represent significant feeding areas for many resident and migratory aquatic birds (Johnson 1988).

4.5.1.3 Reefs

Several reserves have been established in South Australia in order to protect the diverse fauna and flora of reefs. These include: Port Noarlunga Reef-Onkaparinga Estuary, Aldinga Reef, Troubridge Hill, Goose Island and West Island. The rocky habitats and reefs of these reserves support a range of algal and faunal communities typical of a range of low to moderate wave energy conditions, generally characteristic of transitional warm to cool-temperate coasts. All these reefs, apart from the reef at West Island, are located in the sheltered gulf ecosystems of Gulf St Vincent and Spencer Gulf. As such, no reefs have been reserved in the south-east or on the west coast of South Australia, where higher-energy wave conditions and habitats occur.

Port Noarlunga Reef (in the Port Noarlunga Reef-Onkaparinga Estuary Aquatic Reserve) and Aldinga Reef represent two popular reef habitats. In close proximity to Adelaide, both of these areas are frequented often by SCUBA divers. Port Noarlunga Reef is a narrow 1.6km reef formed from a consolidated Pleistocene sand dune, whilst Aldinga Reef is a limestone reef with a spectacular cliff or "drop-off".

The fauna and flora of these reefs is generally typical of many reefs in South Australia (see Duyverman 1976, Shepherd & Sprigg 1976, Shepherd & Womersley 1970, 1971, 1976, 1981), however both reserves, because of their proximity to metropolitan Adelaide, are susceptible to a considerable amount of human impact, both from recreation users and from land-based pollution (Ottaway *et al*. 1980).

A range of brown algal communities are represented on these reefs with kelp (*Ecklonia radiata*) preferring the higher-energy habitats, whilst less exposed areas are dominated by other brown algae, such as *Cystophora moniliformis, C.subfarcinata, C.monilifera* and *Sargassum* spp. These reefs typically contain a range of invertebrate fauna, with bryozoans, sponges, hydroids, ascidians commonly occurring in crevices and under overhangs, and gorgonian corals in areas of strong tidal movement. Molluscs are well-represented and include species such as the Blacklip Abalone (*Haliotis rubra*) and Pheasant Shells (*Phasianella* spp.).

Both Port Noarlunga Reef (in the Port Noarlunga Reef-Onkaparinga Estuary Aquatic Reserve) and Aldinga Reef were established to protect reef fish from spearfishing activities. Since their declaration in 1971, many of the common reef fish such as Magpie Perch, Scalyfin, Leatherjackets, Wrasses, Herring Cale, Coral fish, Tommy Rough, and Salmon Trout, have returned to these areas.

Troubridge Hill (Yorke Peninsula), in contrast to Port Noarlunga Reef and Aldinga Reef, represents a relatively unspoilt rocky marine habitat. This is reflected in the high diversity of reef fauna in this reserve, particularly with regards to the reef fish. This reserve is also the site of the historic shipwreck of *`Clan Ranald'*. Seal Bay-Bales Beach on the exposed southern coast of Kangaroo Island is subject to high wave energy and the subtidal reef area supports marine flora and fauna typical of high wave energy, cool-temperate water.

4.5.2 Endangered Species and Habitats

Only 2 endangered or rare marine species have been afforded specific habitat protection in South Australia through Marine Protected Areas: the rare Australian Sea Lion (*Neophoca cinerea*), and the endangered Southern Right Whale (*Eubalaena australis*). Two of South Australia's marine reserves have been established in order to protect the habitat and main breeding areas of the Australian Sea Lion, one of the rarest species of pinnipeds in the world. These reserves include Seal Bay Aquatic Reserve (Kangaroo Island) and Point Labatt Aquatic Reserve (West Coast).

Seal Bay provides sanctuary for several hundred seals, and is one of the main breeding sites for the species in South Australia (Robinson & Dennis 1988). The aquatic reserve runs adjacent to the terrestrial Seal Bay Conservation Park and extends the protected habitat of the sea lions to one kilometre offshore. Point Labatt represents the only breeding sea lion colony on the Australian mainland.

In 1995, the Great Australian Bight Marine Park Whale Sanctuary was declared under the *Fisheries Act*, specifically to protect the breeding and calving habitat of the endangered Southern Right Whale at the head of the Great Australian Bight. In 1996, additional habitat protection was provided through the establishment of the Great Australian Bight Marine National Park under the *National Parks and Wildlife Act*, and also, to provide habitat protection for breeding colonies of Australian Sea Lions at the base of the Nullarbor Cliffs. The waters at the head of the Great Australian Bight represent one of the most significant calving sites in the world for this endangered species. Estimates currently put the world population of Southern Right Whales at around 1 500 to 3 000. Many other coastal bay and inlets around South Australia are also popular sites for visits by the Southern Right Whale.

No other rare or endangered species or habitats has been afforded specific protection as a MPA in South Australia.

4.5.3 Areas for Economically Important Species

Many of the mangrove and seagrass areas in South Australia have been established as Aquatic Reserves in order to protect important nursery and feeding areas of economically important species. These reserves include Whyalla-Cowleds Landing (Spencer Gulf), South Australia's largest Aquatic Reserve; Blanche Harbour-Douglas Bank (upper Spencer Gulf); Yatala Harbor; American River Inlet (Kangaroo Island); Barker Inlet-St.Kilda and St.Kilda-Chapman Creek (Adelaide).

Many of these reserves have been shown, through surveys conducted by the former Department of Fisheries, to be extremely important nursery and feeding areas for a wide range of commercially important fish species (Jones 1981). These include, King George Whiting (*Sillaginodes punctatus*), Yellow Fin Whiting (*Sillago schomburgkii*), Jumping Mullet (*Liza argentea*), Yellow Eye Mullet (*Aldrichetta fosteri*), Salmon Trout (*Arripis truttaceaus*), Garfish (*Hyporhamphus melanochir*), and Tommy Rough (*Arripis georgianus*). These areas also represent important nursery and feeding areas for the Western King Prawn (*Penaeus latisulcatus*), and the Blue Swimming Crab (*Portunus pelagicus*). In the Barker Inlet-St.Kilda Aquatic Reserve for instance, it has been shown that the mangrove and seagrass communities provide a nursery area for several species, including *Penaeus latisulcatus*, *Sillaginodes punctatus* and *Sillago schomburgkii*, *Hyporhamphus melanochir, Aldrichetta fosteri*, bream (*Acanthopagrus butcheri*) and *Portunus pelagicus* (Jones 1981, 1984). In particular, this reserve represents the most significant nursery area for *Sillaginodes punctatus* in Gulf St Vincent (Jones 1984).

More recently it has been demonstrated that reserves can also play an important role in maintaining stocks in commercially harvested species by acting as harvest refugia (Davis 1989). In the Greenlip Abalone (*Haliotis laevigata*), recent research studies indicate that local unfished populations in Aquatic Reserves (such as West Island) provide an important larval source in times of poor recruitment and also act to maintain genetic diversity by preserving local gene pools (Shepherd & Brown 1993).

4.5.4 Tourism, Recreation and Education

Many of the reserves which have been established for their remarkable reef fauna and flora, also represent popular areas for recreational activities particularly SCUBA diving and fishing (Johnson 1983, 1988). These reserves include Port Noarlunga Reef and the Onkaparinga Estuary, Aldinga Reef, Barker Inlet-St.Kilda, St.Kilda-Chapman Creek, Goose Island.

Port Noarlunga Reef in particular, as South Australia's most intensively-used aquatic habitat, is its best-known Aquatic Reserve. Notwithstanding, a visitor survey conducted by Sutherland (1987) however, revealed that fewer than 50% of users knew that it was an aquatic reserve, with less than 33% unaware that the area is managed by Primary Industries South Australia (Fisheries). Sutherland (1987) also found that, over half the visitors returned to the reserve more than ten times within a year; SCUBA divers and jetty fishers revisited the area most;nearly half of the respondents lived within a 5km radius of the reserve; and that the area was generally regarded as a local beach with a jetty and had little conservation significance.

In light of the poor results of the visitor survey by Sutherland (1987), Primary Industries South Australia (Fisheries) has recently instigated new signs for its Aquatic Reserves, with visual information provided on boundaries and also, permitted and non-permitted activities.

In 1995, an underwater interpretation trail was established at Port Noarlunga Reef Aquatic Reserve (Dalgetty & Edyvane 1996), following the commissioning of a feasibility study (Papple 1990). The 800 metre snorkel and SCUBA trail (with 12 interpretative trail markers) represents the first and only underwater marine interpretation trail in South Australia, and was specifically established to raise community awareness of the marine fauna and flora of Port Noarlunga Reef and the role of Aquatic Reserves in protecting marine life. The trail represents a focal point for marine and aquatic recreational and educational activities in the region and also, will be vital in controlling and managing the impacts of the rapidly increasing number of snorkellers and SCUBA divers who frequent the reef (Dalgetty & Edyvane 1996).

4.5.5 Cultural and Historical Purposes

Historic shipwrecks are generally well protected in South Australia, particularly in the sheltered gulf ecosystems. A total of 19 historic shipwrecks have been protected under the *South Australian Historic Shipwrecks Act 1981*. Of these, 11 shipwrecks have been reserved in the Gulfs regions: Tigress (1840-1848), Grecian (1841-1850), Marion (1850-1851), Nashwauk (1853-1855), San Miguel (1865-1867), Zanoni (1865-1867), Iron King (1867-1873), Star of Greece (1868-1888), Glenpark (1897-1901), Norma (1889-1907) and the Santiago (1856-1945); with the remaining 8 reserved around Wardang Island: Songvaar (1884-1912), Moorara (1909-1975), Australian (1879-1912), MacIntyre (1877-1927), Monarch (1871-1909), Notre Dame D'Arvor (1902-1920), Investigator (1882-1918) and Aagot (1882-1907).

A further 10 historic shipwrecks have been protected in the Commonwealth waters of South Australia under the Commonwealth Historic Shipwrecks Act 1976. Of these, 5 occur in the south-east/Coorong region: Margaret Brock (1848-1852), Nene Valley (1852-1854), SS Admella (1857-1859), Geltwood (1876) and the Glenrosa (1857-1908); and 5 occur around Kangaroo Island: Fides (1857-1860), Loch Vennachar (1875-1905), Montebello (1900-1906), Robert Burns (1857-1908) and the SS Clan Ranald (1900-1909).

Presently, there are no historic sites protected in the Great Australian Bight or Eyre Peninsula region. However, this is probably due to lack of research rather than an absence of sites (B. Jefferies, State Heritage Branch, *pers.comm*.).

As mentioned previously, only the remains of a vessel and any artefacts associated with it, are protected under the *Historic Shipwreck Act*. The fish and marine life on a wreck remain unprotected unless a protection zone is declared. Only one wreck, the `Zanoni', has a declared protection zone, and hence is South Australia's only shipwreck which is a recognised MPA.

In some areas of South Australia the density of archaeological remains, or the existence of a link between several sites suggests that a substantial area should be managed as a single unit. This approach would suit Wardang Island (where 8 historic shipwrecks are presently reserved) and also the west coast of Kangaroo Island. As such, the established Maritime Heritage Trail around Wardang Island could form an integral part of a multiple-use, zoned, Marine Park.

On the west coast of Kangaroo Island, the number of shipwrecks and the associated large loss of life, also results in a region of significant historical and cultural value. The wrecks in this area include the Loch Sloy, Loch Vennachar, Montebello, Mars, Emily Smith and Portland Maru. This region is also an area of outstanding natural values.

4.5.6 Research Purposes

Only one MPA has been established in South Australia specifically for scientific research purposes. The small granite island of West Island, was established as an Aquatic Reserve in 1971, in order to protect the local abalone population from exploitation and to provide for a research station in which to undertake long-term marine ecological studies. Following initial subtidal ecological studies (Shepherd & Womersley 1970), most studies have since focussed on long-term trends in the population dynamics of the resident Greenlip Abalone population (Shepherd & Brown 1993).

There is a need to formally protect areas as MPAs in order that research can be conducted to understand marine and coastal ecological processes. As such, there are a number of sites in South Australia which have traditionally been used by scientific researchers and educators in South Australia as marine and coastal research sites. For instance, Coobowie (Yorke Peninsula) is the site of the University of Adelaide's marine research station, while Cape Jervis, Wright Island and the Bluff (Victor Harbour), have been the focus of marine biological research studies for almost four decades.

In addition, other areas have been the focus of regular scientific expeditions by Royal Society of South Australia. These include some of the State's offshore islands, such as Pearson Island (Investigator Group) and St Francis Island (Nuyts Archipelago).

4.5.7 Environmental Monitoring

Three Aquatic Reserves in South Australia are located close to urban centres and are susceptible to a number of human impacts (Aldinga Reef, Barker Inlet-St Kilda, and Port Noarlunga Reef and Onkaparinga Estuary). However, none of these were established specifically to monitor the effects of environmental impacts or global change.

The Barker Inlet-St.Kilda Aquatic Reserve, located adjacent to metropolitan Adelaide, is presently influenced by a number of land-based pollutant discharges. These include sewage effluent, stormwater discharge, and the cooling water from a power station (Steffensen 1985, Thomas *et al*. 1986). These pollutant loads have significantly increased the level of heavy metal contaminants in the mangrove-seagrass ecosystem (Harbison 1986a,b). Studies are currently being undertaken by the South Australian Research and Development Institute (Aquatic Sciences) to investigate the effect of these urban discharges on the estuary, and in particular, the mangrove ecosystem (Edyvane 1991a,b).

There are a number of potential sites in South Australia which could function as long-term environmental or global monitoring sites. These should include relatively pristine coastal sites where scientific research is currently being conducted and designated offshore areas, preferably where environmental monitoring has previously been conducted, such as Neptune Island in lower Spencer Gulf.

5 ESTABLISHING A NETWORK OF MARINE PROTECTED AREAS IN SOUTH AUSTRALIA

5.1 Why Marine Protected Areas ?

The establishment of Marine Protected Areas is widely regarded, both nationally and internationally, as one of the most effective mechanisms for protecting biodiversity while permitting the sustainable use of natural resources. As an island continent, Australia has a diverse range of coastal, marine and estuarine environments. These range from the tropical ecosystems of northern Australia (such as coral reefs and tropical mangrove forests), to the cool temperate ecosystems in the south (such as kelp forests and deep-water sponge beds). As a developed nation with a maritime area larger than the continent itself (ie. 894 million hectares), and as a signatory to international conventions like the *Convention on Biological Diversity* (UNEP 1994), Australia has a special responsibility for the conservation and management of its marine and coastal environments and their resources. To this extent, Australia is presently regarded as a world leader in marine conservation and management.

`Marine Protected Areas' in Australia range from small, high protection Marine Reserves, to large, multiple-use Marine Parks (like the Great Barrier Reef Marine Park) which permit a wide range of exploitative uses, such as fishing (commercial and recreational), tourism and recreation. Marine Protected Areas can be established for a variety of purposes and it is possible to provide for a range of activities while still protecting the environment. For example, Marine Protected Areas can be reserved for conservation, fisheries management, research, education, social and historical importance, tourism or recreational use - or a combination of any of these - and may also include neighbouring coastal lands and islands. As such, Marine Protected Areas are defined as:

> *"An area of land/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means." (IUCN 1994)*

To-date, over 43 million hectares (or 5%) of Australia's waters (comprising States, Territories, External Territories and Commonwealth waters) has been reserved in approximately 148 Marine Protected Areas (Cresswell & Thomas 1997). Of this total area reserved as Marine Protected Areas in Australia, approximately 88% is in the region of the Great Barrier Reef region - leaving many regions, particularly temperate ecosystems, poorly or under represented, if at all. Recently it has been estimated that 21 out of the 32 biogeographic regions around Australia lack any significant protection as protected areas (Ivanovici 1993). Notable regions included the Gulf of Carpentaria, the Great Australian Bight, and deep offshore regions.

5.2 A National, Representative System of Marine Protected Areas (NRSMPA)

While reserve systems in Australia have been in place for terrestrial ecosystems for many decades, the formal conservation of Australia's marine environments and their resources is a relatively recent phenomenon - with only 5% of Australia's coastal, estuarine and marine habitats formally reserved as Marine Protected Areas (or MPAs). However, in 1991, the Commonwealth announced the initiation of a 10 year marine conservation program, called `Ocean Rescue 2000' to ensure the conservation and sustainable use of Australia's marine and estuarine environments. A key component of this initiative was a commitment to expand Australia's existing marine reserve system, through the establishment of a national, representative system of Marine Protected Areas (or NRSMPA), which would protect areas, while permitting appropriate uses and promoting public education (Muldoon & Gillies 1996).

Establishing a NRSMPA also fulfils Australia's international obligations as a signatory to the *Convention on Bi*ological Diversity (UNEP 1994), which at a global level, through the International Union for the Conservation of Nature (IUCN), Commission on National Parks and Protected Areas (CNPPA), has been carrying out a program to promote the establishment of a global representative system of marine protected areas (MPAs) (see Box 5.1).

BOX 5.1
A GLOBAL NETWORK OF MARINE PROTECTED AREAS

Article 6 of the Convention on Biological Diversity (UNEP 1994) states that signatory Nations shall:

(a) develop national strategies, plans or programs for the conservation and sustainable use of biological diversity or adapt for this purpose existing strategies, plans or programs which shall reflect, inter alia, the measures set out in this convention relevant to the contracting Party concerned; and

(b) integrate, as far as possible and as appropriate, the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plan, programs and policies.'

At the global level, the International Union for the Conservation of Nature (IUCN), through its Commission on National Parks and Protected Areas (CNPPA), has been carrying out a program to promote the establishment of a global representative system of Marine Protected Areas (MPAs).

The primary goal of the IUCN-CNPPA Marine Protected Areas Program is:

> *`to provide for the protection, restoration, wise use, understanding and enjoyment of the marine heritage of the world in perpetuity through the creation of a global, representative system of Marine Protected Areas and through the management, in accordance with the principles of the World Conservation Strategy, of human activities that use or affect the marine environment.'*

At a national level, a NRSMPA has been endorsed by States/Territory under the Inter-governmental Agreement on the Environment (IGAE), through the development of national strategies such as the *National Strategy for Ecologically Sustainable Development (1992)* (ie. Objective 10.2), and the *National Strategy for the Conservation of Australia's Biological Diversity (1996)* (ie. Objective 1.4).

In 1992, the former Australian National Parks and Wildlife Service commissioned a report on 'Marine and Estuarine Protected Areas: A Strategy for a National Representative System within Australian Coastal and Marine Environments' (Ray & McCormick-Ray 1992). This report provided the strategic technical framework for establishing a national representative system of MPAs and identified the following steps in establishing such a system :

(a) Define operational objectives - endpoints defined with predictable, measurable outcomes, eg. fish refuge.

(b) Focus on ecosystem processes - produce ecological gradients which circumscribe the boundaries of ecosystems. Resist generalisations about the sea.

(c) Emphasise land-sea interactions - linkages, water-sheds.

(d) Gain public support - society must see itself as a stakeholder in the health and sustainability of the coastal zones and oceans. A sense of urgency must be achieved.

(e) Represent biodiversity/seascape - species lists inadequate for marine systems. Level of seascape is practical.

(f) Set MPAs in a regional context - set with i) large, oceanographic systems, and ii) land-sea, coastal zone interactions.

(g) Use appropriate scale - nested, hierarchical structure of ecosystems, ie. management at many scales, eg. bay, islands, vs. region, migratory vs. demersal fish.

(h) Provide for multiple-use & cooperative management

(i) Apply scientific procedures - intuitive judgements by experts, public participation and on political and social opportunity. But only as a first step. Scientific procedures must follow. Clearly scientifically defensible boundaries must follow.

(j) Attain a national system - need a systematic ecological framework or classification to produce a network of protected areas with collective goals of biodiversity, ESD and public support. Central information system - GIS. For a networked system need: i) a hierarchical, ecological framework within which MPAs are set, and ii) facilitation of communications among individual sites.

Of particular importance in a national system of MPAs in Australia is the development of a national guidelines and a legislative framework to ensure that there is a national approach to the declaration of MPAs (Ray & McCormick-Ray 1992).

In particular, there is a need to incorporate the goals, terminology, definitions and objectives for MPAs into State/Territory legislation.

Through the former `Ocean Rescue 2000' Marine Protected Areas program, and the ANZECC Taskforce on Marine Protected Areas, the Commonwealth Government is working cooperatively with State and Territory governments to expand the existing system of Marine Parks and Reserves, to conserve the range of Australia's coastal and marine biodiversity, while allow sustainable uses. The national Marine Protected Areas program is presently administered by the Environment Australia, with management and technical advice provided by the Biodiversity Group, Marine Group and the Great Barrier Reef Marine Park Authority. In some jurisdictions, marine conservation planning is advanced. For instance, in Western Australia and Victoria, policy and technical frameworks for a representative system of Marine Protected Areas have been identified and are now being implemented (CALM 1994, LCC 1993, 1996).

5.3 Primary Goal of the SA Representative System of MPAs

Essentially the primary objective of MPAs in Australia, as elsewhere in the world, is the same as for terrestrial protected areas: to protect ecosystems, particularly, representative, unique or vulnerable species, communities or habitats, and to ensure the sustainable use of resources. As such, IUCN (1988) recommended that marine protected areas should:

> *"provide for the protection, restoration, wise use, understanding and enjoyment of the marine heritage of the world in perpetuity through the creation of a global representative system of marine protected areas and through the management in accordance with the principles of the World Conservation Strategy of human activities that use or affect the marine environment".*

Marine Protected Areas (or MPAs) in Australia can be created for a variety of purposes and it is possible to provide for a range of activities that are consistent with a general conservation objective. For example, MPAs can be reserved for conservation and fisheries management, research, education, social and historical importance, tourism or recreational use - or a combination of any of these. As early as 1982, States/Territory and Commonwealth governments have sought to develop a national approach to the establishment of MPAs, including management objectives (ACIUCN 1986) (and also, classification and nomenclature). Since this time, MPAs in Australia have been established with the objectives of preserving endangered or threatened species or habitats; preserving economically or ecologically important species or habitats or ecosystems; preserving areas for education and scientific research; and preserving historical and cultural sites (Pollard 1977, Suter 1983, Kenchington 1985, Ivanovici 1984, Mobbs 1988, McNeill 1991).

BOX 5.2
ACIUCN MANAGEMENT OBJECTIVES FOR MPAS

In 1982, CONCOM/ACIUCN proposed the following nine management objectives for MPAs in an attempt to give a national approach to the conservation and management of Australian waters:

1 the conservation and management of representative samples of marine/estuarine habitats and ecosystems;

2 the protection of endangered species and habitats;

3 the conservation and management of important breeding areas for economically important species;

4 the preservation of aesthetic values for present and future generations;

5 the protection of valuable archaeological, historical and cultural sites;

6 the preservation of sites for the interpretation and appreciation of marine areas for the purposes of tourism, recreation and education of the public;

7 the preservation of sites for the education and training of reserve managers;

8 the preservation of sites for the installation of research stations in which to learn of marine/estuarine ecosystem processes;

9 as sites for monitoring the environmental effects of development and its various perturbations.

Although most States/Territory utilise the CONCOM/ACIUCN objectives for MPA declaration, these objectives have generally not been included in the relevant state legislation. In Australia most MPAs have only fulfilled one or two of the CONCOM/ACIUCN management objectives (McNeill 1991).

- ***Primary Goal***

Any system of Marine Protected Areas in South Australia, should reflect the primary goal of the NRSMPA, as defined by the ANZECC Taskforce on Marine Protected Areas (Environment Australia 1998):

> *`To establish and manage substantial, representative examples of marine and estuarine ecosystems of South Australia as protected areas to ensure their long-term ecological viability, to maintain ecological processes and systems, and to protect biological diversity at all levels.'*

- ***Secondary Goals***

Consistent with the *National Biodiversity Strategy* (Commonwealth of Australia, 1996), and the generally accepted objectives of MPAs (eg Kelleher & Kenchington 1991, Thackway 1996). the South Australian component of the NRSMPA should have as its secondary goals:

- ***Ecological***

- ***Representative Habitats, Ecosystems, Biodiversity***

– To protect and manage examples of marine and estuarine systems to ensure their long-term ecological viability and to maintain biological diversity at all levels by establishing a comprehensive, adequate and representative system of MPAs, including highly protected areas, across all marine bioregions and biounits and across a range of ecosystems and habitats within bioregions and biounits.

- ***Rare, Endangered Threatened Species, Habitats***

– To protect depleted, threatened, rare, endangered or endemic species and ecological communities and in particular to preserve habitats considered critical for the survival of such species.

- ***Sensitive, Vulnerable or Species***

– Provide for special groups of organisms, eg. species with complex habitat requirements or mobile or migratory species, or species vulnerable to disturbance which may depend on reservation for their conservation.

- ***Ecologically Significant Areas***

– Protect areas of high species diversity, natural refugia for flora and fauna and centres of endemism.

- ***Economic***

- ***Economically Significant Habitats***

– To protect and manage habitats of significance to the life-cycles of economically important species.

- ***Integrated Marine Management***

– To provide a formal management framework for a broad spectrum of human activities, including recreation, tourism and the use or extraction of resources, that are compatible with the primary goal.

- ***Social***

- ***Geological, Archaeological, Historical and Cultural Sites***

– To protect and manage significant geological, archaeological, historical and cultural sites for present and future generations.

- ***Aesthetic Values***

– To protect the natural aesthetic values of marine and estuarine areas for present and future generations.

- ***Indigenous Cultural Practices and Values***

– To cater for the management of marine areas and species by indigenous communities in accordance with traditional cultural practices and affiliations.

- ***Community Support and Participation***

– To achieve the support and cooperation of the community, including indigenous communities.

- ***Public Education and Community Awareness***

– To facilitate the interpretation of marine and estuarine systems for the purposes of conservation, recreation and public education.

- ***Scientific***

- ***Environment Impact Assessment***

– To provide for research and training, and for monitoring the environmental effects of human activities, including the direct and indirect effects of development and adjacent land-use practices.

- ***Scientific Reference Sites***

– To provide for reference sites for scientific studies, including sites for baseline fisheries monitoring and long term environmental monitoring.

- ***Rehabilitation of Degraded Ecosystems***

– To facilitate the restoration of degraded marine ecosystems; and

- ***Ongoing Review of Goals, Objectives and Performance***

– To be capable of evolving in light of new information.

- ***Management Outcomes***

The goals of the NRSMPA relate primarily to the conservation of biodiversity and sustainable and equitable management of human usage. However, the MPAs that make up the NRSMPA may also protect and manage many other important values such as geological, archaeological, historical and cultural attributes. As well as the benefits or outcomes relating to biodiversity values there are other significant outcomes for the NRSMPA that relate to the management and wise use of a range of other values. The outcomes listed apply to the national system of MPAs as a whole and not necessarily to each individual MPA within the system.

The outcomes of the NRSMPA will include:

– conservation and sustainability of Australia's biodiversity;

– protection and management of significant geological, archaeological, historical and cultural sites;

– recognition and protection of indigenous cultural and heritage values;

- management of marine areas and species by indigenous communities in accordance with traditional cultural practices and affiliations;

- involvement of the community and a focus for research and training;

- monitoring the environmental effects of human activities, including the direct and indirect effects of development and adjacent land use practices;

- reference sites for scientific studies, including sites for long-term environmental monitoring;

- educating the community about the environment, attributes and appropriate uses of MPAs;

- protection of the natural aesthetic values of marine protected areas for the educational, recreational and spiritual benefit of the community;

- facilitation of the restoration of degraded marine ecosystems; and

- protection and management of habitats of significance to the life cycles of economically important species including marine propagation areas.

5.4 Defining Marine Protected Areas in South Australia

In Australia, as elsewhere around the world, there is wide range of nomenclature and definitions for Marine Protected Areas (ie. Marine Parks, Marine National Parks, Aquatic Reserves, Nature Reserves, Marine Reserves, Fish Habitat Reserves, etc.). This causes considerable confusion as different labels can be used for protected areas with identical management objectives.

In South Australia, it may be useful to utilise the definition of the NRSMPA and the IUCN definition of `protected area' for a Marine Protected Area:

> *"An area of land/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means." (IUCN 1994)*

This definition has been recently endorsed by the Commonwealth Government, ANZECC, Ministerial Council on Forestry, Fisheries and Aquaculture (MCFFA) and the State and Territory conservation agencies for use in a variety of protected area contexts.

5.4.1 Definition of Existing Marine Protected Areas in South Australia

For protected areas that contain both terrestrial and marine components, it is important to classify them appropriately as either Terrestrial Protected Areas or Marine Protected Areas.

