Department for Environment and Heritage

Adelaide and Mount Lofty Ranges Natural Resources Management Region

Estuaries Information Package

Government of South Australia

Australian Government

www.environment.sa.gov.au

Contents

Figures

Tables

Appendices

Overview

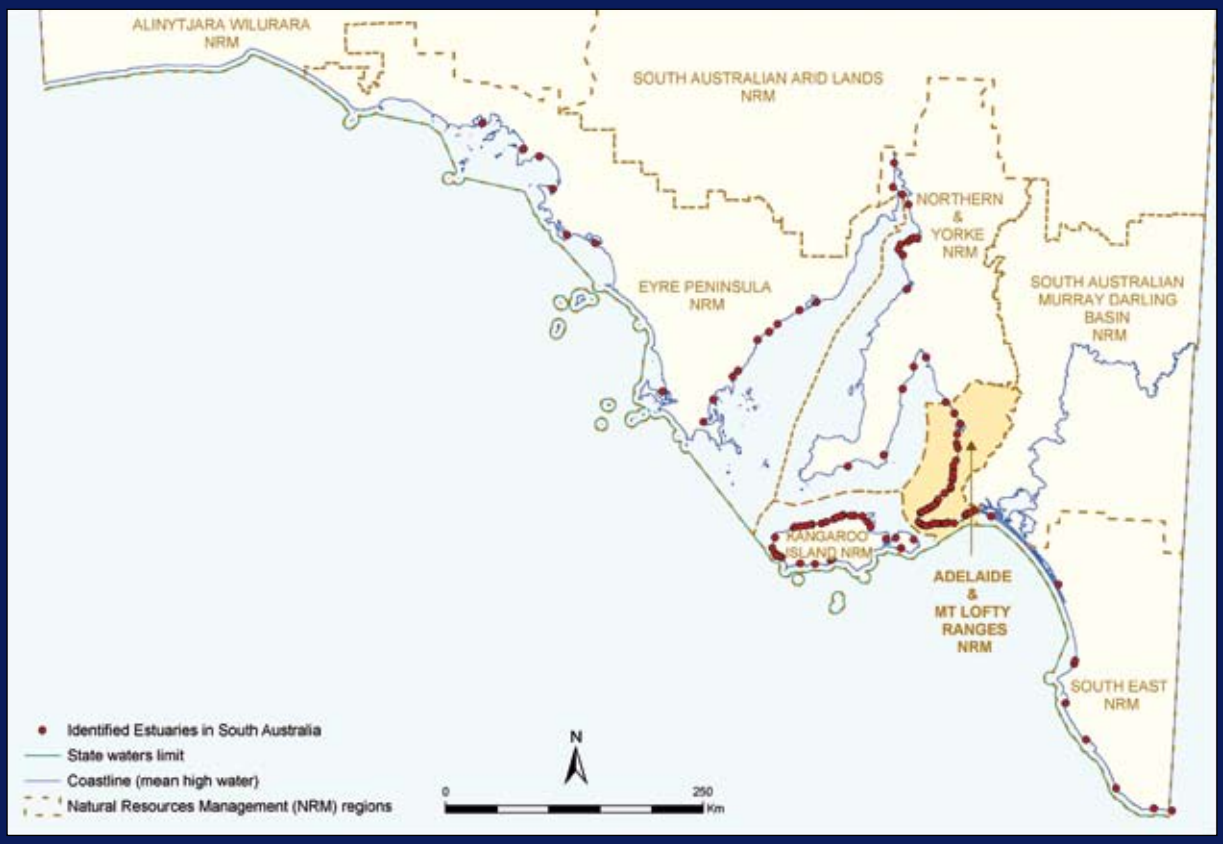
The Adelaide and Mount Lofty Ranges Natural Resources Management region (AMLR NRM region) is one of eight NRM regions within the State (see Figure 1).

The region covers nearly 4,000 km^2 and includes urban plains, ranges and coast and marine ecosystems. Thirty seven estuaries have been identified in the region. These provide substantial environmental, economic and social values to the community.

Environment

- The estuaries identified in the National Land and Water Resources Audit (NLWRA) are either wave or tide dominated, with the exception of the Onkaparinga River estuary that is river dominated.
- Groundwater appears to be a significant input into several of the estuaries.
- All of the estuaries and their catchments have been modified to some degree. (eg weirs, dams, channel modifications), impacting environmental flows.
- The Gawler River, Port River Barker Inlet and the Onkaparinga River estuaries contain extensive saltmarshes.
- The Gawler River estuary and Port River Barker Inlet are the only two estuaries in the region where mangroves are present.

Figure 1. The AMLR NRM region and identified estuaries in South Australia



Conservation and protection

- The nationally vulnerable bead samphire *Halosarcia flabelliformis* (*Environment Protection and Biodiversity Conservation (EPBC) Act 1999*, *National Parks and Wildlife (NPW) Act 1972*) has been identified on Garden Island (Port River Barker Inlet) and within the Port Gawler Conservation Park (Gawler River estuary).
- Seventeen of the region's estuaries are within sites listed on the Register of the National Estate.
- The Gawler River, Port River Barker Inlet, Onkaparinga River and Aldinga Catchment estuaries are included in the Directory of Important Wetlands in Australia.
- The Port River Barker Inlet and Onkaparinga River estuaries are within Aquatic Reserves dedicated under the *Fisheries Management Act 2007*.
- The Gawler River, Port River Barker Inlet, Onkaparinga River, Deep Creek, Blowhole Creek and Waitpinga Creek estuaries are all located within conservation parks.
- The Port River Barker Inlet and the Gawler River estuary are within the Adelaide Dolphin Sanctuary.
- The Port River Barker Inlet is an important breeding and nursery area for many of the State's commercial and recreational fish species.
- Numerous migratory bird species of international and national importance are dependent on estuarine habitats within the AMLR NRM region.
- The golden haired sedge-skipper butterfly *Hesperilla chrysotricha* is associated with coastal saw-sedge *Gahnia trifida*, which is in decline in the area and is the same habitat as for the endangered orange-bellied parrot *Neophema chrysogaster* and southern emu-wren *Stipiturus malachurus* (*EPBC Act 1999*).

Cultural and socio-economic values

- Numerous significant indigenous sites are situated around the AMLR NRM region's estuaries.
- European heritage sites are located around the AMLR NRM region's estuaries.
- The region's estuaries provide economic benefits to the community through employment, industry, tourism, agricultural practices and international exports.

Issues and initiatives

- Estuaries are under pressure from a range of activities including land use, recreational pursuits, and agricultural and industrial practices.
- Several initiatives are underway that aim to increase our understanding of local estuarine environments and help to manage and protect the region's estuaries.

1. Introduction

The South Australian Department for Environment and Heritage (DEH), with support from the Australian Government's Natural Heritage Trust, has developed this estuaries information package (EIP) for the Adelaide and Mount Lofty Ranges (AMLR) region to support natural resources management (NRM) bodies, State and local government and other agencies in undertaking planning and management in estuarine areas.

There are four other EIPs in the series for South Australia: Eyre Peninsula (EP), Northern and Yorke (NY), Kangaroo Island (KI) and South East (SE) NRM region EIPs.

Each EIP consists of information collated from various sources relevant to the estuaries within that region. As a result, some key information gaps and potential directions have been included as a guide for management options for South Australia's estuaries.

As part of the *State NRM Plan 2006*, one of the resource condition targets for water is that by 2015, no further net loss of wetlands or estuaries, extent or condition, has occurred compared to 2006.

2. What is an estuary?

Estuaries and the land surrounding them are places of transition - where water from the land meets and mixes with the sea. They may be large or small systems, influenced by tidal exchange, stormwater discharge or groundwater intrusion.

Fluctuating salinity levels occur in estuaries. A variety of flora and fauna species have been able to adapt to these conditions and live within the estuaries.

Estuaries are generally highly productive systems that are essential for the health and well being of the marine environment. The health of the estuary is very dependent on the catchment-coast-ocean connection. Land management practices and land uses occurring upstream and on the adjacent lands have the potential to affect water quality, animal life and habitats within the estuary.

The *Natural Resources Management Act 2004* defines an estuary as:

'A partially enclosed coastal body of water that is either permanently, periodically, intermittently or occasionally open to the sea within which there is a measurable variation in salinity due to the mixture of seawater with water derived from on or under the land'.

The Act also notes that an estuary may include any ecosystem processes or biodiversity associated with an estuary and estuarine habitats adjacent to an estuary.



3. Estuaries of the AMLR NRM region

3.1 Estuary classification

Thirty seven estuaries have been identified for the region (see Figure 2) by an across-agency Estuaries Working Group. These estuaries vary from small ephemeral channels such as Boat Harbor Creek to river-dominated systems such as the Onkaparinga River and large tide-dominated systems such as the Port River Barker Inlet.

Information on estuary classification, maximum length, perimeter and water area is contained in Table 1; only those estuaries that have been mapped as part of the NLWRA (2001) have been included. Table 2 provides information on the catchment size for each estuary.

3.2 Regional NRM Groups

The AMLR NRM region is separated into four areas for management purposes: Northern, Central, Southern and Fleurieu (see Figure 2). Within each of these group areas there are estuaries with differing features, functions and pressures that need to be managed.

It is a role of the NRM Groups, in consultation with other organisations, to oversee and implement a range of management actions to protect those estuaries within each of their group's boundaries.

3.3 Coastal councils

Twelve coastal councils are located within the AMLR NRM region, with varying numbers of estuaries located in each (see Figure 3). Although land-based influences can occur upstream in non-coastal council areas (and there is a duty of care for upstream councils), it is the coastal councils that have direct responsibility for managing estuaries within their boundaries.

The District Council of Yankalilla contains over half (19) of the estuaries identified in the region, followed by the City of Onkaparinga with seven estuaries, the City of Victor Harbor with three and Alexandrina Council containing two estuaries. The City of Charles Sturt, City of Holdfast Bay and the City of Marion each contain one estuary, whilst the Port River Barker Inlet lies within both the City of Salisbury and City of Port Adelaide Enfield, and the Gawler River estuary is situated within both the City of Playford and the District Council of Mallala. The City of West Torrens is the only council area in the region to have no estuaries located within its boundaries.

