

Department for Environment and Heritage

South East  
Natural Resources Management Region



Estuaries Information Package



Government  
of South Australia



Australian Government



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# Overview

The South East Natural Resources Management region (SE NRM region) is one of eight NRM regions within the State (see Figure 1). The region covers nearly 400 kilometres of coastline and nine estuaries have been identified in it. These provide substantial environmental, economic and social values to the community.

## Environment

- The estuaries referred to in this document extend from Salt Creek (SE) to the South Australian section of the Glenelg River.
- While part of the Coorong lies within the SE NRM region, most of the Lower Lakes, Murray Mouth and Coorong estuary is within the SA Murray Darling Basin NRM region.
- Lake George is identified as a wave-dominated estuary in the National Land and Water Resources Audit (NLWRA).
- Groundwater is a key feature of the region, with many estuaries influenced by a shallow watertable.
- Drainage discharge in the South East is affecting the health of dense seagrass beds within several bays.

## Conservation and protection

- The South East provides a diversity of habitats for the 275 bird species recorded in the region; Salt Creek (SE), Lake George, Robe Lakes Drain L and Lake Bonney are all identified as important shorebird sites in the region.
- Recreational, commercial and other native fish species including the congolli *Pseudaphritis urvillii*, black bream *Acanthopagrus butcheri* and King George whiting *Sillagnodes punctata*, are present within the region.
- Salt Creek (SE) is located within the Coorong National Park and Lake Bonney is within the Canunda National Park.
- Salt Creek (SE), Eight Mile Creek, Lake George and the Glenelg River estuaries have been identified as nationally important wetlands in the Directory of Important Wetlands in Australia (DIWA).
- Salt Creek (SE) forms part of the Coorong and Lakes Alexandrina and Albert wetland Ramsar listing.
- Eight sites around Salt Creek (SE), Blackford Drain, Robe Lakes Drain L, Lake George and Lake Bonney are included in the Register of the National Estate.

## Cultural and socio-economic values

- Numerous indigenous significant sites are listed in and around the SE NRM region's estuaries.
- Several activities of economic and social value are reliant on estuaries in the region.

## Issues and initiatives

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



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





# 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 South East (SE) 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), Adelaide and Mount Lofty Ranges (AMLR) and Kangaroo Island (KI) 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 SE NRM region

## 3.1 Estuary classification

Within the SE NRM region, nine estuaries (see Figure 2) have been identified by an across-agency Estuaries Working Group. This includes a four kilometre stretch of the Glenelg River estuary that lies within South Australia. The mouth and headwaters of the river are located within Victoria, so it is important that both States work together for the management of the estuary.

The Coorong, Lower Lakes and Murray Mouth estuary is managed across three NRM regions. The South Australian Murray-Darling Basin NRM Board takes the lead role for the management of the majority of the estuary, and the South East and Adelaide and Mount Lofty Ranges NRM Boards invest in the management of relevant sections of the Coorong and Lower Lakes respectively. The Coorong, Lower Lakes and Murray Mouth estuary has not been included in this document because detailed information is readily available in:

- Coorong and Lakes Alexandrina and Albert Management Plan (DEH 2000)
- Coorong and Lower Lakes habitat-mapping program (Seaman 2003)
- Ecological Character Description of the Coorong, Lakes Alexandrina and Albert Wetland of International Importance (Phillips and Muller 2006)
- The Lower Lakes, Coorong and Murray Mouth Icon Site Environmental Management Plan (MDBC 2006)
- Ngarrindjeri Nation Yarluwar-Ruwe Plan: Caring for Ngarrindjeri Sea Country and Culture (Ngarrindjeri Tendi et al. 2006).

Therefore, of the nine identified estuaries in the region, only eight are referred to in this package. Of these eight Lake George and the Glenelg River estuary are included in the NLWRA (2001). The classification, maximum length, perimeter and water area for these two estuaries are shown in Table 1.

The management of estuaries within the region is mainly the responsibility of the SE NRM Board, the South Eastern Water Conservation and Drainage Board (SEWCDB), and local government authorities.

**Table 1. SE 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 <sup>2</sup> )
Lake George	Wave dominated	Wave-dominated estuary	L = 8.22 P = 36.85 A = 41.72
Glenelg River	Wave dominated	Wave-dominated estuary	L = 16.67 P = 37.58 A = 2.73

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





### 3.2 South East catchment area

Unlike other NRM regions in the State, the SE NRM region includes only one catchment area of 28,120 km<sup>2</sup> (SECWMB 2003). This catchment area extends from the South Australian/Victorian border in the east along the coast to the south and west. All of the estuaries in the region (apart from the Glenelg River) fall within this catchment boundary. The Glenelg River estuary has a catchment area of 12,380 km<sup>2</sup> (WCB 2002).

Artificial subcatchments in the region have been created through the development of the drainage system. Estuaries are located within these artificial subcatchments. Further information is available through the South Eastern Water Conservation and Drainage Board (SEWCDB).

### 3.3 Regional NRM Groups

The SE NRM region is separated into three areas for management purposes: Southern, Central and Northern. Within these group areas there are estuaries with differing features, functions and pressures.

### 3.4 Coastal councils

Five coastal councils are located within the SE NRM region (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 Councils of Kingston and Grant have two identified estuaries within their boundaries, whilst the Wattle Range Council and the District Councils of Robe and Coorong each have one estuary. The Glenelg River estuary is located in both the Glenelg Shire in Victoria and the District Council of Grant in South Australia.