In this regard, reserves which contain both, land and sea components, should be defined as Marine Protected Areas if they were especially dedicated to protect marine areas, and Terrestrial Protected Areas if they were specifically established to protect land areas. Using this definition and the IUCN definition of a protected area, only Marine Parks, Aquatic Reserves, and Marine Sanctuaries should be defined as Marine Protected Areas. While island and coastal Conservation Parks, Conservation Reserves and National Parks which extend down to the low water mark are more appropriately classified as Terrestrial Protected Areas (with a marine component). Netting Closures are not formally recognised as a Marine Protected Area (see Cresswell & Thomas 1997), but rather as a fisheries management tool, as they are not established specifically to protect marine biodiversity or processes.

- ***Marine Protected Areas***

- In 1984, a total of 52 areas were listed as Marine Protected Areas in South Australia, in *An Inventory of Declared Marine and Estuarine Protected Areas in Australia* (Ivanovici 1984) (see Table 5.1). These comprised 12 Aquatic Reserves, 4 Sanctuaries, 3 Conservation Parks, 1 National Park and 1 Historic Shipwreck. A total of 31 Restricted Use areas were also recognised (Ivanovici 1984).

Designation of MPA	Legislation	Area (ha)	Year Declared	CONCOM Designation
AQUATIC RESERVE	South Australian Fisheries Act 1982			
Aldinga Reef		505	1971	Marine Reserve
American River		1,525	1971	Marine Reserve
Barker Inlet-St Kilda		2,055	1973	Marine Reserve
Blanche Harbour-Douglas Bank		3,160	1980	Marine Reserve
Goose Island		54	1971	Marine Reserve
Port Noarlunga Reef and Onkaparinga Estuary		300	1971	Marine Reserve
Seal Beach		1,140	1971	Marine Park
St Kilda-Chapman Creek		870	1980	Marine Reserve
Troubridge Hill		460	1983	Marine Reserve
West Island		65	1971	Marine Park
Whyalla-Cowleds Landing		3,230	1980	Marine Reserve
Yatala Harbour		1,426	1980	Marine Reserve
Subtotal (12)				
RESTRICTED USE AREAS				
Jetties, Piers, Wharves and Netting Closures (29)		NA	Various	Marine Reserve
Outer Harbour-Marino		2,166	1974,1976	Marine Reserve
Rivers Hindmarsh and Inman		25	1976	Marine Reserve
Subtotal (31)		>2,191 (1.1%)		
SANCTUARY				
Cape Jaffa		950	1971	Marine Reserve
Gleasons Landing		350	1982	Marine Reserve
Margaret Brock Reef		314	1977	Marine Reserve
Penguin Island-Rivoli Bay		40	1977	Marine Reserve
Subtotal (4)				
CONSERVATION PARK	South Australian National Parks and Wildlife Act 1972			
Clinton		165 (1,854)	1970	Marine Reserve
Port Gawler		340 (434)	1971	Marine Park
Seal Bay		2 (700)	1967	Marine Park
Subtotal (3)		607 (0.3%)		
NATIONAL PARK				
Coorong (lagoon area)		3 178	1966	Marine Reserve
Subtotal (2)		127,910 (64%)		
HISTORIC SHIPWRECK PROTECTED ZONE	Historic Shipwrecks Act 1981			
'Zanoni'		95 (0.05%)	1983	Marine Reserve
STATE WATERS:		6,094,800 ha		

Table 5.1 **The status of Marine Protected Areas (MPAs) in South Australia in 1984 (from Ivanovici 1984). Marine components (and total areas) of terrestrial Conservation Parks are indicated.**

More recently, the national inventory, ie. *Terrestrial and Marine Protected Areas in Australia* (Cresswell & Thomas 1997), which utilises the national `Collaborative Australian Protected Areas Dataset' (CAPAD) lists a total of 15 Marine Protected Areas in South Australia (comprising 14 Aquatic Reserves, and 1 Marine Sanctuary) as of 30 June 1997(see Table 5.2 below). The current national inventory does not recognise reserves declared principally to protect terrestrial lands, as Marine Protected Areas, or Restricted Use Areas (ie. netting closures, etc.) declared primarily for fisheries management purposes, or Historic Shipwrecks, protected for historic purposes. The Coorong National Park is also recognised as a Terrestrial Protected Area by Cresswell & Thomas (1997).

Designation of MPA	Legislation	Area (ha)	IUCN Category	Year Declared
AQUATIC RESERVE	South Australian Fisheries Act 1982			
Aldinga Reef		674	II	1971
American River		1,545	II	1971
Barker Inlet-St Kilda		2,087	II	1973
Blanche Harbour-Douglas Bank		3,037	II	1980
Goose Island		68	II	1971
Point Labatt		202	II	1986
Port Noarlunga Reef and Onkaparinga Estuary		408	II	1971
Seal Bay, Bales Beach		447 1,011	II, II	1971
St Kilda-Chapman Creek		1,270	II	1980
Troubridge Hill		328	II	1983
West Island		34	II	1971
Whyalla-Cowleds Landing		3,600	II	1980
Yatala Harbour		1,139	II	1980
Subtotal (14)		15,850		
SANCTUARY				
Great Australian Bight Whale		43,730	II	1995
STATE WATERS:		6,094,800 ha		
STATE TOTAL: (15)		>59,580 ha (0.98%)		

Table 5.2 **The status of Marine Protected Areas (MPAs) in South Australia, to June 1997 (from Cresswell & Thomas 1997).**

- ***Current Status of MPAs in SA***

However, the current national dataset does not include 4 Sanctuaries previously recognised by Ivanovici (1984), Marine Protected Areas declared under *Historic Shipwrecks Act* or the recent declaration of the Great Australian Bight Marine National Park under the *National Parks and Wildlife Act.* The *`Zanoni'* has a declared protection zone to protect fish and marine life, in addition to the remains of the vessel and any artefacts associated with it. In this regard, this reserve should be formally recognised as a Marine Protected Area. The Coorong National Park has been declared largely to protect estuarine lagoonal habitats and hence, should be appropriately defined as Marine Protected Areas.

With these amendments, there are currently a total of 22 recognised MPAs in South Australia, comprising 14 Aquatic Reserves, 5 Sanctuaries, 2 National Parks, and 1 Historic Shipwreck (see Table 5.3). Together, these comprise approximately 3.1% of South Australia's jurisdictional waters

Designation of MPA	Legislation	Area (ha)	IUCN MPA Management Category	Year Declared
AQUATIC RESERVE	South Australian Fisheries Act 1982			
Aldinga Reef		674	II	1971
American River		1,545	II	1971
Barker Inlet-St Kilda		2,087	II	1973
Blanche Harbour-Douglas Bank		3,037	II	1980
Goose Island		68	II	1971
Point Labatt		202	II	
Port Noarlunga Reef and Onkaparinga Estuary		408	II	1971
Seal Bay, Bales Beach		447 1,011	II	1971
St Kilda-Chapman Creek		1,270	II	1980
Troubridge Hill		328	II	1983
West Island		34	II	1971
Whyalla-Cowleds Landing		3,600	II	1980
Yatala Harbour		1,139	II	1980
Subtotal (14)		**15,850 (8.4%)**		
SANCTUARY				
Great Australian Bight Whale		43,730	II	1995
Cape Jaffa		950		1971
Gleasons Landing		350		1982
Margaret Brock Reef		314		1977
Penguin Island-Rivoli Bay		40		1977
Subtotal (5)		**45,384 (24.0%)**		
NATIONAL PARK				
Coorong (lagoon area)		3,178	II	1966
Great Australian Bight Marine		124,732	II	1997
Subtotal (2)		**127,910 (67.6%)**		
HISTORIC SHIPWRECK PROTECTED ZONE	Historic Shipwrecks Act 1981			
'Zanoni'		95 (<0.05%)	II	
STATE WATERS:		**6,094,800 ha**		
STATE TOTAL: 22 MPAs		**>189,239 ha (3.1%)**		

Table 5.3 **The present status of Marine Protected Areas (MPAs) in South Australia, as of June 1998.**

- ***Terrestrial Protected Areas (with marine components)***

Of the Terrestrial Protected Areas, with marine and coastal components, South Australia has many coastal and offshore island Conservation Parks, Conservation Reserves, and National Parks (see Table 5.4 below). While these have been generally classified as Terrestrial Protected Areas by Cresswell and Thomas (1997), some of these protected areas have been primarily established to protect marine species and intertidal marine habitats (ie. mangroves). As such, some of the offshore island conservation parks protect key breeding and haul out sites of the Australian Sea Lion (eg. Seal Bay, Nuyts Reef, Olive Island, Sir Joseph Banks, Investigator Group, The Pages CP) and New Zealand Fur Seal (eg. Neptune Islands, Rocky Island, Cap Island) in South Australia and also, important breeding sites for seabirds (eg. Eba Island, Lipson Island, Avoid Bay Islands, Pigface Island). While some coastal conservation parks and reserves have been established primarily to protect intertidal mangrove and saltmarsh habitats (eg. Clinton, Port Gawler, Acraman Creek).

Park Name	Total Area (ha)	IUCN Category
Acraman Creek Conservation Park	3,960	III
Althorpe Islands Conservation Park	116.5	III
Avoid Bay Islands Conservation Park	16	IA
Baird Bay Islands Conservation Park	24	IV
Baudin Rocks Conservation Park	17	IA
Beachport Conservation Park	710	III
Beatrice Islet Conservation Park	10	IA
Bird Islands Conservation Park	26	IA
Busby Islet Conservation Park	10	IA
Butcher Gap Conservation Park	178	III
Canunda Conservation Reserve	1,091	III
Canunda National Park	9,312	II
Cap Island Conservation Park	8	IA
Cape Bouguer Wilderness Protection Area	5,530	IB
Cape Gantheaume Conservation Park	4,220	IA
Cape Gantheaume Wilderness Protection Area	20,100	IB
Cape Hart Conservation Park	1,030	IA
Cape Torrens Conservation Park	0.788	IB
Cape Torrens Wilderness Protection Area	751	IB
Clinton Conservation Park	1,951	III
Coffin Bay Conservation Reserve	40	III
Coffin Bay National Park	29,106	II
Coorong National Park	46,745	II
Deep Creek Conservation Park	4,227.76	II
Douglas Point Conservation Park	31	III
Eba Island Conservation Park	121	III
Ewens Ponds Conservation Park	34	III
Flinders Chase National Park	32,604.36	II
Fowlers Bay Conservation Reserve	8,649	III
Franklin Harbor Conservation Park	1,333	IA
Gambier Islands Conservation Park	64	IA
Goose Island Conservation Park	19	IA
Great Australian Bight Marine National Park	112,200	VI
Greenly Island Conservation Park	190	IA
Guichen Bay Conservation Park	121	III
Hallett Cove Conservation Park	50	III
Innes National Park	9,232.49	II
Investigator Group Conservation Park	116	IA
Isles of St. Franci Conservation Park	1,320	IA
Kellidie Bay Conservation Park	1,780	IA
Lake Newland Conservation Park	8,448	IA
Laura Bay Conservation Park	267	III
Laura Bay Conservation Reserve	9.409	III
Leven Beach Conservation Park	493	III
Lincoln National Park	29,060	II
Lincoln - 2 Conservation Reserve	308	III
Lipson Island Conservation Park	1	III
Little Dip Conservation Park	2,138	III

Table 5.4 **The status of Terrestrial Protected Areas with marine components (coastal National Parks, Conservation Parks and Conservation Reserves) in South Australia, declared under the *South Australian National Parks and Wildlife Act1972* (from Lewis, Edyvane & Newland *in press*).**

Park Name	Total Area (ha)	IUCN Category
Marino Conservation Park	30	III
Moana Sands Conservation Park	21	III
Mount Dutton Bay Conservation Park	12	IA
Munyaroo Conservation Park	12,334	IA
Munyarroo Conservation Reserve	6,082	IA
Nepean Bay Conservation Park	33	III
Neptune Islands Conservation Park	318	IA
Newland Head Conservation Park	1,036	III
Nullarbor National Park	588,283	II
Nuyts Archipelago Conservation Park	5,483	IB
Nuyts Reef Conservation Park	29	IB
Olive Island Conservation Park	21	IB
Onkaparinga River Recreation Park	284.1	III
Pelican Lagoon Conservation Park	365	IA
Penguin Island Conservation Park	5	IA
Piccaninnie Ponds Conservation Park	547.3	III
Pigface Island Conservation Park	10	IA
Point Bell Conservation Reserve	602	III
Point Davenport Conservation Park	239	III
Point Labatt Conservation Park	39	III
Port Gawler Conservation Park	418	III
Pullen Island Conservation Park	3	IA
Ravine Des Casoars Wilderness Protection Area	41,320	IB
Rocky Island (North) Conservation Park	9	IA
Rocky Island (South) Conservation Park	4	IA
Sceale Bay Conservation Reserve	531.5	III
Seal Bay Conservation Park	1,911	III
Sinclair Island Conservation Park	1	IA
Sir Joseph Banks Group Conservation Park	2,033	IA
Sleaford Mere Conservation Park	697	III
The Pages Conservation Park	15	IA
Torrens Island Conservation Park	79	III
Troubridge Island Conservation Park	314	III
Tumby Island Conservation Park	35	IA
Venus Bay Conservation Park	1,423	III
Venus Bay Conservation Reserve	3,357	IA
Vivonne Bay Conservation Park	1,481	IA
Wahgunyah Conservation Reserve	29,163	III
Waitpinga Conservation Park	2.5	III
Waldegrave Islands Conservation Park	434	IA
West Island Conservation Park	18	IA
Western River Conservation Park	167	IB
Western River Wilderness Protection Area	2,373	IB
Whidbey Isles Conservation Park	271	IA
Winninowie Conservation Park	7,852	Ia
Wittelbee Conservation Park	153	III

Table 5.4 Continued.

5.4.2 IUCN Protected Area Categories

Marine Protected Areas can be categorised or classified on the basis of IUCN's Protected Area Management Categories (see Box 5.3). This classification would enable a national and internationally consistent scheme of management types – independent of local nomenclature – and ensure the consistent reporting of objectives and management, rather than the label (Davey 1996). This classification has been adopted at the global level, by IUCN's Commission of National Parks and Protected Areas (CNPPA) for it's Global Representative System of Marine Protected and also, at the national level, by the ANZECC Taskforce on Marine Protected Areas, for the NRSMPA.

BOX 5.3
IUCN PROTECTED AREA MANAGEMENT CATEGORIES

- ***IA Strict Nature Reserve***

– Protected area managed mainly for science.

– Areas of land and/or sea possessing some outstanding or representative ecosystems, geological or physiological features and/or species, available primarily for scientific research and/or environmental monitoring.

- ***IB Wilderness Area***

– Protected area managed mainly for wilderness protection.

– Large area of unmodified or slightly modified land and/or sea, retaining its natural character and influence, without permanent or significant habitation, which is protected and managed so as to preserve its natural condition.

- ***II National Park***

– Protected area managed mainly for ecosystem protection and tourism.

– Natural area of land and/or sea, designated to (a) protect the ecological integrity of one or more ecosystems for present and future generations, (b) exclude exploitation or occupation inimical to the purposes of designation of the area, and (c) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible.

–

- ***III Natural Monument***

– Protected area managed mainly for conservation of specific natural features.

– Area containing one, or more, specific natural or natural/cultural feature which is of outstanding or unique value because of its inherent rarity, representative or aesthetic qualities or cultural significance.

- ***IV Habitat/Species Management Area***

– Protected area managed mainly for conservation through management intervention.

– Area of land and/or sea subject to active intervention for management purposes so as to ensure the maintenance of habitats and/or to meet the requirements of specific species.

- ***V Protected Landscape and Seascape***

– Protected area managed mainly for landscape/seascape conservation and recreation.

– Area of land, with coast and sea as appropriate, where the interaction of people and nature over time has produced an area of distinctive character with significant aesthetic, ecological and/or cultural value, and often with high biological diversity. Safeguarding the integrity of this traditional interaction is vital to the protection, maintenance and evolution of such an area.

- ***VI Managed Resource Protected Area***

– Protected area managed mainly for the sustainable use of natural ecosystems.

– Area containing predominantly unmodified natural systems, managed to ensure long term protection and maintenance of biological diversity, while providing at the same time a sustainable flow of natural products and services to meet community needs. The area must also fit the overall definition of a protected area.

The IUCN protected area management categories provide a uniform classification which both identifies the principal management objectives of a protected area, as well as acknowledging that other secondary uses and values can be conserved through reservation. In this respect, Marine Protected Areas often achieve a mix of management objectives (Table 5.5).

Management by Objective	IUCN Protected Area Management Category						
	IA	*IB*	*II*	*III*	*IV*	*V*	*VI*
Scientific Research	1	3	2	2	2	2	3
Wilderness Protection	1	2	2	3	3	-	2
Preservation of Species and Generic Diversity	1	2	1	1	1	2	1
Maintenance of Environmental Services	2	1	1	-	1	2	1
Protection of Specific Natural / Cultural Features	-	-	2	1	3	1	3
Tourism and Recreation	-	2	1	1	3	1	3
Education	-	-	2	2	2	2	3
Sustainable use of Resources from Natural Ecosystems	-	3	3	-	2	2	1
Maintenance of Cultural / Traditional Attributes	-	-	-	-	-	1	2

Key
1 Primary Objective
2 Secondary Objective
3 Potentially Applicable Objective
- Not Applicable

Table 5.5 Management objectives of the IUCN Protected Area Management Categories.

The majority of the MPAs which have been established in South Australia generally afford high levels of protection to marine fauna and flora (see Table 5.6), but they generally do not afford the highest levels of protection allowing limited recreational activities (eg. fishing) or access for mineral and petroleum exploration or provide areas for multiple-use management. To this end, there is a paucity of strict nature conservation areas (Category IA) and Wilderness Areas (Category IB), and also, multiple-use areas (Category IV, V and VI).

IUCN MPA Category	Number	Area (ha)	% SA Area
IA	0	0	0
IB	0	0	0
II	22	>189,239 ha	(3.1%)
III	0	0	0
IV	0	0	0
V	0	0	0
VI	0	0	0
Total	**22**	**>189,239 ha**	**(3.1%)**

Table 5.6 The status of IUCN protected area management categories for MPAs in South Australia.

5.4.3 Definitions for a System of MPAs in South Australia

In defining a system of Marine Protected Areas in South Australia, which encompass the various management objectives, and also, the various levels of activities which can be accommodated within protected areas – new definitions and nomenclature (which recognise the need for national and international consistency) are needed.

The proposed definitions and nomenclature outlined below recognise the principles and goals of the *Fisheries Act* in sustainable fisheries management (within an ecosystem context), and goals of the *National Parks and Wildlife Act* in conserving biodiversity and managing human impacts and social and cultural interactions with natural ecosystems. In line with current national trends to standardise nomenclature for Marine Protected Areas (MPAs) across Australia, to assist with national reporting, the following definitions and nomenclature for MPAs are suggested in South Australia:

- ***National Parks and Wildlife Act 1972***

1 Marine Reserve

- ***IUCN Category IA (Strict Nature Reserve)***

– *Areas of sea possessing some outstanding or representative ecosystems, geological or physiological features and/or species, available for scientific research and/or monitoring. These reserves afford the highest level of conservation and protection of biological diversity and are created primarily for conservation and scientific research. Although low-impact tourism may be permitted, no recreational or commercial fishing, aquaculture, mineral exploration or petroleum drilling or production should be allowed in these areas.*

2 Marine Park

These reserves afford the second highest level of conservation and protection of biological diversity and are created primarily to protect natural features and aesthetic values while at the same time enabling recreational and commercial uses where these activities do not compromise conservation values.

- ***IUCN Categories II (National Park)***

– *Natural area of land and/or sea, designated to (a) protect the ecological integrity of one or more ecosystems for present and future generations, (b) exclude exploitation or occupation inimical to the purposes of designation of the area, and (c) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible.*

- ***IUCN Category III (Natural Monument)***

– *Area containing one, or more, specific natural or natural/cultural feature which is of outstanding or unique value because of its inherent rarity, representative or aesthetic qualities or cultural significance.*

- ***IUCN Category IV (Habitat/Species Management Area)***

– *Area of land and/or sea subject to active intervention for management purposes so as to ensure the maintenance of habitats and/or to meet the requirements of specific species.*

3 Marine Management Area:

These areas afford the lowest of conservation and protection of biological diversity but provide a formal integrated management framework over areas that have high conservation value and intensive multiple-use. These areas should be selected primarily on the basis of their biological and recreational values and their existing or future commercial activities such as mineral and petroleum production, commercial fishing and aquaculture. As with other Marine Protected Areas, Marine Management Areas should be subject to environmental impact assessments for activities referrable under the Environment Protection Act.

- ***IUCN Categories V (Protected Seascape)***

– *Area of land, with coast and sea as appropriate, where the interaction of people and nature over time has produced an area of distinctive character with significant aesthetic, ecological and/or cultural value, and often with high biological diversity. Safeguarding the integrity of this traditional interaction is vital to the protection, maintenance and evolution of such an area.*

- ***IUCN Category VI (Managed Resource Protected Area)***

– *Area containing predominantly unmodified natural systems, managed to ensure long term protection and maintenance of biological diversity, while providing at the same time a sustainable flow of natural products and services to meet community needs. The area must also fit the overall definition of a protected area.*

- ***Wilderness Protection Act 1992***

4 Marine Wilderness Area

- ***IUCN Category IB (Wilderness Area)***

– *Large area of unmodified or slightly modified land and/or sea, retaining its natural character and influence, without permanent or significant habitation, which is protected and managed so as to preserve its natural condition.* While most of the oceans are uninhabited, the intent of designated wilderness areas are to preserve natural areas in a largely unmodified and uninhabited state. In such areas, marine activities which require permanent structures (eg. petroleum drilling, aquaculture) or significantly modify habitats (eg. dredging), should be prohibited, while other extractive uses such as fishing, tourism and recreation may be appropriate.

- ***Fisheries Act 1982***

5 Fisheries Reserve

- ***IUCN Category IA (Strict Nature Reserve)***

– *Areas of sea possessing some outstanding or representative ecosystems, geological or physiological features and/or species, available for scientific research and/or monitoring.* These reserves afford the highest level of conservation and protection of biological diversity and should be created primarily for conservation and scientific research. Although low-impact tourism may be permitted, no recreational or commercial fishing, aquaculture, mineral exploration or petroleum drilling or production should be allowed in these areas.

6 Fish Habitat Management Area

- ***IUCN Category IV (Habitat/Species Management Area)***

– *Area of land and/or sea subject to active intervention for management purposes so as to ensure the maintenance of habitats and/or to meet the requirements of specific species.* These areas should be created under the Fisheries Act 1982 to protect specific fish species and fish habitats, and to specific provide tools for fisheries area management. These areas should allow low-impact tourism, but prohibit any activity that is deemed incompatible with the primary objective of fisheries and marine habitat management.

The proposed mix of nomenclature and classifications, enables a standardised but flexible approach to declaration and establishment of Marine Protected Areas in South Australia. Ideally, high protection areas (ie. IUCN Category IA, IB), could be encompassed within medium protection areas (ie. IUCN Category II) or multiple-use managed areas (ie. IUCN Category IV, V, VI), the latter which could provide essential buffer or management zones to protect core areas of high conservation value.

Under the proposed classification, existing Aquatic Reserves would be renamed Fish Habitat Management Areas, if they allowed restricted exploitative activities such as line fishing, spearfishing, crabbing (eg. Barker Inlet – St Kilda, Blanche Harbour, Port Noarlunga Reef – Onkaparinga Estuary, St Kilda – Chapman Creek, Troubridge Hill, Whyalla – Cowleds Landing). Alternatively, protection within these existing Aquatic Reserves could be increased to enable standardised classification as Fisheries Reserves (Category IA).

BOX 5.4
HOW ARE ACTIVITIES MANAGED WITHIN A MARINE PROTECTED AREA ?

The term `protected area' is an unfortunate piece of terminology which conjures up images of exclusion and removal of activities and uses. This is not the case. The concept of `Marine Protected Areas' is one of managed use within a conservation framework. Marine Protected Areas vary from high protection Aquatic Reserves to large, multiple use Marine Parks that attempt to integrate the management of a range of activities (such as commercial and recreational fishing, recreation, tourism and mining) by providing for varying levels of protection and use throughout the area. The principal aim of a Marine Park is not to exclude use but to manage all activities and uses in the area on an integrated, ecosystem level for ecologically sustainable use.

The integrated management of uses or activities within a Marine Protected Area is achieved through a process of zoning. Zoning separates a Marine Protected Area into discrete management units or zones and provides levels of protection which reflect the characteristics of natural resources, biodiversity and traditional use. Most importantly, by separating potentially conflicting uses and activities into different areas or zones, zoning minimises conflicts that may arise between the different user groups.

The zoning of activities or uses within a Marine Protected Area is determined with community and industry participation through the development of a `management plan'.

Some of the best known examples of a multiple use Marine Protected Areas are the Great Australian Bight Marine Park and the Great Barrier Reef Marine Park, which provide for a range of activities, such as tourism, fishing (commercial and recreational), conservation, recreation and scientific research, while maintaining the essential ecological processes which sustain these ecosystems.

Ideally an integrated approach to marine management should extend to coordinated management of marine and adjacent terrestrial areas, into the coastal zone and beyond. However, the complexity of boundaries and jurisdictional responsibility of different agencies effectively precludes this under a single piece of legislation. In South Australia, an integrated, ecosystem approach to marine and coastal management can only be achieved through the development of integrated resource strategies and policies, such as the SA Marine and Estuarine Strategy.

5.4.4 Management of Activities within MPAs

Zoning is the essential tool which makes conservation and multiple-uses and activities possible within Marine Protected Areas. Zoning plans allow for a range of activities to be undertaken or regulated within various sections of a protected area, and hence, can resolve the conflict which often exists between competing and non-compatible uses or activities (see Box 5.4).

Within Marine Parks, it is proposed that four statutory management zones be legislated under the *National Parks and Wildlife Act*, to enable management of the Category II (Natural Park), III (Natural Monument) and IV (Habitat/Species Management Area) Marine Protected Areas. This will enable a spectrum of activities from the highest levels of protection in Category II parks to provisions for recreational and commercial activities within Category IV parks (within a multiple-use planning framework).

I Sanctuary Zones

- Are `look but don't take' areas managed solely for nature conservation and low-impact recreation and tourism.

II Recreation Zones

- These areas provide for conservation and recreation including recreational fishing (subject to bag limits and other conservation measures).

III General Use Zones

- Are areas of Marine National Parks not included in Sanctuary, Recreation or Special Purpose Zones. Conservation of natural resources in general use zones is the priority but activities such as sustainable commercial fishing, aquaculture, mineral and petroleum exploration and production are permissible provided they do not compromise conservation values.

IV Special Purpose Zones

– are areas managed for a particular priority use or issue. This could be protection of habitat, a seasonal event such as wildlife breeding or whale-watching or a particular type of commercial fishing. Uses compatible with the priority use or seasonal event are allowed in these zones.

Under the proposed classification of MPAs outlined in Section 5.4.3, Marine Management Areas and Marine Parks are both effectively multiple-use areas. Under this scheme it is anticipated that zoning for exclusion of activities and uses will be extensive in Marine Parks, whereas in Marine Management Areas zoning for exclusion of use will be rare. In a Marine Park, the *National Parks and Wildlife Act 1972* will prevail only in the exclusion zones, which should be determined by reference to incompatibility of the proposed use with the objectives for the relevant zone. In the zones of a Marine Park where use is allowed, and in Marine Management Areas, the relevant resource sector Act should prevail over the *National Parks and Wildlife Act 1972*. In Marine Parks and Marine Management Areas, organisms not subjected to *Fisheries Act 1982* should fall under the *National Parks and Wildlife Act 1972*. Table 5.7 outlines proposed possible marine activities within Marine Protected Areas in South Australia.

Marine Management Areas should be selected primarily on the basis of their biological and recreational values, and the initial choices of locations and boundaries of Marine Management Areas are likely to be substantially influenced by the potential for conflicts between competing uses. In Marine Management Areas, management of the resources normally managed under other Acts (like the Fisheries, Petroleum Acts) will continue. Zoning of areas within Marine Management Areas for specific uses can nonetheless be erected after extensive stakeholder consultation.

Coordination and compatibility amongst the multiple objectives of the fishing, mining and conservation sectors can be achieved by according to the Ministers for Fisheries and Mining the requirement to consent to any area proposed for dedication under the *National Parks and Wildlife Act* and *Fisheries Act*. This consent requirement is not limited to areas of existing sectoral activity.