Figure 2. Estuaries of the AMLR NRM region

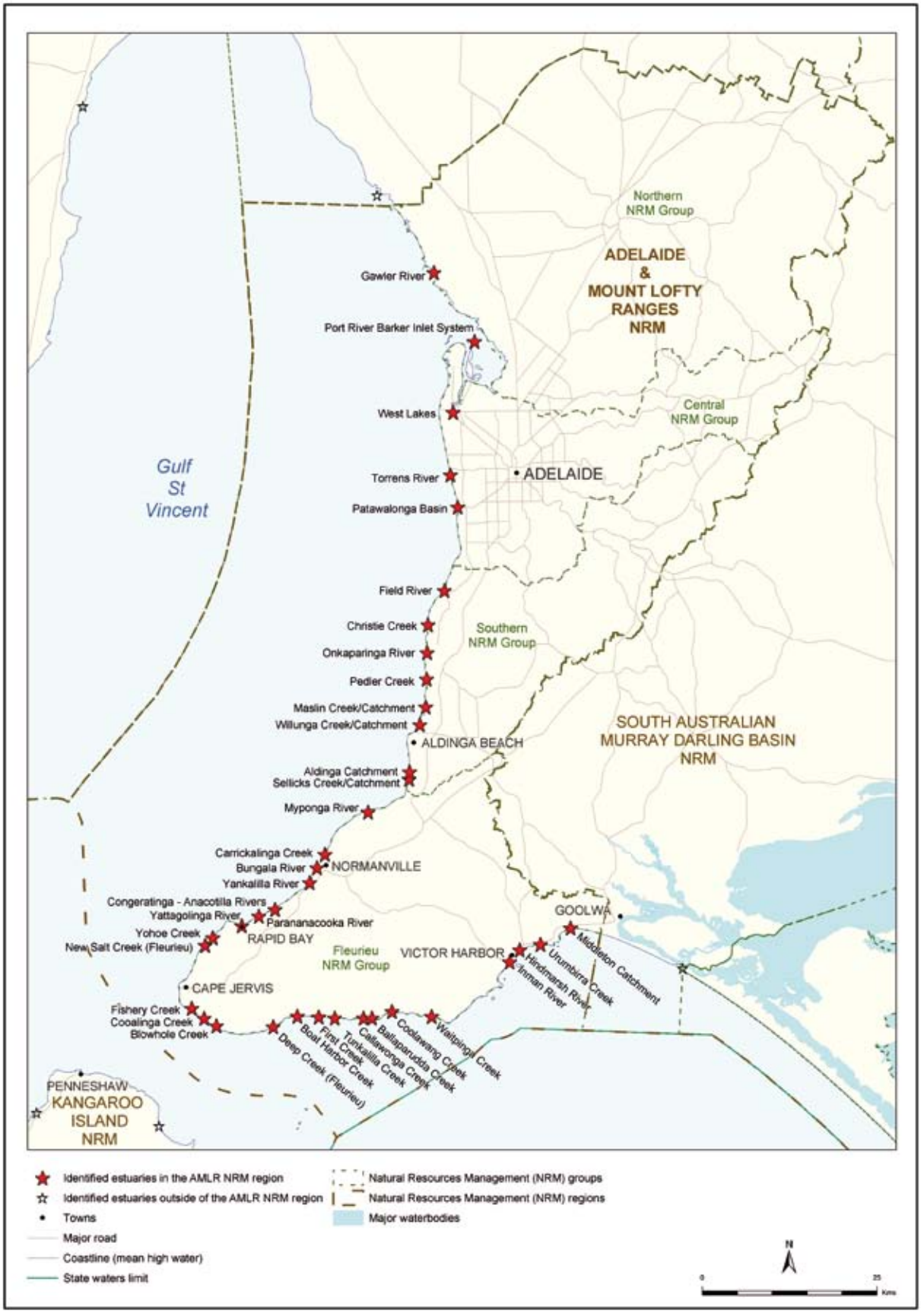


Table 1. AMLR NRM region estuary classification and size

Estuary	Classification	Sub classification	Approximate size of estuary (maximum length, perimeter and water area) L= length (km) P = perimeter (km) A = area (km^2)
Gawler River	Tide dominated	Tidal flat/creek	L = 2.66 P = 6.58 A = 0.17
Port River Barker Inlet	Tide dominated	Tidal flat/creek	L =15.67 P = 90.62 A = 49.64
Patawalonga Basin	Wave dominated	Coastal embayment, coastal creek or channel	L = 2.56 P = 5.60 A = N/A
Onkaparinga River	River dominated	Wave-dominated delta	L = 11.02 P = 22.87 A = 1.14
Myponga River	Wave dominated	Coastal embayment, coastal creek or channel	L = 1.22 P = 2.66 A = 0.12
Inman River	Wave dominated	Coastal embayment, coastal creek or channel	L = 1.57 P = 3.37 A = 0.13
Hindmarsh River	Wave dominated	Coastal embayment, coastal creek or channel	L = 2.27 P = 4.99 A = 0.24

Note: only those estuaries mapped as part of the NLWRA (2001) have been included.



Table 2. Estuaries and their associated catchment size

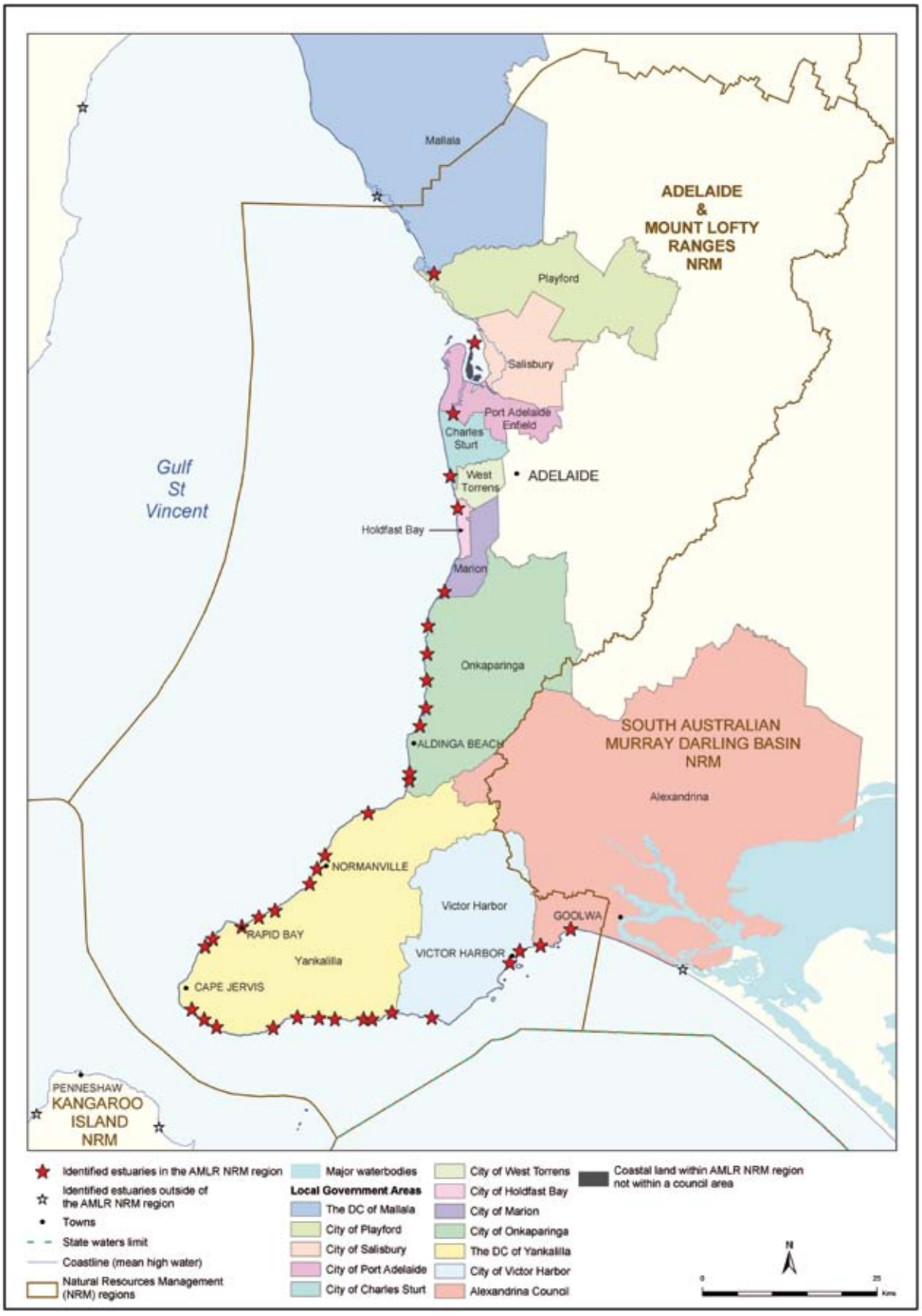
Estuary	Catchment size (km^2)	Estuary	Catchment size (km^2)
Gawler River	1,105	Yattagolinga River	25
Port River Barker Inlet[1]	346	Yohoe Creek	18
West Lakes	130	New Salt Creek (Fleurieu)	16
Torrens River	500	Fishery Creek	8
Patawalonga Basin	212	Cooalinga Creek	4
Field River	55	Blowhole Creek	12
Christie Creek	38	Deep Creek (Fleurieu)	41
Onkaparinga River	554	Boat Harbor Creek	20
Pedler Creek	106	First Creek	5
Maslin Creek/Catchment	34	Tunkalilla Creek	26
Willunga Creek/Catchment	30	Callawonga Creek	19
Aldinga Catchment	49	Ballaparudda Creek	13
Sellicks Creek/Catchment	7	Coolawang Creek	41
Myponga River	139	Waitpinga Creek	61
Carrickalinga Creek	56	Inman River	192
Bungala River	49	Hindmarsh River	112
Yankalilla River	83	Urumbirra Creek	15
Congeratinga-Anacotilla Rivers	38	Middleton Catchment	16
Parananacooka River	13		

Source: surface-water catchments – DWLBC

Note: although every effort has been made to ensure the accuracy of the statistical information provided, errors in the spatial data are possible.

[1] Note: the Port River Barker Inlet encompasses three catchment areas: Port Adelaide (130 km^2), Dry and Cobbler Creeks (142 km^2) and Little Para River (94 km^2).

Figure 3. Estuaries located within coastal council areas



4. Surface water, groundwater and marine areas

4.1 Environmental flows

Many of the estuaries within this region have poor flow to the sea, with upstream modifications such as dams and weirs and extensive groundwater extraction decreasing environmental flows and potentially changing channel morphology. Table 3 shows environmental flow information where available.

4.2 Groundwater influence

Groundwater features in the AMLR NRM region are shown in Figure 4. Groundwater appears to influence many of the estuaries, with variable groundwater discharges along the coast (eg from 120 ML/year at Maslin Sands to 500 ML/year at Northern Adelaide Plains; Lamontagne et al. 2005). Unconfined groundwater systems are prevalent in coastal dune systems although accurate estimates of groundwater discharges to Gulf St Vincent have not been possible because of limited groundwater monitoring (Lamontagne et al. 2005).

4.3 Marine bioregions and biounits

A marine bioregion is an area within the marine environment that has distinctive biodiversity and can consist of several smaller biounits. Each marine biounit is defined primarily on the basis of coastal physiography, topography and major marine physical habitat or seascape features of habitat distributions at a scale of 100 km^2. For further information see: http://www.environment.sa.gov.au/coasts/marineparks/background/marine_bioregions.html.

The AMLR NRM region has two marine bioregions, the Gulf St Vincent and Coorong. The biounits in the Gulf St Vincent bioregion contained in the AMLR NRM region include: Clinton, Yankalilla, Encounter, Sprigg and Investigator, and minor areas of Backstairs passage, Nepean and Orontes biounits. Only a small area of the Coorong biounit (within the Coorong bioregion) is contained in the AMLR NRM region (see Figure 5).

Table 3. Environmental flow information

Estuary	Environmental flow
Gawler River	The Gawler River is a highly modified system, with 56% of the natural flow diverted for consumptive purposes. Total volumes, durations, frequencies and seasonality of flows have all been affected. Flow is heavily regulated due to dams, weirs and diversion from Gawler River tributaries (NABCWMB 2000).
Port River Barker Inlet	A flow-through system was constructed in the 1970s that draws seawater into West Lakes and discharges it through the Port River. The constructed system has probably changed the flow and salinity environment of the Port River (EPA 2000).
Torrens River	The Torrens River estuary (originally a flood channel, Breakout Creek) was artificially created to allow water during high flood events to be released into the sea (http://www.amlrnrm.sa.gov.au/board_areas/creeks/torrens_river.shtml). Water historically was released to the sea via the Patawalonga Basin or Port River Barker Inlet estuaries. Freshwater flows have decreased due to extraction from the Torrens River catchment (Bryars 2003).
Patawalonga Basin	Water is regulated by a lock and pipeline (Barcoo Outlet) that drains into West Beach. The estuary is fed by the Patawalonga Creek, Brownhill Creek, Sturt Creek and various other urban drains (Bryars 2003). Decreased freshwater flows are caused by extraction from the Patawalonga River catchment and by the historical diversion of Torrens River that originally flowed into the Patawalonga Basin (Bryars 2003).
Field River	The flow regime of the Field River has been substantially modified as a consequence of agricultural and urban development (Galley 2006). The flow is highly seasonal with an annual runoff of 5,100 ML (AMLR NRM Board website http://www.amlrnrm.sa.gov.au/).
Christie Creek	As a consequence of agricultural and urban development, the physical characteristics and flow regime of Christie Creek have been substantially modified. This catchment discharges, annually, around 4.5 GL more water than would be expected from an urban catchment of its size (approximately 130% more flow than might be expected) (Wilkinson et al. 2005).
Onkaparinga River	Flows in the lower Onkaparinga River have changed significantly due to the construction of Mt Bold Reservoir and Clarendon Weir. It appears that approximately 75% of flow has been extracted prior to entering the estuary (PPK Environment and Infrastructure 2000). A technical report addressing environmental flow requirements for the Onkaparinga River was completed in 2003 (SKM 2003).
Willunga Creek/ Catchment	The creek is ephemeral with no flow for long periods, especially over summer. It is likely to only flow to sea during storm events (Wilkinson et al. 2005).
Aldinga Catchment	The creek is ephemeral with no flow for long periods, especially over summer. It is likely to only flow to sea during storm events (Wilkinson et al. 2005).
Myponga River	Seasonal flow occurs, with minimal flow during summer. Water releases from the Myponga reservoir can often result in increased stream width and large amounts of sediments being washed down the river (Gramp, pers. comm.). Decreased freshwater flows are caused by extraction, particularly from the Myponga reservoir (Bryars 2003).
Bungala River	Decreased freshwater flow is caused by extraction from the catchment (Bryars 2003).
Yankalilla River	Decreased freshwater flow is caused by extraction from the catchment (Bryars 2003).
Waitpinga Creek	Seasonal flow occurs (flow ceases during summer) and decreased freshwater flow is caused by extraction from the catchment (Bryars 2003).
Inman River	Decreased freshwater flow is caused by extraction from the catchment (Bryars 2003).
Hindmarsh River	Decreased freshwater flow is caused by extraction from the catchment (Bryars 2003). Connection to the ocean is at high tide only.
Urumbirra Creek	Limited connection occurs between the river and ocean.
Middleton Catchment	Connection occurs only at high tide.