Figure 2. Estuaries of the SE NRM region

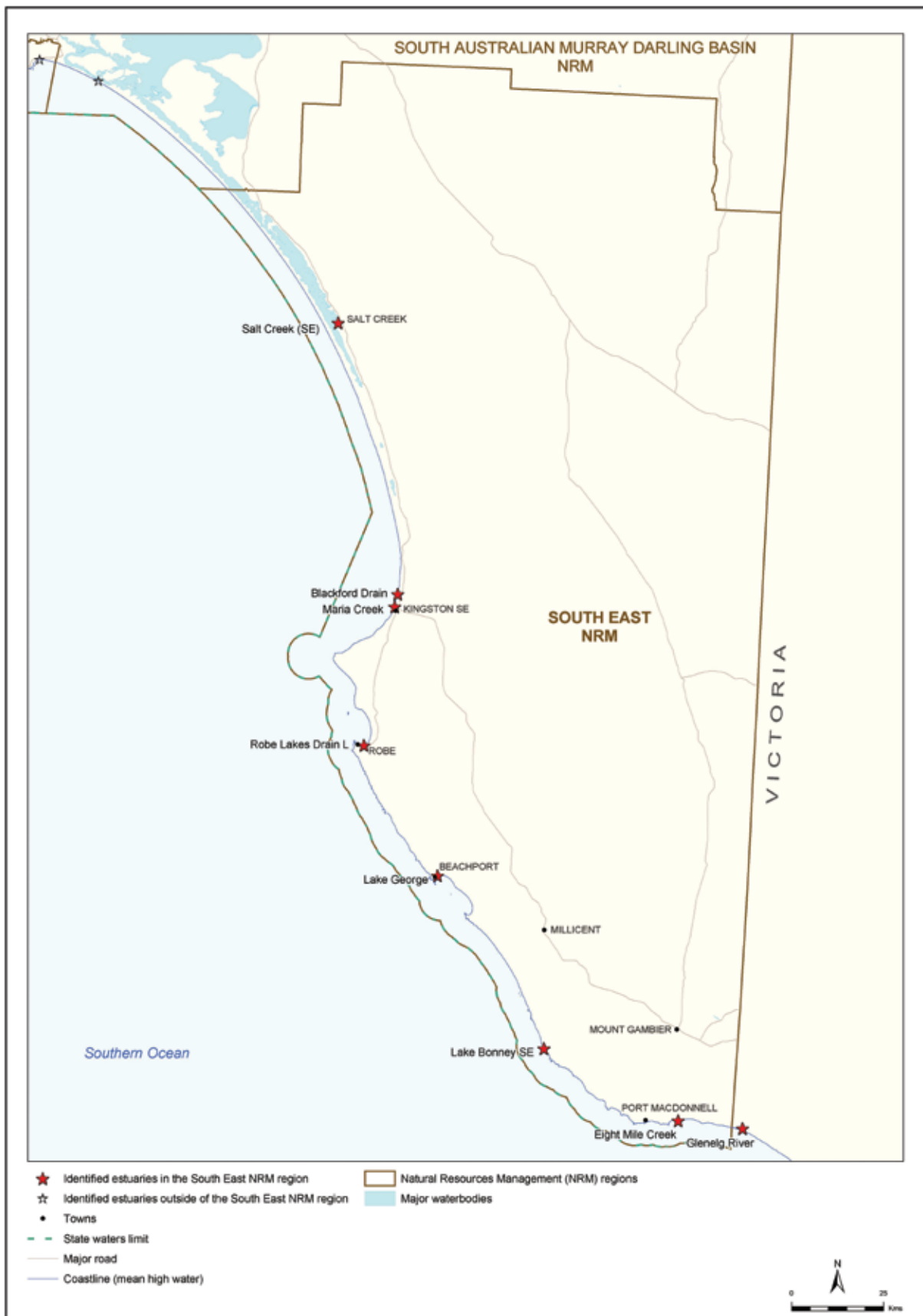
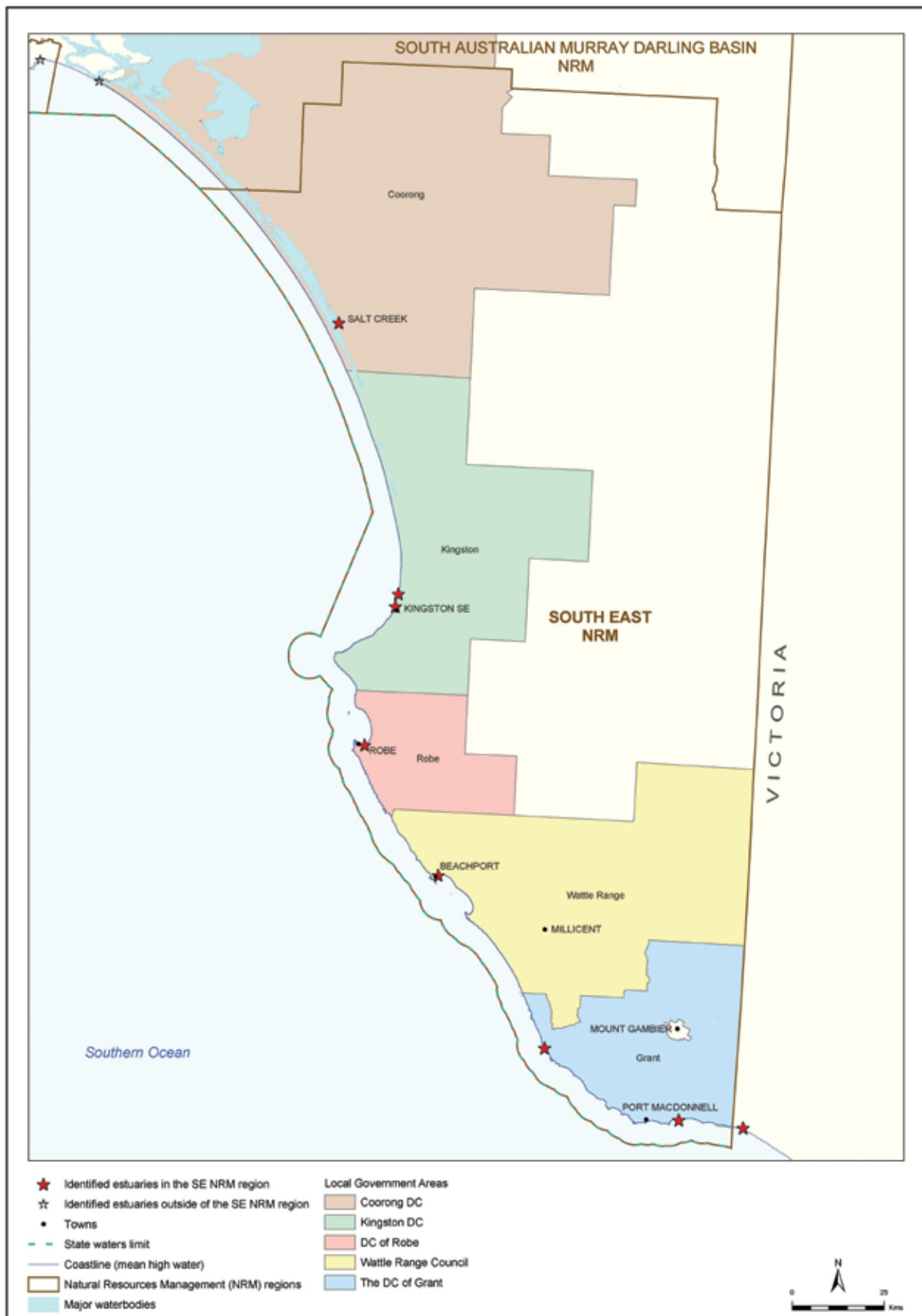


Figure 3. Estuaries within coastal council areas





## 4. Surface water, groundwater and marine areas

### 4.1 Environmental flows

Salt Creek (South East), Eight Mile Creek, Blackford Drain, Maria Creek and Glenelg River estuaries are permanently flowing watercourses (DEH 2006, SECWMB 2003). Lake George and Lake Bonney also have permanent water supplies but limited flow to the sea (DEH 2006).

### 4.2 Groundwater influence

Groundwater is an important feature of the region, with a shallow watertable occurring throughout much of the South East (SECWMB 2003). There are two major groundwater basins, the Otway and the Murray. These contain both shallow unconfined aquifers and deeper confined aquifers. The unconfined aquifers are the main source of water for irrigation, industry, stock and domestic supply to the region whilst the deeper confined aquifers are utilised mainly for agriculture and municipal water supplies (SECWMB 2003).

The introduction of the drainage system has altered groundwater discharge to the coast and marine environment. Estuaries such as Eight Mile Creek and Robe Lakes Drain L are predominantly groundwater-fed systems (SECWMB 2003). Groundwater basins and watertable depth for the South East region are shown in Figure 4.

### 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 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<sup>2</sup>. For further information see [http://www.environment.sa.gov.au/coasts/marineparks/background/marine\\_bioregions.html](http://www.environment.sa.gov.au/coasts/marineparks/background/marine_bioregions.html).

The SE NRM region has two marine bioregions, the Coorong and Otway. Salt Creek (South East), Blackford Drain and Maria Creek are located within the Coorong bioregion, whilst Robe Lakes Drain L, Lake George, Lake Bonney (SE) and Eight Mile Creek are located in the Otway bioregion.