Activity	Marine Management Area	Marine Park				Marine Wilderness Area	Fisheries Reserve
		General Use Zone	*Special Purpose Zone*	*Recreational Zone*	*Sanctuary Zone*		Marine Reserve
Petroleum Drilling and Production							
Mining							
Trawling							
Aquaculture							
Commercial Fishing							
Recreational Fishing							
Recreation and Tourism							

Table 5.7 **Proposed possible activities in Marine Protected Areas in South Australia.**

5.5 Developing a Protected Area System for South Australia

5.5.1 Characteristics of a Protected Area System

Protected areas are a key part of *in situ* conservation under the Convention on Biological Diversity, but no protected area is likely to be sustainable if established or managed in isolation. There are biological, social and economic interactions between different places and different system components. Systems thinking is a necessary part of striking appropriate balances between conservation and development and between the management emphases of different protected area units.

There are at least five key characteristics of a system of protected areas:

- ***Representativeness, Comprehensiveness and Balance***

– Including examples of the highest available quality of the full range of environment types within a country; includes the extent to which protected areas provide balanced sampling of the environment types they purport to represent.

- ***Adequacy***

– Integrity, sufficiency of spatial extent and networked arrangement of contributing units, together with effective management, to support at least maintenance of viability of the environmental processes and/or species, populations and communities which make up the biodiversity of the country.

- ***Coherence and Complementarity***

– Positive contribution of each site towards the whole; this is also related to efficiency, which is a subset of cost effectiveness, efficiency and equity.

- ***Consistency***

– Application of management objectives, policies and types under comparable conditions in standard ways, so that the purpose of each unit is clear and to maximise the chance that management and use do actually support the objectives.

- ***Cost Effectiveness, Efficiency and Equity***

– Appropriate balance between the costs and benefits, and appropriate equity in their distribution; includes efficiency: the minimum number and area of protected areas needed to achieve system objectives.

While these characteristics define a system overall, they also serve as criteria against which individual areas can be assessed as to their potential or actual contribution to the system relative to other areas. Additional criteria of **irreplaceability, flexibility** and **explicitness** should underlie methods used for selecting system components.

5.5.2 National Guidelines for Establishing the NRSMPA

In May 1998, the ANZECC Taskforce for Marine Protected Areas released *'Guidelines for Establishing the National Representative System of Marine Protected Areas' (Draft Version 2.0)* (Environment Australia 1998). The guidelines provide a strategic framework for a NRSMPA including:

– goals of the NRSMPA

– principles for development of the NRSMPA

– outcomes of the NRSMPA

– development of the NRSMPA – developing national and regional priorities, role of jurisdictions

– criteria for identification and selection of MPAs

– implementation of the NRSMPA, and

– evaluation of the NRSMPA.

Importantly, the adoption of a common approach to MPA identification, selection, and gap analysis, and national standards for evaluation will ensure a systematic approach to establishment of the NRSMPA and consistency of reporting across jurisdictions.

5.5.3 Principles for the Development of a RSMPA in SA

A Representative System of Marine Protected Areas in SA (as a component of the NRSMPA) should be developed in accordance with following principles:

- ***Ecological***

- A Representative System of MPAs (RSMPA) in South Australia should provide for the protection of South Australia's range of biodiversity, species, habitats, ecosystems.

- A RSMPA should acknowledge South Australia's rare, threatened and unique species, habitats, and ecosystems.

- A RSMPA should provide for a comprehensive, adequate and representative system of Marine Protected Areas in South Australia.

- Ecosystems should be the primary unit of biodiversity addressed within the RSMPA for South Australia and as the basis for determining representativeness of the NRSMPA.

- Individual MPAs should be effective in achieving management objectives through an appropriate level of ecological integrity, through ensuring:

  – an appropriate size to be effective;

  – protection from land-based pollution;

  – a networked design;

  – safeguards against redundancy – ie. establishing several, replicated MPAs to provide insurance against natural and anthropogenic disasters.

- ***Economic-Social-Scientific***

- MPAs should, where possible, facilitate, integrate and assist the sustainable management of economically important species in South Australia.

- MPAs should, where appropriate, provide economic benefits.

- MPAs should, where appropriate, provide for the protection of the rights of non-extractive uses (recreation, education, tourism, navigation, etc.).

- Public education on the marine environment, and the role and benefits of MPAs, should be provided to ensure successful establishment and community ownership of MPAs.

- Appropriate scientific studies within MPAs should be facilitated.

- Monitoring of marine life, habitats, ecosystems and human activities within MPAs and adjacent areas is necessary to ensure effective management.

- Processes of selection, establishment and management of MPAs should include a process of consultation and public participation with community and user groups including indigenous communities.

- ***Planning and Management***

- Management of MPAs should reflect the values and objectives of the MPA and may incorporate zones ranging from core conservation zones, affording high levels of protection, to sustainable multiple use zones, accommodating a wide spectrum of human activities.

- The Interim Marine and Coastal Regionalisation for Australia (IMCRA) classification of Australia's marine ecosystems should provide the national and regional planning framework for developing the RSMPA in South Australia.

- MPAs should contain a representative sample of marine ecosystems within the IMCRA planning framework for the Australian Exclusive Economic Zone (EEZ), including State/Territory and Commonwealth waters.

- MPAs should be established and managed to facilitate national and international consistency in management approaches.

- Effective compliance promotion and law enforcement should be provided within each MPA.

- Integrated coastal and marine management should be facilitated through ensuring MPAs are managed in a manner consistent with other statutes, plans and policies.

- MPAs within a RSMPA should have secure status which can only be revoked by a decision of Parliament

- Develop a long term strategy for establishing a network of MPAs.

- Establishment of MPAs and a RSMPA should adopt a `systems approach' to planning (ie. interdisciplinary project team; project management; use of a comprehensive data bases; and use of planning, design, and management tools).

5.5.4 Key Steps in the Development of the NRSMPA in South Australia

The NRSMPA is being developed jointly by Commonwealth, State and Territory agencies. The overall approach towards the establishment of the NRSMPA and has been generally agreed by the Commonwealth, State and the Northern Territory (Environment Australia 1998). The approach utilises IMCRA as the template for planning the NRSMPA (see IMCRA 1997) and consists of nine steps. Some of these steps may be carried out concurrently.

- ***Step 1***

– Gather baseline data including ecosystem mapping;

- ***Step 2***

– Identification of threatening processes;

- ***Step 3***

– Identify gaps in the representation of ecosystems in existing MPAs within each IMCRA mesoscale bioregion and microscale biounit;

- ***Step 4***

– Develop national and regional priorities;

- ***Step 5***

– Identify a list of candidate MPAs within IMCRA bioregions and biounits to represent major ecosystems using identification criteria, vulnerability assessment and reference to national and regional priorities;

- ***Step 6***

– Develop additional criteria for identification and selection of MPAs if required;

- ***Step 7***

– Select sites for MPAs from those listed using selection criteria, any other additional criteria developed in step 6, and vulnerability assessment;

- ***Step 8***

– Assess feasibility of potential MPAs and negotiate new protected areas;

- ***Step 9***

– Establish MPAs and initiate management.

5.5.5 Setting Targets for a System of MPAs

It is difficult to set a target for the optimal protected area coverage for the world's oceans and coastal regions. For terrestrial systems, the present coverage of protected areas around the world is still far off the 10% global target which has been set for the conservation of these ecosystems. For marine and coastal areas, factors determining the optimal size and coverage of protected areas are particularly complex and still not fully understood (Tisdell & Broadus 1989). Hence, it is not yet clear whether or not 10% of the world's coastline is an appropriate target for coastal and marine protected areas (Elder 1993). Also, the marked ecological and other differences between coastal environments and the open sea need to be taken into account. Thus, the target for protected area coverage in the open sea may differ from that in coastal environments (Elder 1993).

- ***Global Targets***

At the global level, IUCN and the Commission on National Parks and Protected Areas (CNPPA) have identified a global target for protected area systems). Under Resolution 19.38 Targets for Protected Areas Systems, as well as Recommendation 16 of the Caracas Congress, governments have been urged to ensure that protected areas should cover a minimum of 10% of each biome by the year 2000. The recent World Conservation Congress in Montreal, Canada (IUCN 1996) urged quicker action on States to establish national representative systems of Marine Protected

Areas, and also, recommended the establishment of Category I and II MPAs to protect a representative proportion of marine ecosystems in a natural state (and help maintain sustainable use and biodiversity throughout marine ecosystems).

- ***Targets within Australia***

– Within Australia, only one State, Tasmania, is considering an overall target for achieving a representative system. Under the recent *Marine and Aquatic Reserves Bill 1997*, the act proposes the following goal and target:

> *An Act to conserve 10% of representative marine and aquatic habitats in Tasmanian waters within a replicated regime of aquatic reserves, to protect marine and aquatic ecosystems and to act as a precautionary fisheries management tool.*

Under this proposed Bill, the `Bioregionalisation Classification of Marine and Aquatic Ecosystems' (ie. the IMCRA bioregion classification) is incorporated into legislation, which provides the framework for the representative system of reserves.

In Victoria, under the LCC's *`Marine and Coastal Special Investigation. Draft Final Recommendations* (LCC 1996), a total of 20 marine parks, were proposed for Victoria's 2 000 km coastline. These encompass the major habitats of Victoria's five biophysical marine regions (defined under IMCRA) as well as its three major bays. A total of 21 sanctuary zones are proposed within the marine parks, to provide the highest level of habitat protection). The recommended Marine Parks encompassed 195 300 ha or 19% of Victoria's marine area, 55 000 ha of which was located within existing Marine Protected Areas.

In Western Australia, in the scientific report, *`A Representative Marine Reserve System for Western Australia*' (1994), a total approximately 70 areas were identified representing coastal habitats along 12 500 km of coastline of WA. However, no targets were proposed for the representative system and also, further public consultation is proposed before any of the areas are dedicated as any one of the three categories of marine conservation reserve.

5.5.6 Guidelines for Developing a SA Marine Protected Area System Plan

In South Australia, the key policy framework for a Representative System of MPAs (as a component of the NRSMPA) would be best developed and facilitated through the development of a formal strategic plan. A Protected Area System Plan is essential in outlining the fundamental components of an integrated or systems approach to developing a protected area network. To this end, a SA Marine Protected Area System Plan should utilise the following IUCN key guidelines and components of a systems plan (Davey 1996):

(a) Objectives, Rationale, Categories, Definitions, Future Directions

– A clear statement of the objectives, rationale, protected area categories, definitions and future directions for protected areas in a country/state/region.

(b) Assessment of Existing Conservation Status, Condition, Management Viability

– Assessment of the conservation status, condition and management viability of the various units

(c) Adequacy - Natural, Cultural Heritage

– Review of how well the system samples the biodiversity and other natural and cultural heritage of the country/state/region.

(d) Procedures for Selecting and Designing a Protected Area System

– Procedures for selecting and designing additional protected areas to make system coverage more fully meet system characteristics.

(e) National, Regional, Local Linkages

– Identification of the ways in which activities undertaken at national, regional and local levels interact to fulfil national and regional objectives for a system of protected areas – the national system plan of a unitary country is likely to be very different from that of a federal country

(f) Integration with Other Planning Strategies

- A clear basis for integration and coordination of protected areas with other aspects of national planning; this is one example of the need for coordination with national biodiversity strategies and so forth, but also with land use, economic and social planning in a wider sense

(g) Assessment of Institutional Framework and Priorities for Capacity Building

- An assessment of institutional framework (relationships, linkages, responsibilities) and identification of priorities for capacity building.

(h) Evolution of System

- Outline of priorities for further evolution of the protected area system.

(i) Identification of Management Categories

- Procedures for deciding the management category most appropriate to each existing and proposed unit, to make best use of the full range of available protected area categories, and to promote identification of the ways in which the different system categories support each other.

(j) Investment needs and Priorities

- Identification of investment needs and priorities for protected areas.

(k) Training and Human resource Development Needs

- Identification of training and human resource development needs for protected area management

(l) Guidelines for Management Policies and Management Plans

- Guidelines for preparation and implementation of management policies and site-level management plans.

5.6 Identification of State and Regional Priorities for MPAs

5.6.1 Defining Gaps and Priorities

IMCRA can be used to identify the gaps in the current system of Marine Protected Areas in South Australia (and Australia) and to set priorities for allocating planning and management resources to fill these gaps (IMCRA 1997). A suite of conservation planning attributes, which may be combined to identify broad gaps in the current system of protected areas and set priorities for developing a NRSMPA, are under consideration by Commonwealth and State/Territory jurisdictions under the ANZECC Taskforce on Marine Protected Areas.

Potential marine conservation planning attributes identified include:

- the **reservation status** of each bioregion or biounit;

- the **level of bias** within protected areas, ie. how comprehensively the existing protected areas in each bioregion or biounit sample the known environmental variation;

- **ecosystem integrity**, ie. the health of each ecosystem in each bioregion or biounit;

- **risks and limiting factors** in establishing a viable NRSMPA;

- **alternative conservation planning and management measures** (for eg. statutory protection, planning instruments, and voluntary conservation agreements).

Three levels of priority are being considered in establishing the NRSMPA, using a combination of: (1) level of reservation status; (2) the level of bias in the comprehensiveness of ecosystems within MPAs; and (3) the threatening processes:

- ***Priority 1***

- nil MPAs or low reservation status,
- nil MPAs and/or high bias in the comprehensiveness of ecosystems within MPAs, and
- threatened by current resource use activities and/or management.

- ***Priority 2***

– low to moderate reservation status;
– high to moderate bias in the comprehensiveness of ecosystems within MPAs; and
– threatened by current resource use activities and/or management.

- ***Priority 3***

– moderate to high reservation status;
– moderate to low bias in the comprehensiveness of ecosystems within MPAs; and
– not threatened by current resource use activities and/or management.

The order of these priorities reflect that the highest priority is to be given to those IMCRA bioregions or biounits where there is greatest need (IMCRA 1997). Second and third level priorities are allocated to lesser needs.

While IMCRA at the bioregion or mesoscale may be used for broad identification of gaps, it is not appropriate for reserve identification and selection, which must occur at a much finer scale, ie. microscale or biounit scale (IMCRA 1997). Similarly, IMCRA alone should not be used as the sole criterion for allocating priorities in the selection of areas for reservation (IMCRA 1997).

5.6.2 Methodology for SA Gap Analysis

In South Australia, the following steps and criteria can be used in defining the reserve priorities at the bioregion scale:

- ***Step 1***

- **Assess Level of Endemism and/or Rarity** of each mesoscale bioregion or microscale biounit – all southern temperate regions of Australia have very high levels of endemism (ie. >90%), however, within this region, the gulfs ecosystems are recognised as containing distinct endemic elements. Due to past sea level changes, the ecosystems of western Eyre Peninsula, particularly the offshore islands, are also recognised as containing isolated populations and rare fauna and flora.

- ***Step 2***

- **Assess Reservation Status** of each bioregion or biounit:

– very low (<1%)
– low (1-10%)
– medium (10-30%)
– high (>30%)

- ***Step 3***

- **Assess the Level of Bias or Representativeness** within protected areas for each bioregion or biounit by examining:

– the range and proportion of habitats within each bioregion or biounit;

– the range and proportion of habitats within existing MPAs for each bioregion or biounit.

- ***Step 4***

- **Existing and Potential Threats to Ecosystem** in each bioregion or biounit by examining:

– ***water quality:*** land-based marine pollution discharges;
– ***habitat integrity:*** habitat loss/degradation, dredging, trawling, feral pests;
– ***coastal development:*** coastal population pressure, tourism, recreation;
– ***marine developments:*** aquaculture (ie. fish farms, shellfish farms), mining & petroleum leases.

- ***Step 5***

- Assign Priorities to Bioregions and Biounits for MPA Establishment Based on Steps 1-4.

Priorities for conservation were defined by adding up the cumulative score for reservation status (1-4), bias (1-4), threats (1-4) and biodiversity/endemism (1-2). 'Threats' were weighted by multiplying by a factor of two prior to aggregation. Priorities were arbitrarily ranked as follows: high (scores equal or greater than 15); moderate (scores equal or greater than 12, but less than 15); low (scores less than 12).

In some cases, there are widely ranging differences in the level of existing and potential threats within a bioregion. For instance, the Eyre Bioregion has both areas of high population and high human impact (eg. Port Lincoln), but also, areas of very low coastal population and high habitat integrity and water quality (eg. southern-western Eyre Peninsula). In these instances, an indicative range (and value) was given of the level of threats within a bioregion.

5.6.3 Defining Gaps and Priorities for MPAs at the Bioregional Level

- ***State and Commonwealth Waters***

On the basis of the IMCRA regionalisation (see Chapter 3), ecologically and biogeographically, many bioregions and habitats are under-represented as MPAs in South Australia (see Table 5.8). The Eucla Bioregion is the only bioregion with significant representation of MPAs (ie. 3 MPAs or 16.9% of the total area of the bioregion). In contrast, Eyre, Spencer Gulf, St Vincent Gulf, Coorong and Otway bioregions have very low representation of MPAs (ie. <1% of the total area). The Murat Bioregion has no representation of MPAs at all.

Bioregion	Area of Bioregion (ha)	Number of MPAs (% SA)	Area of MPAs (ha)	% MPA in Bioregion	Reservation Status
Eucla	11,111,514	3	1,881,748	16.9	moderate
Murat	3,558,736	0	0	0	nil
Eyre	7,216,500	5	1,722	0.07	very low
Spencer Gulf	1,187,451	1	54	0.005	very low
Northern Spencer Gulf	444,803	3	7,816	1.76	low
St Vincent Gulf	1,283,817	14	8,641	0.6	very low
Coorong	3,197,170	2	10,018	0.08	very low
Otway	3,733,126	3	1,304	0.35	very low
Total Area (inshore, offshore)	**32,000,000**	**31**	**1,911,334**	**5.97**	low

Table 5.8 **The status of MPAs, at a bioregional level, in the offshore and inshore waters off South Australia.**

The consequences of the present system of MPAs, is that biogeographically, major provinces and bioregions and habitats are either not represented or poorly represented as MPAs. This includes the habitats, communities or ecosystems of the cold temperate Maugean Subprovince of the south-east (east of Robe), and also, the marine habitats, communities and ecosystems associated with the spectacular limestone cliff formations and dune transgressions on the west coast of South Australia. Specifically, kelp communities, rocky reefs, soft-bottom benthos, estuaries, beach habitats and wave-exposed cliffs habitats, are significantly under-represented in South Australia.

- ***Offshore (Commonwealth) Waters***

Until recently, no offshore areas off South Australia were reserved as Marine Protected Areas. In April 1998, the Commonwealth Government approved the proclamation of the Commonwealth waters component of the Great Australian Bight Marine Park. The park covers 1 713 429 ha, including a band 20 nautical miles wide which extends from the State park boundary to the edge of the Exclusive Economic Zone. Within the Commonwealth waters component, 382 477 ha along the coastline have been reserved for marine mammal protection, while a further 1 330 952 ha has been designated to conserve the benthic fauna and flora. With the establishment of the Commonwealth component of the Great Australian Bight Marine Park, the Eucla Bioregion remains the only bioregion in South Australia with protection of offshore waters.

- ***State Waters***

When State jurisdictional waters are examined it can be seen that similar patterns of reservation status and representativeness emerge (see Table 5.9). The Eucla Bioregion emerges with a high reservation of MPAs, while the remaining bioregions have low to nil reservation.

Bioregion	SA Area of Bioregion (ha)	Number of MPAs (% SA)	Area of MPAs (ha)	% MPA in Bioregion (SA)	Reservation Status
Eucla	189,073	2	168,319	89.02	high
Murat	133,703	0	0	0	nil
Eyre	1,425,723	5	1,722	0.12	very low
Spencer Gulf	1,199,299	1	54	0.005	very low
Northern Spencer Gulf	478,824	3	7,816	1.63	low
St Vincent Gulf	1,441,971	14	8,641	0.60	very low
Coorong	178,575	2	10,018	5.61	low
Otway	120,639	3	1,304	1.08	low
Total Area (inshore waters)	5,167,807	30	197,905	3.83	low
SA Waters	6,094,800	30	197,905	3.2	low

Table 5.9 The status of MPAs, at a bioregional level, in the inshore waters off South Australia.

When the representation of habitats within bioregions and the existing MPAs are compared (see Table 5.10), the following bioregional gaps and priorities for MPAs for South Australia emerge:

- ***Eucla Bioregion***

– High reservation status, high representation status, particularly for sand and reefal habitats.

- ***Murat Bioregion***

– Nil reservation status, nil representation status for mangroves, seagrass, sand and reefal habitats.

- ***Eyre Bioregion***

– Very low reservation status, low representation status, particularly for sand and seagrass habitats.

- ***Spencer Gulf Bioregion***

– Very low reservation status, low representation status, particularly for mangroves, seagrass and sand habitats.

- ***Northern Spencer Gulf Bioregion***

– Moderate reservation status, low representation status, particularly for sand and reef habitats.

- ***Gulf St Vincent Bioregion***

– Low reservation status, low representation status, particularly for sand and seagrass habitats.

- ***Coorong Bioregion***

– Very low reservation status, low representation status, particularly for reef and seagrass habitats.

- ***Otway Bioregion***

– Low reservation status, low representation status, particularly for reef and sand habitats.

When reservation status, adequacy (based on representation), levels of endemism and threats (existing and potential are examined at the bioregional level (see Table 5.11), then the Murat and Gulf St Vincent Bioregions emerge as the highest priority regions for MPA establishment.

5.6.4 Defining Conservation Status and Gaps at the Biounit Level

Similar patterns in reservation status and bias emerge when examining the status of MPAs at the microscale biounit level. (See Tables 5.12, 5.13 and 5.14).

Bioregion	% Seagrass Bioregion	% Reef Bioregion	% Sand Bioregion	Major Habitats in MPAs	Adequacy or Bias
Eucla	0.0	11.5	88.5	sand, reef	high
Murat	61.3	17.2	21.5	nil	low
Eyre	19.2	24.6	56.2	reef	low
Spencer Gulf	41.2	18.3	40.5	reef	low
Northern Spencer Gulf	58.1	6.9	34.9	mangroves, seagrass	moderate
St Vincent Gulf	59.6	14.5	25.9	mangroves, seagrass, reef	low
Coorong	12.4	48.2	39.5	sand	low
Otway	0.1	87.4	12.6	reef, sand	low
Total	**43.9**	**19.4**	**36.7**		

Table 5.10 Status of bioregional representation of major inshore habitats within MPAs in South Australia.

Bioregion	Endemism / Rarity	Reservation Status	Adequacy or Bias	Threats	Priority For MPAs
Eucla	1	1	1	2	low
Murat	1	4	3	4	high
Eyre	1	4	3	3	moderate
Spencer Gulf	2	4	3	3	high
Northern Spencer Gulf	2	3	2	4	high
St Vincent Gulf	2	4	3	4	high
Coorong	1	3	3	2	low
Otway	1	4	3	2	moderate

Table 5.11 **Priorities for MPA establishment at the bioregional level, for the inshore waters of South Australia.**

Biounit	Area of Biounit (ha)	Number of MPAs (% SA)	Area of MPAs (ha)	% MPA in Biounit	Major Habitats in MPA
1 Nullarbor	842,642	1	168,319	100	sand, reef
2 Wahgunyah	195,381	2	168,319	100	sand, reef
3 Fowlers	146,486	0	0	0	nil
4 Nuyts	283,165	0	0	0	nil
5 Streaky	190,949	0	0	0	nil
6 Yanerbie	82,854	1	230	0.28	reef
7 Newland	45,238	0	0	0	nil
8 Flinders	125,957	0	0	0	nil
9 Sheringa	51,156	0	0	0	nil
10 Douglas	67,645	0	0	0	nil
11 Whidbey	132,689	0	0	0	nil
12 Jussieu	240,439	0	0	0	nil
13 Dutton	255,443	0	0	0	nil
14 Franklin	198,588	0	0	0	nil
15 Yonga	55,267	1	3,230	5.84	mangroves, seagrass, sand
16 Winninowie	423,557	2	4,586	1.08	mangroves, seagrass, sand
17 Tiparra	243,228	0	0	0	nil
18 Wardang	285,583	1	54	0.02	reef
19 Pondalowie	22,130	1	350	1.58	reef
20 Gambier	536,544	0	0	0	nil
21 Sturt	183,058	0	0	0	nil
22 Investigator	280,063	0	0	0	nil
23 Orontes	183,762	2	490	0.27	reef
24 Clinton	249,136	5	5,731	2.3	mangroves, seagrass
25 Yankalilla	51,562	2	805	1.56	reef
26 Sprigg	160,548	0	0	0	nil
27 Backstairs	35,911	0	0	0	nil
28 Nepean	102,304	1	1,525	1.49	seagrass
29 Cassini	45,760	0	0	0	nil
30 Gantheaume	167,363	3	1,140	0.68	reef
31 Encounter	39,389	1	460	1.17	reef
32 Coorong	1,290,715	2	10,018	0.78	sand
33 Canunda	233,897	3	1,304	0.55	reef
34 Nene	32,543	0	0	0	nil
35 Piccaninnie	44,923	0	0	0	nil
TOTAL					

Table 5.12 **Marine Protected Area status at the biounit level, for the inshore waters of South Australia.**

Biounit	% Seagrass Biounit	% Reef Biounit	% Sand Biounit	Major Habitats in MPAs	Adequacy or Bias
36 Nullarbor	0.0	24.8	75.2	sand, reef	high
37 Wahgunyah	0.0	5.8	94.2	sand, reef	high
38 Fowlers	6.2	81.9	11.9	nil	nil
39 Nuyts	5.3	91.6	3.1	nil	nil
40 Streaky	77.6	2.1	20.2	nil	nil
41 Yanerbie	30.0	26.4	43.6	reef	low
42 Newland	0.0	42.8	57.2	nil	nil
43 Flinders	0.0	100.0	0.0	nil	nil
44 Sheringa	1.3	94.1	4.6	nil	nil
45 Douglas	23.1	26.8	50.1	nil	nil
46 Whidbey	0.0	11.9	88.1	nil	nil
47 Jussieu	37.1	20.0	42.9	nil	nil
48 Dutton	98.5	0.8	0.7	nil	nil
49 Franklin	10.9	27.7	61.4	nil	nil
50 Yonga	59.1	2.4	38.5	mangroves, seagrass, sand	moderate
51 Winninowie	30.4	0.0	69.6	mangroves, seagrass, sand	high
52 Tiparra	81.3	4.4	14.3	nil	nil
53 Wardang	18.0	37.3	44.7	reef	low
54 Pondalowie	0.1	15.9	83.9	reef	low
55 Gambier	23.1	8.4	68.4	nil	nil
56 Sturt	75.0	14.9	10.1	nil	nil
57 Investigator	0.0	0.0	100.0	nil	nil
58 Orontes	56.5	36.9	6.6	reef	low
59 Clinton	84.4	2.1	13.5	mangroves, seagrass	moderate
60 Yankalilla	30.0	7.7	62.2	reef	low
61 Sprigg				nil	nil
62 Backstairs	52.1	41.1	6.8	nil	nil
63 Nepean	49.6	4.5	45.9	seagrass	moderate
64 Cassini	4.2	14.3	81.6	nil	nil
65 Gantheume	2.4	60.5	37.1	reef	low
66 Encounter	5.4	57.8	36.9	reef	low
67 Coorong	14.7	41.2	44.2	sand	moderate
68 Canunda	0.0	90.5	9.5	reef	low
69 Nene	0.0	97.7	2.3	nil	nil
70 Piccaninnie	1.3	19.2	79.6	nil	nil
TOTALS	**40.9**	**20.6**	**38.5**		

Table 5.13 **Adequacy of existing MPAs at the biounit level, for major inshore habitats in South Australia.**

Biounit	Endemism /Rarity	Reservation Status	Adequacy or Bias	Threats	Conservation Priority
71 Nullarbor	1	1	1	2	low
72 Wahgunyah	1	1	1	2	low
73 Fowlers	1	4	4	2	moderate
74 Nuyts	2	4	4	3	high
75 Streaky	1	4	4	4	high
76 Yanerbie	1	3	3	2	low
77 Newland	1	4	4	2	moderate
78 Flinders	2	4	4	2	moderate
79 Sheringa	1	4	4	2	moderate
80 Douglas	1	4	4	3	high
81 Whidbey	1	4	4	2	moderate
82 Jussieu	2	4	4	4	high
83 Dutton	2	4	4	3	high
84 Franklin	2	4	4	3	high
85 Yonga	2	2	2	4	moderate
86 Winninowie	2	2	1	3	low
87 Tiparra	2	4	4	3	high
88 Wardang	2	3	3	3	moderate
89 Pondalowie	2	3	3	2	moderate
90 Gambier	2	4	4	3	high
91 Sturt	2	4	4	3	high
92 Investigator	2	4	4	2	moderate
93 Orontes	2	3	3	4	high
94 Clinton	2	2	2	4	moderate
95 Yankalilla	2	3	3	4	high
96 Sprigg	2	4	4	2	moderate
97 Backstairs	2	4	4	4	high
98 Nepean	2	3	2	4	high
99 Cassini	2	4	4	4	high
100 Gantheaume	2	3	3	3	moderate
101 Encounter	2	3	3	4	high
102 Coorong	1	2	2	2	low
103 Canunda	1	3	3	3	moderate
104 Nene	1	4	4	2	moderate
105 Piccaninnie	1	4	4	2	moderate
TOTAL					

Table 5.14 **Conservation status and priorities at the biounit level, for the inshore waters of South Australia.**

5.7 Identification of Potential Marine Protected Areas in South Australia

5.7.1 Delphic vs. Analytic Approaches

The identification of areas of high conservation significance, for establishment as potential Marine Protected Areas, can utilise informal approaches, such as the qualitative, best guess of experts (ie. `delphic' approach) or more formal, systematic approaches utilising guidelines, criteria and priority-setting frameworks (ie. `analytic' approach).