Figure 4. Groundwater watertable depth and groundwater basins

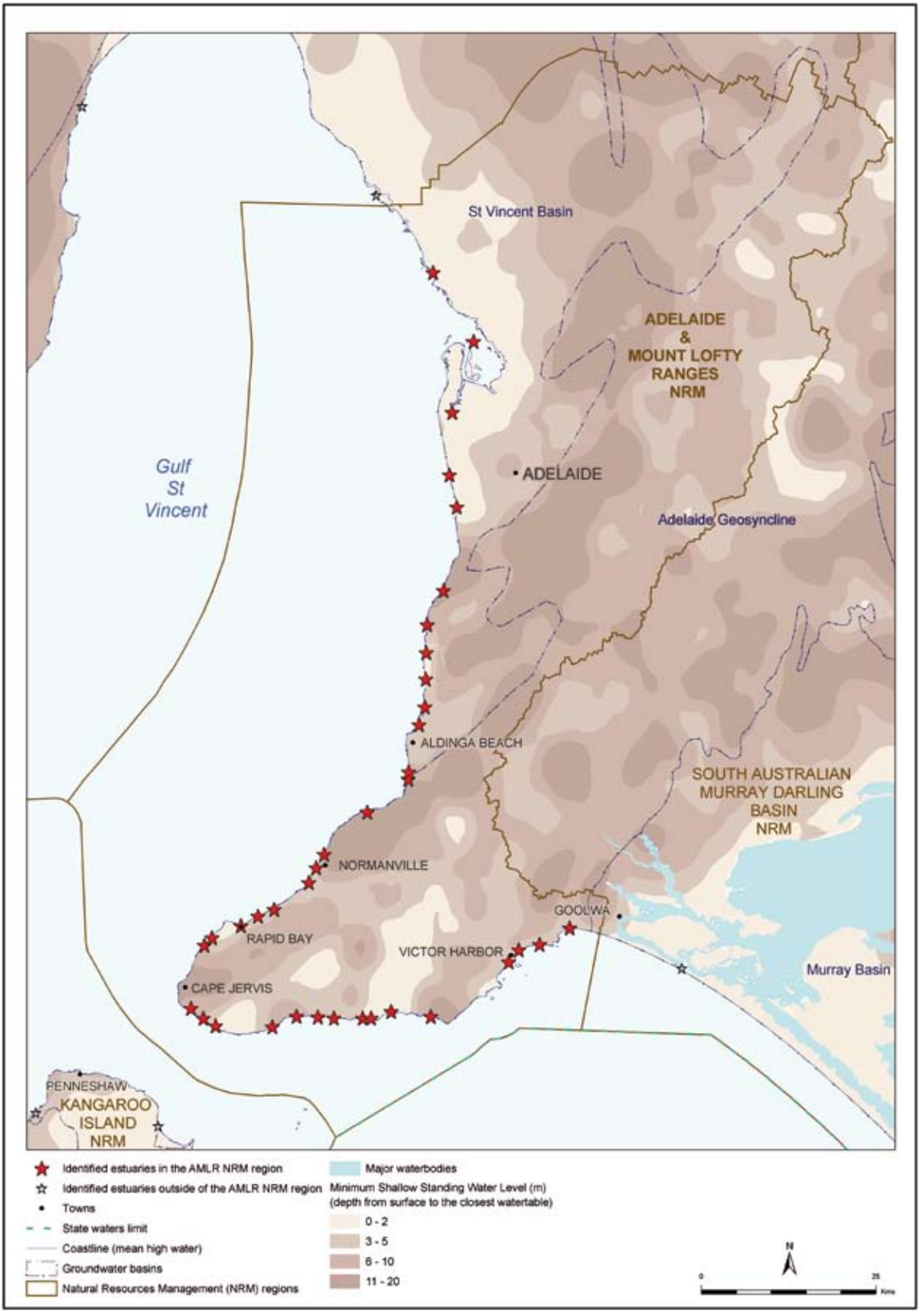
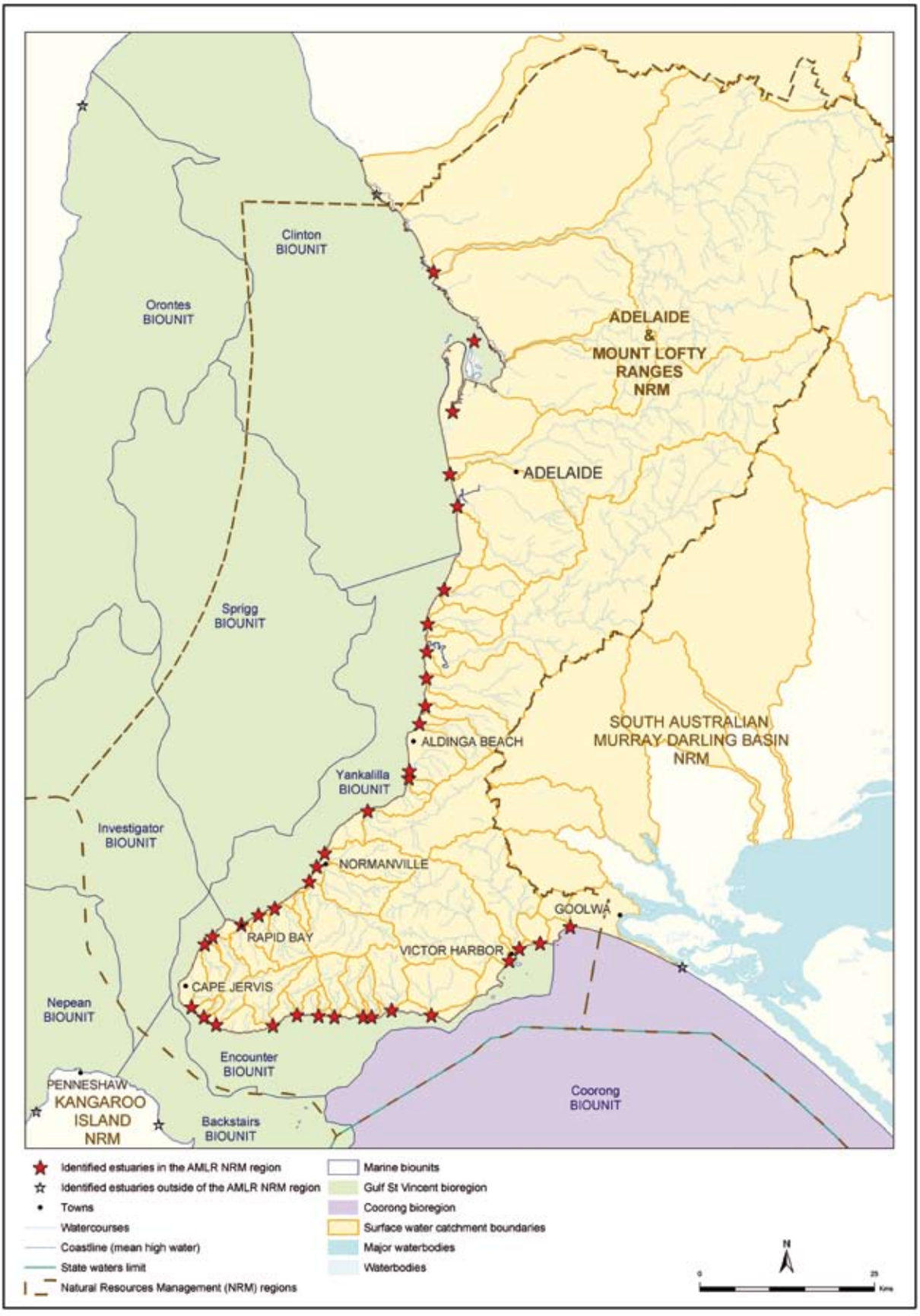


Figure 5. Marine bioregions and biounits



5. Habitats of the AMLR NRM region's estuaries

5.1 Floodplains

Floodplains can provide valuable habitat and act as a refuge for migratory birds and other animals during the dry season (Turner et al. 2004). Plant species most commonly found in flood plains include *Melaleuca* species, sedges and grasses.

5.2 Saltmarshes

Within the AMLR NRM region, the Gawler River, Port River Barker Inlet and Onkaparinga River estuaries are the only estuaries to have extensive areas of saltmarsh habitat (see Table 4). The saltmarshes within the Port River Barker Inlet comprise 13% of the estuary area (Baker 2004).

Clearance of saltmarshes without consent can be an offence under the *Native Vegetation Act 1991*. There are exemptions.

The nationally threatened bead samphire[2] *Halosarcia flabelliformis* (*EPBC Act 1999*; *NPW Act 1972*) has been recorded on Garden Island in the Port River Barker Inlet and within the Port Gawler Conservation Park (EA 2001). The rare cushion samphire *Centrolepis cephaloformis* (listed under the *NPW Act 1972*) has been recorded on Torrens Island (Port River Barker Inlet).

Saltmarshes are under threat from inappropriate use of off-road vehicles, which has resulted in networks of informal tracks, as well as from illegal dumping of rubbish. Projected sea level rise resulting from climate change will likely cause habitat retreat and have secondary impacts on fish and many other species dependent on saltmarsh habitat for survival.

Approximately 80% of saltmarshes have been lost already, particularly through increasing coastal development (MLR IINRM Group 2003).

5.3 Intertidal mudflats

Mudflats are home to a range of invertebrate species such as polychaete worms, amphipods, molluscs and crustaceans. The tidal cycle also increases the use of the mudflats by other animals (eg crabs) and provides feeding sites for migratory shorebirds.

Mudflats in several of the estuaries within the region have been mapped as part of the NLWRA (2001) (see Table 4).

Table 4. Saltmarshes and mudflats mapped in the National Land and Water Resources Audit

Estuary	Saltmarsh area (km^2)	Saltmarsh species	Mudflat area (km^2)
Gawler River	1.9	*Sarcocornia* spp. *Halosarcia* spp. *Atriplex* spp. *Nitraria* spp. *Arthrocnemum* spp. *Sclerostegia* spp.	0.5
Port River Barker Inlet	6.3		7.2
Patawalonga Basin	none		0.004
Onkaparinga River	0.3		0.03

[2] Samphires are saltmarsh plants dominated by the family *Chenopodiaceae*.

5.4 Mangrove communities

Only one species of mangrove *Avicennia marina* is represented in South Australia (Graham et al. 2001). The Port River Barker Inlet has the most extensive area of mangroves (17.7 km^2) in the region. There are no mangroves extending south of the Port River Barker Inlet (see Figure 6).

Mangrove communities, particularly those in the Port River Barker Inlet, are under threat from the high level of nutrients entering the ocean from stormwater, wastewater treatment plants and soda products factory outfall (Baker 2004). The high nutrient loads have resulted in significantly increased production of *Ulva* sp. (green algae) offshore. The *Ulva* sp. washes ashore and smothers mangrove seedlings, pneumatophores and small seagrass seedlings (Baker 2004).

Over 250 ha of mangroves between St Kilda and Port Gawler have been lost since 1956 and many more areas are in poor health (MLR IINRM Group 2003).

5.5 Seagrass communities

Dense seagrass beds are located along the coastline from the Yattagolinga River to Yankalilla River estuaries and also around the Fishery Creek, Hindmarsh River, Inman River and Gawler River estuaries. Less dense seagrass beds are located further offshore from the Myponga River, Sellicks Creek/Catchment, Port River Barker Inlet, Torrens River, Patawalonga Basin and Field River estuaries (see Figure 6). Seagrass species colonising the area include the tapeweed *Posidonia australis* and eelgrass *Heterozostera tasmanica*.