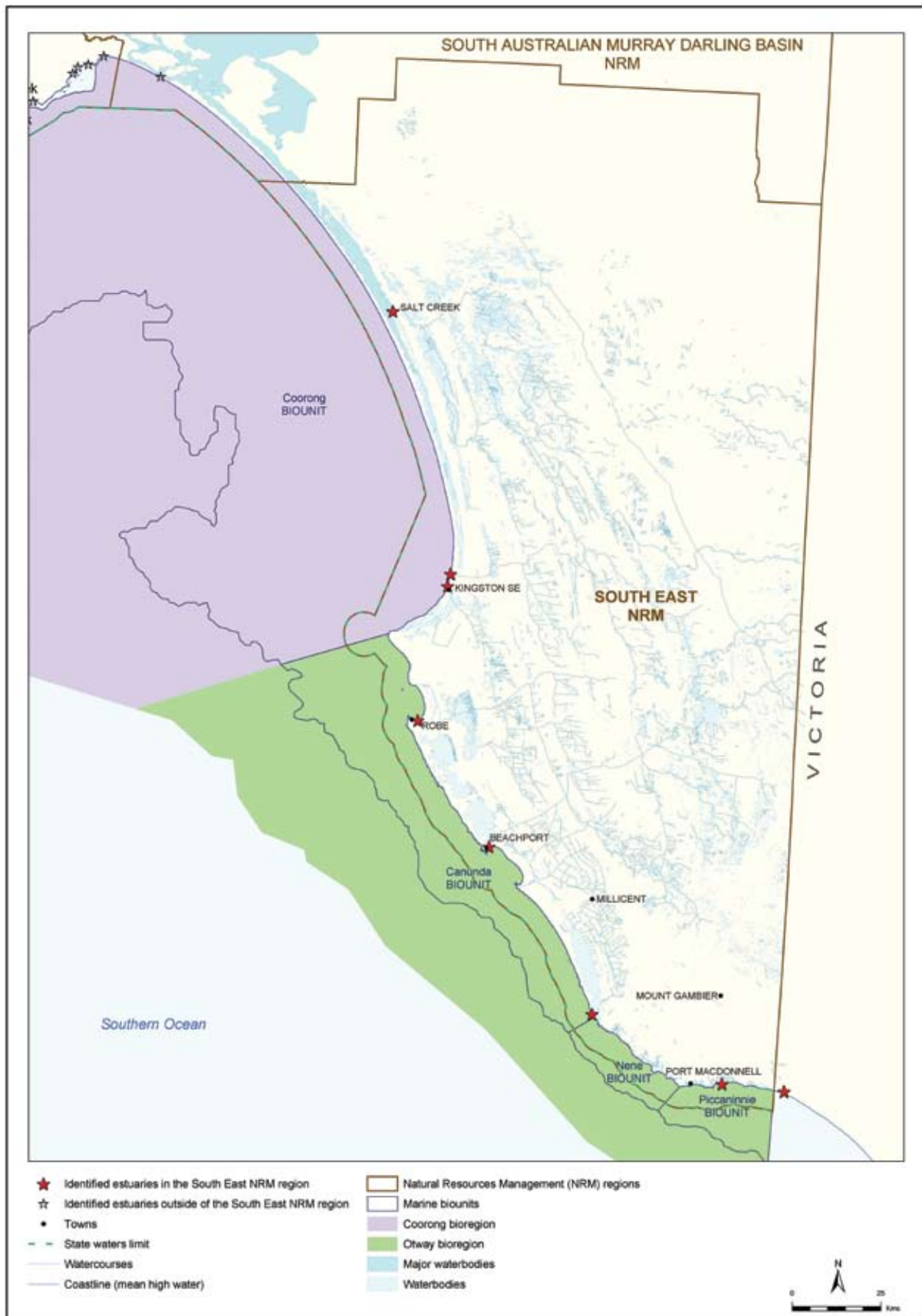
The biounits in the Otway bioregion include Piccaninnie, Nene and Canunda. The Coorong bioregion contains only one biounit: the Coorong (see Figure 5).



Figure 4. Groundwater watertable depth and groundwater basins



Figure 5. Marine bioregions and biounits



# 5. Habitats of the SE 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 the floodplain include *Melaleuca* species, sedges and grasses.

## 5.2 Saltmarshes

Saltmarsh habitats are sparse around the estuaries of the South East with only Salt Creek, Lake George and Maria Creek estuaries including samphires<sup>1</sup>.

Lake George and the Glenelg River are the only estuaries in the region that have had saltmarshes mapped as part of the NLWRA (2001) (See Table 2).

Clearance of saltmarsh (samphire) without consent can be an offence under the *Native Vegetation Act 1991*. Note there are exemptions.

## 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.

**Table 2. Saltmarshes and mudflats mapped in the National Land and Water Resources Audit**

Estuary	Saltmarsh area (km <sup>2</sup> )	Mudflat area (km <sup>2</sup> )
Lake George	< 0.01	0.18
Glenelg River	0.66	0.75

## 5.4 Mangrove communities

There are no mangroves present in the South East.

## 5.5 Seagrass communities

Seagrass meadows occur in Rivoli Bay (Lake George), Lacepede Bay (Maria Creek, Blackford Drain) and Guichen Bay (Robe Lakes Drain L) (see Figure 6). Seagrass species in the region include the tape weed *Posidonia* spp., wire grass *Amphibolis* spp. and eelgrass *Zostera* spp. The largest single seagrass meadow in the South East (25,062 ha) is located in Lacepede Bay (Wear et al. 2006).

In seagrass beds around the region's estuaries, commercial fish species such as the King George whiting *Sillagnodes punctata*, southern sea garfish *Hyporhamphus melanochir*, Western Australian salmon *Arripis truttacea* and snapper *Chrysophrys auratus* have been recorded (Bryars 2003).

The drainage discharge from estuaries such as Blackford Drain, Drain M (Lake George outlet) and Maria Creek is thought to affect the health of adjacent seagrass communities (Seddon et al. 2003, Wear et al. 2006).

<sup>1</sup> Samphires are saltmarsh plants dominated by the family *Chenopodiaceae*.



Figure 6. Habitats within and surrounding estuaries





## 6. Internationally and nationally protected bird species

The diversity of habitats within the region, including wetlands, coastal and estuarine areas, is important in supporting the region's 275 recorded bird species (representing 77% of the State's total species) (Croft et al. 1999).

Watkins (1993) identified sites including the Coorong (eg Salt Creek South East), Guichen Bay (eg Robe Lakes Drain L), Lake George and Rivoli Bay (eg Lake Bonney) as internationally or nationally important sites for shorebirds. Within the Coorong, nine species of international importance and ten species of national importance have been recorded. These include the sharp-tailed sandpiper *Calidris acuminata* and red-necked stint *Calidris ruficollis* (EPBC Act 1999 and international treaties). Lake George has three species of both international and national importance (eg the curlew sandpiper *Calidris ferruginea* (EPBC Act 1999)), Rivoli Bay has one species of international importance and two species of national importance (eg the sanderling *Calidris alba* (EPBC Act 1999)), and Guichen Bay is nationally important for one species, the ruddy turnstone *Arenaria interpres* (EPBC Act 1999 and international treaties).

Wilson (2000) also identifies Salt Creek (South East) as an important site for waders and Lake George has been identified by Wetlands International as an internationally important shorebird site for three species: the red-necked stint *Calidris ruficollis* (EPBC Act 1999 and international treaties), sharp-tailed sandpiper *Calidris acuminata* and curlew sandpiper *Calidris ferruginea* (EPBC Act 1999 and international treaties) (see [http://www.shorebirds.org.au/International\\_sites.html](http://www.shorebirds.org.au/International_sites.html)).

Lake George is also an important wintering ground in the region for the critically endangered orange-bellied parrot *Neophema chrysogaster* (EPBC Act 1999, NPW Act 1972) and the double-banded plover *Charadrius bicinctus* (EPBC 1999) (EA 2001). See Appendix 1 for a list of bird species identified at estuarine sites across the region.



## 7. Fish of the SE NRM region's estuaries

The estuaries of the SE NRM region provide habitat for a range of commercial, recreational and other native fish species including the Western Australian salmon *Arripis truttacea*, southern sea garfish *Hyporhamphus melanochir*, black bream *Acanthopagrus butcheri*, tommy ruff *Arripis georgiana* and congolli *Pseudaphritis urvillii* (see Appendix 2). In particular, Maria Creek is believed to provide habitat for the Western Australian salmon *Arripis truttacea*, eastern Australian salmon *Arripis trutta*, yellow-eye mullet *Aldrichetta forsteri* and black bream *Acanthopagrus butcheri* (Baker 2004), while areas around Lacepede Bay are believed to provide habitat for the King George whiting *Sillagnodes punctata*, tommy ruff *Arripis georgiana*, southern sea garfish *Hyporhamphus melanochir* and yellow-eye mullet *Aldrichetta forsteri* (Bryars 2003).