In South Australia, the identification of areas of conservation significance has, until recently, principally adopted an `expert panel' or `delphic' approach, utilising existing `qualitative' biophysical/biogeographical information and the best technical judgements of local experts. This involved the hosting of a technical workshop on the identification of a ecologically representative system of Marine Protected Areas in South Australia in November 1991 and the formation of the SA Marine Protected Areas Technical Working Group to identify potential MPAs in November 1991; and regular technical reviews of the proposed scientific framework and list of recommended potential MPAs by the SA MPA Technical Working Group (see Edyvane and Baker 1995).

5.7.2 Criteria for Identifying Areas of Conservation Significance

The present approach to identifying areas of high marine conservation value in South Australia, utilises a analytic approach, which applies formal criteria, based on a range of ecological, social and economic criteria to identify areas of high conservation value (for establishment as potential Marine Protected Areas). Application of these criteria acknowledges:

- previous recommendations of the SA Marine Protected Areas Technical Working Group (see Edyvane and Baker 1995);
- areas of recognised State significance (eg. National Parks, Conservation Parks;
- Conservation Reserves, sites listed on the SA Heritage List, historic shipwrecks, geological monuments);
- areas of recognised national significance (eg. Wetlands of National Importance, sites listed on the Register of the National Estate);
- areas of recognised international significance (eg. RAMSAR listed sites).

Marine Protected Areas (MPAs) formally recognise the conservation significance of habitats, species and ecosystems. MPAs range from small high protection areas, such as Aquatic Reserves, which exclude exploitative activities to large, zoned multiple-use areas, such as Marine Parks, which allow a range of sustainable activities, compatible with the primary conservation objective. The following is a list of formal criteria endorsed by IUCN (Kelleher & Kenchington 1991) and nationally (Environment Australia 1998), which can used in both the identification and selection process for establishing Marine Protected Areas:

- ***Naturalness***
  - This is the extent to which the area has been protected from, or has not been subject to human-induced change (eg. wilderness areas).

- ***Biogeographic Importance***
  - An area which possesses either rare biogeographic qualities or is representative of a biogeographic "type" or types; contains unique or unusual geological features.

- ***Ecological Importance***
  - An area which contributes to maintenance of essential ecological processes or life-support systems eg. source for larvae for downstream areas; integrity - the degree to which the area either by itself or in association with other protected areas, encompasses a completer ecosystem; contains a variety of habitats; contains habitat for rare or endangered species; contains nursery or juvenile areas (eg. seagrass, mangroves); contains feeding, breeding or rest areas; contains rare or unique habitat for species; preserves genetic diversity, ie. is diverse or abundant in species terms.

- ***Economic Importance***
  - An area of existing or potential contribution to economic value by virtue of its protection eg. protection of an area for recreation, subsistence, use by traditional inhabitants, appreciation by tourists and others or as a refuge nursery area or source of supply for economically important species (eg. fish nursery/breeding/feeding areas).

- ***Social Importance***

– An area of existing or potential value to the local, national or international communities because of its heritage, historical, cultural, traditional aesthetic, educational or recreational qualities.

- ***Scientific Importance***

– An area of value for research and monitoring (eg. research sites in which to demonstrate ecological processes or monitor global change)

- ***International or National Significance***

– An area which is or has the potential to be listed on the World or a national Heritage List or declared as a Biosphere Reserve or included on a list of areas of international or national importance or is the subject of an international or national conservation agreement.

- ***Practicality and Feasibility***

– An area with a degree of insulation from external destructive influences; social and political acceptability, degree of community support; accessibility for education, tourism, recreation; compatibility with existing uses, particularly by locals; ease of management, compatibility with existing management regimes (eg. adjacent to terrestrial parks).

Areas adjacent to terrestrial parks benefit from their proximity to terrestrial parks because there are likely to be less environmentally damaging threats to the marine environment from the controlled and protected terrestrial sources within the park. As such, terrestrial parks act as buffer zones to MPAs. The preservation of MPAs adjacent to terrestrial parks is also important because their combined areas increase the total area of protection more efficiently than reserving MPAs in isolation.

By examining a range of these IUCN attributes it is possible to identify areas of high conservation values in South Australia, based on a range of natural, social, economic and cultural criteria. Areas in South Australia of where these IUCN attributes apply are based on application of the formal criteria, and are outlined later in this report for each coastal region and recognised biounit.

5.7.3 Sites of Recognised Conservation Significance

5.7.3.1 Wetlands of International and National Importance Significance

Under the Ramsar Convention on Wetlands of International Importance, Australia is committed to protecting and managing ecological significant wetland and waterfowl habitat. In recent years, States and Territory conservation agencies have been assisting the Commonwealth in developing a national inventory, of all important wetlands in Australia, known as the 'Directory of Important Wetlands in Australia' (ANCA 1996, see Table 5.12). The definition of a wetland utilises the Ramsar Convention definition:

"areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or sal, including areas of marine water the depth of which does not exceed six metres".

In South Australia, several coastal and marine wetlands of national importance have been identified and are suitable for consideration as potential Marine Protected Areas (see Table 5.12). Identification was based on a formal assessment process, which encompassed a range of biogeographic, ecological and socio-cultural criteria, which were defined by the ANZECC Wetlands Network in 1994 (see ANCA 1996).

Region	Coastal And Marine Wetlands Of National Importance
Coorong	Coorong Lagoon (including Lake Alexandrina, Lake Albert),Tookayerta and Finniss River.
Eyre	Davenport Creek (Tourville Bay), Streaky Bay (Acraman Creek), Point Labatt, Baird Bay, Lake Newland, Lake Hamilton, Coffin Bay, Tod River, Tumby Bay.
Kangaroo Island	American River, Cygnet River, D'Estres Bay, Rocky River, Breakneck River, North West River, South West River.
Spencer Gulf	upper Spencer Gulf mangroves (from Port Augusta, south to Whyalla and Jarrold's Point, Fisherman's Bay and Port Broughton), Franklin Harbor.
Gulf St Vincent	Clinton, Barker Inlet estuary, Wills Creek, Davenport Creek, Port Gawler.
South-East	Butchers and Salt Lakes, Ewens Ponds, Piccaninnie Ponds and the coastal lakes of Lake Robe, Eliza, George, and St Clair.

Table 5.12 **Coastal and marine wetlands in South Australia of recognised national importance, as identified in the in the `Directory of Important Wetlands in Australia' (ANCA 1996).**

5.7.4.2 Sites on the Register of the National Estate

There are a large number of coastal sites of natural significance in South Australia which have been identified, described and assessed as areas of high natural heritage values, and are currently listed on the Register of the National Estate. For this reason, existing sites on the Register of the National Estate in many cases are generally suitable for consideration as potential Marine Protected Areas. Importantly, the formal identification and assessment process required for heritage listing provides comprehensive, systematic criteria and goals (ie. natural, social, economic, cultural), which are generally relevant in the identification and selection process for potential Marine Protected Areas.

5.8 Selection of Marine Protected Areas in South Australia

5.8.1 Approaches to Selection of Marine Protected Areas

A rich literature exists on the criteria for establishing terrestrial nature parks (Smith & Theberge 1986) and many of these criteria have been used in the selection of marine parks (eg. Salm 1989). The most widely used classification scheme for marine parks is that proposed by Ray (1975). This scheme allows for development of a system of parks which will include a range of habitat types and is reflective of ecosystem processes. The criteria formulated by Ray (1995) for selection of parks is a combination of ecological, cultural, recreational and educational criteria and also involves the feasibility of physically and economically preserving and managing the area. The ecological criteria include representativeness, uniqueness, diversity, naturalness, natural unity and inclusiveness. Cultural, educational and recreational criteria take into account diversity types of organisms and abundance, physiography and topography, uniqueness and rarity, climate, weather and oceanographic conditions, cultural value and scientific value. The last set includes pragmatic criteria such as the value for research and monitoring, degree of threat or fragility, feasibility, redundancy, national and international value and educational, recreational and economic value. Although these criteria for choosing a site as a marine park are extensive, it is impossible to be entirely objective in choosing one area over others as worthy of preservation. A systematic selection of marine parks is also needed to ensure that representative areas are selected.

5.8.2 MPA Selection Issues

The prime objective in the establishment of a representative system of MPAs is the protection and conservation of marine and coastal ecosystems. There is a wide range of issues which must be considered in selecting between alternative protected area system designs. The final location, size and boundaries of contributing areas, where there is any flexibility available, will usually be influenced by numerous factors other than representation alone. Examples include:

- habitat/area requirements of rare or other species and their minimum viable population sizes;
- connectivity between units (corridors) to permit wildlife migration, or isolation to minimise transfer of disease, predators and the like;
- perimeter/area relationships;
- natural system linkages and boundaries – eg. watersheds (surface and groundwater), volcanism, ocean currents, aeolian or other active geomorphic systems;
- accessibility to undertake management operations or inaccessibility to deter potentially impacting activity;
- existing degradation or external threats;
- traditional use, occupance and sustainability;
- cost of achieving protected area status (most commonly land acquisition, compensation or transfer costs, or costs of establishing co-management mechanisms).

Although the criteria for choosing sites as MPAs are extensive, it is impossible to be entirely objective in choosing one area over others as worthy of preservation. For this reason it is important that a systematic selection of MPAs occurs to ensure that representative areas are selected. IUCN (see Kelleher & Kenchington 1991) have identified a range of factors or criteria that can be used in deciding whether an area should be included in a MPA or in determining the boundaries for a MPA.

One of the major factors to consider in the selection of MPAs is the degree of `connectedness' of the marine environment. For these reasons, proximity to present or potential environmental threats, whether marine or land-based, is very important in the selection of MPAs. As such, ACIUCN (1986) endorsed the principle of, wherever possible, incorporating terrestrial and marine environments in one planning or management unit.

While no formal national guidelines currently exist for selecting and prioritising Marine Protected Areas, the IUCN MPA criteria can be applied in various systematic approaches to provide a rational, defensible and objective approach to selecting and prioritising MPAs in establishing a representative system of MPAs. Appendix 1 contains a methodology currently being developed by WA CALM (CALM 1998) to assist the WA Government in selecting and prioritising MPAs in Western Australia.

5.8.3 Proposed Guidelines for MPA Selection and Prioritisation in South Australia

- ***Step 1***
- ***Identify Status, Targets and Priorities***

– Assess bioregional and biounit conservation status and set targets and priorities for MPA establishment in South Australia (see Sections 5.6.3 and 5.6.4).

- ***Step 2***
- ***Identify Candidate Areas Based on IUCN MPA Criteria***

– Identify candidate MPAs for each bioregion based on Part II of this report which has identified areas of high conservation value in each biounit based on IUCN Criteria.

- ***Step 3***
- ***Select and Prioritise Candidate Areas Based on Standardised Selection Methodology***

– With information contained in Part II of this report, select and prioritise MPAs, using a standardised methodology (for eg. the WA CALM methodology).

Relate weightings to bioregional and biounit priorities identified in Step 1.

5.9 Management of Individual MPAs

5.9.1 Management Agency

MPAs might ideally be managed by a single agency. This is because the management of ecologically sustainable uses and activities, in addition to the conservation of biodiversity, is best achieved through a coordinated and integrated framework. However, in Australia, MPAs are generally managed at a State level by a number of agencies. In South Australia, like most States, resource management and conservation objectives are separated, with MPAs being successfully established and managed jointly under fisheries legislation (ie. *Fisheries Act 1982*) and national parks (or equivalent) legislation (ie. *National Parks & Wildlife Act 1972*).

5.9.2 Guidelines for Establishment of Individual MPAs

Various guidelines exist for the establishment and management of a MPA (Salm & Clark 1984, Kelleher & Kenchington 1991). Kelleher and Kenchington (1991) have outlined the following sequence or hierarchy of decision-making in the establishment of a MPA:

- ***Stage 1***

– Legal establishment of boundaries

- ***Stage 2***

– Zoning

- ***Stage 3***

– Enactment of zoning regulations

- ***Stage 4***

– Specific site planning

- ***Stage 5***

– Specific site management

- ***Stage 6***

– Day-to-day management

- ***Stage 7***

– Review and revision of management

At each of these stages of decision-making, it has been recommended that the following factors should be taken into account, with the level of detail in which these factors are presented and considered, increasing from Stage 1 to Stage 7:

- geographic habitat classification
- physical and biological resources
- climate
- access
- history
- current usage
- management issues and policies
- management resources

In South Australia, the establishment and management of MPAs should also recognise the national guidelines recommended and endorsed by the Council for Nature Conservation Ministers or ACIUCN (1986):

- collection of baseline data on at least the resources present and the usage levels, prior to or concurrently with, the development of a MPA proposal;

- preparation of a management plan which has, as a paramount consideration the maintenance of the ecosystem;

- close collaboration among agencies with responsibilities within and adjacent to MPA boundaries;

- subsequent to declaration, wherever possible, a regular monitoring program should be undertaken which would include:

- assessment of the extent to which the objectives identified for each MPA are being achieved;

- assessment of possible impacts on the ecosystem from human activity;

- refinement of and adjustments to the management plan;

- any necessary subsequent adjustments to legislation.

- development of an effective enforcement program which would include penalties for gross or persistent infringement of regulations;

- the use of regular surveillance to monitor activities and usage in MPAs. Such surveillance will contribute to safety, acquisition of resource data and act as an effective deterrent. Aerial surveillance offers a most appropriate and cost-effective, multi-purpose management tool, especially for larger or widely-dispersed, relatively inaccessible MPAs;

- development of a comprehensive and well-planned education and information programs to increase public awareness of MPAs;

- regular review of management plans on the basis of monitoring and research data.

5.9.3 The Management Planning Process

A management plan is the means by which the planners and managers define the purposes for which a MPA may be used. In many cases the zoning and management plan may be synonymous. For large MPAs, the important objectives of a management plan will be both, the integrated management of the entire ecosystem (in some cases like the Great Australian Bight Marine Park, large MPAs may in fact encompass whole ecosystems), and also, site specific management appropriate to various areas within the MPA. Achieving the first objective will require a broad strategic approach to sustainable use and management of natural resources and environments (such as fishing and pollution), on a scale which matches the scale of marine ecosystems. The second objective will require tactical site or habitat management to address specific objectives of biodiversity preservation, research, education and recreation.

A zoning or management plan is likely to be successful only if planning is carried out systematically using a holistic, interdisciplinary or `systems' approach and if the plan is supported by the majority of the users and neighbours of a MPA. As such, public participation should be a key element in the drawing up of any zoning plan for a MPA. Kelleher and Kenchington (1991) outline 5 desirable stages in the development of a zoning plan for a MPA:

106 Initial Information Gathering and Preparation

107 Public Participation or Consultation - Prior to the Preparation of a Plan

108 Preparation of a Draft Plan

109 Public Participation or Consultation - Review of Draft Plan

110 Plan Finalisation

The format of a zoning or management plan will depend on the legislative basis and upon conventions and procedures of the government agencies responsible for and involved in the plan development. An example of a management plan for a MPA is shown in Table 5.13. In addition, international guidelines now exist to assist in the drawing up of management and zoning plans for MPAs (see Kelleher & Kenchington 1991).

5.9.3.1 The Need for Buffer Zones

In managing human activities within a MPA, the idea of fences or boundaries to protect critical areas is purely nominal. The concept of protecting specific areas in the marine environment must provide for buffer zones. This is because water has the potential ability to transport not only pollutants, but also, nutrients and marine organisms, into or out of protected areas. As such, zoning or management plans for MPAs should incorporate buffer and transition zones if specific areas are to be protected.

This principle of a buffer zone protecting a core site from impact was originally developed under UNESCO's Biosphere Reserve system, and although it is well established for terrestrial environments, it application to marine environments is very recent. However, the more connected or open nature of marine environments suggest that the minimum area for protected areas and their buffer zones may have to be considerably larger in marine environments than in terrestrial environments, if external influences are to be adequately buffered or diluted.

Large multiple use MPAs are an ideal tool for establishing buffer and transition zones to protect core areas. As such, small, high protection areas such as Marine Reserves can be encompassed and protected within a broader integrated management regime afforded by a Marine Park. This concept has been encapsulated in the phrase: *`islands of protection in a sea of management'* and is widely acknowledged, both nationally and internationally, as providing the best protection for marine environments, while allowing sustainable resource use (see Kelleher & Kenchington 1991).

AN EXAMPLE OF A MPA MANAGEMENT PLAN

EXECUTIVE SUMMARY

INTRODUCTION

OBJECTIVES FOR MANAGEMENT

RESOURCE DESCRIPTION

- Name of Area and Location
- Geographic and Habitat Classification
- Conservation Status
- Access and Regional Context
- History and Development
  - Archaeology
  - Historical Relics
  - Written and Oral History
  - Recent Developments
  - Current Human Use and Development
- Physical Features
  - Coastal Landforms
  - Bathymetry
  - Tides
  - Salinity and Turbidity
  - Geology
  - Dominant Currents
  - Freshwater Inputs
- Climate
  - Precipitation
  - Temperature
  - Winds
- Plant Life
- Marine Fauna
- Miscellaneous

Table 5.13: A proposed outline for a Marine Protected Area management plan (after Kelleher & Kenchington 1991).

AN EXAMPLE OF A MPA MANAGEMENT PLAN (CONT.)

DESCRIPTION OF MANAGEMENT ISSUES

- Historic and Current Conflicts
- Pollution
- Future Demand
- Potential Conflicts

MANAGEMENT POLICIES

❖ Objectives

❖ Resource Units

- Natural
- Development Areas
- Areas of Impact

❖ Zoning

- Management Policies for Resource Units

SURVEILLANCE

MONITORING

EDUCATION AND INTERPRETATION

ENFORCEMENT

MAINTENANCE AND ADMINISTRATION

❖ Budget
❖ Staffing

INFORMATION SOURCES

APPENDICES

❖ Boundary and Area Description
❖ Legislation
❖ Plant Species
❖ Animal Species
❖ Special Features
❖ Past, Present and Proposed Use
❖ Maps

Table 5.13 (continued).

5.9.4 Management Tasks

Within the agreed management framework for MPAs, the tasks of developing, coordinating and implementing a framework of conservation and coordination is somewhat different from the sectoral management tasks. In general, the management of the various sectoral interests within the agreed framework is little changed except to the extent that they are required to operate within the broader framework. Hence, these should ideally continue to be conducted by those interests (Kenchington 1993). The sectoral management tasks continue to encompass:

- licensing and supervising equipment and maximising the sustainable efficiency of commercial fisheries;
- allocating sustainable yield between commercial and recreational fishing interests;
- licensing and supervision of recreational boating and related activities;
- supervising the use of sites protected for the purposes of research, education, recreation and tourism.

While these are specialised management activities, it is important to note that they can still be undertaken within a single agency through specialised sub-units. In general, these tasks may be achieved utilising a combination of instruments to achieve the desired level of usage:

- establishing area boundaries for specific activities;
- enforcing closure during parts of the year critical to life histories of species or for longer periods;
- setting size limits, maximum permitted catches, harvest limits;
- prohibiting or limiting use of unacceptable equipment;
- licensing or issue of permits to provide specific controls or to limit the number of participants in a form of use; or
- limiting access by setting a carrying capacity which may not be exceeded.

Other key management tasks of MPAs include training, education, surveillance or activity monitoring, enforcement, monitoring, impact prediction and management, and review (see Kenchington 1990).

5.9.4.1 Monitoring

The ecological integrity and protection of marine resources in an established MPA will depend on regular monitoring and research into the effects of human usage on the designated area. As such, three of the key elements of a management program for MPAs are essentially monitoring tasks:

111 surveillance or activity monitoring (ie. to assess how people are using the area);

112 monitoring (ie. to provide information on the condition of the managed area and the impacts on it from human use and other factors); and

113 impact prediction and management (ie. advance assessment of likely impact of new or altered uses, eg. facility development, and establishment of management conditions for that use) (Kenchington 1990).

In the assessment of impacts, monitoring should test predictions of likely impacts. However, it is important to note that regular monitoring can not only test the effectiveness of certain management regimes to provide protection for species and habitats, but can also, assess the effectiveness of reservation, by examining areas before and after establishment as MPAs.

5.9.4.2 Education

Effective education and promotion programs are a key element of the management of MPAs. Educational measures ensure that those user groups which are affected by a proposed MPA are aware of their rights and responsibilities under the management plan and also, that the community at large supports the goals and objectives of the legislation. Few countries can afford the cost of effective enforcement in the presence of a generally hostile public. Conversely, where public support exists, costs of enforcement can be very low (Kelleher & Kenchington 1991).

Further, a well designed education and public involvement program can generate political and public enthusiasm for a proposed MPA, together with its goal and objectives. In particular, the establishment of the concept of `local ownership',ie. that it is the people's MPA, can generate local support and pride and commitment to the MPA's objectives.

5.9.4.3 Review

Statutory provision for a review of zoning or other protective arrangements within a specified time is seen as an important part of the management of MPAs. The period between reviews should be neither so short that lack of resources is a problem, nor so long that management is not responsive, 5-7 years is preferable (Kelleher & Kenchington 1991). The review must have as its basis the monitoring of impacts, of patterns of use, of the effectiveness of implementation of existing management arrangements and improved scientific understanding.

5.9.4.4 Community Participation

Public participation is one of the most important elements in the management of MPAs. Unless users are persuaded that the restrictions are reasonable and likely to achieve a useful purpose, measures to protect the environment are likely to be costly and ineffective. This is particularly true in marine environments where the environment and its resources are `common property' and where it is often very difficult to define and close boundaries or to establish and check entry points. Hence, without public and user commitment to the planning process and its outcomes, any marine or maritime management strategy will probably fail.

Multiple-users of the marine environment and its resources effectively means that there are multiple-owners. Hence, it follows that the essential issues of marine conservation strategy and the role of protected areas within it cannot be addressed without coordination, consideration of the interests of, and involvement of all users. If it is to be effective, the coordination must not be dominated or directed by any one sectoral interests.

In encouraging community participation, usage patterns, expectations, attitudes and local knowledge of users should be determined in the planning stage. Planning should not be allowed to become the task of remote experts with no direct contact with or understanding of local issues (Kelleher & Kenchington 1991).

5.10 MPA Legislation

In issues of natural resource conservation it is generally the case that the views of the most powerful local interests in an area are strongly biased to realising short-term economic benefits. For this reason it has been strongly recommended that sufficient detail be written into law for management to be protected from unreasonable local pressures (Kelleher & Kenchington 1991). The following is a list of issues which IUCN (from Kelleher and Kenchington 1991) recommend be considered in establishing a legal framework for MPAs:

- ***Policy***

An overall policy on the management, sustainable use and conservation of marine and estuarine protected areas should be developed for the country as a whole, for regions of the country, where appropriate, and for any identified sites of particular significance. Ideally such a policy should also address coordination with management of coastal lands.

- ***Statement of Objectives***

Objectives encompassing conservation, recreation, education and scientific research should be written into legislation. A primary conservation objective in resource management legislation must be recognised as essential to sustained use and enjoyment of the resource.

- ***Linkages Between Marine Environments***

Linkages between marine environments should be recognised. Marine organisms, their food and pollutants can travel considerable distances in the marine environment. Hence to ensure effective management, legislation and policy should take into account regional, international and multi-lateral treaties or obligations.

- ***Ecologically Sustainable Use***

Legislation should recognise `ecosystem management', ie. recognise the linkage between protection and maintenance of ecological processes and habitats and the sustainable use of living resources. Explicit reference to the objectives and concepts of the World Conservation Strategy may reinforce the legislation and its effectiveness.

- ***Multiple Use Protected Areas***

It is strongly recommended that legislation be based upon sustainable multiple use managed areas (eg. the Biosphere Reserve concept), as opposed to isolated highly protected pockets in an area that is otherwise un-managed or is subject to regulation on a piecemeal or industry basis. Such umbrella legislation can be justified on the grounds of world-wide experience of conventional piecemeal protection of small marine areas alongside conventional fisheries management. This usually leads to over-exploitation and collapse, perhaps irreversible, of stocks of exploited species and progressive deterioration of the protected area. In designing umbrella legislation the following goals merit consideration:

- provide for conservational management over large areas;
- provide for a number of levels of access and fishing and collecting in different zones within a large area; and
- provide for continuing sustainable harvest of food and materials in the majority of a country's marine areas.

- ***Coordination***

Legislation should provide for coordination of planning and management, by all intra-government, inter-government and international agencies with statutory responsibilities within areas to be managed. Provision should be made to define the relative precedence of the various pieces of legislation which may apply to such areas. Because of the interconnectedness of species and habitats in marine ecosystems, the legislation should provide for control within protected areas over all marine and estuarine resources of flora, fauna, terrain and overlying water and air.

- ***Activities External to MPAs***

Because of the linkages between marine environments and between marine and terrestrial environments it is important that legislation include provisions for the control of activities which occur outside a MPA which may adversely affect features, natural resources or activities within the area. Often, low or high water marks constitute a jurisdictional boundary. Other boundaries exist between MPAs and adjacent marine areas. A collaborative and interactive approach between the governments or agencies with adjacent jurisdictions is essential. The ideal is to have integration of objective and approaches within a formal system of coastal zone management.

- ***Legal Powers***

The power to establish any marine protection/conservation management system should be provided by law, with approval and any subsequent amendments to require endorsement by the highest body responsible for such legislative matters in the country concerned. Establishment in this context includes the requirement that the legislation contain enough detail for:

- proper implementation and compliance;
- delineation of boundaries;
- providing adequate statements of authority and precedence; and
- providing infrastructure support and resources to ensure that the necessary tasks can be carried out.

- ***Management Arrangements***

If management is to succeed, inter-agency disputes, concerns, obstruction or delay must be minimised. It follows that legislation and management arrangements should grow from existing institutions unless there is overwhelming public and political support for completely new administrative agencies. Therefore:

- creation of new agencies should be minimised;
- existing agencies and legislation should be involved by inter-agency agreements where practicable;
- existing sustainable uses should be interfered with as little as practicable;
- existing staff and technical resources should be used wherever practicable;
- unnecessary conflict with existing legislation and administration should be avoided; and
- where conflict with other legislation and administration is inevitable, precedence should be defined unambiguously.

- ***Consistency with Tradition***

Legislation should be consistent with the legal, institutional and social practices and values of the nations and peoples enacting and governed by legislation:

– legislation should consider traditional law and management practices of indigenous people in the MPA;

– legislation should consider and reflect the critical consideration of customary or accepted ownership and usage rights of the MPA.

- ***Definitions***

Legislation should use standard terminology, particularly for goals, objectives and purposes of the legislation.

- ***Responsibility***

Legislation should identify and establish institutional mechanisms and specific responsibility for management and administration of marine areas. Responsibility, accountability and capacity should be specific and adequate to ensure that the basic goals, objectives and purposes can be realised. As well as government agencies, local government and administration, traditional village community bodies, individual citizens, clubs and associations with compatible goals, objectives and responsibilities should be involved in management when practicable.

- ***Management and Zoning Plans***

For a small MPA, a single series of management provisions may apply uniformly to all parts of the area. For multiple-use protected areas however, a more complex management plan or zoning plan will be needed to prescribe different management measures in different parts of the protected area. Legislation should require that a management plan be prepared for each managed area and should specify constituent elements and essential considerations to be addressed in developing the plan. Further, the legislation should include the concept of zoning as part of management. The legislation should require zoning arrangement to be described in sufficient detail to provide adequate control of activities and protection of resources. The provisions of zoning plans should over-ride all conflicting legislative provisions, within the constraints of international law.