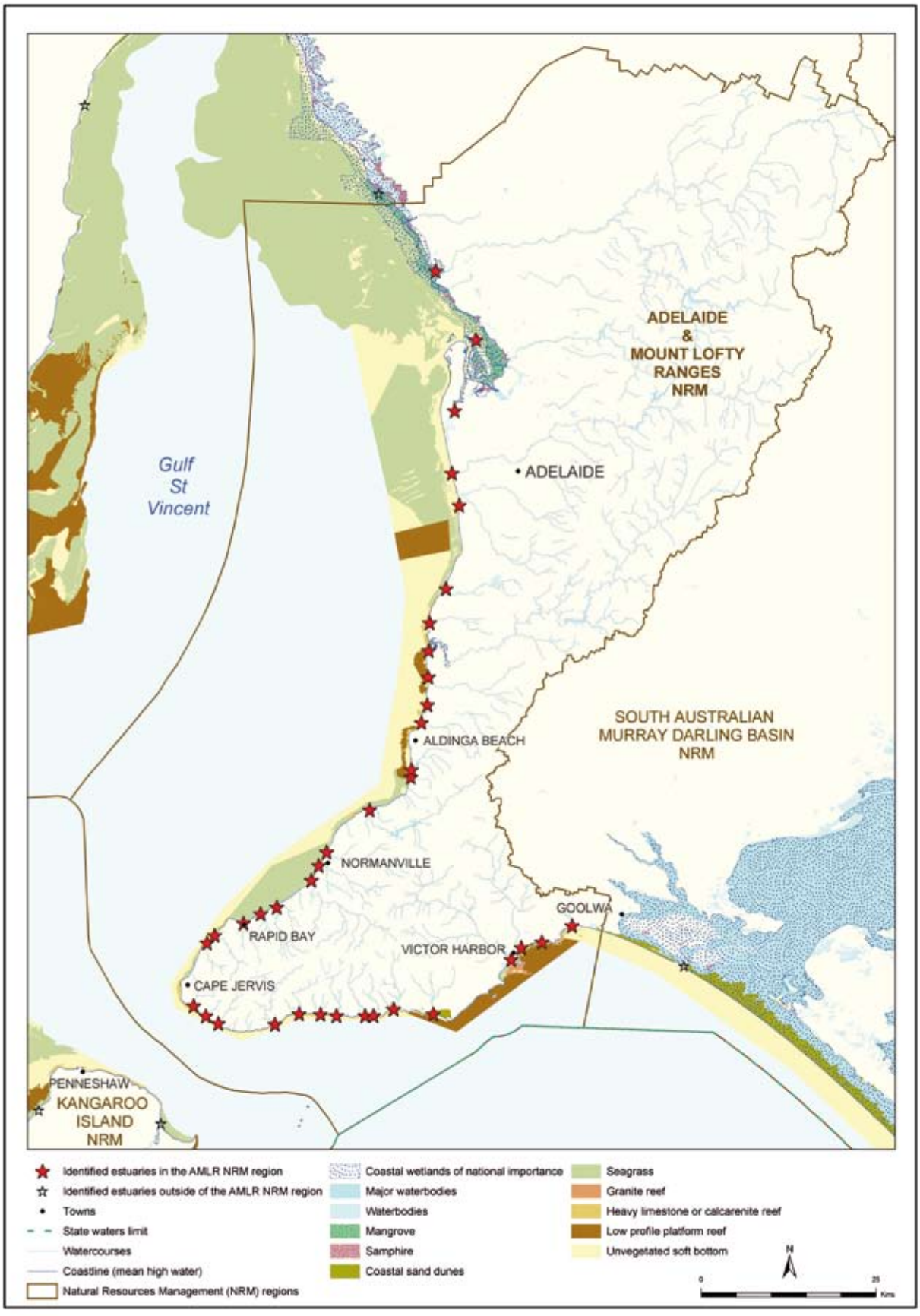
Seagrasses, like mangroves, are under threat from elevated nutrient levels, as well as from increased levels of sediment entering the gulf from effluent, stormwater and other industrial discharges. Impacts from these nutrients have resulted in the loss of more than 6,000 ha of seagrass off the metropolitan Adelaide coastline since 1949 (MLR IINRM Group 2003).

6. Internationally and nationally protected bird species

The estuaries of the AMLR NRM region are rich in bird life (see Appendix 1). Areas of particular importance for migratory and threatened bird species include the Port Gawler Conservation Park (68 bird species, 12 listed under the *EPBC Act 1999* and international treaties), Port River Barker Inlet (57 waterbirds, 12 listed under the *EPBC Act 1999* and international treaties), Onkaparinga River estuary (nearly 200 bird species, 18 listed under the *EPBC Act 1999* and international treaties, 25 under the *NPW Act 1972*), Deep Creek estuary (113 bird species, 9 listed under the *NPW Act 1972*) and Newland Head Conservation Park (100 bird species, 3 listed under the *EPBC Act 1999* and international treaties, 13 protected under the *NPW Act 1972*). The Penrice saltfields and the Port River mouth have been identified as areas of international importance in South Australia for shorebirds (Watkins 1993). Penrice saltfields are of particular importance being ranked fourth in importance within South Australia (Watkins 1993). Wilson (2000) further identified the Port River Barker Inlet as an important site for wader birds.

Extensive bird lists are available for the Onkaparinga River estuary (see HTC & EMS Pty Ltd 2006), Deep Creek Conservation Park (http://www.parks.sa.gov.au/deepcreek/index.htm), Newland Head Conservation Park (DEH 2004a) and the Port Gawler Conservation Park (see DEP 1983).

Figure 6. Habitats within and surrounding estuaries



7. Fish of the AMLR NRM region's estuaries

Several estuaries of the AMLR NRM region provide valuable nursery and breeding areas for many of the State's commercially and recreationally important fish species (see Appendix 2). For example, the Port River Barker Inlet is a major nursery area for the King George whiting *Sillaginodes punctata*, yellow-fin whiting *Sillago schomburgkii*, southern sea garfish *Hyporhamphus melanochir*, yellow-eyed mullet *Aldrichetta forsteri*, jumping mullet *Liza argentea*, black bream *Acanthopagrus butcheri* and blue swimmer crab *Portunus pelagicus* (BIPEC 2004).

The Bungala, Hindmarsh, Inman and Myponga River estuaries and the Waitpinga Creek estuary are considered to be nursery and breeding areas for the black bream *Acanthopagrus butcheri*. Numerous other juvenile and adult fish species are found in these estuaries including the yellow-eyed mullet *Aldrichetta forsteri* and Western Australian salmon *Arripis truttacea* (Bryars 2003).

The Gawler River, Patawalonga Basin, Torrens River and Port River Barker Inlet have a range of commercial and non-commercial fish species including flatheads *Platycephalus* spp., flounders (eg *Rhombosolei tapirina),* the small-mouthed hardyhead *Atherinosoma microstoma* and congolli *Pseudaphritis urvilli* (Bryars 2003).

Several species from the *Sygnathidae* family have been recorded around the AMLR NRM region's estuaries including various species of pipefish (Baker 2004).

A review of fish species living in the Onkaparinga River estuary was completed as part of the *Onkaparinga Estuary Rehabilitation Action Plan* (Hammer 2006a). Using a range of resources (eg the South Australian Museum records), 59 fish species have been recorded in the estuary.

8. Other fauna and flora

Dolphins

The Port River Barker Inlet provides an important habitat for bottlenose dolphins *Tursiops* spp. to feed, shelter, mate and safely rear their young.

The *Adelaide Dolphin Sanctuary Act 2005* provides for the protection of dolphins and their habitat.

Invertebrates

Many species of invertebrates occur within the estuaries of the region. These play a vital role in ecosystem dynamics. The Port River Barker Inlet has been described as the most significant crustacean nursery and feeding area in Gulf St Vincent (Baker 2004). Other species of invertebrates have been recorded (eg in the Port River Barker Inlet and the Gawler River estuary) including the southern calamari *Sepioteuthis australis*, sand crab *Ovalipes australiensis*, blue swimmer crab *Portunus pelagicus*, razorfish *Pinna bicolor* and scallops *Pecten fumatus* and/or *Chlamys bifrons* (Baker 2004).

Butterflies

The golden haired sedge-skipper butterfly *Hesperilla chrysotricha* has been found around the Waitpinga Creek estuary (Taylor, pers. comm.). This butterfly shares the same habitat (ie coast saw-sedge *Gahnia trifida*) as the endangered orange-bellied parrot *Neophema chrysogaster* and the southern emu-wren *Stipiturus malachurus* (listed under the *EPBC Act 1999*). Much of its habitat is in decline from agricultural and urban impacts.

Flora

A total of 359 indigenous plant species has been recorded in the Onkaparinga River Recreation Park (HTC & EMS Pty Ltd 2006), with 18 of these listed as threatened under the *NPW Act 1972* (eg the Austral rush *Juncus australis*). Extensive plant lists are available for Deep Creek Conservation Park (DENR 1997) and Newland Head Conservation Parks (DEH 2004).

9. Protection arrangements for the AMLR NRM region's estuaries

9.1 Parks and reserves

Several estuaries are managed in conservation or recreation parks and aquatic reserves. Other estuaries are partially situated in coastal reserves that protect the significant cultural or biological values of the area.

Management plans to conserve, protect, rehabilitate and restore the indigenous flora and fauna within parks and reserves are available (see Table 5 and Figure 7). In addition, DEH is currently developing the *Biodiversity Plan for the Greater Mount Lofty Ranges region*.

Table 5. Protection arrangements and management plans

Estuary	Conservation/ recreation park *(NPW Act 1972)*	Coastal reserve *(Crown Lands Act 1929)*	Aquatic reserve *(Fisheries Management Act 2007)*	Management plan
Gawler River	Port Gawler Conservation Park			*Draft Port Gawler Conservation Park Management Plan* (DEP1983)
Port River Barker Inlet	Torrens Island Conservation Park Adelaide Dolphin Sanctuary		Barker Inlet Aquatic Reserve St Kilda - Chapman Creek Aquatic Reserve	*A Management Framework and Action Plan for the Barker Inlet and Port Estuary Environs* (BIPEC 2004) *Draft Adelaide Dolphin Sanctuary Management Plan* (DEH 2007)
Torrens River		Managed by City of Charles Sturt Council. The reserve is located at the mouth of estuary.		
Patawalonga Basin		Managed by City of Holdfast Bay Council. The reserve is located between the airport and King St bridge.		
Field River				*Management Action Plan for the Lower Field River Hallett Cove* (Galley 2006) *Field River Catchment Water Management Plan* (BC Tonkin and Associates 1998)
Christie Creek				*Christie Creek Catchment Management Plan* (BC Tonkin and Associates 1995)
Pedler Creek	Moana Sands Conservation Park			

table continued

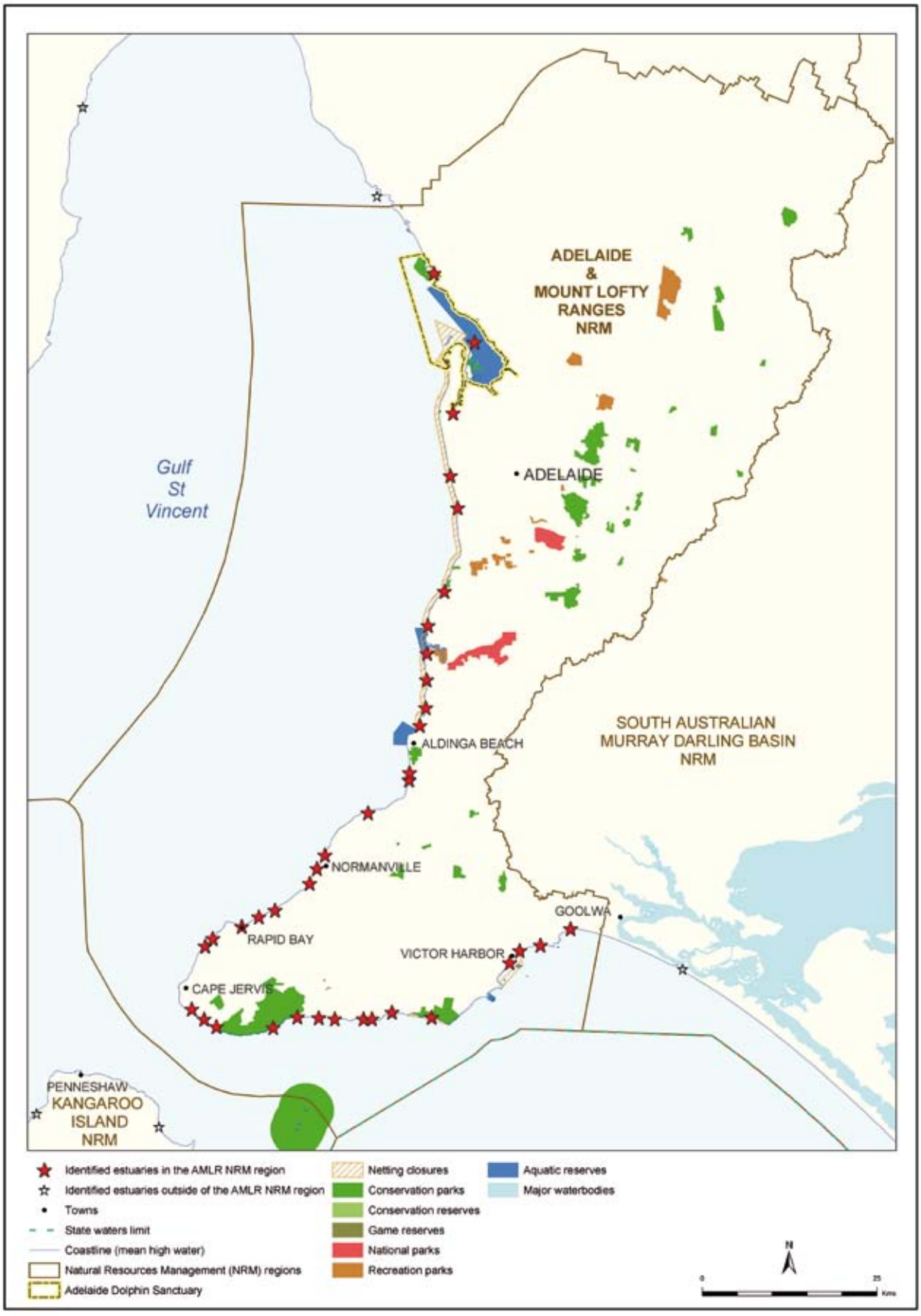
Table 5. Protection arrangements and management plans continued