## 8. Protection arrangements for SE NRM region's estuaries

### 8.1 Parks and reserves

The Salt Creek (South East) estuary is located within the Coorong National Park, and Lake Bonney is partially surrounded by Canunda National Park (see Figure 7). These parks are managed by DEH under the *NPW Act 1972*. Further information is available in the Coorong National Park and the Canunda National Park Management Plans (see DEP1990a and b).

The South Australian section of the Glenelg River estuary is not protected in the reserve system, though the entire Victorian section of the river is listed as a heritage river area under the Victorian *Heritage Rivers Act 1992*<sup>2</sup>. The Victorian Department of Natural Resources and Environment has prepared a draft management plan for the Glenelg Heritage River Area (see DNRE 2002). A draft management plan for the Glenelg River estuary is also available (see GHMA 2006).

### 8.2 Internationally and nationally important wetlands

Three South Australian estuaries within the region have been identified as wetlands of international and/or national importance. The Victorian sections of the Glenelg River estuary have also been identified as a nationally important wetland, however this listing does not include the South Australian section (EA 2001) (see Table 3).

Internationally protected wetlands are listed under the Ramsar convention, whilst nationally important wetlands are included in the Directory of Important Wetlands in Australia (DIWA). Further information and the criteria for determining wetlands of international or national importance are included in Appendix 3.

<sup>2</sup> The *Heritage Rivers Act 1992* 'provides for the protection of public land in particular parts of rivers and river catchment areas in Victoria that have significant nature conservation, recreation, scenic or cultural heritage attributes' (GHMA 2006).



Figure 7. Conservation areas and aquatic reserves including estuaries



**Table 3. Estuaries identified as part of internationally or nationally important wetlands**

Estuary	Wetland name	Ramsar wetland criteria for inclusion	DIWA inclusion criteria
Salt Creek (SE)	The Coorong, and Lakes Alexandrina and Albert Wetland	1, 2, 3, 4, 5, 6	1, 2, 3, 4, 5, 6
Lake George	SE Coastal Salt Lakes		1, 3, 6
Eight Mile Creek	Ewens Ponds		1, 5, 6
Glenelg River	Glenelg River (Victoria) <sup>3</sup>	N/A	1,3,4

### 8.3 Register of the National Estate

Several sites across the SE NRM region are included on the Register of the National Estate (<http://www.ahc.gov.au/register/>) (see Table 4).

**Table 4. Sites including or associated with estuaries in the Register of the National Estate**

Site <sup>4</sup>	Estuary	Significance
Coorong Game Reserve (natural)	Salt Creek (SE)	This site is preserved for the conservation of waterfowl and other fauna.
Coorong National Park (natural)	Salt Creek (SE)	This site is important as a migratory route for birds, a biological corridor and for its unusual lake systems.
Lacepede Bay Scrub (natural)	Blackford Drain	The area supports remnant coastal vegetation and is an important winter habitat for the orange-bellied parrot <i>Neophema chrysogaster</i> (EPBC Act 1999, NPW Act 1972).
Robe Urban Conservation Area (historic)	Robe Lakes Drain L	The township of Robe was first proclaimed as a port in 1847 and was utilised as a location for the entry of Chinese migrants. Wool, cheese, butter and other produce were exported from the port.
Canunda National Park (natural)	Lake Bonney (SE)	This site is of national and regional conservation significance for both animal and plant species, eg the hooded plover <i>Thinornis rubricollis</i> (EPBC Act 1999, NPW Act 1972) and orange-bellied parrot <i>Neophema chrysogaster</i> (EPBC Act 1999, NPW Act 1972).
Cape Banks Lighthouse (historic)	Lake Bonney (SE)	The lighthouse is significant as it has a fourteen-sided lantern room for one of the three remaining lanterns of its type in South Australia.
Lake George (natural)	Lake George	The estuary supports a high diversity of waterbird species and is the most important wetland in the State for five migratory species. The site also provides one of the remaining locations in the South East for the nationally and critically endangered orange-bellied parrot <i>Neophema chrysogaster</i> (EPBC Act 1999, NPW Act 1972, IUCN 2006) and the rare double-banded plover <i>Charadrius bicinctus</i> (EPBC Act 1999).

Sources: estuaries – marine estuarine database – DEH, NPWSA reserves, National Estate. Compiled July 2006.  
Australian Heritage Database - compiled November 2006.

<sup>3</sup> Only the Victorian section of the river has been included in the DIWA.

<sup>4</sup> Sites may not necessarily fall within actual estuary boundaries as actual estuary boundaries have yet to be defined.



## 9. Cultural assets

Prior to European settlement, Tanganekald, Meintangk, Boandik, Bunganditj, Ngarkat and Potaruwutj Aboriginal people lived in the SE NRM region (SECWMB 2003).

There are many Aboriginal sites of cultural significance associated with the estuaries in the region (see figure 8). Aboriginal heritage sites are recorded with the Department of Premier and Cabinet, Aboriginal Affairs and Reconciliation Division, and some sites are also listed on the Register of the National Estate (<http://www.ahc.gov.au/register/>). All Aboriginal sites, objects and remains of significance in South Australia are protected under the *Aboriginal Heritage Act 1988*.

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

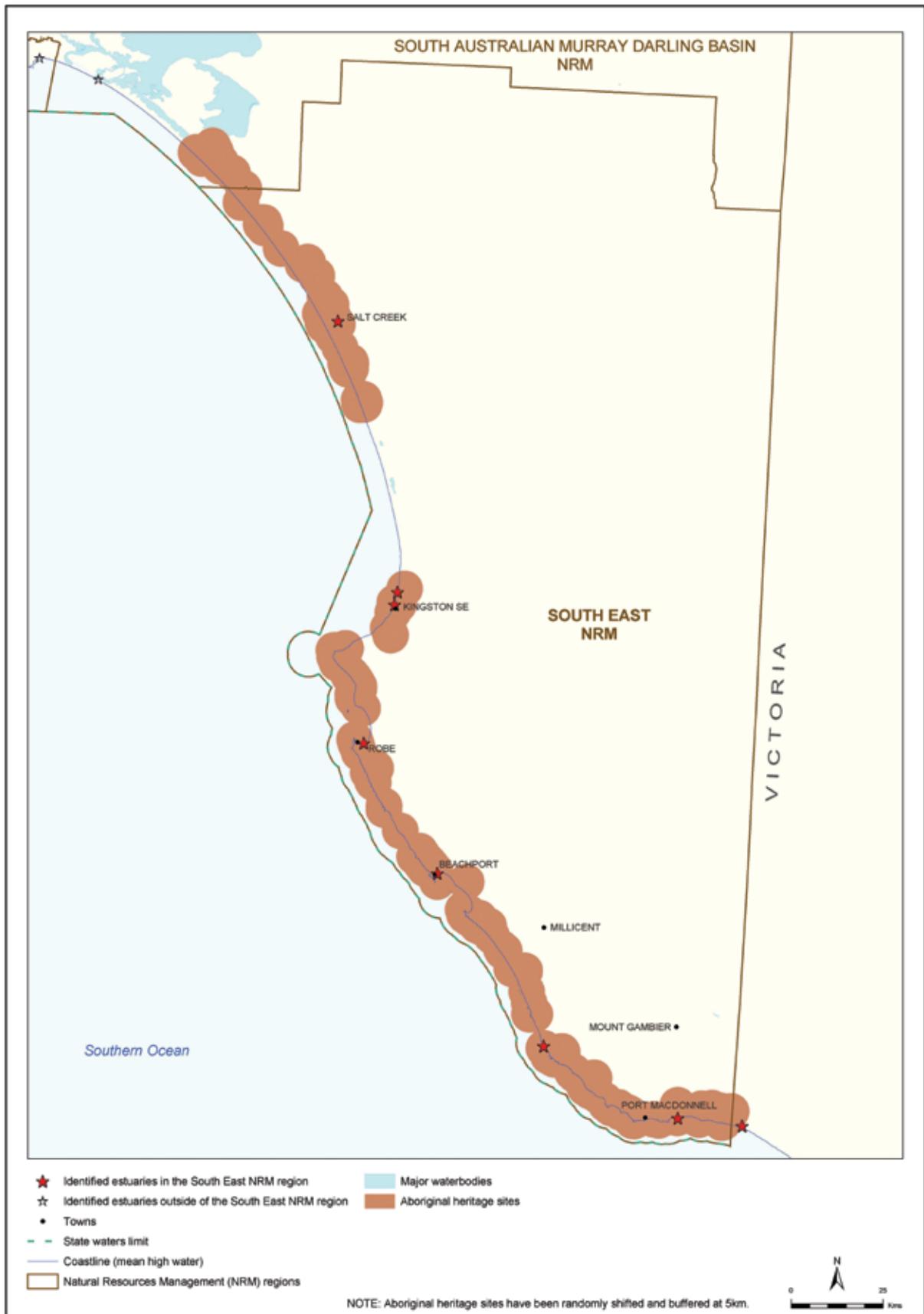
NOTE: Pursuant to section 23 of the *Aboriginal Heritage Act 1988 (SA)*, a person must not, without the authority of the Minister [for Aboriginal Affairs and Reconciliation] -