- ***Public Participation***

Public participation should be provided for in legislation to participate with the planning or management agency in the process of preparing management and zoning plans for MPAs including: the preparation of the statement of MPA purpose and objectives; the preparation of alternative concept plans; the preparation of the final plan; and any proposed major changes to the plan.

- ***Preliminary Research and Survey***

International experience has shown that it is often a mistake to postpone, by legislation or otherwise, the establishment and management of MPAs until massive research and survey programs have been completed. Often, sufficient information to make strategically sound decisions regarding the boundaries of MPAs and the degree of protection to be provided to zones or areas within them already exists. Postponement of such decisions often leads to increasing pressure on the areas under consideration and greater difficulty in making the eventual decision. Provision in legislation for periodic review of management and zoning plans allows their continual refinement as user demands change and research information becomes available.

- ***Monitoring, Research and Review***

The legislation should provide for surveillance of use in order to determine the extent to which users adhere to the provisions of management, for monitoring to determine the condition of the managed ecosystem and its resources and for research to assist in development, implementation and assessment of management. The legislation should provide for periodic review of management and zoning plans in order to incorporate desirable modifications indicated from the results of surveillance, monitoring and research. The processes of, and the degree of public participation in, plan review should be the same as for initial plan development.

- ***Compensation***

Consideration should be given, where local rights and practices are firmly established, to arrangements for specific benefit to local inhabitants in terms of employment in management or of compensation for lost rights, because experience has shown that the success of conservation management programs depends critically on the support of local people.

- ***Financial Arrangements***

Financial arrangements for management of marine areas should be identified in legislation according to local practice. Consideration should be given to establishing special funds whereby revenue arising from marine management can be applied directly back to the program or to affected local people.

- ***Regulations***

Legislation must provide authority for adequate regulations in order than activities can be controlled or as necessary prohibited. Three types of regulation should be considered: regulations to enforce a plan; interim regulations to provide protection to an area for which a plan is being developed; and external regulation to control activities occurring outside a managed area which may adversely affect features, resources or activities within the area.

- ***Enforcement and Penalties***

Legislation must provide adequate enforcement powers and duties. These should include:

– effective penalties for breach of regulations;

– incentives for self-enforcement of rules and regulations by users;

– adequate powers for professional field staff to take effective enforcement action;

– provisions, where feasible, for local people to reinforce or provide enforcement.

6 TOWARDS INTEGRATED MARINE CONSERVATION MANAGEMENT IN SA

6.1 The Need for `Off-Reserve' Marine Biodiversity Management

6.1.1 Rare, Endangered and Threatened Marine Species Management

While commercial marine species and marine mammal in South Australia have been afforded protection both, through specific fisheries/activities regulations and through the establishment of Marine Protected Areas, few non-commercial marine species are afforded similar specific legislative protection or management. Despite the very high level of endemism among the marine fauna and flora in South Australia, and the limited distribution of a number of marine species, only 1 non-commercial fish species is currently fully protected in South Australian waters under the *Fisheries Act*: the Leafy Sea Dragon (*Phycodurus eques*). No known rare, endangered or threatened species of invertebrates or marine plants (excluding mangroves) are currently afforded specific habitat or legislative protection in South Australia.

In line with international and national efforts to conserve rare, threatened and endangered fish species, fisheries management agencies are increasingly recognising the need to formally protect species through legislative mechanisms. Internationally, the publication of the *IUCN Red List* is (published by the World Conservation Union), is the recognised forum for technical specialist to formally assess the conservation status of endangered, threatened or rare flora and fauna, both terrestrial and marine species. While these lists are not comprehensive and in most cases, reliant on the degree of effort by specialist to conduct global assessments, they are widely recognised as the technical benchmark for conservation assessment of species.

Following recent amendments to the *NSW Fisheries Act 1994,* a total of 9 species of marine fish have been formally protected in NSW, including the Grey Nurse Shark (*Carcharius taurus*), Queensland Groper (*Epinephelus lanceolatus*), Elegant Wrasse (*Anampses elegans*), Ballina Angelfish (*Chaetodontoplus ballinae*), Black Cod (*Epinephalus daemelii*), Bleekers Devil Fish (*Paraplesiops bleekeri*), Estuary Cod (*Epinephelus suillus*), the Common Seadragon (*Phyllopteryx taeniolatus*) and most recently, the Great White Shark (*Carcharodon carcharias*).

In South Australia, only 2 species of marine fish are presently afforded protection status under the *Fisheries Act 1982*, the Leafy Seadragon (*Phycodurus eques*) and the Western Blue Groper (*Achorerdus gouldi*), which is afforded limited protection (in Gulf waters only). Despite this, there exists considerable evidence that South Australian waters, particularly gulf waters, are home to small populations of a number of species, particularly from the Family Sygnathidae (pipefishes, seahorses), which are not only unique to South Australia, but to the world. A recent study by CSIRO Fisheries on marine fish species in Australia, has concluded that the gulfs region of SA is a unique biogeographical region, and one of only nine distinct marine biogeographical regions identified in Australia. This was largely based on a number of small, endemic populations of Sygnathid fish species.

In Tasmania, the conservation significance and vulnerability of Sygnathid fish species has recently resulted in protection status being afforded to all species of the Family Sygnathidae under the *Fisheries Act*.

Species of Sygnathidae, and Clinidae (weedfishes) tend to be very vulnerable to human impacts because of their preference for very shallow, sheltered habitats, particularly seagrass areas. While selected species of Labridae (wrasses) and Plesiopidae (bluedevils, hulas) are increasingly under threat from spearfishing and aquarium collections. With increasingly threats to these species, particularly from coastal nearshore development and increasingly, the aquarium trade, there is a need for proactive conservation of these species in SA.

The *IUCN Red List* has recently identified a number of marine fish species in SA which should be afforded legislative protection by IUCN member states and countries. In SA, the species essentially comprise species of the Family Sygnathidae (pipefish, seahorses), reviewed in a previous global assessment by Dr Amanda Vincent. However, there are other species of fish, which have been afforded protection status in other States (ie. Tasmania, New South Wales) or been recommended for protection status by fish experts.

On the basis of their conservation status and vulnerability to human impacts and exploitation in SA waters, a number of marine fish species should be considered for full legislative protection status in SA jurisdictional waters under the *Fisheries Act 1982* (see Appendix 2). These include 15 species of Sygnthidae (pipefishes, seahorses), 2 species of Clinidae (weedfishes), 1 species of Labridae (wrasses), 4 species of Plesiopidae (bluedevils, hulas), and 4 species of Elasmobranchs (sharks, rays). Protecting these species would also complement recent conservation measures in New South Wales and Tasmania, and also, support recommendations from the *IUCN Red List*.

For the purposes of compliance, full protection status should be considered to all species of Sygnathidae (as recently implemented in Tasmania), and also, Clinidae and Gobiesocidae, as taxonomic difficulties makes it difficult to differentiate *in situ* between these small cryptic species. These species are also, the subject of aquarium harvesting and due to distinct and localised distribution patterns are likely to be vulnerable to overexploitation.

It is important to note that, in effect, full protection under the *SA Fisheries Act 1982,* does not prohibit aquarium collections of these unique fish species, but rather will ensure an accurate record of permits and monitoring of collections, while acknowledging the formal conservation status of these species. For species which are presently recreational or commercially exploited, such as the Western Blue Groper, there will be continuing public pressure to fully list this species.

6.1.2 Marine Habitat Management, Policies and Guidelines

Marine habitat management in South Australia is characterised by a lack of resources and conservation policy development. For instance in Gulf St Vincent, a total of 9 marine wetlands have been recognised as wetlands of national importance (ANCA 1996), yet only 4 of these currently have management plans in place to protect key conservation values (see Table 6.1). Further, apart from the Onkaparinga Estuary, there has been limited or no significant visitor management in these wetlands, in terms of site development, education or interpretative initiatives in these wetlands.

In South Australia, there has been limited targeted resources or personnel to promote or importantly, implement marine habitat conservation and management. Within DEHAA, the wetlands conservation branch is principally focussed on freshwater and estuarine wetland policy development, while within PIRSA, there is currently only 1 full-time marine habitat and environmental officer. While there has been some attempt to conserve marine habitats through protected areas (ie. Conservation Parks, Aquatic Reserves) and specific flora protection (primarily for mangroves), there has been no initiatives to develop "off-reserve" habitat management plans and establish development guidelines, Codes of Practice, assessment criteria and approvals processes to conserve marine habitats.

Wetland Reference No	Marine Wetland	Jurisdictions	Status of Management
EYB010SA	Point Davenport	DENR	No management plan. Subtidal areas unreserved.
EYB016SA	Wills Creek	None.	DENR in process of proclaiming a conservation park.
EYB004SA	Clinton (Wakefield River)	DENR, Fisheries	No management plan. Subtidal areas unreserved.
EYB012SA	Port Gawler & Buckland Park	DENR	Draft management plan prepared in 1983. Subtidal areas unreserved.
EYB002SA	Barker Inlet & St Kilda	DENR, Fisheries, ETSA, Penrice	No management plan. No coordinated management of area. Many areas unreserved.
LB013SA	Onkaparinga Estuary	DENR, Fisheries	Management plan prepared in 1993. Boardwalks and dune stabilisation program.
LB003SA	Busby and Beatrice Islets (KI)	DENR	Management plan prepared in 1987. Subtidal areas unreserved.
LB001SA	American River Wetland System (KI)	DENR, Fisheries	Management plan prepared in 1987.
LB004SA	Cygnet Estuary (KI)	DENR	Management plan prepared in 1987. Subtidal areas unreserved.

Table 6.1 **Coastal and marine wetlands in Gulf St Vincent of recognised national importance, as identified in the in the `Directory of Important Wetlands in Australia' (ANCA 1996).**

The native flora of all marine habitats in South Australia is protected under the *Native Vegetation Act 1990*, which is administered by the Department of Environment, Heritage and Aboriginal Affairs (DEHAA). Additional protection is afforded to mangroves under fisheries legislation (due to their recognised fisheries values). However, no such additional protection is afforded to other marine habitats, such as seagrasses, reefs or coastal saltmarshes. Marine habitats in South Australia can also be protected under protected area legislation under the *Fisheries Act* and the *National Parks and Wildlife Act.*

While mangrove ecosystems have been relatively well protected through the establishment of Conservation Parks and Aquatic Reserves in South Australia, there is a significant lack of formal habitat protection for seagrasses and tidal saltmarshes. In some mangrove areas (eg. Port River estuary), reservation under both pieces of legislation, has led to unclear agency jurisdictional responsibilities.

In South Australia, there are no specific development guidelines or processes to protect marine wetlands from activities such as the construction of jetties, location of moorings and fishing. For instance, in New South Wales, the *Fisheries Management Act 1994* provides for the development of Habitat Protection Plans to protect habitat "whether the habitat is critical for the survival of the species or required to maintain harvestable populations of fish". The primary objective of the plans are to ensure that there is no further net loss of seagrass within the coastal and estuarine waters of New South Wales. Under the plans, seagrass meadows in NSW are protected by preventing or limiting threatening processes and regulating development activities.

6.1.3 Public and Political Awareness of Coastal and Marine Habitats

The ongoing loss of marine habitats in South Australia, particularly in the metropolitan Adelaide region, have been significantly influenced by a lack of both, a public and political awareness of the ecological, social and economic value of coastal and marine habitats. Historically, there has been a lack of significant resources and political commitment to marine habitats conservation in South Australia. While seagrass loss off metropolitan Adelaide was first linked to elevated nutrients from discharges from the Glenelg sewage effluent outfall in 1970 (Shepherd 1970), effluent discharges to nearshore gulf waters have only been regulated since 1990 (with the passing of the *Marine Environment Protection Act 1990*).

As such, South Australia was the last state in Australia to legislate to control marine pollution from point source discharges; approximately 17 years after all other states (Rozenbilds 1991).

The development of national water quality guidelines and standards by ANZECC in 1991 (ANZECC 1992) has been largely adopted by State/Territory governments and has facilitated many states, such as South Australia, in implementing significant environmental monitoring and improvement programs to meet the national and State water quality standards.

In South Australia, the establishment of the 1.4 km St Kilda mangrove interpretation trail in 1990 by the City of Salisbury has assisted considerably in raising community awareness of the value of marine wetlands (particularly mangroves) in the State. However, the lack of a marine education policies, resources or personnel (at the State and local operational level) continues to hinder greater understanding of the values and the ongoing threats faced by marine wetlands in South Australia, particularly outside the metropolitan Adelaide region. Only one public education brochure has been produced on marine wetlands (ie. mangroves) in SA (Edyvane 1995).

6.1.4 Marine Environmental Impact Assessment and Monitoring

The assessment of the environmental impacts of development and activities on marine wetlands (particularly subtidal wetlands) is very limited in South Australia, and largely confined to the effects of sewage discharges on seagrass beds. Past marine monitoring and assessment programs in the gulf have been irregular and generally inadequate (Rozenbilds 1991), and principally `outfall-based' and lacking biological and ecological criteria (see Reichelt 1990, Edyvane 1996). The environmental impacts of many of the sewage and industrial discharges into the gulfs have generally been monitored through State government water quality programs (Lewis 1975, Walters 1977, 1989, Steffensen 1981a,b, 1982, 1985, Steffensen & Walters 1980). Since 1990, these have been regulated by the SA EPA through agreed Environmental Improvement Programs (EIPs) under the *Environment Protection Act 1993*. Virtually all point sources of pollution are now licensed with conditions requiring licensees to monitor their discharges. Water quality standards in South Australia have generally adopted the national water quality criteria and standards developed by ANZECC (1991). Under the *Environment Protection Act 1993* licensees are required to submit an Environmental Improvement Program in order to meet targets within a timetable permitted under transitional arrangements.

The arrangements allow for all existing discharges to comply with water quality guidelines before the year 2001. Discharges commencing after the Act received assent must comply with guidelines immediately they are licensed.

However, several areas and activities in the gulf are presently exempt under the Act. These include several areas of contaminated inland waters, which discharge into the sea, including the Patawalonga Basin (Edyvane 1996) and also, the marine pollution discharges of the SA Generation Corporation Torrens Island power station. Sea-based fish farming is also exempt under the Act, despite being identified as a significant contributor to nutrient pollution, and a high priority issue under the SA EPA water quality guidelines (SA EPA 1993). As is the case in many states, the Act also does not provide for control or regulation of diffuse-source pollution, which in metropolitan Adelaide is a significant contributor to declining water quality.

The SA EPA has recently sought cooperation of other State and local government agencies and research organisations to plan ambient monitoring of nutrients, faecal contamination, suspended particulates, exotic species and heavy metals in areas of known contamination (see Cugley 1994). Priority areas and issues identified for marine monitoring in GSV include: water quality, particularly in the Port River, Onkaparinga and Patawalonga estuaries; seagrass loss; mangrove loss (in the Port River region); changes in biodiversity; sedimentation of nearshore reefs; and the monitoring of heavy metal levels in mussels (Cugley 1994).

The EPA is developing an Environment Protection (Water Quality) Policy for SA waters including marine and estuarine waters. This need has been identified as there is not a consistent approach to water quality protection in the state. Industry does not operate under uniform requirements. For example, large industries licensed under the Act are required to comply with licence conditions, yet many smaller industries in the same business are not licensed. These unlicensed industries are required to meet their general environmental duty under the Act but may not operate with those constraints applying to licensed industries. A preferred approach for SA has been developed which will also include marine discharges beyond 2001.

While Environmental Impact Assessment (EIA) procedures in Australia are the principal tool for management of the potential adverse environmental impacts of development, their contribution to the overall management of the marine environment has generally not been fully realised (Martyn & Boer 1996). This is partly because of the deficiencies of the EIA process in Australia: ie. inconsistency of application; lack of total transparency in decision-making; failure to systematically incorporate cumulative impacts; questions of resource allocation; and biases of environmental consultants towards the proponent (their client) (Martyn & Boer 1996).

In particular, the complexities of jurisdiction, legal and policy instruments in the coastal zone retards the integration of EIA into any strategic coastal planning process. The emphasis on project-specific assessment and the complexity of the land-sea interface makes regional assessment necessary, but this infrequently occurs in practice). Finally, comparatively little work has been done on the design and application of EIA `framework' guidelines for use in the marine environment.

6.1.5 The Need for Environmental Accounting in the Assessment Process

In South Australia, as elsewhere in Australia, land-based development proposals rarely assess the potential impacts on coastal and subtidal habitats, including, the cumulative and synergistic impacts of developments and activities on a single waterbody and ecosystem, the effects of currents and coastal processes in transferring environmental impacts away from the development site, and the ecosystem effects of habitat loss and loss of primary production. Further, the social and economic costs of loss and degradation of wetlands is rarely incorporated into decision-making. While environmental valuations have estimated the value of a single hectare of seagrass/agal beds at US$19 004 per yr and tidal marshes/mangroves at US$9 990 per yr (Constanza *et al.* 1997): rarely are the economic benefits of wetlands in terms of ecosystem services and natural capital incorporated into the development assessment and approvals process.

6.1.6 Marine Biodiversity and Habitat Research and Monitoring

Despite the ecological significance of South Australia's coastal and marine habitats and biodiversity, few ecological studies have been undertaken on the nearshore marine habitats and ecosystems (eg. Shepherd & Sprigg 1976, Butler *et al.* 1977, Connolly *et al.* 1997). Most studies have largely being undertaken to assess environmental impacts on marine habitats in the metropolitan Adelaide region, such as seagrass loss from eutrophication (see Shepherd *et al.* 1989 for review), thermal pollution (eg. Thomas *et al.* 1986), and heavy metal pollution in Spencer Gulf (see Ward *et al.* 1986), rather than understand the structure and key ecological processes of natural ecosystems within the gulfs and oceanic waters. It is only recently that broadscale and systematic mapping and biodiversity surveys of marine habitats have been undertaken in South Australia (Edyvane & Baker 1996).

Several recent studies by the EPA in South Australia have been designed to assist with future proposed ambient monitoring programs. These include methods to quantify seagrass loss off the metropolitan coast (Hart 1995, 1997), potential biological indicators of nearshore eutrophication (Harbison & Wiltshire 1997a,b), the impact of the exotic European fanworm, *Sabella spallanzanii*, in the metropolitan region, and the status of nearshore subtidal metropolitan reefs (Cheshire *et al.* 1996a, 1997). Other ongoing studies in Gulf St Vincent by the South Australian Research and Development Institute (SARDI) and universities, are also contributing to an understanding of the ecological status of the gulf. These studies include, the effects of stormwater and effluent discharges on mangroves (Edyvane 1991a, Bayard 1992, Fairhead 1995); heavy metal contamination in the marine biota (Boxall 1994, Hamman 1994) and the effects of harvesting and trampling on intertidal reef areas in the metropolitan region (Williams 1996).

As in many parts of Australia, lack of resources continue to hinder research and adequate marine monitoring of the habitats and ecosystems of South Australia, particularly non-seagrass habitats and areas outside the metropolitan Adelaide region. In 1993/94, the newly established EPA allocated a budget of approximately $150 000 for ambient marine monitoring in SA. Due to financial constraints, present marine monitoring efforts in South Australia are still principally outfall-based (ie. in the metropolitan Adelaide region) and are largely undertaken by industry consultants. Water quality studies in the metropolitan region remain the highest priority monitoring issue in South Australia (see Cugley 1994), with seagrass and mangrove loss (monitored by aerial photography) identified as key biological indicators. However, for early detection of trends, this scale of monitoring will have to be significantly increased (ie. via field-based surveys). No ambient nearshore reef monitoring program has been proposed by the EPA, apart from a series of community-based reef surveys (ie. `ReefWatch').

Despite the number of marine studies conducted in South Australia, there remains a lack of basic research into biodiversity and ecological processes of our coastal and offshore habitats and ecosystems. Further, there is a lack of a strategic and integrated approach to research and monitoring to underpin the sustainable management of the marine habitats and ecosystems of the State. This is marked by a lack of integrative, interdisciplinary modelling studies which examine pollutant inputs into the gulf environments (ie. from catchment studies), and describe the behaviour and fate of contaminants (ie. from oceanographic and water quality studies) and importantly, assess their ecological consequences (ie. from environmental studies).

For instance, a number of hydrodynamic and modelling studies have been undertaken on the Gulf St Vincent (Bye 1976, de Silva & Lennon 1987, Evans 1993, Grzechnik & Noye 1996, Lord 1995) and also, in the Port River estuary (Bye & Hancock 1988, Lord 1996). However, there has been a general failure to extend these hydrodynamic studies to incorporate marine management or ecological goals (through water quality and environmental modelling). For instance, no attempt has been made to model the ecological effects of coastal eutrophication (eg. algal blooms, seagrass and mangrove loss) from existing water quality information. Further, the nearshore sediment transport monitoring undertaken for coastal engineering purposes (by the Coastal Management Branch), remains to be integrated with seagrass loss data (collected by the EPA), such that an integrated model can be developed to correlate seagrass loss with coastal erosion.

6.1.7 Towards Strategic Research, Monitoring and Management

To facilitate multiple-use management and conservation of marine habitats and ecosystems, future research and management efforts in South Australia should focus at the ecosystem level. For marine biodiversity researchers and ecologists this will require more research effort into baseline mapping and ecological processes determining patterns of marine biodiversity, the impacts of human use (at a range of temporal and spatial scales), long time-series datasets for trend analysis, comprehensive coastal and gulf inventories, coastal spatial information systems, bioeconomic modelling and the modelling of coastal and gulf processes and biological components.

There is also a need for greater focus on ecological processes, particularly trophodynamic studies and the linkages between:

- catchment practices and effects on nearshore marine ecosystems;
- wetland habitats and reefal habitats;
- offshore and nearshore ecosystems;
- benthic and pelagic ecosystems;
- coastal physiography, physical processes and scaled patterns of biodiversity.

This approach will require greater interdisciplinary research, and a greater commitment to integrated, coordinated strategic research to underpin marine biodiversity and ecosystem management. However, like in many regions of Australia, the ultimate success of the long-term conservation of the marine biodiversity and habitats of South Australia, will depend on: the degree of public awareness of the threats to marine habitats and species; political commitment to resource the necessary protection and management measures required; and importantly, administrative reform, to facilitate the coordinated and integrated ecosystem approach needed to manage the diverse and ecologically significant coastal and marine habitats and ecosystems of South Australia.

6.2 Developing a Strategic Approach to Marine and Coastal Biodiversity Management

In developing a strategic, integrated approach to the management of the South Australia's marine biodiversity, the following elements are essential:

- Establishment of a Ecologically, Representative System of MPAs.
- Marine Species Protection.
- Marine Habitat Protection.
- Ecological Sustainable Use of Marine Activities.
- Bioregional Planning Framework.
- Integrated Coastal Zone Management.
- Recognition of National and International Policies and Frameworks.

A range of well-resourced actions or measures need to be taken to ensure an adequate information base for enabling effective conservation and management of South Australia's marine biodiversity:

- ***Research, Monitoring and Information Systems Needs***

1 Conduct systematic biological surveys of the marine biodiversity of SA, for baseline, and conservation assessment purposes. Priority should be given to benthic biodiversity (due to potential habitat impacts from aquaculture, pollution and coastal development), and seabirds.

2 Monitor the status of rare, endangered and threatened marine species in SA, and identify threatening processes and critical habitats.

3 Develop marine biodiversity databases and spatial information systems to house existing and future data (species distributions, conservation rankings) to facilitate conservation assessment, information dissemination. All relevant datasets should be to incorporated into the SA node of the Australian Coastal Atlas.

4 Support and promote research and monitoring into ecological sustainable marine fisheries in SA. In particular, monitoring of environmental and ecosystem impacts by all fisheries (ie. incidental by-catch, food chain or ecosystem effects, loss of benthic habitat and biodiversity).

5 Support and promote research and monitoring into ecological sustainable marine and coastal aquaculture activities in SA. In particular: identification of suitable sites and habitats (without significant impacts on the biodiversity values of SA); assessment of the optimal carrying capacity of aquaculture activities; and research and monitoring of environmental impacts by all aquaculture activities (ie. marine wildlife entanglements, loss of benthic habitat and biodiversity, eutrophication, overcatch or feral populations, genetic pollution).

6 Support SARDI Aquatic Sciences, as the major research and information provider for marine biodiversity and conservation-related issues to DEHAA and PIRSA.

7 Conduct research to assist and validate community-based marine monitoring programs (ie. `Reef Watch', `Dragon Search'), to ensure data validation, optimal and valid program design and identify future community-based monitoring opportunities.

- ***Policy Development***

8 Identify and establish a representative network of Marine Protected Areas in South Australia, at the bioregion level, as part of the National Representative System of Marine Protected Areas (NRSMPA), with stakeholder and community input and participation.

9 Ensure the immediate establishment of small, high-protection Marine Protected Areas (ie. Sanctuaries, Aquatic Reserves), in areas containing rare, endangered, threatened species and/or habitats (and threatened by development activities, such as aquaculture, coastal development), while the development of a representative system of Marine Protected Areas is being considered.

10 Implement the protection of Common SeaDragon and other rare, threatened and endangered marine fish species formally recommended for protection by the Environment and Biodiversity Program of SARDI.

11 Undertake reviews of major marine faunal and macrofloral groups in SA to identify potential rare, threatened and endangered species, for formal legislative protection.

12 Develop and implement recovery plans for all rare, threatened and endangered marine species.

13 Investigate and implement the protection of major breeding, feeding and calving habitats of existing marine species protected under State and Commonwealth legislation. Priority should be given to establishing high-level protection Marine Protected Areas (ie. Sanctuaries, Aquatic Reserves) for species and areas where known threatening processes occur (eg. Australian Sea Lion, New Zealand Fur Seal, Southern Right Whale, Leafy SeaDragon).

14 Investigate legislative opportunities for the designation of non-mammal marine species (ie. fish, invertebrates, flora) as protected species under the *National Parks and Wildlife Act 1972.*

15 Develop criteria for development assessment purposes for marine habitats of ecological significance, (ie. seagrasses, reefs, mangroves, coastal saltmarshes).

16 Develop a legislative approach to the protection of marine habitats through the development of guidelines and management plans for marine habitats of ecological significance (ie. seagrasses, reefs, mangroves, saltmarshes).

17 Investigate the development of a "no net loss of marine habitat policy".

18 Support and promote the development of Codes of Practise for all marine fisheries in SA. In particular, ensure elimination and/or reduction and mandatory monitoring of environmental and ecosystem impacts by all fisheries (ie. incidental by-catch, food chain or ecosystem effects, loss of benthic habitat and biodiversity).

19 Support and promote the development of Codes of Practise for all marine and coastal aquaculture activities in SA. In particular, ensure elimination and/or reduction and mandatory monitoring of environmental impacts by all aquaculture activities (ie. marine wildlife entanglements, loss of benthic habitat and biodiversity, eutrophication, overcatch or feral populations, genetic pollution).

- ***Education and Community Awareness***

20 Coordinate and undertake, on behalf of SA government agencies, major State, national and international community and public awareness raising activities in SA, with regard to the marine biodiversity and the marine environment (ie. `SeaWeek' program in SA, `Ocean Care Day', `International Year of the Oceans').

21 As a matter of priority, promote the marine biodiversity and environments of South Australia, Marine Protected Areas and threats to biodiversity, as part of International Year of the Oceans.

22 Implement the establishment of the rare Leafy SeaDragon (*Phycodurus eques*) as South Australia's state fish.

23 Support the community-based education activities of the `Reef Watch' program which monitors the status of nearshore reefs in SA.

24 Support the community-based education activities of the `Dragon Search' program which monitors the status of seadragons, seahorses and pipefishes in SA.

25 Establish community-based `Adopt a Marine Reserve' program.

6.3 Towards Integrated, Multiple-Use Marine Management[1]

6.3.1 The Need for Multiple-Use Planning

Effective long-term multiple-use management requires both, bioregional planning and also the establishment of appropriate legislative and operational frameworks. In Australia, the present fragmented approach to management of the marine environment and its resources lacks a single framework that integrates social, environmental and economic goals. This has resulted in a `tyranny of small decisions' in which a range of governments and agencies hold often overlapping and sometimes conflicting responsibilities and jurisdiction.

In Australia, existing marine sector legislation needs to be reviewed and rationalised to identify gaps and overlaps, and steps should be taken towards establishing a consultative framework to facilitate communication and harmonise arrangements between governments and interests groups.