Estuary	Conservation/ recreation park (*NPW Act 1972*)	Coastal reserve (*Crown Lands Act 1929*)	Aquatic reserve (*Fisheries Management Act 2007*)	Management plan
Onkaparinga River	Onkaparinga River Recreation Park	Managed by City of Onkaparinga Council. The reserve is located near the mouth of the estuary.	Port Noarlunga Aquatic Reserve	*Onkaparinga Estuary Rehabilitation Action Plan* (see HTC & EMS Pty Ltd 2006) *Onkaparinga River Reserve Management Plan* (DEH 2004b)
Willunga Creek/ Catchment		Managed by City of Onkaparinga Council. The reserve is located along the foreshore/mouth.		
Aldinga Catchment		Managed by City of Onkaparinga Council. The reserve is located upstream from the mouth.		
Sellicks Creek/ Catchment		Managed by City of Onkaparinga Council. The reserve is located on the foreshore.		
Fishery Creek		Managed by District Council of Yankalilla. The reserve is located upstream[3].		
Deep Creek	Deep Creek Conservation Park			*Deep Creek and Talisker Conservation Parks Management Plan* (DENR 1997)
Blowhole Creek	Deep Creek Conservation Park			*Deep Creek and Talisker Conservation Parks Management Plan* (DENR 1997)
Waitpinga Creek	Newland Head Conservation Park			*Newland Head Conservation Management Plan* (DEH 2004a)
Inman River		Managed by City of Victor Harbor Council. The reserve is located upstream from the mouth.		
Hindmarsh River		Managed by City of Victor Harbor Council. The reserve is located upstream from the estuary mouth.		

Note: the Department for Environment and Heritage manages conservation parks and reserves under the *NPW Act 1972*, whilst aquatic reserves are currently managed by PIRSA under the *Fisheries Management Act 2007*. Coastal reserves are managed under the *Crown Lands Act 1929*.

[3] The estuary may not necessarily fall within coastal reserve boundaries as actual estuary boundaries are yet to be defined.

Figure 7. Conservation areas and aquatic reserves including estuaries



9.2 Directory of Important Wetlands

Three estuaries within the AMLR NRM region have been included in the Directory of Important Wetlands in Australia (DIWA) (see Table 6 and Figure 6, which includes coastal wetlands of national importance). The criteria for inclusion are shown in Appendix 3.

Table 6. Estuaries included in the Directory of Important Wetlands in Australia

Estuary	DIWA name	Criteria for inclusion
Gawler River	Port Gawler and Buckland Park Lake (SA015)	1, 3, 5, 6
Port River Barker Inlet	Barker Inlet and St Kilda (SA005)	1, 2, 3, 5, 6
Onkaparinga River	Onkaparinga estuary (SA033)	1, 3, 5, 6
Aldinga Catchment	Washpool Lagoon (SA072)	1

9.3 Register of the National Estate

Many sites associated with estuaries across the AMLR NRM region are included on the Register of the National Estate (http://www.ahc.gov.au/register/) (see Table 7).

Table 7. Sites including or associated with estuaries in the Register of the National Estate

Place on register	Estuary	Significance
Port Gawler Conservation Park (natural)	Gawler River	The tidal flat features a mangrove of low woodland, and small areas of samphire shrub-land occur at the mouth of the Gawler River. The park contains one of the largest areas of mangrove and samphire association conserved in the State.
Torrens Island Conservation Park (natural)	Port River Barker Inlet	The saltmarsh area supports a vast array of invertebrates, which provide a food source for many bird species.
Torrens Island Quarantine Station (historic)	Port River Barker Inlet	Not stated.
River Torrens - outside Adelaide City (natural)	Torrens River	The river is the only east-west corridor in the Adelaide region for movement of birds and other animals between the coast and the foothills.
Port Noarlunga Aquatic Reserve and Onkaparinga River estuary (natural)	Onkaparinga River	This part of the river remains ecologically intact.
Moana site area (indigenous)	Pedler Creek	This area has prehistoric significance and unusual red sands.
Nashwauk shipwreck (historic)	Pedler Creek	This shipwreck is historically and archaeologically significant as a deposit of well-preserved cargo from an emigrant ship of the mid nineteenth century.

table continued

Table 7. Sites including or associated with estuaries in the Register of the National Estate continued

Place on register	Estuary	Significance
Maslin Bay – Aldinga Bay geological site (natural)	Maslin Creek/ Catchment Aldinga Catchment	The area contains rare exposures of Cainozoic sediments of the Adelaide region.
Myponga Beach area (natural)	Myponga River	Lignum and reed swamps occur near the river mouth, and a rare exposure of fossiliferous limestone of Cambrian age is present on the shore platform and headlands.
Normanville dunes (natural)	Carrickalinga River Bungala River Yankalilla River	These comprise one of only two naturally vegetated dune systems between Sellicks Beach and Port Elliot.
Landsend to Fishery Beach (natural)	Fishery Creek	The area is geologically significant and a significant site for mallee box *Eucalyptus porosa* and dryland tea-tree *Melaleuca lanceolata*, which are relatively uncommon on the Fleurieu Peninsula.
Deep Creek Conservation Park and Deep Creek Conservation Park – extension (natural)	Deep Creek Blowhole Creek	The park provides important habitat for a range of bird and animal species including the yellow-tailed black cockatoo *Calyptorhynchus funereus.*
Tunkalilla Creek – Tunkalilla beach area (natural)	Tunkalilla Creek First Creek	This area contains significant vegetation including two rare ferns: the coral fern *Gileichenia microphylla* and the water fern *Blechnum* spp.
Newland Heads area (natural)	Waitpinga Creek	The area has a high diversity of habitats and floristic and faunal diversity.
Inman River estuary (natural)	Inman River	The area supports remnant vegetation historically widespread throughout estuaries in the region, and includes one of only two remaining localities of the swamp paperbark *Melaleuca halmaturorum.*
Hindmarsh River estuary (natural)	Hindmarsh River	The area is an island-refuge and corridor for birds. The estuarine vegetation is also uncommon in South Australia.
Encounter Bay region (natural)	Waitpinga Creek Inman River Hindmarsh River Middleton Catchment	The region has high levels of biodiversity and endemism as well as many culturally significant sites.

Source: Australian Heritage Directory http://www.heritage.gov.au/datalists.html.

10. Cultural assets

The AMLR NRM region is rich in Aboriginal heritage. Historically, four Aboriginal groups lived in the area: the Kaurna, Ngarrindjeri, Peramangk and Ramindjeri people. The Ramindjeri people in particular have a strong cultural affiliation with the lower Fleurieu Peninsula (including within the Newland Head Conservation Park) (DEH 2004a). Sites and areas that are culturally significant are listed on the Register of the National Estate (see Figure 8).

Sites of indigenous value associated with estuaries considered to be of National Estate importance include:

- River Torrens (outside Adelaide City)
- Normanville dunes
- Encounter Bay region
- Hallett Cove
- Port Adelaide heritage area
- Port Noarlunga – Onkaparinga.

The *Aboriginal Heritage Act 1988* provides protection for Aboriginal sites, objects, anthropology, history and tradition.

NOTE: Pursuant to section 23 of the *Aboriginal Heritage Act 1988 (SA),* a person must not, without the authority of the Minister [for Aboriginal Affairs and Reconciliation] -

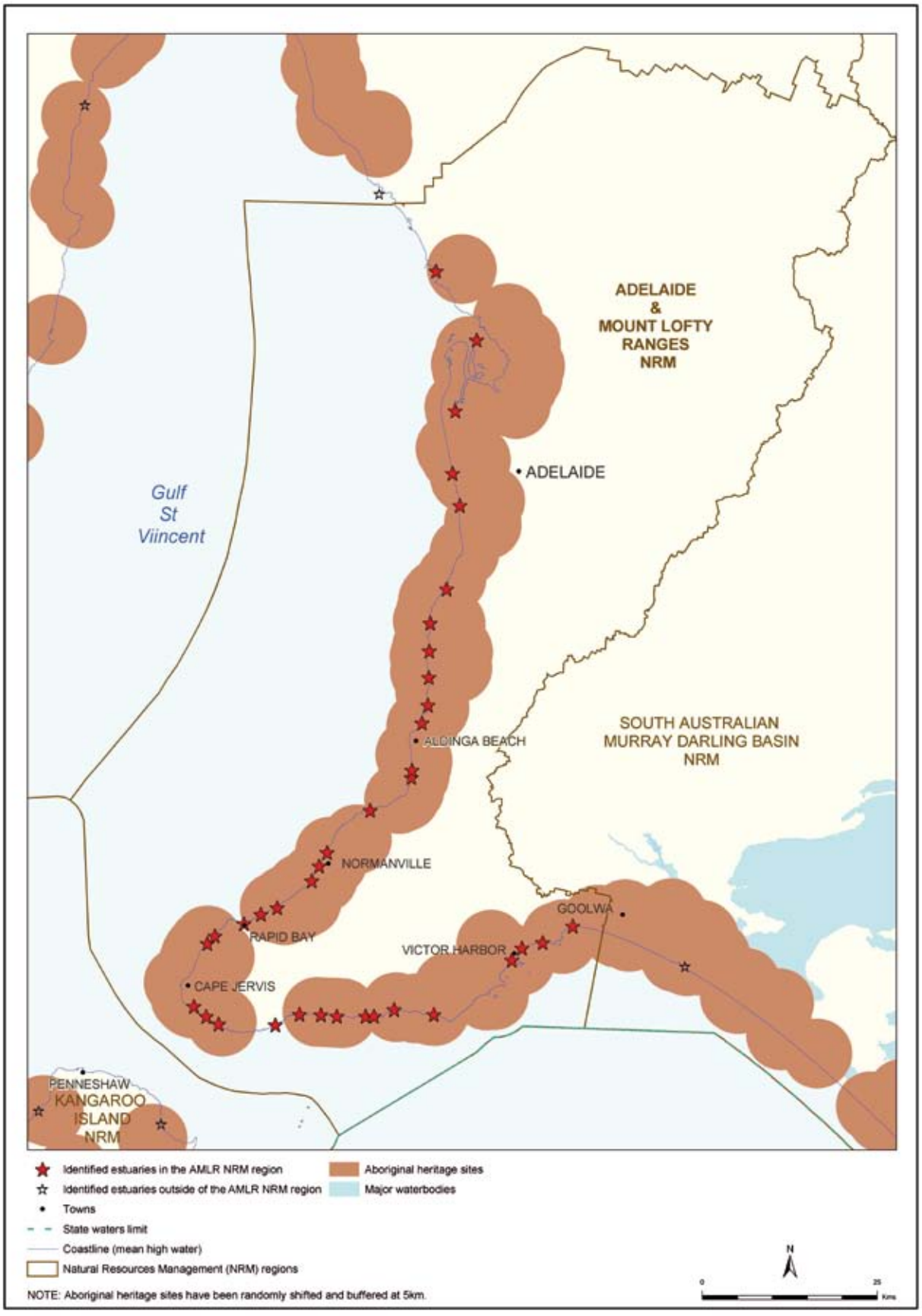
(a) damage, disturb or interfere with any Aboriginal site; or
(b) damage any Aboriginal object; or
(c) where any Aboriginal object or remains are found -
    (i) disturb or interfere with the object or remains; or
    (ii) remove the object or remains.