- (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.

Many of the early European settlements in the South East region were situated around estuarine areas including the townships of Robe, Beachport and Kingston. The early introduction of ports and jetties at these locations lead to the early expansion of these settlements. European Heritage sites can be found on the State Heritage Register (<http://www.heritage.gov.au/ahpi/index.html>) and also on the Register of the National Estate (<http://www.ahc.gov.au/register/>).



Figure 8. Aboriginal heritage sites associated with estuaries



## 10. Economic and social regional importance

Much of the economic development within the region is strongly linked to the local environment including water resources, coastal and marine assets. The region's economy is continuing to grow through the expansion of forestry, agriculture (including viticulture and dairying) and tourism. All of these industries are reliant on the sustainable management of the region's natural resources, in particular its water (SECMWB 2003). Economic drivers for the region include:

### • Forestry

The SE NRM region contains the majority of the State's softwood plantations (2.8 million tonnes of softwood logs produced in 2001) and processing facilities (OID 2005). Blue gum *Eucalyptus globulus* plantations are increasing, with 28,000 ha planted in 2003 and large scale harvesting expected to commence from 2008 (OID 2005). The industry employs more than 4,000 people and has an annual value of \$1.3 billion (<http://www.lcrdb.com/forestry.htm>).

### • Tourism

An estimated 591,000 overnight visitors stayed 1.8 million nights in the region during 2005. Domestic overnight visitors to the region spent \$176 million, whilst domestic day visitors spent an estimated \$67 million (2004) (SATC 2006).

### • Agricultural practices, dairy farming, beef processing and production

Agricultural industries generate \$500 million per annum, with sheep (meat and wool) valued at \$80 million annually, prime beef production and processing at \$160 million annually, and dairy farming at \$234 million annually (wholesale value) (<http://www.lcrdb.com/>). The gross annual value of grain production in the region is about \$41 million (OID 2005).

### • Industry, eg commercial fishing and exports

The rock lobster annual catch (1,890 tonnes) is valued at \$60 million annually, supporting 400 full-time jobs (<http://www.lcrdb.com>) and is a major export for the region (OID 2005).

### • Aquaculture

Aquaculture is a developing industry with operators currently producing abalone eg *Haliotis* spp., Murray cod *Maccullochella peelii*, barramundi *Lates calcarifer* and salmon eg *Salmo salar* (OID 2005).

### • Recreational activities, eg fishing, boating, camping

The region provides a range of recreational opportunities for residents and tourists, of which many are water related (SECMWB 2003). Going to the beach, visiting national parks and fishing rate highly in participation rates by visitors to the South East (SATC 2006). Other recreational pursuits including swimming, boating, bird watching, 4WD tours and water skiing are highly valued and have good participation rates (SECMWB 2003).

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 prosperity and quality of life than agriculture, manufacturing, mining, wine or information technology (SATC 2002a, SATC 2002b).

Industries such as commercial fishing are considered to have multiplier effects for other industries, especially for increasing employment opportunities. Commercial and recreational fishing activities are highly valued by the community, particularly in coastal areas where employment, flow-on activities to other industries, and health and lifestyle benefits are prominent. Most fishers also feel a strong attachment to their local community and indicate that their community is an extremely good place to live (Schirmer and Pickworth 2005).



## 11. Activities and pressures associated with estuaries of the SE NRM region

Of the two estuaries included in the NLWRA (2001), the Glenelg River was classified as modified, whilst Lake George was identified as being in an extensively modified condition<sup>5</sup>.

Various modifications to all estuaries in the region have occurred over time to support human settlement, economic development and to provide recreational opportunities to the community. Each of these is linked to a range of activities occurring in, and on the land surrounding estuaries including:

- agricultural practices including viticulture and dairying
- tourism
- forestry and wood processing industry
- recreational pursuits (eg fishing, hiking, camping)
- aquaculture
- commercial fishing
- petroleum and geothermal exploration<sup>6</sup>.

(See Figures 9 and 10).

Some of the infrastructure and issues related to these activities are given in Table 5. Of particular note in the region is the forestry, agricultural industrial and recreational use, as well as the potential impacts arising from climate change, especially in low lying coastal areas.

<sup>5</sup> Modified estuaries have some problems due to impacts from the catchment, waterway and estuary (NLWRA 2001), whereas extensively modified estuaries are generally recognised as having multiple problems due to a complexity of impacts (NLWRA 2001).

<sup>6</sup> Both the *Petroleum Act 2000* and the *Petroleum (Submerged Lands) Act 1982* have similar requirements. Environmental values and appropriate protection measures must be identified prior to activities occurring in the affected area, eg coastal waters. *The Petroleum Act 2000* also requires existing Management Plans to be considered and incorporated into the objectives of the proposed activity prior to the mineral or petroleum industry receiving access. *The Mining Act 1971* also requires activities not to contravene the *Fisheries Management Act 2007* that requires provisions for aquatic reserves. Specific conditions can also be placed on licences on a case-by case basis to ensure environmental values are protected.