6.3.2 Principles of Multiple-Use Management

Multiple-use management results in the integration of multiple-uses to reach an acceptable balance of outcomes across the full range of uses and users that is consistent with four fundamental principles. The integration of decision-making recognises sector-specific objectives, management plans and strategies, and less than optimal outcomes could be generated for some users. The four fundamental principles of multiple-use management are:

1 Maintenance of Ecosystem Integrity.

This specifically includes:

(i) maintenance of biodiversity at biological community, habitat, species and genetic levels;

(ii) maintenance of the ecological processes that support both biodiversity and resource productivity;

(iii) maintenance of not only the existence of ecosystems and biodiversity but also their effective functional role in biological systems; and

(iv) application of precautionary and anticipatory decision-making.

2 Wealth Generation and Resource Use.

The management and use of the marine environment for the sustainable, efficient and effective delivery of food, economic wealth, human enjoyment and human well-being.

3 Equity

The management of the marine environment to deliver and preserve inter-generational, intra-generational, cross-sectoral, cross-boundary and cross-cultural equity and options, including through ensuring national security. Equity implies a principle of stewardship by Governments and the community. Intergenerational equity is sought through the avoidance of actions that are not potentially reversible on a time scale of a human generation, consideration of long term consequences in decision-making, and restitution of degraded aspects of the physical and biological environment.

4 Participatory Framework for Decision-Making

Multiple-use management uses a decision-making framework that meaningfully includes and considers all sectoral and community interests, ensure its management objectives and decision-making processes are not dominated or determined by particular sectors or interest groups, and integrates sector specific management processes to ensure the four multiple-use management principles are addressed and achieved. The framework includes mechanisms to ensure participants have similar access to both information and investigative capacity, so that they can participate meaningfully in decision-making. Participants recognise and accept that the decisions made may not be optimal for all individual interests, and the framework provides dispute resolution mechanisms. Within the framework there is a capacity to monitor achievement with respect to the four principles of multiple-use management and to take corrective action as necessary.

[1] From `Multiple Use Management in the Australian Marine Environment: Principles, Definitions and Elements' (Sainsbury *et al.* 1997).

6.3.3 Implementation of Multiple-Use Management

In any application some of these principles may be given more weight than others, depending on sectoral and regional priorities, but all are necessary and fundamental for successful multiple-use management. Within a multiple-use management framework:

(i) management of specific industry sectors would meet objectives and performance measures based explicitly on the above principles, and

(ii) the combination of all uses and sector-specific management would meet regional and national objectives and performance measures based on these principles.

Multiple-use management will inevitably involve spatially-based management arrangements and measures at a hierarchy of scales, reflecting the spatial hierarchy of ecological systems and processes. Consequently, while spatial structure is not a fundamental principle of multiple-use management, identification of appropriate hierarchies of management regions, and the interconnections and coordination between them, is a key consideration in the practical application of multiple-use management. The hierarchy of spatially based management arrangements must recognise ecological structures and processes.

The elements required for an effective multiple-use management framework are:

- ***An Appropriate Legislative Framework.***

- ***An Appropriate Operational Framework, consisting of:***

– A **consultative mechanism** encompassing inter- and intra-sectoral interests and comprising cooperative management arrangements across sectors, facilitation arrangements, mechanisms for conflict resolution and for potential compensation and/or transfer of rights.

– **Explicit management strategies and plans** that meet a minimum set of cross-sectoral objectives based on consistent interpretation of multiple-use management and ecologically sustainable development. The strategies and plans would include specification of a monitoring program, and how monitoring (a) would be used to provide operational performance measures, sustainability indicators and precautionary reference points and (b) would be linked via precautionary reference points to management actions to achieve multiple-use management objectives.

– **Evaluation and assessment** of the management plan, including demonstration that it can reasonably be expected to achieve defined management objectives despite lack of complete knowledge about the ecosystem and uncertainties in implementation of management measures.

– **Implementation capability and process.** Including the financial, legal and human resources to allow effective implementation of management plans, including compliance and enforcement, and cross sector auditing or evaluation of the performance of the plans.

The current legislative framework is overly complex and cumbersome. It does not adequately address multiple-use management and will make integrated management difficult. There is a need to develop a new legislative framework to allow efficient and effective multiple-use management in the medium term. Achieving multiple-use management would be greatly facilitated if sectoral management were required to apply consistent principles of Ecological Sustainable Development and multiple-use management – as, for example, the principles provided through the Tasmanian Resource and Management System.

Development of appropriate consultative forums that cost-effectively achieve national and cross sectoral objectives, and which harmonise existing sectoral arrangements to this end, is another key area requiring development. A suggested approach involves the identification of a relatively small number of regions, probably at the Large Marine Ecosystem (LME) scale. The scale is chosen to be ecologically meaningful, to balance reasonably the complexity of ecological and management interactions within and between regions, to allow for recognition of multiple-use management outcomes at the national level, and to provide a natural setting for examination of management arrangements and outcomes at nested smaller space scales.

Consultative procedures for application at the regional level are suggested. The characteristics of these procedures are:

(iii) That national goals and objectives for multiple-management are established within the National Ocean Policy;

(iv) That ongoing processes emphasise and ensure increasing understanding between policy makers and non-government stakeholders at both national and regional levels;

(v) That all significant stakeholder groups can have meaningful and informed participation, including an understanding of the opportunities and compromises of multiple-use management;

(vi) That stakeholder input will own and drive implementation, with Government agencies providing a facilitation role for multiple-use management;

(vii) That cross sectoral arrangements on appropriate management arrangements be established; and

(viii) That a lead agency be given carriage of an adequately resourced process.

Technical methods for the design and evaluation of cross sectoral management plans, including the identification of operational performance measures and reference points, could be developed from some approaches already applied within some sectors. These approaches have proved effective in participatory management forums.

6.3.4 Multiple-Use Marine Management in South Australia

South Australia's diverse marine and coastal ecosystems and their resources are of immense ecological, cultural and economic importance to South Australians. In the long-term, the success of a comprehensive marine conservation program will depend on a coordinated and integrated approach to the management of marine ecosystems and their resources. This will be essential for both, the protection and conservation of the South Australia's marine heritage, and also, the economic welfare of the State's aquatic resource base.

The development of an integrated management framework which provides for multiple-use ecosystem management is currently being addressed in South Australia through the development of a SA Marine and Estuarine Strategy, and also, through participation in the development of a national Oceans Policy. Fundamental to this is the development of both, a bioregional planning framework (see Section 6.3.3) and also, the necessary legislative and operational framework. With regard the former, the identification of a hierarchy of spatially-scaled management regions, based on ecological structures and processes, has been undertaken in South Australia, principally as part of the national Interim Marine and Coastal Regionalisation of Australia (IMCRA) project. This bioregional planning framework is discussed in detail in Chapter 3.

The challenge however, remains the development of complementary spatially-based management arrangements (at a hierarchy of scales), to provide integrated multiple-use management. This is one of key objectives of the SA Marine and Estuarine Strategy.

In the interim, Marine Protected Areas currently provide a key tool for implementing multiple-use marine management regimes in South Australia. However, while the establishment of an ecologically representative system of Marine Protected Areas (ie. Marine Parks and Aquatic Reserves) is important for marine biodiversity conservation - equally important, is the recognition that integrated planning and management, ie. "integrated catchment management", is essential for the sustainable management of our marine environments. This is because ocean currents and tides, ensure that virtually all marine activities have the potential to affect one another. In this respect, "off-reserve management" and the need for catchment management is more important under the sea than on land.

7 CASE-STUDIES IN ESTABLISHING AND MANAGING MARINE PROTECTED AREA NETWORKS

7.1 State-based Approaches to Marine Protected Area Systems

In identifying possible directions for the establishment and implementation of a network of Marine Protected Areas in South Australia, it is useful to examine the legislative, policy and administrative approaches of other States in Australia. Victoria, and Western Australia both share similar temperate environments to South Australia, and both have developed strategic approaches to establishing and managing a representative system of Marine Protected Areas. Tasmania, while having identified a bioregional framework (Edgar *et al.* 1995, 1997), and recently undertaking legislative reform to establish a representative system, under the *Marine and Aquatic Reserves Bill 1997*, have yet to release a policy framework for a network of Marine Protected Areas. For this reason, a comparative analysis has been confined to Victoria and Western Australia. A summary of the comparative analysis is detailed below in Table 7.1.

Aspect of MPA Planning Process	Western Australia	Victoria
Designated MPA Management Agency	Marine Reserves and Parks Authority (CALM)	Department of Natural Resources & Environment
Sequential/Simultaneous of MPAs	sequential	simultaneous
Zoning	within designated reserves under the CALM Act	whole-of-coast & waters
Planning for Resource Development	facilitated within multiple-use reserves	Designated development zones, facilitated with multiple-use reserves
Identification of MPAs	no formal criteria or guidelines	limited formal criteria
Selection of MPAs	no formal criteria or guidelines	5-step selection process
Level of Information	limited subtidal information, best available expert advice, additional studies when required	mostly intertidal information, limited subtidal information
Social-Economic Assessment	explicit in the assessment & establishment of individual MPAs	formal socio-economic assessment for whole of coast
Community Participation	2 formal submission periods, State-wide consultation	3 formal submission periods, extensive consultation (1991-1997)
Additional Infrastructure	Marine Conservation Unit (CALM)	none specified
Integrated Coastal Zone Management (land-sea)	no formal linkages or integration with whole-of-coast coastal planning strategies, but integration across adjacent terrestrial and marine reserves	formal linkages & complementary whole-of-coast planning with the `Victorian Coastal Strategy'

Table 7.1 Comparison of approaches utilised by Western and Victoria in establishing representative systems of Marine Protected Areas.

7.2 Western Australia's Approach to a MPA Network

7.2.1 MPA Strategic Plan

The policy framework for the establishment and implementation of a representative system of Marine Conservation Reserves in WA was outlined in the *New Horizons in Marine Management* policy which was released in November 1994 by the Government of WA. The *New Horizons* policy outlined the WA Government proposal to establish new legislation to implement a structured multiple-use Marine Conservation Reserves system to:

- to preserve representative as well as special ecosystems in the marine environment; and

- to put a formal management framework in place to ensure the various uses of marine conservation reserves are managed in an equitable, integrated and sustainable manner.

To this end, a system of Marine Conservation Reserves was established which preserves conservation values while providing for wise use of resources via multiple-use management and a more coordinated approach to the management of marine resources. In this regard, the establishment of a marine reserves system has been the vehicle for both, preserving representative ecosystems and also, establishing multiple-use management regime in the marine environment.

The establishment and implementation of marine reserves system, which provide for multiple use, was outlined in the *New Horizons* in 1994, and has been achieved via:

- ***Establishment of a `Marine Parks and Reserves Authority'***

- A Marine Parks and Reserves Authority has been established under the *Conservation and Land Management Act* to oversee the development of Marine Conservation Reserves system, including development of marine reserve policy and the preparation and implementation of management plans for marine reserves by the Department of Conservation and Land Management (CALM). It also advises the Minister for the Environment on marine conservation and can develop policies to preserve the natural marine and estuarine environments outside Marine Conservation Reserves. All Marine Nature Reserves, Marine Parks and Marine Management Areas are vested in the Authority. The Authority has seven members, nominated by the Minister for Environment and appointed by the Governor.

  Ministers whose portfolios have a significant interest in the marine environment – such as Fisheries and Mines – can recommend nominees to the Minister for the Environment. Members are appointed for their expertise and do not represent sectoral interests and can include a wide range of expertise and interests, such as:

- Conservation
- Commercial Fishing
- Recreational Fishing
- Other Water-based Recreation Groups
- Tourism
- Marine Science
- Petroleum Industry
- Community Representatives
- State Government

- ***Legislative Reform***

- In 1997, the WA Parliament passed 2 Bills to implement multiple-use management in the marine environment. The first is the *Acts Amendment (Marine Reserves) Bill 1997*, which coordinates activities in marine conservation. This Bill amends six existing Acts relating to the Department of Conservation and Land Management (CALM) and to the fishing and mining sectors, including the establishement of the Marine Parks and Reserves Authority under the *Conservation and Land Management Act* and the vesting of all marine conservation reserves in the Authority. The second Bill is the *Fisheries Adjustments Bill 1997* which provides for compensation in respect of any adverse impact the marine reserve legislation has on rights conferred under existing pearling and fishing legislation.

- ***Establishment of a Scientific Advisory Committee***

- A seven-member scientific advisory committee has been established to advise the Marine Parks and Reserves Authority and advise the Minister on scientific matters. The committee comprises marine scientists from the non-government sector research institutions, the Department of Conservation and Land Management (CALM), the WA Museum, Fisheries WA.

- ***Establishment of a Specialist Marine Conservation Branch in CALM***

- CALM is responsible for overall management of marine conservation reserves.

A specialist Marine Conservation Branch has been established within CALM and, among other things, provides support for the new Authority and scientific advisory committee. The Branch staff have expertise in a wide range of marine sciences, management and policy.

- ***Identification of Marine Conservation Reserves***

– The blueprint or framework for a representative system of marine reserves will incorporate the findings of Marine Parks and Reserves Selection Working Group, ie. *`A Representative Marine Reserve System for Western Australia*' (1994).

- ***Community Participation in the Marine Reservation Process***

– The WA Government will progressively announce its marine conservation reserves program priorities after considering the advice of the Marine Parks and Reserves Authority. While the Working Group Report provides a valuable source of information and advice to the Government, the report's recommendations for individual areas have no formal Government endorsement until the formal process of community participation and consultation has been followed in accordance with the Conservation and Land Management Act (see Box 7.1).

BOX 7.1
COMMUNITY PARTICIPATION IN THE MARINE RESERVATION PROCESS – *WA CONSERVATION AND LAND MANAGEMENT ACT*

The WA Government is committed to full and open consultation before an area is dedicated as one of the three categories of marine conservation reserve (ie. Marine Nature Reserve, Marine Park, Marine Management Area). The Government therefore has clearly defined the process that will have to be followed for an area to be considered as a marine conservation reserve:

(a) The area is identified and its proposed boundaries determined.

(b) A comprehensive assessment of the area's biological and economic resources and social values is carried out.

(c) Community liaison and advisory committees are normally set up to assist in the process, including preparation of the management plan and determining the various management zones proposed.

(d) A report on the reservation proposal is prepared for the Minister for the Environment by the Marine Parks and Reserves Authority.

(e) An indicative management plan outlining the reserve's proposed management objectives and zones is prepared.

(f) The Ministers for Mines and Fisheries are provided with a reservation proposal for their consideration and agreement before a notice of intent to reserve the area is published.

(g) When these steps have been completed, the Minister for Environment formally publishes a notice of intent to declare a marine conservation reserve and releases the indicative management plan for public comment. (All marine conservation reserve proposals are subject to a minimum three-month public comment period before a final decision by Government).

(h) The Marine Parks and Reserves Authority provides the Minister for Environment with a report on the public submissions received in response to the reservation proposal and the indicative management plan for the proposed marine conservation reserve.

(i) The concurrence of the Ministers for Fisheries and Mines is obtained.

(j) The reserve is then created by Order of the Governor.

(k) The Minister for the Environment also tables in each House of Parliament the order to reserve the new marine reserve. Either House can resolve to disallow a reservation order.

For established marine conservation reserves, public consultation is required in the development of management plans and zoning schemes.

7.2.2 Identification of a Representative System

The blueprint or framework for a representative system of marine reserves will incorporate the findings of Marine Parks and Reserves Selection Working Group that identified potential candidate areas to be considered for incorporation into the marine reserves network. The scientific report, entitled *`A Representative Marine Reserve System for Western Australia*' (1994), was undertaken over 7 years and identified approximately 70 areas, that represent the range of marine ecosystems along the 12 500 km coastline of WA, for consideration as marine conservation reserves. The Working Group Report recommendations will be progressively assessed, but this is likely to take many years, especially where further scientific investigations and surveys are required. Nevertheless, priority areas will be identified for further investigation as marine conservation reserves. These areas will be selected because of the need for conservation management, increasing pressures of use and public interest in expanding the marine conservation reserve system.

7.2.3 Integrated Multiple-Use Management

In WA, a system of Marine Conservation Reserves was established which would not only preserve conservation values but would also provide for the essential but often competitive activities of fishing, recreation, aquaculture, pearling, tourism, scientific research and mineral and petroleum exploration and production. Multiple-use management is facilitated by establishing a range of Marine Conservation Reserves under the *CALM Act* with varying levels of protection and use.

7.2.4 Marine Management Zones

The present Marine Conservation Reserves system in WA encompasses four types of reserves: under the *Acts Amendment (Marine Reserves) Bill 1997*, three types of Marine Conservation Reserves which can be established under the *CALM Act* (ie. Marine Nature Reserve, Marine Parks, Marine Management Area) and the Fish Habitat Protection Areas which can be created under the *Fish Resources Management Act*:

1 Marine Nature Reserves

- These reserves afford the highest level of conservation and protection of biological diversity and are created primarily for conservation and scientific research. Although low-impact tourism may be permitted, no recreational or commercial fishing, aquaculture, pearling or petroleum drilling or production is allowed in these areas.

  Currently there is one Marine Nature Reserve in WA – Hamelin Pool in Shark Bay which has the finest examples of stromatolites in the world.

2 Marine Parks

- These reserves afford the second highest level of conservation and protection of biological diversity and are created primarily to protect natural features and aesthetic values while at the same time enabling recreational and commercial uses where these activities do not compromise conservation values. Current examples of Marine Parks in WA include Rowley Shoals, Ningaloo, Shark Bay, Marmion, Shoalwater Islands and Swan Estuary. In Marine Parks, four statutory management zones can be created:

IV Sanctuary Zones

- Are `look but don't take' areas managed solely for nature conservation and low-impact recreation and tourism.

V Recreation Zones

- These areas provide for conservation and recreation including recreational fishing (subject to bag limits and other conservation measures).

VI General Use Zones

- Are areas of Marine Parks not included in Sanctuary, Recreation or Special Purpose Zones. Conservation of natural resources in general use zones is the priority but activities such as sustainable commercial fishing, aquaculture, pearling and petroleum exploration and production are permissible provided they do not compromise conservation values.

VII Special Purpose Zones

- Are areas managed for a particular priority use or issue. This could be protection of habitat, a seasonal event such as wildlife breeding or whale-watching or a particular type of commercial fishing. Uses compatible with the priority use or seasonal event are allowed in these zones.

3 Marine Management Areas

- These areas afford the lowest of conservation and protection of biological diversity but provide a formal integrated management framework over areas that have high conservation value and intensive multiple-use. These areas will be selected primarily on the basis of their biological and recreational values and their existing or future commercial activities such as petroleum production and commercial fishing. As with other Marine Conservation Reserves, Marine Management Areas will be subject to environmental impact assessments for activities referrable under the Environment Protection Act.

4 Fish Habitat Protection Areas

- These areas are created under the *Fish Resources Management Act* to protect fish and fish habitats. As Fish Habitat Protection Areas and CALM Act Marine Conservation Reserves cannot co-exist in the same location, existing Fish Habitat Protection Areas cease to exist if a Marine Conservation Reserve is established over the same area and a management plan becomes operative.

Marine Management Areas (MMAs) and Marine Parks (MPs) are both effectively multiple-use areas (see Table 7.2). CALM staff anticipate that zoning for exclusion of activities and uses will be extensive in MPs, whereas in MMAs zoning for exclusion of use will be rare. In a MP the CALM Act will prevail only in the exclusion zones, which are determined by reference to incompatibility of the proposed use with the objectives for the relevant zone. In the zones of a MP where use is allowed, and in MMAs, the relevant resource sector Act prevails over the CALM Act. In MPs and MMAs, organisms not subjected to Pearling or Fisheries Acts fall under the CALM Act.

Activity	Marine Management Area	Marine Park				Marine Nature Reserve
		General Use Zone	*Special Purpose Zone*	*Recreational Zone*	*Sanctuary Zone*	
Petroleum Drilling and Production						
Mining						
Commercial Fishing						
Aquaculture						
Pearling						
Recreational Fishing						
Recreation and Tourism						

Table 7.2 **Possible activities in Marine Conservation Reserves in Western Australia (CALM 1994).**

MMAs are to be selected primarily on the basis of their biological and recreational values, and the initial choices of locations and boundaries of MMAs are likely to be substantially influenced by the potential for conflicts between competing uses. In MMAs, management of the resources normally managed under other Acts (like the Fisheries, Pearling, Petroleum Acts) will continue. CALM staff anticipate that zoning of areas within MMAs for specific uses may nonetheless be erected after extensive stakeholder consultation.

Coordination and compatibility amongst the multiple objectives of the fishing, mining and conservation sectors is achieved by according to the Ministers for Fisheries and Mining the requirement to consent to any area proposed for dedication under the Bill. This consent requirement is not limited to areas of existing sectoral activity.

7.2.5 MPA Management Responsibilities

The Marine Parks and Reserves Authority is the principal body responsible for overseeing the development of Marine Conservation Reserves system in WA. This includes development of marine reserve policy and the preparation and implementation of management plans for marine reserves by the Department of Conservation and Land Management (CALM). Development and implementation of marine reserves legislation under the *Conservation and Land Management Act* enables resource security for sector operations while simultaneously conserving marine biodiversity, using an overall process codified into a statutory framework (Sainsbury *et al.* 1997). Apart from Marine Nature Reserves and exclusion zones in Marine Parks, other government agencies will continue to have responsibility for those aspects of marine and coastal management defined in their legislation. Neither of the two Bills affects the standing of the Environment Protection Act, which will continue to apply in all circumstances in all areas.

7.3 Victoria's Approach to a MPA Network

7.3.1 MPA Strategic Plan

2000km of coastline, Victoria's coastal waters within the 5.5km (ie. 3 nautical mile limit) territorial limit cover more than 10 000 sq.km. The development of a strategic approach to the establishment of a representative system of Marine Protected Areas in Victoria began in 1991, when the Land Conservation Council began its formal investigations. The Land Conservation Council (LCC) was appointed under the *Land Conservation Act 1970* to advise on public land use planning. In 1991, the LCC was required by the Victorian Government to conduct the following investigation:

> *The Governor in Council under Section 8 of the Land Conservation Act 1970, requires the Land Conservation Council to carry out an investigation of marine, coastal and estuarine areas in the State of Victoria and to make recommendations by 30 November 1994 on the protection of significant environmental values and the sustainable use of these areas.*
>
> *The area to be investigated extends from the Victorian offshore territorial limit (5.5km) to a distance of approximately 1km inland from the high water mark; it includes the land (terrain, and overlying water) affected marine, estuarine, and coastal processes.*
>
> *In making recommendations to provide for the balanced use of land in Victoria, the Council shall have regard to the social and economic implications relevant to its recommendations.*

In 1993, the LCC released the *`Marine and Coastal Special Investigation. Descriptive Report'* (LCC 1993) which provided a major review of existing information, management issues and approaches relevant to conserving and managing Victoria's coast, including reviews of: (a) major physical, biological, cultural and landscape values along the Victorian coast; (b) current and potential uses; (c) social and economic issues and context; (d) existing administrative and legislative context; and (e) approaches to coastal conservation and resource use.

In April 1995, the LCC released its proposed recommendations, and following a period of public consultation, released its Draft Final Recommendations in June 1996 (ie. *`Marine and Coastal Special Investigation. Draft Final Recommendations'*). The report proposed:

- ***A Strategic Multiple-Use Planning Framework***

– Incorporating objectives, planning principles and management guidelines for the whole of Victoria's marine, coastal and estuarine area.

- ***An Outline of a Representative System of Marine Parks Encompassing:***

– 20 Marine Parks, encompassing the major habitats of Victoria's five biophysical marine regions as well as its three major bays;

– 21 Sanctuary Zones within the Marine Parks, to provide the highest level of habitat protection.

- ***Zoning of existing coastal reserves into Coastal Recreation and Coastal Protection zones.***

- ***Reservation of all other marine reserves as Coastal Waters Reserve, to ensure the clear management responsibility and active management.***

- ***Eight preferred Marine Aquaculture Areas to provide opportunities for this use.***

- ***Allocation of responsibilities to ensure coordination and accountability.***

The recommended Marine Parks encompassed 195 300 ha or 19% of Victoria's marine area, 55 000 ha of which was located within existing Marine Protected Areas. The completion date for the investigation was extended to 31 December 1996. In late 1996, prior to LCC's Final Recommendations being released, the *Land Conservation Act 1970* was revoked and the LCC was abolished and replaced by the Environment Conservation Council (ECC).

In 1997, the Environment Conservation Council (ECC) was established under the new *Environment Conservation Council Act 1997* to advise the Minister for Conservation and Land Management, on the balanced use or development of public land. The ECC has three members – and is chaired by the previous Chairman of the previous LCC. The ECC's investigation of Victoria's marine, coastal and estuarine areas builds on the earlier work of the LCC and also takes into account work done by the Victorian Coastal Council and the development of an Australian Oceans Policy (ECC 1998).

Under the new terms of reference for the ECC's investigation (ECC 1998), the ECC is required to make recommendations on the protection of significant environmental values and sustainable use of Victoria's offshore territorial limit (5.5km) to 1km inland, with priority given:

(a) a preferred approach and priorities for the progressive establishment of a representative system of marine parks in the State of Victoria; and

(b) areas suitable for marine aquaculture, which can be developed on an environmentally sustainable basis.

Final recommendations on Marine Parks for Victoria's entire coast are to be released by the ECC by June 1998, however if the proposed areas deviate largely from the areas recommended by the LCC (LCC 1996), another round of public consultation will be offered.

7.3.2 Identification of a Representative System

As part of the national *Interim Marine and Coastal Regionalisation of Australia (IMCRA)* project, the LCC and the then Department of Conservation and Natural Resources initiated the development of a biophysical regionalisation of Victoria's waters (VIMS *et al.* 1994, Hamilton 1994). A total of 6 bioregions were defined (see Table 7.3). The results of this work was used in the national regionalisation report (IMCRA 1997). A five step process was used to identify and select representative areas in order to protect significant environmental values. `Representativeness' referred to the identification of areas containing examples of the range of marine habitats within each biophysical region. The steps were:

1 Subdivide biophysical regions according to the eight major habitat types (see Table 7.3). Intertidal rocky shores and subtidal reef habitats were also subdivided according to major rock types of the substrate.

2 Identify specific coastline and offshore sections for each biophysical region/habitat combination that have known significant biological or ecological values.

3 Using areas with known values as a core, delimit sections of the coast from high water to the territorial limit in order to include the variability associated with increasing water depth and distance from shore.

4 For those sections of the coast where clear alternative areas exist, choose the area in the best environmental condition and least conflict with incompatible facilities or activities.

5 Consider the social and economic implications of choosing particular areas and the identified range of appropriate uses.

Habitat	Bays, Inlets and Estuaries	Open Coast Region				
		Western	*Otway*	*Central*	*Wilsons Promontory*	*Eastern*
Intertidal rocky[1] shores						
Subtidal rocky[2] reefs	minor					
Seagrass beds			minor			none known
Mangroves		not present	not present	not present	not present	not present
Intertidal sandy beaches						
Sheltered intertidal flats		not present	not present	not present	not present	not present
Subtidal soft substrata						
Pelagic environment						

Notes:

1 Shading indicates habitat/region combinations that occur along the Victorian coast.
2 Major substratum rock types are basalt, granite, limestone, calcarenite and sandstone.

Table 7.3 Victoria's major marine, coastal and estuarine habitats by biophysical region.

7.3.3 Integrated Multiple-Use Management

In Victoria, a system of Marine Parks is proposed which will not only preserve conservation values but will also provide for the essential but often competitive activities of fishing, recreation, aquaculture, tourism, scientific research and mineral and petroleum exploration and production. Multiple-use management is facilitated by establishing marine management areas (ie. Marine Parks, Sanctuary Zones, Coastal Waters Reserves) under various acts, with varying levels of protection and use.

The LCC (1996) proposed an integrated approach to the protection of important marine and coastal values and the sustainable use of resources. This approach extends to the entire marine, estuarine and coastal area, and also to catchments that drain to the coast and to the sea beyond the Victorian territorial limit. To this end, a key recommendation of the LCC (1996) was the adoption of a single responsible authority (ie. Department of Natural Resources and Environment) for all of Victoria's marine and coastal area, other than the major ports.