Europeans settled in the Fleurieu area during the mid to late 1830s. Much of the region's European heritage significance relates to early land uses including agriculture, mining, whaling and timber felling.

European heritage sites can be found on the State Heritage Register, (http://www.heritage.gov.au/ahpi/index.html), which lists places of heritage significance to the State. Sites that are associated with estuaries include:

- Second Valley seawall, causeway, bridge and jetty
- Second Valley coastal cliff geological site
- Birkenhead bridge
- Hindmarsh River railway bridge
- Pingle farm
- former Cape Jervis whaling station near mouth of Fishery Creek
- Maslin Bay to Aldinga Bay coastal cliff section geological site.

Figure 8. Aboriginal heritage sites associated with estuaries



11. Economic and social regional importance

Much of the economic development within the region is strongly linked to the local environment including the estuarine areas. Economic drivers for the region include:

• Urban development

The fastest growing industries in Victor Harbor are property and development (1991-2001), with the purchase of investment properties by non-residents strongly influencing the economic growth of the Fleurieu region (SACES 2001).

• Industry

The Port River area is of significant value for international and national shipping, with 96% of all container cargo shipped out of the State from the port facility. More than 1,000 international ships docked and 4.57 million tonnes were exported to international markets from Port Adelaide during 2002/2003 (Baker 2004).

In addition, Penrice Soda Holdings, Ltd. employs over 190 people and contributes 74% of soda as and 88% of sodium bicarbonate to the Australian market.

• Recreational activities

Increasing importance is being placed on healthy lifestyles (SATC 2002). Around $148 million was spent on recreational fishing in South Australia during 1999-2000 (ABARE 2005), and though no figures are available it is reasonable to assume that a significant amount of this was spent in the AMLR NRM region. In the Fleurieu region, 65% of the holiday homeowners in the Southern Fleurieu region use the sea/coast/beaches whilst staying in the region (Huggo and Rudd 2004).

• Agriculture

More than 80% of the AMLR NRM region is used for agricultural purposes (MLR IINRM Group 2003). Field crops grown in the Fleurieu region contributed $4.5 million to the region's economy during 2002/2003 (FRD 2004). Since the early 1990s, viticulture has become the major contributor to gross value of production in the region (MLR IINRM Group 2003).

• Tourism

The Fleurieu Peninsula accounts for 12% of the visitor nights in SA, with 81% of day trips by Adelaide residents. More than 48% of people visit the region because of the beaches and 11% go there to fish. Approximately one in three jobs in the Fleurieu region is related to tourism (http://www.victor.sa.gov.au/). Tourism has many flow-on effects to other industries, with 49% of all retail expenditure in the Victor Harbor region believed to be from regional tourism.

The St Kilda mangrove trail and interpretive centre is a valuable asset, providing a good drawcard to the area for a wide cross section of the community including schools, community groups and intrastate and interstate visitors.

• Commercial fishing

Up to 155 people are employed in the fishing industry in Gulf St Vincent/Kangaroo Island area (ABARE 2005).

Social values associated with all the above activities are varied. In a community attitudes survey completed in 2001 for the development of the South Australian Tourism Plan, the community indicated that tourism is more important to community prosperity and quality of life than agriculture, manufacturing, mining, wine or information technology (SATC 2002a, SATC 2002b). Recreational activities such as boating and fishing are believed to enhance interpersonal skills, make people more adaptable to change and enhance community stewardship (Planning SA 2004). Many new residents to the Fleurieu region indicated they purchased a property in the region because of the environment (SACES 2001).

Industries such as commercial fishing also have multiplier effects for other industries, especially for increasing employment opportunities.



12. Activities and pressures associated with estuaries of the region

Adelaide and the Mount Lofty Ranges are the most densely populated regions in South Australia (MLR IINRM Group 2003). Land use within these areas is extremely diverse and includes commercial and rural enterprises and residential and rural properties. Increasing and conflicting land uses are reliant on both surface and groundwater supplies to retain productivity, though only minimal water reuse occurs within the region (MLR IINRM Group 2003). Coastal land is highly valued, with new developments occurring across the region, particularly in the Fleurieu and metropolitan Adelaide sectors.

The NLWRA (2001) indicated that of the seven estuaries included in the audit, all but one were in an extensively modified[4] condition and under high to very high pressure. Most estuaries in the region have been modified over time to support human settlement, economic development and to provide recreational opportunities for the community. Each of these is linked to a range of activities occurring in and on the land surrounding estuaries including:

- cropping and grazing
- soda ash production
- electricity supply
- wastewater disposal
- fishing, boating, camping
- tourism, eg geological site visits, camping, walking in conservation parks
- shipping, transportation of goods/services
- industry usage including fishing
- petroleum, mining and geothermal exploration.

(See Figures 9 and 10).

Some of the infrastructure and issues related to these activities are given in Table 8. Of particular note in the region is the extent of urban, recreational and industrial use, as well as the potential for impacts arising from climate change.

[4] Extensively modified estuaries are generally recognised and documented as having multiple problems due to a complexity of impacts from within the catchment, waterway and estuary. Remedial works and activities for recovery are likely to be substantial and may be cost prohibitive (NLWRA 2001).

Figure 9. Activities occurring in and around estuaries

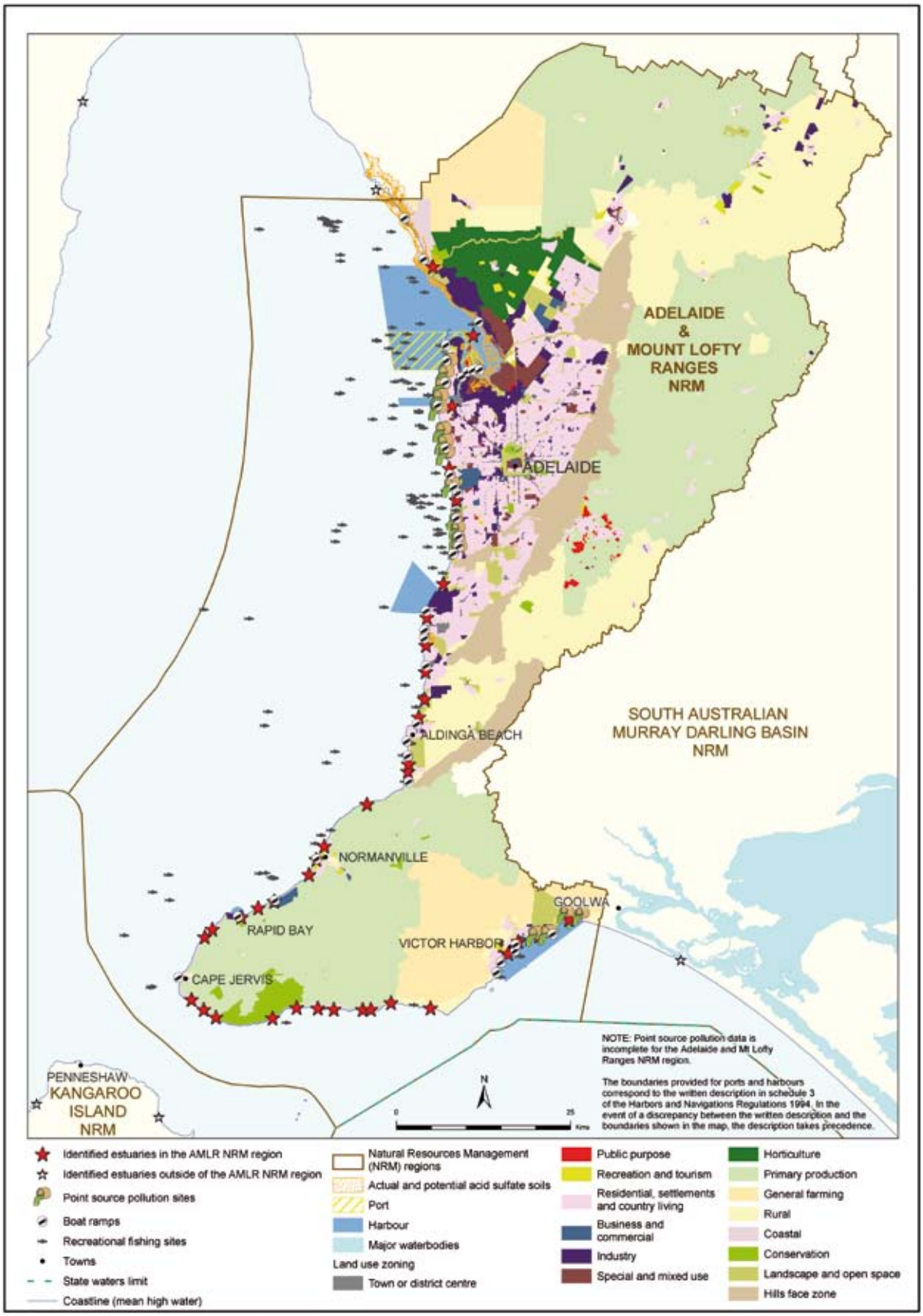


Figure 10. Petroleum, mining and geothermal exploration licences and applications

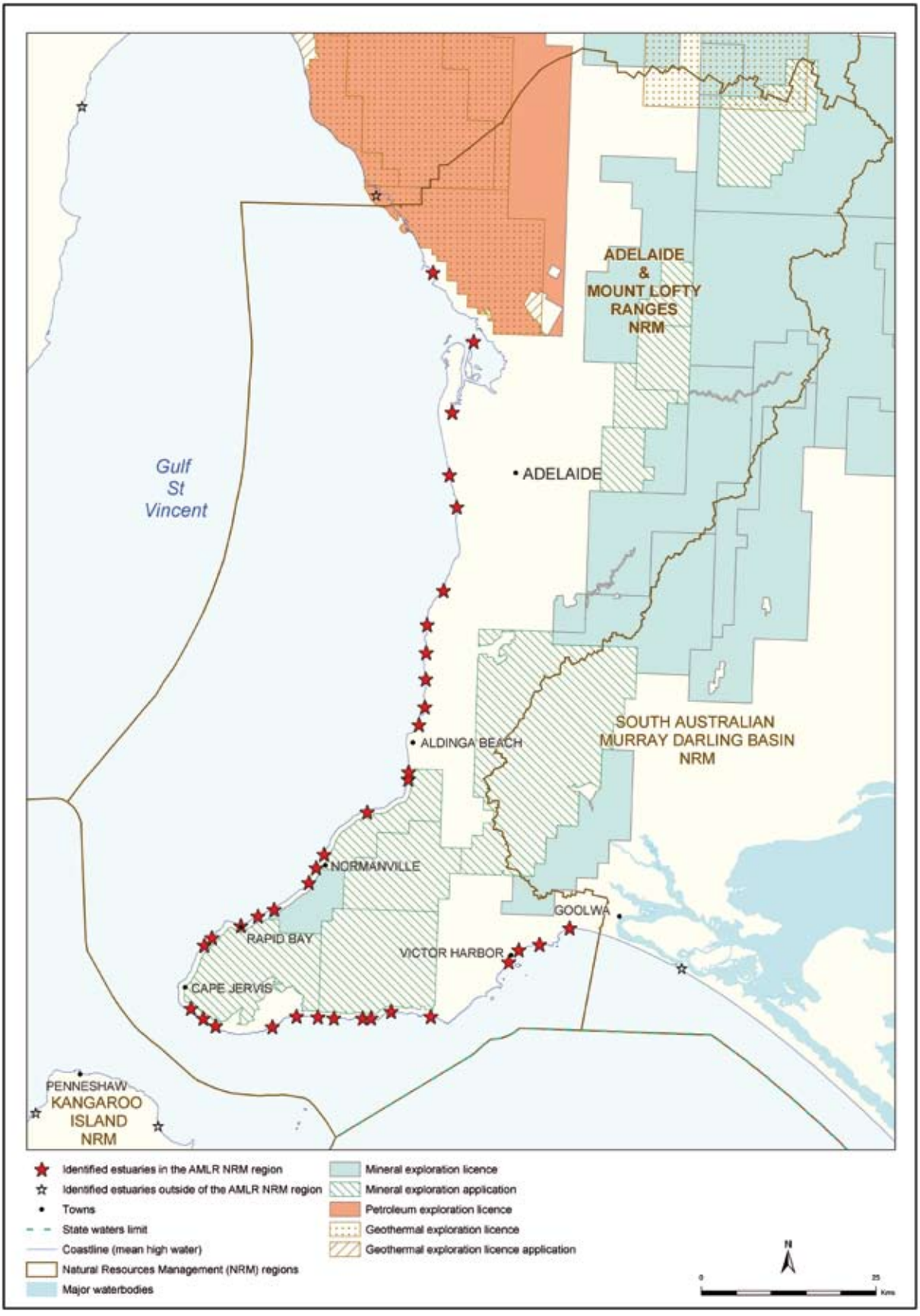


Table 8. Some of the infrastructure, activities and issues within estuaries

	Feature	Location
Infrastructure	Boat ramps	• 1 at Port Gawler (small boats only) • 7 within the Port River Barker Inlet • 1 at Holdfast Shores marina • 3 informal ramps within Onkaparinga River (small boats only) • 1 north of Aldinga Catchment estuary mouth • 1 south of Sellicks Creek/Catchment mouth • 1 sand ramp at Myponga River estuary mouth (tractors required) • 1 north of Bungala River estuary mouth • 1 at Wirrina Cove (Congeratinga-Anacotilla rivers)
	Marinas	• Holdfast Shores marina • Wirrina Cove marina
	Wastewater treatment plant (WWTP)	• Port Adelaide WWTP historically discharged into the north arm of the river. It was decommissioned in 2005, with waste now received at the Bolivar high-salinity plant that discharges into Gulf St. Vincent (GSV) (http://www.sawater.com.au/). • Glenelg WWTP (Patawalonga Basin – accounts for 27% of the WWTP discharge into GSV (Wilkinson et al. 2003). • Christies Beach WWTP – sewerage pipe occurs along the length of Field River and accounts for 32% of WWTP discharge to GSV. Proposed plant upgrade to WWTP to be completed by November 2011.
	Electricity plant	Port River Barker Inlet: • Torrens Island • Osborne • Pelican Point

table continued

Table 8. Some of the infrastructure, activities and issues within estuaries continued