Figure 9. Activities occurring in and around estuaries

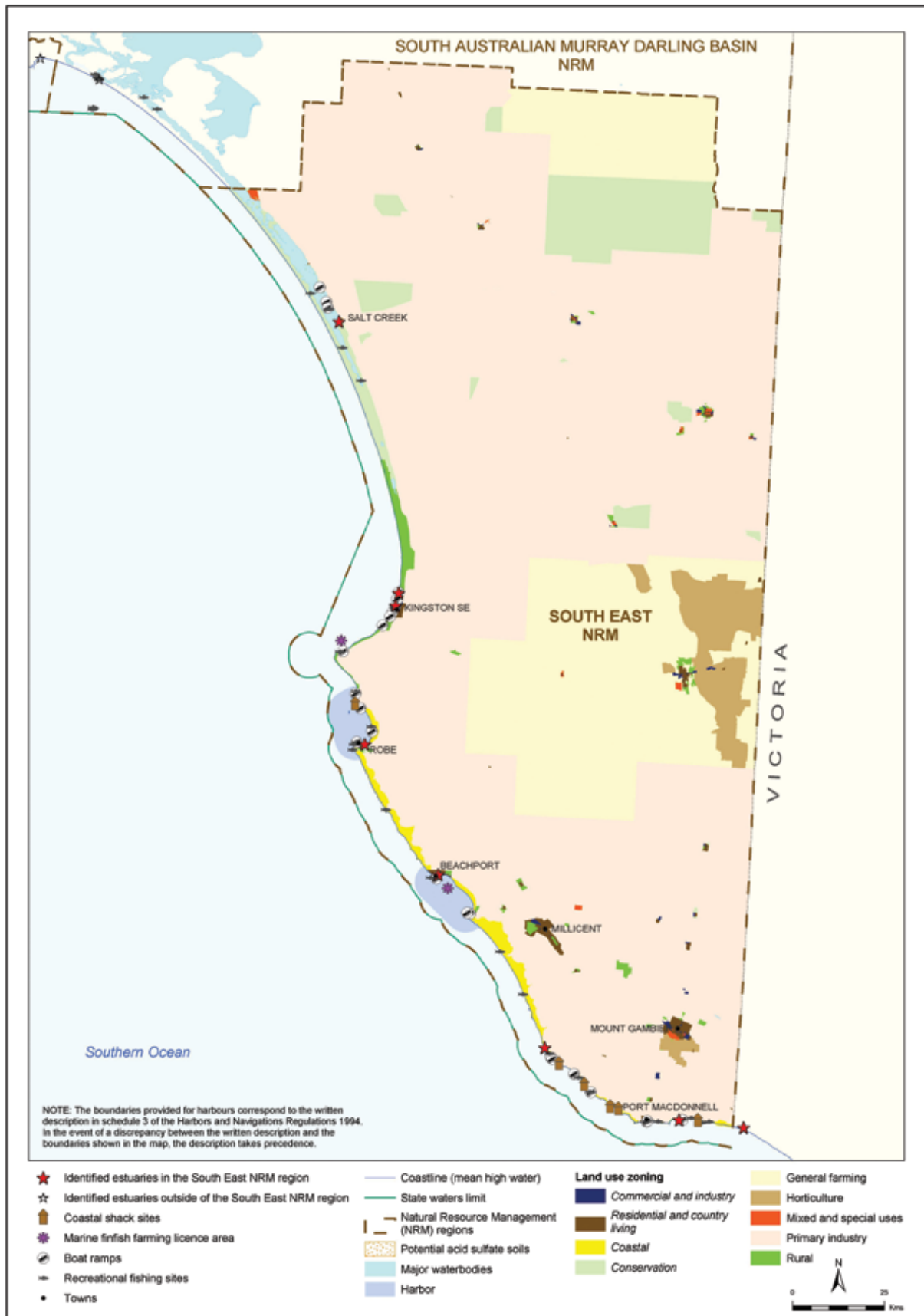
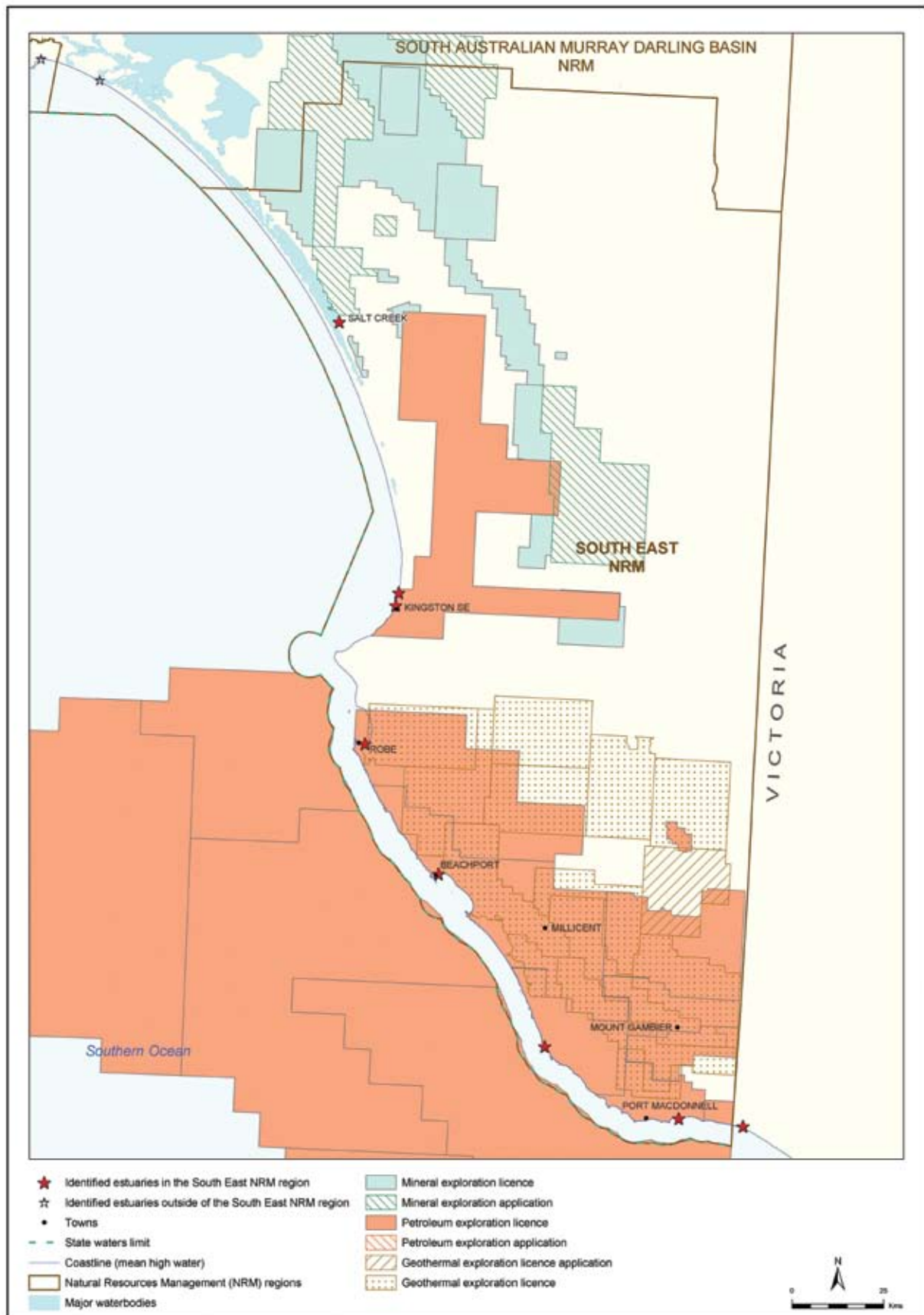




Figure 10. Petroleum, mining and geothermal exploration licences and applications