While `umbrella' legislation was considered, in facilitating the coordinated and integrated management of Victoria's marine and estuarine areas, the LCC (1996) preferred the use of existing legislation, with amendments as required. In particular, the *Coastal Management Act 1995* which establishes a coastal planning and management system which covers Victoria's coastal and marine environment to its territorial limits. In this regard, LCC proposed that the Victorian Coastal and Bay Management Council, established under the act, be the principal body to ensure that coastal planning is coordinated and that priorities are established. However, the LCC recommended close liaison between the Victorian Coastal and Bay Management Council and Regional Boards, the Fisheries Co-Management Council (recently established under the *Fisheries Act 1995*) and the Catchment and Land Protection Council and Regional Boards (established under the *Catchment and Land Protection Act 1994*).

- ***Victoria's Coastal Strategy***

The Victorian Coastal Council was appointed under the *Coastal Management Act 1995* as the peak body for the strategic planning and management of the Victorian coast, and to provide advice on coastal issues to the Minister for Conservation and Land Management. The *Coastal Management Act 1995* defines objectives for coastal management and the functions of the Council. The Council has eleven members – an independent chairman, six independent community representatives, a Local Government representative and three Government representatives from the Departments of Infrastructure (Planning and Transport) and Natural Resources and Environment. One of the Council's major statutory tasks is to prepare a Strategy for the whole of the Victorian coast.

The `Victorian Coastal Strategy' (VCC 1997) is the main policy framework for ensuring overall integrated coastal zone management along the Victorian coast and nearshore waters (out to the 5.5 km territorial limit). The Strategy establishes the broad strategic directions and specific actions required to ensure the long term care, management and development of the Victorian coast (see Box 7.2). It is guided by four key objectives defined in the *Coastal Management Act 1995*:

1 To ensure the protection of significant environmental features of the coast.

2 To provide clear direction for the future use of the coast including the marine environment.

3 To identify suitable development areas and development opportunities for the coast.

4` To ensure the sustainable use of natural coastal resources.

Importantly, a total of 12 core values and 69 specific policy and planning principles outlined in the Strategy provide specific direction for decision makers on the use and development of the coast. Specific principles for coastal management are provided to guide decisions in the following policy areas:

- Protection of the Natural Environment
- Aboriginal Use and Culture
- Catchment and Water Management
- European History
- Ownership
- Catchment and Water Management
- Boating
- Public Access
- Community Consultation and Participation
- Beach and Foreshore Protection Works
- Industrial and Commercial Activities
- Tourism and Recreation
- Economic
- Development
- Quality of Design
- Private Land
- Coastal Crown Land

Implementation of the Strategy will be achieved via:

- ***Local Government Planning Schemes***

– Will provide a mechanism for integrating coastal development, management and outcomes by linking across public and private land.

- ***Coastal Action Plans***

– Are one of the main means of delivering the Strategy. These will be developed by the Regional Coastal Boards and other agencies and provide for coordinated action, decision making and defined outcomes for coastal areas and issues.

- ***Guidelines***

– Will be developed to provide more direction for planners and managers.

- ***Use and Development Approvals Processes***

– Will be made more effective and simplified through a re-defined and accepted planning policy for the coast.

The Strategy recognises that many actions are currently under way in Victoria (and nationally) to varying degrees, and is aimed at the 20 year horizon and beyond and will be reviewed every five years to ensure it remains relevant and effective.

7.3.4 Marine Management Zones

The present system of marine management in Victoria encompasses four types of use: Marine Parks which can be established under the *National Parks Act 1975,* Sanctuary Zones which can be proclaimed within Marine Parks under the *Reference Areas Act 1978*, and multiple-use Coastal Waters Reserves which can be proclaimed under the *Crown Land (Reserves) Act 1978* and managed by the Department of Natural Resources and Environment, and the *Fisheries Reserves* which can be created under the *Fisheries Act 1995:*

1 Marine Parks

Marine Parks will protect a representation of the major habitats of Victoria's marine and estuarine environments. Marine Parks afford conservation and protection of biological diversity and are created primarily to protect natural features and aesthetic values while at the same time enabling recreational and commercial uses where these activities do not compromise conservation values. Proposed examples of Marine Parks in Victoria include Wilsons Promontory, Lady Julia Percy Island, Cape Liptrap. Within Marine Parks, the LCC is recommending establishment of Sanctuary Zones - statutory management zones which provide the highest level of habitat protection:

I Sanctuary Zones

– Are `look but don't take' areas managed solely for nature conservation and low-impact recreation and tourism. Areas should be large enough to be viable.

2 Coastal Waters Reserves

– These areas comprise the major part of Victoria's marine estate and generally a formal integrated management framework over areas that have high conservation value and intensive multiple-use. These areas include all remaining waters outside Marine Parks, and include 4 management zones which provide varying levels of protection and use:

I General Use Zone

– Provides for all existing legal uses and activities. These areas provide the lowest levels of conservation and protection of biological diversity.

II Port Access Zone

– Provide for safe navigation of vessels and access to ports from shipping.

III Special Management Zones

– To provide protection for identified special values such as breeding colonies of seals, waterbirds, sites of ecological significance, education value, etc. These zones provide for passive recreation, education, scientific study and other uses if they are consistent with protection of the identified special values. Mineral, gas, petroleum exploration and extraction permitted subject to relevant approvals (ie. environmental management plan, EES) and consent by the Minister responsible for the management zone. Special Management Zones are subject to the preparation of a management plan.

IV Preferred Marine Aquaculture Areas

– To provide for sea-based aquaculture activities.

Fisheries Reserves may also be an appropriate mechanism to implement some of the recommended Special Management Zones. The *Fisheries Act 1995* will require amendment to provide for fisheries reserves to be established in the Coastal Waters Reserve (being a reserve under *the Crown Lands (Reserves) Act 1978*) (LCC 1996).

7.3.5 MPA Management Responsibilities

The Land Conservation Council (1996) recommended that the Department of Natural Resources and Environment be responsible for the management of the public land of Victoria's marine, estuarine and coastal areas, other than the major ports. Other government agencies, such as the Environment Protection Authority, will continue to have responsibility for those aspects of marine and coastal management defined in their legislation.

Marine Parks will be established under the *Crown Land (Reserves) Act 1978*, and be included in a schedule to the *National Parks Act 1975* and managed by the National Parks Service, in consultation with the relevant fisheries authorities. Sanctuary Zones are to be proclaimed under the *Reference Areas Act 1978*, which provides for the Minister to issue directives for protection, control and management. An Advisory Committee, established under the Act, assists the Minister. Multiple-use Coastal Waters Reserves will be proclaimed under the *Crown Land (Reserves) Act 1978* and managed by the Department of Natural Resources and Environment.

BOX 7.2 - `VICTORIAN COASTAL STRATEGY'

The `Victorian Coastal Strategy' (VCC 1997) is the main policy framework for ensuring overall integrated coastal zone management along the Victorian coast and nearshore waters. The Strategy outlines 4 major objectives, and specific actions, to achieve integrated and sustainable use of Victoria's coastal resources:

- ***Objective 1***

– To ensure the protection of significant environmental features of the coast.

- ***Actions***

1 Addressing processes which threaten coastal and marine biodiversity.
2 Establishing a register for environmentally and culturally sensitive sites.
3 Protecting coastal wetlands.
4 Establishing a representative system of marine and coastal reserves.
5 Improving conservation status of freehold land.
6 Habitat enhancement initiatives.
7 Control of pest animals and weeds.
8 Establishing cultural trails.
9 Improving community awareness of cultural issues.

- ***Objective 2***

– To provide clear direction for the future use of the coast including the marine environment.

- ***Actions***

1 Defining activity nodes and functions.
2 Protecting the scenic landscape.
3 Managing and protecting the Port Phillip Bay and Western Port.
4 Vulnerability and risk assessment.
5 Achieving excellence in Coastal Committees of Management.
6 Defining management boundaries.
7 Review of coastal funding arrangements.
8 Streamlining of grants programs.
9 A new system for planning and approving use and development of public and private coastal land.
10 A new system for planning and approving use and development in the marine environment.
11 TImproving coastal design outcomes.
12 Improving existing buildings on the foreshore.

- ***Objective 3***

– To identify suitable development areas and development opportunities for the coast.

- ***Actions***

1 Improving opportunities for development in suitable coastal locations.
2 Establishing seaside food outlets.
3 Community use of foreshore land.
4 Improving access and facilities for boating.
5 Improving access and facilities for shore-based recreational fishing.
6 Improving tourist based opportunities.
7 Improving coastal car parks.
8 Coordinated visitor and tourism information centres.
9 Improving access by foot along the coast.
10 Sustainable economic development of Port Phillip Bay and Western Port.
11 New opportunities for sporting and cultural coastal events.
12 Improving signs along the coast.
13 The Victorian Scenic Coastal Drive.
14 Improving accommodation along the coast.

- ***Objective 4***

– To ensure the sustainable use of natural coastal resources.

- ***Actions***

1 Water quality standards and monitoring.
2 Improving water quality of the marine environment.
3 Upgrading of ocean outfalls.
4 Addressing the impact from shipping activities.
5 Improving approvals for and conduct of dredging operations.
6 Protection of intertidal areas from harvesting.
7 Consistency in regulations across coastal land and marine areas.
8 Increasing community awareness.
9 Increasing opportunities for community participation.
10 Addressing stormwater in urban areas.
11 Addressing drainage in non-urban areas.
12 Minimising sediment input.
13 Annual awards for excellence in the coastal environment.
14 Annual Victorian coastal and marine research and development forum.
15 Southern Australian Marine Research and Education Centre feasibility study.
16 Increasing school-based programs.
17 Improving communication with Aboriginal communities in coastal areas.
18 Establishing a schedule of coastal competitions and events.

7.4 Comparison of Approaches

7.4.1 Strategic Approach

Despite the similarity of marine environments, there are some fundamental differences in their legislative, policy and administrative approaches to the establishing MPA networks in Victoria and Western Australia. Put simply, the establishment and implementation of the Marine Conservation Reserves system in Western Australia (WA) has incorporated the concept of multiple-use Marine Protected Areas in it's policy framework (see Section 7.2). In this regard, the establishment of a marine reserves system has been the vehicle for both, preserving representative ecosystems and also, establishing multiple-use management regime in the marine environment. In contrast, the Victorian government has developed a comprehensive over-arching integrated, multiple-use coastal policy framework for the Victorian coast and nearshore waters, a component of which is a representative system of multiple-use marine reserves.

> ***Implications for South Australia:*** *South Australia has opportunities to consider either strategic approach. The process of developing an integrated approach to coastal zone management (ie. land and sea), as conducted in Victoria would require considerable resources. In contrast, multiple use management frameworks can be established simply and sequentially, for different regions of the State, using the concept of multiple-use Marine Protected Areas, as resources and regional priorities dictate.*

7.4.2 Sequential vs. Simultaneous MPA Declarations

The Victorian and Western Australian approach to establishing a representative system of Marine Protected Areas contrast significantly. The former proposes a simultaneous declaration of all Marine Parks and Sanctuary Zones along the Victorian coast (within a `whole-of-coast' zoning for conservation and development). In contrast, Western Australia have proposed a sequential declaration of Marine Conservation Reserves, on the basis of the need for conservation management, user-group conflict and threats, and also, importance for recreation and tourism.

In many ways the high usage and length of the Victorian coast (ie. 2 000 km) has prompted the immediate establishment of a multiple-use framework for the entire state. In contrast, Western Australia has an extensive coastline (ie. 12 600 km) and many remote regions which experience relatively low human usage. In this regard, establishing multiple-use Marine Conservation Reserves has been a very effective option for establishing multiple-use management regimes on a "as needs" basis, and allocating and prioritising planning and management resources.

> ***Implications for South Australia:*** *South Australia has probably more in common with the temperate regions of Western Australia, rather than Victoria, in terms of coastal length (ie. 3 600 km), types and patterns of human use along the coast and also, human population patterns along the coast (ie. the prevalence of remote, low density, coastal populations). In this respect, sequential declaration of Marine Protected Areas would allow prioritisation of planning and management resources and also, the potential to raise public awareness of the value of Marine Protected Areas.*

7.4.3 Zoning of Jurisdictional Coastal Waters

The recommendations of the former Land Conservation Council (1996) proposed the zoning of all coastal public lands and nearshore jurisdictional waters of Victoria (ie. inland to 1 km and seaward to the 5.5 km). In contrast, the WA Marine Parks and Reserves Authority will establish a system of Marine Conservation Reserves (ie. Marine Parks, Marine Management Areas) along the WA coast, but not including all WA coastal jurisdictional waters. In this respect, it is expected that areas between Marine Conservation Reserves will not be zoned for specific uses under the *CALM Act*, but will comprise general use areas.

The need for integration of Marine Protected Areas and adjacent public lands and coastal activities (ie. catchment management) is of paramount importance in ensuring the integrity of coastal ecosystems. This is in many ways facilitated by vesting responsibility for coastal and marine reserves and marine management zones with one agency, as well as undertaking an intersectoral, coastal planning exercise, as has been done in Victoria.

The formal zoning of waters between Marine Protected Areas, in many cases is a question of jurisdictional responsibility rather than the specific management of activities, as these areas are often zoned for general uses. As such, specific regulations relating to the environmental protection (eg. water quality), resource use (eg. fisheries, mineral and petroleum exploration and development) and the formal assessment of environmental impacts (ie. EIA), generally prevail. However, there is clearly a case for overall management responsibility of these waters, in terms of ecosystem management and integrity, and sustainable use. In Victoria, this responsibility has been vested with the Department of Natural Resources and Environment.

> ***Implications for South Australia:*** *In South Australia, coastal public lands and overall coastal management is overseen by the Coastal Protection Board established under the Coast Protection Act and administered by the Department of Environment, Heritage and Aboriginal Affairs. In this regard, there is the potential to establish integrated marine and coastal conservation management regimes under the National Parks and Wildlife Act and Coast Protection Act and administered by a single agency.*

7.4.4 Resource Development and Planning

The approach by the former Land Conservation Council (1996) and Environment Conservation Council (1998), and also, the Victorian Coastal Council (1996), specifically recognises the need to identify, and plan for, existing and future coastal development (ie. aquaculture, tourism), as well as identifying areas for protection within a multiple-use framework. To this end, the LCC (1996) in its final draft recommendations (LCC 1996) defined 8 specific areas for aquaculture (ie. Aquaculture Management Zones) along the Victorian coast, as well as zoning areas specifically for shipping (Port Access Zones). Further, this framework has been integrated with adjacent coastal land uses via the Victorian Coastal Strategy (VCC 1997) which has identified activity nodes, and planning guidelines for development along the coast.

In contrast, in the establishment of Marine Conservation Reserves in Western Australia, development and uses are facilitated in a conservation framework (ie. with defined conservation reserves under the *CALM Act*) via zoning for multiple use in Marine Management Areas and to a lesser extent, in Marine Parks. Multiple-use is also accommodated outside defined Marine Conservation Reserves. In this regard, the reserve framework in WA does not actively plan or identify area for future economic and resource development, but rather, considers these uses and activities in the overall assessment and consultation process in establishing individual Marine Conservation Reserves.

> ***Implications for South Australia:*** *In South Australia, policies and management plans are presently in place for marine-based aquaculture. These plans identify areas for aquaculture development along the South Australian coast and nearshore waters, and are formally recognised and approved as developments under the Development Act 1993. In this regard, in developing a system of Marine Protected Areas in South Australia, there is a need to consider these development plans, and also, to formally recognise potential Marine Protected Areas sites under the Development Act.*

7.4.5 Identification of Candidate MPA Areas

The identification of candidate Marine Protected Areas for a representative system in Western Australia is based on the qualitative or best available advice from technical experts on the Marine Reserves Selection Working Group (CALM 1994). The scientific report from the Working Group, entitled *`A Representative Marine Reserve System for Western Australia*' (1994), was undertaken over 7 years and identified approximately 70 candidate areas, that represent the range of marine ecosystems along the 12 500 km coastline of WA, for consideration as marine conservation reserves. The comprehensive report defines a biophysical (principally geomorphological) classification of the coast, but this pre-dated the biophysical classification of Australia's marine ecosystems under the national, *Interim Marine and Coastal Regionalisation of Australia* project (IMCRA 1997). Using this biophysical classification, the report provides a detailed outline of the regional uses and values (natural, social, economic) and identified candidate areas based on representative habitats, ecosystems; ecological significant or critical habitats/species; unique, rare and endangered habitats/species; economically important areas; geological values; aesthetics and wilderness values; tourism and recreational values. No specific identification criteria (eg. IUCN) or formal identification process was articulated in the report by the Working Group (CALM 1994). However CALM is presently developing a set of formal guidelines for identification and selection, and priority-setting for Marine Conservation Reserves, in order to formally assess the list of candidate reserves identified by the Working Group.

In Victoria, the identification of candidate marine protected areas for a representative system utilised several scientific studies commissioned by the Land Conservation Council. The principal study included a detailed descriptive report of the values, uses of the Victoria's coast (ie. *Marine and Coastal Special Investigation. Descriptive Report* (LCC 1993). In addition, several reports were commissioned by the LCC to assist with the identification of a representative system. This included reports identifying the biophysical regions of Victoria's coastal waters (VIMS *et al.* 1994, Hamilton 1994); description of intertidal and shallow subtidal habitats (Handreck & O'Hara 1994) and offshore habitats (VFRI 1996); sites of ecological and biological value (LCC 1994); description of recreational fishing activities (Craig 1994), fishing techniques and impacts (Moulton 1996); consultation and principles for traditional use by Victoria's coastal aboriginal communities (Mullett 1994, 1995, Harding & Rawlinson 1996); socio-economic values of the coast (TBA Planners 1996).

Five criteria were used to identify, assess and compare sites of ecological and biological significance: (1) high diversity of habitats, (2) high diversity of species, (3) habitats for rare, endangered, uncommon, depleted species, (4) nursery, feeding, breeding or rest areas, (5) rare or unique habitats.

Both, Western Australia and Victoria utilise aspects of the international IUCN criteria for identifying Marine Protected Areas (Kelleher & Kenchington 1991). More recently, these criteria have been formally adopted in the development of national guidelines for the establishment of a representative system of Marine Protected Areas, by the ANZECC Taskforce on Marine Protected Areas (Thackway 1996, Environment Australia 1998).

> ***Implications for South Australia:*** *In South Australia, there are significant opportunities in utilising the international and also, national guidelines for identification and selection of Marine Protected Areas currently being developed by the Commonwealth and States/Territory via the ANZECC Taskforce on Marine Protected Areas.*

7.4.6 Selection of Candidate MPAs

There are presently no formal national guidelines or methodologies for selecting particular Marine Protected Areas from a list of candidate areas.

For Western Australia, no specific selection criteria (eg. IUCN) or formal selection process was articulated in the report by the Working Group (CALM 1994). However CALM is presently developing a set of formal guidelines for identification and selection, and priority-setting for Marine Conservation Reserves, in order to formally assess the list of candidate reserves identified by the Working Group (see Appendix 1).

For Victoria, no specific selection criteria (eg. IUCN) were articulated, but the following 5-step selection process for a representative system was outlined by the LCC (1996):

1 Subdivide biophysical regions according to the eight major habitat types (see Table 7.3). Intertidal rocky shores and subtidal reef habitats were also subdivided according to major rock types of the substrate. Forty-eight potential region-habitat combinations were identified.

2 Identify specific coastline and offshore sections for each biophysical region/habitat combination that have known significant biological or ecological values.

3 Using areas with known values as a core, delimit sections of the coast from high water to the territorial limit in order to include the variability associated with increasing water depth and distance from shore.

4 For those sections of the coast where clear alternative areas exist, choose the area in the best environmental condition and least conflict with incompatible facilities or activities.

5 Consider the social and economic implications of choosing particular areas and the identified range of appropriate uses.

> ***Implications for South Australia:*** *In South Australia, there are significant opportunities in building on approaches to the selection and prioritisation of Marine Protected Areas currently being developed by other States/Territory (ie. Western Australia).*

7.4.7 Level of Information

The level of information available for planning the representative systems of MPAs in Victoria and Western Australia, particularly information on subtidal habitats and ecosystems, has been limited, both in spatial extent and in the quality of information. To this end, no systematic biological surveys of the coastal waters were undertaken prior to the identification of candidate areas. However, the level of information in both States varied considerably for coastal areas, with some areas the

subject of several scientific investigations, while other areas had limited or no information. For instance, in Western Australia, the Marine Reserves Selection Working Group (CALM 1994) utilised the best available published information and expert knowledge of technical specialists, however, spatial information and datasets on marine habitats and biology was generally limited.

Similarly, in Victoria, the LCC (1993) published a major descriptive report of the natural, social and economic values of the coast, however, biological information, once again, was limited, particularly for subtidal habitats. The LCC also commissioned a number of additional reports to assist with the planning process including:

- ***Information on Coastal, Marine, Offshore Habitats***

– Occurrence of Selected Species of Intertidal and Shallow Subtidal Invertebrates at Victorian locations (Handreck & O'Hara 1994); Sites with Important Biological and Ecological Values (LCC 1994); Offshore Survey of Selected Areas (VFRI 1996). More recently, mapping has also been undertaken of Victoria's nearshore waters, using satellite imagery was also undertaken by the LCC, the Department of Natural Resources and Environment, in associated with CSIRO Fisheries (Dr Hugh Kirkman).

- ***Biophysical Regions of Victoria's Coastal Waters***

– ie. Environmental Classification of Victoria's Marine Ecosystems – Stage One: Biophysical Classification Final Report (VIMS et al. 1994), and Environmental Classification of Victoria's Marine Ecosystems – Stage Two: A Physical Classification of Bass Strait Waters (Hamilton 1994).

- ***Fisheries Values***

– Saltwater Recreational Fishing in Victoria: A Questionnaire Survey of Recreational Fishers (Craig 1994); Fishing Techniques and Their Impacts (Moulton 1996);

- ***Aboriginal Values***

– Consultation with Victoria's Coastal Aboriginal Communities (Mullett 1994, 1995); Principles for Traditional Use of Victoria's Marine and Coastal Areas (Harding & Rawlinson 1996);

- ***Socio-Economic Values***

– A Socio-Economic Study of Coastal Towns (TBA Planners 1996).

Implications for South Australia: *In South Australia, a comprehensive mapping and biodiversity assessment of the nearshore marine habitats has been undertaken since 1992, by the SA Research and Development Institute (with assistance from CSIRO Division of Marine Research, SA Museum and SA Herbarium), to identify areas of high conservation value and assist in the identification of a representative system of Marine Protected Areas. This information will allow improved definition and delineation of representative habitats and ecologically significant areas and greater precision in achieving ecological management objectives (ie. representativeness, viability, ecological integrity).*

7.4.8 Public and Community Participation

In Western Australia, public and community consultation was received both on the scientific report of the Marine Reserves Selection Working Group, entitled *`A Representative Marine Reserve System for Western Australia*' (1994), and also, the policy document, *New Horizons in Marine Management* (CALM 1994). Public submissions were facilitated both by use of the media and also, by State-wide public meetings.

In Victoria, public consultation for the Land Conservation Council's Marine and Coastal Investigation was characterised by extensive consultation during the entire LCC investigation (ie. 1991-1997). The consultation and submission process included 3 formal public submission periods (8-20 weeks) and release of the following public documents:

– Background Descriptive Report (LCC 1993)
– Proposed Recommendations (LCC 1995)
– Draft Final Recommendations (LCC 1996)
– Final Recommendations (ECC, due June 1998)

Extensive use of the media was made to notify availability of reports and invite public submissions and over 2000 submissions were received on the process. This was also facilitated by over 100 briefings and public meetings.

Implications for South Australia: *In South Australia, formal public consultation processes are required for the establishment of individual Marine Protected Areas (ie. under the Fisheries Act 1982 and the National Parks and Wildlife Act 1972). However, there is a need for significant public consultation and input on both, the selection, prioritisation and establishment of a network of Marine Protected Areas.*

7.4.9 Social and Economic Assessment

In Western Australia, there has been no formal social and economic assessment of the representative system of Marine Conservation Reserves. This is largely due to the fact that the report by the Marine Reserves Selection Working Group (CALM 1994) is intended to indicate areas for consideration as Marine Conservation Reserves, and not as government endorsement of establishing reserves in these areas. To this end, there is a clear and explicit commitment by the Marine Reserves and Parks Authority (and the Department of Conservation and Land Management) to undertaking a formal social and economic assessment of individual reserves as they are considered for declaration (see Box 7.1).

In Victoria, in the later stages of the preparation of the final recommendations, the LCC commissioned a social and economic assessment of the draft final recommendations of the Marine and Coastal Special Investigation, ie. *`A Social and Economic Assessment of Draft Final Recommendations'* (McLennan Magasanik Associates Pty Ltd). The consultants concluded that the principal benefit from implementing the recommendations would be conservation and enhancement of the value of the environmental resource. Benefits for marine aquaculture were considered to be potentially large. Other benefits were associated with increased tourism and recreation. The principal costs identified were associated with constraints on certain uses in some zones, particularly in Sanctuary Zones – mainly commercial fishing and oil and gas production (LCC 1996). Benefits outweighed costs.

With respect to social impacts it was concluded that the recommendations would result in both beneficial and adverse impacts. Improvements in environmental amenity were considered to be beneficial to the community as a whole, and positive spin-offs due to employment as a result of increased tourism and recreation were identified. Other job gains identified were associated with stimuli to economic activity, such as marine aquaculture. Also identified were adverse impacts on employment, mainly from reductions in commercial fishing and on the area available to those who participate in certain forms of recreation. Job gains were estimated to substantially outweigh job losses. The consultants also noted that the benefits, particularly recreation and tourism, will probably occur locally and offset adverse local impacts from the curtailment of other commercial activity, mainly commercial fishing.

Implications for South Australia: *In South Australia, there is an opportunity for formal social and economic assessment of individual reserves as they are considered for declaration (as in Western Australia). Alternatively, a comprehensive cost-benefit analysis could be performed on establishing an entire system of Marine Protected Areas (as in Victoria).*

APPENDIX 1
CASE STUDY - SELECTION AND PRIORITISATION OF MARINE PROTECTED AREAS (WA CALM)

While no formal guidelines currently exist for selecting and prioritising Marine Protected Areas, the IUCN MPA criteria can be applied in various systematic approaches to provide a rational, defensible and objective approach to selecting and prioritising MPAs in establishing a representative system of MPAs. Below is a methodology currently being developed by WA CALM (CALM 1998) to assist the WA Government in selecting and prioritising MPAs in Western Australia.

In July 1994, the Minister for the Environment released a report entitled *A Representative Marine Reserve System for Western Australia* (CALM 1994). This report was compiled by the Marine Parks and Reserves Selection Working Group (MPRSWG) and identified 70 areas in the coastal waters of Western Australia that were worthy of consideration for marine reservation under the *Conservation and Land Management (CALM) Act (1984)*. In order to adopt a strategic approach to the establishment of a statewide system of multiple-use marine conservation reserves, the Marine Parks and Reserves Authority sought advice from the Marine Parks and Reserves Scientific Advisory Committee (MPRSAC) on an appropriate methodology to prioritize the implementation of the 70 areas identified in the MPRSWG report. This process outlined below describes CALM's proposed methodology and applies this framework, using both unweighted and weighted criteria, to eighteen of the areas identified in the MPRSWG report, as working examples. Although there is a logical basis for the proposed methodology it should be remembered this is not a strictly scientific exercise and should not be considered as such (CALM 1998). The objective is simply to provide a way to develop a more rational and visible basis for determining priorities for marine reservation in Western Australia. It is worth noting that, similar frameworks that could be used or modified for the purposes outlined above, do not appear to exist in Australia. Although most natural resource management agencies in Australia that were contacted about the above indicated that they prioritized their various activities, none could provide copies of formal prioritizing frameworks suitable for the above purposes.

- ***Prioritizing Framework***

The proposed framework is focused around twelve criteria in three broad categories involving ecological (E1-5) attributes and primary (H1-5) and secondary (L1-2) human values. The relative (between areas) value of each criterion is given a score of between 1 (low) to 5 (high). In the first working example no weighting is applied to the criteria and priorities are determined from a simple ranking of the summation of the criteria scores. In the weighted example, the ecological criteria (E1-5) have a weighting of three, the primary human values (H1-5) a weighting of two and the secondary human values (L1-2) a weighting of one. Priorities, in this case, are determined from a ranking of the summation of the weighted criteria scores.

The criteria broadly reflect the two major objectives of the multiple-use marine conservation reserve system in Western Australia which are (i) *to preserve representative, as well as special ecosystems in the marine environment and* (ii) *to put a formal framework in place to ensure the various uses of marine conservation reserves are managed in an equitable, integrated and sustainable manner* (WA Government, 1998). The weighting reflects the primacy of the conservation objective in terms of both the primary purpose of the marine reserve system and the dependency of many human uses on a healthy environment.