	Feature	Location
Activities	Industry	Port River Barker Inlet: • Garden Island Wingfield landfill • boat building facilities • cement works • fuel storage • coal handling facilities. Patawalonga Basin: • airport • small businesses ie dive shop. Field River: • Lonsdale Industrial Estate (including the closed Port Stanvac oil refinery and Mitsubishi Motors). Onkaparinga River: • sewage works (soon to be defunct sludge ponds) • former abattoir works. Yattagolinga River: • limestone quarry. Waitpinga Creek: • quarry mining prior to 1985 • wattle bark tanning industry prior to constitution of park. Inman River: • light industry.
	Dredging	• Port River Barker Inlet • Onkaparinga River estuary • Patawalonga Basin
Issues	Coastal acid sulfate soils[5]	• Gawler River estuary – thick potential acid sulfate soils (PASS) in mangroves (high risk area), supratidal PASS (moderate risk area). • Port River Baker Inlet – actual acid sulfate soils (AASS) formed as a result of dredging and bunding in the Barker Inlet area, moderate risk of PASS in the tidal channel. • Onkaparinga River estuary – moderate risk of PASS in soils underlying in tidal streams and sand dunes, moderate to low risk in supratidal.
	Climate change	• Possible sea level rise, increase in water temperature and CO_2 absorption, and likelihood of more frequent storm events. One of the impacts of climate change will be habitat retreat, particularly for mangroves and saltmarshes.
	Netting closures	• Port Adelaide River (Port River Barker Inlet/West Lakes) • Outer Harbor to Aldinga (Torrens River to Willunga Creek/ Catchment estuaries) • Parsons Beach – Fleurieu Peninsula (Waitpinga Creek) • Encounter Bay (Inman River/Hindmarsh River)

Sources:
Topography - boat ramps - DEH, Coast Protection Branch
Coastal acid sulfate soils – Coast maps, Government of SA
Marina/moorings - DEH
Netting closures - PIRSA

Note: although every effort has been made to ensure the accuracy of the statistical information provided, errors in the spatial data are possible.

[5] Coastal acid sulfate soils are soils that generate sulfuric acid when exposed to oxygen.

13. Case studies

As with many of the region's estuaries, the Port River Barker Inlet, Onkaparinga River and the Waitpinga Creek estuaries are valued environmentally, socially and economically for the benefits they provide to the community.

These localities are under threat from a range of influences, with further planning, management and action necessary to ensure their health is sustained. Further information on these estuaries is given in the following case studies.

Case study one: Port River Barker Inlet

The environs of the Port River Barker Inlet are ecologically, economically, socially and culturally significant (BIPEC 2004). The estuary is home to abundant bird species, threatened saltmarsh plants, and is surrounded by an extensive mangrove network. It is also a known nursery area for a range of fish species, the blue swimmer crab *Portunus pelagicus* and western king prawn *Penaeus latisculcatus*.

Much of the area is protected as part of the Torrens Island Conservation Park, Port Gawler Conservation Park, Barker Inlet Aquatic Reserve, St Kilda-Chapman Creek Aquatic Reserve and the Adelaide Dolphin Sanctuary. It is also listed as a wetland of national importance.

The Port River Barker Inlet is surrounded by industry. The industries include saltworks, two electricity plants, boat building and coal handling facilities, fuel storage depots, and a wastewater treatment plant. The area is also used for a range of activities including shipping, fishing, boating, kayaking and research.

This estuary also offers many eco-tourism activities such as the Barker Inlet wetland tours, Port River dolphin cruise and self-guided tours of the mangroves.

Additionally, Port Adelaide is becoming increasingly urbanised with a range of new housing developments and the construction of the Port River expressway and the bridge underway.

The major threats identified by Bryars (2003) facing the Port River Barker Inlet include:

- industrialisation, eg thermal pollution, industrial run-off, effluent disposal, ballast water, heavy metals and other toxicants
- urbanisation, eg stormwater runoff
- adjacent land uses, eg rubbish dumps at Wingfield and Garden Island
- ballast water exchange with the potential for the introduction of marine pests.

Other potential threats could include:

- increasing recreational demand, eg fishing and boating
- tourism.

The Barker Inlet and Port Estuary Committee (BIPEC) developed the *Management Framework and Action Plan for the Barker Inlet and Port Estuary Environs 2004*. Key actions from this document will be integrated into NRM planning in the AMLR NRM region.

The Adelaide Dolphin Sanctuary Advisory Board is also currently guiding the preparation of a management plan under the *Adelaide Dolphin Sanctuary Act 2005*.

Case study two: Onkaparinga River estuary

The Onkaparinga River estuary is home to numerous nationally and internationally protected bird species. It has saltmarsh areas and wetlands on the floodplain that reduce the pollutants from stormwater runoff. The Onkaparinga River estuary is a popular recreation site. There are walking tracks through the saltmarshes, bird watching sites and the Port Noarlunga offshore reef is used for diving and snorkelling.

The township of Noarlunga is situated next to the estuary and is a popular area for tourism and development.

The Onkaparinga River catchment (approximately 550 km^2) supports a variety of land uses including urban development, agriculture and industry. The impacts from all of these activities culminate within the estuary.

The major threats facing the Onkaparinga River estuary include:

- reductions in water flows entering the estuary (as a result of diversions to Adelaide)
- recreation and tourism pressures including bait digging, recreational boating, off-road vehicle use and pedestrian access
- land use within the catchment (approximately 93% of the catchment has been developed for either agriculture, housing or industry) and increasing urban development
- increased nutrients from the sludge drying lagoons adjacent to the estuary and stormwater runoff (plans are in place for SA Water to decommission these lagoons by 2009).

The former Onkaparinga Catchment Water Management Board (now part of the AMLR NRM Board) has previously undertaken several initiatives to better manage the Onkaparinga River estuary. The AMLR NRM Board has developed the *Onkaparinga Estuary Rehabilitation Action Plan* (HTC & EMS Pty Ltd 2006) that addresses environmental flows, weed issues, water quality monitoring requirements, sea level rise and increasing stormwater impacts.

Case study three: Waitpinga Creek estuary

Waitpinga Creek estuary is located within the Newland Head Conservation Park. The Park supports a range of bird and plant species, several of which are protected. The vulnerable golden-haired sedge-skipper butterfly *Hesperilla chrysotricha* has been found within the park. The area is a popular recreation site for surfers, walkers, campers, birdwatchers and to a lesser extent swimmers.

The Waitpinga Creek catchment (61 km^2) supports a variety of land uses including conservation, agriculture and increasing urbanisation in the surrounding lands. Newland Head Conservation Park offers recreation and tourism opportunities not widely available elsewhere within the region (DEH 2004a).

The major threats facing the Waitpinga Creek estuary include:

- ecotourism, eg visitation is increasing to the estuary and nearby town populations are expanding, with infrastructure also increasing to support these activities
- urbanisation and the sea change phenomenon, eg farmers are selling off land for future housing, and current wastewater systems (septics) are not extensive enough to support the growth in population
- adjacent land usage, eg land clearance, possibility of stock entering waterways from unfenced land
- pest plants and animals, eg sea wheatgrass *Thinopyrum junceiforme* is populating the mouth of the estuary (Taylor pers. comm.).

The Waitpinga Creek estuary is managed as part of the Newland Head Conservation Park within the National Reserve System.



14. Current management initiatives

Table 9 indicates those projects currently underway in the AMLR NRM region's estuaries. Many agencies, local government and community groups are responsible for the management and protection of these estuaries. There is also scope for other research, monitoring, education, awareness-raising and on-ground activities.

Table 9. Current management initiatives

Initiative	Agency/group involved	Estuary included in the project	Contact details
Environmental water provisions for the Onkaparinga River downstream of Clarendon Weir	AMLR NRM Board	Onkaparinga River	AMLR NRM Board Ph.(08) 8273 9100
Monitoring and evaluation of environmental flows downstream of Clarendon Weir	AMLR NRM Board/ DWLBC	Onkaparinga River	AMLR NRM Board Ph.(08) 8273 9100
Environmental water requirements of Pedler Creek and Maslin Creek/ Catchment	AMLR NRM Board	Onkaparinga River	AMLR NRM Board Ph.(08) 8273 9100
Environment Protection (Water Quality) Policy 2003 implementation, which provides a consistent State-wide approach to the protection of water quality in SA's estuaries	EPA	All estuaries	www.epa.sa.gov.au
Environmental water provisions for selected estuaries	AMLR NRM Board	Pedler Creek and Maslin Creek/ Catchment	AMLR NRM Board Ph.(08) 8273 9100
Ambient water quality monitoring program (measures basic water quality indicators)	EPA, AMLR NRM Board and DWLBC in the Patawalonga Basin	Deep Creek, Inman River, Onkaparinga River, Patawalonga Basin	EPA Ph.(08) 8204 2000 AMLR NRM Board Ph.(08) 8273 9100
Investigating the use of biological indicators of estuarine condition in South Australia	EPA	Selected estuaries	Senior Aquatic Biologist Environment Protection Authority Ph.(08) 8204 2044
Water Proofing Adelaide	Government of South Australia	All estuaries within the region	www.waterproofingadelaide.sa.gov.au/main/

table continued

Table 9. Current management initiatives continued

Initiative	Agency/group involved	Estuary included in the project	Contact details
Implementation of the Draft Adelaide Dolphin Sanctuary Management Plan	Minister for Environment and Conservation	Port River Barker Inlet	Conservation Officer Adelaide Dolphin Sanctuary Ph.(08) 8347 6100 www.deh.sa.gov.au/coasts/ads/
Management of *Caulerpa taxifolia* in South Australia	PIRSA Marine Bio-security/ SARDI Environment and Ecology Program	West Lakes, Port River Barker Inlet	www.pir.sa.gov.au/weeds
Research into epifaunal response to seagrass fragmentation in the Barker Inlet	SARDI Environment and Ecology Program	Port River Barker Inlet	www.sardi.sa.gov.au
Port Waterways Water Quality Improvement Plan	EPA	Port River Barker Inlet	EPA Ph.(08) 8204 2004 www.epa.sa.gov.au
Finalisation and implementation of domestic ballast water management arrangements as part of the National Ballast Water Framework and the National System for the Prevention and Management of Marine Pest Incursions	PIRSA	Estuaries that have ports and marinas	PIRSA Fisheries Marine Biosecurity Program Ph.(08) 8226 2874
Development of Coastal Marina Strategy and Guidelines	Chaired by Planning SA (DAARE, DEH, DTEI, DWLBC, EPA, OLG, PIRSA, SATC)	SA coast	PIRSA Planning SA (Strategic and Social Planning) www.planning.sa.gov.au Ph.(08) 8303 0760
Estuarine community monitoring programs	Waterwatch SA	Selected estuaries located within the Adelaide and Mount Lofty Ranges	Waterwatch SA C/ Central Adelaide Waterwatch program Ph.(08) 8234 7255
Beach profile, saltmarsh monitoring and habitat mapping	DEH/Coast Protection Board	Onkaparinga River, Port River Barker Inlet and other selected estuaries	Coastal Protection Branch Ph.(08) 8124 4700
Draft Carrickalinga Estuary Restoration Project	MLR Southern Emu-Wren and Fleurieu Peninsula Swamps Recovery Program	Carrickalinga Creek	C/ Conservation Council of SA Ph.(08) 8223 5155

15. Future developments

The following future developments have been identified as relevant to estuarine condition and management by regional NRM officers, local government officers and community members:

- Onkaparinga River - a new residential development planned for Seaford, and a proposed railway line through the middle of the Onkaparinga River Reserve
- Field River - a possible water reuse project (eg stormwater harvesting), extensive housing developments at Hallett Cove Heights and potential for further housing developments
- Sellicks Creek/Catchment - recent development along the foreshore, with a wetland likely to be built to reduce stormwater impacts on the creek
- Myponga River - a new subdivision on the cliff face adjacent to the beach
- Yankalilla River - 25 ha of land sold for development
- Bungala River - urbanisation and expansion of the caravan park
- Waitpinga Creek - farmers have been selling off portions of their land to non-residents
- Watson's Gap (Urumbirra Creek) - land has been sold to a developer for a residential development.