**Table 5. Some of the infrastructure, activities and issues within estuaries**

	Feature	Location
Infrastructure	Boat ramps	<ul style="list-style-type: none"> <li>• 2 at Beachport</li> <li>• 1 near Robe (Lake Butler)</li> <li>• 1 at Snipe Point (near Salt Creek)</li> </ul>
	Harbours	<ul style="list-style-type: none"> <li>• Beachport Harbor (Lake George)</li> <li>• Southend Harbor (Lake George)</li> <li>• Robe Harbor</li> </ul>
	Wastewater treatment systems and disposal	<p>Finger Point Wastewater Treatment Plant (WWTP) near Mt Gambier is the only plant in the region to dispose of waste into coastal waters. Millicent and Naracoorte WWTP discharge into watercourses that ultimately drain to Lake Bonney (SECWMB 2003).</p> <p>There is demand for a Septic Tank Effluent Disposal Scheme (STEDS) within the region.</p> <p>There is also historical contamination and discharge of wastewater into waterways and groundwater, eg from pulp and paper mill and dairy effluent (SECWMB 2003).</p>
	Wind farms	Two farms are operational, with the possibility of further farms developed along the coast. A third farm is currently under construction at Lake Bonney.
	Water supply	Water is supplied from the Taillem Bend to Keith pipeline (Murray-Darling water), as well as from regional surface and groundwater supplies.
	Industry	<ul style="list-style-type: none"> <li>• Dairy farms, viticulture, grazing, forestry and pulpmills located throughout the region.</li> </ul>
	Aquaculture	<ul style="list-style-type: none"> <li>• Marine finfish aquaculture at Cape Jaffa and Rivoli Bay.</li> </ul>
Issues	Coastal acid sulfate soils <sup>7</sup>	<ul style="list-style-type: none"> <li>• Salt Creek – potential acid sulfate soils (PASS) in supratidal samphire</li> <li>• Lake George – PASS in intertidal zone (moderate risk) and PASS in supratidal zone</li> <li>• Maria Creek – PASS in intertidal samphire (moderate risk), PASS in underlying tidal stream, and disturbed PASS in the stranded tidal flat samphire</li> </ul>
	Climate change	Possible sea level rise, increase in water temperature and CO <sub>2</sub> absorption and likelihood of more frequent storm events.
Activities	Netting closures	<ul style="list-style-type: none"> <li>• Guichen Bay, Robe</li> <li>• Rivoli Bay, Beachport</li> <li>• Admelia dunes</li> </ul>
	Exploration licences	<ul style="list-style-type: none"> <li>• Petroleum exploration licences located around Blackford Drain, Maria Creek, Robe Lakes Drain L, Lake George, Lake Bonney SE and Eight Mile Creek</li> <li>• Geothermal exploration licences located around Lake George and Robe Lakes Drain L</li> </ul>

Sources: Topography - boat ramps – DEH, Coastal Protection Branch  
 Aquaculture licences and lease boundaries – PIRSA  
 Exploration licences - PIRSA  
 Acid sulfate soils – Coast maps, Government of SA  
 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.

<sup>7</sup> Coastal acid sulfate soils are soils that generate sulfuric acid when exposed to oxygen.



## 12. Case study

Like many of the estuaries in the region, Lake George is valued for its environmental, economic and social attributes. This estuary is under threat from a range of influences, with further planning, management and action necessary to ensure its health is sustained.

### Case study: Lake George

Lake George covers an area of nearly 6,000 ha and is 3.5 m deep at the northern end (Australian Heritage Database <http://www.deh.gov.au/>). It receives freshwater input from Drain M, in addition to many private drains and freshwater soaks that flow into the lake. An artificial outlet from Lake George to the sea has been created to allow for changes in the lake's level during high flow events.

The area is of high conservation value, with the estuary being identified as an internationally important site for shorebirds, as well as a wintering ground for the critically endangered orange-bellied parrot *Neophema chrysogaste* (EPBC Act 1999, NPW Act 1972) and the double-banded plover *Charadrius bicinctus* (EPBC Act 1999). Over 200 bird species have been recorded around Lake George, with six vulnerable species recorded (NPW Act 1972, DEHAA 1984). Seven species of frogs and 14 reptile species have also been recorded in surrounding areas (DEHAA 1984). See DEHAA (1984) for a full fauna species list.

Lake George is part of the South East Coastal Salt Lakes Nationally Important Wetland Site, as well as being listed as a Register of the Natural Estate site (natural).

The lake is a popular recreational location, particularly for camping, water-sports and holiday accommodation.

The major threats facing Lake George include:

- a sudden increase in water depth, combined with increased and prolonged level of nutrients entering the lake. This has caused the growth of a photosynthetic bacteria (picoplankton) that has turned the lake green (Coleman, pers. comm.)
- the clearance of large areas of scrub around the lake and the grazing of adjacent pastures (DEHAA 1984)
- high turbidity levels through increased levels of sediment entering the lake.

A one-year water quality monitoring program funded by the SE NRM Board is currently underway.

## 13. Current management initiatives

Table 6 indicates those projects currently underway in the SE NRM region's estuaries. Many agencies, local governments and community groups are responsible for the management and protection of these estuaries. Across the region there is also scope for other research, monitoring, education, awareness raising, and on-ground activities.

**Table 6. Current management initiatives**

Initiative	Agency/group involved	Estuaries included in the project	Contact details
Finalise and implement 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 (DPC, DEH, DTEI, DWLBC, EPA, OLG, PIRSA, SATC)	SA coast	PIRSA Planning SA (Strategic and Social Planning) <a href="http://www.planning.sa.gov.au">http://www.planning.sa.gov.au</a> Ph.(08) 8303 0760
Wetland inventories for the upper South East region	DEH	Selected estuaries within the South East	DEH – South East Regional Office Ph.(08) 8735 1111
Baseline vegetation survey of Lake Bonney SE	DEH/SARDI	Lake Bonney	DEH – South East Regional Office Ph.(08) 8735 1111
Wader bird counts of the South East	SEWCDB/DEH/Australasian Wader Study Group	Selected sites within the South East	Australasian Waders Study Group <a href="http://www.tasweb.com.au/awsg/">http://www.tasweb.com.au/awsg/</a>
Hydro-dynamic study and ecological response modelling project	SARDI, SEWCDB, SE NRM Board, EPA, UA	Lake George	SEWCDB Ph.(08) 8733 3533
Lake George monitoring project	SARDI, SEWCDB, SE NRM Board, DWLBC EPA, UA	Lake George	SEWCDB Ph.(08) 8733 3533
Nomination of Lake George as a shorebird site on the East-Asian Network	DEH	Lake George	DEH – South East Regional Office Ph.(08) 8735 1111





## 14. Potential directions

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

Information gaps and potential directions for management include:

- develop a regional inventory of estuaries
- refine regional targets for healthy estuarine ecosystems and describe ecosystem services
- identify environmental flow requirements
- identify groundwater influences and use 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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Department for Environment and Heritage

<http://www.environment.sa.gov.au> (viewed March 28th 2007)

Environmental flows for the Lower Lakes, Coorong and Murray Mouth

<http://www.dwlbc.sa.gov.au/murray/flows/lowerlakes.html> (viewed May 9th 2007)

Estuaries Management and Planning (SA)

<http://www.environment.sa.gov.au/coasts/estuaries.html> (viewed March 28th 2007)

Lake George water quality monitoring program

Big Lake

<http://e-nrims.dwlbc.sa.gov.au/imsdata/monitoring/A2391077/A2391077.htm> (viewed June 6th 2007)

Middle Lake

<http://e-nrims.dwlbc.sa.gov.au/imsdata/monitoring/A2391078/A2391078.htm> (viewed June 6th 2007)

Limestone Coast Regional Development Board

<http://www.lcrdb.com/index.htm> (viewed March 28th 2007)

National Land and Water Resources Audit

<http://www.nlwra.gov.au/> (viewed March 28th 2007)

Protecting Waterways Manual

[http://www.transport.sa.gov.au/pdfs/environment/waterway\\_pdfs/all\\_chapters.pdf](http://www.transport.sa.gov.au/pdfs/environment/waterway_pdfs/all_chapters.pdf)  
(viewed March 28th 2007)

Shorebird conservation toolkit

[http://www.shorebirds.org.au/new\\_sites.html](http://www.shorebirds.org.au/new_sites.html) (viewed March 28th 2007)

South East Natural Resources Management Board

<http://www.senrmb.com.au/> (viewed March 28th 2007)

## Relevant legislation

*Aboriginal Heritage Act 1988*

<http://www.legislation.sa.gov.au/index.aspx> (viewed March 28th 2007)

*Environment Protection Act 1993*

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

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*Fisheries Management Act 2007*

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*South Eastern Water Conservation and Drainage Act 1992*