- ***Criteria***

Many sets of criteria, dating from the mid-seventies, exist for the selection and prioritisation of areas for marine reservation and approved by the IUCN and other international and national bodies. At an *International Conference on Marine Parks and Reserves* (IUCN, 1976), criteria and guidelines for the identification and management of 'critical marine habitats' were presented (Ray, 1976). The criteria for selection were grouped into the following categories: (i) ecological criteria, (ii) cultural, recreational and educational criteria and (iii) pragmatic criteria. These criteria are similar to the criteria of Kelleher & Kenchington (1991) for the selection of priority areas for marine reservation. The criteria used here to form the basis of the prioritizing framework for the establishment of marine reserves in Western Australia are, in general, derived from these primary sources.

The Kelleher & Kenchington (1991) criteria have subsequently appeared in a number of documents relating to marine reserves by the RAC (1993); Kelleher, Bleakley & Wells (1995); Thackway (1996) and Environment Australia (1998). The Kelleher & Kenchington criteria have also been adopted by the International Maritime Organisation for use in the identification of Particularly Sensitive Sea Areas and by the parties to the Helsinki Convention for identification of a system of marine protected areas for the Baltic Sea.

A brief description of the criteria is outlined below:

- ***Ecological Value (E1)***

Ecological values include the physical, chemical, geological and biological attributes and processes of natural systems. Spatial scales range from local, regional and global scales. Temporal scales range from seconds to evolutionary timescales. Biological attributes include species, populations, communities and ecosystems.

The ecological value of natural systems can be assessed from the following characteristics:

- ***Uniqueness:***
  - Contains unique species, populations, communities or ecosystems. Global uniqueness would afford an area a conservation value of international significance (eg stromatalites in Hamelin Pool Marine Nature Reserve).

- ***Representativeness:***
  - Representativeness is the degree to which the area in question represents a species, population, community or ecosystem type within a particular marine bioregion. Physiographic features and ecological processes or other natural characteristics can also contribute to the representativeness of an area.

- ***Dependency:***
  - Ecological processes are highly dependent on biotically structured systems. Examples include coral reefs, kelp 'forests', mangrove 'forests' and seagrass meadows. For example, these areas may contain nursery or juvenile areas or contain feeding, breeding or rest areas for migratory marine fish, reptiles, birds or mammals or are a source of larvae for downstream ecosystems.

- ***Diversity:***
  - The area has a high variety of species, populations, communities and ecosystems.

- ***Productivity:***
  - The species, populations, communities or ecosystems of an area have a high natural biological productivity.

- ***Naturalness:***
  - The area has a high degree of naturalness (ie is not disturbed or degraded by anthropogenic activities).

- ***Integrity:***
  - The area is a biologically functional unit; an effective, self-sustaining ecological entity.

- ***Vulnerability:***
  - The area is highly susceptible to degradation by natural events or anthropogenic activities. Biotic communities associated with coastal populations may have a low tolerance to changes in environmental conditions, or may exist close to the limits of their tolerance (defined by water temperature, salinity, turbidity or depth).

- ***Bioregional Representation (E2)***

This criterion relates to the extent to which a proposed reserve would be representative of the ecological attributes of the marine bioregion that it is situated within (IMCRA, 1997; Appendix I). If a proposed area is equal to or greater than 30% of the bioregion it is considered to have a high degree of bioregional representation and, as such, scores highly for this criterion.

- ***The Level of Existing and/or Potential Threats (E3)***

This criterion reflects one of the two major objectives of the marine reserve system which is to provide a formal framework to ensure integrated, equitable and sustainable management of human activities. The level of existing and potential threats is related to the nature and intensity of current and future uses, respectively, of an area on the assumption that as usage increases the level of threat to ecological and social values also generally increases. As such, the higher the level of current or projected use, the higher the score for this criterion.

For example, the recommended northern extension of the Shoalwater Islands Marine Park would be considered to have a relatively high degree of potential threat to its ecological and cultural values due to the discharge of contaminants from a wastewater outfall that is adjacent to the area in question. This reserve would therefore rate highly in this criterion. In contrast, a low score would be allocated to this criterion for area of the proposed southern extension to the Ningaloo Marine Park due to the relatively low usage and, therefore, low level of threat to the values of this area.

- ***Functional Integrity (E4)***

This criterion explicitly acknowledges the critical issue of spatial scale in marine management and is based on the assumption that management based on ecological boundaries is likely to be more effective, from an ecological perspective, than management based on sociological boundaries. Ideally, the spatial scales of marine reserves should be reconciled with the spatial scales of key ecosystem processes, given the primacy of the conservation objective (ie the area is maintained as a biologically functional unit; an effective, self-sustaining ecological entity). Thus, the greater a proposed marine reserve complies with this condition, the greater the functional ecological integrity of the reserve and the higher the score for this criterion.

For example, the functional integrity of the Ningaloo Marine Park would be greatly improved by the addition of the remaining unreserved portion of this reef system to the south of the marine park. Similarly, adding the Bernier/Dorre Islands area to the Shark Bay Marine Park would increase the functional integrity of this reserve.

- ***Integration of Terrestrial and Marine Management (E5)***

This criterion acknowledges the functional linkages between terrestrial and marine systems and, as such, the importance of integrating marine and terrestrial management frameworks. Because integrated management is obviously easier to achieve within a single agency, proposed marine reserve areas adjoining CALM-managed lands would score higher for this criterion than marine areas adjoining terrestrial areas that are not managed by CALM.

Examples of the former include the marine waters adjacent to the terrestrial reserves of Fitzgerald River National Park and the Dampier Archipelago, both of which are currently managed by CALM.

- ***Cultural Value (H1)***

'Cultural' values are defined here in the broadest sense of the word and include the entire range of human uses of the natural environment.

- ***Social Significance:***

– The area has existing or potential value to the local, regional, national or international communities because of its heritage, historical, cultural, traditional, aesthetic, educational or recreational qualities.

- ***Economic Significance:***

– The area has existing or potential economic value. For example, the area has important commercial activities such as fisheries, aquaculture and nature-based tourism, is a food source and/or a source of income for indigenous communities, or is a nursery area or replenishment area for economically important species.

- ***Scientific Significance:***

– The area has particular significance for scientific study at local, regional, national and international scales.

- ***International and National Values:***

– The area has the potential to be listed on the World or a National Heritage List, declared as a Biosphere Reserve, included on a list of areas of international or national importance or is the subject of an international or national conservation agreement.

- ***Existing Information (H2)***

This criterion acknowledges the high up-front information demand of the 'new' marine reserve provisions of the CALM Act which require ecological and socio-economic resource assessments as part of the planning process prior to the release of the Notice of Intent (NOI) to reserve. As there are obvious costs attached to the acquisition and interpretation of this data, and resources are limited, the more existing relevant information that is available the lower the cost to establish the reserve, which is clearly advantageous. Thus, within the proposed framework, the greater the level of existing relevant information the higher the score for this criterion.

- ***The level of Existing and/or Potential Conflict (H3)***

This criterion reflects one of the two major objectives of the marine reserve system which is to provide a formal framework to ensure integrated, equitable and sustainable management of human activities. The level of existing and potential conflict is often related to the nature and intensity of current and future uses, respectively, of an area on the assumption that as usage increases, the level of conflict also generally increases. This, in turn, increases the need for more formal management arrangements. As such the higher the level of current or projected use, the higher the score for this criterion.

- ***Socio-Political Considerations (H4)***

This criterion reflects the revised consultative approach of the recently amended marine reserve provisions of the CALM Act and relates to the level of State Government, local government, stakeholder, community, and industry support for a proposed marine reserve area. As stakeholder advisory committees will generally have a pivotal role in the planning and establishment of marine reserves, a high level of support for a proposal is obviously advantageous. As such, the more support there is the higher the score for this criterion.

- ***Strategic Importance (H5)***

This criterion relates to the relative strategic importance of the proposed reserve areas in relation to the overall marine reserve program. Historically, particular sectors such as commercial fishing and the petroleum industry have viewed the establishment of marine reserves as, at best, an impediment and, at worst, a 'threat' to their own interests. Thus proposed marine reserve areas which, if successfully established, effectively demonstrate that conservation objectives and sustainable commercial activities are not mutually exclusive, have a higher strategic importance than areas where these concerns are less evident.

- ***Linkages to Public Sector Programs (L1)***

This criterion addresses a key responsibility of Government agencies which is to work in an integrated and co-operative manner. Ecological studies and monitoring programs relating to marine reserve management have significant relevance to fisheries management (and vice versa). Similarly, compliance monitoring of fisheries and marine safety regulations by marine park officers could have significant benefits through the sharing of surveillance costs. Thus the greater the benefits a marine reserve would bring to other State Government marine management and regulatory programs the higher the score for this criterion.

- ***Linkages to Private Sector Programs (L2)***

This criterion addresses a key responsibility of Government agencies which is to work in a co-operative manner with the private sector. Ecological studies and monitoring programs in marine reserves have significant relevance to the environmental management responsibilities of marine-based industries (and vice versa). Thus, for this criterion, the greater the benefits a marine reserve area would bring to the private sector the higher the score.

- ***Working Examples of the Prioritizing Framework***

This section outlines working examples of the prioritizing framework using both unweighted and weighted criteria. The rationale for the selection, scoring and weighting of the criteria is outlined above in the section headed "Prioritizing Framework". The use of individual area scores to provide individual area rankings (priorities) provides a basis to compare the results of the two approaches. The results are presented in Tables 1 and 2.

In the unweighted example, the first six priorities were (in order) the Dampier Archipelago, Monte-bellos/ Barrow, Northern Extension of the Shoalwater Islands Marine Park, Jurien Bay (4), Geographe Bay/Capes area (4) and Broke Inlet. In the weighted example the first six priorities were the Dampier Archipelago, Monte-bellos/ Barrow, Geographe Bay/Capes area, Broke Inlet, Fitzgerald River and the Northern Extension of the Shoalwater Islands Marine Park. The Jurien Bay area was priority number seven.

The lowest six priorities (in descending order) in the unweighted example were Albany, Roebuck Bay, Exmouth Gulf, Southern Ningaloo, Buccaneer Archipelago and Cambridge Gulf. In the weighted example the six lowest priorities were Exmouth Gulf, Southern Ningaloo, Buccaneer Archipelago, Roebuck Bay, Albany and Cambridge Gulf.

These results demonstrate a degree of coherence between both approaches in that the results of both the weighted and unweighted examples identify many of the same areas in both the top and bottom six priorities. Given the level of coherence between the two approaches and the subjectivity of much of the data, it would be appear pointless to refine the prioritizing framework much beyond the level of complexity presented here.

In summary, the weighted framework appears to be the most sensible option in that it more closely reflects the hierarchy of the objectives of the marine reserve system and provides a rational and visible basis for determining priorities for marine reservation in Western Australia.

AREA/CRITERIA	E1	E2	E3	E4	E5	H1	H2	H3	H4	H5	L1	L2	SUM	PRIORITY
Cambridge Gulf	4	1	1	1	1	1	1	1	2	1	1	1	14	18
Buccaneer Archipelago	5	3	1	2	1	2	1	1	2	3	1	1	23	15
Roebuck Bay	5	1	1	1	1	2	2	1	5	3	2	2	28	13
Dampier Archipelago	4	3	4	3	5	5	5	5	5	2	3	2	46	1
Montebello-Barrow	4	3	3	3	5	4	4	4	4	5	3	2	44	2
Exmouth Gulf	4	3	1	3	1	3	3	1	3	1	1	2	26	14
Sth Ningaloo MP	5	1	1	5	1	3	1	1	2	1	1	1	23	15
Bernier-Dorre	4	1	2	3	5	3	4	1	3	1	1	1	29	11
Abrolhos	5	2	3	2	1	5	4	5	2	1	3	3	36	7
Beagles	4	2	1	1	5	3	2	1	5	1	2	2	29	11
Jurien	4	2	3	1	3	4	5	2	5	5	2	2	38	4
Nth SIMP	3	2	5	3	2	5	5	5	3	1	3	2	39	3
Geographe -Capes	4	3	4	3	3	5	2	5	4	2	2	1	38	4
Walpole-Nornalup	4	2	3	3	5	4	2	3	3	1	2	1	33	9
Broke Inlet	5	2	2	5	5	5	2	1	3	1	5	1	37	6
Albany	3	2	2	1	2	3	2	2	2	1	2	1	23	15
Fitzgerald	5	4	1	5	5	2	5	1	2	3	1	1	36	7
Recherche	5	4	1	5	5	3	2	1	2	1	2	1	32	10

Score:

5 = high
1 = low

Table 1 **Marine Reserve Implementation Priorities (Unweighted Example)**

AREA / CRITERIA	*E1*	*E2*	*E3*	*E4*	*E5*	*SUM*	*WEIGHTED SUM (*3)*	*H1*	*H2*	*H3*	*H4*	*H5*	*SUM*	*WEIGHTED SUM (*2)*	*L1*	*L2*	*SUM*	*WEIGHTED SUM (*1)*	*WEIGHTED SCORE*	*PRIORITY*
Cambridge Gulf	4	1	1	1	1	8	24	1	1	1	2	1	5	10	1	1	2	2	36	18
Buccaneer Archipelago	5	3	1	2	1	12	36	2	1	1	2	3	9	18	1	1	2	2	56	15
Roebuck Bay	5	1	1	1	1	9	27	2	1	1	5	3	12	24	2	2	4	4	55	16
Dampier Archipelago	4	3	4	3	5	19	57	5	5	5	5	2	22	44	3	2	5	5	106	1
Montebello-Barrow	4	3	3	3	5	18	54	4	4	4	4	5	21	42	3	2	5	5	101	2
Exmouth Gulf	4	3	1	3	1	12	36	3	3	1	3	1	11	22	1	2	3	3	61	13
Sth Ningaloo MP	5	1	1	5	1	13	39	3	1	1	2	1	8	16	1	1	2	2	57	14
Bernier-Dorre	4	1	2	3	5	15	45	3	4	1	3	1	12	24	1	1	2	2	71	11
Abrolhos	5	2	3	2	1	13	39	5	4	5	2	1	17	34	3	3	6	6	79	10
Beagles	4	2	1	1	5	13	39	3	2	1	5	1	12	24	1	1	2	2	65	12
Jurien	4	2	3	1	3	13	39	4	5	2	5	5	21	42	2	2	4	4	85	7
Nth SIMP	3	2	5	3	2	15	45	5	5	5	3	1	19	38	3	2	5	5	87	6
Geographe -Capes	4	3	5	3	3	18	54	5	2	5	4	2	18	36	2	1	3	3	93	3
Walpole-Nornalup	4	2	3	3	5	17	51	4	2	3	3	1	13	26	2	1	3	3	80	9
Broke Inlet	5	2	2	5	5	19	57	5	2	1	3	1	12	24	5	1	6	6	89	4
Albany	3	2	2	1	2	10	30	3	2	2	2	1	10	20	2	1	3	3	53	17
Fitzgerald	5	4	1	5	5	20	60	2	5	1	2	3	13	26	1	1	2	2	88	5
Recherche	5	4	1	5	5	20	60	3	2	1	2	1	9	18	2	1	3	3	81	8

Score:

5 = high
1 = low

Table 2 **Marine Reserve Implementation Priorities (Weighted Example)**

APPENDIX 2
RECOMMENDED SA MARINE FISH SPECIES FOR PROTECTION

- ***Family Syngnathidae (seahorses, pipefishes)***

1 Common or Weedy Seadragon (*Phllopteryx taeniolatus*).

– This species is endemic to southern Australia, from central NSW to at least Rottnest Island (WA), including Tasmania and may be less common in SA waters. Preferred habitat appears to be among algal beds and rocky reefs in depths of 3-50m. The species has been protected in NSW under the *NSW Fisheries Act 1994*. The species was recently listed on the *IUCN Red List*, and has also been categorised as `data deficient'.

2 Bigbelly Seahorse, (*Hippocampus abdominalis*).

– This species in endemic to southern Australia (from NSW to SA, including Tasmania), and New Zealand. Lives in shallow, somewhat muddy rocky areas, especially near the edges of rocks. This is the largest and most common of the non-leafy seahorses found in southern waters. Individuals are easily kept in aquaria if fed regularly on a diet of small shrimp and other crustaceans. The species was recently listed on the *IUCN Red List*, and categorised as `Vulnerable', with expected reduction of 80% in the next ten years due to actual and potential levels of exploitation, (Hudson E & G Mace, 1996).

3 Shortsnout Seahorse (*Hippocampus breviceps*).

– This species is endemic to southern Australia, from central NSW to Perth (WA), including northern Tasmania. Found in shallow seagrass beds and floating seaweed. The species was recently listed on the *IUCN Red List*, and has also been categorised as `data deficient'.

4 White's Seahorse (*Hippocampus whitei*).

– A subtropical, endemic Australian species, reported from Queensland south and westward to South Australia, including Tasmania. Found on estuarine weedflats of sheltered embayments. This species commonly occurs in warm water, and occurs rarely in SA. The species was recently listed on the *IUCN Red List*, and has also been categorised as `data deficient'.

5 Robust Pipehorse, (*Solegnathus robustus*).

– This species is endemic to southern Australia, known only from the Flinders Island (Tas.), westward to off Point Weyland (SA) in the Great Australian Bight. Occurs in depths of 42-68m. The species was recently listed on the *IUCN Red List*, and categorised as `Vulnerable', with expected reduction of 80% in the next ten years due to actual and potential levels of exploitation, (Hudson E & G Mace, 1996).

6 Longsnout Pipefish (Vanacampus poecilolaemus).

– This species is endemic to southern Australia, and is known only from a few small areas of WA (Carnac Island to Geographe Bay), northern Tasmania and Kangaroo Island. Occurs among vegetation in estuaries and in offshore waters to depths of about 11m. The species is moderately common in grassy embayments along the coast.

7 Deepbody Pipefish (*Kaupus costatus*).

– This species is recorded from Bruthen Creek (Victoria), Flinders Island (Tasmania), Kangaroo Island and elsewhere in South Australia. Occurs among algae or seagrasses at depths of 10m or less. This species appears to have disappeared from known sites in Victoria, however it is still relatively common in isolated areas undisturbed by boating in SA, such as American River Inlet (Kuiter *pers.comm*.)

8 Vercos Pipefish (*Vanacampus vercoi*).

– This species is endemic to South Australia, and is known only from Spencer Gulf, Gulf St Vincent and Kangaroo Island. This species has the most restricted range of any species in the family Signathidae in southern Australian waters. Occurs among vegetation in depths of 2-3m.

9 Little Pipehorse (Acentronura australe)

– This species is endemic to southern Australia, recorded from Gulf St Vincent and Cape Jervis (SA) and Carnac Island (WA). This seahorse is known only from 5 specimens, all taken by dredges.

10 Gales Pipefish (*Campichthys galei*).

– This species is endemic to western and southern Australian species, known from Shark Bay to Point Peron and Rottnest Island (WA) and from Boston Island (SA). Maximum recorded depth 18m.

11 Tryon's Pipefish (*Campichthys tryoni*).

– This species is endemic to Australian waters, and is recorded from southern Queensland and Gulf St Vincent (SA). This is one of many small species of pipefish known from but a few specimens. The South Australian record is based on a single, damaged specimen.

12 Tiger Pipefish (*Filicampus tigris*).

– This species is endemic to subtropical Australia, however it has been recorded in Port Lincoln and elsewhere in Spencer Gulf (SA). The South Australian specimens are based on three specimens. Occurs mostly at depths of 2-25m.

13 Briggs Crested Pipefish (*Histiogamphelus briggsii*).

– This species is endemic to southeastern Australia, known from NSW to SA, including northern Tasmania. Occurs over coastal sandy bottom at depths of 3-20m, occasionally among seaweed. The species is not common.

14 Macleays Crested Pipefish (*Histiogamphelus cristatus*).

– This species is endemic to southern Australia, known only from Spencer Gulf, Gulf St Vincent and Kangaroo Island (SA) and from the Recherche Archipelago to Rottnest Island (WA). Usually occurs in seagrass beds.

15 Shaggy Pipefish (Hypselognathus horridus).

– This species is endemic to southern Australia, known only from the Great Australian Bight at depths of 40-55m. This recently described species is known only from a few trawl specimens. Nothing is known of its habits.

- ***Family Clinidae (weedfishes)***

2 Eelblenny (Peronedys anguillaris).

– This species is endemic to Australia, and is known only from Kangaroo Island and Gulf St Vincent (SA) and Moreton Bay (Qld.). The species lives among seagrass roots.

16 Spotted Snakeblenny (*Ophiclinops pardalis*).

– This species is endemic to South Australia, and is known only from a few sites in Spencer Gulf, St Vincent and Kangaroo Island. The species lives with weed litter and amongst the roots of seagrass, and is possibly dependant on undisturbed seagrass.

- ***Family Labridae (wrasses)***

1 Western Blue Groper (*Achorerdus gouldi*).

– This species is endemic to southwestern Australia, known from eastern SA to Lancelin (WA). The species occurs on rocky reefs to depths of about 40m. These docile fish have long been exploited by spear fishermen and anglers because of their great size and excellent eating quality. Consequently, their numbers have been diminished markedly and spear fishing restrictions have been placed on them to allow populations to recover. The species is presently afforded limited protection in SA (ie. gulf waters only). If given full protection could be economically important for dive viewing industry. Recent studies, suggest that this species could be possibly be an important keystone species in SA reefal environments (Shepherd *pers.comm.*).

- ***Family Plesiopidae (blue devils, hulas)***

1 Bluedevil (Paralesiops meleagris).

– This species is endemic to southern Australia, occurring from Cape Woolamai (Vic.) to the Houtman Abrolhos Islands (WA). Occurs within a depth range of 10 to at least 45m. This is an attractive fish, which is ideal subject for underwater photographers. It is commonly found of reefs, particularly in somewhat deeper offshore water and protected shallow areas. In areas close to centres of population, the species has suffered considerable local declines due to spearfishing activities.

2 Alisons Bluedevil (*Paralesiops alisonae*).

– This species is endemic to southern Australia, occurring from Wilsons Promontory (Vic.) and Tasmania to Kangaroo Island (SA). Found on rocky reefs in depths to about 35m.

3 Southern Hulafish (Trachinops caudimaculatus).

– This is a common species in Bass Strait, where it is found almost exclusively on reefs, particularly near drop-offs. In South Australian waters it is uncommon, and usually occurs with *Trachinops noarlungae*.

4 Noarlunga Hulafish (*Trachinops noarlungae*).

– This species is endemic to southwestern Australia, extending from Gulf St Vincent (SA) to the Houtman Abrolhos Islands (WA). Occurs on reef areas, especially those with large caves, at depths of about 30m and often occurs in schools of several hundred individuals.

- ***Elasmobranchs* (sharks, rays)**

1 Great White Shark (Carcharodon carcharias).

– Found around Australia, but particularly off the southern coast. Occurs elsewhere in oceanic and continental shelf areas within the tropical and temperate belts of all major oceans, though more abundant in shelf regions of the temperate zone. This species is protected in the waters of Tasmania and New South Wales. Commercial catch of this species is prohibited in SA. The species was recently listed on the *IUCN Red List*, and categorised as `Vulnerable', with expected reduction of 80% in the next ten years due to declines in extent of occurrence world wide and decline in habitat, and actual levels of exploitation and by-catch (Sarah Fowler, IUCN Shark Specialist group). The vulnerable status of this species has been recognised internationally through protected species status in South Africa, Florida and California.

5 Grey Nurse Shark, (Carcharias taurus).

– In Australia, distributed around the southern coast, excluding Tasmania, north to Queensland, Port Headland (WA) and near Melville Island (NT). Elsewhere, occurs throughout tropical and warm temperate regions of the Indian, Atlantic (including the Mediterranean Sea) and western Pacific Ocean. Found at shallow depths, rarely greater than 60m depth. This species has undergone severe depletion in numbers in eastern Australia.

– The species is formally protected in NSW, and has been listed as `Vulnerable' by Australian Society for Fish Biology, the peak professional body for fisheries researchers in Australia.

6 Bluntnose Sixgill Shark (*Hexanchus griseus*).

– In Australia, this species is recorded only from the Northwest Shelf (WA), near Beachport (SA), Port Fairy (Vic.), Tasmania and Norah Head (NSW). Recorded at depths of 201-457m. Elsewhere, inhabits tropical and temperate open oceanic waters throughout the world, usually at considerable depths on or near the seabed, though occasionally in shallows. Recently listed on *IUCN Red List*, and cateogorised as `Vulnerable'. In SA, recorded only from Beachport.

7 Magpie Fiddler Ray (*Trygonorrhina melaleuca*).

– This species is endemic to South Australia, known only from shallow water in Gulf St Vincent. Preferred habitat and depth distribution is unknown. Only several specimens have been recorded.

Other marine fish species to be considered due to difficulties in compliance (and vulnerability to overexploitation):

- ***Family Sygnathidae***

2 Upsidedown Pipefish (*Heraldia nocturna*).

– This species is endemic to southern Australia, known from Seal Rocks (NSW), south and westward to Kangaroo Island (SA), and from Cape Le Grande and Geographe Bay (WA). Restricted to rocky areas in depths of 2-30m.

8 Knifesnout Pipefish (*Hypselognathus rostratus*).

– This species is endemic to southeastern Australia, known from the coasts of Victoria, northern Tasmania and South Australia.

9 Brushtail Pipefish (Leptoichthys fistularius).

– This species is endemic to southern Australia, known from Melbourne (Vic.), Flinders Island and Bridport (Tas.), westward to Albany (WA). This is one of the largest of Australia's inshore pipefishes, occurring in sheltered, shallow seagrass beds.

10 Smooth Pipefish (Lissocampus caudalis).

– This species is endemic to southern Australia, known from Victoria to Rottnest Island (WA), including northern Tasmania. Occurs among algae and eelgrass (*Zostera*), in shallow inshore waters and tide-pools. This species is infrequently seen.

11 Javelin Pipefish (*Lissocampus runa*).

– This species is endemic to southern Australia, known from southern NSW to Rottnest Island (WA), including northern Tasmania. Occurs mostly in tidepools and sheltered inshore areas to depths of about 3m.

12 Sawtooth Pipefish (Marouba perserrata).

– This species is endemic to southern Australia, known from central NSW to Rottnest Island (WA), including Tasmania. Found beneath ledges and in caves during the day.

13 Red Pipefish (Notiocampus ruber).

– This species is endemic to southeastern Australia, from central NSW to Kangaroo Island and Cape Jaffa (SA), including Flinders Island (Tas.). Occurs at depths of 12-20m. This species is not often encountered, being chiefly taken by dredges.

14 Pugnose Pipefish (*Pugnaso curtirostris*).

– This species is endemic to southern Australia, known from Bass Strait (Vic. and Tas.) to near Rottnest Island (WA). Often found among algae and eelgrass at depths down to 11m.

***15* Spotted Pipefish (*Stigmatopora argus*).**

– This species is endemic to southern Australia, from the Hawkesbury River (NSW) to Rottnest Island and Shark Bay (WA), and in Tasmanian waters. Most common among vegetation in inshore bays and estuaries, but occurs to depths of at least 8m and among floating algae (*Sargassum).*

16 Ringback Pipefish (*Stipecampus cristatus*).

– This species is endemic to the coasts and bays of Victoria and South Australia. Appears to prefer weed and sand areas to seagrass beds, down to depths of about 12m.

17 Hairy Pipefish (Urocampus carinirostris).

– Known in Australia, from southern Queensland, south and westward to the Swan River (WA), and from Tasmania, and also, Papua New Guinea. Most common among vegetation in protected estuarine areas , down to depths of 3m.

- ***Family Gobiesocidae (clingfishes)***

3 Broadhead Clingfish (Cochleoceps bassensis).

– The species is endemic to southeastern Australia, from eastern Victoria to South Australia. Usually lives on sponges attached to flat bottoms at depths to 40m, but also found on jetty piles.

2 Western Cleaner Clingfish *(Cochleoceps bicolor*).

– The species is endemic to southern Australia, from Victoria to southern Western Australia, excluding Tasmania. Often found on sponges and ascidians.

3 Spadenose Clingfish (*Cochleoceps spatula*).

– The species is endemic to the coastal waters of South Australia and southern Western Australia. Occurs in shallow protected seagrass beds.

4 Tasmanian Clingfish (Aspasmogaster tasmaniensis).

– The species is endemic to southern Australia, and is known from Tasmania and Victoria to southern Western Australia. Common on coastal rocky bottoms in shallow subtidal and intertidal areas; also found under jetties. The species is frequently encountered when turning over rocks and rubble in shallow embayments, especially near piers and wharfs.

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