16. Potential directions

There are several information gaps that could be addressed to improve the management of estuaries in the AMLR NRM region.

Information gaps and potential directions for management include:

- develop a regional inventory for estuaries
- refine regional targets for healthy estuarine ecosystems and describe ecosystem services
- identify environmental flow requirements
- identify groundwater influences and uses within estuaries (including whether salinity levels are rising and impacting estuarine condition, flora and fauna)
- develop and implement an estuarine monitoring program for priority estuaries (including biogeochemical, water quality and water quantity, habitat assessment and species diversity, presence and abundance) to monitor trends in the condition of estuaries
- determine whether the artificial opening of entrances to estuaries is an issue, and develop management strategies where required
- determine the impacts of stormwater and urban encroachment on estuaries and amend council development plans accordingly
- investigate and address other potential sources of pollution to the estuarine environment
- develop targeted education programs and activities to engage landholders, tourists, industry and other estuary users, and the broader community to build capacity for the management of estuaries
- identify potential climate change impacts for estuaries and their adjacent habitats.

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Adelaide Dolphin Sanctuary
http://www.environment.sa.gov.au/coasts/ads (viewed 27 March 2007)

Australian Heritage Directory
http://www.heritage.gov.au/datalists.html (viewed 27 March 2007)

Australian Institute of Marine Science
http://www.aims.gov.au/ (viewed 27 March 2007)

City of Victor Harbor
http://www.victor.sa.gov.au/ (viewed 27 March 2007)

Department for Environment and Heritage
http://www.environment.sa.gov.au (viewed 27 March 2007)

Estuaries Management and Planning (South Australia)
http://www.environment.sa.gov.au/coasts/estuaries.html (viewed 27 March 2007)

National Land and Water Resources Audit
http://www.nlwra.gov.au/ (viewed 27 March 2007)

Register of the National Estate
http://www.ahc.gov.au/register/ (viewed 27 March 2007)

SA Water
http://www.sawater.com.au

The Protecting Waterways Manual
http://www.transport.sa.gov.au/publications/protecting_the_waterways.asp
(viewed 27 March 2007)

Victorian Estuaries Network
http://www.dse.vic.gov.au/VEN (viewed 27 March 2007)

Water Proofing Adelaide
http://www.waterproofingadelaide.sa.gov.au/main/ (viewed 27 March 2007)

Waterwatch - Southern Adelaide
http://www.onkaparinga.net (viewed 27 March 2007)

Relevant legislation

Aboriginal Heritage Act 1988
http://www.legislation.sa.gov.au/browseActs.aspx (viewed 27 March 2007)

Adelaide Dolphin Sanctuary Act 2005
http://www.legislation.sa.gov.au/browseActs.aspx (viewed 27 March 2007)

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http://www.legislation.sa.gov.au/browseActs.aspx (viewed 27 March 2007)

Abbreviations

AMLR NRM	Adelaide and Mount Lofty Ranges Natural Resources Management
BIPEC	Barker Inlet Port Estuary Committee
CASS	Coastal acid sulfate soils
DEH	Department for Environment and Heritage
DIWA	Directory of Important Wetlands in Australia
DPC - AARD	Department of Premier and Cabinet – Aboriginal Affairs and Reconciliation Division
DTEI	Department of Transport, Energy and Infrastructure
DWLBC	Department of Water, Land and Biodiversity Conservation
EPA	Environment Protection Authority
GL	gigalitre
ha	hectare
ML	megalitre
MLR IINRM Group	Mount Lofty Ranges Interim Integrated Natural Resources Management Group
NABCWMB	Northern Adelaide and Barossa Catchment Water Management Board
NLWRA	National Land and Water Resources Audit
NRM	Natural Resources Management
OLG	Office of Local Government
PASS	Potential acid sulfate soils
PIRSA	Primary Industries and Resources, South Australia
SATC	South Australian Tourism Commission
WWTP	Wastewater treatment plant

Appendices

Appendix 1. A sample of bird species associated with the AMLR NRM region's estuaries

	Port Gawler [1]	Port River Barker Inlet [2]	Onkaparinga River [3]	Waitpinga Creek [4]	Inman River [2]
Australian bittern			●		
Australasian shoveler			●		
banded stilt			●		
bar-tailed godwit			●		
black-tailed godwit	●	●	●		
black-chinned honeyeater					●
black swan				●	
black-winged stilt	●	●			
blue-billed duck			●		
Cape Barren goose			●	●	
caspian tern		●			
cattle egret			●		
common greenshank	●	●			
common sandpiper	●		●		
crested tern		●			
curlew sandpiper	●	●			
eastern curlew	●				
eastern reef egret			●		
glossy ibis			●		
great crested crebe			●		
great egret	●				
golden plover	●				
hooded plover				●	●
intermediate egret			●		
Latham's snipe			●		
Lewin's rail			●		
little egret	●	●			

table continued

Appendix 1. A sample of bird species associated with the AMLR NRM region's estuaries continued

	Port Gawler [1]	Port River Barker Inlet [2]	Onkaparinga River [3]	Waitpinga Creek [4]	Inman River [2]
marsh sandpiper	●	●			
musk duck	●		●		
orange-bellied parrot			●		
painted snipe			●		
peregrine falcon			●		
red-capped plover	●				
red-necked stint	●	●			
royal spoonbill					●
sacred ibis	●				
sharp-tailed sandpiper	●	●			
shining bronze cuckoo			●		
silver gull		●			
slender-billed thornbill	●	●			
sooty oystercatcher		●			
spotless crake			●		
whiskered tern	●				
white-bellied sea eagle	●	●		●	
white-faced heron				●	
wood sandpiper	●				

Sources:
[1]DEP(1983)
[2]EA (2001)
[3]FOOP (2004) & HTC & EMS Pty Ltd (2006)
[4]DEH (2004a)

Many of the nationally and internationally protected bird species listed above are protected under treaties and legislation. For species protection status refer to the following:

• *National Parks and Wildlife Act 1972*
http://www.legislation.sa.gov.au/browseActs.aspx

• *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)

Migratory species
http://www.deh.gov.au/biodiversity/migratory/index.html

Marine species
http://www.deh.gov.au/coasts/species/marine-species-list.html

• China-Australia Migratory Bird Agreement (CAMBA)
http://www.austlii.edu.au/au/other/dfat/treaties/1988/22.html

• Japan-Australia Migratory Bird Agreement (JAMBA)
http://www.austlii.edu.au/au/other/dfat/treaties/1981/6.html

Appendix 2. A sample of fish species recorded in the AMLR NRM region's estuaries

	Gawler River	Port River Barker Inlet	Patawalonga Basin	Torrens River	Onkaparinga River	Myponga River	Bungala River	Yankalilla River	Waitpinga Creek	Inman River	Hindmarsh River
Commercial fish species											
black bream	●	●	●	●	●	●	●	●	●	●	●
flathead		●	●								●
flounder	●	●	●		●						
King George whiting	●	●			●						●
mulloway		●	●	●	●					●	●
river garfish		●			●						
school whiting	●	●									
snapper		●									
snook		●									
southern sea garfish	●	●			●						
tommy ruff		●			●					●	●
trevally		●									
Western Australian salmon*		●	●		●	●	●	●	●	●	●
yellow-eyed mullet	●	●	●	●	●	●	●	●	●	●	●
yellowfin whiting		●		●							
jumping mullet	●	●			●						
Other fish species											
blue sprat*		●			●						
blue weed whiting*					●						
blue-spotted goby	●	●			●						
bridled goby	●	●			●						●
climbing galaxias					●						
common galaxias	●				●						
congolli		●			●						●
dusky flathead*					●						
dwarf flathead gudgeon					●						
elongate flounder*					●						
elongate hardyhead					●						
flathead gudgeon	●				●						●
glass goby		●			●						
greenback flounder	●	●			●						
largemouth goby					●						
leatherjackets*		●			●						
longsnout flounder*					●						

table continued

Appendix 2. A sample of fish species recorded in the AMLR NRM region's estuaries continued

	Gawler River	Port River Barker Inlet	Patawalonga Basin	Torrens River	Onkaparinga River	Myponga River	Bungala River	Yankalilla River	Waitpinga Creek	Inman River	Hindmarsh River
Other fish species continued											
mountain galaxias	●				●						
old wife		●			●						
pikehead hardyhead*					●						
pipefish (pugnose, spotted, widebodied)*					●						
pouched lamprey					●						
rough bullseye*					●						
shorthead lamprey					●						
silver whiting*	●				●						
small-mouthed hardyhead		●			●						
smalltooth flounder*		●			●						
southern longfin goby*		●			●						
striped perch	●	●			●						
Tamar River goby		●			●						
Tasmanian blenny*					●						
toadfish (prickly, weeping, smooth)*		●			●						
yellowfin bream					●						
western blue spot goby					●						
western striped grunter*					●						
Introduced fish species											
brown trout					●						
carp					●						
eastern gambusia					●						
goldfish					●						
Murray Darling golden perch					●						
rainbow trout					●						
redfin perch					●						
tench					●						

Sources: Bryars (2003), Hammer (2005), Hammer (2006a), Hammer (2006b), Jones (pers comm.), Rowntree (2004)
(Note: the data included in this table is limited, not all estuaries in the region have been included and fish lists are not extensive).

* indicates those species that are marine stragglers or temporary visitors that may have only been chance strays into the estuary.

Appendix 3. Criteria for determining important wetlands in Australia

A wetland may be considered nationally important if it meets at least one of the following criteria (EA 2001):

1. It is a good example of a wetland type occurring within a bio-geographic region in Australia.
2. It is a wetland which plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex.
3. It is a wetland which is important as the habitat for animal taxa at a vulnerable stage in their life cycles, or provides a refuge when adverse conditions such as drought prevail.
4. The wetland supports 1% or more of the national populations of any native plant or animal taxa.
5. The wetland supports native plant or animal taxa or communities which are considered endangered or vulnerable at the national level.
6. The wetland is of outstanding historical or cultural significance.

Maps produced by
Coast and Marine Conservation Branch
Department for Environment and Heritage
GPO Box 1047
Adelaide SA 5001

Map Source
Topographic data, NPWSA reserves, point source pollution, boat ramps, ports and harbours, CASS data, saltmarsh and mangrove mapping, coastal sand dune mapping, recreational fishing sites, Adelaide Dolphin Sanctuary, LGAs - DEH
Estuaries - NLWRA and DEH
Marine bioregions, marine biounits - DEH and SARDI, PIRSA
Coastal wetlands data from 'A Directory of Important Wetlands in Australia, 3rd ed., 2001'
Benthic habitat mapping - CSIRO, DEH and SARDI, PIRSA
Aquatic reserves, netting closures, aquaculture licenses, mining data - PIRSA
Water catchment boundaries, NRM boundaries, groundwater basins, shallow standing water level data - DWLBC
Land use zoning - Planning SA, PIRSA
Aboriginal heritage sites - AARD, DPC
Maritime boundaries - Geoscience Australia

Department for Environment and Heritage (2007)
Adelaide and Mount Lofty Ranges Natural Resources Management Region Estuaries Information Package, Department for Environment and Heritage, Adelaide, SA.

For further information please contact:
Coast and Marine Conservation Branch
Department for Environment and Heritage
GPO Box 1047
Adelaide SA 5001
Telephone: (08) 8124 4900
Fax: (08) 8214 4920
Website: www.environment.sa.gov.au/coasts

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