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## Abbreviations

<b>DEH</b>	Department for Environment and Heritage
<b>DEHAA</b>	Department for Environment Heritage and Aboriginal Affairs
<b>DEP</b>	Department for Environment and Planning
<b>DIWA</b>	Directory of Important Wetlands in Australia
<b>DNRE</b>	Department of Natural Resources and Environment
<b>DPC</b>	Department of Premier and Cabinet
<b>DTEI</b>	Department of Transport, Energy and Infrastructure
<b>DWLBC</b>	Department of Water, Land and Biodiversity Conservation
<b>EA</b>	Environment Australia
<b>EPA</b>	Environment Protection Authority
<b>ha</b>	hectare
<b>IUCN</b>	The World Conservation Union
<b>m</b>	metres
<b>NLWRA</b>	National Land and Water Resources Audit
<b>NRM</b>	Natural Resources Management
<b>OID</b>	Office for Infrastructure Development
<b>OLG</b>	Office of Local Government
<b>PIRSA</b>	Primary Industries and Resources, South Australia
<b>SARDI</b>	South Australian Research and Development Institute
<b>SATC</b>	South Australian Tourism Commission
<b>SECWMB</b>	South East Catchment Water Management Board
<b>SEWCDB</b>	South Eastern Water Conservation and Drainage Board
<b>SE NRM</b>	South East Natural Resources Management
<b>UA</b>	University of Adelaide
<b>WCB</b>	Western Coastal Board

# Appendices

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

	Salt Creek (SE)	Blackford Drain	Maria Creek	Robes Lake Drain L	Lake George	Lake Bonney (SE)	Eight Mile Creek	Glenelg River
artic jaeger								•
Australian grebe	•				•			
Australian magpie	•		•		•			•
Australian pelican	•							
Australian raven	•							
Australian shelduck	•							•
Australian wood duck	•							
Australasian bittern								•
Australasian shoveler	•				•	•		•
Australian spotted crake	•		•					
azure kingfisher								•
banded stilt	•	•			•			
bar-tailed godwit								•
beautiful firetail		•		•				•
blackbird	•							•
black-eared cuckoo	•							
black-fronted cuckoo	•							
black-fronted dotterel	•							
black-shouldered kite			•					
black swan	•				•			
black-tailed godwit								•
black-tailed native hen	•		•					
black-winged stilt	•							
blue-billed duck	•				•	•		•
blue-winged parrot					•			•
brown-headed honeyeater	•							
brown thornbill			•					•
brown quail	•		•					
buff-banded rail	•							•
bush bronzewing								•
Cape Barren goose	•							•
caspian tern	•			•	•	•	•	
chestnut teal	•				•			•
common bronzewing	•							
common greenshank	•			•	•		•	•
common sandpiper	•			•				
common starling	•							•
crested tern	•							
crimson rosella								•
curlew sandpiper	•				•	•	•	
darter	•							

table continued

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

	Salt Creek (SE)	Blackford Drain	Maria Creek	Robes Lake Drain L	Lake George	Lake Bonney (SE)	Eight Mile Creek	Glenelg River
double-banded plover	•		•		•			•
dusky moorhen	•				•		•	•
eastern curlew					•			•
eastern reef egret					•			
eastern spinebill					•			•
eastern yellow robin								•
elegant parrot			•					
eurasian coot	•				•			•
fairy tern	•			•	•			•
forest raven								•
freckled duck	•				•	•		•
glossy ibis					•			
golden-headed cisticola								•
great cormorant	•				•			
great crested grebe	•			•	•		•	•
great egret	•			•	•	•	•	•
great knot					•			
greater sand plover					•			
grey currawong	•							
grey fantail								•
grey goshawk								•
grey plover					•			•
grey shrike thrush	•				•			•
grey teal	•				•			
great skua								•
hard head	•							
hoary-headed grebe	•				•			•
hooded plover	•				•			•
house sparrow	•							
intermediate egret				•	•		•	
kelp gull								•
Latham's snipe				•	•	•		
laughing kookaburra								•
lesser sand plover					•			
Lewin's rail	•				•			
little bittern								•
little black cormorant	•				•		•	•
little egret	•							
little grassbird	•							
little pied cormorant	•				•			
little raven	•				•			
little tern								•

table continued

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

	Salt Creek (SE)	Blackford Drain	Maria Creek	Robes Lake Drain L	Lake George	Lake Bonney (SE)	Eight Mile Creek	Glenelg River
long-toed stint					•			
maggie lark			•					
marsh sandpiper	•				•			•
masked lapwing			•		•			
musk duck	•		•	•	•	•	•	•
nankeen night heron								•
New Holland honeyeater	•		•					•
northern giant-petrel								•
olive whistler								•
orange-bellied parrot						•		
orange chat					•			
osprey								•
pacific black duck	•		•		•	•	•	•
pacific golden plover					•			
pacific gull	•				•			
peaceful dove	•							
piebald cormorant	•				•			
piebald currawong								•
piebald oystercatcher	•							•
pink-eared duck	•				•			
purple-gaped honeyeater	•							
red-necked avocet	•				•			
red-capped plover	•		•		•			
red-kneed dotterel	•	•		•				
red knot	•				•			
red-necked avocet					•			
red-necked stint	•			•	•	•	•	
red wattlebird	•				•			•
restless flycatcher	•							
rock dove			•					
royal spoonbill	•				•		•	•
ruddy turnstone	•	•	•		•			
rufous bristlebird	•			•	•	•		•
sacred ibis					•			
sanderling			•					•
sharp-tailed sandpiper	•			•	•	•		
shining bronze-cuckoo				•				•
silveryeye			•		•			•
silver gull	•		•		•			
singing honeyeater	•		•					
sooty oystercatcher								•
southern emu-wren			•					•
spiny-cheeked honeyeater	•		•					

table continued





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

	Salt Creek (SE)	Blackford Drain	Maria Creek	Robes Lake Drain L	Lake George	Lake Bonney (SE)	Eight Mile Creek	Glenelg River
spotted turtledove	●							●
straw-necked ibis	●				●		●	
striated field-wren		●						
superb fairy-wren			●					
welcome swallow	●		●					●
whiskered tern	●				●		●	
white-bellied sea eagle								●
white-eared honeyeater								●
white-faced heron			●		●		●	
white-napped honeyeater								●
wood sandpiper		●						
yellow-billed spoonbill	●				●			
yellow-faced honeyeater								●
yellow-tailed black-cockatoo								●



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

	Salt Creek (SE)	Blackford Drain	Maria Creek	Robe Lakes Drain L	Lake George	Lake Bonney (SE)	Eight Mile Creek	Glenelg River
Australian salmon			●		●			●
Australian smelt								●
black bream			●		●		●	●
common galaxias						●		
congolli	●				●			
eastern Australian salmon			●					
estuary perch								●
flathead					●			
flounder					●			
garfish					●			
greenback flounder					●			
King George whiting					●			
lagoon goby						●		
large-mouth goby								●
leatherjacket					●			
long-nosed flounder								●
mulloway			●		●			●
old wife					●			
pufferfish					●			
rainbow trout					●			
red gurnard					●			
short-finned eel							●	
small-mouthed hardyhead	●	●		●		●		
smooth toadfish								●
southern pygmy perch				●		●		
tommy ruff					●			●
trevally								●
Western Australian salmon*			●					
Yarra pygmy perch						●		
yellow-eyed mullet			●		●		●	●

## Appendix 3. Criteria for determining internationally and nationally important wetlands

### (a) Criteria for determining a Ramsar wetland (revised in 1999)

A wetland should be considered internationally important if (EA 2001):

1. It contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.
2. It supports vulnerable, endangered, or critically endangered species or threatened ecological communities.
3. It supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.
4. It supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.
5. It regularly supports 20,000 or more waterbirds.
6. It regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.
7. It supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity.
8. It is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.
9. It regularly supports 1% of the individuals in a population of one species or subspecies of wetland-dependent non-avian animal species.

### (b) 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

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#### Map Source

Topographic data, NPWSA reserves, rock lobster sanctuary, point source pollution, boat ramps, ports and harbours, coastal shack sites, CASS data, saltmarsh and mangrove mapping, coastal sand dune mapping, recreational fishing sites, 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

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